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FINAL
ENGINEERING EVALUATION/COST ANALYSIS
FOR THE OPERABLE UNIT 2 SOURCE AREAS
STRATFORD ARMY ENGINE PLANT
Stratford, Connecticut

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TABLE OF CONTENTS

Section No.	Title	Page No.
EXECUTIVE SUMMARY		ES-1
1.0 INTRODUCTION		1-1
1.1 PURPOSE AND SCOPE OF THE ENGINEERING EVALUATION/COST ANALYSIS		1-1
1.2 AUTHORITY		1-2
1.3 REPORT ORGANIZATION		1-2
2.0 SITE CHARACTERIZATION		2-1
2.1 SITE DESCRIPTION AND BACKGROUND		2-1
2.1.1 Location		2-1
2.1.2 Facility and Operational History		2-1
2.1.3 Existing Site Conditions		2-2
2.1.4 Site Geology and Hydrogeology		2-3
2.1.5 Surrounding Land Use, Populations, and Sensitive Ecosystems		2-5
2.1.6 Meteorology		2-6
2.2 PREVIOUS REMOVAL ACTIONS		2-7
2.2.1 Plating Facility Interior Decontamination		2-7
2.3 PREVIOUS INVESTIGATIONS		2-8
2.3.1 Preliminary Chromium Plating Facility Investigations		2-8
2.3.2 Pre-Design Investigations		2-8
2.3.3 Operable Unit 2 NCRA Investigations		2-10
2.4 SOURCE, NATURE, AND EXTENT OF CONTAMINATION		2-13
2.4.1 Plating Facility Interior Structures		2-13
2.4.2 Chromium in Soils		2-14
2.4.3 Chromium in Groundwater		2-14
2.4.4 VOCs in Groundwater		2-15
2.4.5 VOCs in Soil Vapor		2-19
2.4.6 VOCs in Indoor Air		2-20
2.5 TREATABILITY TESTING RESULTS		2-21
2.6 PRELIMINARY RISK EVALUATIONS		2-22
3.0 IDENTIFICATION OF REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES		3-1
3.1 STATUTORY LIMITS OF REMOVAL ACTION		3-1
3.2 DETERMINATION OF REMOVAL ACTION SCOPE		3-1
3.3 DETERMINATION OF REMOVAL ACTION SCHEDULE		3-2

TABLE OF CONTENTS
(continued)

Section No.	Title	Page No.
3.4	REMOVAL ACTION OBJECTIVES	3-2
3.4.1	Chromium-Contaminated Structures	3-3
3.4.2	Hexavalent Chromium in Groundwater	3-3
3.4.3	VOCs in Groundwater	3-3
3.5	REMOVAL ACTION GOALS	3-3
3.6	EXTENT OF CONTAMINATION	3-4
3.7	APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS	3-4
3.7.1	Chemical-specific ARARs	3-6
3.7.2	Location-specific ARARs	3-7
3.7.3	Action-specific ARARs	3-7
4.0	IDENTIFICATION AND SCREENING OF POTENTIAL REMOVAL ACTION TECHNOLOGIES	4-1
5.0	IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES	5-1
5.1	ALTERNATIVE CR-S-1 – REMOVAL AND OFF-SITE DISPOSAL OF FLOOR AND WALL/DECONTAMINATION OF BEAMS	5-3
5.1.1	Description of the Alternative	5-3
5.1.2	Effectiveness	5-4
5.1.3	Implementability	5-7
5.1.4	Cost	5-7
5.2	ALTERNATIVE CR-S-2 – REMOVAL AND OFF-SITE DISPOSAL OF WALL/IMPERMEABLE COVER ON FLOOR/DECONTAMINATION OF BEAMS	5-10
5.2.1	Description of the Alternative	5-10
5.2.2	Effectiveness	5-11
5.2.3	Implementability	5-13
5.2.4	Cost	5-14
5.3	ALTERNATIVE CR-GW-1 - IN-SITU REDUCTION USING FERROUS SULFATE	5-16
5.3.1	Description of the Alternative	5-17
5.3.2	Effectiveness	5-20
5.3.3	Implementability	5-23
5.3.4	Cost	5-24
5.4	ALTERNATIVE CR-GW-2 – GROUNDWATER MONITORING	5-27
5.4.1	Description of the Alternative	5-27
5.4.2	Effectiveness	5-28
5.4.3	Implementability	5-30
5.4.4	Cost	5-31

FINAL
ENGINEERING EVALUATION/COST ANALYSIS
FOR THE OU 2 SOURCE AREAS
STRATFORD ARMY ENGINE PLANT

TABLE OF CONTENTS
(continued)

Section No. Title Page No.

5.5 ALTERNATIVE VOC-1 –IN-SITU SVE AND GROUNDWATER MONITORING 5-32
5.5.1 Description of the Alternative 5-32
5.5.2 Effectiveness 5-36
5.5.3 Implementability 5-39
5.5.4 Cost 5-40
5.6 ALTERNATIVE VOC-2 – IN-SITU CHEMICAL OXIDATION USING POTASSIUM PERMANGANATE, IN-SITU AIR SPARGING, IN-SITU SVE, AND GROUNDWATER MONITORING 5-43
5.6.1 Description of the Alternative 5-43
5.6.2 Effectiveness 5-49
5.6.3 Implementability 5-53
5.6.4 Cost 5-55
5.7 ALTERNATIVE VOC-3 – IN-SITU THERMAL TREATMENT, IN-SITU SVE, AND GROUNDWATER MONITORING 5-59
5.7.1 Description of the Alternative 5-60
5.7.2 Effectiveness 5-63
5.7.3 Implementability 5-67
5.7.4 Cost 5-68

6.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES 6-1
6.1 APPROACH TO THE COMPARATIVE ANALYSIS 6-1
6.1.1 Threshold Criteria 6-1
6.1.2 Primary Balancing Criteria 6-1
6.1.3 Modifying Criteria 6-2
6.2 COMPARATIVE ANALYSIS 6-2

7.0 RECOMMENDED REMOVAL ACTION ALTERNATIVES 7-1

7.1 CHROMIUM-CONTAMINATED STRUCTURES 7-1
7.2 HEXAVALENT CHROMIUM IN GROUNDWATER 7-1
7.3 VOCs IN GROUNDWATER 7-1

APPENDICES

APPENDIX A - PLATING FACILITY INTERIOR DECONTAMINATION RISK-BASED CLEANUP GOALS
APPENDIX B - DETAILED COST ESTIMATES
APPENDIX C - ENGINEERING CALCULATIONS
APPENDIX D - SOIL VAPOR EXTRACTION SYSTEM AIR FLOW MODEL

TABLE OF CONTENTS
(continued)

Section No.	Title	Page No.
APPENDIX E -	RESPONSE TO REGULATORY AGENCY COMMENTS	

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

REFERENCES

LIST OF FIGURES

Figure	Title
2-1	Site Location Map
2-2	Site Features
2-3	Chromium Detected in Soil Boring Samples
2-4	Estimated Horizontal Extent of Hexavalent Chromium In Groundwater
2-5	Cross Section CR-A-A' Hexavalent Chromium Groundwater Profile
2-6	Cross Section CR-B-B' Hexavalent Chromium Groundwater Profile
2-7	Estimated Horizontal Extent of Select VOCs Exceeding SWPC in Groundwater
2-8	Cross Section Locations
2-9	Estimated Extent of VOCs in Groundwater Exceeding SWPC Cross-section A-A'
2-10	Estimated Extent of VOCs in Groundwater Exceeding SWPC Cross-section B-B'
2-11	Estimated Extent of VOCs in Groundwater Exceeding SWPC Cross-section C-C'
2-12	Estimated Extent of VOCs in Groundwater Exceeding SWPC Cross-section D-D'
2-13	Estimated Extent of VOCs in Groundwater Exceeding SWPC Cross-section E-E'
2-14	Estimated Extent of VOCs in Groundwater Exceeding SWPC Cross-section F-F'
2-15	Estimated Extent of VOCs in Groundwater Exceeding SWPC Cross-section G-G'
2-16	Chlorinated VOC Hot-spot No. 1 Horizontal Delineation and Cross-section Locations
2-17	Interpretive Vertical Distribution of TCE in Groundwater Chlorinated VOC Hot-spot No. 1 Cross-section VOC1-A/A'
2-18	Interpretive Vertical Distribution of TCE in Groundwater Chlorinated VOC Hot-spot No. 1 Cross-section VOC1-B/B'
2-19	Chlorinated VOC Hot-spots Nos. 2 and 3 Horizontal Delineation and Cross-section Locations
2-20	Interpretive Vertical Distribution of TCE in Groundwater Chlorinated VOC Hot-spot No. 2 Cross-section VOC2-A/A'
2-21	Interpretive Vertical Distribution of TCE in Groundwater Chlorinated VOC Hot-spot No. 2 Cross-section VOC2-B/B'
2-22	Interpretive Vertical Distribution of 1,1,1-TCA in Groundwater Chlorinated VOC Hot-spot No. 3 Cross-section VOC3-A/A'
2-23	Interpretive Vertical Distribution of 1,1,1-TCA in Groundwater Chlorinated VOC Hot-spot No. 3 Cross-section VOC3-B/B'
2-24	Groundwater Sampling Locations Exceeding CTDEP I/C Volatilization Criteria
2-25	Soil Vapor Locations Exceeding CTDEP I/C Volatilization Criteria
5-1	Removal Actions for Chromium Plating Facility Structures
5-2	Alternative CR-GW-1 Proposed Injection and Well Location
5-3	In-situ Reduction Process Flow Diagram
5-4	Alternative CR-GW-2 Proposed Monitoring Well Locations
5-5	Rationale for Selection of SVE System Coverage

LIST OF FIGURES

Figure	Title
5-6	Soil Vapor Extraction Process Flow Diagram
5-7	Soil Vapor Extraction System Plan View
5-8	Proposed VOC Groundwater Monitoring Locations
5-9	In-situ Oxidation Chlorinated VOC Hot-spot No. 1
5-10	In situ Oxidation Chlorinated VOC Hot-spot No. 2
5-11	In situ Oxidation Chlorinated VOC Hot-spot No. 1 Cross Section
5-12	In situ Oxidation Process Flow Diagram
5-13	In situ Oxidation Chlorinated VOC Hot-spot No. 2 Cross Section
5-14	Air Sparging Plan View Hot-spot No. 3
5-15	Air Sparging Cross Section Hot-spot No. 3
5-16	Air Sparging and Vapor Extraction Process Flow Diagram
5-17	Six-Phase Heating Process Flow Diagram
5-18	Six-Phase Heating Layout Chlorinated VOC Hot-spot No. 1
5-19	Six-Phase Heating Layout Chlorinated VOC Hot-spot No. 2
5-20	Six-Phase Heating Layout Chlorinated VOC Hot-spot No. 3
5-21	Six-Phase Heating Chlorinated Hot-spot No. 1 Cross Section
5-22	Six-Phase Heating Chlorinated Hot-spot No. 2 Cross Section
5-23	Six-Phase Heating Chlorinated Hot-spot No. 3 Cross Section
5-24	Dynamic Underground Stripping Well Locations Chlorinated VOC Hot-spot No. 1
5-25	Dynamic Underground Stripping Well Locations Chlorinated VOC Hot-spot No. 2
5-26	Dynamic Underground Stripping Well Locations Chlorinated VOC Hot-spot No. 3
5-27	Dynamic Underground Stripping Process Flow Diagram
5-28	Dynamic Underground Stripping Chlorinated VOC Hot-spot No. 1 Cross Section
5-29	Dynamic Underground Stripping Chlorinated VOC Hot-spot No. 1 Cross Section
5-30	Dynamic Underground Stripping Chlorinated VOC Hot-spot No. 2 Cross Section

LIST OF TABLES

Table	Title
ES-1	Removal Action Goals
2-1	Inorganics in Soil Exceeding CTDEP Criteria
2-2	Inorganics in Groundwater Exceeding CTDEP SWPC
2-3	Selected VOCs in Groundwater Exceeding CTDEP SWPC
2-4	VOCs in Groundwater Exceeding CTDEP I/C Volatilization Criteria
2-5	VOCs in Soil Vapor Exceeding CTDEP I/C Volatilization Criteria
3-1	Removal Action Goals
3-2	Chemical-specific ARARs, Criteria, Advisories, and Guidance
3-3	Location-specific ARARs, Criteria, Advisories, and Guidance
3-4	Potential Action-specific ARARs, Criteria, Advisories, and Guidance
4-1	Description of Potential Groundwater Removal Action Alternatives
4-2	Screening of Potential Groundwater Removal Action Alternatives
5-1	Alternative CR-S-1 Conceptual Cost Estimate
5-2	Alternative CR-S-2 Conceptual Cost Estimate
5-3	Alternative CR-GW-1 - In Situ Reduction Conceptual Cost Estimate
5-4	Alternative CR-GW-2 - Proposed Monitoring Well Rationale
5-5	Alternative CR-GW-2 – Groundwater Monitoring Conceptual Cost Estimate
5-6	Alternative VOC-1 Proposed Monitoring Well Rationale
5-7	Alternative VOC-1 – Groundwater Monitoring/SVE Conceptual Cost Estimate
5-8	Alternative VOC-2 – Groundwater Monitoring/SVE/In-Situ Oxidation/Air Sparging Conceptual Cost Estimate
5-9	AlternativeVOC-3A – Groundwater Monitoring/SVE/Six-Phase Heating Conceptual Cost Estimate
5-10	Alternative VOC-3B – Groundwater Monitoring/SVE/Dynamic Underground Stripping Conceptual Cost Estimate
6-1	Comparative Analysis of Former Chromium Plating Facility Structures Alternatives
6-2	Comparative Analysis of Hexavalent Chromium Groundwater Alternatives
6-3	Comparative Analysis of VOC Groundwater Alternatives

EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) was prepared as part of a Non-time-Critical Removal Action (NCRA) for contaminant source areas in Operable Unit (OU) 2, the groundwater OU at the Stratford Army Engine Plant (SAEP), located in Stratford, Connecticut. The OU 2 NCRA addresses hexavalent chromium-contaminated structures inside the former Chromium Plating Facility, four areas of relatively high groundwater contaminant concentrations that are believed to be source areas for general groundwater contamination at the site, and indoor air contamination by volatile organic compounds (VOCs). The proposed NCRA is not expected to be the final remedy for OU 2. General groundwater contamination will be addressed in the Remedial Investigation (RI) Report and Feasibility Study (FS) Report for the SAEP facility. Results of the proposed NCRA, including post-removal monitoring data, will be incorporated into the FS and considered during design of the final remedy for the site.

The purpose of the EE/CA is to identify removal action objectives, develop and evaluate removal action alternatives that will achieve those objectives, and recommend, based on the evaluation, the alternative that best meets the evaluation criteria. This document was prepared in accordance with the United States Environmental Protection Agency (USEPA) guidance for preparing EE/CAs (USEPA, 1993b) and is intended to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1990).

The SAEP property is zoned light commercial and the site has been used for development, manufacture, and assembly of aircraft or engines since 1929. In October 1995, SAEP was placed on the Base Closure and Realignment (BRAC) list, known as BRAC 95. Pursuant to the Defense Base Closure and Realignment Act of 1990, the BRAC Environmental Restoration Program mandates that environmental contamination on BRAC properties be investigated and remediated, as necessary, prior to disposal and reuse. In August 1998, SAEP was transitioned from an active production facility to caretaker status.

SAEP consists of approximately 124 acres, of which approximately 76 acres are improved land and 48 acres are tidal flats/wetlands adjacent to the Housatonic River. The 76 acres of improved land consists of 49 buildings, paved roadways and grounds, and five paved parking lots. Also included in the improved land are an estimated 10 acres along the Housatonic River where fill was placed over tidal flats during the development of SAEP. An estimated two acres of property comprise a causeway constructed in the 1930s to provide access to the river channel.

The conceptual geologic model for the SAEP site (from ground surface to bedrock) defines a 2- to 15-foot thick fill layer underlain by an estuarine silt, a reworked glacial outwash, glacial outwash, and finally, black schist and greenstone bedrock. Groundwater at the site ranges from approximately 4 to 11 feet below ground surface (bgs) depending on surface elevation and tidal influence. Overall groundwater flows toward the

Housatonic River and the estimated flow velocities in the soils range from 0.002 feet per day beneath Building B-2, to 0.3 feet per day toward the Dike (Foster Wheeler Environmental Corporation/Harding Lawson Associates [Foster Wheeler/HLA], 2000a).

Previous activities at the site have included a decontamination of the former Chromium Plating Facility, preliminary investigations around the former Chromium Plating Facility, hexavalent chromium and VOC pre-design investigations, OU 2 NCRA investigations, and indoor air sampling. Based on these investigation activities, the following description of the source, nature, and extent of contamination was developed.

Hexavalent Chromium-Contaminated Structures. Wipe sampling completed following decontamination of the former Chromium Plating Facility in December 1998, identified concentrations of hexavalent chromium on the facility floor, walls, and overhead beams in excess of HLA developed risk-based cleanup standards. Significant concentrations of hexavalent chromium were visually identified throughout the entire thickness of the concrete floor in the northwestern corner of the facility.

Hexavalent Chromium-Contaminated Soil and Groundwater. Subsurface soil and groundwater analytical data were collected during field investigations completed from January 1999 to April 1999 (Foster Wheeler/HLA, 2000a). Soil data were compared to the Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulation (RSR) Pollutant Mobility Criteria (PMC) for total chromium by the Synthetic Precipitate Leaching Procedure (SPLP), and the Direct Exposure Criteria (DEC). Groundwater results were compared to CTDEP RSR Surface Water Protection Criteria (SWPC). Groundwater Protection Criteria are not established for GB classified areas, which is the classification of SAEP groundwater.

The comparison of soil data to the CTDEP RSR criteria identified two locations of subsurface soil exceeding the CTDEP RSR DEC for hexavalent chromium (SP-99-11 and SP-99-14).There are also numerous exceedances of the CTDEP RSR PMC for total chromium beneath the footprint of the facility. However, because infiltration of precipitation in the area of the exceedances is not likely, due to the concrete floor and the facility ceiling, chromium-contaminated soils are not considered during development of removal action objectives and alternatives.

An area of groundwater located near the northwestern-most corner of the former Chromium Plating Facility, and covering approximately 40,000 square feet, contains hexavalent chromium in excess of the CTDEP RSR SWPC (0.11 milligrams per liter [mg/L]). A second area of hexavalent chromium-contaminated groundwater at concentrations in excess of the CTDEP RSR SWPC is located beneath the south central portion of the former Chromium Plating Facility, and covers an area of approximately 10,400 square feet.

Volatile Organic Compound (VOC)-Contaminated Groundwater. Groundwater analytical data were collected during field investigations completed from January 1999 to

June 1999. Additional data were collected during aquifer testing, bench-scale treatability testing, and pilot-scale treatability testing. Groundwater VOC concentrations were compared to the CTDEP RSR SWPC for class GB groundwater and Industrial/Commercial Volatilization Criteria (I/C VC). Additionally, soil gas concentrations were compared to the CTDEP RSR Soil Vapor I/C VC and indoor air concentrations were compared to CTDEP RSR Industrial/Commercial Indoor Air Target Concentrations (I/C IATC).

Three groundwater VOC source areas were identified during evaluation of the VOC groundwater data. These source areas are summarized below.

Chlorinated VOC Hot-spot No. 1. VOC Hot-spot No. 1 is located beneath the former Chromium Plating Facility in Building B-2. TCE was detected in groundwater at a maximum concentration of 830,000 micrograms per liter (µg/L) immediately above the surface of the aquitard identified during investigations (approximately –20 feet mean sea level [MSL]). The estimated horizontal extent of TCE in groundwater at concentrations exceeding 100,000 µg/L covers the majority of the footprint of the former Chromium Plating Facility. The source of the TCE is suspected to be from degreasing operations completed as part of facility operations. Visual observation of subsurface soil and groundwater samples, and shake tests using Sudan IV dye, did not reveal the presence of TCE non-aqueous phase liquid (NAPL).

Tetrachloroethylene (PCE) and 1,1-dichloroethylene (1,1-DCE) concentrations also exceeded SWPC in the vicinity of VOC Hot-spot No. 1. VOC concentrations in groundwater also exceeded the I/C VC in the vicinity of VOC Hot-spot No. 1

Chlorinated VOC Hot-spot No. 2. VOC Hot-spot No. 2 is located between Buildings B-48 and B-16. The primary VOC detected at high concentrations in this area is TCE. TCE was detected at a maximum concentration of 264,000 µg/L within the sandy silt zone (approximately –8 feet MSL). The horizontal extent of TCE in groundwater exceeding 100,000 µg/L is estimated to cover an area roughly 75 feet in diameter; however, it is possible the area of TCE concentrations greater than 100,000 µg/L may extend under Building B-16. The source of the TCE is suspected to be from disposal on the ground surface, and/or degreasing operations completed in Building B-16. Visual observation of subsurface soil and groundwater samples did not reveal the presence of TCE NAPL.

PCE and 1,1-DCE concentrations also exceeded SWPC in the vicinity of VOC Hot-spot No. 2. VOC concentrations in groundwater also exceeded the I/C VC in the vicinity of VOC Hot-spot No. 2.

Chlorinated VOC Hot-spot No. 3. VOC Hot-spot No. 3 is located in the center of Building B-2. The primary VOC detected in this area is 1,1,1-trichloroethane (1,1,1-TCA). The maximum concentration of 1,1,1-TCA detected in VOC Hot-spot No. 3 was 280,000 µg/L at a depth of approximately –24 feet MSL. Concentrations of 1,1,1-TCA from deeper samples in this area indicate that 1,1,1-TCA has migrated to the bedrock surface (approximately -152 feet MSL). The estimated horizontal extent of 1,1,1-TCA in groundwater at concentrations exceeding 100,000 μg/L covers an area of roughly 35,000 square feet; however, it is possible this area of contamination is actually two distinct areas, centered around explorations CT-99-08 and WP-99-48, respectively. The estimated source of the 1,1,1-TCA is suspected to be from degreasing operations formerly conducted in this portion of Building B-2. Visual observation of subsurface soil and groundwater samples did not reveal the presence of 1,1,1-TCA NAPL.

TCE and 1,1-DCE concentrations also exceeded SWPC in the vicinity of VOC Hot-spot No. 3. VOC concentrations in groundwater also exceeded the I/C VC in the vicinity of VOC Hot-spot No. 3.

VOC-Contaminated Soil Vapor and Indoor Air. Analytical results from the soil vapor survey indicate that soil vapor in the SAEP subsurface exceeds I/C VC for vinyl chloride, 1,1-DCE, and TCE. VOC soil vapor concentrations beneath the central portion of Building B-2, extending northeast and east toward Buildings B-15 and B-16, respectively, generally exceed CTDEP I/C VC. However, not all of the explorations in this region indicate exceedance of the criteria. In general, the distribution of soil vapor exceedances is co-located with groundwater contamination by the same chlorinated VOCs.

Analytical results of indoor air quality sampling indicate concentrations of 1,1-DCE and vinyl chloride exceed CTDEP Industrial/Commercial I/C IATC in a number of sample locations in Buildings B-1, B-2, B-9, B-12, B-48, and B-65. Contaminants detected in indoor air samples are also found in soil vapor samples and groundwater.

Removal Action Justification. Removal actions for Chromium Plating Facility structures are being considered in this EE/CA as a result of risks calculated from exposure to concentrations of hexavalent chromium still present on structures following facility decontamination. Removal actions for groundwater source areas are being considered to significantly reduce hot-spot concentrations and promote natural attenuation processes in groundwater outside hot-spots. In addition, reduction of high concentrations of hexavalent chromium and VOCs will reduce the overall toxicity of the groundwater, and should have a positive impact on indoor air quality.

Removal Action Objectives and Goals. Removal action objectives have been developed for contaminated media at SAEP, including former Chromium Plating Facility structures, hexavalent chromium-contaminated groundwater, and VOC-contaminated groundwater. Removal action objectives have been developed considering the proposed future use of the facility, the existing contamination distributions, CTDEP RSR criteria, and risk-based cleanup goals.

The following removal action objective has been developed to address existing hexavalent chromium contamination on facility structures:

- Protect potential receptors from exposure to high concentrations of hexavalent chromium on former Chromium Plating Facility structures.

The following removal action objective has been developed for hexavalent chromium-contaminated groundwater:

- Prevent high concentrations of hexavalent chromium from potentially migrating to surface water and impacting receptors.

The following removal action objectives have been established for VOC-contaminated groundwater:

- Prevent the migration of VOC-contaminated vapors from groundwater hot-spots to the interior of on-site buildings.
- Prevent high concentrations of VOCs in shallow groundwater from potentially migrating to surface water and impacting receptors.

Numerical removal action goals have been developed to conduct a complete evaluation of the proposed alternatives. Table ES-1 presents the proposed removal action goals. In addition, the extent of groundwater contamination to be addressed by the removal actions has been defined based on an evaluation of the contamination extent presented in the OU 2 Pre-design Investigation Report (Foster Wheeler/HLA, 2000a). Concentration limits of greater than (>) 100,000 µg/L for TCE; > 5,000 µg/L for 1,1-DCE; and > 100,000 µg/L for 1,1,1-TCA have been used to define groundwater hot-spots for this EE/CA. The rationale for selection of these concentrations is based on the estimated potential of contamination to significantly contribute to ongoing groundwater and indoor air contamination. The deep groundwater contamination (i.e., >60 feet) at VOC Hot-spot No. 3 is not anticipated to adversely affect indoor air quality and therefore, is not addressed in the EE/CA. This deep groundwater contamination will be addressed in the FS for the SAEP facility.

Removal Action Alternatives. To attain the removal action objectives listed, different categories of potential groundwater hot-spot removal action technologies have been identified. Following identification of the technologies, screening of the technologies with respect to site- and waste-limiting characteristics is performed. The resulting list of retained technologies is then used to develop potential removal action alternatives for groundwater hot-spots.

The removal action alternatives developed for evaluation in this EE/CA include:

<u>Chromium Hot-spot Area – Former Chromium Plating Facility Structures:</u>

Alternative CR-S-1	Removal and Off-site Disposal of Floor and Wall; Decontamination of Beams
Alternative CR-S-2	Removal and Off-site Disposal of Wall; Impermeable Cover on Floor; Decontamination of Beams

Chromium Hot-spot Area - Groundwater:
Alternative CR-GW-1 In-situ Reduction using Ferrous Sulfate
Alternative CR-GW-2 Groundwater Monitoring

VOC Hot-spot Areas 1, 2, and 3 - Groundwater:

Alternative VOC-1	In-situ Soil Vapor Extraction (SVE) and Groundwater Monitoring
Alternative VOC-2	In-situ Chemical Oxidation using Potassium Permanganate, In-situ Air Sparging, In-situ SVE, and Groundwater Monitoring
Alternative VOC-3	In-situ Thermal Treatment, In-situ SVE, and Groundwater Monitoring

Former Chromium Plating Facility Structures. The two alternatives developed for addressing hexavalent chromium contaminated structures contain similar activities designed to reduce or eliminate risk. Both alternatives propose removal of the northwestern wall in the former Chromium Plating Facility, decontamination of overhead beams in the northwestern portion of the facility, and implementation of an Environmental Land Use Restriction (ELUR) that will restrict floor penetration and subsurface exploration in the former Chromium Plating Facility. Alternative CR-S-1 proposes removal of the existing concrete floor, placement of an impermeable vapor barrier, and pouring of a new floor; while Alternative CR-S-2 proposes placement of a vapor barrier and pouring of a new floor over the existing floor. The estimated two-year removal action cost for Alternative CR-S-1 is $601,000, and the estimated net present worth (NPW) cost for post-removal operation and maintenance (O&M) is $40,000. The estimated two year removal action cost for Alternative CR-S-2 is $522,000, and the estimated NPW cost for post-removal O&M is $40,000.

Hexavalent Chromium-Contaminated Groundwater. Alternative CR-GW-1 proposes the injection of a ferrous sulfate solution on the perimeter of hexavalent chromium groundwater contamination and collection and extraction of groundwater in the central portion of the plume. Ferrous sulfate solution would also be infiltrated from the surface to address hexavalent chromium contamination at the groundwater table. Ferrous sulfate reduces hexavalent chromium contamination to the less toxic trivalent form, which is then sorbed to subsurface soil and immobilized. Extracted groundwater would be discharged to the Chemical Waste Treatment Plant (CWTP) where it would receive treatment for VOCs and inorganic contaminants. The estimated two-year removal action cost for this alternative is $3,128,000, and the NPW cost for post-removal O&M is $310,000.

Alternative CR-GW-2 proposes the installation of groundwater monitoring wells within and surrounding the hexavalent chromium groundwater plume. Newly installed and existing monitoring wells would be sampled and analytical results would be used to support future remedial actions for site groundwater. Implementation of an ELUR would prevent the use of groundwater in the vicinity of the former Chromium Plating Facility for any purpose. The estimated two-year removal action cost for this alternative is $396,000, and the NPW cost for post-removal O&M is $457,000.

VOC-Contaminated Groundwater. Alternative VOC-1 proposes the installation of an in-situ soil vapor extraction (SVE) system, approximately 20 acres in size, to collect subsurface vapors and prevent the migration of VOC-contaminated vapors to on-site buildings in areas of VOC-contaminated groundwater. In addition, newly installed and existing monitoring wells would be sampled under the groundwater monitoring program and analytical results would be used to support future remedial actions for site groundwater. Implementation of an ELUR would prevent the use of SAEP groundwater for any purpose. The estimated two-year removal action cost for this alternative is $4,250,000, and the NPW cost post-removal O&M is $3,419,000.

Alternative VOC-2 proposes active treatment of VOC Hot-spot Nos. 1 and 2 with in-situ chemical oxidation and active treatment of VOC Hot-spot No. 3 with air sparging. A 20-acre SVE system, a groundwater monitoring program, and an ELUR would also be implemented under this alternative. In-situ chemical oxidation involves the injection of a potassium permanganate solution on the perimeter of VOC hot-spots and collection and extraction of groundwater in the central portion of the plumes. Potassium permanganate transforms chlorinated ethenes (e.g., TCE and 1,1-DCE) to less toxic byproducts. Extracted groundwater would be discharged to the CWTP where it would receive treatment for VOCs and inorganic contaminants. In-situ air sparging involves the injection of air into the subsurface using injection wells and the collection of generated vapors using an SVE system in the vadose zone. Surface treatment of collected vapors would be performed to remove VOCs from the vapor stream. The estimated two-year removal action cost for this alternative is $14,163,000, and the NPW cost for post-removal O&M is $5,353,000.

Alternative VOC-3 proposes active treatment of the three VOC hot-spots using in-situ thermal processes and the implementation of a 20-acre SVE system, groundwater monitoring, and an ELUR. Two types of in-situ thermal treatment have been evaluated under this alternative, Six-phase Heating (SPH) and Dynamic Underground Stripping (DUS). The SPH technology involves electrical heating of the subsurface (soil and groundwater) using vertical thermal points. Heating is conducted until contaminants and groundwater boil in the subsurface. Generated vapors are collected by an SVE system in the vadose zone and treated on the surface. DUS uses injected steam to heat the subsurface (soil and groundwater). Contamination is vaporized and collected by an SVE system for surface treatment. A separate cost estimate has been completed for each thermal treatment technology. The estimated two-year removal action cost to complete SPH at all three VOC hot-spots is $18,856,000, and the NPW cost for post-removal O&M is $956,000. The estimated two-year removal action cost to complete DUS at each hot-spot is $15,326,000, and the NPW cost is $1,492,000.

A detailed evaluation of each of the alternatives is conducted using the effectiveness, implementability, and cost criteria set forth in the NCP and USEPA guidance (USEPA, 1993b). Specific criteria include:

- Overall Protection of Human Health and the Environment

- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
- Long-term Effectiveness
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-term Effectiveness
- Technical Feasibility
- Administrative Feasibility
- Availability of Services and Materials
- State and Community Acceptance

Following completion of the detailed evaluations, a comparative analysis of the alternatives is conducted. The alternatives developed for each media (i.e., structures, hexavalent chromium groundwater, and VOC groundwater) are compared against one another to facilitate future selection of recommended removal action alternatives. The recommended removal action alternatives are presented in the final section of this report. The rationale for selection of the preferred alternatives is also presented.

1.0 INTRODUCTION

Foster Wheeler Environmental Corporation (Foster Wheeler) and Harding Lawson Associates (HLA) have been contracted through the United States Army Corps of Engineers – New England District (USACE) to complete a Non-time-Critical Removal Action (NCRA) for source areas in Operable Unit (OU) 2, the groundwater OU at the Stratford Army Engine Plant (SAEP). The NCRA is being completed under Task Order No. 020 of The New England Total Environmental Restoration Contract (TERC) (Contract No. DACW33-94-D-0002) in order to address hexavalent chromium-contaminated structures inside the former Chromium Plating Facility, four areas of high groundwater contamination that are believed to be source areas for general groundwater contamination, and indoor air contamination at the site. The proposed NCRA is not expected to be the final remedy for OU 2. General groundwater contamination will be addressed in the Remedial Investigation (RI) Report and Feasibility Study (FS) Report for the SAEP facility. Results of the proposed NCRA, including post-removal monitoring data, will be incorporated into the FS and considered during design of the final remedy for the site.

The objectives of this Task Order are to: (1) complete additional field activities necessary to characterize physical and chemical conditions in OU 2, (2) summarize the results of field activities in a Pre-Design Investigation Report (Foster Wheeler/HLA, 2000a), and (3) document the decision process for selection of a removal action for groundwater contamination source areas in an Engineering Evaluation/Cost Analysis (EE/CA) and a Removal Action Memorandum (RAM). The first two objectives of this Task Order have been completed. This EE/CA presents a description and evaluation of possible removal action alternatives, followed by a recommendation of the preferred removal action alternatives.

1.1 PURPOSE AND SCOPE OF THE ENGINEERING EVALUATION/COST ANALYSIS

The purpose of the EE/CA is to identify removal action objectives, and develop and evaluate removal action alternatives that will achieve these objectives. The development and evaluation process for removal action alternatives consists of five steps: (1) identification of removal action objectives; (2) screening of potential removal action technologies; (3) identification of removal action alternatives; (4) evaluation of removal action alternatives against specified criteria; and (5) selection of the proposed remedy. The EE/CA serves as the basis for the RAM, the primary decision document substantiating the need for a removal response, and for design and implementation of the removal action.

This EE/CA has been prepared for contaminated structures within the former Chromium Plating Facility and four groundwater contamination source areas in OU 2, the groundwater operable unit at the SAEP. General groundwater contamination will be addressed in the RI and FS Reports for the SAEP facility. This EE/CA was developed primarily from the information presented in the Pre-Design Investigation Report for OU 2 (Foster Wheeler/HLA, 2000).

Removal actions for Chromium Plating Facility structures are being developed in this EE/CA to eliminate the risk associated with exposure to hexavalent chromium remaining on structures following facility decontamination. Removal actions for groundwater source areas are being considered to significantly reduce hot-spot concentrations, and promote natural attenuation processes in groundwater outside hot-spots. In addition, reduction of high concentrations of hexavalent chromium and volatile organic compounds (VOCs) will reduce the overall toxicity of the groundwater, and should have a positive impact on indoor air quality.

Development of removal actions is being conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (United States Environmental Protection Agency [USEPA], 1990), and the USEPA "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (USEPA, 1993b).

1.2 AUTHORITY

For BRAC 95 facilities, the Environmental Restoration Program begins with an Environmental Baseline Survey (EBS) to describe the environmental condition of the property. ABB Environmental Services (subsequently HLA) published the Final EBS in December 1996. The RI is currently being completed by URS Greiner-Woodward Clyde Federal Services (URSGWCFS), under a contract to the USACE Omaha District, to characterize the type and extent of contamination at SAEP and evaluate associated potential risks to human health and the environment.

In June 1998, chromium contamination was identified in subsurface soil beneath the concrete floor of the former Chromium Plating Facility in Building B-2. SAEP contracted HLA, through a subcontract to AlliedSignal, to perform additional site characterization to develop a removal action recommendation for the site. HLA's sampling indicated concentrations of hexavalent chromium in soil and groundwater beneath the former Chromium Plating Facility that exceeded Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulation (RSR) criteria. HLA's sampling also identified high concentrations of chromium in dust samples within the building. Based on the concentrations of total chromium in the dust samples, a Time-critical Removal Action Memorandum (HLA, 1998) was written, proposing decontamination of the former Chromium Plating Facility and further investigation of site soil and groundwater followed by in-situ hexavalent chromium reduction of soil.

The facility decontamination was completed in December 1998. Decontamination procedures included sweeping, the removal of debris and dust from the concrete floor, and pressurized steam washing of the ceiling, overhead beams, walls, and floor. Wipe sampling completed following the decontamination procedures indicated that relatively high concentrations of hexavalent chromium were still present in the concrete floor and in limited areas on overhead beams and walls (Foster Wheeler/HLA, 2000a).

Further soil and groundwater investigations revealed concentrations of hexavalent chromium in groundwater at nearly 100 times previously detected levels (concentrations of up to 950 milligrams per liter [mg/L]), and in an area much larger than expected (Foster Wheeler/HLA, 2000a). In addition, high concentrations of VOCs were detected during the groundwater chromium investigations (concentrations above 500 mg/L). Investigations completed by HLA through May 1999 indicated significant concentrations of VOCs in groundwater in several areas around SAEP facility. As a result of these investigations, a NCRA was recommended by the U.S. Army for OU 2 hexavalent chromium and VOC groundwater hot-spots at SAEP.

The OU 2 Pre-design Investigation Report (Foster Wheeler/HLA, 2000a) contains a detailed description of activities and investigations conducted under the Time-critical Removal Action and the NCRA.

1.3 Report Organization

Section 1.0 of this document introduced the purpose and scope of the EE/CA. Section 2.0 presents the site characteristics, including the site location and history, existing site conditions, geology and hydrogeology, and a contamination assessment.

Section 3.0 discusses the scope, goals, and objectives of the removal action. The Applicable or Relevant and Appropriate Requirements (ARARs) that will govern the removal action are also included in Section 3.0.

Section 4.0 provides a brief screening of potential removal action technologies and Section 5.0 presents and describes the removal action alternatives developed from retained technologies. Section 5.0 also evaluates the alternatives based on the criteria of effectiveness, implementability, and cost. Section 6.0 provides a comparison of the alternatives relative to the evaluation criteria, and identifies the advantages and disadvantages relative to one another. Section 7.0 presents the recommended removal action alternatives for former Chromium Plating Facility structures, hexavalent chromium-contaminated groundwater, and VOC-contaminated groundwater.

2.0 SITE CHARACTERIZATION

This section provides a summary of site characteristics including the site location and history, existing site conditions, geology and hydrogeology, and a contamination assessment.

2.1 Site Description and Background

This subsection includes a description and history of the SAEP site.

2.1.1 Location

SAEP is located in Stratford, Connecticut, on the Stratford Point peninsula in the southeast corner of Fairfield County (Figure 2-1). The site lies on the borderline of the Bridgeport and Milford United States Geological Survey Quadrangles. Latitudinal and longitudinal coordinates of SAEP are approximately 41° 10' North and 73° 07' West. The site is bounded on the east by the Housatonic River, on the south and north by paved parking and open areas, and on the west by Main Street and the Sikorsky Memorial Airport.

2.1.2 Facility and Operational History

The SAEP property is zoned light commercial and the site has been used for development, manufacture, and assembly of aircraft or engines since 1929. The plant history has been categorized into the following periods:

1929 to 1939: Sikorsky Aero Engineering Corporation developed and manufactured sea planes at the Stratford plant.

1939 to 1948: Chance Vought Aircraft located its operations at the Stratford plant in 1939, and the company became known as Vought-Sikorsky Aircraft Division. Sikorsky developed the helicopter and left the plant in 1943 because of overcrowding. Chance Vought developed the 'Corsair' for the U.S. Navy, and mass-produced Corsairs during World War II. Chance Vought vacated the Stratford Plant in 1948.

1948 to 1951: The Stratford plant was idle.

1951 to 1976: The U.S. Air Force procured the Stratford plant in 1951 and named it Air Force Plant No. 43. The Avco Corporation (AVCO) was contracted by the U.S. Air Force to operate the plant. AVCO manufactured radial engines for aircraft in the 1950s, and developed and manufactured turbine engines, primarily for aircraft, in the 1960s and 1970s.

1976 to 1997: The plant was transferred from the U.S. Air Force to the U.S. Army in 1976. At that time the plant was renamed the Stratford Army Engine Plant, although it continued under AVCO operations. AVCO was contracted by the U.S. Army to develop the AGT-1500 engine to power the Abrams tank and develop and manufacture industrial engines. AVCO merged with Textron in December 1985, and subsequently formed the Textron Lycoming Stratford Division. The contract for operation of SAEP was transferred from Textron Lycoming to AlliedSignal in 1994. AlliedSignal continued to develop, manufacture, and test turbine engines at the SAEP for both military and commercial aircraft and land vehicles until 1997.

1995: Responsibility for the jurisdiction, control, and accountability of SAEP was transferred from the U.S. Army Aviation and Troop command to the U.S. Army Tank-Automotive and Armament Command (TACOM) in September 1995. In October 1995, SAEP was placed on the Base Closure and Realignment (BRAC) list, known as BRAC 95. Pursuant to the Defense Base Closure and Realignment Act of 1990, the BRAC Environmental Restoration Program mandates that environmental contamination on BRAC properties be investigated and remediated, as necessary, prior to disposal and reuse.

1997 to Present: Since the cessation of AlliedSignal operations, the focus of activities at SAEP has been completion of an environmental assessment of the site and assessment of potential for re-development. In August 1998, SAEP was transitioned from an active production facility to caretaker status.

2.1.3 Existing Site Conditions

SAEP facility. SAEP consists of approximately 124 acres, of which approximately 76 acres are improved land and 48 acres are tidal flats/wetlands along the Housatonic River. A riparian right is a right of access to, or use of, the shore, bed, or water of land on the bank of a natural watercourse. The 76 acres of improved land consist of 49 buildings, paved roadway and grounds, and five paved parking lots. Included in the improved land are an estimated 10 acres along the Housatonic River where fill was placed over tidal flats during the development of SAEP. An estimated two acres of property comprise a causeway constructed in the 1930s to provide access to the river channel.

Future land use. Future land use at the site has been the subject of study by the SAEP Local Redevelopment Authority (LRA). As reported in the "SAEP Redevelopment Plan and Implementation Strategy and Homeless Assistance Submission", the preferred land use plan developed by the LRA includes the development of approximately 800,000 square feet of building space for office, research and development, and "flex space". In addition, approximately 100,000 square feet of museum space and approximately 16 acres of parkland along the Housatonic River waterfront are proposed (RKG Associates, Inc. [RKG], 1997). The proposed parkland (i.e., recreational area) would include a landscaped park with pathways for pedestrians and bicyclists, public water access from a new dock located at the end of the former seaplane boat ramp at the end of the Causeway, and an off-street parking area.

Topography. SAEP is located in the Western Highlands of Connecticut, part of the New England Physiographic Province. The local area is part of a coastal belt of dissected hilly country that extends along the coast of Connecticut. The coastal belt is characterized by uplands that range from mean sea level (MSL) to 650 feet above MSL, with an irregular, rocky coastline. Within the coastal belt, hilltops slope southward at a rate of about 50 feet per mile. Topographic features in the area mostly trend in the north-south or northeast-southwest direction, reflecting the structural trends of the local bedrock (Flint, 1968).

SAEP is situated on the Stratford Point peninsula that extends into Long Island Sound. The peninsula is relatively flat, with a slight slope toward the sound. Almost all the land at SAEP is less than 10 feet above MSL. The exception to this is a dike that was constructed along the Housatonic River in 1951 for flood protection. SAEP is within the 100-year floodplain.

Surface water. Surface water bodies in the site vicinity include Long Island Sound, the Housatonic River, Frash Pond, and the Marine Basin and drainage channel. Long Island Sound receives all of the region's drainage, in large part via the Housatonic River. According to the CTDEP, the following are reported tidal levels for the Housatonic River at Stratford, based on the National Geodetic Vertical Datum (NGVD).

Mean low tide level	-2.7 feet NGVD
Mean high tide level	4.1 feet NGVD
High tide level	7 feet NGVD

Most of the SAEP surface is paved or covered with buildings; therefore, runoff during storm events is heavy. Most of the precipitation that falls on SAEP is collected by one of a network of six storm drainage systems, treated, and drained to the Housatonic River. Each of the storm drain systems is equipped with a pumping station because of the low elevation of the site and proximity of the Housatonic River and Long Island Sound. Effluent from the storm drainage system is pumped through the Oil Abatement Treatment Plant, except in times of heavy precipitation, when some runoff is pumped directly to the Housatonic through individual outfalls.

2.1.4 Site Geology and Hydrogeology

This subsection summarizes the site geology and hydrogeology for the area of SAEP north of Sniffens Lane and east of South Main Street (Figure 2-2). Sources of data for interpretation of subsurface conditions presented here include the Phase II RI Report (Woodward-Clyde Consultants [W-C], 1996), boring logs and observations from 1999 RI investigations, and 1998 through 1999 HLA and Foster Wheeler/HLA investigations.

Site Geology. A conceptual geologic model has been developed, with stratigraphy descriptions on a macroscopic scale. These descriptions are typically accurate with minor variations in the stratigraphy seen throughout SAEP. The following paragraphs present the conceptual geologic model (from ground surface to bedrock):

Fill: SAEP is mantled with sand, gravel, and debris fill associated with buildings, roads, utilities, site grading, and other structures. The fill is generally about 2 to 5 feet thick, but locally extends approximately 10 to 15 feet below the ground surface (bgs) near the dike. The fill is thicker near the Dike due to the emplacement of fill over existing intertidal sediments to extend the shoreline of the facility in the 1940s.

Estuarine Silt: Typically, the silt deposits encountered in subsurface samples are characterized as fine silts with very fine sands, rich in organics, and having a sulfur dioxide smell consistent with tidal mud-flat deposits. Thickness of the silt deposits varies from as much as 30 feet to nonexistent in the direction from the Dike toward the interior of the facility. Silt deposits exist beneath the fill from the length of the Dike southwest toward the former Chromium Plating Facility (see Figure 2-2). This aerial extent is consistent with the area of former intertidal flats, which were filled in the 1940s to extend the shoreline of the SAEP property further north and eastward toward the Housatonic River.

Reworked Glacial Outwash: Sand and gravel deposits of glacial origin underlie the fill and silt deposits. The deposits are divided into units of sand, with trace amounts of coarser material of sand and gravel with clay, silt, and cobbles. The working hypothesis for this unit is that glacial deposits have been reworked and sorted by the actions of the meandering Housatonic River. The reworked glacial outwash is thickest beneath the southwestern part of the site (along Main Street), and thins toward the Housatonic River. Note that the distinguishing feature of these deposits on the referenced cross-sections is the trace gravel, and loosely cemented gravel zones. The bottom depth of these deposits varies between approximately 20 and 40 feet bgs.

Glacial Outwash: Beneath the reworked glacial outwash, and above the bedrock surface, lies a fine to medium sand with some silt, interpreted to be glacial outwash. The glacial outwash contains silt/clay seams and fine silty sand lenses. The glacial outwash is generally stratified, and exhibits a fining-down sequence, which has a micaceous component. Micaceous zones are observed in the northwestern area of the site; these zones are mostly below 60 feet bgs.

Bedrock: Bedrock beneath SAEP has been identified as a black schist with greenstone. Results of the seismic refraction survey, coupled with soil boring information, indicate bedrock depths range from about 49 feet to 184 feet bgs beneath SAEP. These depths translate to elevations of approximately –50 to –175 feet MSL. It is apparent from seismic survey results that the bedrock surface elevation is highly variable over localized areas. Bedrock is deepest to the northwest, and shallowest to the southeast along Sniffens Lane. Site-wide, results show that the bedrock surface has a general dip direction to the northwest, with the shallowest depths to bedrock being located along Sniffens Lane and the South Parking Lot area.

Site Hydrogeology. The following summarizes the hydrogeology for the area of SAEP north of Sniffens Lane and east of South Main Street:

- The depth to water in this area of the facility ranges from approximately 4 to 11 feet bgs, depending upon the surface elevation and tidal influence.
- The estimated hydraulic conductivities of the geologic materials are as follows: fill $2.0x10^{-2}$ to 0.1 feet per minute (ft/min); silt $3.0x10^{-4}$ to $9.0x10^{-4}$ ft/min; reworked glacial outwash $6.0x10^{-5}$ to $2.0x10^{-2}$ ft/min.; and glacial out wash $1.0x10^{-4}$ to $3.0x10^{-2}$ ft/min.
- Horizontal hydraulic gradients range from 0.0001 feet/foot beneath Building B-2 to 0.002 feet/foot to the east of Building B-16.
- Vertical hydraulic gradients indicate a downward (recharging) potential to the south and west of Main Street; flattening gradients toward the central portion of the facility; and upward (discharging) potential in the vicinity of the Dike near the Housatonic River.
- Overall groundwater flow direction is from west to east/northeast, toward the Housatonic River.
- Groundwater flow velocities in the glacial outwash are estimated to be on the order of 0.002 feet per day beneath Building B-2 and 0.3 feet per day to the east of Building B-16 toward Building B-19 and the Dike.

2.1.5 Surrounding Land Use, Populations, and Sensitive Ecosystems

SAEP is bounded by a paved parking lot and wetlands to the north; the Housatonic River to the east; an open field, a drainage channel, and small commercial businesses to the south; and hangar buildings, the Sikorsky Memorial Airport, several small businesses, and Frash Pond to the west.

Land Use. Historically, land in the SAEP vicinity has been used for agricultural and residential purposes. At present, local land-based agricultural activities are practically nonexistent. The primary agricultural (aquaculture) activity in the area involves growing oysters. Oysters are seeded in areas of the Housatonic River in the spring, collected in the fall, and placed in Long Island Sound to mature. The seed oyster beds are carefully managed by the State of Connecticut Department of Agriculture because of concerns regarding bioaccumulation of contaminants from the Housatonic River.

The SAEP property is zoned light industrial, and land in the vicinity of SAEP is zoned light industrial, business, commercial, or residential. Recreational facilities in the area include Short Beach Park and nearby public wildlife areas include Nells Island and the Great Meadow Salt Marsh.

Population. The Greater Bridgeport Regional Planning Agency's population census of Stratford was 49,389 people in 1990. Slow population growth has been a trend in Stratford for nearly two decades, and the Connecticut Office of Policy and Management anticipates a continued slow or declining growth rate for Stratford with a population projection of 48,650 for the year 2000, and 45,800 for the year 2010 (W-C, 1991).

SAEP is located about 3/4-mile southeast of Johnson Junior High School and Birdseye School. SAEP is located about 1/2-mile northwest of Short Beach Park, which had over 80,000 users reported for the year 1991. There are several businesses located west of Main Street, across from SAEP, including a small strip mall, several gas stations, and a restaurant.

Access into the plant is restricted, with a perimeter fence and security guards. Boaters, fishermen, and shell fishers could potentially access unrestricted intertidal flats within SAEP property.

Drinking Water Sources. The Bridgeport Hydraulic Company supplies the cities of Bridgeport and Stratford with potable water from the Trap Falls Reservoir in Shelton, Connecticut, approximately 6.5 miles north-northwest (upgradient) of SAEP. In 1989, the Trap Falls Reservoir supplied drinking water to 99.9 percent of the population of Bridgeport and Stratford, including residents in the immediate area of SAEP. There are no water supply wells within a 0.5-mile radius of SAEP according to a well survey conducted by the CTDEP and the Stratford Health Department.

Historic Preservation. Two prehistoric archeological sites are reportedly located on SAEP property, as well as an Indian burial site (W-C, 1991).

Sensitive Ecosystems. Freshwater wetlands, intertidal flats, and tidal marshes occur both in the vicinity of SAEP and on site. Freshwater wetlands in the vicinity are associated with Frash Pond, Selby Pond, and a small acreage of land abutting the SAEP property to the north. Intertidal flats in the vicinity are located in a band along the shoreline of the Housatonic River and Long Island Sound. SAEP's riparian rights encompass an estimated 51 acres of intertidal flats. Large tidal marshes occur in the vicinity of SAEP, including the Great Meadow Salt Marsh, areas along the Housatonic River, Nells Island, and land around Sikorsky Airport.

No federally-listed threatened or endangered mammalian, amphibian, invertebrate, aquatic, or plant species have been reported to occur in the vicinity of SAEP. Two federally-listed (the piping plover and roseate tern) and 11 state-listed threatened, endangered, or special concern birds have the potential to occur in the vicinity of SAEP. The intertidal flats area of SAEP may be feeding areas for the plover and tern.

2.1.6 Meteorology

The climate of the SAEP area is strongly influenced by a land-sea breeze, which is most pronounced from spring to early autumn. The sea breeze promotes air mixing, which results in slightly higher amounts of precipitation and slightly cooler temperatures at SAEP than inland.

The prevailing wind is from the southwest at an average speed of about 11 miles per hour. Precipitation averages about 44 inches per year, with about 16 inches per year of snowfall.

Average monthly temperatures range from a low of about 28 degrees Fahrenheit (°F) in January, to a high of about 73°F in July.

SAEP is located in an area that is subjected to hurricanes, and has an intermediate tornado frequency. On average, SAEP is subject to hail approximately twice each year.

2.2 Previous Removal Actions

A Time-Critical Removal Action was conducted in December 1998 to remove hexavalent chromium-contaminated dust from the former Chromium Plating Facility. No other removal actions have been completed at the SAEP site. Closure activities at SAEP have been conducted in accordance with the Resource Conservation and Recovery Act (RCRA). These activities include closure of three former storage lagoons, an equalization basin, and drum storage area.

2.2.1 Plating Facility Interior Decontamination

As a result of the high concentrations of chromium detected in dust samples, it was determined that there was an imminent hazard to workers inside the former Chromium Plating Facility. Therefore, the U.S. Army requested that the interior of the facility be decontaminated under a Time-Critical Removal Action prior to additional investigation activities. The Final Pre-design Investigation Report for the OU 2 NCRA, submitted in May 2000, contains additional information on the facility decontamination (Foster Wheeler/HLA, 2000a).

The following bullets summarize activities completed during the facility decontamination.

- Decontamination activities were completed in December 1998.
- Open sumps and holes in the floor were sealed by filling them with concrete.
- Loose debris and dust were swept from the floor of the plating facility and placed into boxes and drums for off-site disposal.
- Overhead beams, walls, and floor surfaces were pressure-washed to remove chromium-contaminated dust and residue.
- Rinse water generated during building decontamination activities was collected in a polyethylene tank to remove solids, treated with sodium metabisulfite, and then discharged to the SAEP Chemical Waste Treatment Plant (CWTP).
- Wipe sampling and analyses for total chromium and hexavalent chromium, were performed on overhead beams, walls, columns, and the floor to evaluate effectiveness of decontamination procedures.
- Five concrete dust samples were collected using a concrete drill and sent to an off-site laboratory for total chromium and hexavalent chromium analyses.

2.3 PREVIOUS INVESTIGATIONS

Numerous pre-design investigations have been completed at the SAEP site in support of the OU 2 NCRA. Several of these investigations were completed prior to designation of OU 2. The Final OU 2 Pre-design Investigation Report provides the details of these investigations (Foster Wheeler/HLA, 2000a). The following subsections summarize the investigations.

2.3.1 Preliminary Chromium Plating Facility Investigations

Two preliminary investigations were completed at the former Chromium Plating Facility to assess the potential for plating-related contamination. In June 1998, TACOM/SAEP hired AJS Environmental Services, Inc. to collect subsurface soil samples from beneath the concrete floor and analyze the samples for total chromium. Analytical results indicated total chromium concentrations in soil would exceed the CTDEP RSR for hexavalent chromium (if all the total chromium was the hexavalent species); however, no chromium speciation was performed as part of this initial sampling event.

As a result of the detected chromium contamination, SAEP contracted HLA, through a subcontract to AlliedSignal, to perform additional site characterization and develop removal action alternatives to address the contamination. In August 1998, soil and groundwater samples were collected from under the concrete floor of the former Chromium Plating Facility to determine the presence or absence of hexavalent chromium contamination in these media.

In addition to soil and groundwater sampling, two dust samples were collected from the surface of the concrete floor. These samples were collected from areas where a yellow precipitate was evident on rougher surfaces of the concrete floor. Analytical results indicated facility decontamination and additional investigations should be conducted in the area of the former Chromium Plating Facility.

2.3.2 Pre-Design Investigations

Based on the results of preliminary soil and groundwater sampling in the area of the former Chromium Plating Facility, pre-design investigations were completed by HLA at SAEP from January 1999 through June 1999 through a contract with AlliedSignal. These investigations included chromium-focused soil and groundwater sampling and VOC groundwater sampling.

Chromium-Focused Investigations Following preliminary investigations and facility decontamination, HLA initiated a chromium-focused investigation in the former Chromium Plating Facility to delineate the extent of chromium contamination in soils and groundwater. These investigations were completed in January and February 1999. Soil samples were analyzed by an off-site laboratory for total chromium, hexavalent chromium, cyanide and pH. In addition, Synthetic Precipitate Leaching Procedure (SPLP) analyses for total chromium were performed on select samples.

Groundwater samples were analyzed on-site by HLA for hexavalent chromium and ferrous iron using Hach™ test kits. Field readings of pH, temperature, dissolved oxygen (DO), specific conductivity, turbidity, and oxidation-reduction potential (ORP) were also collected for each sample. Thirty of the groundwater samples were sent for confirmation analysis at an off-site laboratory for hexavalent chromium, inorganic compounds, cyanide, sulfate, and alkalinity. In addition, four samples were sent off-site for analysis for VOCs and semi-volatile organic compounds (SVOCs), due to the presence of a solvent-like odor observed during sample purging activities.

HLA installed 13 piezometers for water level measurement and analytical sampling in the vicinity of the former Chromium Plating Facility during the chromium-focused investigation in January and February 1999. Groundwater samples were collected from selected wells and tested on-site for hexavalent chromium and ferrous iron using Hach™ test kits. In addition, HLA completed one round of synoptic water level measurements from the piezometers and monitoring wells on February 11, 1999, at low tide.

Four soil samples were also collected for grain size analysis by the American Society for Testing and Materials Method D 422 from the subsurface soils in the northern corner of the former Chromium Plating Facility.

Chlorinated VOC Investigations – Groundwater As a result of the very high concentrations (greater than [>]100mg/L) of VOCs detected during the chromium-focused investigations, the Army requested that HLA delineate the extent of VOC contamination in groundwater emanating from the former Chromium Plating Facility.

In March 1999, HLA initiated a VOC groundwater investigation to delineate the horizontal and vertical extent of VOC groundwater contamination detected in the vicinity of the former Chromium Plating Facility. The following bullets summarize the March 1999 investigations:

- Collection of 126 groundwater samples with on-site analysis of these samples for select VOCs using a gas chromatograph (GC)
- Collection of field readings of pH, temperature, DO, specific conductivity, turbidity, and ORP for each sample
- Split sample collection of ten groundwater samples for confirmation analysis at an off-site laboratory for VOCs
- Collection of groundwater samples from six existing monitoring wells and on-site analysis for VOCs

Groundwater samples were analyzed on-site for the following VOCs:

- Tetrachloroethylene (PCE)

- Trichloroethylene (TCE)
- cis- and trans-1,2-Dichloroethylene (cis-1,2-DCE and trans-1,2-DCE)
- Vinyl chloride
- 1,1-dichloroethylene (1,1-DCE)
- 1,1,1-Trichloroethane (1,1,1-TCA)

HLA completed additional VOC groundwater investigations in April and May 1999 using a cone penetrometer to access depths not previously attainable. The cone penetrometer VOC groundwater investigation is summarized below:

- Nineteen total cone penetrometer explorations were completed for stratigraphic data acquisition and collection of groundwater samples.
- A total of 87 groundwater samples from the water table to a maximum depth of 158 feet bgs, were sent to an off-site laboratory for VOC analyses.
- Stratigraphic logs of 17 explorations were recorded to better define in-situ subsurface geologic conditions beneath SAEP.
- Thirty-eight dissipation tests were completed to obtain estimates of in-situ horizontal hydraulic conductivity.

2.3.3 Operable Unit 2 NCRA Investigations

Foster Wheeler/HLA pre-design activities completed for the OU 2 NCRA under the TERC contract with the USACE included a seismic refraction survey, soil boring and piezometer installation, aquifer testing, a location and elevation survey, a soil vapor survey, indoor air quality sampling, and bench-scale and pilot-scale treatability testing. The Final OU 2 Pre-design Investigation Report (Foster Wheeler/HLA, 2000a) details the methodology and results of these investigations.

Seismic Refraction Survey. A seismic refraction survey was completed at the SAEP with the objective of determining the bedrock depth and configuration beneath the survey area. Results from the survey produced data of sufficient quality to make interpretations of the depth and configuration of the bedrock surface at SAEP, which are presented in Section 6 of the OU 2 Pre-design Investigation Report (Foster Wheeler/HLA, 2000a).

Soil Borings, Piezometers, and Extraction Well Installations In August 1999, three soil borings, 7 piezometers and one extraction well were installed in the vicinity of the former Chromium Plating Facility. The objectives of these explorations were to: 1) obtain subsurface soil and groundwater chemical data; 2) collect soil and groundwater samples for bench-scale treatability testing of hexavalent chromium and VOC treatment technologies; and 3) provide a pumping well and water level observation points for aquifer testing of the subsurface hydraulic conditions.

Subsurface soil samples were collected during the field program and sent to an off-site laboratory for analysis for VOCs, SVOCs, metals (including hexavalent chromium and cyanide), SPLP, total organic carbon (TOC), total petroleum hydrocarbons (TPH), and cation exchange capacity. Off-site laboratory grain-size analyses were also completed on select samples.

A total of seven piezometers were installed from August 17, through August 20, 1999 in the vicinity of the Chromium Plating Facility. Two sets of three nested piezometers, consisting of a shallow, mid-depth and deeper piezometer, were set in two borings, and a single shallow piezometer was placed in a third boring. One extraction well was installed in order to perform aquifer testing within the area of the former Chromium Plating Facility.

Aquifer Testing. A stepped-rate discharge test was conducted on the extraction well on August 30, 1999. Three steps of increasing discharge rate were completed. Water level data were collected electronically from piezometers during the test, but were not considered usable due to the marginal observed drawdown response in observation piezometers. A constant-rate discharge test was performed on the extraction well on August 31, 1999 with a discharge rate of 15 gallons per minute. Electronic measurements of pressure head were again collected in eight observation piezometers, the extraction well, and a background piezometer. These were supplemented by manual water level meter data throughout the course of the pumping test.

The purpose of aquifer testing was to:

- assess immediate aquifer response to pumping;
- identify the approximate specific capacity of the pumping well;
- determine aquifer hydraulic parameters in the vicinity of the pumping well, including transmissivity, hydraulic conductivity, and specific yield;
- provide observational data on the approximate zone of capture, evaluate the presence of aquifer boundary conditions, and determine the magnitude of tidal influence on groundwater elevations in the area of the test; and
- provide information on groundwater quality near the areas of known chromium and VOC impact.

Section 6.0 of the Pre-design Investigation Report (Foster Wheeler/HLA, 2000a) contains the results of aquifer testing, including a summary of the hydrogeology in the area of the site.

Location and Elevation Survey. A registered land surveyor surveyed the location and elevation of all Foster Wheeler/HLA exploration locations. Horizontal and vertical control points used during previous RI surveys by URSGWCFS at SAEP were used during this survey for consistency. Vertical elevation accuracy was established at 0.01-foot and horizontal location accuracy was set at 0.1-foot.

Soil Vapor Survey. The soil vapor survey was completed in August 1999 to determine if concentrations of VOC vapors in the subsurface exceed the CTDEP Industrial/Commercial Volatilization Criteria (I/C VC) for soil vapor and, therefore, pose a threat to indoor air quality in SAEP buildings. The survey consisted of the collection of soil vapor samples from 52 locations, at depths ranging from 1 to 3 feet.

Soil vapor samples were analyzed on-site for 1,1-DCE, TCE, PCE, and vinyl chloride using a GC. Ten percent of samples were collected as duplicates and sent to an off-site laboratory for analysis to provide a comparison to on-site data .

Indoor Air Quality Sampling. Following review of the soil vapor sampling results, the USACE requested that Foster Wheeler/HLA conduct indoor air quality monitoring at SAEP. As of January 1, 2000, Foster Wheeler/HLA had completed four rounds of sampling in various buildings at SAEP. Foster Wheeler/HLA submitted a technical memorandum in December 1999, which summarized the results of the first three rounds of sampling completed at the SAEP between September 1, 1999 and October 22, 1999. In addition, the technical memorandum presented a review of detected indoor air contaminants to further assess potential risks to workers, and provide perspective as to the likelihood of potential future risks.

In January 2000, Foster Wheeler/HLA was contracted to perform additional indoor air quality sampling work. The initial round of sampling was completed in early February, and will continue monthly for a period of six months. Following the sampling, a report will be prepared in the summer of 2000 which will:

- summarize all indoor air sampling results to date;
- present a revised risk assessment; and
- recommend proposed future actions regarding indoor air quality.

Bench-scale and Pilot-Scale Treatability Testing. Bench-scale treatability testing (i.e., remedy-screening testing) was completed in August 1999 to evaluate the effectiveness of potential in-situ treatment technologies on site contamination. The rationale for selection of treatment technologies used during testing was presented in a Technical Memorandum summarizing the technology screening process and detailing the bench-scale testing methodology (Foster Wheeler/HLA, 1999a), submitted to the Army on July 30, 1999.

As a result of technology screening, three potential groundwater treatment technologies, hexavalent chromium reduction using ferrous sulfate, VOC chemical oxidation using potassium permanganate, and VOC chemical oxidation using hydrogen peroxide, were selected for testing on three areas of the site. Area 1 tested the effectiveness of potassium permanganate and hydrogen peroxide at oxidizing VOCs, primarily TCE. Area 2 tested the effectiveness of ferrous sulfate at reducing hexavalent chromium and Area 3 tested the effectiveness of potassium permanganate and hydrogen peroxide on VOCs; however, the primary contaminant of concern was 1,1,1-TCA.

Samples of aquifer soil and groundwater were collected from the depth of maximum contaminant (groundwater) concentrations in the respective test areas and specified concentrations of the reagents were added to the samples to complete testing. Pre-test and post-test samples of the groundwater/soil mixture (a water sample) were collected and analyzed on-site for hexavalent and total chromium, ferrous iron, total iron, pH, temperature, and ORP potential and off-site for VOCs and the water quality parameters: alkalinity, hardness, dissolved calcium, magnesium, and manganese, sulfide, and chloride. The changes in contaminant concentrations were used to determine the effectiveness of each of the reagents at reducing contamination.

Based on the results of bench-scale treatability testing, pilot-scale treatability testing was completed from November 1999 to January 2000 at TCE and hexavalent chromium hot-spot areas in the vicinity of the former Chromium Plating Facility. Potassium permanganate was tested in the TCE hot-spot area, and ferrous sulfate solution was tested in the hexavalent chromium hot-spot area.

The tests consisted of the injection of the respective reagent through four injection wells placed at the edges of a 30-foot diameter test cell. Groundwater was then extracted through a centrally located extraction well to provide hydraulic control. Piezometers located at varying distances between the injection and extraction wells were monitored for water level and sampled for VOCs, hexavalent chromium, and iron to determine the effectiveness of the pilot-scale tests.

Detailed methodology for the bench-scale treatability testing is presented in the Pilot-scale Treatability Study Work Plan (Foster Wheeler/HLA, 1999b) and the methodology for the pilot-scale treatability study is presented in the Final Pilot-Scale Treatability Study Report (Foster Wheeler/HLA, 2000b).

2.4 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

This subsection summarizes the source, nature, and extent of contamination detected during the investigations presented in Subsection 2.3. The Final Pre-design Investigation Report for the OU 2 Groundwater NCRA (Foster Wheeler/HLA, 2000a) presents a detailed description of the investigation results.

2.4.1 Plating Facility Interior Structures

Following decontamination of the interior of the former Chromium Plating Facility, wipe samples were collected from the floor, walls, and beams for analysis of total and hexavalent chromium. In addition, five concrete samples were collected for off-site analyses.

Although visible loose dust and debris was successfully removed during the decontamination, wipe sample results indicated exceedances of HLA's risk-based cleanup goals on areas of the floor in the northwestern and southern areas of the facility and on the northernmost wall, columns, and overhead beams. In addition, concentrations of hexavalent chromium in concrete dust samples exceed HLA's risk-based cleanup goals, and visual observations of concrete cores collected from the northwestern-most area of the floor indicate chromium contamination exists throughout the entire thickness of the concrete in this area.

2.4.2 Chromium in Soils

Table 2-1 presents a summary of chromium, and other inorganics, at concentrations exceeding CTDEP Industrial/Commercial Direct Exposure Criteria (I/C DEC) and Pollutant Mobility Criteria (PMC) in soils in the vicinity of the former Chromium Plating Facility.

Contamination of subsurface soils by chromium is observed beneath the entire footprint area of the former Chromium Plating Facility. Concentrations of total chromium from SPLP analyses were detected at up to 25.5 mg/L, versus the PMC of 0.5 mg/L. With two exceptions,the concentrations of hexavalent chromium in soils are less than I/C DEC of 100 milligrams per kilogram (mg/kg). At one location (SP-99-11),hexavalent chromium was detected in the shallow sample at 640 mg/kg and in the 4-to-6-foot sample at 513 mg/kg. At location SP-99-14 hexavalent chromium was detected in the shallow sample and the 5-to-7-foot sample at 486 mg/kg and 304 mg/kg, respectively. Generally, the higher chromium concentrations (from SPLP analysis) were detected in the northern corner of the former Chromium Plating Facility (Figure 2-3).

Because infiltration of precipitation in the area of chromium-contaminated soil is not likely due to the concrete floor and the ceiling, vadose zone soil is not considered further in this EE/CA.

2.4.3 Chromium in Groundwater

The extent of chromium in groundwater was investigated during both 1998 and 1999. Results of the sampling and analyses demonstrate that hexavalent chromium is present in groundwater beneath the former Chromium Plating Facility. Figure 2-4 presents the horizontal extent of hexavalent chromium exceeding the Surface Water Protection Criteria (SWPC) of 0.11 mg/L. The vertical distribution of hexavalent chromium in groundwater is presented in Figures 2-5 and 2-6. Table 2-2 presents a summary of hexavalent chromium and other inorganics detected in groundwater at concentrations exceeding SWPC.

Figure 2-4 presents what appears to be two distinct hexavalent chromium groundwater plumes beneath the former Chromium Plating Facility. The smaller of the two, located beneath the southeast end of the facility, is approximately 80 feet by 130 feet in area (10,400 square feet), with a maximum concentration of 11 mg/L of hexavalent chromium. The larger of the two plumes appears to emanate from the northwestern end of the facility, centered around a maximum concentration of 950 mg/L of hexavalent chromium in groundwater. This second, larger plume extends radically from exploration location WP-99-15; 160 feet to the northwest, 135 feet to the northeast, 90 feet to the southeast, and 100 feet to the southwest. This plume covers an approximate area of 40,000 square feet. The plume extends beneath Buildings B-10 and B-12, in the approximate direction of groundwater flow (north to northeast). The extremely small groundwater horizontal gradients appear to have limited extensive migration of the hexavalent chromium in groundwater.

One possible reason for the distribution of hexavalent chromium in these two distinct plumes may be a result of the high TCE concentrations in groundwater between the two plumes. The TCE concentrations (greater than 800,000 micrograms per liter [μg/L]) may be causing anaerobic conditions within the groundwater, which would cause the hexavalent chromium to transform to a reduced state (i.e., trivalent chromium)

Vertical distribution of the hexavalent chromium in groundwater is generally limited to less than 35 feet bgs (see Figures 2-5 and 2-6). The exception is near the suspected source area in the northern corner of the former Chromium Plating Facility, where hexavalent chromium is detectable in groundwater up to a depth of 45 feet bgs (exploration location WP-99-15). Although there are very small groundwater vertical gradients in this area the hexavalent chromium plume extends to an approximate depth of 40 feet bgs. One possible explanation for this deep distribution is the probable high density of the former plating solutions relative to groundwater. However, it appears that the relative differences in vertical to horizontal permeability in the fine sands and silts at approximately 30 feet bgs impeded vertical movement of the hexavalent chromium plume, causing the plume to spread horizontally (see Figures 2-5 and 2-6).

2.4.4 VOCs in Groundwater

The following subsections present an assessment of chlorinated VOC contamination in groundwater beneath the main portion of the SAEP facility, bounded by Main Street to the south, and Sniffens Lane to the east. Included is a discussion of chlorinated VOC exceedances of CTDEP SWPC within this area and discussions of three chlorinated VOC groundwater "hot-spots", or areas in which chlorinated VOC concentrations exceed 100,000 μg/L in groundwater. These "hot-spots" are considered to be potential source areas for facility-wide groundwater contamination, and will be the primary focus of the OU 2 NCRA EE/CA, in addition to the hexavalent chromium groundwater plume.

SWPC VOC Exceedances in Groundwater. The four VOCs thatexceed SWPC over the majority of the main portion of the facility are 1,1-DCE, PCE, TCE, and 1,1,1-TCA. Figure 2-7 presents the estimated horizontal extent of these four VOC at concentrations exceeding their respective SWPC. Figure 2-8 shows the geologic cross-section locations and Figures 2-9 through 2-15 present cross-sections A-A' through G-G' respectively, which show the vertical extent of VOCs in groundwater at concentrations exceeding the SWPC. Table 2-3 presents a summary of 1999 groundwater data with concentrations of these four VOCs exceeding their respective SWPC.

1,1-DCE appears to be one of the most widespread of the four VOCs exceeding SWPC in groundwater beneath the main portion of the facility (see Figure 2-7). 1,1-DCE was detected in groundwater at concentrations above the SWPC of 96 μg/L from just south of the North Parking Lot, eastward south of the Dike to Sniffens Lane, and southward bisecting the Chromium Plating Facility. The maximum concentration of 1,1-DCE detected in groundwater is 9,400 µg/L at piezometer PZ-99-03, located between Buildings B-2 and B-12. The highest concentrations of 1,1-DCE appear to be co-located with 1,1,1-TCA SWPC exceedances.

PCE was detected at concentrations exceeding its SWPC of 88 µg/L over an area from Building B-13 eastward in a widening plume that encompasses Buildings B-10, B-48, B-8, B-7, B-4, and B-19 to Sniffens Lane. The maximum concentration of PCE detected in groundwater was 1,900 µg/L in exploration WP-99-45, located between Buildings B-48 and B-16.

TCE was detected at concentrations exceeding its SWPC of 2,340 µg/L over an area from the northern end of Building B-2 eastward in a widening plume toward the former Chromium Plating Facility, and terminating just to the east of Building B-3A near the Dike (see Figure 2-7). The maximum concentration of TCE detected was 830,000 µg/L in exploration WP-99-33, located beneath the former Chromium Plating Facility.

1,1,1-TCA was detected at concentrations exceeding its SWPC of 62,000 µg/L over a much more limited area than the other three chlorinated VOCs. The area of exceedances by this compound is located in the central portion of Building B-2 (see Figure 2-7). As indicated on Figure 2-7, the dashed line of 1,1,1-TCA SWPC exceedance indicates some question as to whether the exceedance should be one, or two areas, each focused around explorations CP-99-08 and WP-99-48, respectively.

Chlorinated VOC Hot-spot No. 1. Chlorinated VOC Hot-spot No. 1 is located beneath the Chromium Plating Facility in Building B-2. During the chromium-focused groundwater investigation in January 1999, TCE was detected in exploration WP-99-09 at a concentration exceeding 130,000 µg/L at a depth of 29 feet bgs. Detection of concentrations of TCE in this range prompted the VOC-focused groundwater investigations.

Figure 2-16 presents the horizontal delineation of VOC Hot-spot No. 1, as well as the cross-section locations. Cross-sections VOC 1-A/A' and VOC 1-B/B' are presented as Figures 2-17 and 2-18, respectively. Table 2-3 presents a summary of 1999 groundwater data with concentrations of VOCs exceeding their respective SWPC and Table 2-4 presents a summary of VOCs in groundwater with concentrations exceeding I/C VC.

The estimated horizontal extent of TCE in groundwater at concentrations exceeding 100,000 µg/L is presented in Figure 2-16, and covers the majority of the footprint of the former Chromium Plating Facility. The source of the TCE is suspected to be from degreasing operations completed as part of the former Chromium Plating Facility operations.

The vertical distribution of TCE in groundwater beneath the former Chromium Plating Facility appears to be controlled by the layer of silt and very fine sand, the top of which is at an elevation of approximately –20 feet MSL (see Figures 2-17 and 2-18). The lower vertical permeability of the silt and very fine sand appear to have impeded, to a large extent, the vertical migration of the highest concentrations (>100,000 µg/L) of TCE in groundwater. The current conceptual model for this hot-spot is that TCE migrated from the plating facility vertically through the unsaturated zone, into and beneath the water table, to the surface of the silt and very fine sand aquitard. Over time, the TCE has diffused into the silt and very fine sand aquitard. The highest concentration of TCE detected was 830,000 µg/L in exploration WP-99-33, immediately above the surface of the aquitard (see Figure 2-17). Concentrations of TCE beneath the aquitard are generally less than the SWPC of 2,340 µg/L (see Figures 2-17 and 2-18).

The concentrations of TCE at Hot-spot No. 1 are indicative of the possible presence of a non-aqueous phase liquid (NAPL). The solubility of TCE in water is approximately 1,100,000 µg/L and the highest concentration of TCE detected in groundwater is 830,000 µg/L; approximately 75 percent of TCE's solubility limit in water. Visual observation of subsurface soil and groundwater samples did not reveal the presence of any TCE NAPL. Shake tests were performed on soil and groundwater samples using Sudan IV dye to test for the presence of NAPL, but test results were negative. Analytical results from explorations CP-99-10 (73 to 75 feet bgs sample) and WP-99-33 (76 to 80 feet bgs sample) indicate that TCE is not present at concentrations exceeding the SWPC at depths near the bedrock surface.

Chlorinated VOC Hot-spot No. 2. Chlorinated VOC Hot-spot No. 2 is located between Buildings B-48 and B-16 (see Figure 2-19). The primary VOC detected at high concentrations in this area is TCE. Figure 2-19 presents the horizontal delineation of VOC Hot-spot No. 2, as well as the cross-section locations. Cross-sections VOC 2-A/A' and VOC 2-B/B' are presented as Figures 2-20 and 2-21, respectively. Table 2-3 presents a summary of 1999 groundwater data with concentrations of VOCs exceeding their respective SWPC and Table 2-4 presents a summary of VOCs in groundwater with concentrations exceeding I/C VC.

The estimated horizontal extent of TCE in groundwater at concentrations exceeding 100,000 µg/L is presented in Figure 2-19, and covers an area roughly 75 feet in diameter. The extent depicted on Figure 2-19 is conservative, and it is possible the area of TCE concentrations exceeding 100,000 µg/L is larger than that depicted (i.e., it may extend beneath Building B-16). The source of the TCE is suspected to be from disposal on the ground surface, and/or degreasing operations completed in Building B-16.

The vertical distribution of TCE in groundwater at VOC Hot-spot No. 2 appears to be controlled by the layer of sandy silt, the top of which is at an elevation of approximately –8 feet MSL (see Figures 2-20 and 2-21). The lower vertical permeability of the sandy silt appears to have impeded, to a large extent, the vertical migration of the highest concentrations (>100,000 µg/L) of TCE in groundwater. It is likely that TCE migrated from the ground surface vertically through the unsaturated zone, into and beneath the water table, to an area within the sandy silt. The highest concentration of TCE detected was 264,000 µg/L in exploration WP-99-45, within the sandy silt (see Figure 2-20).

Concentrations of TCE beneath the sandy silt are generally less than 1,000 µg/L, and less than the SWPC of 2,340 µg/L (see Figures 2-20 and 2-21). It is also apparent from the cross-sections (Figures 2-20 and 2-21) and Figure 2-19 that the higher concentrations of TCE (>1,000 µg/L) from this hot-spot have not reached the Dike or the intertidal flats.

The depth to bedrock in the vicinity of VOC Hot-spot No. 2 varies from –90 feet MSL to –105 feet MSL, dipping from southeast to northwest. Analytical results from exploration WP-99-45 indicate that TCE concentrations do not exceed the SWPC of 2,340 µg/L at a depth of 60 feet. However, the concentration of TCE detected in nearby monitoring well WC2-3D (100 feet south of WP-99-33), screened on the top of bedrock, is 3,100 µg/L. This indicates that some TCE has migrated vertically through the subsurface soils to the bedrock surface.

The concentrations of TCE at Hot-spot No. 2 are indicative of the possible presence of a NAPL. The solubility of TCE in water is approximately 1,100,000 µg/L. The highest concentration of TCE detected in groundwater (264,000 µg/L) is approximately 24 percent of TCE's solubility limit in water. Visual observation of subsurface soil and groundwater samples did not reveal the presence of any TCE NAPL.

Additional chlorinated VOCs detected at concentrations exceeding SWPC in the vicinity of Hot-spot No. 2 are PCE at 1,900 µg/L (WP-99-45, 11-15 feet bgs), and 1,1-DCE at 4,500 µg/L (WP-99-45, 11-15 feet bgs). Due to the dilutions required for analysis of samples containing high TCE concentrations, some of the results indicated other VOCs were not detected. Therefore, it is possible that the concentrations of PCE and 1,1-DCE reported above may not be the highest ones in the vicinity of Hot-spot No. 2.

Chlorinated VOC Hot-spot No. 3. Chlorinated VOC Hot-spot No. 3 is located in the center of Building B-2 (see Figure 2-19). The primary VOC detected at high concentrations in this area is 1,1,1-TCA. Figure 2-19 presents the horizontal delineation of VOC Hot-spot No. 3, as well as the cross-section locations. Cross-sections VOC 3-A/A' and VOC 3-B/B' are presented as Figures 2-22 and 2-23, respectively. Table 2-3 presents a summary of 1999 groundwater data with concentrations of VOCs exceeding their respective SWPC and Table 2-4 presents a summary of VOCs in groundwater with concentrations exceeding I/C VC.

The estimated horizontal extent of 1,1,1-TCA in groundwater at concentrations exceeding 100,000 µg/L is presented in Figure 2-19, and covers an area roughly 350 feet long by 100 feet wide. The extent depicted on Figure 2-19 is based on extrapolation of concentrations from CP-99-08 to WP-99-48. However, it is possible the area of 1,1,1-TCA concentrations exceeding 100,000 µg/L is actually two distinct areas, each focused around these explorations (see Figure 2-19). The source of the 1,1,1-TCA is suspected to be from degreasing operations completed in this portion of Building B-2.

The vertical distribution of 1,1,1-TCA in groundwater at VOC Hot-spot No. 3 is depicted in Figures 2-22 and 2-23. PCPT logs indicate that the geology is primarily uniform fine sand with silty sand, with a 10-foot thick gravelly zone centered vertically at –20 feet MSL. Unlike the geology at VOC Hot-spots Nos. 1 and 2, there is no apparent layer of silt which would attenuate the vertical migration of 1,1,1-TCA. The conceptual model for this hot-spot indicates that 1,1,1-TCA migrated from the ground surface vertically through the unsaturated zone, into and beneath the water table, to bedrock. The highest concentration of 1,1,1-TCA detected was 280,000 µg/L in exploration CP-99-08 at a depth of approximately –24 feet MSL (see Figure 2-22). It is apparent from Figure 2-22 that the 1,1,1-TCA has migrated to the bedrock surface (approximately –152 feet MSL) in the vicinity of exploration CP-99-08. The depth to bedrock in the vicinity of VOC Hot-spot No. 3 varies from approximately –144 feet MSL to –170 feet MSL, dipping from southeast to northwest. The concentration of 1,1,1-TCA in groundwater at the bedrock surface is 210,000 µg/L (see Figure 2-22). As indicated in Figures 2-22 and 2-23, the extent of 1,1,1-TCA near the bedrock surface has been delineated to the southeast of CP-99-08 (see exploration CP-99-18), but is not completely delineated to the east (toward exploration WP-99-48) and northwest (toward exploration CP-99-06).

Figure 2-23 interprets the shallower 1,1,1-TCA groundwater contamination exceeding 100,000 µg/L to extend from CP-99-08 to WP-99-48. The rationale for this interpretation is based on the historical usage of 1,1,1-TCA in degreasing operations in this portion of Building B-2.

The concentrations of 1,1,1-TCA at Hot-spot No. 3 are indicative of the possible presence of a NAPL. The solubility of 1,1,1-TCA in water is approximately 1,500,000 µg/L. The highest concentration of 1,1,1-TCA detected in groundwater (280,000 µg/L) is approximately 19 percent of 1,1,1-TCA's solubility limit in water. Visual observation of subsurface soil and groundwater samples did not reveal the presence of any 1,1,1-TCA NAPL.

Additional chlorinated VOCs exceeding SWPC in the vicinity of Hot-spot No. 3 are TCE at concentrations up to 20,000 µg/L (CP-99-08, near the bedrock surface), and 1,1-DCE at concentrations up to 9,000 µg/L (CP-99-08, 44 to 46 feet bgs). SVOC analytical results from CP-99-08 (32 to 34 and 44 to 46 feet bgs) were non-detect.

I/C VC Exceedances in Groundwater. The four VOCs that exceed the I/C VC over the majority of the main portion of the facility are 1,1-DCE, TCE, 1,1,1-TCA, and vinyl chloride. Table 2-4 summarizes the VOCs in groundwater at concentrations exceeding the I/C VC. The locations where VOC concentrations in groundwater exceed the I/C VC are shown on Figure 2-24.

2.4.5 VOCs in Soil Vapor

The objective of the soil vapor survey was to determine if concentrations of VOC vapors in the subsurface soil above the water table exceed the CTDEP I/C VC for soil vapor, and therefore pose a threat to indoor air quality in SAEP buildings. Analytical results, including notation of I/C VC, are presented in Table 2-5. Figure 2-25 presents the locations of the soil vapor samples and denotes exceedances of the I/C VC.

Analytical results from the soil vapor survey indicate that soil vapor in the SAEP subsurface exceeds I/C VC for the chlorinated VOCs 1,1-DCE and TCE. VOC soil vapor concentrations beneath the central portion of Building B-2, extending northeast and east toward Buildings B-15 and B-16, respectively, generally exceed CTDEP I/C VC (see Figure 2-25). However, not all of the explorations in this region indicate exceedance of the criteria. 1,1-DCE was detected at concentrations exceeding the I/C VC of 0.35 ppmv in explorations SG-99-01, -04, -10, -17, -18, -41, -49, and –50. TCE was detected at concentrations exceeding the I/C VC of 16 ppmv in explorations SG-99-04, -06 -10, -47, and –51.

In general, the distribution of soil vapor VOC I/C VC exceedances is co-located with groundwater contamination by the same chlorinated VOCs. One exception is in the southeastern end of Building B-2 at exploration SG-99-51, where the concentration of TCE (110 ppmv) exceeded the I/C VC of 16 ppmv by an order of magnitude. The interpretation presented in Figure 2-7 does not indicate exceedance of the SWPC for TCE in groundwater in this area.

2.4.6 VOCs in Indoor Air

Based on the results of the soil vapor survey, TACOM/SAEP contracted Foster Wheeler/HLA to conduct an indoor air quality sampling program to assess the impact of soil vapor on indoor air quality. Foster Wheeler/HLA submitted a technical memorandum in December 1999, which summarized the results of the first three rounds of sampling completed at the SAEP between September 1, 1999 and October 22, 1999. In addition, the technical memorandum presented a review of detected indoor air contaminants to further assess potential risks to workers, and provide perspective as to the likelihood of potential future risks.

Analytical results from Round 3 of indoor air quality sampling indicated concentrations of 1,1-DCE and vinyl chloride exceeding CTDEP Industrial/Commercial Indoor Air Target Concentrations (I/C IATC) in a number of sample locations in buildings B-1 (outside security headquarters; first floor only), B-2 (Meyers lease area, and near the boiler room), B-9, B-12, B-48, B-65.

The following bullets summarize the results of Rounds 1-3 of indoor air quality sampling:

- Exceedances of CTDEP I/C IATC are widespread in buildings at SAEP.
- Contaminants detected in indoor air samples are also found in soil vapor samples, and groundwater.
- Maximum detected concentrations of three compounds (vinyl chloride, TCE, and 1,1-DCE) exceed I/C IATC.

- A preliminary screening level risk evaluation showed that the cumulative excess cancer risk met the CTDEP criteria of $1x10^{-5}$.
- Cancer risks for three compounds calculated based on maximum concentrations exceed the CTDEP cancer risk limit for individual compounds. However, if exposures to these levels of contaminants are limited to 5 years, risk levels are not exceeded.
- Maximum concentrations likely overestimate risks.
- No short-term or long-term workplace exposure standards are exceeded.
- Additional sampling should be performed to continue to assess indoor air contamination levels.

In January 2000, Foster Wheeler/HLA was contracted to perform additional indoor air quality sampling work. Monthly indoor air sampling was conducted from February 2000 through August 2000 (Rounds 4 through 10). A revised risk assessment was prepared using data from rounds 1 through 10 of sampling. The revised risk assessment was presented in a September 20, 2000 HLA Technical Memorandum, entitled "Summary of Indoor Air Quality Sample Analyses, Sampling Rounds 1-10"

Worst-Case Exposure Scenarios Evaluated:

- Worst Case Scenario 1: Indoor maintenance worker, 2 hr/day in B-2 (central area), 6 hr/day in other portions of facility
- Worst Case Scenario 2: Full-time indoor worker, 8 hr/day inside facility (not B-2 central area)
- Both scenarios assume workers exposed to maximum detected concentrations, 250 days/year for 25 years

Conservative Exposure Scenarios Evaluated:

- Conservative Scenario 1: Indoor maintenance worker, 2 hr/day in B-2 (central area), 6 hr/day in other portions of facility
- Conservative Scenario 2: Full-time indoor worker, 8 hr/day inside facility (not B-2 central area)
- Both scenarios assume workers exposed to average concentrations, 250 days/year for 25 years
- Conservative scenarios are assumed to be more realistic than worst-case scenarios

Risks for a maintenance worker (Worst Case Scenario 1 and Conservative Scenario 1) and full-time office worker (Worst Case Scenario 2 and Conservative Scenario 2) were estimated for possible inhalation exposures to VOCs in indoor air. The total cancer risk for the maintenance worker under Worst Case Scenario 1 is 2×10^{-5}, which is above the cumulative excess lifetime cancer risk limit of 1×10^{-5} required by CTDEP. The cancer risk for the office worker under Worst Case Scenario 2 (1×10^{-5}) is equal to, but does not exceed the cumulative excess lifetime cancer risk limit of 1×10^{-5}. The cancer risk calculated for the following compounds exceed the excess lifetime cancer risk limit for individual compounds of 1×10^{-6}: 1,1-DCE (Worst Case Scenarios 1 and 2) and TCE

(Worst Case Scenarios 1 and 2). Total non-cancer risks for workers under both worst case scenarios are all below an HI of 1.

The total cancer risk for the maintenance worker under Conservative Scenario 1 is 7×10^{-6}, which is below the cumulative excess lifetime cancer risk limit of 1×10^{-5} required by CTDEP. The cancer risk for the office worker under Conservative Scenario 2 (5×10^{-6}) is also below the cumulative excess lifetime cancer risk limit of 1×10^{-5}. However, the cancer risks for 1,1-DCE under Conservative Scenarios 1 and 2 exceed the excess lifetime cancer risk limit for individual compounds of 1×10^{-6}. Total non-cancer risks for workers under both worst case scenarios are all below an HI of 1.

Assuming continuous exposure to maximum detected concentrations during the workday, the exposure duration that would be associated with cancer risks meeting regulatory limits have been calculated. For Worst Case Scenarios 1 and 2, an exposure duration of up to 3.5 years yields risk estimates that meet regulatory requirements. For Conservative Scenario 1, an exposure duration of up to 6 years yields risk estimates that meet regulatory requirements. For Conservative Scenario 2, an exposure duration of up to 7 years yields risk estimates that meet regulatory requirements. Given the overall conservative nature of this assessment, longer exposures in most locations are likely to meet regulatory requirements.

To supplement the worst case risk evaluation, maximum detected indoor air concentrations were compared to screening criteria. All concentrations of VOCs detected in indoor air samples are below ACGIH TLVs.

2.5 Treatability Testing Results

The following paragraphs summarize the results of bench-scale and pilot-scale treatability testing conducted at the SAEP site. The Pilot-scale Treatability Study Work Plan (Foster Wheeler/HLA, 1999b) presents the results of bench-scale treatability testing and the Pilot-scale Treatability Study Report (Foster Wheeler/HLA, 2000b) presents the results of the pilot-scale study.

Bench-scale Testing. In general, bench-scale testing indicated that potassium permanganate was slightly more effective than hydrogen peroxide at reducing concentrations of chlorinated ethenes (e.g., TCE and 1,1-DCE) in the jar samples. Neither potassium permanganate nor hydrogen peroxide appeared effective at reducing concentrations of chlorinated ethanes (e.g., 1,1,1-TCA) in jar samples; therefore, alternative technologies, such as air sparging or six-phase heating (SPH) are considered for the 1,1,1-TCA area and pilot-scale treatability testing was not conducted. Testing in samples collected for in-situ hexavalent chromium reduction indicated ferrous sulfate appeared capable of reducing hexavalent chromium to trivalent chromium.

Pilot-scale Study. Based on the pilot test results and their interpretation, it was determined that TCE was effectively remediated by a combination of flushing and oxidation to concentrations below the CTDEP RSR SWPC of 2.34 mg/L; however, local variations in subsurface conditions led to greater travel times to effectively distribute the reagent. In addition, a higher mass of reagent was required than predicted based on TCE concentrations in soil and groundwater, most likely due to local variations in TCE concentration and natural organic matter found in the soil. It was also noted that oxidation of TCE by potassium permanganate in the former TCE area oxidized some trivalent chromium to hexavalent chromium.

Hexavalent chromium concentrations also were reduced by a combination of flushing and oxidation to concentrations at least two orders of magnitude lower than at the start of the test. The CTDEP RSR SWPC (0.11 mg/L) were not achieved throughout the treatment areas, most likely due to fouling of the subsurface with iron which inhibited further delivery of ferrous sulfate to some areas. Increased test durations and higher ferrous sulfate doses were required than predicted based on aquifer properties and measured concentrations of hexavalent chromium in soil and groundwater.

For both potassium permanganate and ferrous sulfate, injection at higher concentrations over a shorter period of time appeared to achieve faster and more effective treatment than lower concentrations injected over a longer period of time. The result may be a combination of the effect of higher reagent concentrations and a greater amount of acid to maintain a low pH in the aquifer.

Preliminary results from monthly rebound sampling indicate that TCE concentrations are rebounding in several piezometers. It is unknown if the increase in concentrations is due to dissolution of NAPL, or influences from contamination outside the treated zone. A complete discussion on rebound sampling will be included in the Final Pilot-scale Treatability Study Report scheduled for submission in September 2000.

2.6 PRELIMINARY RISK EVALUATIONS

Chromium Plating Facility. Wipe samples collected following facility decontamination were analyzed for hexavalent and total chromium. The analytical results were compared to risk-based cleanup goals developed by HLA for the former Chromium Plating Facility based on calculations developed for a site in Watertown, Massachusetts. Appendix A contains the calculations used to develop the cleanup goals. In accordance with the CTDEP RSR, these risk-based cleanup goals must be approved by the Commissioner of Environmental Protection.

Indoor Air. A risk evaluation was prepared for indoor air contamination, based on data from ten sampling events conducted between September 1999 and August 2000. The risk evaluation methodology was presented in a September 20, 2000 HLA Technical Memorandum, entitled "Summary of Indoor Air Quality Sample Analyses, Sampling Rounds 1-10". A summary of the risk evaluation is presented in Section 2.4.6 of this document. . In accordance with the CTDEP RSR, these risk-based cleanup goals must be approved by the Commissioner of Environmental Protection.

Although a risk evaluation has not been performed under the scope of the OU 2 NCRA for the media of subsurface soil, groundwater, and soil gas,contaminant concentrations in these media have been compared to the appropriate CTDEP RSR criteria. These criteria have been established to be protective of human health. A risk assessment is being conducted as part of the RI.

3.0 IDENTIFICATION OF REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES

The NCP states that an appropriate removal action may be conducted at a site when a threat to human health or welfare or the environment is determined. The removal action is undertaken to abate, prevent, minimize, stabilize, mitigate, or eliminate the release, or the threat of release, at a site. Section 300.415 of the NCP outlines factors to be considered when determining the appropriateness of a removal action, such as high concentrations of hazardous substances, pollutants, or contaminants in soil, largely at or near the surface that may migrate.

Once it is decided that a removal action is appropriate, a determination is made whether the removal is an "emergency", "time-critical", or "non-time-critical" removal. "Emergencies" are those removals in which response actions must begin within hours or days after completion of the site evaluation. "Time-critical" removals are those for which, based on a site evaluation, it is determined there are less than six months available before on-site response activities must begin. "Non-time-critical" removals are those for which it is determined there are more than six months available before removal actions must begin. The removal action for the OU 2 source areas is considered a "non-time-critical removal action" (i.e., NCRA).

The following subsections present the scope, goals, and objectives of the removal action, including the ARARs that will govern the removal action.

3.1 Statutory Limits of Removal Action

CERCLA Section 104(c)(1) has established statutory limits for Superfund-financed removal actions, which require that removal actions be terminated after $2 million has been allocated for the removal, or 12 months have elapsed since the removal was initiated. Funding for removal activities at SAEP will be provided through the Department of Defense's Defense Environmental Restoration Account, rather than Superfund. Therefore, the CERCLA duration and cost limitations are used only as guidance for this EE/CA.

3.2 Determination of Removal Action Scope

To determine the scope of the OU 2 Source Area NCRA, data collected during OU 2 field investigations (Foster Wheeler/HLA, 2000a) and previous investigations were compared to the CTDEP RSR criteria (soil, groundwater, soil vapor, and indoor air concentrations) or HLA's previously developed risk-based cleanup goals (chromium-contaminated structures). In addition, groundwater contaminant concentrations were evaluated against observed soil gas and indoor air concentrations to determine if there was a correlation between groundwater contamination, soil vapor concentrations, and indoor air quality.

Based on the contamination assessment presented in Subsection 2.4, concentrations of hexavalent chromium present on the facility floor, walls, and overhead beams pose a risk to site workers. There are exceedances of the CTDEP RSR criteria throughout site groundwater (hexavalent chromium and VOCs), and exceedances of the CTDEP RSR criteria for total chromium (by SPLP) in soil beneath the former Chromium Plating Facility. The observed soil gas and indoor air contaminant concentrations exceed CTDEP RSR criteria, and generally indicate that areas of the facility with the highest indoor air contaminant concentrations are co-located with the groundwater VOC hot-spots.

The VOC contamination in deep groundwater (i.e., > 60 feet bgs) is not anticipated to adversely affect indoor air quality and therefore, is not addressed in this EE/CA. The RI/FS for the SAEP site will address general OU 2 groundwater contamination including deep VOC contamination.

As a result of the source and nature of contamination described in Subsection 2.4, former Chromium Plating Facility structures, hexavalent chromium-contaminated groundwater, and VOC-contaminated groundwater (less than 60 feet bgs), and indoor air contamination are being addressed in this EE/CA.

3.3 Determination of Removal Action Schedule

Because the removal action is not financed by Superfund, it is exempt from the 12-month statutory limit. OU 2 removal action activities, including alternative design, are anticipated to begin in the fall of 2000.

3.4 Removal Action Objectives

The buildings at the SAEP have been proposed for future use as office space, research and development space, and "flex" space. In addition, approximately 100,000 square feet of museum space and approximately 16 acres of parkland along the Housatonic River waterfront are proposed (RKG, 1997). The proposed parkland (i.e., recreational area) would include a landscaped park with pathways for pedestrians and bicyclists, public water access from a new dock located at the end of the former seaplane boat ramp at the end of the Causeway, and an off-street parking area. Removal action objectives and proposed removal action alternatives should consider the proposed future use of the facility.

Removal action objectives have been developed to be consistent with CTDEP RSR criteria, including SWPC, groundwater and soil vapor I/C VC, and indoor air I/C IATC, and to provide protection to potential human and ecological receptors. Additionally, HLA's previously developed risk-based cleanup goals for hexavalent chromium-contaminated dust on structures, and risk evaluations for indoor air were considered.

Based on the proposed future use of the facility and the existing contaminant distributions, three contamination types will be addressed in the EE/CA. The contamination types include: 1) hexavalent chromium-contaminated structures in the former Chromium Plating Facility; 2) hexavalent chromium-contaminated groundwater; and 3) shallow VOC-contaminated groundwater (less than 60 feet bgs), and indoor air.

3.4.1 Chromium-Contaminated Structures

The following removal action objective has been developed to address existing hexavalent chromium contamination on facility structures:

- Protect potential receptors from exposure to high concentrations of hexavalent chromium on former Chromium Plating Facility structures.

3.4.2 Hexavalent Chromium in Groundwater

The following removal action objective has been developed for hexavalent chromium-contaminated groundwater:

- Prevent high concentrations of hexavalent chromium from potentially migrating to surface water and impacting receptors.

3.4.3 VOCs in Groundwater

The following removal action objectives have been established for VOC-contaminated groundwater:

- Prevent the migration of VOC-contaminated vapors from groundwater hotspots to the interior of on-site buildings.
- Prevent high concentrations of VOCs in shallow groundwater from potentially migrating to surface water and impacting receptors.

3.5 REMOVAL ACTION GOALS

Risk-based removal action goals have been developed for the chromium-contaminated structures. Removal action goals for indoor air are based on the CTDEP RSR I/C IATC. The removal action goals for groundwater are based on (1) the CTDEP RSR SWPC for hexavalent chromium-contaminated groundwater, and (2) the lower of the CTDEP RSR SWPC or I/C VC for VOC-contaminated groundwater. Table 3-1 presents the removal action goals developed for this EE/CA.

The removal action goals for groundwater, based on the CTDEP RSR criteria, will be used for the groundwater hot-spot areas. However, in support of the long-term remedy for the site, alternate criteria may be developed during preparation of the FS for SAEP. These alternate criteria will be developed in accordance with the CTDEP RSR and will consider the SAEP numerical, groundwater-contaminant fate and transport model being conducted in conjunction with the RI report. In accordance with the CTDEP RSR, alternate criteria must be approved by the Commissioner of Environmental Protection.

3.6 Extent of Contamination

The extent of groundwater contamination to be addressed by removal action alternatives presented in this EE/CA was defined based on evaluation of the contamination extent as defined in the OU 2 Pre-design Investigation Report (Foster Wheeler/HLA, 2000a), as explained below.

The hexavalent chromium groundwater hot-spot was defined as the area of detectable hexavalent chromium concentrations, greater than 0.1 mg/L. The VOC hot-spot areas (VOC Hot-spot Nos. 1 through 3) were defined as the areas where VOC concentrations were greater than the following:

- TCE greater than 100,000 µg/L
- 1,1-DCE greater than 5,000 µg/L
- 1,1,1-TCA greater than 100,000 µg/L

The rationale for selection of these concentrations is based on the estimated potential of these concentrations to significantly contribute to ongoing groundwater and indoor air contamination. The potential for these contaminant concentrations to contribute to indoor air contamination is based on a comparison of the groundwater data relative to the CTDEP RSR I/C VC, as well as the documented indoor air contamination. All three VOC hot-spots contain VOCs in groundwater at concentrations exceeding the CTDEP RSR I/C VC. In addition, the RI did not identify any significant vadose zone VOC contamination.

Because VOC contamination in deep groundwater (i.e., > 60 feet bgs) is not expected to contribute to soil vapor contamination or migrate toward the Housatonic River, it is not addressed in this EE/CA. The RI/FS for the SAEP site will address general OU 2 groundwater contamination including deep VOC contamination.

3.7 Applicable or Relevant and Appropriate Requirements

The NCP requires that removal actions pursuant to CERCLA Section 106 attain ARARs under federal or state environmental laws or facility siting laws to the extent practicable considering the urgency of the situation and the scope of the removal action.

ARARs are federal and state human health and environmental requirements and guidelines used to (1) evaluate the appropriate extent of site cleanup; (2) define and formulate removal action alternatives; and (3) govern implementation and operation of the selected action. Only those promulgated state requirements identified by the state in a timely manner that are more stringent than federal requirements may be ARARs.

Under CERCLA Section 121(e), permits are not required for response actions conducted entirely on site. This permit exemption applies to administrative permit requirements (e.g., documentation, recordkeeping, and enforcement). However, compliance with the substantive requirements of applicable regulations must be achieved.

The NCP defines three categories of potential requirements in the remedial response process: (1) applicable requirements, (2) relevant and appropriate requirements, and (3) information to be considered. These definitions are discussed in the following paragraphs.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. An example of an applicable requirement is the use of Maximum Contaminant Level (MCL) drinking water standards for a site where groundwater contamination has affected a public water supply.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. There is discretion in this determination in that it is possible for only part of a requirement to be considered relevant and appropriate, the rest being dismissed if judged not to be relevant and appropriate in a given case. For example, MCLs for drinking water would be relevant and appropriate requirements at a site where groundwater contamination could affect a potential, rather than actual, drinking water source.

Information to be considered is nonpromulgated advisories or guidance issued by the federal or state government that are not legally binding, and do not have the status of potential ARARs. However, if there are no specific ARARs for a chemical or site condition, or if existing ARARs are not deemed sufficiently protective, then guidance or advisory criteria should be identified and used to confirm protection of human health and the environment.

Development of a comprehensive inventory of ARARs involves a two-tiered analysis: establishing the applicability of an environmental regulation, and evaluating relevancy and appropriateness if the regulation is not applicable. A requirement may be "applicable" or "relevant and appropriate", but not both.

Because of their site-specific nature, identification of ARARs require evaluation of federal, state, and local environmental and health regulations regarding chemicals of concern, site characteristics, and proposed remedial alternatives. Requirements that pertain to the remedial response at a CERCLA site can be categorized in three distinct areas:

Chemical-specific ARARs are typically health- or risk-based numerical values or methodologies that establish site-specific acceptable chemical concentrations or amounts. These values are used to develop action levels or cleanup concentrations.

Location-specific ARARs involve restrictions established for specific substances or activities based on their location.

Action-specific ARARs involve performance, design, or other action-specific requirements and are generally technology- or activity-based.

A discussion of chemical- and location-specific ARARs, and potential action-specific ARARs is presented in the following subsections.

3.7.1 Chemical-specific ARARs

Chemical-specific ARARs are numerical values or procedures that, when applied to a specific site, establish numerical limits for individual chemicals or groups of chemicals. These ARARs will govern the extent of site remediation by providing either actual cleanup levels or the basis for calculating such levels. The chemical-specific ARARs are presented in Table 3-2.

Promulgated federal standards for groundwater include MCLs, Secondary MCLs, and MCL Goals. Groundwater beneath the SAEP site is classified as GB groundwater, which is defined by CTDEP Water Quality Standards as, "Groundwater within a historically highly urbanized area or an area of intense industrial activity and where public water supply service is available. Such groundwater may not be suitable for human consumption without treatment due to waste discharges, spills, or leaks of chemicals or land use impacts." Promulgated federal standards are applicable to groundwater that is or may be used as a source of drinking water. Therefore, the federal standards are not considered applicable for the OU 2 Source Area NCRA.

The CTDEP RSR includes standards for groundwater remediation. The CTDEP RSR requires that groundwater be remediated to attain the VC and SWPC. As stated in Section 3.5, the removal action goals for groundwater are based on the lower of the CTDEP RSR SWPC or I/C VC. The removal action alternatives evaluated in this EE/CA will provide a reduction in hexavalent chromium and VOC concentrations in groundwater hot-spot areas. The goal of these removal actions is not to reduce groundwater contaminant concentrations in all of OU 2 groundwater to the CTDEP RSR criteria, only to reduce concentrations in hot-spot area groundwater.

The CTDEP RSR includes a provision that remediation of VOCs in groundwater is not required if the concentration of VOCs in soil vapors below a building do not exceed the CTDEP RSR VC for soil vapor and an Environmental Land Use Restriction (ELUR) is in affect. However, for OU 2 there are exceedances of the groundwater VC, soil vapor VC, and indoor air target concentrations. Therefore, the VOC groundwater contamination requires remediation in accordance with the CTDEP RSR.

If a groundwater plume discharges to a wetland, the aquatic life criteria in the CTDEP Water Quality Standards would be applicable, rather than the CTDEP RSR SWPC. A numerical, groundwater-contaminant fate and transport model is being conducted in conjunction with the RI/FS for SAEP. Because the model has not yet been completed, it has not been determined whether the OU 2 groundwater hot-spots discharge to the tidal flats of the Housatonic River. Therefore, the CTDEP RSR SWPC (and I/C VC) will be used for the OU 2 groundwater hot-spots. If the model determines that groundwater discharges to the tidal flats of the Housatonic River, the long-term groundwater remedy will comply with the CTDEP Water Quality Standards.

In support of the long-term groundwater remedy, alternate SWPC and/or site-specific VC may be developed in conjunction with the FS. The alternate criteria will be developed in accordance with the CTDEP RSR and must be approved by the Commissioner of Environmental Protection.

Other chemical-specific criteria and guidance to be considered for this removal action are the USEPA Risk Reference Doses (RfDs) and Cancer Slope Factors (CSFs). The USEPA RfDs and CSFs were used in development of risk-based cleanup goals for indoor building surface decontamination of chromium-contaminated material.

3.7.2 Location-specific ARARs

Location-specific ARARs set restrictions on the concentrations of hazardous substances or the performance of activities solely because they are in special locations. These ARARs set restrictions relative to special locations such as wetlands, floodplains, sensitive ecosystems, and historical or archeological sites, and provide a basis for assessing existing site conditions. The location-specific ARARs are presented in Table 3-3.

3.7.3 Action-specific ARARs

Action-specific ARARs, unlike chemical- or location-specific ARARs, are usually technology- or activity-based limitations that direct how removal actions are conducted. The applicability of this set of requirements is directly related to the particular activities selected for the site. Evaluation of action-specific ARARs is one criterion for assessing the feasibility and effectiveness of proposed removal alternatives. The potential action-specific ARARs that may apply to the proposed removal alternatives identified in this EE/CA are presented in Table 3-4. The action-specific ARARs for the selected removal action alternative will be presented in the OU 2 RAM.

4.0 IDENTIFICATION AND SCREENING OF POTENTIAL REMOVAL ACTION TECHNOLOGIES

To address general OU 2 groundwater contamination at SAEP, a preliminary approach for long-term contaminant reduction has been developed. This general approach considers reduction of hexavalent chromium and VOC concentrations in hot-spot areas and long-term VOC residual contaminant reduction from natural attenuation processes. Groundwater hot-spots may be addressed with several technologies; however, in order for natural attenuation processes to reduce residual VOC contamination the aquifer must be left in a reduced state.

Different categories of potential groundwater hot-spot removal action technologies have been identified based on a review of literature, vendor information, performance data, previous experience with the technologies, and the need for a reduced state aquifer following hot-spot contaminant removal. The technologies were identified to attain the removal action objectives established in Subsection 3.4. The result is a list of potential removal action technologies that may be developed into removal action alternatives. Table 4-1 identifies the potential groundwater hot-spot removal technologies and provides a brief description of each.

The candidate removal action technologies are then screened based on their applicability to site- and waste-limiting characteristics. The screening process assesses each technology for its probable effectiveness and implementability with regard to site-specific conditions and known contaminants. The effectiveness evaluation focuses on:

- whether the technology can achieve the removal action objectives,
- whether the technology is capable of addressing the estimated volumes and concentrations of contaminants,
- whether the technology is protective of human health and the environment during construction and implementation, and
- whether the technology is proven and reliable with respect to contaminants and conditions at the site.

The implementability evaluation considers both the technical and administrative feasibility of implementing a technology.

Effectiveness and implementability are incorporated into two screening criteria: waste- and site-limiting characteristics. Waste-limiting characteristics consider the suitability of a technology based on contaminant types, individual compound properties (e.g., volatility, solubility, specific gravity, adsorption potential, and biodegradability), and interactions that may occur between mixtures of compounds. Site-limiting characteristics consider the effect of site-specific physical features on the implementability of a technology, including topography, geology, location of buildings, and underground utilities, available space, and proximity to sensitive operations.

Table 4-2 summarizes the technology-screening process. Technologies judged ineffective or not implementable were eliminated from further consideration. The technologies retained following screening may be used either alone or integrated with other technologies to develop removal action alternatives. Pilot-scale treatability studies may be required prior to final technology selection to confirm the effectiveness of a given technology.

5.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Although Section 300.415 of the NCP provides examples of removal actions, it sets forth no specific requirements for identifying and evaluating removal alternatives. USEPA guidance on preparing EE/CAs suggests developing and assessing a limited number of alternatives appropriate for addressing the removal action objectives, while considering the CERCLA preference for treatment. The guidance also suggests the use of presumptive remedy guidance to provide an immediate focus to the discussion and selection of alternatives, and limit the universe of alternatives (USEPA, 1993b). In this section, a limited number of removal action alternatives are developed using the removal action technologies retained during screening in Section 4.0.

Following development of the removal action alternatives, the alternatives are evaluated using the effectiveness, implementability, and cost criteria set forth in the NCP and USEPA guidance on preparing EE/CAs.

The effectiveness of each alternative is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Implementability addresses the technical and administrative feasibility of implementing the alternative and is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

State and community acceptance will be addressed following regulatory agency and public review of this EE/CA.

A cost estimate was prepared for each alternative to aid in selection of a removal action. Each estimate contains removal action costs for Years 1 and 2, and a net present worth (NPW)) cost for the remainder of alternative operation (i.e., post-removal operation and maintenance [O&M]), to a maximum of 30 years. The two-year capital cost is presented in order to provide an estimate of the costs associated with activities to be completed as part of the NCRA, and includes (1) the direct and indirect costs associated with alternative construction, and (2) O&M costs for the first two years of the alternative. The NPW post-removal cost, includes costs associated with long-term operation and/or monitoring of the alternative. The removal action alternatives presented in this EE/CA are not expected to be the final remedy for the site; however, they are anticipated to be consistent with the final remedy. Post-removal costs (i.e., long-term O&M) have been developed to provide a cost estimate that represents the anticipated lifetime cost of the alternative, if it wereselected as the final remedy for the site during the FS.

The U.S. Army is responsible for the jurisdiction, control, and accountability of the SAEP facility, as well as the O&M activities associated with the removal actions. Funding for the removal actions, including O&M, will be provided through the U.S. Army.

The following subsections provide a detailed description of the alternatives, and evaluate the alternatives using the effectiveness, implementability, and cost criteria. The removal action alternatives evaluated in the following subsections are:

<u>Chromium Hot Spot Area – Chromium Plating Room Structures:</u>

Alternative CR-S-1	Removal and Off-site Disposal of Floor and Wall/Decontamination of Beams
Alternative CR-S-2	Removal and Off-site Disposal of Wall/Impermeable Cover on Floor/Decontamination of Beams

<u>Chromium Hot Spot Area - Groundwater:</u>

Alternative CR-GW-1	In-situ Reduction using Ferrous Sulfate
Alternative CR-GW-2	Groundwater Monitoring

<u>VOC Hot Spot Areas 1, 2, and 3 - Groundwater:</u>

Alternative VOC-1	In-situ Soil Vapor Extraction (SVE) and Groundwater Monitoring
Alternative VOC-2	In-situ Chemical Oxidation using Potassium Permanganate, In-situ Air Sparging, In-situ SVE, and Groundwater Monitoring
Alternative VOC-3	In-situ Thermal Treatment, In-situ SVE, and Groundwater Monitoring

Additional characterization of soil and groundwater will be necessary prior to design and implementation of the removal action alternatives. The additional characterization activities, to be conducted during design of the removal action alternatives, may affect the conceptual designs and cost estimates presented in this EE/CA. Additional characterization will be conducted for the following:

- Shallow soil characterization for potential chromium contamination outside the footprint of the former Chromium Plating Facility;
- Groundwater characterization for deeper chromium contamination in the southern/eastern portion of the former Chromium Plating Facility; and
- Further delineation of the lateral extent of VOC Hot-spot No. 2.

5.1 ALTERNATIVE CR-S-1 – REMOVAL AND OFF-SITE DISPOSAL OF FLOOR AND WALL/DECONTAMINATION OF BEAMS

The scope of Alternative CR-S-1 includes the following components:

- A structural analysis
- Removal of the northwestern wall
- Removal of the concrete floor and placement of a vapor barrier and new concrete
- Washing, sandblasting, and painting of the overhead beams
- Implementation of ELURs
- Long-term O&M

5.1.1 Description of the Alternative

Alternative CR-S-1 will include a structural analysis of the facility to evaluate the stability of the former Chromium Plating Facility under the conditions anticipated to be encountered during the removal action. The structural analysis will include a building inspection and a summary report.

Removal of the northwestern wall of the facility will be the initial construction component of Alternative CR-S-1 (Figure 5-1). Heavy construction equipment, such as a backhoe, will be used to break up the concrete blocks. Wall debris (i.e., broken concrete block) will be stockpiled in a designated area within the former Chromium Plating Facility while characterization sampling is completed. The wall will not be replaced following removal; however, to secure the former Chromium Plating Facility area, three new doorways will be constructed on the adjacent wall.

The second construction component of Alternative CR-S-1 will involve the removal and replacement of the estimated 15,200 square foot concrete floor. The concrete will be cut with a saw, broken into smaller pieces, and removed with a small backhoe. Metal sump covers and hydraulic lift platforms will be removed, decontaminated, and sent off-site for disposal or future re-use. Prior to concrete removal, existing monitoring wells and piezometers not scheduled to be used during future removal actions will be abandoned by filling the wells with bentonite grout. Following floor removal, the well casings will be cut flush with the ground surface. Twelve existing monitoring wells that may be used for future removal actions will remain in place.

Wall debris and excavated concrete will be stockpiled in a designated area within the former Chromium Plating Facility and sampled to characterize the debris for off-site disposal.. Following receipt of sampling results, the debris will be loaded into trucks and transported off-site for disposal. Characterization sampling and analysis will determine if the debris will be disposed as a non-hazardous waste or as a RCRA hazardous waste.

After concrete floor removal, an impermeable vapor barrier will be placed over the exposed soil in the former Chromium Plating Facility. The vapor barrier will consist of 40 mil High-Density Polyethylene (HDPE) sheeting that will be heat seamed and booted around the existing monitoring wells and steel support posts. A new 6-inch thick concrete floor will then be poured over the sheeting.

Cleaning of the contaminated overhead beams in the northwestern end of the facility will then be completed (see Figure 5-1). A three-step process will be implemented, if necessary, starting with steam washing using a pressure washer, sandblasting, and painting. Wipe sampling will be conducted between each phase of the process to determine the effectiveness of the previous phase. If sampling indicates the previous phase successfully removed hexavalent chromium contamination, the subsequent phase will not be implemented. Upon successful removal of hexavalent chromium-contaminated dust, the entire Chromium Plating Facility will be washed using pressurized steam cleaning equipment to remove dust generated during wall and floor removal. Decontamination water generated during the facility cleaning will be containerized for possible treatment and discharge to the SAEP CWTP.

The final actions to be completed under Alternative CR-S-1 will be the implementation of ELURs and preparation of a Final Removal Action Report. ELURs will be implemented to prevent floor penetration and subsurface work within the limits of the facility. These restrictions will prevent the potential exposure of receptors to any remaining subsurface contamination. A Final Removal Action Report will be written documenting the removal action activities and the results of confirmation sampling and analysis.

Long-term O&M of the former Chromium Plating Facility structures will include a building inspection to be conducted one year following completion of the removal actions, and subsequent five-year site reviews. The building inspection will consist of a site walkover to evaluate the condition of the concrete floor and overhead beams and a summary technical memorandum. Six five-year reviews, consisting of a building inspection and a summary report, will be conducted to monitor the integrity of the concrete floor. Building maintenance activities will be conducted, as necessary on the former Chromium Plating Facility structures.

Alternative Interactions

It is not anticipated that implementation of this alternative will significantly impact the implementation of future actions at the site, including removal actions for hexavalent chromium-contaminated groundwater or VOC-contaminated groundwater.

5.1.2 Effectiveness

The effectiveness of Alternative CR-S-1 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative CR-S-1 uses a combination of engineering controls and institutional controls to eliminate risks to potential receptors from hexavalent chromium on facility structures. The alternative will provide protection of human health and the environment by removing structures within the former Chromium Plating Facility that contain concentrations of hexavalent chromium greater than the risk-based removal action goals. In addition, if hexavalent chromium cannot be removed from the overhead beams, painting of the beams will effectively encapsulate contamination and prevent exposure to potential receptors. Contamination of the new concrete floor from the underlying soil and future exposure to contamination will be controlled by the placement of an impermeable vapor barrier under the new floor.

Construction activities completed during the removal action may pose a short-term risk to site workers. Completion of the work in the appropriate level of personal protection and monitoring of site conditions during alternative implementation will limit the potential for worker exposure. Characterization sampling and analysis and appropriate off-site disposal will ensure removed contamination is properly handled.

Compliance with ARARs. Alternative CR-S-1 will be designed and implemented to attain the identified federal and state ARARs (see Tables 3-2 through 3-4).

Chemical-specific ARARs related to Alternative CR-S-1 include the USEPA RfDs and CSFs that were used to develop the risk-based removal action goals for structures. Removal of structures with contamination in excess of the goals will meet chemical-specific ARARs and eliminate risk associated with hexavalent chromium dust.

Location-specific ARARs pertaining to this alternative include those related to flood plain and coastal zone management. Actions taken under this alternative are not anticipated to have negative impacts to the shoreline of the Housatonic River. Design of the alternative will consider these location-specific ARARs and minimize its impact to the river.

Action-specific ARARs related to this alternative include air emissions, noise pollution, waste identification and listing, and waste generation and storage. Dust and noise levels will be monitored during demolition activities. If necessary, dust control measures will be implemented. Demolition debris generated, including wall and floor material, will be characterized through sampling and analysis and appropriately disposed off-site.

Long-term effectiveness. Alternative CR-S-1 will provide long-term effectiveness by removing structures within the former Chromium Plating Facility that contain concentrations of hexavalent chromium greater than the risk-based removal action goals. Placement of an impermeable vapor barrier under the new floor and implementation of ELURs will control risks associated with contamination remaining in subsurface soil. If hexavalent chromium can not be removed from the overhead beams, painting of the beams will effectively encapsulate residual contamination and prevent exposure to potential receptors. This contamination will be the only residual remaining on facility structures under Alternative CR-S-1.

The long-term effectiveness of Alternative CR-S-1 will be monitored by five-year site reviews. Building inspections will determine the competence of the concrete floor and the condition of the overhead beams. Regular maintenance of the facility structures will be completed as necessary to prevent exposure.

This alternative will not interfere with future removal actions or remedial actions at the SAEP site.

Reduction of toxicity, mobility, or volume through treatment. Because Alternative CR-S-1 proposes removal of contamination from the SAEP site, it provides a significant and irreversible reduction in contaminant volume to potential SAEP receptors. If hexavalent chromium contamination is not removed from the overhead beams and is covered by paint, the process will provide for a reduction in contaminant mobility. The mobility of hexavalent chromium contamination from subsurface soil to the new concrete floor will be reduced by the placement of a vapor barrier below the new floor. Concentrations of hexavalent chromium will be unable to migrate from the underlying soil into the new concrete. The potential for receptor exposure to residual contamination on overhead beams and leached contamination in the new floor is not considered significant.

Contaminated structures will be transported off-site for disposal based on the results of characterization sampling and analysis. Direct landfilling of the contaminated material will provide for a slight reduction in contaminant mobility; however, contaminant toxicity and volume will not change. Because contamination on structures will not be treated, this alternative does not meet the CERCLA statutory preference for treatment.

Short-term effectiveness. Access to the SAEP facility is restricted; therefore, potential risks to the community will be minimized during construction activities. Monitoring of dust levels will be conducted and engineering controls will be implemented, as necessary, to prevent off-site migration of contaminated dust. Short-term risks to the community from off-site transportation of demolition debris will be minimized through the use of dump truck covers and dust control measures.

Alternative CR-S-1 will have potential short-term risks to site workers; however, these risks will be minimized by effectively implementing an approved Site Safety and Health Plan (SSHP). Use of the appropriate level of personal protection will prevent inhalation of potentially contaminated dust. Monitoring of site conditions (e.g., dust levels, VOC field readings, etc.), will determine the appropriate level of personal protection.

Due to the location of the former Chromium Plating Facility, including the distance to ecological environments, implementation of Alternative CR-S-1 is not anticipated to have any negative impacts on the environment.

It is anticipated that implementation of Alternative CR-S-1 could be completed in approximately 12 weeks, at which time the removal action objectives will be achieved.

5.1.3 Implementability

The implementability of Alternative CR-S-1 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative CR-S-1 is considered technically feasible because traditional demolition and construction activities will be required to complete the action. It has been assumed that temporary support of the facility ceiling and columns will not be necessary during wall and floor removal. If support is necessary, the details of these actions will be easily developed during engineering design. This alternative will not interfere with future removal actions or remedial actions.

Administrative feasibility. Alternative CR-S-1 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met. Construction activities proposed under this alternative will be completed on the SAEP site.

Availability of services and materials. Alternative CR-S-1 can be implemented using standard or commonly available construction methods, services, and materials. Experienced contractors and materials necessary for demolition of the northwest wall, removal and replacement of the floor, and cleaning of the overhead beams are readily available. Off-site licensed treatment, storage, and disposal facilities (TSDFs) are also available for the chromium-contaminated materials and demolition debris.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

5.1.4 Cost

The two-year removal action cost for this alternative is estimated to be $601,000 and the NPW post-removal O&M cost is estimated to be $40,000. The cost summary for this alternative is provided in Table 5-1 and Appendix B presents the detailed cost estimate. Consistent with USEPA guidance, a discount rate of seven percent was used to prepare the cost estimate (USEPA, 1993a).

The following bullets summarize the assumptions used to prepare the cost estimate for Alternative CR-S-1. Changes in the assumptions may result in reductions or increases in the actual costs.

GENERAL COST ASSUMPTIONS

- A licensed structural engineer will perform a structural analysis of the former Chromium Plating Facility prior to initiation of removal actions. The analysis shall include a summary report.
- No actions will be necessary to maintain structural stability of the building during the removal action .
- Removal actions will be conducted in Level B personal protective equipment.
- Removal of the northwestern wall will occur first, followed by removal and replacement of the concrete floor, washing, sandblasting, and painting of the overhead beams, and a final steam wash of the entire facility (to remove generated dust).
- Some mobilization costs such as decontamination pads and personnel showers were not included based on their inclusion in one of the VOC alternatives, and the assumption they will be located close enough for use during this alternative.
- Assumes that existing office space, toilets, and phones are provided by the facility for the remediation work, and that no additional cost to the project is incurred for these facilities.

Wall Removal

- The northwestern wall of the facility is not a load-bearing wall and will not require temporary support during removal.
- The wall will not be replaced following removal; however, three new doorways will require construction following wall removal to secure the area. The existing plywood wall and door in the southwestern corner of the facility will remain in place.
- No other portions of the facility walls will be removed.

Floor Removal and Re-pouring

- The control panels located outside the northwestern-most wall will be removed in order to facilitate removal of the concrete floor in this area.
- The hydraulic elevator platforms and sump covers will be removed, steam cleaned, and salvaged.
- It is assumed temporary bracing of the support columns will not be necessary.

- An estimated 13 existing monitoring wells and piezometers in the former Chromium Plating Facility will be abandoned prior to removal of the concrete floor.
- The TCE area pilot test extraction well, four injection wells, and seven piezometers will remain in place.
- Concrete on the floor of the facility will be cut with a saw and crushed and removed with a small backhoe.
- A vapor barrier, consisting of 40 mil HDPE, will be placed in all areas of the facility where subsurface soil is exposed following floor removal.
- A new concrete floor will be poured to the same thickness as the original floor.

Debris Sampling, Analysis, and Off-site Disposal

- Characterization samples for off-site disposal will be collected at a rate of one sample per 25 cubic yards in floor material. Up to five samples will be collected from wall concrete.
- Stockpiling of concrete will occur within the former Chromium Plating Facility; a separate stockpile area will not be built.
- It is estimated that 20 percent of the wall concrete and 50 percent of the floor concrete will require off-site disposal as RCRA hazardous debris. The remaining 80 percent of wall concrete and 50 percent of floor concrete will be disposed of at an off-site non-hazardous waste landfill.

Overhead Beam Cleaning and Sampling

- It has been assumed, strictly for costing purposes, that steam washing and sandblasting of overhead beams in the northwestern-most end of the facility will not entirely remove contamination; therefore, painting of the beams also will be required after sandblasting to reduce potential for contaminant exposure.
- Approximately 1000 linear feet of overhead beam will require decontamination.
- A hydraulic lift will be necessary to complete each phase of overhead beam decontamination.
- Confirmation sampling will be conducted following completion of steam washing and sandblasting.

Long-term O&M

- ELURs will be placed on the former Chromium Plating Facility following completion of removal actions to prevent floor penetration and subsurface work within the limits of the facility.
- A Final Removal Action Report will be written documenting the removal action activities and the results of confirmation sampling and analysis.
- Follow-up building inspections are assumed to be unnecessary.
- Six five-year site reviews will be conducted and will consist of a building inspection and a summary report.

5.2 ALTERNATIVE CR-S-2 – REMOVAL AND OFF-SITE DISPOSAL OF WALL/IMPERMEABLE COVER ON FLOOR/DECONTAMINATION OF BEAMS

The scope of Alternative CR-S-2 includes the following components:

- A structural analysis
- Removal of the northwestern wall
- Washing, sandblasting, and painting of the overhead beams
- Placement of a vapor barrier and the pouring of a new floor
- Implementation of ELURs
- Long-term O&M

5.2.1 Description of the Alternative

Alternative CR-S-2 will include a structural analysis of the facility to evaluate the stability of the former Chromium Plating Facility under the conditions anticipated to be encountered during the removal action. The structural analysis will include a building inspection and a summary report.

Removal of the northwestern wall of the facility will be the initial construction component of Alternative CR-S-2 (see Figure 5-1). Removal of the wall will be completed as described for Alternative CR-S-1.

Wall debris will be stockpiled in a designated area within the former Chromium Plating Facility and sampled for off-site characterization analysis. Following receipt of sampling results, the debris will be loaded into trucks and transported off-site for disposal. Characterization sampling and analysis will determine if the debris will be disposed as a non-hazardous waste or as a RCRA hazardous waste.

The second construction component of Alternative CR-S-2 will involve cleaning of the contaminated overhead beams in the northwestern-most end of the facility (see Figure 5-1). The three-step process described for Alternative CR-S-1 will also be implemented under this alternative, if necessary. Upon successful removal of hexavalent chromium-contaminated dust, the entire Chromium Plating Facility will be washed using pressurized steam cleaning equipment to remove dust generated during wall removal. Decontamination water generated during the facility cleaning will be containerized for possible treatment and discharge to the SAEP CWTP.

Existing monitoring wells and piezometers not scheduled to be used during future removal actions will be abandoned by filling the wells with bentonite grout and cutting the well casings flush with the existing floor surface. Twelve existing monitoring wells that may be used for future removal actions will remain in place. The risers of these monitoring wells will be extended to allow access to the wells after pouring of the new concrete floor. In addition, the two existing hydraulic lift platforms and existing metal sump covers will be removed from the facility, decontaminated, and sent off-site for disposal or future re-use. All existing sumps in the concrete floor will be sealed.

A vapor barrier will be placed over the existing floor in the former Chromium Plating Facility. The vapor barrier will consist of 40 mil HDPE sheeting that will be heat seamed and booted around the existing monitoring wells. A new 6-inch thick concrete floor will then be poured over the sheeting. The new concrete will be ramped to existing entryways such that the doorways will not require rebuilding.

As for Alternative CR-S-1, implementation of ELURs and preparation of a Final Removal Action Report will be completed. Long-term O&M of the former Chromium Plating Facility structures will include a building inspection to be conducted one year following completion of the removal actions and five-year site reviews. The building inspection will consist of a site walkover to evaluate the condition of the concrete floor and overhead beams and a summary technical memorandum. Six five-year reviews, consisting of a building inspection and a summary report, will be conducted to monitor the integrity of the concrete floor. Maintenance activities will be conducted, as necessary, on the former Chromium Plating Facility structures.

Alternative Interactions

It is not anticipated that implementation of this alternative will significantly impact the implementation of future actions at the site, including removal actions for hexavalent chromium-contaminated groundwater or VOC-contaminated groundwater.

5.2.2 Effectiveness

The effectiveness of Alternative CR-S-2 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative CR-S-2 uses a combination of engineering controls and institutional controls to reduce risks to potential receptors from hexavalent chromium on facility structures. The alternative will provide protection of human health and the environment by removing the wall within the former Chromium Plating Facility that contains concentrations of hexavalent chromium greater than the risk-based removal action goals. Placement of an impermeable vapor barrier and approximately six inches of concrete over the existing contaminated floor along with implementation of ELURs will prevent potential receptor exposure to contaminated concrete. The vapor barrier will prevent contamination of the new concrete floor. If hexavalent chromium can not be removed from the overhead beams during re-washing and sandblasting, painting of the beams will effectively encapsulate contamination and prevent exposure to potential receptors.

Construction activities completed during the removal action may pose a short-term risk to site workers. Completion of the work in the appropriate level of personal protection and monitoring of site conditions during alternative implementation will limit the potential for worker exposure. Characterization sampling and analysis and appropriate off-site disposal will ensure removed contamination was properly handled.

Compliance with ARARs. Alternative CR-S-2 will be designed and implemented to attain the identified federal and state ARARs (see Tables 3-2 through 3-4).

Chemical-specific ARARs related to Alternative CR-S-2 include the USEPA RfDs and CSFs that were used to develop the risk-based removal action goals for structures. Placement of a vapor barrier and six inches of concrete over the existing floor will eliminate the receptor exposure pathway to contamination.

Location-specific ARARs pertaining to this alternative include those related to flood plain and coastal zone management. Actions taken under this alternative are not anticipated to have negative impacts to the shoreline of the Housatonic River. Design of the alternative will consider these location-specific ARARs and minimize its impact to the river.

Action-specific ARARs related to this alternative include air emissions, noise pollution, waste identification and listing, and waste generation and storage. Dust and noise levels will be monitored during demolition activities. If necessary, dust control measures will be implemented. Demolition debris generated, including wall material, will be characterized through sampling and analysis and appropriately disposed off-site.

Long-term effectiveness. Alternative CR-S-2 will provide protection of human health and the environment by removing the wall within the former Chromium Plating Facility that contains concentrations of hexavalent chromium greater than the risk-based removal action goals. Placement of an impermeable vapor barrier and approximately 6 inches of concrete over the existing contaminated floor along with implementation of ELURs will prevent potential receptor exposure to contaminated concrete. The vapor barrier will prevent contamination of the new concrete floor from the residual contamination on the underlying floor. If hexavalent chromium can not be removed from the overhead beams during re-washing and sandblasting, painting of the beams will effectively encapsulate residual contamination and prevent exposure to potential receptors.

The long-term effectiveness of Alternative CR-S-2 will be monitored by five-year site reviews. Building inspections will determine the competence of the concrete floor and the condition of the overhead beams. Regular maintenance of the facility structures will be completed as necessary to prevent exposure.

The alternative will not interfere with future removal actions or remedial actions at the SAEP site.

Reduction of toxicity, mobility, or volume through treatment. Because Alternative CR-S-2 proposes removal of the contaminated concrete wall from the SAEP site, it provides a significant and irreversible reduction in contaminant volume to potential SAEP receptors. The placement of a vapor barrier and 6 inches of new concrete will reduce the mobility of contamination in the existing concrete floor; concentrations of hexavalent chromium will be unable to migrate from the underlying concrete floor to the new concrete. If hexavalent chromium contamination is not removed from the overhead beams and is covered by paint, the process will provide for a reduction in contaminant mobility. The potential for receptor exposure to residual contamination on overhead beams and leached contamination in the new floor is not considered significant.

Contaminated concrete from the wall will be transported off-site for disposal based on the results of characterization sampling and analysis. Direct landfilling of the contaminated material will provide for a slight reduction in contaminant mobility; however, contaminant toxicity and volume will not change. Because contamination on structures will not be treated, this alternative does not meet CERCLAs preference for treatment.

Short-term effectiveness. Access to the SAEP facility is restricted; therefore, potential risks to the community will be minimized during construction activities. Monitoring of dust levels will be conducted and engineering controls will be implemented, as necessary, to prevent off-site migration of contaminated dust. Short-term risks to the community from off-site transportation of demolition debris will be minimized through the use of dump truck covers and dust control measures.

Alternative CR-S-2 will have potential short-term risks to site workers; however, these risks will be minimized by effectively implementing an approved SSHP. Use of the appropriate level of personal protection will prevent inhalation of potentially contaminated dust. Monitoring of site conditions (e.g., dust levels, VOC field readings, etc.), will determine the appropriate level of personal protection.

Due to the location of the former Chromium Plating Facility, including the distance to ecological environments, implementation of Alternative CR-S-2 is not anticipated to have any negative impacts on the environment.

It is anticipated that implementation of Alternative CR-S-2 could be completed in approximately 12 weeks, at which time the removal action objectives will be achieved.

5.2.3 Implementability

The implementability of Alternative CR-S-2 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative CR-S-2 is considered technically feasible because traditional demolition and construction activities will be required to complete the action. It has been assumed that temporary support of the facility ceiling and columns will not be necessary during wall removal. If support is necessary, the details of these actions will be easily developed during engineering design. This alternative will not interfere with future removal actions or remedial actions.

Administrative feasibility. Alternative CR-S-2 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met. Construction activities proposed under this alternative will be completed on the SAEP site.

Availability of services and materials. Alternative CR-S-2 can be implemented using standard or commonly available construction methods, services, and materials. Experienced contractors and materials necessary for demolition of the northwest wall, replacement of the floor, and cleaning of the overhead beams are readily available. Off-site licensed TSDFs are also available for the chromium-contaminated materials and demolition debris.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

5.2.4 Cost

The two-year removal action cost for this alternative is estimated to be $522,000 and the NPW post-removal O&M cost is estimated to be $40,000. The cost evaluation for this alternative is provided in Table 5-2 and Appendix B presents the detailed cost estimate. Consistent with USEPA guidance, a discount rate of seven percent was used to prepare the cost estimate (USEPA, 1993a).

The following bullets summarize the assumptions used to prepare the cost estimate for Alternative CR-S-2. Changes in the assumptions may result in reductions or increases in the actual costs.

GENERAL COST ASSUMPTIONS

- A licensed structural engineer will perform a structural analysis of the former Chromium Plating Facility prior to initiation of removal actions. The analysis will include a summary report
- No actions will be necessary to maintain structural stability of the building during the removal action.
- Removal actions will be conducted in Level B personal protective equipment.
- Removal of the northwestern-most wall will occur first, followed by washing, sandblasting, and painting of the overhead beams, steam washing the entire facility (to remove generated dust), and placement of a vapor barrier and a new concrete floor.
- Some mobilization costs such as decontamination pads and personnel showers were not included based on their inclusion in one of the VOC alternatives, and the assumption they will be located close enough for use during this alternative.
- Assumes that existing office space, toilets, and phones are provided by the facility for the remediation work, and that no additional cost to the project is incurred for these facilities.

Wall Removal

- The northwestern-most wall of the facility is not a load-bearing wall and will not require temporary support during removal.
- The wall will not be replaced following removal; however, three new doorways will require construction following wall removal to secure the area. The existing plywood wall and door in the southwestern-most corner of the facility will remain in place.
- No other portions of the facility walls will be removed.

Debris Sampling, Analysis, and Off-site Disposal

- Up to five characterization samples for off-site disposal will be collected from wall concrete.
- Stockpiling of concrete will occur within the former Chromium Plating Facility; a separate stockpile area will not be built.
- It is estimated that 20 percent of the wall concrete will require off-site disposal as RCRA hazardous debris. The remaining 80 percent of wall concrete will be disposed of at an off-site non-hazardous waste landfill.

Overhead Beam Cleaning and Sampling

- It has been assumed, strictly for costing purposes, that steam washing and sandblasting of overhead beams in the northwestern-most end of the facility will not entirely remove contamination; therefore, painting of the beams also will be required after sandblasting to reduce potential for contaminant exposure.
- Approximately 1000 linear feet of overhead beam will require decontamination.

- A hydraulic lift will be necessary to complete each phase of overhead beam decontamination.
- Confirmation sampling will be conducted following completion of steam washing and sandblasting.

Vapor Barrier Placement and Pouring of a New Floor

- The control panels located outside the northwestern-most wall will be removed in order to facilitate repouring of the concrete floor in this area.
- The hydraulic elevator platforms and sump covers will be removed, steam cleaned, and salvaged.
- An estimated 13 existing monitoring wells and piezometers in the former Chromium Plating Facility will be abandoned prior to repouring of the concrete floor.
- The TCE area pilot test extraction well, four injection wells, and seven piezometers (including nested piezometer PZ-99-01 A/B/C) will remain in place and will be extended to be level with the new floor.
- A vapor barrier will be placed under all areas of the new floor. The vapor barrier will consist of 40 mil HDPE and will be heat seamed and booted around existing wells
- Concrete ramps will be used in the doorways to the former Chromium Plating Facility laboratory, in doorways leading to other areas of Building B-2, and in doorways leading outdoors; however, four existing doorways will require replacement to account for the new floor elevation.

Long-term O&M

- ELURs will be placed on the former Chromium Plating Facility following completion of removal actions to prevent floor penetration and subsurface work within the limits of the facility.
- A Final Removal Action Report will be written documenting the removal action activities and the results of confirmation sampling and analysis.
- Follow-up building inspections are assumed to be unnecessary.
- Six five-year site reviews will be conducted and will consist of a building inspection and a summary report.

5.3 ALTERNATIVE CR-GW-1 - IN-SITU REDUCTION USING FERROUS SULFATE

The scope of Alternative CR-GW-1 includes the following components:

- Installation of ferrous sulfate injection wells
- Construction of an injection system
- Pressure testing the chemical waste pipeline (from Building 63 to the CWTP) and replacement of the pipeline, if necessary
- Installation of groundwater extraction wells
- Construction of an organics treatment system (at the CWTP)

- O&M of the in-situ treatment system
- Groundwater sampling and analysis
- Implementation of an ELUR

5.3.1 Description of the Alternative

The removal action for Alternative CR-GW-1 will include injection of ferrous sulfate to reduce hexavalent chromium in groundwater to trivalent chromium. Extraction wells will be used to provide hydraulic control within the groundwater treatment areas. The extracted groundwater will be transferred to the CWTP where the groundwater will be treated and discharged.

In-situ Chemical Reduction. In-situ chemical reduction is a technology involving the delivery of a chemical reducing agent to the subsurface where it reacts with hexavalent chromium and creates the less toxic and less mobile trivalent chromium. There are several reducing agents that can be used for in-situ chemical reduction including ferrous sulfate, sulfur dioxide, and sodium dithionate. Based on bench-scale and pilot-scale treatability tests previously conducted at SAEP, ferrous sulfate has been identified as an effective reducing agent for the site (Foster Wheeler/HLA, 2000b). For purposes of alternative evaluation and cost estimation, the use of ferrous sulfate for chromium reduction will be assumed; however, other reducing agents may be considered during design of this alternative, if selected as the remedy.

Ferrous sulfate has been demonstrated to chemically reduce hexavalent chromium to trivalent chromium and form a precipitate containing trivalent chromium. The reaction of ferrous sulfate with hexavalent chromium proceeds as follows:

$$HCrO_4^- + 3Fe(II) + 7H^+ \rightarrow Cr(III) + 3Fe(III) + 4H_2O$$

where the chromate ion ($HCrO_4^-$) reacts with ferrous iron (Fe(II)) and hydrogen ions (H^+) to form trivalent chromium (Cr(III)), ferric iron (Fe(III)) and water (H_2O). The reaction proceeds rapidly for hexavalent chromium dissolved in groundwater; however, the overall effectiveness of the technology can be limited by the ability to effectively distribute the reducing agent in highly heterogeneous soil.

A pilot-scale treatability test for in-situ reduction was conducted for the Chromium Hot-spot (Foster Wheeler/HLA, 2000b). One of the recommendations following completion of the test was that more effective distribution of the reductant may be achieved by using many closely-spaced injection points without extraction, rather than relying on the transport of chemical along with the movement of groundwater created by injection and extraction. Given the highly developed nature of the SAEP site however, the surface access necessary for closely-space injection points is not possible without extensive demolition. For this reason, conceptual design of the in-situ reduction system is based on the injection and extraction delivery method.

The groundwater injection and extraction well locations for the Chromium Hot-spot are shown on Figure 5-2. The system will have a total of 32 injection well locations. Perimeter injection wells will be installed at 23 locations and will contain a well screen from 20 to 30 feet bgs (i.e., shallow wells). Twelve of these 23 locations will contain a second well screened from 30 to 35 feet bgs (i.e., intermediate wells). The nine remaining locations (not co-located with the above 23) will contain a well screened from 35 to 45 feet bgs (i.e., deep wells). The conceptual design is based on treating the deeper chromium-contaminated groundwater in the central portion of the former Chromium Plating Facility. However, additional groundwater characterization for deeper chromium contamination in the southern and eastern portion of the former Chromium Plating Facility will be considered during system design.

Extraction wells will be installed at two locations (see Figure 5-2). Both locations will contain one well screened from 20 to 30 feet bgs. The northwest location will contain two additional wells, one screened from 30 to 35 feet and the other from 35 to 45 feet bgs. In addition, surface infiltration trenches will be installed in the center of the hot-spot as indicated on Figure 5-2 to provide treatment from the groundwater table down to the top of the shallow screened interval.

It is estimated that the infiltration trench will receive 15 gallons per minute (gpm), the shallow zone injection wells (20 to 30 feet bgs) will receive 1 gpm each (23 gpm total), the intermediate zone injection wells will receive 1 gpm each (12 gpm total), and the deep zone injection wells will receive 0.25 gpm each (2.25 gpm total). Shallow zone extraction wells will remove 15 gpm (southeast) and 40 gpm (northwest) (55 gpm total), the intermediate extraction well will remove 15 gpm, and the deep zone extraction well will remove 5 gpm for a total overall extraction rate of 75 gpm.

Groundwater monitoring piezometers will be installed in the area of the hexavalent chromium treatment system for the collection of water levels, field parameter readings, and groundwater samples during system operation. System monitoring will be conducted to evaluate the effectiveness of the treatment system and hydraulic control. Groundwater samples will be analyzed for total chromium, hexavalent chromium, dissolved iron, and select VOCs.

Based on the results of the pilot-scale treatability test and an estimate of the mass of hexavalent chromium present in Chromium Hot-spot, approximately 617,000 pounds of ferrous sulfate will be injected into the subsurface, and treatment of the hot spot will take approximately 1.5 years (Appendix C). A process flow diagram for the ferrous sulfate injection is presented on Figure 5-3. For purposes of alternative evaluation and cost estimation, it has been assumed that potable water will be mixed with powdered ferrous sulfate to form a ferrous sulfate solution for subsurface injection. During design of this alternative, a comparison of the advantages and disadvantages of reinjection of previously extracted groundwater versus the use of potable water will be completed. This evaluation will determine the most effective method for injection of ferrous sulfate solution. Regardless of the method chosen, acid will likely be added to prevent clogging of injection wells and premature oxidation of the ferrous iron.

To limit the mass of iron that would need to be injected into the subsurface and reduce the possibility of well fouling, operation of the extraction wells could be initiated prior to injection of ferrous sulfate to flush the system. Based on the results of the pilot test, it is estimated that this initial flush would reduce the concentration (and mass) of hexavalent chromium in groundwater; thereby reducing the estimated mass of ferrous sulfate that would be required to reduce the remaining hexavalent chromium to trivalent chromium. For purposes of alternative evaluation and cost estimation, an initial flushing of the system has been assumed; however, it is also assumed that addition of acid, cleaning of wells, and installation of additional wells, would be conducted.

The initial flushing of the system is primarily intended to address shallow groundwater contamination above the first injection/extraction interval (i.e., 20 to 30 feet bgs); however, some treatment of shallow soil contamination will likely occur as a result of the initial flushing. Given that shallow soil contamination in the eastern portion of the former Chromium Plating Facility contains hexavalent chromium at concentrations that could possibly cause re-contamination of groundwater, flushing in this area may be considered during design of the treatment system.

Because the Chromium Hot-spot is co-located with VOC Hot-spot No. 1, it is expected that extracted groundwater will contain TCE in addition to hexavalent chromium. For this reason, extracted groundwater from VOC Hot-spot No. 1 will receive treatment for organics at an organics treatment system built at the influent to the CWTP. Extracted water will be directed to the existing sump at Building 63. This sump currently directs water to the CWTP via a chemical waste pipeline. This chemical waste pipeline will be pressure tested as part of this alternative. For costing purposes it is assumed that no leaks will be identified by the pressure testing; however, pipeline replacement could be necessary if this is not the case. An ultraviolet (UV)/oxidation system will be installed at the CWTP for TCE treatment prior to discharge to the CWTP. The CWTP is designed to remove hexavalent chromium and other inorganics through chemical reduction and precipitation. A UV/oxidation system was assumed for purposes of alternative evaluation and cost estimation because it is generally less susceptible to fouling than activated carbon or air stripping from the potentially high manganese or iron concentrations. Other VOC treatment options may be considered during design of a treatment system if this alternative is selected for implementation.

Alternative Interactions

Implementation of this alternative has potential impacts on future actions that may be completed at the site. As a result of the reduction of hexavalent chromium to trivalent chromium, it is possible that the length of time that groundwater monitoring is required could be reduced, compared to an alternative that does not propose treatment. However, for purposes of alternative evaluation and cost assumption, it has been assumed that 30 years of groundwater monitoring will be required to ensure reducing conditions persist in the area of the Chromium Hot-spot.

A second possible interaction is that between chromium and the oxidizing conditions possible during treatment of VOC Hot-spot No. 1. In order to limit the potential for re-oxidation of trivalent chromium by potassium permanganate, chemical oxidation of VOC Hot-spot No. 1, if selected as the remedy for that hot-spot, would be implemented prior to chemical reduction in the Hexavalent Chromium Hot-spot. Implementation of the alternatives in this order could significantly increase the amount of ferrous sulfate necessary to complete reduction of hexavalent chromium. Injected ferrous sulfate would react with excess potassium permanganate prior to reducing hexavalent chromium.

5.3.2 Effectiveness

The effectiveness of Alternative CR-GW-1 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative CR-GW-1 uses a combination of contaminated media treatment and institutional controls to reduce and control risks associated with hexavalent chromium-contaminated groundwater. In-situ reduction of the hexavalent chromium hot-spot is anticipated to reduce the concentration of hexavalent chromium to removal action goals (i.e., CTDEP RSR SWPC). Injection of ferrous sulfate will reduce hexavalent chromium to trivalent chromium that will be bound to subsurface soil and immobilized. Extracted groundwater containing hexavalent chromium will be discharged to the CWTP where the chromium will be reduced and precipitated out.

The proposed groundwater monitoring will provide information on the effectiveness of the in-situ reduction process at immobilizing chromium contamination and preventing contaminant concentrations greater than the CTDEP RSR SWPC from migrating toward the Housatonic River tidal flats.

Implementation of ELURs will provide for institutional control at the SAEP site. Alternative CR-GW-1 proposes restricting groundwater usage in the area of the Chromium Hot-spot. These restrictions will prevent potential receptor exposure to contaminated groundwater.

Alternative CR-GW-1 will provide protection to human health and the environment by (1) providing for the treatment of the hexavalent chromium groundwater hot-spot and (2) restricting the use of contaminated groundwater until CTDEP RSR criteria are met.

Compliance with ARARs. Alternative CR-GW-1 will be designed and implemented to attain the identified federal and state ARARs (see Tables 3-2 through 3-4).

Chemical-specific ARARs pertaining to Alternative CR-GW-1 are the CTDEP RSR criteria The applicable criterion is the SWPC for groundwater discharge to the tidal flats. It is anticipated that in-situ reduction will achieve CTDEP RSRs.

Location-specific ARARs pertaining to this alternative include those related to flood plain and coastal zone management. Actions taken under this alternative are not anticipated to have negative impacts to the shoreline of the Housatonic River. Design of the alternative will consider these location-specific ARARs and minimize its impact to the river.

Action-specific ARARs related to this alternative pertain to noise pollution, surface water protection, underground injection, groundwater well installation, waste identification and listing, and waste generation and storage. Installation and operation of the in-situ reduction system will be designed to comply with these ARARs.

Injection of ferrous sulfate and related chemicals into the subsurface will be conducted as detailed in a discharge to groundwater authorization obtained from the CTDEP prior to system installation. Discharge of extracted groundwater to the CWTP for eventual discharge to the Housatonic River will be allowed only as detailed in a discharge authorization. Installation of monitoring wells and handling and disposal of generated investigation-derived waste (IDW) will be conducted in compliance with specified regulations.

Long-term effectiveness. Alternative CR-GW-1 will provide long-term effectiveness because active treatment of the Chromium Hot-spot will reduce hexavalent chromium contamination in-situ. The potential exists for oxidation of the resulting trivalent chromium back to hexavalent chromium under oxidizing conditions. The condition under which oxidation may most readily occur is when manganese dioxide is present. Such a condition would be created by the addition of potassium permanganate to the reduced zone during oxidation of VOC Hot-spot No. 1. To limit the potential for re-oxidation of trivalent chromium, chemical oxidation of VOC Hot-spot No. 1, if selected as the remedy for that hot-spot, would be implemented prior to chemical reduction in the Hexavalent Chromium Hot-spot.

In the location of the Chromium Hot-spot, the aquifer will be left in a reduced state following treatment to prevent possible oxidation of trivalent chromium. Treatment of extracted groundwater at the CWTP will remove chromium contamination from the wastewater stream. Precipitated chromium sludge will be disposed off-site.

The groundwater monitoring component of Alternative CR-GW-1 will evaluate the long-term effectiveness of the alternative and ensure concentrations of hexavalent chromium greater than the CTDEP RSR SWPC are not mobilized and migrating toward the

Housatonic River tidal flats. ELURs will prevent the use of groundwater in the vicinity of the former Chromium Plating Facility for any purpose.

Following completion of this alternative, it is estimated that residual hexavalent chromium contamination will not be present.

Reduction of toxicity, mobility, or volume through treatment. Alternative CR-GW-1 proposes in-situ chemical reduction to transform hexavalent chromium contamination in the groundwater hot-spot to trivalent chromium, and groundwater extraction for hydraulic control. Transformation of the chromium to the trivalent form will be a reduction in contaminant toxicity. In addition, the in-situ trivalent chromium will be sorbed to the soil particles, resulting in a reduction in mobility. The potential exists for oxidation of the resulting trivalent chromium back to hexavalent chromium under certain conditions (i.e., the process is reversible). In the location of the hexavalent Chromium Hot-spot, the aquifer will be left in a reduced state following treatment to prevent possible oxidation of trivalent chromium.

Extracted groundwater containing hexavalent chromium will be treated at the CWTP using chemical reduction to trivalent chromium and precipitation. This process will provide an irreversible reduction in contaminant toxicity, mobility, and volume because the precipitated trivalent chromium will be removed from the extracted groundwater. This irreversible reduction in contaminant toxicity, mobility, and volume will likely be consistent with the long-term groundwater remedy. Precipitate from the CWTP will be sent off-site for disposal. Because Alternative CR-GW-1 involves active treatment, the alternative will satisfy the CERCLA statutory preference for treatment as a principal element of the remedy.

Alternative CR-GW-1 is anticipated to effectively treat the entire volume of hexavalent chromium-contaminated groundwater to below the CTDEP RSR SWPC. It is anticipated that no significant residual hexavalent chromium contamination will remain in the Chromium Hot-spot.

Short-term effectiveness. Access to the SAEP facility is restricted; therefore, potential risks to the community will be minimized during alternative installation and operation. Activities proposed under this alternative will be completed within the SAEP site boundary. Groundwater in the vicinity of the SAEP site is classified as GB Groundwater, indicating it is not used and is not proposed for use for any purpose by the community or site workers.

The in-situ chemical reduction injection and extraction system will have potential short-term risks to site workers during installation due to the potential for contaminant exposure; however, these risks will be minimized by effectively implementing an approved SSHP. The appropriate level of personal protection will be used during installation activities to prevent dermal contact with contamination. Monitoring of site conditions also will be conducted.

Groundwater monitoring during alternative implementation will provide short-term effectiveness by ensuring concentrations of hexavalent chromium in groundwater above the CTDEP RSR SWPC are not migrating toward the Housatonic River tidal flats. Discharge of treated groundwater from the CWTP to the outfalls will be monitored with regular sampling for hexavalent chromium and other permit-required parameters. Due to the location of the Chromium Hot-spot, other impacts to the environment are not expected.

It is anticipated that construction activities associated with Alternative CR-GW-1 will be completed in approximately 6 months. Operation of the in-situ chemical reduction system is estimated to continue for approximately 1.5 years, at which time the response objectives will be achieved. It has been assumed that groundwater monitoring activities will be conducted for 30 years.

5.3.3 Implementability

The implementability of Alternative CR-GW-1 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative CR-GW-1 is considered technically feasible for the areas of hexavalent chromium-contaminated groundwater. In-situ treatment of hexavalent chromium-contaminated groundwater, groundwater extraction to maintain hydraulic control in the treatment areas, and treatment of extracted groundwater in the CWTP are well-demonstrated processes. A pilot-scale treatability study demonstrating the effectiveness of in-situ chemical reduction was successfully completed in the Chromium Hot-spot at the SAEP site.

If chemical oxidation is chosen as the remedy for VOC Hot-spot No. 1, chemical oxidation would be performed prior to chemical reduction to prevent the re-oxidation of trivalent chromium to hexavalent chromium. Implementation of the alternatives in this order could significantly increase the amount of ferrous sulfate necessary to complete reduction of hexavalent chromium. Injected ferrous sulfate would react with excess potassium permanganate prior to reducing hexavalent chromium..

Administrative feasibility. Alternative CR-GW-1 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met. Discharge permits for injection to groundwater should be attainable, based on the results of pilot-scale testing of the in-situ chemical reduction system. A permit for the discharge to the CWTP, should also be easily attainable. Actions proposed under this alternative will be completed on the SAEP site.

Availability of services and materials. Alternative CR-GW-1 can be implemented using standard or commonly available construction methods, services, and materials. Experienced contractors and materials necessary for installation and operation of the in-situ chemical reduction system and the groundwater monitoring system are readily available. Laboratory services for the analysis of groundwater samples also are available. Electrical power required for system operations is available from the SAEP site.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

5.3.4 Cost

Removal action costs associated with the alternative (i.e., alternative construction and system operation) are estimated to be $3,128,000. The NPW post-removal O&M cost of this alternative (i.e., 28-years of monitoring) is estimated to be $310,000. Consistent with USEPA guidance, a discount rate of seven percent used to prepare the cost estimate (USEPA, 1993a). The cost summary for this alternative is provided in Table 5-3 and Appendix B presents the detailed cost estimate.

The following bullets summarize the assumptions used to prepare the cost estimate for Alternative CR-GW-1. Changes in the assumptions may result in reductions or increases in the actual costs.

GENERAL ASSUMPTIONS

- Removal actions will be conducted in Level D personal protective equipment.
- In-situ oxidation, if selected for the VOC area beneath the former Chromium Plating Facility, will be completed prior to in-situ reduction. In-situ reduction will also encompass the area between the two hexavalent chromium areas identified in the OU 2 Pre-design Investigation Report (Foster Wheeler/HLA, 2000a).
- It is assumed the removal action for the chromium-contaminated groundwater will require 2 years to complete including 6 months of design, procurement, and construction and 1.5 years of operation.
- Assumes purchase of all treatment equipment, not equipment leasing.
- Assumes a Geoprobe investigation will be required prior to start of alternative to reevaluate contaminant distribution after implementation of a VOC remedy at the co-located VOC Hot-spot No. 1.
- Some mobilization costs, such as decontamination pads and personnel showers, were not included based on their inclusion in one of the VOC alternatives, and the assumption they will be located close enough for use during this alternative.

- Assumes that existing office space, toilets, and phones are provided by the facility for the remediation work, and that no additional cost to the project is incurred for these facilities.

IN-SITU REDUCTION SYSTEM

Installation of extraction system

- Wells will be installed with pre-cast concrete manhole sections and covers.
- Both extraction well locations will be located inside the building; therefore, piping will not need to be installed below frost level within the building. Buried piping outside the building will be installed below the frost depth..
- Power will be supplied from Building 63. Level controls/recorders will also be located at Building 63.

Installation of injection system

- Low-clearance drill rig and/or Geoprobe required for indoor locations.
- Wells will be installed above grade with pressure gauges, flow meters, flow control valves, and hose connections on each well.
- Infiltration trenches will be installed at a 5-foot spacing within the area indicated.
- Additional injection wells will be installed during system operation to address areas where insufficient distribution of ferrous sulfate solution is observed. The number of additional injection wells is assumed to be 50 percent of the initial number of injection wells.

Installation of monitoring system

- A total of 72 piezometers will be installed to provide monitoring locations.
- All piezometers will be finished with flush-mount road boxes.

Installation of chemical make-up system

- A berm will be constructed inside Building B-10 to contain the ferrous sulfate make-up system.
- Ferrous sulfate will be delivered as a powder in bulk bags. A bulk bag dump station will feed the ferrous sulfate into a storage hopper.
- The storage hopper will have a feeder (weight or volumetric) that feeds ferrous sulfate powder into a ferrous sulfate flash mix tank. The flash mix tank will feed directly into a ferrous sulfate solution storage tank. Potable water (at 44 gpm) and sulfuric acid will also enter the flash mix tank. Sulfuric acid addition will be controlled by a pH probe in the ferrous sulfate solution tank. Automatic controls will adjust water, ferrous sulfate, and sulfuric acid rates.
- A two-week supply of ferrous sulfate will be maintained on site.
- 95 percent of the ferrous sulfate will be injected during the first year of operation. The remaining 5 percent will be injected during the last half year of operation.
- A single 5 horsepower (HP) pump will supply the required flow and pressure to the injection system. Flow rates to the wells will be controlled by control valves

at each injection well. The injection pump will have a duplicate to allow backup/maintenance. Ferrous sulfate solution will be hard piped to hose connection manifolds in six areas. Outside piping will be insulated and heat traced; no secondary containment will be provided. From the manifolds, high-pressure hose will be used to deliver ferrous sulfate solution to the individual injection wells.

Pressure testing of underground pipeline

- The entire pipeline from Building 63 to the CWTP will be pressure tested to verify no leaks are present. It is assumed no leaks will be discovered.
- Assume control wire conduit exists adjacent to this pipe and that new control wires will be pulled from the CWTP to Building 63.

Installation of Organics Treatment System

- For costing purposes, it is assumed no removal of VOCs from previous treatment; therefore, the extracted groundwater must be treated to remove organics prior to discharge to the CWTP.
- The organics treatment system will be installed adjacent to the equalization tanks of the CWTP. Water pumped from the Building 63 sump will be treated using pH adjustment to below 2.8 and UV/oxidation for TCE removal prior to discharge to the equalization basins.
- It is assumed that acid for pH reduction will be obtained from acid dosage systems at the CWTP. New piping and pH control systems will be connected to existing acid tanks/pumps.
- A centrifugal pump will pump water from the pH adjustment tank, through the UV/oxidation system and into the equalization tanks.
- It is assumed that the pH of the UV/oxidation effluent does not need to be raised back up since the first treatment step in the CWTP is pH reduction.
- A hydrogen peroxide tank and delivery system will be required as part of the UV/Oxidation system. Secondary containment of the peroxide tank will be required.
- The UV/Oxidation system will be capable of treating 75 gpm of water containing up to 100 ppm TCE down to 50 parts per billion (ppb) TCE.
- Control systems will be interlocked with the well injection/extraction system and the chemical waste treatment plant such that the plant operator receives alarms and can shut down the systems from the CWTP.
- Power for the UV/oxidation system, mixer, acid and peroxide feed systems will come from the CWTP.
- The pH adjustment tank, UV/oxidation feed pump, UV/oxidation system, and hydrogen peroxide tank/system will be housed in a new small metal structure set on a concrete pad adjacent to the CWTP.
- Discharge of the water to the CWTP will increase the operational cost of the treatment plant.

- The CWTP was adequate capacity (maximum design flow if 400 gpm) to handle the proposed 75 gpm flow rate for this alternative plus anticipated flow from other activities.

System Operation

- Sampling and analysis during system operation will include groundwater sampling and treatment system performance sampling.
- A full-time operator will be required to manage the system during the 1.5 year operation period.

Long-term O&M

- An ELUR will be placed on the former Chromium Plating Facility following completion of in-situ reduction to prevent extraction of groundwater within the limits of the facility.
- A Final Removal Action Report will be written documenting the removal action activities and the results of confirmation sampling and analysis.
- Thirty years of annual monitoring will be required to verify that the reducing conditions and acceptable hexavalent chromium concentrations are maintained in the subsurface.
- Six five-year site reviews will be conducted and will consist of a review of sampling results and a summary report.

5.4 Alternative CR-GW-2 – Groundwater Monitoring

The scope of Alternative CR-GW-2 includes the following components:

- Installation of groundwater monitoring wells
- Groundwater sampling and analysis
- Implementation of an ELUR

5.4.1 Description of the Alternative

The removal action for Alternative CR-GW-2 will include groundwater sampling of existing and newly installed monitoring wells. The groundwater samples will be analyzed for a variety of parameters, and the data will be used to evaluate contaminant concentrations over time, migration of the hexavalent chromium plume, and the occurrence of natural attenuation processes. The groundwater data and evaluation will then be used in support of evaluating and selecting a final groundwater remedy for the SAEP facility in the FS. Alternative CR-GW-2 will also include establishing an ELUR for groundwater associated with the Chromium Hot-spot.

Groundwater sampling will be conducted from existing monitoring wells and newly installed monitoring wells in the vicinity of the delineated hexavalent chromium-contaminated groundwater areas. The proposed monitoring well network, which includes three existing monitoring wells and eight new monitoring wells, is presented on Figure 5-4. These monitoring wells are located upgradient, downgradient, within, and lateral to the areas of hexavalent chromium-contaminated groundwater. Table 5-4 presents the rationale for the proposed locations of the sampling wells.

Groundwater samples will be analyzed for target contaminants of concern (COCs): total chromium and hexavalent chromium. Several other parameters will also be analyzed for to monitor and evaluate natural attenuation processes. These parameters will include TOC, nitrate, sulfate, ferrous iron, dissolved manganese, alkalinity, salinity, and chemical oxygen demand (COD). Other parameters that will be monitored using field measurements during groundwater sampling will include DO, ORP, specific conductivity, temperature, turbidity, and pH.

Groundwater monitoring will be conducted quarterly for two years. Following each groundwater sampling event, a letter report will be prepared to provide a summary and evaluation of the data, a data quality assessment, and any proposed recommendations based on a review and evaluation of the data.

The first two years of groundwater data will be used to evaluate hexavalent chromium concentrations over time and migration of the hexavalent chromium plume. The groundwater data will also be used to update the numerical, groundwater-contaminant fate and transport model prepared for the SAEP facility. Once an adequate data set is obtained, the data will be used in support of statistical and/or trend analysis. The data will also be used to evaluate if natural attenuation processes may be occurring as a result of reducing conditions in the estuarine silt layer underlying the SAEP facility. The evaluation will consider if natural conditions are providing a transformation of hexavalent chromium to the less toxic trivalent form, providing a reduction in concentrations, or a reduction in mobility. The groundwater data and evaluation will then be used in support of evaluating and selecting a final groundwater remedy for the SAEP facility in the FS, which may include monitored natural attenuation (MNA).

In accordance with the CTDEP RSR criteria, an ELUR will be required, which will establish restrictions on future use of groundwater associated with the Chromium Hot-spot.

Alternative Interactions

It is not anticipated that implementation of this alternative will significantly impact the implementation of future actions at the site, including removal actions for hexavalent chromium-contaminated structures or VOC-contaminated groundwater.

5.4.2 Effectiveness

The effectiveness of Alternative CR-GW-2 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative CR-GW-2 uses institutional controls to control risks associated with hexavalent chromium-contaminated groundwater. The groundwater associated with the SAEP facility is classified as a GB area, and is not currently used for any purposes. Alternative CR-GW-2 will provide protection of human health by establishing an ELUR that restricts future use of groundwater associated with the Chromium Hot-spot.

Currently, there is no significant exposure of environmental receptors to the groundwater. The monitoring program provides protection of the environment in so far that it will identify if the contamination is migrating closer to the point where it could result in exposure to environmental receptors and additional actions are needed.

Alternative CR-GW-2 includes the collection of groundwater data that will be used to (1) evaluate contaminant concentrations over time; (2) evaluate whether the groundwater contaminants are migrating; (3) update the numerical, groundwater-contaminant fate and transport model prepared for the SAEP facility; (4) support conducting statistical and/or trend analysis; and (5) evaluate whether natural attenuation processes are occurring. The groundwater data and evaluation will then be used in support of evaluating and selecting a final groundwater remedy for the SAEP facility that will provide overall protection of human health and the environment.

Compliance with ARARs. Alternative CR-GW-2 will be designed and implemented to attain the identified federal and state ARARs (see Tables 3-2 through 3-4).

Chemical-specific ARARs pertaining to Alternative CR-GW-2 are the CTDEP RSRs. The applicable criterion is the SWPC for groundwater discharge to the tidal flats. The removal action likely will not meet the listed CTDEP RSRs; however, groundwater data collected during the removal action will support a future remedial action (e.g., MNA) which will be implemented to comply with CTDEP RSRs.

Location-specific ARARs pertaining to this alternative include those related to flood plain and coastal zone management. Actions taken under this alternative are not anticipated to have negative impacts to the shoreline of the Housatonic River. Design of the alternative will consider these location-specific ARARs and minimize its impact to the river.

Action-specific ARARs related to this alternative pertain to noise pollution, surface water protection, groundwater well installation, waste identification and listing, and waste generation and storage. Discharge of liquids (i.e., extracted groundwater from monitoring well development) to the CWTP for eventual discharge to the Housatonic River will be allowed only as detailed in a discharge authorization from CTDEP. Installation of monitoring wells and handling and disposal of generated IDW will be conducted in compliance with specified regulations.

Long-term effectiveness. Alternative CR-GW-2 will provide long-term effectiveness by establishing institutional controls (i.e., on ELUR) to limit groundwater use and human-receptor exposure to contaminated groundwater. Long-term maintenance of these restrictions will be essential for long-term effectiveness. The groundwater data collected as part of this alternative will be used in support of a final groundwater remedy for the SAEP facility that will provide long-term effectiveness.

Groundwater monitoring will not reduce the concentrations of hexavalent chromium in groundwater; therefore, significant concentrations will remain following completion of the alternative.

Reduction of toxicity, mobility, or volume through treatment. Alternative CR-GW-2 does not include active treatment technologies and therefore, does not satisfy the CERCLA statutory preference for treatment. Additionally, groundwater monitoring alone does not provide a reduction in contaminant toxicity, mobility, or volume. However, the evaluation of groundwater data collected as part of this alternative may indicate that natural attenuation processes are providing a reduction in contaminant concentrations and/or preventing further migration of contaminated groundwater. If this were the case, natural attenuation processes will provide an irreversible reduction in contaminant toxicity, mobility, and/or volume.

Short-term effectiveness. Access to the SAEP facility is restricted; therefore, potential risks to the community during monitoring system installation and sample collection will be minimized. Alternative CR-GW-2 will have potential short-term risks to site workers; however, these risks will be minimized by effectively implementing an approved SSHP. Negative impacts on the environment are limited to the small potential that installation of wells could result in transport of contamination to greater depths. This potential impact would be minimized by proper well design and installation.

It is anticipated that construction activities associated with Alternative CR-GW-2 will be completed in approximately two months. Groundwater monitoring will be conducted for two years.

5.4.3 Implementability

The implementability of Alternative CR-GW-2 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials

- State acceptance
- Community acceptance

Technical feasibility. Alternative CR-GW-2, which includes groundwater sampling and analysis, is considered technically feasible. It is also technically feasible to evaluate the groundwater data collected as part of this alternative in support of determining if natural attenuation processes are occurring and in selecting a final groundwater remedy for the SAEP facility.

Administrative feasibility. Alternative CR-GW-2 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met.

Availability of services and materials. Alternative CR-GW-2 can be implemented using standard or commonly available construction methods, services, and materials. Experienced contractors and materials necessary for installation of monitoring wells and collection and analysis of groundwater samples are readily available.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

5.4.4 Cost

The two-year removal action cost for this alternative is estimated to be $396,000. The NPW post-removal O&M cost ($457,000) is provided to allow comparison of the total costs estimated to be required to achieve removal action objectives for Alternatives CR-GW-1 and CR-GW-2.

Consistent with USEPA guidance, a discount rate of seven percent was used to prepare the cost estimate (USEPA, 1993a). The cost summary for this alternative is provided in Table 5-5 and Appendix B presents the detailed cost estimate.

The following bullets summarize the assumptions used to prepare the cost estimate for Alternative CR-GW-2. Changes in the assumptions may result in reductions or increases in the actual costs.

- An ELUR restriction will be established for groundwater associated with the SAEP facility.
- Groundwater monitoring will be conducted using three existing monitoring wells and eight new monitoring wells.

- Groundwater monitoring will include monitoring wells located upgradient (2), downgradient (2), lateral (2), and within (5) the areas of hexavalent chromium-contaminated groundwater.
- Groundwater samples will be collected quarterly during years one and two, semiannually during years three through ten, and annually during years 11 through 30.
- Quality control samples will be collected at a frequency of one per ten regular samples (ten percent).
- Groundwater samples will be analyzed for total and hexavalent chromium, TOC, nitrate, sulfate, ferrous iron, dissolved manganese, alkalinity, salinity, and COD. Other parameters that will be monitored using field measurements will include DO, ORP, specific conductivity, temperature, turbidity, and pH.
- Following each monitoring event, a letter report will be prepared to provide a summary and evaluation of the groundwater data, a data quality assessment, and proposed recommendations.
- Some mobilization costs, such as decontamination pads and personnel showers, were not included based on their inclusion in one of the VOC alternatives, and the assumption they will be located close enough for use during this alternative.
- Assumes that existing office space, toilets, and phones are provided by the facility for the remediation work, and that no additional cost to the project is incurred for these facilities.

5.5 Alternative VOC-1 –In-situ SVE and Groundwater Monitoring

The scope of Alternative VOC-1 includes the following components:

- Construction of a 20-acre, in-situ SVE system
- O&M of the SVE system
- Installation of groundwater monitoring wells
- Groundwater sampling and analysis
- Implementation of ELURs

5.5.1 Description of the Alternative

The removal action provided under Alternative VOC-1 will include a 20-acre, in-situ SVE system to mitigate the migration of VOC vapors from the subsurface to buildings at the SAEP facility. A monitoring well network will be installed to monitor contamination concentrations in OU 2 groundwater.

SAEP Soil Vapor Extraction. An approximately 20-acre SVE system will be installed for Alternative VOC-1. Based on the results of groundwater sampling from 0 to 15 feet below the groundwater table, soil vapor sampling, and indoor air sampling, it was determined that VOC contamination present in groundwater was migrating to soil vapor and ultimately to indoor air. Determination of the area of influence for the SVE system was completed by evaluating the exceedances of the I/C VC for groundwater from 0 to 15 feet below the water table and in soil vapor, and evaluating indoor air sampling results. In addition, proposed future use of the facility was considered. Figure 5-5 presents the rationale for the SVE installation area. The conceptual design of the SVE system was based in part on the air flow model developed for the system (Appendix D).

The SVE technology uses a surface blower and perforated piping placed in the vadose zone to collect soil vapors. The blower creates a negative pressure in the collection pipes, promoting the flow of soil vapor from the unsaturated zone, into the collection pipes, and to the surface treatment system. Continued volatilization of VOC contaminants from shallow groundwater and subsurface soil allows continuous collection of vapors. The purpose of the SAEP SVE system is not to treat the entire mass of contaminant in the shallow subsurface, but rather to prevent the migration of contaminated soil vapor to the interior of on-site buildings. The full-scale system design, including parameters such as collection well spacing and system flow rate, will be determined during installation and operation of a pilot-scale system.

For purposes of cost estimation and alternative evaluation, it has been assumed that the pilot-scale SVE system will consist of two horizontal collection wells placed in trenches approximately one foot below the concrete floor of Building B-10. However, it is possible that an evaluation of the effectiveness of vertical vapor collection wells versus horizontal vapor collection wells could be conducted during the pilot test. The horizontal collection wells will be 200 feet in length and spaced 100 feet apart. The header pipe for the wells will run aboveground through a knock-out tank designed to remove liquids from the vapor stream and connect to the blower. Vapor from the blower will be piped to a vapor treatment system prior to discharge to the atmosphere. Liquid from the knock-out tank will be discharged to the liquid treatment system and eventually to the Building 63 CWTP sump. Figure 5-6 presents the process flow diagram for the SVE system.

Pilot-scale system monitoring will be completed using 15 vapor monitoring points installed to a depth of 5 feet bgs in the SVE area. Plastic tubing placed inside the well will be used as a sample port for the collection of field readings (e.g., subsurface vacuum and photoionization detector [PID] readings) and the collection of vapor samples for VOC analysis. The system will also be monitored using sample ports located on the junctions of the header pipe with the vapor extraction wells.

The full-scale SVE system will cover the area identified in Figure 5-7, an approximate 20 acres. A GPR survey will identify possible locations for the vapor collection pipes. Due to the presence of numerous underground utilities, it is unlikely the configuration of the system will be exactly as shown on Figure 5-7. It is possible that several shorter collection wells may be used rather than single longer wells; however, for purposes of evaluation and costing, the configuration shown has been assumed. In addition, the use of subsurface vents around the boundary of the system may be necessary to provide atmospheric air for collection into the vapor collection pipes if leakage from the surface is minimal.

The full-scale system vapor collection wells will be installed horizontally in trenches approximately 1-foot deep below the concrete floor. The trenches will be backfilled with coarse sand material and concrete will be replaced over the trench. The northern portion of the collection well system will be manifolded to a single header and the southern portion of the system will be manifolded to a separate header. The header pipes will be installed in trenches below the concrete floor to allow future use of Building B-2. The header pipes will be sloped to the junctions with the extraction wells to allow condensate from the system to flow into the extraction wells and drain through the perforations. A flow control valve and a sample port will be located at each junction of the header pipe and the extraction wells. An alternative method that may be evaluated during system design, and that may be preferable to the regulatory agencies, would be to collect the condensate in a sump followed by discharge to the CWTP for treatment.

The header pipes will be trenched to the system controls located in Building B-10 (see Figure 5-7). Each pipe will run through a separate knockout tank designed to remove liquids from the incoming vapor stream and to its own blower. From the blowers, the vapor streams will be combined and piped to a vapor treatment system consisting of two carbon units, a primary unit and a polish unit. Treated vapors will be discharged to the atmosphere. Sample ports will be located along the vapor collection and treatment system to ensure contaminated vapors are not discharged to the atmosphere. It is assumed an air discharge permit will be necessary to operate the SVE system.

Liquids in the knockout tanks will periodically be pumped to the liquid treatment system. The system will consist of a holding tank that will collect the liquid until it is pumped through activated carbon canisters. A second holding tank will store the treated effluent until sampling confirms treatment. Treated liquids will be discharged to the CWTP (see Figure 5-6).

Vapor monitoring points will be installed throughout the system area of influence to monitor system effectiveness. Field parameter readings (e.g., vacuum readings and PID readings) and vapor samples will be collected to monitor conditions in the subsurface. In addition, indoor air sampling will be conducted to evaluate if the SVE system is preventing the migration of VOC vapor to SAEP buildings. Monitoring will occur throughout the operation lifetime of the system to evaluate the system effectiveness. It is estimated that operation of the SVE system will be required until VOC contamination in groundwater from 0 to 15 feet below the water table is no longer above the CTDEP RSR I/C VC; however, for purposes of evaluation an alternative duration of 2 years has been assumed to be consistent with other alternatives. A 30-year cost has also been presented in order to more closely estimate the lifetime cost of the SVE system without VOC hot-spot treatment.

Groundwater Monitoring. Groundwater monitoring will be conducted as part of Alternative VOC-1. Groundwater sampling will be conducted from existing monitoring wells and newly installed monitoring wells in the vicinity of the delineated VOC-contaminated groundwater areas. The proposed monitoring well network, which includes

21 existing monitoring wells and eight new monitoring wells, is presented on Figure 5-8. These monitoring wells are located upgradient, downgradient, and within the areas of VOC-contaminated groundwater. Table 5-6 presents the rationale for the proposed locations of the sampling wells.

Groundwater samples will be analyzed for target COCs: 1,1,1-TCA; 1,1-DCA; 1,1-DCE; PCE; TCE; cis- and trans-1,2-DCE; and vinyl chloride. Analysis for several other parameters will be conducted to monitor and evaluate natural attenuation processes. These parameters will include TOC, nitrate, sulfate, ethane, ethylene, ferrous iron, dissolved iron, dissolved manganese, alkalinity, salinity, and COD. Other parameters that will be monitored using field measurements during groundwater sampling will include DO, ORP, specific conductivity, temperature, turbidity, and pH.

Groundwater monitoring will be conducted quarterly for two years. Following each groundwater sampling event, a letter report will be prepared to provide a summary and evaluation of the data, a data quality assessment, and any proposed recommendations based on a review and evaluation of the data.

The collected groundwater data will be used to evaluate contaminant concentrations over time and whether groundwater contaminants are migrating. The groundwater data will also be used to update the numerical, groundwater-contaminant fate and transport model prepared for the SAEP facility. Once an adequate data set is obtained, the data will be used in support of statistical and/or trend analysis. The data will be used to evaluate whether natural attenuation processes may be occurring as a result of reducing potential conditions in the estuarine silt layer underlying the SAEP facility. The evaluation will consider if natural conditions are providing a transformation of VOC contaminants to a less toxic form, a reduction in concentrations, or a reduction in contaminant mobility. The groundwater data and evaluation will then be used in support of evaluating and selecting a final groundwater remedy for the SAEP facility, which may include MNA or a more aggressive treatment approach.

In accordance with the CTDEP RSR, an ELUR will be required, which will establish restrictions on future use of groundwater associated with the SAEP facility.

For purposes of alternative evaluation, a 2-year period has been assumed for groundwater monitoring and SVE system operation; however, a 30-year cost has also been presented in order to more closely estimate the lifetime cost of the Groundwater Monitoring alternative.

Alternative Interactions

It is not anticipated that implementation of this alternative will significantly impact the implementation of future actions at the site, including removal actions for hexavalent chromium-contaminated structures or hexavalent chromium-contaminated groundwater.

5.5.2 Effectiveness

The effectiveness of Alternative VOC-1 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative VOC-1 uses a combination of contaminated media treatment, engineering controls, and institutional controls to reduce and control risks associated with VOC contamination in groundwater. The SVE system will prevent the migration of VOC-contaminated vapors from the subsurface to the interior of SAEP buildings; thereby limiting human receptor exposure to contaminant concentrations greater than the CTDEP RSR I/C IATCs. Indoor air sampling will confirm the effectiveness of the SVE system at preventing vapor migration. The SVE system also will remove VOC-contaminated vapors from the subsurface and provide for removal of VOC contaminants from the vapor in a surface treatment system. VOC contamination remaining in the carbon treatment system will be sent off-site for regeneration and destruction of the contaminants.

Although the SVE system is not anticipated to have a large impact on the concentrations of VOC contamination in groundwater, the groundwater monitoring component of Alternative VOC-1 will provide information on the ability of natural attenuation processes to reduce contaminant concentrations through volatilization, dispersion, and degradation. Analytical data gathered during two years of groundwater monitoring will evaluate if natural attenuation processes, coupled with SVE, will effectively reduce VOC contaminant concentrations over the long-term, such that groundwater concentrations greater than the CTDEP RSR SWPC will not be discharged to the Housatonic River. If the evaluation determines natural attenuation will effectively prevent the discharge of contamination, a MNA approach may be considered as a final remedy for SAEP groundwater in the future FS. In this respect, Alternative VOC-1 is consistent with the potential final remedy for the site.

Implementation of an ELUR will provide for institutional control at the SAEP site. Alternative VOC-1 proposes restricting groundwater usage for the OU 2 area. This restriction will prevent potential receptor exposure to contaminated groundwater.

Alternative VOC-1 will provide protection to human health and the environment by (1) preventing the migration of soil vapor into indoor buildings, (2) providing limited treatment of vadose zone vapors and soil, (3) monitoring the migration and concentrations of VOC contaminants in groundwater, and (4) restricting access to subsurface contamination and the use of contaminated groundwater.

Compliance with ARARs. Alternative VOC-1 will be designed and implemented to attain the identified federal and state ARARs (see Tables 3-2 through 3-4).

Chemical-specific ARARs pertaining to Alternative VOC-1 are the CTDEP RSRs. Applicable criteria include the I/C VC and SWPC for groundwater, I/C VC for soil vapor and, I/C IATC for indoor air. The removal actions likely will not meet all the listed CTDEP RSRs; however, the removal actions will be designed to be consistent with future remedial actions which will be implemented to meet CTDEP RSRs. Operation of the SVE system will meet I/C IATC for indoor air.

Location-specific ARARs pertaining to this alternative include those related to flood plain and coastal zone management. Actions taken under this alternative are not anticipated to have negative impacts to the shoreline of the Housatonic River. Design of the alternative will consider these location-specific ARARs and minimize its impact to the river.

Action-specific ARARs related to this alternative pertain to air emissions, noise pollution, surface water protection, groundwater well installation, waste identification and listing, and waste generation and storage. Operation of the SVE system will be conducted such that treated vapor emissions are monitored for VOC content. An air discharge permit will be required to operate the system. Discharge of liquids (i.e., condensed groundwater from the vapor stream) to the CWTP for eventual discharge to the Housatonic River will be allowed only as detailed in a discharge authorization. Installation of monitoring wells and handling and disposal of generated IDW will be conducted in compliance with specified regulations.

Long-term effectiveness. Alternative VOC-1 will provide long-term effectiveness for the SAEP site because the SVE system will prevent the migration of VOC-contaminated vapors for as long as the system operates. Alternative VOC-1 considers operation of the SVE system for two years; however, it is estimated that the SVE system will operate until VOC concentrations in shallow groundwater no longer exceed the CTDEP RSR I/C VC under future remedial actions, if implemented under this removal action. In addition, implementation of an ELUR will prevent the use of contaminated groundwater for any purpose.

The groundwater monitoring component of Alternative VOC-1 will evaluate if natural attenuation processes will effectively reduce VOC concentrations such that contamination greater than the CTDEP RSR SWPC will not be discharged to the Housatonic River in the long-term. Regardless of the evaluation results, Alternative VOC-1 will provide for long-term effectiveness because the final remedy chosen for SAEP groundwater will be dependent upon the evaluation. If the evaluation indicates natural attenuation processes will prevent VOC concentrations greater than RSR criteria from discharging to the Housatonic River, the final remedy may propose MNA; however, if natural attenuation processes will not be able to prevent discharge, a more aggressive treatment option may be chosen.

Reduction of toxicity, mobility, or volume through treatment. The proposed SVE system will meet the CERCLA statutory preference for treatment as a principal element of a removal action. Capture and surface treatment of contaminated vapors will provide for an irreversible reduction in VOC contaminant volume and mobility. Removal of the VOC-contaminated carbon from the SAEP site and regeneration at an off-site facility will destroy the sorbed contaminants and will provide for a reduction in toxicity.

The SVE system will be designed to eliminate the migration of contaminated vapors from the subsurface to SAEP buildings rather than treat contaminated subsurface soil and groundwater. As a result, it is estimated that a limited mass of contaminant will volatilize from the groundwater and be captured by the SVE system and a significant mass of residual contaminant will remain in the hot-spots after two years. Continued operation of the SVE system will be considered in the SAEP FS.

The USEPA does not consider natural attenuation processes an active treatment technology and groundwater monitoring will not reduce the toxicity, mobility, or volume of contaminants. However, the groundwater monitoring component of this alternative will evaluate if natural attenuation can provide an irreversible reduction in toxicity and volume of contaminants.

Short-term effectiveness. Access to the SAEP facility is restricted; therefore, potential risks to the community during construction of Alternative VOC-1 will be minimized. Alternative VOC-1 will have potential short-term risks to site workers during installation of the SVE wells and the monitoring well network; however, these risks will be minimized by effectively implementing an approved site-specific health and safety plan. Construction activities will be conducted in an appropriate level of personal protection and monitoring of the site conditions will be conducted.

Operation of the SVE system will provide an immediate improvement to indoor air quality and provide short-term benefits to site workers. Impacts to the community and the environment are possible during operation of the soil vapor treatment system; the potential exists for discharge of VOC-contaminated vapor to the atmosphere. The vapor treatment system will be designed with a sample port following vapor stream discharge from the polish carbon vessel, such that monitoring of the discharge can be conducted. In addition, instrumentation can be used, if necessary, to continuously monitor the discharge.

Groundwater monitoring will provide short-term effectiveness by ensuring concentrations of VOCs in groundwater above the CTDEP RSR SWPC are not discharging to the Housatonic River . Implementation of an ELUR will prevent use of contaminated groundwater for any purpose.

It is anticipated that construction activities associated with Alternative VOC-1 will be completed in approximately 6 months. Groundwater monitoring and continued operation of the in-situ SVE system are estimated to continue for approximately two years; however, operation of the SVE system will be considered under the SAEP FS if implemented for this removal action.

5.5.3 Implementability

The implementability of Alternative VOC-1 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative VOC-1 is considered technically feasible for the areas associated with shallow VOC-contaminated groundwater and subsurface soil. The in-situ SVE and groundwater monitoring processes are well demonstrated.

The presence of a relatively shallow groundwater table necessitates the use of horizontal wells for the SVE system. The location of numerous underground utilities and structures (e.g., vaults and concrete pits) may limit the ability to install lengthy horizontal wells. The issue of restricted subsurface access will be addressed during engineering design by evaluating existing utility maps and through the completion of a GPR survey prior to well installation.

Implementation of this alternative will not interfere with future removal actions or remedial actions at the SAEP site.

Administrative feasibility. Alternative VOC-1 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met. In addition, permits necessary for operation of the SVE system, including air discharge permits and a discharge authorization for the CWTP, should be easily attainable. Actions proposed under this alternative will be completed on the SAEP site.

Availability of services and materials. Alternative VOC-1 can be implemented using standard or commonly available construction methods, services, and materials. Experienced contractors and materials necessary for installation and operation of the in-situ SVE system, installation of monitoring wells, and collection and analysis of groundwater samples are readily available. Electrical power required for system operations is available from the SAEP site.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

5.5.4 Cost

The two-year removal action cost for this alternative is estimated to be $4,250,000. The NPW post-removal O&M cost of this alternative (i.e., Years 3 through 30) is estimated to be $3,996,000. Consistent with USEPA guidance, a discount rate of seven percent was used to prepare the cost estimate (USEPA, 1993a). A cost summary for this alternative is provided in Table 5-7 and Appendix B provides a detailed breakdown of the cost estimate.

The following bullets summarize the assumptions used to prepare the cost estimate for Alternative VOC-1. Changes in the assumptions may result in reductions or increases in the actual costs.

GENERAL COST ASSUMPTIONS

- Removal actions will be completed in Level D personal protective equipment
- Soil IDW will be drummed for sampling and off-site disposal. Water IDW not containing surfactants will be treated on-site.
- Assumes that existing office space, toilets, and phones are provided by the facility for the remediation work, and that no additional cost to the project is incurred for these facilities.

SAEP IN-SITU SVE SYSTEM

Pilot-scale Treatability Test

- A pilot-scale test will be conducted to provide estimates on flow rates, extraction well spacing, and vacuum pressures for the full-scale SVE system.
- The pilot test will be conducted under Building B-10 and will consist of two 1-foot deep trenches approximately 200 feet in length containing fabric-wrapped perforated HDPE pipe. The trenches will be spaced 100 feet apart.
- The wells will be connected at one end to a header pipe that will run aboveground and be connected to a blower capable of 20 to 50 scfm.
- A sample port and a flow control valve will be installed at the junction of the header pipe and the two wells. Field readings of vacuum and vapor concentration will be measurable from the sample ports.
- Prior to entering the blower, the header pipe will run through a knockout tank. After passing through the blower, the vapors will be piped to a vapor treatment system.
- The pilot-scale vapor treatment system will consist of an air-to-air heat exchanger and activated carbon. Sample valves will be placed prior to vapor entry into the carbon canister and prior to venting to the atmosphere.
- Liquid from the knockout tank will be piped to the liquid treatment system, which will consist of a holding tank and activated carbon. Treated water will be discharged to a second holding tank to await sampling and will ultimately be discharged to the CWTP.

- Fifteen vapor monitoring points will be installed in the area of the pilot test.
- The pilot-scale SVE system shall be operated seven days per week for 4 weeks (one month). During that month vacuum readings and PID readings shall be collected from the vapor monitoring points and the vapor extraction well sampling ports on a daily basis.
- Vapor samples (from the vapor monitoring points) and indoor air samples will also be collected during pilot-scale testing and sent to an off-site laboratory for analysis for VOCs.

Full-scale SVE System

- A geophysical survey will locate underground utilities in the proposed SVE system area (an estimated 1,000,000 square feet).
- An air discharge permit will be required to operate the SVE system and a discharge authorization for liquid discharge to the CWTP will also be required.
- The proposed SVE wells will be placed in 1-foot deep trenches and will be constructed of fabric-wrapped perforated pipe. The SVE trenches will be spaced 100 feet apart.
- Subsurface vaults will be placed at the junction of the header pipe with each soil vapor lateral. Each vault shall contain a sampling port and a flow control valve.
- Header pipes will be sloped to the junctions with the extraction well laterals to allow condensate from the system to flow into the extraction well laterals and drain through the perforations.
- Gaps in the concrete floors in the SVE system influence area will be caulked following system installation.
- Three grassed areas located between Buildings B-1 and B-2 shall be covered with 6 inches of concrete to prevent infiltration of atmospheric air and potential short-circuiting of the SVE system.
- The southern portion of Building B-10 will be used to house the system controls necessary for operation of the SVE system. Electrical wiring for the control and treatment system shall be placed in a separate building located on the southeastern side of Building B-10 such that electrical hazard class requirements are met.
- One knockout tank will be connected to each incoming header pipe to remove liquid from the incoming vapor stream.
- Each header pipe shall be connected to a separate variable speed blower capable of a 1000 scfm flow. The blowers shall be capable of maintaining a 6-inch to 12-inch vacuum in the system.
- A third blower shall be available as a back up for use during breakdown or maintenance of the primary blowers.
- The vapor flows will be combined after exiting the blowers and shall be sent to the vapor treatment system. Treated vapors will be discharged to the atmosphere.
- The vapor treatment system shall consist of an air to air heat exchanger, a primary activated carbon vessel, and a carbon polish vessel.
- Vapor sampling ports will be located throughout the vapor stream to ensure contaminated vapors are not discharged to the atmosphere.

- Liquids from the knockout tank will be discharged to the liquid treatment system. Treated liquids will be discharged to the CWTP.
- The liquid treatment system will be similar in design to the system detailed for the pilot-scale SVE test.

SVE System Operation and Monitoring

- For purposes of evaluation and costing, it is assumed the SVE system will operate for 30 years.
- Approximately 40 vapor monitoring points will be installed in the SVE system area.
- System start-up monitoring will consist of collection of system field readings (vacuum, pressure, PID, etc.) and collection of soil vapor samples for VOC analysis.
- Vapor samples will be collected from each monitoring point and header/vapor well junction during start-up and analyzed on-site for VOCs to locate potential vapor hot-spots and determine system effectiveness.
- Indoor air samples will be collected during the first month of system operation and sent to an off-site laboratory for analysis.
- Long-term system monitoring (i.e., collection of system field readings) will be conducted on a bi-weekly basis for remainder of the first year, monthly for the second year, and quarterly for the lifetime of the SVE system.
- In addition to field readings, complete vapor sampling rounds will be completed on a quarterly basis for the first year and on an annual basis for the lifetime of the SVE system. Samples will be sent off-site for VOC analysis.
- Indoor air sampling will be conducted on a monthly basis for the first year of system operation and on an annual basis for the lifetime of the SVE system.
- It is assumed that the liquid-phase and vapor-phase carbon will be replaced on a semi-annual basis.
- The concrete floor will be inspected on an annual basis to ensure its integrity. Cracks and gaps in the concrete will be repaired, as necessary.

GROUNDWATER MONITORING

- Eight monitoring wells will be installed in order to collect groundwater samples for analysis.
- Complete groundwater sampling rounds will be conducted on a quarterly basis for the first two years, on a semiannual basis for Years 3 through 10, and annually for Years 11 through 30.
- Groundwater samples will be analyzed off-site for the following parameters:
    - Chlorinated VOCs: 1,1,1-TCA; 1,1-DCA; 1,1-DCE; PCE; TCE; cis-1,2-DCE; trans-1,2-DCE; and vinyl chloride.
    - Alkalinity; COD; available carbon sources; TOC; nitrate; sulfate; metabolic byproducts; ethane; and ethylene
- Groundwater samples will be analyzed on-site for the following parameters:

  - The field parameters: ORP; specific conductivity; temperature; turbidity; DO; salinity; and pH.
  - Using field testing kits: ferrous iron and dissolved manganese.
- A Groundwater Monitoring Data Letter Report will be submitted following each sampling event and will include a data summary, a data quality assessment, and evaluation of the chemical trends.

5.6 Alternative VOC-2 – In-situ Chemical Oxidation using Potassium Permanganate, In-situ Air Sparging, In-situ SVE, and Groundwater Monitoring

The scope of Alternative VOC-2 includes the following components:

- Installation of potassium permanganate injection wells
- Construction of an injection system
- Pressure testing the chemical waste pipeline (from Building 63 to the CWTP) and replacement of the pipeline, if necessary
- Installation of groundwater extraction system
- Construction of an organics treatment system
- Construction of an in-situ air sparging system
- Construction of an in-situ SVE system
- O&M of the in-situ treatment systems
- Installation of groundwater monitoring wells
- Groundwater sampling and analysis
- Implementation of ELURs

5.6.1 Description of the Alternative

The removal action provided under Alternative VOC-2 will include injection of potassium permanganate to reduce VOC concentrations in groundwater at VOC Hot-spot Nos. 1 and 2. Extraction wells will be used to provide hydraulic control within the groundwater treatment areas. The extracted groundwater will be transferred to the CWTP where the groundwater will be treated and discharged. An in-situ air sparging system will be installed to provide a reduction in VOC concentrations in groundwater at Hot-spot No. 3 and a sitewide in-situ SVE system will be installed to provide a reduction in VOC concentrations in soil vapor and shallow groundwater, as well as mitigate the migration of VOC vapors from the subsurface to buildings at the SAEP facility. A monitoring well network will be installed for the OU 2 groundwater.

In-situ Chemical Oxidation. In-situ chemical oxidation is a technology involving the delivery of a chemical oxidant to the subsurface where it reacts with and destroys organic contaminants. There are three types of oxidants used in application of this type of remedy including hydrogen peroxide with iron (i.e., Fenton's reagent), potassium permanganate, and ozone. Based on bench-scale and pilot-scale treatability tests previously conducted at SAEP, potassium permanganate has been identified as the most likely oxidant for the site (Foster Wheeler/HLA, 2000b). Potassium permanganate has been demonstrated to oxidize TCE by breaking the carbon double bond at the center of the TCE molecule and is considered an applicable technology for VOC Hot-spot Nos. 1 and 2. Potassium permanganate is less effective at breaking a carbon single bond such as that in the center of a 1,1,1-TCA molecule. For this reason in-situ oxidation is not included for Hot-spot No. 3, which has high concentrations of 1,1,1-TCA.

The reaction of potassium permanganate with TCE proceeds as follows:

$$2MnO_4^- + C_2HCl_3 \rightarrow 2CO_2 + 2MnO_2 + 3Cl^- + H^+$$

where the permanganate ion (MnO_4^-) reacts with TCE (C_2HCl_3) to form carbon dioxide, manganese dioxide (MnO_2), chloride ions (Cl^-), and hydrogen ions (H^+). The reaction proceeds rapidly for TCE dissolved in groundwater; however, the overall effectiveness of the technology can be limited by the ability to effectively distribute the oxidant in highly heterogeneous soils and to address TCE that is sorbed to soil particles.

A pilot-scale treatability test for in-situ oxidation has been conducted for VOC Hot-spot No. 1 (Foster Wheeler/HLA, 2000b). One of the recommendations following completion of the test was that more effective distribution of the oxidant may be achieved by using many closely-spaced injection points without extraction rather than relying on the transport of chemical along with the movement of groundwater created by injection and extraction. Given the highly developed nature of the SAEP site however, the surface access necessary for closely-space injection points is not possible without extensive demolition. For this reason, conceptual design of the in-situ oxidation system is based on the injection and extraction delivery method.

The groundwater injection and extraction well locations for VOC Hot-spot Nos. 1 and 2 are shown on Figures 5-9 and 5-10. VOC Hot-spot No. 1 will have 16 injection well locations around the perimeter of the hot spot and two extraction well locations in the middle of the hot spot. Both injection well and extraction well locations will have wells screened in two intervals; the shallow interval (from 20 to 30 feet bgs) will be screened in the fine to medium sand layer and the deep interval (from 30 to 40 feet bgs) in the silt and very fine sand layer. Figure 5-11 presents a cross-section of the in-situ oxidation system at VOC Hot-spot No. 1. In addition surface infiltration trenches will be installed in the center of the hot spot as indicated on Figure 5-9 to provide treatment from the groundwater table down to the top of the shallow screened interval.

It is estimated that the infiltration trench will receive 20 gpm, the shallow zone injection wells will receive 1 gpm each (16 gpm total), and the deep zone injection wells will receive 0.25 gpm each (4 gpm total). Shallow zone extraction wells will remove 25 gpm each (50 gpm total) and deep zone extraction wells will remove 4 gpm each (8 gpm total) for a total overall extraction rate of 58 gpm. Based on the results of the pilot-scale treatability test and an estimate of the mass of TCE present in VOC Hot-spot No. 1, about

31,000 pounds of potassium permanganate will be injected into the subsurface and treatment of the hot-spot will take approximately 1.5 years.

A process flow diagram for the potassium permanganate injection is presented on Figure 5-12. For purposes of alternative evaluation and cost estimation, it is assumed potable water will be mixed with crystalline potassium permanganate to form a permanganate solution for subsurface injection. During design of this alternative, a comparison of the advantages and disadvantages of reinjection of previously extracted groundwater versus the use of potable water will be completed. This evaluation will determine the most effective method for injection of the potassium permanganate solution. Regardless of the method chosen, acid will likely be added to prevent clogging of the injection wells. Because VOC Hot-spot No. 1 is co-located with the hexavalent chromium hot spot, it is expected that extracted groundwater will contain hexavalent chromium in addition to TCE. For this reason extracted groundwater from VOC Hot-spot No. 1 will be directed to the CWTP. An organics treatment system will be built at the influent to the CWTP. Extracted water will be directed to the existing sump at Building 63. This sump currently directs water to the CWTP via a chemical waste pipeline. This chemical waste pipeline will be pressure tested as part of this alternative. For costing purposes it is assumed that no leaks will be identified by the pressure testing; however, pipeline replacement could be necessary if this is not the case. A UV/oxidation system will be installed at the CWTP for TCE treatment prior to discharge to the CWTP. The CWTP is designed to remove hexavalent chromium and other inorganics through chemical reduction and precipitation. A UV/oxidation system was assumed because of it is less susceptible to fouling the activated carbon or air stripping and high manganese concentrations are possible.

VOC Hot-spot No. 2 will have 10 injection well locations around the perimeter of the hot spot and one extraction well location in the middle of the hot spot. Both injection well and extraction well locations will have wells screened in two intervals; the shallow interval (from 20 to 30 feet bgs) will be screened in the fine to medium sand layer and the deep interval (from 30 to 40 feet bgs) in the silt and very fine sand layer. Figure 5-13 presents a cross-section of the in situ oxidation system at VOC Hot-spot No. 2. In addition, surface infiltration trenches will be installed in the center of the hot-spot as indicated on Figure 5-10 to provide treatment from the groundwater table down to the top of the shallow screened interval. However, the lateral extent of VOC Hot-spot No. 2 requires further delineation, possibly affecting the design and cost of this alternative.

It is estimated that the infiltration trench will receive 20 gpm, the shallow zone injection wells will receive 1 gpm each (10 gpm total), and the deep zone injection wells will also receive 1 gpm each (10 gpm total). The shallow zone extraction well will remove 35 gpm and deep zone extraction well will remove 13 gpm each for a total overall extraction rate of 48 gpm. Based on the results of the pilot-scale treatability test and an estimate of the mass of TCE present in VOC Hot-spot No. 2, about 14,000 pounds of potassium permanganate will be injected into the subsurface and treatment of the hot-spot will take approximately 1 year.

VOC Hot-spot No. 2 is not expected to contain hexavalent chromium; therefore, it is anticipated that extracted water could be treated for TCE and discharged directly to the Publicly-owned Treatment Works (POTW) through sewer manholes located on the SAEP property. As indicated in the process flow diagram (see Figure 5-12) extracted water from VOC Hot-spot No. 2 will not be directed to the Sump at Building 63 and transferred to the CWTP. Instead an organics treatment system including UV/Oxidation will be installed at Building B-10 and treated water will be discharged directly to the POTW from that location.

In-situ Air Sparging. An in-situ air sparging system will be installed in the area of VOC Hot-spot No. 3 to address concentrations of VOCs greater than the removal action goals. The VOCs of concern in this hot-spot are 1,1,1-TCA and 1,1-DCE. Bench-scale treatability testing indicated 1,1,1-TCA is not effectively oxidized using potassium permanganate; therefore, air sparging is the selected removal action technology for VOC Hot-spot No. 3.

Air sparging is an in-situ technology that can reduce concentrations of VOCs dissolved in the groundwater, sorbed to saturated soils, and trapped in pores of the saturated zone by injecting air into the saturated zone. The injected air reduces contaminant concentrations primarily through volatilization but also provides oxygen to the subsurface to enhance aerobic biological degradation of the contaminants. The technology uses a surface blower and wells placed below the zone of groundwater contamination to inject air into the subsurface. Often, a vapor collection system is coupled with the air sparging system to capture vapors liberated by the sparging process. Captured vapors are transported to the surface and treated prior to discharge to the atmosphere.

The effectiveness of an air sparging system depends primarily on the soil's intrinsic permeability and the contaminant type. Soil with higher permeability and contaminants with high vapor pressures are generally remediated more effectively using an air sparging system. Previous investigations in the area of VOC Hot-spot No. 3 indicate the permeability of the soil is conducive to air sparging. In addition, 1,1,1-TCA and 1,1-DCE both have vapor pressures above that generally recommended for remediation with an air sparging system.

The proposed full-scale air sparging system for VOC Hot-spot No. 3 will consist of vertical air injection wells, horizontal SVE wells, subsurface piping, and a surface control system and vapor treatment system. Figure 5-14 presents the air sparging system plan view and Figure 5-15 presents the cross-section conceptual design for the full-scale air sparging system. The full-scale system will be designed using information obtained during installation and operation of a pilot-scale system in the same area.

The pilot-scale air sparging system will consist of one air injection well installed to a depth of 60 feet bgs and two horizontal SVE wells placed in trenches approximately one foot below the concrete floor. The SVE wells will be 60 feet in length and spaced 30 feet apart. The header pipes for the air sparging and the SVE wells will run aboveground to the system controls. The air sparging header pipe will be connected to a blower that will inject air into the sparging well. The SVE system header will run through a knockout tank designed to remove liquids from the vapor stream and connect to a blower pulling air out of the SVE wells. Vapor from the SVE blower will be piped to a vapor treatment system prior to discharge to the atmosphere. Liquid from the knockout tank will be discharged to the liquid treatment system and eventually to the Building 63 CWTP sump. Figure 5-16 presents the process flow diagram for the air sparging system.

The pilot-scale monitoring system will consist of five groundwater monitoring points and five vapor monitoring points. The groundwater monitoring points will be installed to an average depth of 40 feet bgs and will be used to monitor field parameters (e.g. DO, ORP, pH, temperature, etc.) and collect groundwater samples for VOC analysis. The vapor monitoring points will be installed to a depth of 5 feet bgs and will contain a vapor sampling port from which vacuum readings and vapor samples can be collected.

The full-scale system will contain 22 injection wells installed to a depth of 45 feet bgs and 24 injection wells installed to a depth of 60 feet bgs in the area of Hot-spot No. 3. The proposed well depths are just below the upper zone of 1,1,1-TCA and 1,1-DCE contamination in exceedance of the established removal goal (see Figure 5-15). The 45-foot deep air injection wells will be manifolded to a common header installed below the floor of Building B-2 and run to the system controls. The 60-foot deep air injection wells will be manifolded to a separate header, also installed below the floor of Building B-2 and run to the system controls (see Figure 5-14). The header pipes will connect to separate blowers within the system control building.

A SVE well system consisting of six horizontal extraction wells approximately 550 feet long will be placed horizontally below the building floor at an approximate depth of 1-foot bgs. The SVE header pipe will run through a knock-out tank and to the SVE system blower. The flow rate of the SVE blower will be greater than the combined flow rates of the air sparging system blowers to limit migration of the generated vapors. The flow of vapors from the SVE blower will be as described for the pilot-scale system.

Groundwater monitoring points and vapor monitoring points will be installed throughout the system area of influence to monitor system effectiveness. Field parameter readings (e.g., DO, ORP, pH, temperature, etc.) and groundwater and vapor samples will be collected to monitor conditions in the subsurface. Monitoring will occur throughout the operation lifetime of the system to evaluate the system effectiveness and determine when removal action goals have been met. It is estimated that operation of the air sparging system will be required for 15 years to achieve contaminant reduction to the removal action goals.

Dissolved-phase groundwater contamination downgradient from a source area can frequently be remediated by air sparging in a period of 2 years or less. Models that predict the cleanup time in these situations are available, but may not be fully accepted. For VOC Hot-spot No. 3, air sparging is proposed for what is considered to be a source area. The source area is likely to contain significant contaminant mass that is sorbed to soil in addition to dissolved-phase contamination. Application of air sparging at such locations generally requires much longer timeframes due to limitations imposed by the rate of dissolution/desorption and contaminant diffusion. Application of air sparging in similar situations has shown reasonably rapid reduction in dissolved-phase contamination only to have concentrations rebound when the system is shut down. Therefore, a longer treatment timeframe has been assumed than the typical 1 to 2 years for dissolved-phase treatment by air sparging. Lacking detailed information on the mass and distribution of sorbed contaminants in the soil and accepted models for predicting cleanup times in this situation, the 15-year cleanup time was selected based on professional judgement. However, for cost estimating purposes, it has been assumed that the air sparging system will operate for 30 years.

SAEP Soil Vapor Extraction. The location and details of the 20-acre in-situ SVE system for this alternative will be as described in Subsection 5.5.1 for Alternative VOC-1.

It is unknown if active treatment of the VOC hot-spots will have a significant impact on indoor air quality. Active treatment will reduce overall VOC concentrations in groundwater and will likely reduce the amount of time the SAEP SVE system is needed to prevent the migration of VOC-contaminated vapors to the interior of on-site buildings. For purposes of cost estimation and alternative evaluation an operation period of five years has been assumed for this alternative.

Groundwater Monitoring. Groundwater monitoring will be conducted as part of Alternative VOC-2. The number and location of monitoring wells, analytical parameters, sampling frequency, data evaluation, and reporting requirements for this alternative are the same as discussed in Subsection 5.5.1 for Alternative VOC-1.

In accordance with the CTDEP RSR, an ELUR will be required, which will establish restrictions on future use of groundwater associated with the SAEP facility.

Alternative Interactions

Implementation of this alternative has potential impacts on future actions that may be completed at the site. As a result of the treatment of VOC hot-spots, it is possible that the duration of SAEP SVE system operation and the length of time for which groundwater monitoring is required could be reduced, compared to an alternative that does not propose treatment. For purposes of alternative evaluation and cost assumption, it has been assumed that 5 years of SVE system operation and 30 years of groundwater monitoring will be required to ensure VOC-contaminated vapors and groundwater are not migrating.

A second possible interaction is that between chromium and the oxidizing conditions possible during treatment of VOC Hot-spot No. 1. Chemical oxidation in VOC Hot-spot No. 1 could transform and mobilize trivalent chromium in the area of the hot-spot to hexavalent chromium, including re-oxidation of trivalent chromium reduced during ferrous sulfate treatment. In order to limit the potential for re-oxidation of trivalent chromium by potassium permanganate, chemical oxidation of VOC Hot-spot No. 1 would be implemented prior to chemical reduction in the Hexavalent Chromium Hot-spot. Implementation of the alternatives in this order could significantly increase the amount of ferrous sulfate necessary to complete reduction of hexavalent chromium. The ferrous sulfate would need to react with excess potassium permanganate prior to reducing hexavalent chromium.

5.6.2 Effectiveness

The effectiveness of is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative VOC-2 uses a combination of contaminated media treatment, engineering controls, and institutional controls to reduce and control risks associated with VOC-contaminated groundwater. In-situ chemical oxidation and air sparging of VOC hot-spots will reduce the concentration of VOCs in groundwater hot-spots. Injection of potassium permanganate will irreversibly oxidize VOC contamination in Hot-spot Nos. 1 and 2. Air sparging will physically strip VOC contaminants in shallow areas of Hot-spot No. 3 and lift the vapors to the coupled SVE system for collection. Surface treatment of the generated vapors using activated carbon will immobilize VOC contaminants. VOC contamination remaining in the carbon treatment system will be sent off-site for regeneration and destruction of the contaminants. It is anticipated that moderate quantities of residual contamination will remain in the hot-spots following two years of active treatment. Continued operation of the air sparging system will likely further reduce VOC concentrations in Hot-spot No. 3 and may be considered in the SAEP RI/FS, if implemented for this removal action.

The reduction in groundwater hot-spot VOC concentrations will limit the amount of volatilization occurring from shallow groundwater to the vadose zone. The SAEP SVE system will prevent the migration of VOC-contaminated vapors from the subsurface to the interior of SAEP buildings; thereby limiting human receptor exposure to contaminant concentrations greater than the CTDEP RSR I/C IATC. Indoor air sampling will confirm the effectiveness of the SAEP SVE system at preventing vapor migration. The SVE system also will remove VOC-contaminated vapors from the subsurface and provide for removal of VOC contaminants from the vapor in a surface treatment system. VOC contamination remaining in the carbon treatment system will be sent off-site for regeneration and destruction of the contaminants.

The groundwater monitoring component of Alternative VOC-2 will provide information on the ability of natural attenuation processes to reduce contaminant concentrations in groundwater outside of the hot-spots through volatilization, dispersion, and degradation. Analytical data gathered during two years of groundwater monitoring will evaluate if natural attenuation processes, coupled with hot-spot treatment and SAEP SVE, will effectively reduce VOC contaminant concentrations over the long-term, such that concentrations greater than the CTDEP RSR SWPC will not be discharged to the Housatonic River.

Implementation of an ELUR will provide for institutional control at the SAEP site. Alternative VOC-2 proposes restricting groundwater usage for the OU 2 area. This restriction will prevent potential receptor exposure to contaminated groundwater.

The addition of significant quantities of manganese could have negative impacts on groundwater quality at the site; however, the majority of the potassium permanganate will likely react first with the VOCs, and ultimately with other organic matter in the subsurface. A complete evaluation of the potential impacts would be conducted during design of the alternative, if it is the chosen remedy.

Alternative VOC-2 will provide protection to human health and the environment by (1) preventing the migration of soil vapor into indoor buildings, (2) providing for the treatment of groundwater hot-spots and vadose zone vapors, (3) monitoring the migration and concentrations of VOC contaminants in groundwater, and (4) restricting access to subsurface contamination and the use of contaminated groundwater.

Compliance with ARARs. Alternative VOC-2 will be designed and implemented to attain the identified federal and state ARARs (see Tables 3-2 through 3-4).

Chemical-specific ARARs pertaining to Alternative VOC-2 are the CTDEP RSRs. Applicable criteria include the I/C VC and SWPC for groundwater, I/C VC for soil vapor, and I/C IATC for indoor air. The removal actions may not meet all the listed CTDEP RSRs; however, the removal actions will be designed to be consistent with future remedial actions which will be implemented to meet CTDEP RSRs. Operation of the SVE system will meet I/C IATC for indoor air.

Location-specific ARARs pertaining to this alternative include those related to flood plain and coastal zone management. Actions taken under this alternative are not anticipated to have negative impacts to the shoreline of the Housatonic River. Design of the alternative will consider these location-specific ARARs and minimize its impact to the river.

Action-specific ARARs related to this alternative pertain to air emissions, noise pollution, surface water protection, underground injection, groundwater well installation, waste identification and listing, and waste generation and storage. Operation of the chemical oxidation, air sparging, and SVE systems will be designed and operated to comply with ARARs.

Injection of potassium permanganate and related chemicals into the subsurface will be conducted as detailed in a discharge to groundwater authorization obtained prior to system installation. An air discharge permit will be obtained for operation of the air sparging and SVE systems. Vapor emissions from the vapor treatment systems will be monitored for VOC content. Discharge of liquids to the CWTP for eventual discharge to the Housatonic River will be allowed only as detailed in a discharge authorization. Installation of monitoring wells and handling and disposal of generated IDW will be conducted in compliance with specified regulations.

Long-term effectiveness. Alternative VOC-2 will provide long-term effectiveness because active treatment of groundwater hot-spots will destroy VOC contamination in-situ or remove VOC contamination from the groundwater. The coupled SVE system will remove vapors generated during the air sparging process from the subsurface. Contaminated vapors will be treated prior to discharge to the atmosphere and VOC contamination within the vapors will be immobilized in activated carbon. Because the proposed treatment processes are irreversible, this alternative will provide permanent contaminant reduction.

In addition, the SVE system will prevent the migration of VOC-contaminated vapors for as long as the system operates. For purposes of evaluation, 2 years of operation are considered; however, it is estimated the system will operate until VOC concentrations in site-wide shallow groundwater no longer exceed the CTDEP RSR I/C VC under future remedial actions, if implemented under this removal action. The system will prevent the migration of vapors from the subsurface to on-site buildings, preventing receptor exposure to vapor concentrations in exceedance of the CTDEP RSR I/C IATC. In addition, implementation of an ELUR will prevent the use of contaminated groundwater for any purpose.

The groundwater monitoring component of Alternative VOC-2 will evaluate if natural attenuation processes will effectively reduce VOC concentrations such that contamination greater than the CTDEP RSR SWPC will not be discharged to the Housatonic River in the long-term. Regardless of the evaluation results, Alternative VOC-2 will provide for long-term effectiveness because the final remedy chosen for SAEP groundwater will be dependent upon the evaluation. If the evaluation indicates natural attenuation processes will prevent VOC concentrations greater than RSR criteria from discharging to the tidal flats, the final remedy may propose MNA; however, if natural attenuation processes will not be able to prevent discharge, a more aggressive treatment option for site-wide groundwater may be chosen.

Following completion of this alternative (two-year operation), it is estimated that a moderate amount of contaminant mass (concentrations above CTDEP RSR criteria) will remain in the VOC hot-spots following active treatment for two years. Continued operation of the air sparging system likely will continue to reduce VOC concentrations.

Reduction of toxicity, mobility, or volume through treatment. Alternative VOC-2 proposes in-situ chemical oxidation to destroy VOC contamination in groundwater Hot-spot Nos. 1 and 2 and air sparging to reduce VOC concentrations in groundwater Hot-spot No. 3. The air sparging system will be coupled with a hot-spot SVE system to capture generated vapors. In-situ chemical oxidation (i.e., destruction of VOC contamination) will provide an irreversible reduction in contaminant toxicity and volume, while air sparging will provide an irreversible reduction in contaminant volume. Surface treatment of the vapors generated during the air sparging process will provide additional reduction in contaminant volume and a reduction in mobility. Off-site regeneration of the carbon used in the vapor treatment process will provide an irreversible reduction in contaminant toxicity. Because Alternative VOC-2 involves active treatment, the alternative will satisfy the CERCLA statutory preference for treatment as a principal element of the remedy.

Capture and surface treatment of contaminated vapors by the SAEP SVE system will provide for a small reduction in VOC contaminant volume and mobility. Removal of the VOC-contaminated carbon from the SAEP site and regeneration at an off-site facility will destroy the sorbed contaminants and will provide for a reduction in toxicity. The SVE system will be designed to eliminate the migration of contaminated vapors from the subsurface to SAEP buildings rather than to treat contaminated subsurface soil and groundwater. As a result, it is estimated that a limited mass of contaminant will volatilize from the shallow groundwater and be captured by the SAEP SVE system.

The USEPA does not consider natural attenuation processes an active treatment technology and groundwater monitoring will not reduce the toxicity, mobility, or volume of contaminants. However, the groundwater monitoring component of this alternative will evaluate if natural attenuation can provide an irreversible reduction in toxicity and volume of contaminants.

Following completion of this alternative (two-year operation), it is estimated that a moderate amount of contaminant mass (concentrations above CTDEP RSR criteria) will remain in the VOC hot-spots following active treatment for two years. Continued operation of the air sparging system likely will continue to reduce VOC concentrations.

Short-term effectiveness. Access to the SAEP facility is restricted; therefore, potential risks to the community will be minimized during alternative installation and operation. Groundwater in the vicinity of the SAEP site is classified as GB Groundwater, indicating it is not used and is not proposed for use for any purpose by the community or site workers.

The in-situ chemical oxidation and air sparging components of Alternative VOC-2 will have potential short-term risks to site workers during installation; however, these risks will be minimized by effectively implementing an approved SSHP. The appropriate level of personal protection will be used during installation activities to prevent inhalation of or dermal contact with contamination. Monitoring of site conditions (e.g., dust levels and field VOC concentrations) also will be conducted. Discharge of treated vapor to the atmosphere during operation of the air sparging system may present a risk to the community if contaminated vapors are inadvertently discharged. The treatment system will be designed with a sample port following vapor stream discharge from the activated carbon unit, such that monitoring of the discharge can be conducted. In addition, instrumentation can be used, if necessary, to continuously monitor the discharge

Installation of the SAEP SVE system and the groundwater monitoring wells will also present possible risks to site workers that will be minimized by adherence to the SSHP. Operation of the SAEP SVE system will provide an immediate improvement to indoor air quality and provide short-term benefits to site workers. Impacts to the community and the environment are possible during operation of the soil vapor treatment system if discharge of VOC-contaminated vapor to the atmosphere occurs. The vapor treatment system will be designed with a sample port following vapor stream discharge from the polish carbon vessel, such that monitoring of the discharge can be conducted. In addition, instrumentation can be used, if necessary, to continuously monitor the discharge.

Groundwater monitoring will provide short-term effectiveness by ensuring concentrations of VOCs in groundwater above the CTDEP RSR SWPC are not discharging to the Housatonic River . Implementation of an ELUR will prevent use of contaminated groundwater for any purpose.

It is anticipated that construction activities associated with Alternative VOC-2 will be completed in approximately 6 months. For evaluation purposes in this EE/CA, it has been assumed operation of the in-situ chemical oxidation, in-situ air sparging, and SAEP SVE systems will continue for approximately 2 years. For costing purposes, it has been assumed that the in-situ chemical oxidation system will operate for 2 years, the SAEP SVE system will operate for 5 years, and the air sparging system will operate for 30 years. Continued operation of the SVE and air sparging systems will be considered under the SAEP RI/FS, if implemented for this removal action.

5.6.3 Implementability

The implementability of Alternative VOC-2 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative VOC-2 is considered technically feasible for the areas of VOC-contaminated groundwater and vapors associated with shallow VOC-contaminated groundwater and subsurface soil. The individual components of the in-situ chemical oxidation and air sparging technologies have been used frequently in the past and the technologies have been used with success at an increasing number of sites. A pilot-scale treatability study demonstrating the effectiveness of in-situ chemical oxidation was completed in Hot-spot No. 1 at the SAEP site.

The presence of a relatively shallow groundwater table necessitates the use of horizontal wells for the SVE system. The location of numerous underground utilities and structures (e.g., vaults and concrete pits) may limit the ability to install lengthy horizontal wells. The issue of restricted subsurface access will be addressed during engineering design by evaluating existing utility maps and through the completion of a GPR survey prior to well installation.

Implementation of this alternative will have an impact on hexavalent chromium reduction activities conducted in the area of VOC Hot-spot No. 1. The introduction of potassium permanganate into the subsurface is expected to increase the quantity of ferrous sulfate necessary to complete reduction of hexavalent chromium to trivalent chromium. Other negative impacts are not anticipated from implementation of this alternative.

Administrative feasibility. Alternative VOC-2 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met. Discharge permits for injection to groundwater should be attainable, based on the results of pilot-scale testing of the in-situ chemical oxidation system. Permits necessary for operation of the air sparging system and the SAEP SVE system, including air discharge permits and a discharge authorization for the CWTP or POTW, should also be easily attainable.

Availability of services and materials. Alternative VOC-2 can be implemented using standard or commonly available construction methods, services, and materials. Experienced contractors and materials necessary for installation and operation of the in-situ chemical oxidation system, the in-situ air sparging system, the SAEP SVE system, and the groundwater monitoring system are readily available. Laboratory services for the analysis of groundwater and vapor samples also are available. Electrical power required for system operations is available from the SAEP site.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

5.6.4 Cost

The two-year removal action of this alternative is estimated to be $14,163,000. The NPW post-removal O&M cost of this alternative (i.e., Years 3 through 30) is estimated to be $5,929,000. Consistent with USEPA guidance, a discount rate of seven percent was used to prepare the cost estimate (USEPA, 1993a). The cost summary for this alternative is provided in Table 5-8 and Appendix B provides a detailed breakdown of the cost estimate.

The following bullets summarize the assumptions used to prepare the cost estimate for Alternative VOC-2. Changes in the assumptions may result in reductions or increases in the actual costs.

GENERAL COST ASSUMPTIONS

- Removal actions will be conducted in Level D personal protective equipment.
- Soil IDW will be drummed for sampling and off-site disposal. Water IDW not containing surfactants will be treated on-site.
- A pre-design investigation will be necessary to further define the limits of VOC Hot-spot No. 3.
- Assumes that existing office space, toilets, and phones are provided by the facility for the remediation work, and that no additional cost to the project is incurred for these facilities.

IN-SITU CHEMICAL OXIDATION

- In-situ reduction, if selected for the chromium area, will be completed after in-situ oxidation.
- It is assumed the removal action for the VOC Hot-spot No. 1 will require 2 years to complete including 6 months of design, procurement, and construction and 1.5 years of operation. It is assumed the removal action for VOC Hot-spot No. 2 will require 1.5 years to complete including 6 months of design, procurement, and construction and 1 year of operation.
- Assumes all treatment equipment will be purchased not leased
- Assumes separate treatment equipment for each hot spot not combined systems
- Extraction wells will be installed with pre-cast concrete manhole sections and covers.
- Both extraction well locations at VOC Hot-spot No. 1 are located inside the building and the piping does not need to be installed below frost level. At VOC Hot-spot No. 2 piping will have to be installed below the frost depth.
- Power will be supplied to VOC Hot-spot No. 1 from Building 63 and to VOC Hot-spot No. 2 from Building B-10. Level controls/recorders will also be located at these buildings.
- Low-clearance drill rig and/or Geoprobe required for indoor locations.

- Injection wells will be installed with a 1-feet stick up above grade
- Additional injection wells will be installed during system operation to address areas where insufficient distribution of potassium permanganate is observed. The number of additional injection wells has been assumed to be 50 percent of the initial number of injection wells
- Infiltration trenches will be installed at a 5 feet spacing within the area indicated.
- Piezometers will be installed to monitor the progress of the chemical front and will be finished with flush-mount road boxes.
- Potassium permanganate will be delivered as crystals in bulk bins. A bulk bin automatic feed station will be required that feeds the potassium permanganate into a solution tank
- 95 percent of the potassium permanganate will be injected during the first 2/3 of the operation period. The remaining 5 percent will be injected during the last 1/3 of the operation period.
- A single 5 HP pump will supply the required flow and pressure to the injection system. Flow rates to the wells will be controlled by control valves at each injection well. The injection pump will have a duplicate to allow backup/maintenance. Potassium permanganate solution will be hard piped to hose connection manifolds in near the treatment areas. Outside piping will be insulated and heat traced. No secondary containment will be provided. From the manifolds, high pressure hose will be used to deliver potassium permanganate solution to the individual injection wells.
- The entire pipeline from Building 63 to the Chemical Waste Treatment Plant will be pressure-tested to verify no leaks are present. It is assumed no leaks will be discovered.
- Assume control wire conduit exists adjacent to this pipe and that new control wires will be pulled from the CWTP to Building 63.
- Secondary containment of the peroxide, acid, and caustic tanks will be required.
- The UV/Oxidation system will be capable of treating water containing up to 100 ppm TCE down to 50 ppb TCE.
- Control systems will be interlocked with the well injection/extraction system and the CWTP such that the plant operator receives alarms and can shut down the systems from the chemical waste treatment plant.
- Power for the UV/oxidation system, mixer, acid and peroxide feed systems will come from the CWTP.
- The pH adjustment tank, UV/oxidation feed pump, UV/Oxidation system, and hydrogen peroxide tank/system will be housed in a new small metal structure set on a concrete pad.
- Treatment equipment and tanks for VOC Hot-spot No. 2 will be installed in Building B-10.
- Discharge of the water to the CWTP will increase the operational cost of the treatment plant.
- There will also be a fee for discharges to the POTW.

- One full-time operator will be required to manage the system during the 1.5-year operation period. An engineer will be required half time during this period to evaluate performance.
- An ELUR will be placed on OU 2 groundwater following completion of in-situ reduction to prevent extraction of groundwater within the limits of the facility.
- A Final Removal Action Report will be written documenting the removal action activities and the results of confirmation sampling and analysis.
- Annual long-term monitoring will be required to verify that the reducing conditions and acceptable hexavalent chromium concentrations are maintained in the subsurface.
- Six five-year site reviews will be conducted and will consist of a review of sampling results and a summary report.

IN-SITU AIR SPARGING

Pilot-scale Treatability Testing

- A pilot-scale test will be conducted to provide estimates on well spacing, flow rates, and vacuum pressures for the full-scale air sparging/SVE system.
- The pilot test will be conducted under Building B-2 and will consist of one air sparging well set to a depth of 45 feet bgs and two horizontal SVE wells.
- The SVE wells will be placed in 1-foot deep trenches approximately 60 feet in length and will be constructed of fabric-wrapped perforated pipe. The SVE trenches will be spaced 30 feet apart.
- The air sparging blower will operate at 15 scfm. The SVE blower will operate at 20 scfm.
- The SVE vapor and liquid treatment systems will be similar in design to those detailed for the SVE pilot-scale system.
- Five groundwater monitoring points and five vapor monitoring points will be installed in the area of the pilot test.
- The pilot-scale sparging system shall be operated five days per week for five weeks. During that month field readings, groundwater samples, vapor samples, and indoor air samples will be collected.

Full-scale Air Sparging System

- A geophysical survey will be conducted to locate underground utilities in the proposed sparging system area (an estimated 45,000 square feet).
- An air discharge permit will be required to operate the sparging/SVE system and a discharge authorization for liquid discharge to the CWTP will also be required.
- Twenty-two sparging wells will be installed to a depth of 45 feet bgs and 19 sparging wells will be installed to a depth of 60 feet bgs in the area of Hot-spot No. 3.
- The sparging wells set to a depth of 45 feet bgs and the sparging wells set to a depth of 60 feet bgs shall be connected to a separate header pipes.

- The header pipe for the 45-foot wells will run underground and connect to two 250 scfm blower capable of producing 35 pounds per square inch (psi) of pressure. A spare blower will be provided for backup.
- The header pipe for the 60-foot wells will run underground and connect to two 250 scfm blower capable of producing 45 psi of pressure. A spare blower will be provided for backup
- An interior corner of Building B-2 will be used to house the system controls necessary for operation of the sparging/SVE system. Electrical wiring for the sparging/SVE control and treatment system will be contained in a separate building to be built outside of Building B-2, such that electrical hazard class requirements are met.

Full-scale Hot-spot No. 3 SVE System

- The proposed SVE wells will be placed in 1-foot deep trenches approximately 450 feet in length and will be constructed of fabric-wrapped perforated pipe. The SVE trenches will be spaced 40 feet apart.
- Subsurface vaults will be placed at the junction of the underground header pipe with each vapor extraction lateral. Each vault shall contain a sampling port and a flow control valve.
- Header pipes will be sloped to the junctions with the extraction well laterals to allow condensate from the system to flow into the extraction well laterals and drain through the perforations.
- Gaps in the concrete floors in the sparging/SVE system influence area will be caulked following system installation to prevent infiltration of atmospheric air and potential short-circuiting of the SVE system.
- The SVE header pipe shall run underground to the system control structure where it will pass through a knockout tank and to a 1500 scfm blower capable of producing a 10 psi vacuum in the system.
- A second blower shall be available as a back up for use during breakdown or maintenance of the other blower.
- After exiting the blower, the vapor shall be sent to the vapor treatment system, which will be similar in design to the system detailed for the site-wide full-scale SVE system.
- Liquids from the knockout tank will be discharged to the liquid treatment system. Treated liquids will be discharged to the CWTP.
- The liquid treatment system will be similar in design to the system detailed for the 20-acre SVE system.

System Operation and Monitoring

- For purposes of alternative evaluation, it is assumed the sparging/SVE system will operate for 2 years; however, costs for 30 years of operation have been included to more closely estimate the lifetime cost of the system.
- Seventy-five groundwater monitoring wells and 75 vapor monitoring points will be installed in the area of the air sparging system.

- System start-up monitoring will be conducted for two months and will consist of collection of system field readings (vacuum/pressure, PID, groundwater field parameters, etc.) and collection of groundwater and soil vapor samples for VOC analysis.
- Monitoring will be conducted on a bi-weekly basis for remainder of the first year and monthly for the second year.
- Quarterly sampling will be conducted for the lifetime of the sparging/SVE system.
- In addition to field readings, complete groundwater and vapor sampling rounds will be completed on a monthly basis for the first year and on a quarterly basis for the lifetime of the sparging/SVE system.
- Indoor air sampling will be conducted on a quarterly basis for the first year of system operation and on an annual basis for the lifetime of the sparging/SVE system.
- Groundwater and vapor samples will be analyzed on-site for VOCs during the first year and sent off-site for VOC analysis for the remainder of operation.
- It is assumed that changeout of the liquid-phase and vapor-phase carbon will be necessary on a quarterly basis.
- The concrete floor will be inspected on an annual basis to ensure its integrity. Cracks and gaps in the concrete will be repaired, as necessary.

SAEP In-situ SVE System

- The cost assumptions for the SVE system component of Alternative VOC-2 are similar to those assumptions listed under Alternative VOC-1, except that the expected duration of system operation has been reduced to five years.

Groundwater Monitoring

- The cost assumptions for the groundwater monitoring component of Alternative VOC-2 are similar to those assumptions listed under Alternative VOC-1.

5.7 Alternative VOC-3 – In-situ Thermal Treatment, In-situ SVE, and Groundwater Monitoring

The scope of Alternative VOC-3 includes the following components:

- Construction of the in-situ thermal treatment systems
- Construction of an in-situ SVE system to prevent VOC infiltration into indoor air
- O&M of the in-situ treatment systems
- Installation of groundwater monitoring wells
- Groundwater sampling and analysis

- Implementation of ELURs

5.7.1 Description of the Alternative

The removal action provided under Alternative VOC-3 will include in-situ thermal treatment to provide a reduction of VOC concentrations in groundwater. A 20-acre in-situ SVE system will be installed to provide a reduction in VOC concentrations in soil vapor and shallow groundwater, as well as mitigate the migration of VOC vapors from the subsurface to buildings at the SAEP facility. A monitoring well network will be installed for the OU 2 groundwater.

In-situ Thermal Treatment. Two types of thermal treatment systems are considered under Alternative VOC-3, Six Phase Heating (SPH) and Dynamic Underground Stripping (DUS). Both SPH and DUS provide treatment by raising subsurface temperatures to the boiling point of water or higher which vaporizes contaminants and promotes transport to vapor recovery wells for collection and treatment. The differences between the two technologies are primarily in the subsurface heating method.

SPH is a method of electrical resistance heating of subsurface contaminated areas. Conventional three-phase power is split into six phases using single-phase transformers. Each of the phases is directed to six separate electrodes typically installed in a hexagonal pattern (an array) in the ground. The middle of the array typically contains a neutral electrode. As current flows from electrode to electrode it causes the water temperature to rise due to electrical resistance. As temperatures approach the boiling point of water, contaminants with low boiling points are vaporized and groundwater is vaporized into steam. The steam helps drive contaminants out of tight soils and carry the contaminants upward toward the vapor collection system. Steam and contaminants are captured by the vapor extraction system for surface treatment. The captured steam is run through a condenser and the vapors and condensate are treated using conventional treatment technologies. For electrical resistance heating, soils with low permeability and high water content are preferentially treated. A typical process flow diagram for the technology is shown in Figure 5-17. Treatment effectiveness is typically monitored through a combination of chemical data from extracted vapors and temperature measurements of the treatment area.

Implementation of SPH at SAEP will consist of installation of the six-phase transformer, electrodes, vapor recovery wells, and vapor treatment equipment followed by operation of the system until the entire area of the hot spot has been treated. Figures 5-18, 5-19, and 5-20 show the proposed layouts of the SPH systems at the three VOC hot-spots. Typically, only a few arrays may be treated at a time depending on the capacity of the six-phase transformer. Arrays are typically 30-40 feet across and can treat up to 40 percent of additional area beyond the limits of the hexagon formed by the array. For conceptual design purposes in this EE/CA it was assumed that the arrays will be 40 feet across and that they could be placed six feet apart and still achieve treatment of the area between arrays. Vapor extraction wells are typically installed in the vadose zone and are often installed in the same boring as the electrodes. Extracted vapors are passed through a condenser that cools the vapor stream and collects condensed product and condensed water. Vapor exiting the condenser is treated to remove the organic contaminants. The conceptual designs for this technology assume treatment by catalytic oxidizer although other vapor treatment methods may be applicable such as activated carbon. Exhaust from the catalytic oxidizer may contain hydrochloric acid above the allowable discharge limits; therefore, a hydrochloric acid scrubber is included. Water from the condenser is also treated to remove organics prior to discharge to the POTW. This treatment is assumed to be activated carbon (see Figure 5-17). The following paragraphs described the hot-spot-specific layouts of the six-phase arrays.

VOC Hot-spot No. 1 will have 8 six-phase arrays and 10 partial arrays (see Figure 5-18). Each array will be installed to a depth of 40 feet and the subsurface will be heated to the boiling point of water from approximately 5 to 44 feet bgs. Assuming one 2000 kilowatt (kW) six-phase transformer for this hot spot, treatment is estimated to require eight months.

VOC Hot-spot No. 2 will have 3 six-phase arrays and 5 partial arrays (see Figure 5-19). Each array will be installed to a depth of 40 feet and the subsurface will be heated to the boiling point of water from approximately 5 to 44 feet bgs. Assuming one 2000 kW six-phase transformer for this hot spot, treatment is estimated to require three months. However, the lateral extent of VOC Hot-spot No. 2 requires further delineation, possibly affecting the design and cost of this alternative.

VOC Hot-spot No. 3 will have 27 six-phase arrays and 17 partial arrays (see Figure 5-20). The depth of the arrays will vary as indicated on Figure 5-23. Groundwater from 5 feet bgs to approximately 4 feet below the installed depth will be heated to the boiling point of water. Assuming two 2000 kW six-phase transformers for this hot spot, treatment is estimated to require 12 months.

DUS is a method of heating subsurface contaminated areas by injection of steam via wells. Injected steam vaporizes volatile compounds and drives them toward extraction wells. In some cases DUS also uses electrical resistance heating for silt and clay layers that do not easily transmit steam. Enhanced removal during DUS is also achieved by cycling the steam injection on and off and also by the addition of oxygen to the injected steam. Steam injection cycling causes increased vaporization of water and contaminants as the subsurface adjusts to achieve thermodynamic equilibrium. The overall effect is increased vaporization with less steam input. Addition of oxygen to the injected steam causes thermally accelerated oxidation to occur which is referred to as hydrous pyrolysis/oxidation (HPO). HPO is the oxidation of compounds at elevated temperatures in situ. At these elevated temperatures oxygen acts as an effective oxidizer and it has been demonstrated at other sites that as much as 18 percent of the contamination can be removed by HPO rather than physical removal from the extraction wells.

Implementation of DUS at SAEP will consist of installation of the steam boiler, injection wells, extraction wells, and treatment equipment followed by operation of the systems until the entire area of the hot spot has been treated. Figures 5-24, 5-25, and 5-26 show the proposed well locations for the DUE system s at the three VOC hot-spots. Steam is injected through a short screened section at the bottom of the treatment interval and water and vapors are extracted from a screened section over the entire treatment interval. Typically, the horizontal distance between injection and extraction wells is about the same as the vertical depth of the treatment zone such that adequate vertical dispersion of the steam front is achieved. Deeper injection depths allow for higher injection pressures and injection rates without fracturing of the soil structure. Injection wells are usually positioned around the perimeter of the treatment area and extraction wells are inside the treatment area such that migration of contaminants outside the treatment area is controlled. Figure 5-27 shows a typical process flow diagram for DUS. The vapor treatment process is similar to the process used for SPH with the additional treatment of extracted water through the activated carbon. The following paragraphs described the hot-spot specific layout of the six-phase arrays.

VOC Hot-spot No. 1 will have 14 injection wells and 11 extraction wells (see Figure 5-24). A ring of 12 injection wells will be positioned around the hot spot. To reduce the treatment time required, two injection wells will also be installed in the middle of the treatment area. A ring of extraction wells will then be placed between the perimeter injection wells and the central injection wells. Injection wells will be installed to a depth of 45 feet bgs and will be screened from 35 to 40 feet bgs (Figure 5-28). Extraction wells will be installed to a depth of 40 feet bgs and will be screened from 5 to 40 feet bgs. Assuming one 8,000,000 British Thermal Units per hour (BTU/hr) steam boiler for this hot spot, treatment is estimated to require 8 months.

VOC Hot Spot No. 2 will have seven perimeter injection wells and one central extraction well (see Figure 5-25). Injection wells will be installed to a depth of 45 feet bgs and will be screened from 35 to 40 feet bgs. Extraction wells will be installed to a depth of 40 feet bgs and will be screened from 5 to 40 feet bgs (Figure 5-29). Assuming one 8,000,000 BTU/hr steam boiler for this hot spot, treatment is estimated to require 7 weeks.

VOC Hot Spot No. 3 will have 23 perimeter injection wells and three injection wells in the middle of the treatment area, to reduce treatment time and 19 extraction wells (see Figure 5-26). Nineteen extraction wells will be placed between the perimeter injection wells and the central injection wells as shown. Injection wells will be installed to a depth of 65 feet bgs and will be screened from 55 to 60 feet bgs. Extraction wells will also be installed to a depth of 60 feet bgs and will be screened from 5 to 60 feet bgs (Figure 5-30). Assuming one 32,000,000 BTU/hr steam boiler for this hot spot, treatment is estimated to require 12 months.

SAEP Soil Vapor Extraction. The location and details of the 20-acre, SVE system for this alternative will be as described in Subsection 5.5.1 for Alternative VOC-1.

It is unknown if active treatment of the VOC hot-spots will have a significant impact on indoor air quality. Active treatment will reduce overall VOC concentrations in groundwater and will likely reduce the amount of time the SAEP SVE system is needed to prevent the migration of VOC-contaminated vapors to the interior of on-site buildings. For purposes of cost estimation and alternative evaluation an operation period of five years has been assumed for this alternative.

Groundwater Monitoring. Groundwater monitoring will be conducted as part of Alternative VOC-3. The number and location of monitoring wells, analytical parameters, sampling frequency, data evaluation, and reporting requirements for this alternative are the same as discussed in Subsection 5.5.1 for Alternative VOC-1.

In accordance with the CTDEP RSR, an ELUR restriction will be required, which will establish restrictions on future use of groundwater associated with the SAEP facility.

Alternative Interactions

Implementation of this alternative has potential impacts on future actions that may be completed at the site. As a result of the treatment of VOC hot-spots, it is possible that the duration of SAEP SVE system operation, and the length of time for which groundwater monitoring is required, could be reduced, compared to an alternative that does not propose treatment. For purposes of alternative evaluation and cost assumption, it has been assumed that 5 years of SVE system operation and 30 years of groundwater monitoring will be required to ensure VOC-contaminated vapor and groundwater are not migrating.

5.7.2 Effectiveness

The effectiveness of Alternative VOC-3 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative VOC-3 uses a combination of contaminated media treatment, engineering controls, and institutional controls to reduce and control risks associated with VOC-contaminated groundwater. Thermal treatment of VOC hot-spots is anticipated to reduce the concentration of VOCs in groundwater hot-spots to removal action goals. Heat applied to the subsurface will volatilize VOC contaminants, causing them to rise into the vadose zone and be captured by the coupled SVE system. Limited subsurface destruction of contamination may also occur. Surface treatment of the generated vapors using catalytic oxidation will destroy VOC contaminants.

The reduction in groundwater hot-spot VOC concentrations will limit the amount of volatilization occurring from shallow groundwater to the vadose zone. The SAEP SVE system will prevent the migration of VOC-contaminated vapors from the subsurface to the interior of SAEP buildings; thereby limiting human receptor exposure to contaminant concentrations greater than the CTDEP RSR I/C IATC. Indoor air sampling will confirm the effectiveness of the SVE system at preventing vapor migration. The SVE system will also remove VOC-contaminated vapors from the subsurface and provide for removal of VOC contaminants from the vapor in a surface treatment system. VOC contamination remaining in the carbon treatment system will be sent off-site for regeneration and destruction of the contaminants.

The groundwater monitoring component of Alternative VOC-3 will provide information on the ability of natural attenuation processes to reduce contaminant concentrations in groundwater outside of the hot-spots through volatilization, dispersion, and degradation. Analytical data gathered during two years of groundwater monitoring will evaluate if natural attenuation processes, coupled with hot-spot treatment and SVE, will effectively reduce VOC contaminant concentrations over the long-term, such that concentrations greater than the CTDEP RSR SWPC will not be discharged to the Housatonic River.

Implementation of an ELUR will provide for institutional control at the SAEP site. Alternative VOC-3 proposes restricting groundwater usage for the OU 2 area. This restriction will prevent potential receptor exposure to contaminated groundwater.

Alternative VOC-3 will provide protection to human health and the environment by (1) preventing the migration of soil vapor into indoor buildings, (2) providing for the treatment of groundwater hot-spots and vadose zone vapors, (3) monitoring the migration and concentrations of VOC contaminants in groundwater, and (4) restricting access to subsurface contamination and the use of contaminated groundwater.

Compliance with ARARs. Alternative VOC-3 will be designed and implemented to attain the identified federal and state ARARs (see Tables 3-2 through 3-4).

Chemical-specific ARARs pertaining to Alternative VOC-3 are the CTDEP RSRs. Applicable criteria include the I/C VC and SWPC for groundwater, I/C VC for soil vapor, and I/C IATC for indoor air. The removal actions may meet all the listed CTDEP RSRs and the removal actions will be designed to be consistent with future remedial actions which will be implemented to meet CTDEP RSRs.

Location-specific ARARs pertaining to this alternative include those related to flood plain and coastal zone management. Actions taken under this alternative are not anticipated to have negative impacts to the shoreline of the Housatonic River. Design of the alternative will consider these location-specific ARARs and minimize its impact to the river.

Action-specific ARARs related to this alternative pertain to air emissions, noise pollution, surface water protection, groundwater well installation, waste identification and listing, and waste generation and storage. Operation of the thermal treatment and SVE systems will be designed and operated to comply with ARARs.

An air discharge permit will be obtained for operation of the thermal treatment and SVE systems. Vapor emissions from the vapor treatment systems will be monitored for VOC content. Discharge of condensed liquids to the CWTP for eventual discharge to the Housatonic River will be allowed only as detailed in a discharge authorization. Installation of monitoring wells and handling and disposal of generated IDW will be conducted in compliance with specified regulations.

Long-term effectiveness. Alternative VOC-3 will provide long-term effectiveness because thermal treatment of groundwater hot-spots will remove (or destroy) VOC contamination from the groundwater in hot-spot areas and the coupled SVE system will remove generated vapors from the subsurface. Contaminated vapors will be treated prior to discharge to the atmosphere and VOC contamination within the vapors will be destroyed. Because the proposed treatment processes are irreversible, this alternative will provide permanent contaminant reductions.

In addition, the SVE system will prevent the migration of VOC-contaminated vapors for as long as the system operates. For purposes of evaluation, it is assumed the SVE system will operate for 2 years; however, it is estimated the system will operate until VOC concentrations in site-wide shallow groundwater no longer exceed the CTDEP RSR I/C VC under future remedial actions if implemented under this removal action. The system will prevent the migration of vapors from the subsurface to on-site buildings, preventing receptor exposure to vapor concentrations in exceedance of the CTDEP RSR I/C IATC. In addition, implementation of an ELUR will prevent the use of contaminated groundwater for any purpose.

The groundwater monitoring component of Alternative VOC-3 will evaluate if natural attenuation processes will effectively reduce VOC concentrations such that contamination greater than the CTDEP RSR SWPC will not be discharged to the Housatonic River in the long-term. Regardless of the evaluation results, Alternative VOC-3 will provide for long-term effectiveness because the final remedy chosen for SAEP groundwater will be dependent upon the evaluation. If the evaluation indicates natural attenuation processes will prevent VOC concentrations greater than RSR criteria from discharging to the Housatonic River, the final remedy may propose MNA; however, if natural attenuation processes will not be able to prevent discharge, a more aggressive treatment option for site-wide groundwater may be chosen.

Following completion of this alternative (two-year operation), it is anticipatedthat the source of VOC contamination in groundwater and soil gas will be removed. VOC-contaminated groundwater from outside the hot-spots will flow into the hot-spots following treatment. Subsequent remedial actions will address the residual VOC contamination in groundwater. Removal of the contamination source will greatly improve the effectiveness of addressing the residual groundwater contamination as part of the long-term remedy.

Reduction of toxicity, mobility, or volume through treatment. Alternative VOC-3 proposes in-situ thermal treatment to reduce VOC concentrations in groundwater coupled with a hot-spot SVE system to capture generated vapors. Removal of contamination from hot-spot groundwater will provide an irreversible reduction in contaminant volume, and destruction of VOCs in the surface catalytic oxidation unit will provide an additional reduction in contaminant volume and an irreversible reduction in toxicity. Because Alternative VOC-3 involves active treatment, the alternative will satisfy the CERCLA statutory preference for treatment as a principal element of the remedy.

Capture and surface treatment of contaminated vapors by the SVE systems will provide for a small reduction in VOC contaminant volume and mobility. Removal of the VOC-contaminated carbon from the SAEP site and regeneration at an off-site facility will destroy the sorbed contaminants and will provide for a reduction in contaminant toxicity and volume. The SVE system will be designed to eliminate the migration of contaminated vapors from the subsurface to SAEP buildings rather than to treat contaminated subsurface soil and groundwater. As a result, it is estimated that a limited mass of contaminant will volatilize from the shallow groundwater and be captured by the SVE system.

The USEPA does not consider natural attenuation processes an active treatment technology and groundwater monitoring will not reduce the toxicity, mobility, or volume of contaminants. However, the groundwater monitoring component of this alternative will evaluate if natural attenuation can provide an irreversible reduction in toxicity and volume of contaminants.

Following completion of this alternative, it is estimated that residual VOC contamination will not be present in groundwater hot-spots. Subsequent remedial actions will be designed to address the residual VOC contamination in groundwater outside of the VOC hot-spots.

Short-term effectiveness. Access to the SAEP facility is restricted; therefore, potential risks to the community will be minimized during alternative installation and operation. Groundwater in the vicinity of the SAEP site is classified as GB Groundwater, indicating it is not used and is not proposed for use for any purpose by the community or site workers.

The thermal treatment component of Alternative VOC-3 will have potential short-term risks to site workers during system installation; however, these risks will be minimized by effectively implementing an approved SSHP. The appropriate level of personal protection will be used during installation activities to prevent inhalation of or dermal contact with contamination. Monitoring of site conditions (e.g., dust levels and field VOC concentrations) also will be conducted. Discharge of treated vapor to the atmosphere during operation of the thermal treatment system may present a risk to the community if contaminated vapors are inadvertently discharged. The treatment system will be designed with a sample port following vapor stream discharge from the catalytic oxidation unit, such that monitoring of the discharge can be conducted. In addition, instrumentation can be used, if necessary, to continuously monitor the discharge.

Installation of the SAEP SVE system and the groundwater monitoring wells will also present possible risks to site workers that will be minimized by adherence to the SSHP. Operation of the SVE system will provide an immediate improvement to indoor air quality and provide short-term benefits to site workers. Impacts to the community and the environment are possible during operation of the soil vapor treatment system if discharge of VOC-contaminated vapor to the atmosphere occurs. The vapor treatment system will be designed with a sample port following vapor stream discharge from the polish carbon vessel, such that monitoring of the discharge can be conducted. In addition, instrumentation can be used, if necessary, to continuously monitor the discharge.

Groundwater monitoring will provide short-term effectiveness by ensuring concentrations of VOCs in groundwater above the CTDEP RSR SWPC are not discharging to the Housatonic River. Implementation of an ELUR will prevent use of contaminated groundwater for any purpose.

It is anticipated that construction activities associated with Alternative VOC-3 will be completed in approximately 6 months. Operation of the in-situ thermal treatment and in-situ SVE systems is estimated to continue for approximately 2 years, at which time the response objectives will be achieved within the VOC hot-spots. Continued operation of the SVE system will likely be considered under the SAEP RI/FS to ensure migration of VOC-contaminated vapors is not occurring from groundwater outside the hot-spots, and has been assumed to be necessary for 5 years.

5.7.3 Implementability

The implementability of Alternative VOC-3 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative VOC-3 is considered technically feasible for the areas of VOC-contaminated groundwater and vapors associated with shallow VOC-contaminated soil and groundwater. Although thermal treatment is not considered a well-demonstrated technology, the individual components of the technology have been used frequently in the past. The in-situ SVE and groundwater monitoring processes are well demonstrated.

The presence of a relatively shallow groundwater table necessitates the use of horizontal wells for the SVE system. The location of numerous underground utilities and structures (e.g., vaults and concrete pits) may limit the ability to install lengthy horizontal wells. The issue of restricted subsurface access will be addressed during engineering design by evaluating existing utility maps and through the completion of a GPR survey prior to well installation.

Implementation of this alternative will not interfere with future removal actions or remedial actions at the SAEP site.

Administrative feasibility. Alternative VOC-3 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met. In addition, permits necessary for operation of the thermal treatment system and the SVE system, including air discharge permits and a discharge authorization for the CWTP, should be easily attainable. Actions proposed under this alternative will be completed on the SAEP property.

Availability of services and materials. Alternative VOC-3 can be implemented using standard or commonly available construction methods, services, and materials. Although thermal treatment is not considered a well-demonstrated technology, experienced contractors and materials necessary for construction and operation of the system are available. In addition, services and materials necessary for the installation of the in-situ SVE system, installation of the groundwater monitoring wells, and collection and analysis of groundwater samples are readily available. Electrical power required for system operations is available from the SAEP site.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

5.7.4 Cost

Two cost estimates have been prepared for Alternative VOC-3. The first estimate (Alternative VOC-3A) is for implementation of SPH at the three VOC hot-spots, implementation of the SAEP SVE system, and groundwater monitoring. The second estimate (Alternative VOC-3B) is for implementation of DUS at the three VOC hot-spots, implementation of the SAEP SVE system, and groundwater monitoring. It should be noted that using a combination of SPH and DUS to address hot-spots, using a single treatment system for the three hot spots, or equipment leasing rather than purchase, could provide substantial savings for this alternative.

The two-year removal action cost of the SPH alternative (Alternative VOC-3A) is estimated to be $18,856,000 and the NPW post-removal O&M cost (5-year operation) is estimated to be $1,532,000. The two-year removal action cost of the DUS alternative (Alternative VOC-3B) is estimated to be $15,326,000 and the NPW post-removal O&M cost is estimated to be $1,532,000. Cost summaries for these alternative estimates are provided in Tables 5-9 and 5-10; Appendix B provides a detailed breakdown of the cost estimates.

The following bullets summarize the assumptions used to prepare the cost estimates for Alternative VOC-3. Changes in the assumptions may result in reductions or increases in the actual costs.

General Cost Assumptions

- Removal actions will be conducted in Level D personal protective equipment.
- Soil IDW will be drummed for sampling and off-site disposal. Water IDW not containing surfactants will be treated on-site.
- A pre-design investigation will be necessary to further define the limits of VOC Hot-spot No. 3.
- Demolition of Building 48 will be required in order to install electrodes or steam injection wells for VOC Hot-spot No. 2.
- Assume wells or electrodes will be abandoned in place with a grout backfill.
- Assumes all treatment equipment will be purchased not leased.
- Assumes separate treatment equipment for each hot spot not combined systems.
- Assumes that VOC Hot-spot No. 1 will be completed as a pilot test with a second design stage and re-mobilization for VOC Hot-spot No. 2 and No. 3.
- Assumes that existing office space, toilets, and phones are provided by the facility for the remediation work, and that no additional cost to the project is incurred for these facilities.

Six-phase Heating

- Assume 13.8 kilovolt three phase electrical power (as much as 8 MW) is available at SAEP.
- Assume main power feed will be from a location along Main Street near the main entrance. Assume routine connection to power supply. High voltage power will be run from the main connection to within 50 feet of each six-phase transformer. All electrical cable will be installed above grade along existing cable trays.
- SVE wells will be co-located with each electrode.
- A piezometer will be installed in each treatment ring for monitoring purposes.
- Steam condensers are sized to handle 50, 50, and 100 tons per day for VOC Hot-spot Nos. 1, 2, and 3, respectively.
- Carbon adsorption units for condensate treatment are 1,000, 1,000, and 10,000 pounds each for VOC Hot-spot Nos. 1, 2, and 3, respectively. There are two such units for each hot spot.

- Vapor/steam extraction flow rates are 500, 500, and 1,000 cfm for VOC Hot-spot Nos. 1, 2, and 3, respectively.
- Carbon usage for treatment of condensate will be 4000 pounds, 2000 pounds, and 40,000 pounds, respectively for VOC Hot-spot Nos.1, 2, and 3.

DYNAMIC UNDERGROUND STRIPPING

- Assume new boilers will be complete with water treatment system for softening and water pump. Use of the facility boiler could provide savings if adequate for a DUS application
- Steam condensers are sized to handle 80, 80, and 120 tons per day for VOC Hot Spots No. 1, No. 2, and No. 3 respectively.
- Carbon adsorption units for condensate treatment are 1,000, 1,000, and 10,000 pounds each for VOC Hot Spots No. 1, No. 2, and No. 3 respectively. There are two such units for each hot spot.
- Vapor/steam extraction flow rates are 500, 500, and 1,000 cfm for VOC Hot Spots No. 1, No. 2, and No. 3 respectively.
- Water consumption for the boiler is 36 gallons per cubic yard treated.
- Natural gas consumption for the boiler is based on 127,000 BTU/cubic yard treated and 1000 BTU per cubic foot of natural gas.
- Carbon usage for treatment of condensate will be 4000 pounds, 2000 pounds, and 40,000 pounds respectively for VOC Hot Spots No.1, No. 2, and No. 3.
- Each extraction well will be equipped with an extraction pump for liquid pumping (2 HP) in addition to the vapor extraction system connected to the wellhead.
- The number of electrical resistance tomography wells used to monitor the subsurface temperature in the treatment zones will be the same as the number of injection wells.
- An air permit for boiler will be required.
- Routine connection to power supply and water supply will be possible.

SAEP IN-SITU SVE SYSTEM

- The cost assumptions for the SVE system component of Alternative VOC-3 are similar to those assumptions listed under Alternative VOC-1, except that the expected duration of system operation has been reduced to five years.

GROUNDWATER MONITORING

- The cost assumptions for the groundwater monitoring component of Alternative VOC-3 are similar to those assumptions listed under Alternative VOC-1.

6.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section presents a comparative analysis of the removal action alternatives described in Section 5.0 of this EE/CA. The comparative analysis is a comparison of the alternatives relative to the evaluation criteria. The purpose of the comparative analysis is to identify the advantages and disadvantages of the alternatives relative to one another, and to aid in the eventual selection of a removal alternative.

6.1 APPROACH TO THE COMPARATIVE ANALYSIS

Specific CERCLA requirements are considered when comparing alternatives for selection of a preferred site remedy. The NCP outlines the approach for performing the comparative analysis of alternatives. The recommended alternative must reflect the scope and purpose of the actions being undertaken and indicate how these actions relate to other removal and remedial actions, and the long-term response at the site. Identification of the preferred alternative and final remedy selection are based on an evaluation of the major tradeoffs among the alternatives in terms of the CERCLA evaluation criteria. The USEPA categorizes these evaluation criteria into three groups: threshold, balancing, and modifying. Each of these groups is discussed in the following subsections.

6.1.1 Threshold Criteria

The two threshold criteria described below must be met in order for the alternatives to be eligible for selection in accordance with the NCP.

Overall protection of human health and the environment addresses whether or not the remedy provides adequate protection to human health and the environment and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

Compliance with ARARs addresses whether or not the remedy will meet all of the ARARs of federal and more stringent state environmental laws and/or provide grounds for invoking a waiver.

6.1.2 Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria.

Long-term effectiveness and permanence addresses the criteria that are utilized to assess alternatives for long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

Reduction of toxicity, mobility, or volume through treatment addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site.

Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

Implementability addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

Cost includes estimated removal action costs (indirect and direct) and post-removal O&M costs.

6.1.3 Modifying Criteria

The modifying criteria are used on the final evaluation of alternatives, generally after the public comment period on the EE/CA.

State acceptance addresses the state's position and key concerns related to the preferred alternative and other alternatives, and the state's comments on ARARs and to be considered information or the proposed use of waivers.

Community acceptance addresses the public's general response to the alternatives described in the EE/CA.

6.2 Comparative Analysis

The following removal action alternatives were evaluated in detail in Section 5.0 and will undergo comparative analysis in this section:

<u>Chromium Hot Spot Area – Chromium Plating Room Structures:</u>

Alternative CR-S-1	Removal and Off-site Disposal of Floor and Wall/Decontamination of Beams
Alternative CR-S-2	Removal and Off-site Disposal of Wall/Impermeable Cover on Floor/Decontamination of Beams

<u>Chromium Hot Spot Area - Groundwater:</u>

Alternative CR-GW-1	In-situ Reduction using Ferrous Sulfate
Alternative CR-GW-2	Groundwater Monitoring

<u>VOC Hot Spot Areas 1, 2, and 3 - Groundwater:</u>

Alternative VOC-1	In-situ SVE and Groundwater Monitoring
Alternative VOC-2	In-situ Chemical Oxidation using Potassium Permanganate, In-situ Air Sparging, In-situ SVE, and Groundwater Monitoring

Alternative VOC-3 In-situ Thermal Treatment, In-situ SVE, and Groundwater Monitoring

The comparative analyses for the Chromium Plating Room Structures alternatives, the Chromium Groundwater Alternatives, and the VOC Groundwater Alternatives are presented in Tables 6-1, 6-2, and 6-3, respectively.

7.0 RECOMMENDED REMOVAL ACTION ALTERNATIVES

The following subsections present the recommended removal action alternatives for chromium-contaminated structures, hexavalent chromium-contaminated groundwater, and VOC-contaminated groundwater hot-spots. The recommendations are based on the conclusions presented in the detailed and comparative analyses.

7.1 CHROMIUM-CONTAMINATED STRUCTURES

Alternative CR-S-1 is the preferred removal action alternative for chromium-contaminated structures in the former Chromium Plating Facility. This alternative proposes removal and off-site disposal of the northwestern-most wall and the facility floor, replacement of the floor, and decontamination of the overhead beams. Alternative CR-S-1 is preferred over Alternative CR-S-2, which proposes leaving the existing floor in place and covering it with a impermeable barrier and concrete, because off-site disposal of the contaminated floor removes a larger portion of contaminated material from the facility and provides a greater amount of long-term protection. The added benefits of floor removal are achieved with only an estimated 15 percent increase in overall cost.

Alternative CR-S-1 removes the majority of contaminated structures and encapsulates residual contamination, if necessary, to provide protection of human health. It meets pertinent ARARs and provides both long- and short-term effectiveness. It is estimated that the alternative will require 12 weeks to complete, and that there will be no technical or administrative barriers to implementation. The estimated removal action cost of the alternative is $601,000 and the estimated NPW cost for post-removal O&M is $40,000.

7.2 HEXAVALENT CHROMIUM IN GROUNDWATER

Alternative CR-GW-1: In-situ Reduction using Ferrous Sulfate, is the preferred removal action alternative for hexavalent chromium-contaminated groundwater in the vicinity of the former Chromium Plating Facility. This alternative proposes the subsurface injection of ferrous sulfate to reduce hexavalent chromium in groundwater and subsurface soil to trivalent chromium. Extraction wells will be used to provide hydraulic control within the groundwater treatment areas, and extracted groundwater will be transferred to the CWTP, where it will be treated and discharged.

Alternative CR-GW-1 is preferred over Alternative CR-GW-2 because hexavalent chromium contamination will be reduced to a less toxic form, providing more protection to potential human and ecological receptors at the point of groundwater discharge to the tidal flats. The proposed alternative will be designed to comply with ARARs, will meet the CERCLA preference for treatment, will result in significant reductions in contaminant toxicity, mobility, and volume, and is anticipated to provide long-term effectiveness. Reduction of hexavalent chromium is estimated to be completed in a relatively short period of 2 years. Although the necessary amount of design will be much greater for this alternative, as compared to Alternative CR-GW-2, the technology is thought to be easily implementable, and has been demonstrated to be effective during a pilot-scale treatability study. The estimated removal action cost of the alternative is $3,128,000 and the estimated NPW cost for post-removal O&M is $310,000.

7.3 VOCs IN GROUNDWATER

Alternative VOC-3: In-situ Thermal Treatment, In-situ SVE, and Groundwater Monitoring, is the preferred removal action alternative for VOC-contaminated groundwater hot-spots. This alternative is preferred over the other considered alternatives because it achieves the greatest level of contaminant reduction in the shortest period of time. It is estimated that the thermal treatment portion of Alternative VOC-3 will result in the least amount of VOC residual remaining in the hot-spots, will require 6 months for construction, and 2 years of operation to meet response objectives. Installation and operation of the SVE system will provide immediate improvement to indoor air quality and groundwater monitoring will confirm contamination is not being discharged to the tidal flats.

Alternative VOC-3 will provide protection to human health and the environment, will be designed to comply with ARARs, and will permanently remove contamination from the subsurface. It will meet the CERCLA preference for treatment and will result in an irreversible reduction in contaminant toxicity, mobility, and volume. Although a significant amount of design will be required, the alternative is considered easily implementable from a technical and administrative standpoint. The estimated removal actionl cost of the alternative ranges from $15,326,000 to $18,856,000 and the estimated NPW cost of post-removal O&M of the alternative is $1,532,000.

1,1-DCE	1,1-dichloroethylene
1,1,1-TCA	1,1,1-trichloroethylene
ARAR	Applicable or Relevant and Appropriate Requirement
AVCO	Avco Corporation
bgs	below ground surface
BRAC	Base Closure and Realignment
BTU/hr	British Thermal Units per hour
C2HCl3	TCE
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cl-	chloride ions
COC	contaminant of concern
COD	chemical oxygen demand
Cr(III)	trivalent chromium
CSF	Cancer Slope Factor
CTDEP	Connecticut Department of Environmental Protection
CWTP	Chemical Waste Treatment Plant
DO	dissolved oxygen
DUS	Dynamic Underground Stripping
EE/CA	Engineering Evaluation/Cost Analysis
ELUR	Environmental Land Use Restriction
^{o}F	degrees Fahrenheit
Fe(II)	ferrous iron
Fe(III)	ferric iron
Foster Wheeler	Foster Wheeler Environmental Corporation
FS	Feasibility Study
ft/min	feet per minute
GC	gas chromatograph
gpm	gallons per minute
>	greater than
H+	hydrogen ions
H2O	water
HCrO4-	chromate ion
HDPE	high-density polyethylene
HLA	Harding Lawson Associates
HP	horsepower

HPO	hydrous pyrolysis/oxidation
I/C DEC	Industrial/Commercial Direct Exposure Criteria
I/C IATC	Industrial/Commercial Indoor Air Target Concentrations
I/C VC	Industrial/Commercial Volatilization Criteria
IDW	investigation-derived waste
kW	kilowatt
LRA	Local Redevelopment Authority
µg/L	micrograms per liter
mg/L	milligrams per liter
MNA	monitored natural attenuation
MnO4-	permanganate ion
MnO2	manganese dioxide
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
MSL	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCRA	Non-time-Critical Removal Action
NGVD	National Geodetic Vertical Datum
NPW	Net Present Worth
O&M	operation and maintenance
OU	Operable Unit
PCE	tetrachloroethylene
PID	photoionization detector
PMC	Pollutant Mobility Criteria
psi	pounds per square inch
POTW	Publicly-owned Treatment Works
ppmv	part per million by volume
RAM	Removal Action Memorandum
RCRA	Resource Conservation and Recovery Act
RfD	Risk Reference Dose
RI	Remedial Investigation
RKG	RKG Associates, Inc.
RSR	Remediation Standard Regulation

SAEP	Stratford Army Engine Plant
scfm	standard cubic feet per minute
SPLP	Synthetic Precipitate Leaching Procedure
SPH	Six-phase Heating
SVOC	semivolatile organic compound
TACOM	United States Tank-Automotive and Armament Command
TCE	trichloroethylene
TERC	Total Environmental Restoration Contract
TOC	total organic carbon
TSDF	treatment, storage, and disposal facility
URSGWCFS	URS Greiner Woodward Clyde Federal Services
USACE	United States Army Corps of Engineers – New England District
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
W-C	Woodward-Clyde Consultants

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TABLE ES-1
REMOVAL ACTION GOALS

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Media/Location	Removal Action Goal	Source of Goal
Chromium on facility structures	Total Chromium = 210,000 mg/m^2 Hexavalent Chromium = 0.53 mg/m^2	Risk-based clean-up goals developed by HLA
Hexavalent chromium in site groundwater	110 µg/L	CTDEP RSR SWPC
VOCs in indoor air	PCE = 1.61 ppbv TCE = 0.92 ppbv 1,1,1-TCA = 266 ppbv 1,1-DCE = 0.02 ppbv Vinyl chloride = 0.019 ppbv	CTDEP RSR I/C Indoor Air Target Concentrations
VOCs in hot-spot groundwater	PCE = 88 µg/L TCE = 540 µg/L 1,1,1-TCA = 50,000 µg/L 1,1-DCE = 6 µg/L Vinyl chloride = 2 µg/L	The lower of CTDEP RSR I/C VC or CTDEP RSR SWPC

Notes:

CTDEP = Connecticut Department of Environmental Protection
DCE = dichloroethylene
HLA = Harding Lawson Associates
I/C = Industrial/Commercial
mg/m^2 = milligrams per square meter
PCE = tetrachloroethylene
ppbv = parts per billion by volume
RSR = Remediation Standard Regulation
SWPC = Surface Water Protection Criteria
TCA = trichloroethane
TCE = trichloroethylene
µg/L = microgram per liter
VC = Groundwater Volatilization Criteria
VOC = volatile organic compound

TABLE 2-1
INORGANICS IN SOIL EXCEEDING CTDEP CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

					Loc ID	SP-98-01				SP-98-02				SP-98-03				SP-98-04			
					Samp ID	SP0100		SP0107		SP0200		SP0207		SP0300		SP0307		SP0400		SP0407	
					Samp Date	8/20/98		8/20/98		8/20/98		8/20/98		8/20/98		8/20/98		8/20/98		8/20/98	
					Start Depth	0.25		7		0.33		7		0.25		7		0.4		7	
					End Depth	2		9		2		9		2		9		2		9	
Class	**CAS #**	**PARAMETER**	**UNITS**	**PMC**	**I/C DEC**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**
Inorganics	18540-29-9	Hexavalent Chromium	MG/KG		100	1.1	U	80.4		72.7		35.7		3.7		59.2		8.9		41.9	
	57-12-5	Cyanide	MG/KG		41,000	0.55	U			0.55	U			230				0.55	U		
	7439-96-5	Manganese	MG/KG			174				156				152				234			
	7440-02-0	Nickel	MG/KG		7,500	8.4				6.9				4.6	U			71.8			
	7440-44-0	Total Organic Carbon	MG/KG			110	U			110	U			120	U			140			
	7440-47-3	Total Chromium	MG/KG			705		586		279		162		910		1,380		46.8		252	
	FE2	Ferrous Iron	MG/KG																		
SPLP	7439-96-5	Manganese	MG/L																		
Inorganics	7440-47-3	Total Chromium	MG/L	0.5																	
TCLP	57-12-5	Cyanide	MG/L	2		0.01	U			0.01	U			0.01	U			0.01	U		
Inorganics	7440-47-3	Total Chromium	MG/L	0.5		**7.3**				**3.7**				**1.1**				0.1	U		

Notes:
Bold and shaded values indicate exceedance of CTDEP criteria
PMC = CTDEP Pollutant Mobility Criteria for GB aquifer
I/C DEC = CTDEP Industrial/Commercial Direct Exposure Criteria
Q = qualifier
U = not detected at a concentration above the reported value
J = reported value is estimated
MG/KG = milligrams per kilogram
MG/L = milligrams per Liter

TABLE 2-1
INORGANICS IN SOIL EXCEEDING CTDEP CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

					Loc ID	SP-98-05				SP-98-06				SP-99-01				SP-99-02	
					Samp ID	SP0500		SP0507		SP0600		SP0607		SP9901000X		SP9901004X		SP9902000X	
					Samp Date	8/20/98		8/20/98		8/20/98		8/20/98		1/6/99		1/6/99		1/6/99	
					Start Depth	0.33		7		0.33		7		0		4		4	
					End Depth	2		9		2		9		4		8		8	
Class	**CAS #**	**PARAMETER**	**UNITS**	**PMC**	**I/C DEC**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**
Inorganics	18540-29-9	Hexavalent Chromium	MG/KG		100	11.9		5.9		1.6		1.2	U	0.425	U	0.447	U	0.611	J
	57-12-5	Cyanide	MG/KG		41,000	0.55	U			19				0.267	U	0.279	U		
	7439-96-5	Manganese	MG/KG			215				123				203					
	7440-02-0	Nickel	MG/KG		7,500	29.9				223									
	7440-44-0	Total Organic Carbon	MG/KG			110	U			120	U								
	7440-47-3	Total Chromium	MG/KG			1,380		15.3		574		6.6		7.01		6.01		13.5	
	FE2	Ferrous Iron	MG/KG																
SPLP	7439-96-5	Manganese	MG/L																
Inorganics	7440-47-3	Total Chromium	MG/L	0.5										0.05	U				
TCLP	57-12-5	Cyanide	MG/L	2		0.01	U			0.01	U								
Inorganics	7440-47-3	Total Chromium	MG/L	0.5		**21.8**				0.2									

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MG/KG = milligrams per kilogram
MG/L = milligrams per Liter

TABLE 2-1
INORGANICS IN SOIL EXCEEDING CTDEP CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

					Loc ID	SP-99-03				SP-99-04				SP-99-05				SP-99-07			
					Samp ID	SP9903000XX		SP9903005XX		SP9904000X		SP9904005XX		SP9905000X		SP9905005X		SP9907000XX		SP9907005XX	
					Samp Date	1/7/99		1/7/99		1/7/99		1/7/99		1/11/99		1/11/99		1/8/99		1/8/99	
					Start Depth	0		5		0		5		0		5		0		5	
					End Depth	2		7		2		7		4		7		2		7	
Class	**CAS #**	**PARAMETER**	**UNITS**	**PMC**	**I/C DEC**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**
Inorganics	18540-29-9	Hexavalent Chromium	MG/KG		100	0.444	U, UJ	0.475	U, UJ	0.805	J	0.467	U, UJ	39.8		2.46	J	0.438	U, UJ	0.456	U, UJ
	57-12-5	Cyanide	MG/KG		41,000	0.278	U	0.299	U	0.291	U	0.292	U	0.416		0.287	U	0.495		0.285	U
	7439-96-5	Manganese	MG/KG			87.4				192				157				237			
	7440-02-0	Nickel	MG/KG		7,500																
	7440-44-0	Total Organic Carbon	MG/KG																		
	7440-47-3	Total Chromium	MG/KG			5.69		4.52	U	16.4		9.31		75.8		8.7		9.61		8.44	
	FE2	Ferrous Iron	MG/KG																		
SPLP	7439-96-5	Manganese	MG/L																		
Inorganics	7440-47-3	Total Chromium	MG/L	0.5		0.05	U			0.05	U			**1.31**				0.05	U		
TCLP	57-12-5	Cyanide	MG/L	2																	
Inorganics	7440-47-3	Total Chromium	MG/L	0.5																	

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MG/KG = milligrams per kilogram
MG/L = milligrams per Liter

TABLE 2-1
INORGANICS IN SOIL EXCEEDING CTDEP CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

					Loc ID	SP-99-08				SP-99-09				SP-99-11				SP-99-12			
					Samp ID	SP9908002X		SP9908007X		SP9909000X		SP9909005X		SP9911000X		SP9911006X		SP9912000X		SP9912005X	
					Samp Date	2/7/99		2/7/99		1/9/99		1/9/99		1/5/99		1/6/99		1/12/99		1/12/99	
					Start Depth	0		5		0		5		0		6		0		5	
					End Depth	2		7		4		7		2		8		2		7	
Class	**CAS #**	**PARAMETER**	**UNITS**	**PMC**	**I/C DEC**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**
Inorganics	18540-29-9	Hexavalent Chromium	MG/KG		100	9.04		0.471	U	8.29	J	0.854	J	**640**	J	**513**	J	51.2		3.55	J
	57-12-5	Cyanide	MG/KG		41,000	0.278	U	0.278	U	0.277	U	0.299	U	0.272	U	0.266	U	0.282	U	0.283	U
	7439-96-5	Manganese	MG/KG			238								224				238			
	7440-02-0	Nickel	MG/KG		7,500																
	7440-44-0	Total Organic Carbon	MG/KG																		
	7440-47-3	Total Chromium	MG/KG			31.8		7.47		49.9		21		888		504		56.3		12.5	
	FE2	Ferrous Iron	MG/KG																		
SPLP	7439-96-5	Manganese	MG/L							233											
Inorganics	7440-47-3	Total Chromium	MG/L	0.5		0.314				**0.865**				**25.5**				**1.82**			
TCLP	57-12-5	Cyanide	MG/L	2																	
Inorganics	7440-47-3	Total Chromium	MG/L	0.5																	

Notes:
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I/C DEC = CTDEP Industrial/Commercial Direct Exposure Criteria
Q = qualifier
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MG/L = milligrams per Liter

TABLE 2-1
INORGANICS IN SOIL EXCEEDING CTDEP CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

					Loc ID	SP-99-13				SP-99-14				SP-99-17				SP-99-18			
					Samp ID	SP9913000X		SP9913005X		SP9914002X		SP9914007X		SP9917000X		SP9917005X		SP9918000X		SP9918005X	
					Samp Date	1/12/99		1/12/99		2/7/99		2/7/99		1/7/99		1/7/99		1/7/99		1/7/99	
					Start Depth	0		5		0		5		0		5		0		5	
					End Depth	2		7		2		7		2		7		2		7	
Class	**CAS #**	**PARAMETER**	**UNITS**	**PMC**	**I/C DEC**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**
Inorganics	18540-29-9	Hexavalent Chromium	MG/KG		100	80.1		2.25	J	**486**		**304**		19	J	22.9		0.458	U	0.582	J
	57-12-5	Cyanide	MG/KG		41,000	0.281	U	0.287	U	0.278	U	1.43		5.91		0.294	U	0.286	U	0.298	U
	7439-96-5	Manganese	MG/KG					90.2				111		264				157			
	7440-02-0	Nickel	MG/KG		7,500																
	7440-44-0	Total Organic Carbon	MG/KG																		
	7440-47-3	Total Chromium	MG/KG			109		14.5		814		1,880		61.7		71.8		7.39		7.67	
	FE2	Ferrous Iron	MG/KG																		
SPLP	7439-96-5	Manganese	MG/L																		
Inorganics	7440-47-3	Total Chromium	MG/L	0.5				0.067				**2.09**		0.269				0.05	U		
TCLP	57-12-5	Cyanide	MG/L	2																	
Inorganics	7440-47-3	Total Chromium	MG/L	0.5																	

Notes:
Bold and shaded values indicate exceedance of CTDEP criteria
PMC = CTDEP Pollutant Mobility Criteria for GB aquifer
I/C DEC = CTDEP Industrial/Commercial Direct Exposure Criteria
Q = qualifier
U = not detected at a concentration above the reported value
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MG/KG = milligrams per kilogram
MG/L = milligrams per Liter

TABLE 2-1
INORGANICS IN SOIL EXCEEDING CTDEP CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

					Loc ID	SP-99-19				SP-99-20				SP-PILOT-01				SP-PILOT-02			
					Samp ID	SP9919000X		SP9919005X		SP9920000X		SP9920005XX		SPP1A000XX		SPP1A005XX		SPP2A000XX		SPP2A005XX	
					Samp Date	1/7/99		1/7/99		1/7/99		1/10/99		1/10/99		1/10/99		1/10/99		1/10/99	
					Start Depth	0		5		0		5		2		2		2		2	
					End Depth	2		7		2		7		7		7		7		7	
Class	**CAS #**	**PARAMETER**	**UNITS**	**PMC**	**I/C DEC**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**
Inorganics	18540-29-9	Hexavalent Chromium	MG/KG		100	1.4	J	4.92		0.534	J	0.473	U, UJ	43		9.95		48		4.33	
	57-12-5	Cyanide	MG/KG		41,000	11.2		0.302	U	0.288	U	3.93									
	7439-96-5	Manganese	MG/KG					140		205											
	7440-02-0	Nickel	MG/KG		7,500																
	7440-44-0	Total Organic Carbon	MG/KG																		
	7440-47-3	Total Chromium	MG/KG			127		48.4		19.6		6.83		67.1		19.5		85.2		13.5	
	FE2	Ferrous Iron	MG/KG											43	J	9.95	J	48	J	4.33	J
SPLP	7439-96-5	Manganese	MG/L																		
Inorganics	7440-47-3	Total Chromium	MG/L	0.5				0.05	U	0.05	U			**1.6**						0.161	
TCLP	57-12-5	Cyanide	MG/L	2																	
Inorganics	7440-47-3	Total Chromium	MG/L	0.5																	

Notes:
- Bold and shaded values indicate exceedance of CTDEP criteria
- PMC = CTDEP Pollutant Mobility Criteria for GB aquifer
- I/C DEC = CTDEP Industrial/Commercial Direct Exposure Criteria
- Q = qualifier
- U = not detected at a concentration above the reported value
- J = reported value is estimated
- MG/KG = milligrams per kilogram
- MG/L = milligrams per Liter

TABLE 2-1
INORGANICS IN SOIL EXCEEDING CTDEP CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

					Loc ID	SP-PILOT-03				SP-PILOT-04				SP-PILOT-05			
					Samp ID	SPP3A000XX		SPP3A005XX		SPP4A000XX		SPP4A004XX		SPP5A000XX		SPP5A005XX	
					Samp Date	1/10/99		1/10/99		1/10/99		1/10/99		1/10/99		1/10/99	
					Start Depth	3		3		4		4		6		6	
					End Depth	8		8		9		9		11		11	
Class	**CAS #**	**PARAMETER**	**UNITS**	**PMC**	**I/C DEC**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**	**VALUE**	**Q**
Inorganics	18540-29-9	Hexavalent Chromium	MG/KG		100	46.1		21.5		37.8		6.25		69.9		8.48	
	57-12-5	Cyanide	MG/KG		41,000												
	7439-96-5	Manganese	MG/KG														
	7440-02-0	Nickel	MG/KG		7,500												
	7440-44-0	Total Organic Carbon	MG/KG														
	7440-47-3	Total Chromium	MG/KG			69.3		38.7		58.4		17.5		79.2		23.5	
	FE2	Ferrous Iron	MG/KG			46.1	J	21.5	J	37.8		6.25	J	69.9		8.48	
SPLP	7439-96-5	Manganese	MG/L														
Inorganics	7440-47-3	Total Chromium	MG/L	0.5		**2.01**				**1.6**						0.301	
TCLP	57-12-5	Cyanide	MG/L	2													
Inorganics	7440-47-3	Total Chromium	MG/L	0.5													

Notes: Bold and shaded values indicate exceedance of CTDEP criteria
PMC = CTDEP Pollutant Mobility Criteria for GB aquifer
I/C DEC = CTDEP Industrial/Commercial Direct Exposure Criteria
Q = qualifier
U = not detected at a concentration above the reported value
J = reported value is estimated
MG/KG = milligrams per kilogram
MG/L = milligrams per Liter

TABLE 2-2
INORGANICS IN GROUNDWATER EXCEEDING CTEDEP SWPC

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
ECD-4	8	18	1/22/99	Inorganics	GROUNDWATER	Chromium	2.25		MG/L	1.2
ECD-4	8	18	1/22/99	Inorganics	GROUNDWATER	Hexavalent Chromium	2.25		MG/L	0.11
PZ-PILOT-03	6	8	1/10/99	Inorganics	GROUNDWATER	Chromium	22.5		MG/L	1.2
PZ-PILOT-03	6	8	1/10/99	Inorganics	GROUNDWATER	Hexavalent Chromium	22.5		MG/L	0.11
WP-98-01	5	7	8/20/98	Inorganics	GROUNDWATER	Chromium	5.2		MG/L	1.2
WP-98-01	5	7	8/20/98	Inorganics	GROUNDWATER	Hexavalent Chromium	10.4		MG/L	0.11
WP-98-01	6.5	11.5	8/20/98	Inorganics	GROUNDWATER	Chromium	5.2		MG/L	1.2
WP-99-01	8	10	1/6/99	Inorganics	GROUNDWATER	Copper	0.061		MG/L	0.048
WP-99-02	8	12	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	1		MG/L	0.11
WP-99-02	16	20	1/21/99	Inorganics	GROUNDWATER	Chromium	1.5		MG/L	1.2
WP-99-02	16	20	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	1.5		MG/L	0.11
WP-99-02	24	28	1/21/99	Inorganics	GROUNDWATER	Chromium	350		MG/L	1.2
WP-99-02	24	28	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	350		MG/L	0.11
WP-99-02	30	34	1/22/99	Inorganics	GROUNDWATER	Chromium	75		MG/L	1.2
WP-99-02	30	34	1/22/99	Inorganics	GROUNDWATER	Chromium	53.1		MG/L	1.2
WP-99-02	30	34	1/22/99	Inorganics	GROUNDWATER	Hexavalent Chromium	75		MG/L	0.11
WP-99-02	30	34	1/22/99	Inorganics	GROUNDWATER	Hexavalent Chromium	50.9		MG/L	0.11
WP-99-03	5	9	1/24/99	Inorganics	GROUNDWATER	Chromium	7		MG/L	1.2
WP-99-03	5	9	1/24/99	Inorganics	GROUNDWATER	Hexavalent Chromium	7		MG/L	0.11
WP-99-03	11	15	1/24/99	Inorganics	GROUNDWATER	Chromium	9		MG/L	1.2
WP-99-03	11	15	1/24/99	Inorganics	GROUNDWATER	Hexavalent Chromium	9		MG/L	0.11
WP-99-03	21	25	1/11/99	Inorganics	GROUNDWATER	Chromium	7.17		MG/L	1.2
WP-99-03	21	25	1/11/99	Inorganics	GROUNDWATER	Hexavalent Chromium	8.39		MG/L	0.11
WP-99-03	26	30	1/24/99	Inorganics	GROUNDWATER	Chromium	8		MG/L	1.2
WP-99-03	26	30	1/24/99	Inorganics	GROUNDWATER	Hexavalent Chromium	8		MG/L	0.11
WP-99-04	6	10	1/22/99	Inorganics	GROUNDWATER	Chromium	4.5		MG/L	1.2
WP-99-04	6	10	1/22/99	Inorganics	GROUNDWATER	Hexavalent Chromium	4.5		MG/L	0.11
WP-99-04	16	20	1/22/99	Inorganics	GROUNDWATER	Chromium	95		MG/L	1.2
WP-99-04	16	20	1/22/99	Inorganics	GROUNDWATER	Hexavalent Chromium	95		MG/L	0.11
WP-99-04	22	26	1/22/99	Inorganics	GROUNDWATER	Chromium	700		MG/L	1.2
WP-99-04	22	26	1/22/99	Inorganics	GROUNDWATER	Hexavalent Chromium	700		MG/L	0.11
WP-99-05	56	60	1/23/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.15		MG/L	0.11
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Chromium	13.7		MG/L	1.2
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Chromium	13.6		MG/L	1.2
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Chromium	13.6		MG/L	1.2
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Chromium	13.8		MG/L	1.2
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Copper	0.503		MG/L	0.048
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Copper	0.504		MG/L	0.048
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Cyanide	0.166		MG/L	0.052
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Cyanide	0.174		MG/L	0.052
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Hexavalent Chromium	13.3		MG/L	0.11
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Hexavalent Chromium	13.3		MG/L	0.11

TABLE 2-2
INORGANICS IN GROUNDWATER EXCEEDING CTEDEP SWPC

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Hexavalent Chromium	13.4		MG/L	0.11
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Hexavalent Chromium	13.2		MG/L	0.11
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Nickel	1.02		MG/L	0.88
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Nickel	1.01		MG/L	0.88
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Zinc	1.02		MG/L	0.123
WP-99-07	7	9	1/7/99	Inorganics	GROUNDWATER	Zinc	1.01		MG/L	0.123
WP-99-08	8	12	2/9/99	Inorganics	GROUNDWATER	Chromium	7		MG/L	1.2
WP-99-08	8	12	2/9/99	Inorganics	GROUNDWATER	Hexavalent Chromium	7		MG/L	0.11
WP-99-08	15	19	2/9/99	Inorganics	GROUNDWATER	Chromium	5		MG/L	1.2
WP-99-08	15	19	2/9/99	Inorganics	GROUNDWATER	Hexavalent Chromium	5		MG/L	0.11
WP-99-08	21	25	2/9/99	Inorganics	GROUNDWATER	Chromium	500		MG/L	1.2
WP-99-08	21	25	2/9/99	Inorganics	GROUNDWATER	Hexavalent Chromium	500		MG/L	0.11
WP-99-08	26	30	2/9/99	Inorganics	GROUNDWATER	Chromium	300		MG/L	1.2
WP-99-08	26	30	2/9/99	Inorganics	GROUNDWATER	Hexavalent Chromium	300		MG/L	0.11
WP-99-08	31	35	2/9/99	Inorganics	GROUNDWATER	Chromium	300		MG/L	1.2
WP-99-08	31	35	2/9/99	Inorganics	GROUNDWATER	Hexavalent Chromium	300		MG/L	0.11
WP-99-08	36	40	2/9/99	Inorganics	GROUNDWATER	Chromium	500		MG/L	1.2
WP-99-08	36	40	2/9/99	Inorganics	GROUNDWATER	Hexavalent Chromium	500		MG/L	0.11
WP-99-08	41	45	2/9/99	Inorganics	GROUNDWATER	Chromium	16		MG/L	1.2
WP-99-08	41	45	2/9/99	Inorganics	GROUNDWATER	Hexavalent Chromium	16		MG/L	0.11
WP-99-09	7	11	1/8/99	Inorganics	GROUNDWATER	Copper	0.085		MG/L	0.048
WP-99-09	7	11	1/8/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.669		MG/L	0.11
WP-99-10	8	12	1/25/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.6		MG/L	0.11
WP-99-10	15	19	1/25/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.9		MG/L	0.11
WP-99-10	20	24	1/25/99	Inorganics	GROUNDWATER	Chromium	4		MG/L	1.2
WP-99-10	20	24	1/25/99	Inorganics	GROUNDWATER	Hexavalent Chromium	4		MG/L	0.11
WP-99-10	25	29	1/25/99	Inorganics	GROUNDWATER	Chromium	4.5		MG/L	1.2
WP-99-10	25	29	1/25/99	Inorganics	GROUNDWATER	Hexavalent Chromium	4.5		MG/L	0.11
WP-99-11	7	9	1/8/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.25		MG/L	0.11
WP-99-11	24	28	1/12/99	Inorganics	GROUNDWATER	Chromium	55.2		MG/L	1.2
WP-99-11	24	28	1/21/99	Inorganics	GROUNDWATER	Chromium	50		MG/L	1.2
WP-99-11	24	28	1/12/99	Inorganics	GROUNDWATER	Hexavalent Chromium	54.2		MG/L	0.11
WP-99-11	24	28	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	50		MG/L	0.11
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Chromium	60		MG/L	1.2
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Chromium	41.7		MG/L	1.2
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Chromium	41.2		MG/L	1.2
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Chromium	42.8		MG/L	1.2
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Chromium	42.1		MG/L	1.2
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Cyanide	0.092		MG/L	0.052
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Cyanide	0.091		MG/L	0.052
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	60		MG/L	0.11
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	68.1		MG/L	0.11

TABLE 2-2
INORGANICS IN GROUNDWATER EXCEEDING CTEDEP SWPC

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	67.5		MG/L	0.11
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	42.4		MG/L	0.11
WP-99-11	30	34	1/21/99	Inorganics	GROUNDWATER	Hexavalent Chromium	42.1		MG/L	0.11
WP-99-11	47	51	1/21/99	Inorganics	GROUNDWATER	Cadmium	0.0066		MG/L	0.006
WP-99-12	7	9	1/7/99	Inorganics	GROUNDWATER	Copper	0.423		MG/L	0.048
WP-99-12	20	24	1/12/99	Inorganics	GROUNDWATER	Cyanide	0.182		MG/L	0.052
WP-99-15	7	9	1/20/99	Inorganics	GROUNDWATER	Chromium	17		MG/L	1.2
WP-99-15	7	9	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	17		MG/L	0.11
WP-99-15	9	11	1/20/99	Inorganics	GROUNDWATER	Chromium	4		MG/L	1.2
WP-99-15	9	11	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	4		MG/L	0.11
WP-99-15	11	15	1/20/99	Inorganics	GROUNDWATER	Chromium	3		MG/L	1.2
WP-99-15	11	15	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	3		MG/L	0.11
WP-99-15	16	20	1/20/99	Inorganics	GROUNDWATER	Chromium	8		MG/L	1.2
WP-99-15	16	20	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	8		MG/L	0.11
WP-99-15	21	25	1/20/99	Inorganics	GROUNDWATER	Chromium	150		MG/L	1.2
WP-99-15	21	25	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	150		MG/L	0.11
WP-99-15	26	30	1/11/99	Inorganics	GROUNDWATER	Cadmium	0.0173		MG/L	0.006
WP-99-15	26	30	1/11/99	Inorganics	GROUNDWATER	Chromium	433		MG/L	1.2
WP-99-15	26	30	1/20/99	Inorganics	GROUNDWATER	Chromium	360		MG/L	1.2
WP-99-15	26	30	1/11/99	Inorganics	GROUNDWATER	Cyanide	0.535		MG/L	0.052
WP-99-15	26	30	1/11/99	Inorganics	GROUNDWATER	Hexavalent Chromium	347		MG/L	0.11
WP-99-15	26	30	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	360		MG/L	0.11
WP-99-15	30	34	1/20/99	Inorganics	GROUNDWATER	Chromium	950		MG/L	1.2
WP-99-15	30	34	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	950		MG/L	0.11
WP-99-15	36	40	1/20/99	Inorganics	GROUNDWATER	Chromium	900		MG/L	1.2
WP-99-15	36	40	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	900		MG/L	0.11
WP-99-15	40	44	1/20/99	Inorganics	GROUNDWATER	Chromium	700		MG/L	1.2
WP-99-15	40	44	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	700		MG/L	0.11
WP-99-15	46	50	1/20/99	Inorganics	GROUNDWATER	Chromium	13		MG/L	1.2
WP-99-15	46	50	1/20/99	Inorganics	GROUNDWATER	Hexavalent Chromium	13		MG/L	0.11
WP-99-18	8	12	1/27/99	Inorganics	GROUNDWATER	Chromium	2.25		MG/L	1.2
WP-99-18	8	12	1/27/99	Inorganics	GROUNDWATER	Hexavalent Chromium	2.25		MG/L	0.11
WP-99-18	15	19	1/27/99	Inorganics	GROUNDWATER	Chromium	1.56		MG/L	1.2
WP-99-18	15	19	1/27/99	Inorganics	GROUNDWATER	Hexavalent Chromium	1.57		MG/L	0.11
WP-99-18	15	19	1/27/99	Inorganics	GROUNDWATER	Hexavalent Chromium	1.2		MG/L	0.11
WP-99-18	20	24	1/27/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.25		MG/L	0.11
WP-99-20	15	19	1/28/99	Inorganics	GROUNDWATER	Chromium	35		MG/L	1.2
WP-99-20	15	19	1/28/99	Inorganics	GROUNDWATER	Hexavalent Chromium	35		MG/L	0.11
WP-99-20	20	24	1/28/99	Inorganics	GROUNDWATER	Chromium	300		MG/L	1.2
WP-99-20	20	24	1/28/99	Inorganics	GROUNDWATER	Hexavalent Chromium	300		MG/L	0.11
WP-99-20	25	29	1/28/99	Inorganics	GROUNDWATER	Chromium	15		MG/L	1.2
WP-99-20	25	29	1/28/99	Inorganics	GROUNDWATER	Chromium	5.94		MG/L	1.2

TABLE 2-2
INORGANICS IN GROUNDWATER EXCEEDING CTEDEP SWPC

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
WP-99-20	25	29	1/28/99	Inorganics	GROUNDWATER	Hexavalent Chromium	6.32		MG/L	0.11
WP-99-20	25	29	1/28/99	Inorganics	GROUNDWATER	Hexavalent Chromium	15		MG/L	0.11
WP-99-20	30	34	1/28/99	Inorganics	GROUNDWATER	Chromium	450		MG/L	1.2
WP-99-20	30	34	1/28/99	Inorganics	GROUNDWATER	Hexavalent Chromium	450		MG/L	0.11
WP-99-20	36	40	1/28/99	Inorganics	GROUNDWATER	Chromium	95		MG/L	1.2
WP-99-20	36	40	1/28/99	Inorganics	GROUNDWATER	Hexavalent Chromium	95		MG/L	0.11
WP-99-23	15	19	2/3/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.15		MG/L	0.11
WP-99-23	21	25	2/3/99	Inorganics	GROUNDWATER	Chromium	40		MG/L	1.2
WP-99-23	21	25	2/3/99	Inorganics	GROUNDWATER	Hexavalent Chromium	40		MG/L	0.11
WP-99-26	8	12	2/6/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.3		MG/L	0.11
WP-99-26	15	19	2/6/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.6		MG/L	0.11
WP-99-26	22	26	2/6/99	Inorganics	GROUNDWATER	Chromium	12		MG/L	1.2
WP-99-26	22	26	2/6/99	Inorganics	GROUNDWATER	Hexavalent Chromium	12		MG/L	0.11
WP-99-27	8	12	2/5/99	Inorganics	GROUNDWATER	Chromium	3.2		MG/L	1.2
WP-99-27	8	12	2/5/99	Inorganics	GROUNDWATER	Hexavalent Chromium	3.2		MG/L	0.11
WP-99-27	12	16	2/5/99	Inorganics	GROUNDWATER	Chromium	4.5		MG/L	1.2
WP-99-27	12	16	2/5/99	Inorganics	GROUNDWATER	Hexavalent Chromium	4.5		MG/L	0.11
WP-99-29	36	40	2/4/99	Inorganics	GROUNDWATER	Chromium	11		MG/L	1.2
WP-99-29	36	40	2/4/99	Inorganics	GROUNDWATER	Hexavalent Chromium	11		MG/L	0.11
WP-99-31	8	12	2/5/99	Inorganics	GROUNDWATER	Chromium	2.5		MG/L	1.2
WP-99-31	8	12	2/5/99	Inorganics	GROUNDWATER	Hexavalent Chromium	2.5		MG/L	0.11
WP-99-31	15	19	2/5/99	Inorganics	GROUNDWATER	Chromium	4.5		MG/L	1.2
WP-99-31	15	19	2/5/99	Inorganics	GROUNDWATER	Hexavalent Chromium	4.5		MG/L	0.11
WP-99-31	20	24	2/5/99	Inorganics	GROUNDWATER	Hexavalent Chromium	0.15		MG/L	0.11

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
WP-99-09	WP9909029XX	25	29	1/27/99	VOA	GROUNDWATER	Tetrachloroethene	0.12		MG/L	0.088
WP-99-09	WP9909029XX	25	29	1/27/99	VOA	GROUNDWATER	Trichloroethene	130	H	MG/L	2.34
WP-99-08	WP9908030XX	26	30	2/9/99	VOA	GROUNDWATER	Trichloroethene	110	H	MG/L	2.34
PZ-99-04I	PZ9904I000XX	30	35	2/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.32		MG/L	0.096
PZ-99-04I	PZ9904I000XX	30	35	2/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.093		MG/L	0.088
PZ-99-04I	PZ9904I000XX	30	35	2/11/99	VOA	GROUNDWATER	Trichloroethene	45		MG/L	2.34
PZ-99-12I	PZ9912I000XX	16	21	2/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	1.2		MG/L	0.096
WP-99-33	WP9933030XX	26	30	3/8/99	VOA	GROUNDWATER	Trichloroethene	830		MG/L	2.34
WP-99-33	WP9933040XX	36	40	3/8/99	VOA	GROUNDWATER	Trichloroethene	12		MG/L	2.34
WP-99-33	WP9933050XX	46	50	3/8/99	VOA	GROUNDWATER	Trichloroethene	2.9		MG/L	2.34
WP-99-33	WP9933080XX	76	80	3/9/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.1		MG/L	0.096
WP-99-33	WP9933080XX	76	80	3/9/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.24		MG/L	0.096
WP-99-34	WP99034040XX	36	40	3/9/99	VOA	GROUNDWATER	Trichloroethene	29	E	MG/L	2.34
WP-99-34	WP9934030XX	26	30	3/9/99	VOA	GROUNDWATER	Trichloroethene	170	E	MG/L	2.34
WP-99-34	WP9934030XX	26	30	3/9/99	VOA	GROUNDWATER	Trichloroethene	220		MG/L	2.34
WP-99-34	WP9934040XX	36	40	3/9/99	VOA	GROUNDWATER	Trichloroethene	31		MG/L	2.34
WP-99-35	WP9935026XX	22	26	3/9/99	VOA	GROUNDWATER	1,1-Dichloroethene	2.5		MG/L	0.096
WP-99-35	WP9935026XX	22	26	3/9/99	VOA	GROUNDWATER	Trichloroethene	12		MG/L	2.34
WP-99-36	WP9936034XX	30	34	3/9/99	VOA	GROUNDWATER	Trichloroethene	23		MG/L	2.34
WP-99-36	WP9936048XD	44	48	3/9/99	VOA	GROUNDWATER	Trichloroethene	10		MG/L	2.34
WP-99-36	WP9936048XX	44	48	3/9/99	VOA	GROUNDWATER	Tetrachloroethene	0.26		MG/L	0.088
WP-99-36	WP9936048XX	44	48	3/9/99	VOA	GROUNDWATER	Trichloroethene	11		MG/L	2.34
WP-99-37	WP9937020XX	16	20	3/9/99	VOA	GROUNDWATER	1,1-Dichloroethene	1	J	MG/L	0.096
WP-99-37	WP9937020XX	16	20	3/9/99	VOA	GROUNDWATER	Tetrachloroethene	1	J	MG/L	0.088
WP-99-37	WP9937030XX	26	30	3/9/99	VOA	GROUNDWATER	Trichloroethene	18		MG/L	2.34
WP-99-37	WP9937044XX	40	44	3/9/99	VOA	GROUNDWATER	Trichloroethene	17		MG/L	2.34
WP-99-38	WP9938026XX	22	26	3/10/99	VOA	GROUNDWATER	Trichloroethene	5		MG/L	2.34
WP-99-40	WP9940031XX	27	31	3/11/99	VOA	GROUNDWATER	Trichloroethene	29		MG/L	2.34
WP-99-41	WP9941010XX	6	10	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	1.4		MG/L	0.096
WP-99-41	WP9941022XX	18	22	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	3.7		MG/L	0.096
WP-99-41	WP9941030XX	26	30	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.11		MG/L	0.096
WP-99-41	WP9941030XX	26	30	3/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.42		MG/L	0.088
WP-99-41	WP9941030XX	26	30	3/11/99	VOA	GROUNDWATER	Trichloroethene	23		MG/L	2.34
WP-99-41	WP9941030XX	26	30	3/11/99	VOA	GROUNDWATER	Trichloroethene	48		MG/L	2.34
WP-99-41	WP9941040XX	36	40	3/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.3		MG/L	0.088
WP-99-41	WP9941040XX	36	40	3/11/99	VOA	GROUNDWATER	Trichloroethene	7.6		MG/L	2.34
WP-99-42	WP9942023XX	19	23	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.16		MG/L	0.096

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
WP-99-43	WP9943010XX	6	10	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	1.5		MG/L	0.096
WP-99-43	WP9943020XX	16	20	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	2.4		MG/L	0.096
WP-99-43	WP9943020XX	16	20	3/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.12		MG/L	0.088
WP-99-43	WP9943030XD	26	30	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.43		MG/L	0.096
WP-99-43	WP9943030XD	26	30	3/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.48		MG/L	0.088
WP-99-43	WP9943030XX	26	30	3/11/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.44		MG/L	0.096
WP-99-43	WP9943030XX	26	30	3/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.42		MG/L	0.088
WP-99-43	WP9943040XX	36	40	3/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.12		MG/L	0.088
WP-99-44	WP9944029XX	25	29	3/12/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.2		MG/L	0.096
WP-99-44	WP9944029XX	25	29	3/12/99	VOA	GROUNDWATER	Tetrachloroethene	0.58		MG/L	0.088
WP-99-44	WP9944029XX	25	29	3/12/99	VOA	GROUNDWATER	Trichloroethene	4.9		MG/L	2.34
WP-99-45	WP9945015XX	11	15	3/16/99	VOA	GROUNDWATER	1,1-Dichloroethene	4.5		MG/L	0.096
WP-99-45	WP9945015XX	11	15	3/16/99	VOA	GROUNDWATER	Tetrachloroethene	1.9		MG/L	0.088
WP-99-45	WP9945015XX	11	15	3/16/99	VOA	GROUNDWATER	Trichloroethene	5.9		MG/L	2.34
WP-99-45	WP9945030XX	26	30	3/16/99	VOA	GROUNDWATER	Trichloroethene	264		MG/L	2.34
WP-99-45	WP9945040XX	36	40	3/16/99	VOA	GROUNDWATER	Trichloroethene	246		MG/L	2.34
WP-99-47	WP9947010XX	6	10	3/17/99	VOA	GROUNDWATER	1,1-Dichloroethene	2.2		MG/L	0.096
WP-99-47	WP9947010XX	6	10	3/17/99	VOA	GROUNDWATER	Tetrachloroethene	0.13		MG/L	0.088
WP-99-47	WP9947021XX	17	21	3/17/99	VOA	GROUNDWATER	1,1-Dichloroethene	4.8		MG/L	0.096
WP-99-47	WP9947021XX	17	21	3/17/99	VOA	GROUNDWATER	1,1-Dichloroethene	3.9		MG/L	0.096
WP-99-47	WP9947021XX	17	21	3/17/99	VOA	GROUNDWATER	Tetrachloroethene	1.1		MG/L	0.088
WP-99-48	WP9948009XX	5	9	3/18/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	100		MG/L	62
WP-99-48	WP9948009XX	5	9	3/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	8.5		MG/L	0.096
WP-99-48	WP9948019XX	15	19	3/18/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	82		MG/L	62
WP-99-48	WP9948019XX	15	19	3/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	14		MG/L	0.096
WP-99-48	WP9948019XX	15	19	3/18/99	VOA	GROUNDWATER	Trichloroethene	5.9		MG/L	2.34
WP-99-49	WP9949021XX	17	21	3/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.25		MG/L	0.096
WP-99-49	WP9949043XX	39	43	3/18/99	VOA	GROUNDWATER	Trichloroethene	7.1		MG/L	2.34
WP-99-50	WP9950013XX	9	13	3/18/99	VOA	GROUNDWATER	Trichloroethene	8.4		MG/L	2.34
WP-99-50	WP9950054XX	50	54	3/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.16		MG/L	0.088
WP-99-50	WP9950054XX	50	54	3/18/99	VOA	GROUNDWATER	Trichloroethene	44		MG/L	2.34
WP-99-50	WP9950055XX	51	55	3/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.16		MG/L	0.088
WP-99-53	WP9953010XX	6	10	3/22/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.41		MG/L	0.096
WP-99-53	WP9953020XX	16	20	3/22/99	VOA	GROUNDWATER	1,1-Dichloroethene	4.4		MG/L	0.096
WP-99-53	WP9953032XX	28	32	3/22/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.11		MG/L	0.096
WP-99-53	WP9953032XX	28	32	3/22/99	VOA	GROUNDWATER	Tetrachloroethene	0.67		MG/L	0.088
WP-99-53	WP9953032XX	28	32	3/22/99	VOA	GROUNDWATER	Trichloroethene	7.9		MG/L	2.34

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
WP-99-54	WP9954020XX	16	20	3/23/99	VOA	GROUNDWATER	Tetrachloroethene	0.21		MG/L	0.088
WP-99-54	WP9954030XX	26	30	3/23/99	VOA	GROUNDWATER	Tetrachloroethene	0.4		MG/L	0.088
WP-99-54	WP9954050XX	46	50	3/23/99	VOA	GROUNDWATER	Trichloroethene	3		MG/L	2.34
WP-99-56	WP9956052XX	48	52	3/23/99	VOA	GROUNDWATER	Tetrachloroethene	0.14		MG/L	0.088
WP-99-61	WP9961020XX	16	20	3/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.16		MG/L	0.096
WP-99-61	WP9961028XX	24	28	3/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.53		MG/L	0.096
WP-99-61	WP9961028XX	24	28	3/25/99	VOA	GROUNDWATER	Tetrachloroethene	0.1		MG/L	0.088
WP-99-62	WP9962020XX	16	20	3/25/99	VOA	GROUNDWATER	Tetrachloroethene	0.13		MG/L	0.088
WP-99-62	WP9962030XD	26	30	3/25/99	VOA	GROUNDWATER	Tetrachloroethene	0.18		MG/L	0.088
WP-99-62	WP9962030XX	26	30	3/25/99	VOA	GROUNDWATER	Tetrachloroethene	0.15		MG/L	0.088
WP-99-62	WP9962050XX	46	50	3/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.12		MG/L	0.096
WP-99-62	WP9962050XX	46	50	3/25/99	VOA	GROUNDWATER	Tetrachloroethene	1.1		MG/L	0.088
WP-99-62	WP9962050XX	46	50	3/25/99	VOA	GROUNDWATER	Trichloroethene	11		MG/L	2.34
WP-99-63	WP9963030XX	26	30	3/26/99	VOA	GROUNDWATER	Trichloroethene	4.4		MG/L	2.34
PZ-16D	PZ16D028XX	21	31	3/29/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.1		MG/L	0.096
PZ-8D	PZ8D030XX	20	30	3/29/99	VOA	GROUNDWATER	1,1-Dichloroethene	1.9		MG/L	0.096
PZ-8D	PZ8D030XX	20	30	3/29/99	VOA	GROUNDWATER	Tetrachloroethene	0.19		MG/L	0.088
PZ-8D	PZ8D030XX	20	30	3/29/99	VOA	GROUNDWATER	Trichloroethene	2.5		MG/L	2.34
PZ-13D	PZ13D032XX	22	32	3/30/99	VOA	GROUNDWATER	Tetrachloroethene	0.49		MG/L	0.088
WP-99-68	WP9968010XX	6	10	3/31/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.21		MG/L	0.096
WP-99-68	WP9968020XX	16	20	3/31/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.74		MG/L	0.096
WP-99-69	WP9969010XX	6	10	3/31/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.34		MG/L	0.096
WP-99-69	WP9969020XX	16	20	3/31/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.64		MG/L	0.096
WP-99-69	WP9969030XX	26	30	3/31/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.75		MG/L	0.096
WP-99-69	WP9969030XX	26	30	3/31/99	VOA	GROUNDWATER	Trichloroethene	2.5		MG/L	2.34
WP-99-70	WP9970030XX	26	30	3/31/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.85		MG/L	0.096
PZ-11D	PZ11D034XD	24	34	4/1/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.26		MG/L	0.096
PZ-11D	PZ11D034XD	24	34	4/1/99	VOA	GROUNDWATER	Tetrachloroethene	0.42		MG/L	0.088
PZ-11D	PZ11D034XX	24	34	4/1/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.26		MG/L	0.096
PZ-11D	PZ11D034XX	24	34	4/1/99	VOA	GROUNDWATER	Tetrachloroethene	0.43		MG/L	0.088
WP-99-71	WP9971020XX	16	20	4/1/99	VOA	GROUNDWATER	1,1-Dichloroethene	1.2		MG/L	0.096
WP-99-72	WP9972034XX	30	34	4/1/99	VOA	GROUNDWATER	Trichloroethene	28		MG/L	2.34
DP2-2	DP22-08	5	8	5/5/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.22		MG/L	0.096
DP2-4	DP24-25	22	25	5/6/99	VOA	GROUNDWATER	Tetrachloroethene	0.41		MG/L	0.088
DP2-4	DP24-35	32	35	5/6/99	VOA	GROUNDWATER	Tetrachloroethene	0.33		MG/L	0.088
DP2-4	DP24-45	42	45	5/6/99	VOA	GROUNDWATER	Tetrachloroethene	0.39		MG/L	0.088
DP2-4	DP24-55	52	55	5/6/99	VOA	GROUNDWATER	Tetrachloroethene	0.095		MG/L	0.088

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
DP5-1	C-47-01	28	31	5/7/99	VOA	GROUNDWATER	Tetrachloroethene	0.102		MG/L	0.088
DP5-1	C-47-03	5	8	5/7/99	VOA	GROUNDWATER	Tetrachloroethene	0.244		MG/L	0.088
DP5-1	C-47-04	57	60	5/7/99	VOA	GROUNDWATER	Tetrachloroethene	0.096		MG/L	0.088
CP-99-08	CP9908135XX	133	135	5/8/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	160		MG/L	62
CP-99-08	CP9908135XX	133	135	5/8/99	VOA	GROUNDWATER	1,1-Dichloroethene	2.2		MG/L	0.096
CP-99-08	CP9908135XX	133	135	5/8/99	VOA	GROUNDWATER	Trichloroethene	19	E	MG/L	2.34
CP-99-08	CP9908158XX	156	158	5/8/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	210		MG/L	62
CP-99-08	CP9908158XX	156	158	5/8/99	VOA	GROUNDWATER	1,1-Dichloroethene	3.1		MG/L	0.096
CP-99-08	CP9908158XX	156	158	5/8/99	VOA	GROUNDWATER	Trichloroethene	20	E	MG/L	2.34
CP-99-06	CP9906030XX	28	30	5/9/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.76		MG/L	0.096
DP5-2	C-48-01	27	30	5/10/99	VOA	GROUNDWATER	Tetrachloroethene	0.45		MG/L	0.088
DP5-2	C-48-02	17	20	5/10/99	VOA	GROUNDWATER	Tetrachloroethene	0.14		MG/L	0.088
DP5-3	C-40-01	37	40	5/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.12		MG/L	0.088
DP5-3	C-40-02	27	30	5/11/99	VOA	GROUNDWATER	Tetrachloroethene	0.16		MG/L	0.088
DP5-4	C-50-02	37	40	5/12/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.165		MG/L	0.096
DP5-4	C-50-03	27	30	5/12/99	VOA	GROUNDWATER	Tetrachloroethene	0.41		MG/L	0.088
DP5-5	C-50-05	47	50	5/12/99	VOA	GROUNDWATER	Tetrachloroethene	0.1		MG/L	0.088
DP5-5	C-51-01	37	40	5/13/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.175		MG/L	0.096
DP5-5	C-51-01	37	40	5/13/99	VOA	GROUNDWATER	Tetrachloroethene	0.15		MG/L	0.088
DP3-2	C-52-03	18	21	5/17/99	VOA	GROUNDWATER	Tetrachloroethene	0.56		MG/L	0.088
DP3-2	C-52-04	5	8	5/17/99	VOA	GROUNDWATER	Tetrachloroethene	4.3		MG/L	0.088
CP-99-10	CP9910029XX	27	29	5/18/99	VOA	GROUNDWATER	Trichloroethene	21	E	MG/L	2.34
CP-99-10	CP9910036XX	34	36	5/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.24		MG/L	0.096
CP-99-10	CP9910043XX	41	43	5/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.67		MG/L	0.096
CP-99-10	CP9910075XX	73	75	5/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.55	E	MG/L	0.096
DP3-2	C-52-05	32	35	5/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	7.8		MG/L	0.096
DP3-2	C-52-05	32	35	5/18/99	VOA	GROUNDWATER	Tetrachloroethene	2.4		MG/L	0.088
DP3-3	C-53-01	21	24	5/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.275		MG/L	0.088
DP3-4	C-53-08	18	21	5/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.71		MG/L	0.088
DP3-5	C-53-06	17	20	5/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.11		MG/L	0.088
DP5-6	C-53-03	57	60	5/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.35		MG/L	0.088
CP-99-08	CP9908034XX	32	34	5/19/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	280	E	MG/L	62
CP-99-08	CP9908034XX	32	34	5/19/99	VOA	GROUNDWATER	1,1-Dichloroethene	9		MG/L	0.096
CP-99-08	CP9908034XX	32	34	5/19/99	VOA	GROUNDWATER	Trichloroethene	28		MG/L	2.34
CP-99-08	CP9908046XX	44	46	5/19/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	170	E	MG/L	62
CP-99-08	CP9908046XX	44	46	5/19/99	VOA	GROUNDWATER	1,1-Dichloroethene	7.5		MG/L	0.096
CP-99-08	CP9908046XX	44	46	5/19/99	VOA	GROUNDWATER	Trichloroethene	19		MG/L	2.34

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
CP-99-08	CP9908062XX	60	62	5/19/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.71		MG/L	0.096
CP-99-08	CP9908101XX	99	101	5/19/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.13		MG/L	0.096
DP3-4	C-53-09	30	33	5/19/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.24		MG/L	0.096
DP3-4	C-53-09	30	33	5/19/99	VOA	GROUNDWATER	Tetrachloroethene	1.2		MG/L	0.088
DP3-6	C-53-04	33	36	5/19/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.75		MG/L	0.096
DP3-6	C-53-04	33	36	5/19/99	VOA	GROUNDWATER	Tetrachloroethene	0.428		MG/L	0.088
DP5-7	C-55-07	37	40	5/20/99	VOA	GROUNDWATER	Tetrachloroethene	0.34		MG/L	0.088
DP5-7	C-55-08	27	30	5/20/99	VOA	GROUNDWATER	Tetrachloroethene	0.125		MG/L	0.088
DP5-8	C-55-01	37	40	5/20/99	VOA	GROUNDWATER	Tetrachloroethene	0.18		MG/L	0.088
DP5-9	C-55-14	37	40	5/20/99	VOA	GROUNDWATER	Tetrachloroethene	0.215		MG/L	0.088
DP2-5	C-56-01	37	40	5/21/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.265		MG/L	0.096
DP2-5	C-56-03	17	20	5/21/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.335		MG/L	0.096
DP5-10	C-56-07	37	40	5/21/99	VOA	GROUNDWATER	Tetrachloroethene	0.165		MG/L	0.088
DP2-6	C-57-08	37	40	5/24/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.32		MG/L	0.096
DP2-6	C-57-08	27	30	5/24/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.27		MG/L	0.096
DP2-6	C-57-12	17	20	5/24/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.21		MG/L	0.096
CP-99-18	CP9918100XX	98	100	5/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.097		MG/L	0.096
CP-99-18	CP9918134XX	132	134	5/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.11		MG/L	0.096
CP-99-18	CP9918148XX	146	148	5/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.11		MG/L	0.096
DP2-7	C-58-04	47	50	5/25/99	VOA	GROUNDWATER	Tetrachloroethene	1.6		MG/L	0.088
DP2-7	C-58-04	47	50	5/25/99	VOA	GROUNDWATER	Trichloroethene	3.9		MG/L	2.34
DP2-7	C-58-06	37	40	5/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.21		MG/L	0.096
DP2-7	C-58-06	37	40	5/25/99	VOA	GROUNDWATER	Tetrachloroethene	0.29		MG/L	0.088
DP2-7	C-58-06	37	40	5/25/99	VOA	GROUNDWATER	Trichloroethene	4.1		MG/L	2.34
DP2-7	C-58-07	27	30	5/25/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.225		MG/L	0.096
DP2-7	C-58-07	27	30	5/25/99	VOA	GROUNDWATER	Tetrachloroethene	0.42		MG/L	0.088
DP2-7	C-58-07	27	30	5/25/99	VOA	GROUNDWATER	Trichloroethene	3.1		MG/L	2.34
DP2-7	C-58-08	17	20	5/25/99	VOA	GROUNDWATER	Tetrachloroethene	0.275		MG/L	0.088
CP-99-17	CP9917032XX	30	32	5/26/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	97	E	MG/L	62
CP-99-17	CP9917032XX	30	32	5/26/99	VOA	GROUNDWATER	1,1,2-Trichloroethane	1.7		MG/L	1.26
CP-99-17	CP9917032XX	30	32	5/26/99	VOA	GROUNDWATER	1,1-Dichloroethene	8.1	E	MG/L	0.096
CP-99-17	CP9917032XX	30	32	5/26/99	VOA	GROUNDWATER	Trichloroethene	92	E	MG/L	2.34
CP-99-17	CP9917046XX	44	46	5/26/99	VOA	GROUNDWATER	Trichloroethene	10	E	MG/L	2.34
CP-99-17	CP99170XXXX	18	20	5/26/99	VOA	GROUNDWATER	1,1,1-Trichloroethane	93	E	MG/L	62
CP-99-17	CP99170XXXX	18	20	5/26/99	VOA	GROUNDWATER	1,1,2-Trichloroethane	1.6		MG/L	1.26
CP-99-17	CP99170XXXX	18	20	5/26/99	VOA	GROUNDWATER	1,1-Dichloroethene	8.9	E	MG/L	0.096
CP-99-17	CP99170XXXX	18	20	5/26/99	VOA	GROUNDWATER	Trichloroethene	94	E	MG/L	2.34

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
DP6-2	C-59-07	37	40	5/26/99	VOA	GROUNDWATER	Tetrachloroethene	0.325		MG/L	0.088
DP2-8	C-60-07	57	60	5/27/99	VOA	GROUNDWATER	Tetrachloroethene	0.51		MG/L	0.088
DP2-8	C-60-08	47	50	5/27/99	VOA	GROUNDWATER	Tetrachloroethene	0.24		MG/L	0.088
DP2-8	C-60-09	37	40	5/27/99	VOA	GROUNDWATER	Tetrachloroethene	0.585		MG/L	0.088
DP2-8	C-60-10	27	30	5/27/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.155		MG/L	0.096
DP2-8	C-60-10	27	30	5/27/99	VOA	GROUNDWATER	Tetrachloroethene	0.75		MG/L	0.088
DP2-8	C-60-10	27	30	5/27/99	VOA	GROUNDWATER	Trichloroethene	2.4		MG/L	2.34
DP2-8	C-60-11	17	20	5/27/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.175		MG/L	0.096
DP2-8	C-60-11	17	20	5/27/99	VOA	GROUNDWATER	Tetrachloroethene	0.35		MG/L	0.088
DP6-3	C-60-02	47	50	5/27/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.11		MG/L	0.096
DP6-3	C-61-02	5	8	5/28/99	VOA	GROUNDWATER	1,1-Dichloroethene	3.9		MG/L	0.096
DP2-9	C-62-01	20	23	6/1/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.41		MG/L	0.096
DP2-9	C-62-01	20	23	6/1/99	VOA	GROUNDWATER	Tetrachloroethene	0.165		MG/L	0.088
DP6-4	C-63-02	27	30	6/2/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.124		MG/L	0.096
WC-19S	WC-19S	5	15	6/29/99	VOA	GROUNDWATER	Tetrachloroethene	0.74		MG/L	0.088
WC-19S	WC-19SR2	5	15	6/29/99	VOA	GROUNDWATER	Tetrachloroethene	0.29		MG/L	0.088
WC-19D1	WC-19D1	30	50	6/30/99	VOA	GROUNDWATER	Tetrachloroethene	0.48		MG/L	0.088
PZ-11D	PZ-11D	24	34	7/1/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.34		MG/L	0.096
PZ-11D	PZ-11D	24	34	7/1/99	VOA	GROUNDWATER	Tetrachloroethene	0.37		MG/L	0.088
PZ-1D	PZ-1D	24	34	7/6/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.14		MG/L	0.096
PZ-1D	PZ-1D	24	34	7/6/99	VOA	GROUNDWATER	Tetrachloroethene	0.85		MG/L	0.088
PZ-1D	PZ-1D	24	34	7/6/99	VOA	GROUNDWATER	Trichloroethene	2.5		MG/L	2.34
PZ-1D	PZ-1DR2	24	34	7/6/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.11		MG/L	0.096
PZ-1D	PZ-1DR2	24	34	7/6/99	VOA	GROUNDWATER	Tetrachloroethene	0.79		MG/L	0.088
PZ-13D	PZ-13D	21.5	31.5	7/7/99	VOA	GROUNDWATER	Tetrachloroethene	0.63		MG/L	0.088
PZ-8D	PZ-8D	23.5	33.5	7/7/99	VOA	GROUNDWATER	1,1-Dichloroethene	3.1		MG/L	0.096
PZ-8D	PZ-8D	23.5	33.5	7/7/99	VOA	GROUNDWATER	Trichloroethene	5.9		MG/L	2.34
PZ-8D	PZ-8DR2	23.5	33.5	7/7/99	VOA	GROUNDWATER	1,1-Dichloroethene	3.7		MG/L	0.096
PZ-8D	PZ-8DR2	23.5	33.5	7/7/99	VOA	GROUNDWATER	Tetrachloroethene	0.11	J	MG/L	0.088
PZ-8D	PZ-8DR2	23.5	33.5	7/7/99	VOA	GROUNDWATER	Trichloroethene	6.8		MG/L	2.34
WC-10S	WC-10S	3	13	7/7/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.28		MG/L	0.096
WC2-3D	WC2-3DR2	74.5	84.5	7/7/99	VOA	GROUNDWATER	Tetrachloroethene	0.099	J	MG/L	0.088
WC2-3D	WC2-3DR2	74.5	84.5	7/7/99	VOA	GROUNDWATER	Trichloroethene	3.1		MG/L	2.34
WC-12S	WC-12S	3	13	7/8/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.96		MG/L	0.096
WC-4S	WC-4S	3	13	7/8/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.73		MG/L	0.096
PZ-99-03	PZ03081899XX	4	9	8/18/99	VOA	GROUNDWATER	1,1-Dichloroethene	9.4		MG/L	0.096
PZ-99-02B	PZ2B081999	25	30	8/19/99	VOA	GROUNDWATER	Trichloroethene	82		MG/L	2.34

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
EW-99-01	EW01090199XX	20	40	9/1/99	VOA	GROUNDWATER	Trichloroethene	400		MG/L	2.34
DP3-7	DP3-7	27	30	11/1/99	VOA	GROUNDWATER	Tetrachloroethene	0.6		MG/L	0.088
DP3-7	DP3-7B	27	30	11/1/99	VOA	GROUNDWATER	Tetrachloroethene	0.6		MG/L	0.088
DP3-8	DP3-8	27	30	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.17		MG/L	0.088
DP3-8	DP3-8	17	20	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.09		MG/L	0.088
DP3-8	DP3-8	27	30	11/2/99	VOA	GROUNDWATER	Trichloroethene	16		MG/L	2.34
DP3-8	DP3-8A	17	20	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.09		MG/L	0.088
DP3-8	DP3-8B	27	30	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.17		MG/L	0.088
DP3-8	DP3-8B	27	30	11/2/99	VOA	GROUNDWATER	Trichloroethene	16		MG/L	2.34
DP3-9	DP3-9	17	20	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.26		MG/L	0.088
DP3-9	DP3-9	27	30	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.15		MG/L	0.088
DP3-9	DP3-9	27	30	11/2/99	VOA	GROUNDWATER	Trichloroethene	7		MG/L	2.34
DP3-9	DP3-9	17	20	11/2/99	VOA	GROUNDWATER	Trichloroethene	4.7		MG/L	2.34
DP3-9	DP3-9A	17	20	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.26		MG/L	0.088
DP3-9	DP3-9A	17	20	11/2/99	VOA	GROUNDWATER	Trichloroethene	4.7		MG/L	2.34
DP3-9	DP3-9B	27	30	11/2/99	VOA	GROUNDWATER	Tetrachloroethene	0.15		MG/L	0.088
DP3-9	DP3-9B	27	30	11/2/99	VOA	GROUNDWATER	Trichloroethene	7		MG/L	2.34
DP3-10	DP3-10	37	40	11/3/99	VOA	GROUNDWATER	Trichloroethene	2.5		MG/L	2.34
DP3-10	DP3-10C	37	40	11/3/99	VOA	GROUNDWATER	Trichloroethene	2.5		MG/L	2.34
DP3-11	DP3-11	37	40	11/3/99	VOA	GROUNDWATER	Trichloroethene	5.3		MG/L	2.34
DP3-11	DP3-11	27	30	11/3/99	VOA	GROUNDWATER	Trichloroethene	2.6		MG/L	2.34
DP3-11	DP3-11B	27	30	11/3/99	VOA	GROUNDWATER	Trichloroethene	2.6		MG/L	2.34
DP3-11	DP3-11C	37	40	11/3/99	VOA	GROUNDWATER	Trichloroethene	5.3		MG/L	2.34
DP3-14	DP3-14	37	40	11/4/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.29		MG/L	0.096
DP3-14	DP3-14A	37	40	11/4/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.29		MG/L	0.096
DP5-12	DP5-12D	47	50	11/5/99	VOA	GROUNDWATER	Tetrachloroethene	0.12		MG/L	0.088
WC2-5I	WC2-5I	30	40	11/15/99	VOA	GROUNDWATER	1,1-Dichloroethene	0.1		MG/L	0.096
WC2-6I	WC2-6I	40	50	11/15/99	VOA	GROUNDWATER	Tetrachloroethene	0.61		MG/L	0.088
WC2-6I	WC2-6I	40	50	11/15/99	VOA	GROUNDWATER	Trichloroethene	3.7		MG/L	2.34
WC3-1I	WC3-1I	30	40	11/17/99	VOA	GROUNDWATER	1,1-Dichloroethene	2.8		MG/L	0.096
WC3-1I	WC3-1I	30	40	11/17/99	VOA	GROUNDWATER	Tetrachloroethene	0.59		MG/L	0.088
WC3-2I	WC3-2I	30	40	11/17/99	VOA	GROUNDWATER	Tetrachloroethene	0.13		MG/L	0.088
IW-99-07	IW071118991600	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	88		MG/L	2.34
PZ-99-07	PZ071118991700	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	28		MG/L	2.34
WC-18D3	WC-18D3	30	50	11/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.35		MG/L	0.088
WC3-1D	WC3-1D	75	85	11/18/99	VOA	GROUNDWATER	Tetrachloroethene	0.35		MG/L	0.088
PZ-99-11	PZ111118991437	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	93		MG/L	2.34

TABLE 2-3
SELECTED VOCs IN GROUNDWATER EXCEEDING CTDEP SWPC

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	SAMPLE ID	START DEPTH (feet, bgs)	END DEPTH (feet, bgs)	SAMPLE DATE	CLASS	MATRIX	PARAMETER	VALUE	QUAL	UNITS	CTDEP SWPC
PZ-99-02C	PZ2C1118991447	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	27		MG/L	2.34
IW-99-05	IW051118991455	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	95		MG/L	2.34
IW-99-06	IW061118991500	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	84		MG/L	2.34
PZ-99-02B	PZ2B1118991510	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	77		MG/L	2.34
PZ-99-10	PZ101118991515	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	88		MG/L	2.34
PZ-99-08	PZ081118991525	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	93		MG/L	2.34
PZ-99-02A	PZ2A1118991535	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	14		MG/L	2.34
PZ-99-09	PZ091118991545	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	86		MG/L	2.34
EW-99-03	EW031118991550	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	92		MG/L	2.34
EW-99-03	EW031118991550D	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	88		MG/L	2.34
IW-99-07	IW071118991600	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	73		MG/L	2.34
IW-99-08	IW081118991630	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	94		MG/L	2.34
PZ-99-07	PZ071118991700	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	41		MG/L	2.34
IW-99-04	IW041118991720	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	150		MG/L	2.34
IW-99-01	IW011118991739	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	260		MG/L	2.34
PZ-99-06	PZ061118991754	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	110		MG/L	2.34
IW-99-03	IW031118991805	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	350		MG/L	2.34
EW-99-02	EW021118991815	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	50		MG/L	2.34
EW-99-02	EW021118991815D	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	49		MG/L	2.34
PZ-99-05	PZ051118991820	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	74		MG/L	2.34
PZ-99-01B	PZ1B1118991830	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	200		MG/L	2.34
IW-99-02	IW021118991835	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	44		MG/L	2.34
PZ-99-04	PZ041118991850	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	23		MG/L	2.34
PZ-99-01C	PZ1C1118991900	0	0	11/18/99	VOA	GROUNDWATER	Trichloroethene	2.8		MG/L	2.34

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
CP-99-02	18	20	5/6/99	1,1-Dichloroethene	0.0078		0.006
CP-99-04	32	34	5/7/99	1,1-Dichloroethene	0.013		0.006
CP-99-04	32	34	5/7/99	Vinyl Chloride	0.0036		0.002
CP-99-04	43	45	5/7/99	Vinyl Chloride	0.0034		0.002
CP-99-06	28	30	5/9/99	1,1-Dichloroethene	0.76		0.006
CP-99-06	28	30	5/9/99	Trichloroethene	1.6		0.54
CP-99-06	28	30	5/9/99	Vinyl Chloride	0.014		0.002
CP-99-08	32	34	5/19/99	1,1,1-Trichloroethane	280	E	50
CP-99-08	32	34	5/19/99	1,1-Dichloroethene	9		0.006
CP-99-08	32	34	5/19/99	Trichloroethene	28		0.54
CP-99-08	44	46	5/19/99	1,1,1-Trichloroethane	170	E	50
CP-99-08	44	46	5/19/99	1,1-Dichloroethene	7.5		0.006
CP-99-08	44	46	5/19/99	Trichloroethene	19		0.54
CP-99-08	60	62	5/19/99	1,1-Dichloroethene	0.71		0.006
CP-99-08	60	62	5/19/99	Trichloroethene	1.6		0.54
CP-99-08	71	73	5/19/99	1,1-Dichloroethene	0.075		0.006
CP-99-08	99	101	5/19/99	1,1-Dichloroethene	0.13		0.006
CP-99-08	99	101	5/19/99	Trichloroethene	0.81	E	0.54
CP-99-08	133	135	5/8/99	1,1,1-Trichloroethane	160		50
CP-99-08	133	135	5/8/99	1,1-Dichloroethene	2.2		0.006
CP-99-08	133	135	5/8/99	Trichloroethene	19	E	0.54
CP-99-08	156	158	5/8/99	1,1,1-Trichloroethane	210		50
CP-99-08	156	158	5/8/99	1,1-Dichloroethene	3.1		0.006
CP-99-08	156	158	5/8/99	Trichloroethene	20	E	0.54
CP-99-09	9	11	5/9/99	1,1-Dichloroethene	0.011		0.006
CP-99-09	9	11	5/9/99	Vinyl Chloride	0.054	E	0.002
CP-99-09	33	35	5/9/99	1,1-Dichloroethene	0.074	E	0.006
CP-99-09	33	35	5/9/99	Vinyl Chloride	0.35	E	0.002
CP-99-10	27	29	5/18/99	1,1-Dichloroethene	0.06		0.006
CP-99-10	27	29	5/18/99	Trichloroethene	21	E	0.54
CP-99-10	34	36	5/18/99	1,1-Dichloroethene	0.24		0.006
CP-99-10	34	36	5/18/99	Trichloroethene	1.4		0.54
CP-99-10	41	43	5/18/99	1,1-Dichloroethene	0.67		0.006
CP-99-10	41	43	5/18/99	Trichloroethene	1.4		0.54
CP-99-10	48	50	5/18/99	1,1-Dichloroethene	0.0081		0.006
CP-99-10	48	50	5/18/99	Trichloroethene	1		0.54
CP-99-10	58	60	5/18/99	1,1-Dichloroethene	0.018	E	0.006
CP-99-10	73	75	5/18/99	1,1-Dichloroethene	0.55	E	0.006
CP-99-11	14	16	5/12/99	Vinyl Chloride	0.0038		0.002
CP-99-12	9	11	5/10/99	Vinyl Chloride	0.047	EJ	0.002
CP-99-12	19	21	5/10/99	Vinyl Chloride	0.16	EJ	0.002
CP-99-12	54	56	5/10/99	Vinyl Chloride	0.003		0.002
CP-99-14	16	18	5/19/99	Vinyl Chloride	0.0057		0.002
CP-99-14	29	31	5/19/99	1,1-Dichloroethene	0.07		0.006
CP-99-14	29	31	5/19/99	Vinyl Chloride	0.065		0.002
CP-99-14	40	42	5/19/99	1,1-Dichloroethene	0.066		0.006
CP-99-14	40	42	5/19/99	Vinyl Chloride	0.067		0.002
CP-99-17	18	20	5/26/99	1,1,1-Trichloroethane	93	E	50
CP-99-17	18	20	5/26/99	1,1-Dichloroethene	8.9	E	0.006
CP-99-17	18	20	5/26/99	Trichloroethene	94	E	0.54
CP-99-17	30	32	5/26/99	1,1,1-Trichloroethane	97	E	50
CP-99-17	30	32	5/26/99	1,1-Dichloroethene	8.1	E	0.006
CP-99-17	30	32	5/26/99	Trichloroethene	92	E	0.54
CP-99-17	44	46	5/26/99	Trichloroethene	10	E	0.54
CP-99-17	61	63	5/26/99	1,1-Dichloroethene	0.012		0.006
CP-99-17	61	63	5/26/99	Trichloroethene	0.6		0.54
CP-99-18	98	100	5/25/99	1,1-Dichloroethene	0.097		0.006
CP-99-18	132	134	5/25/99	1,1-Dichloroethene	0.11		0.006
CP-99-18	146	148	5/25/99	1,1-Dichloroethene	0.11		0.006

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
DP2-1	27	30	5/4/99	Vinyl Chloride	0.011		0.002
DP2-2	5	8	5/5/99	1,1-Dichloroethene	0.22		0.006
DP2-2	5	8	5/5/99	Vinyl Chloride	0.02		0.002
DP2-2	17	20	5/5/99	Vinyl Chloride	0.62		0.002
DP2-2	27	30	5/5/99	1,1-Dichloroethene	0.0083	J	0.006
DP2-2	27	30	5/5/99	Vinyl Chloride	1.4	J	0.002
DP2-2	37	40	5/4/99	1,1-Dichloroethene	0.036		0.006
DP2-2	37	40	5/4/99	Trichloroethene	1.4		0.54
DP2-2	37	40	5/4/99	Vinyl Chloride	0.097	J	0.002
DP2-2	47	50	5/4/99	1,1-Dichloroethene	0.014	J	0.006
DP2-2	47	50	5/4/99	Trichloroethene	1.6	J	0.54
DP2-2	47	50	5/4/99	Vinyl Chloride	0.025	J	0.002
DP2-3	27	30	5/5/99	Vinyl Chloride	0.013		0.002
DP2-3	47	50	5/5/99	Vinyl Chloride	0.04	J	0.002
DP2-3	57	60	5/5/99	Vinyl Chloride	0.28	J	0.002
DP2-4	22	25	5/6/99	1,1-Dichloroethene	0.034		0.006
DP2-4	22	25	5/6/99	Trichloroethene	0.74		0.54
DP2-4	22	25	5/6/99	Vinyl Chloride	0.0089		0.002
DP2-4	32	35	5/6/99	1,1-Dichloroethene	0.04	J	0.006
DP2-4	32	35	5/6/99	Trichloroethene	0.94		0.54
DP2-4	32	35	5/6/99	Vinyl Chloride	0.012		0.002
DP2-4	42	45	5/6/99	1,1-Dichloroethene	0.068		0.006
DP2-4	42	45	5/6/99	Trichloroethene	1.3		0.54
DP2-4	42	45	5/6/99	Vinyl Chloride	0.019		0.002
DP2-4	52	55	5/6/99	1,1-Dichloroethene	0.022	J	0.006
DP2-5	5	8	5/21/99	1,1-Dichloroethene	0.065		0.006
DP2-5	5	8	5/21/99	Vinyl Chloride	0.13		0.002
DP2-5	17	20	5/21/99	1,1-Dichloroethene	0.335		0.006
DP2-5	17	20	5/21/99	Vinyl Chloride	0.235		0.002
DP2-5	27	30	5/21/99	1,1-Dichloroethene	0.029		0.006
DP2-5	27	30	5/21/99	Vinyl Chloride	0.014		0.002
DP2-5	37	40	5/21/99	1,1-Dichloroethene	0.265		0.006
DP2-5	37	40	5/21/99	Vinyl Chloride	0.625		0.002
DP2-5	47	50	5/20/99	1,1-Dichloroethene	0.019		0.006
DP2-5	47	50	5/20/99	Vinyl Chloride	0.013		0.002
DP2-6	5	8	5/24/99	1,1-Dichloroethene	0.045		0.006
DP2-6	5	8	5/24/99	Vinyl Chloride	0.01		0.002
DP2-6	17	20	5/24/99	1,1-Dichloroethene	0.21		0.006
DP2-6	17	20	5/24/99	Vinyl Chloride	0.09		0.002
DP2-6	27	30	5/24/99	1,1-Dichloroethene	0.27		0.006
DP2-6	27	30	5/24/99	Vinyl Chloride	0.11		0.002
DP2-6	37	40	5/24/99	1,1-Dichloroethene	0.32		0.006
DP2-6	37	40	5/24/99	Vinyl Chloride	0.078		0.002
DP2-7	5	8	5/25/99	1,1-Dichloroethene	0.009		0.006
DP2-7	5	8	5/25/99	Vinyl Chloride	0.062		0.002
DP2-7	17	20	5/25/99	1,1-Dichloroethene	0.05		0.006
DP2-7	27	30	5/25/99	1,1-Dichloroethene	0.225		0.006
DP2-7	27	30	5/25/99	Trichloroethene	3.1		0.54
DP2-7	27	30	5/25/99	Vinyl Chloride	0.075		0.002
DP2-7	37	40	5/25/99	1,1-Dichloroethene	0.21		0.006
DP2-7	37	40	5/25/99	Trichloroethene	4.1		0.54
DP2-7	37	40	5/25/99	Vinyl Chloride	0.012		0.002
DP2-7	47	50	5/25/99	1,1-Dichloroethene	0.03		0.006
DP2-7	47	50	5/25/99	Trichloroethene	3.9		0.54
DP2-7	57	60	5/25/99	1,1-Dichloroethene	0.034		0.006
DP2-7	57	60	5/25/99	Trichloroethene	0.76		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
DP2-8	5	8	5/28/99	Vinyl Chloride	0.021		0.002
DP2-8	17	20	5/27/99	1,1-Dichloroethene	0.175		0.006
DP2-8	17	20	5/27/99	Trichloroethene	1.05		0.54
DP2-8	17	20	5/27/99	Vinyl Chloride	0.175		0.002
DP2-8	27	30	5/27/99	1,1-Dichloroethene	0.155		0.006
DP2-8	27	30	5/27/99	Trichloroethene	2.4		0.54
DP2-8	27	30	5/27/99	Vinyl Chloride	0.107		0.002
DP2-8	37	40	5/27/99	1,1-Dichloroethene	0.091		0.006
DP2-8	37	40	5/27/99	Trichloroethene	2.045		0.54
DP2-8	37	40	5/27/99	Vinyl Chloride	0.065		0.002
DP2-8	47	50	5/27/99	Trichloroethene	1.175		0.54
DP2-8	57	60	5/27/99	Trichloroethene	2.3		0.54
DP2-9	5	8	6/1/99	1,1-Dichloroethene	0.07		0.006
DP2-9	5	8	6/1/99	Vinyl Chloride	0.03		0.002
DP2-9	20	23	6/1/99	1,1-Dichloroethene	0.41		0.006
DP2-9	20	23	6/1/99	Vinyl Chloride	0.15		0.002
DP28	28	30	5/27/99	1,1-Dichloroethene	0.083	J	0.006
DP28	28	30	5/27/99	1,1-Dichloroethene	0.071		0.006
DP3-10	27	30	11/3/99	1,1-Dichloroethene	0.0073		0.006
DP3-10	27	30	11/3/99	1,1-Dichloroethene	0.0073		0.006
DP3-10	27	30	11/3/99	Trichloroethene	1.9		0.54
DP3-10	27	30	11/3/99	Trichloroethene	1.9		0.54
DP3-10	37	40	11/3/99	1,1-Dichloroethene	0.011		0.006
DP3-10	37	40	11/3/99	1,1-Dichloroethene	0.011		0.006
DP3-10	37	40	11/3/99	Trichloroethene	2.5		0.54
DP3-10	37	40	11/3/99	Trichloroethene	2.5		0.54
DP3-11	27	30	11/3/99	1,1-Dichloroethene	0.02		0.006
DP3-11	27	30	11/3/99	1,1-Dichloroethene	0.02		0.006
DP3-11	27	30	11/3/99	Trichloroethene	2.6		0.54
DP3-11	27	30	11/3/99	Trichloroethene	2.6		0.54
DP3-11	37	40	11/3/99	1,1-Dichloroethene	0.031		0.006
DP3-11	37	40	11/3/99	1,1-Dichloroethene	0.031		0.006
DP3-11	37	40	11/3/99	Trichloroethene	5.3		0.54
DP3-11	37	40	11/3/99	Trichloroethene	5.3		0.54
DP3-14	37	40	11/4/99	1,1-Dichloroethene	0.29		0.006
DP3-14	37	40	11/4/99	1,1-Dichloroethene	0.29		0.006
DP3-2	5	8	5/17/99	Tetrachloroethene	4.3		3.82
DP3-2	5	8	5/17/99	Vinyl Chloride	0.24		0.002
DP3-2	18	21	5/17/99	1,1-Dichloroethene	0.04		0.006
DP3-2	32	35	5/18/99	1,1-Dichloroethene	7.8		0.006
DP3-2	32	35	5/18/99	1,2-Dichloroethane	0.4		0.09
DP3-2	32	35	5/18/99	Trichloroethene	0.6		0.54
DP3-3	21	24	5/18/99	Vinyl Chloride	0.044		0.002
DP3-4	18	21	5/18/99	1,1-Dichloroethene	0.014		0.006
DP3-4	30	33	5/19/99	1,1-Dichloroethene	0.24		0.006
DP3-4	30	33	5/19/99	Trichloroethene	0.56		0.54
DP3-5	17	20	5/18/99	1,1-Dichloroethene	0.05		0.006
DP3-5	17	20	5/18/99	Vinyl Chloride	0.044		0.002
DP3-6	23	26	5/19/99	1,1-Dichloroethene	0.016		0.006
DP3-6	33	36	5/19/99	1,1-Dichloroethene	0.75		0.006
DP3-7	17	20	11/1/99	Trichloroethene	0.94		0.54
DP3-7	17	20	11/1/99	Trichloroethene	0.94		0.54
DP3-7	27	30	11/1/99	1,1-Dichloroethene	0.023		0.006
DP3-7	27	30	11/1/99	1,1-Dichloroethene	0.023		0.006
DP3-7	27	30	11/1/99	Trichloroethene	1.1		0.54
DP3-7	27	30	11/1/99	Trichloroethene	1.1		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
DP3-8	17	20	11/2/99	Trichloroethene	1.6		0.54
DP3-8	17	20	11/2/99	Trichloroethene	1.6		0.54
DP3-8	27	30	11/2/99	1,1-Dichloroethene	0.04		0.006
DP3-8	27	30	11/2/99	1,1-Dichloroethene	0.04		0.006
DP3-8	27	30	11/2/99	Trichloroethene	16		0.54
DP3-8	27	30	11/2/99	Trichloroethene	16		0.54
DP3-8	37	40	11/2/99	Trichloroethene	1.3		0.54
DP3-8	37	40	11/2/99	Trichloroethene	1.3		0.54
DP3-9	17	20	11/2/99	Trichloroethene	4.7		0.54
DP3-9	17	20	11/2/99	Trichloroethene	4.7		0.54
DP3-9	27	30	11/2/99	1,1-Dichloroethene	0.036		0.006
DP3-9	27	30	11/2/99	1,1-Dichloroethene	0.036		0.006
DP3-9	27	30	11/2/99	Trichloroethene	7		0.54
DP3-9	27	30	11/2/99	Trichloroethene	7		0.54
DP3-9	37	40	11/2/99	Trichloroethene	0.82		0.54
DP3-9	37	40	11/2/99	Trichloroethene	0.82		0.54
DP5-11	37	40	6/1/99	1,1-Dichloroethene	0.009		0.006
DP5-11	47	50	6/1/99	1,1-Dichloroethene	0.035		0.006
DP5-11	57	60	6/1/99	1,1-Dichloroethene	0.01		0.006
DP5-2	27	30	5/10/99	1,1-Dichloroethene	0.034		0.006
DP5-2	27	30	5/10/99	Trichloroethene	0.65		0.54
DP5-3	7	10	5/11/99	Vinyl Chloride	0.024		0.002
DP5-3	37	40	5/11/99	1,1-Dichloroethene	0.016		0.006
DP5-3	37	40	5/11/99	Trichloroethene	1.1		0.54
DP5-4	27	30	5/12/99	1,1-Dichloroethene	0.025		0.006
DP5-4	27	30	5/12/99	Vinyl Chloride	0.005		0.002
DP5-4	37	40	5/12/99	1,1-Dichloroethene	0.165		0.006
DP5-4	37	40	5/12/99	Vinyl Chloride	0.035		0.002
DP5-4	47	50	5/12/99	Vinyl Chloride	0.005		0.002
DP5-5	37	40	5/13/99	1,1-Dichloroethene	0.175		0.006
DP5-5	37	40	5/13/99	Vinyl Chloride	0.035		0.002
DP5-5	47	50	5/12/99	1,1-Dichloroethene	0.04		0.006
DP5-6	57	60	5/18/99	Trichloroethene	0.83		0.54
DP5-6	57	60	5/18/99	Vinyl Chloride	0.015		0.002
DP5-7	37	40	5/20/99	1,1-Dichloroethene	0.025		0.006
DP5-7	37	40	5/20/99	Trichloroethene	0.7		0.54
DP5-8	5	8	5/20/99	Vinyl Chloride	0.04		0.002
DP5-8	37	40	5/20/99	1,1-Dichloroethene	0.015		0.006
DP5-8	37	40	5/20/99	Trichloroethene	0.685		0.54
DP5-9	37	40	5/20/99	1,1-Dichloroethene	0.007		0.006
DP6-1	17	20	5/26/99	1,1-Dichloroethene	0.009		0.006
DP6-1	17	20	5/26/99	Vinyl Chloride	0.016		0.002
DP6-2	37	40	5/26/99	1,1-Dichloroethene	0.028		0.006
DP6-2	37	40	5/26/99	Trichloroethene	0.67		0.54
DP6-2	37	40	5/26/99	Vinyl Chloride	0.005		0.002
DP6-3	5	8	5/28/99	1,1-Dichloroethene	3.9		0.006
DP6-3	5	8	5/28/99	Vinyl Chloride	0.97		0.002
DP6-3	17	20	5/27/99	1,1-Dichloroethene	0.027		0.006
DP6-3	17	20	5/27/99	Vinyl Chloride	0.02		0.002
DP6-3	37	40	5/27/99	1,1-Dichloroethene	0.035		0.006
DP6-3	37	40	5/27/99	Vinyl Chloride	0.063		0.002
DP6-3	47	50	5/27/99	1,1-Dichloroethene	0.11		0.006
DP6-3	47	50	5/27/99	Vinyl Chloride	0.048		0.002
DP6-4	5	8	6/2/99	1,1-Dichloroethene	0.012		0.006
DP6-4	17	20	6/2/99	1,1-Dichloroethene	0.088		0.006
DP6-4	17	20	6/2/99	Vinyl Chloride	0.065		0.002
DP6-4	27	30	6/2/99	1,1-Dichloroethene	0.124		0.006
DP6-4	27	30	6/2/99	Vinyl Chloride	0.2		0.002
DP6-4	37	40	6/2/99	1,1-Dichloroethene	0.055		0.006
DP6-4	37	40	6/2/99	Vinyl Chloride	0.33		0.002
DW-4D2	0	0	7/6/99	Vinyl Chloride	0.24		0.002
DW-4D2	0	0	7/6/99	Vinyl Chloride	2.5		0.002
ECD-4	8	18	7/30/92	1,1-Dichloroethene	0.023		0.006
ECD-4	8	18	10/28/92	1,1-Dichloroethene	0.012		0.006

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
EW-99-01	20	40	9/1/99	Trichloroethene	400		0.54
EW-99-02	23	33	12/10/99	Trichloroethene	17	J	0.54
EW-99-02	23	33	12/4/99	Trichloroethene	56		0.54
EW-99-02	23	33	12/9/99	Trichloroethene	38	J	0.54
EW-99-02	23	33	12/8/99	Trichloroethene	38		0.54
EW-99-02	23	33	12/1/99	Trichloroethene	50		0.54
EW-99-02	23	33	8/9/00	Trichloroethene	34		0.54
EW-99-02	23	33	12/2/99	Trichloroethene	48		0.54
EW-99-02	23	33	12/7/99	Trichloroethene	50		0.54
EW-99-02	23	33	12/8/99	Trichloroethene	38		0.54
EW-99-02	23	33	12/2/99	Trichloroethene	47	J	0.54
EW-99-02	23	33	12/3/99	Trichloroethene	42	J	0.54
EW-99-02	23	33	12/2/99	Trichloroethene	47	J	0.54
EW-99-02	23	33	12/5/99	Trichloroethene	64		0.54
EW-99-02	23	33	12/2/99	Trichloroethene	46	J	0.54
EW-99-02	23	33	12/2/99	Trichloroethene	45	J	0.54
EW-99-02	23	33	12/2/99	Trichloroethene	51	EJ	0.54
EW-99-02	23	33	12/6/99	Trichloroethene	59		0.54
EW-99-02	23	33	12/2/99	Trichloroethene	67		0.54
EW-99-02	23	33	12/3/99	Trichloroethene	62		0.54
EW-99-02	23	33	12/2/99	Trichloroethene	46	J	0.54
EW-99-02	23	33	12/2/99	Trichloroethene	46	J	0.54
EW-99-02	23	33	12/2/99	Trichloroethene	45	J	0.54
EW-99-02	23	33	12/1/99	Trichloroethene	58		0.54
EW-99-02	23	33	11/18/99	Trichloroethene	49		0.54
EW-99-02	23	33	12/20/99	Trichloroethene	10		0.54
EW-99-02	23	33	1/19/00	Trichloroethene	19		0.54
EW-99-02	23	33	11/30/99	Trichloroethene	3.8		0.54
EW-99-02	23	33	11/18/99	Trichloroethene	50		0.54
EW-99-02	23	33	12/8/99	Trichloroethene	39	J	0.54
EW-99-02	23	33	12/2/99	Trichloroethene	47	J	0.54
EW-99-03	27.8	37.8	1/19/00	Trichloroethene	20		0.54
EW-99-03	27.8	37.8	1/28/00	Trichloroethene	30		0.54
EW-99-03	27.8	37.8	12/2/99	Trichloroethene	92		0.54
EW-99-03	27.8	37.8	1/22/00	Trichloroethene	52		0.54
EW-99-03	27.8	37.8	12/2/99	Trichloroethene	91		0.54
EW-99-03	27.8	37.8	1/29/00	Trichloroethene	32		0.54
EW-99-03	27.8	37.8	1/24/00	Trichloroethene	40		0.54
EW-99-03	27.8	37.8	1/25/00	Trichloroethene	93		0.54
EW-99-03	27.8	37.8	1/26/00	Trichloroethene	31		0.54
EW-99-03	27.8	37.8	1/30/00	Trichloroethene	34		0.54
EW-99-03	27.8	37.8	1/23/00	Trichloroethene	48		0.54
EW-99-03	27.8	37.8	1/23/00	Trichloroethene	50		0.54
EW-99-03	27.8	37.8	1/20/00	Trichloroethene	17		0.54
EW-99-03	27.8	37.8	1/31/00	Trichloroethene	31		0.54
EW-99-03	27.8	37.8	2/1/00	Trichloroethene	36		0.54
EW-99-03	27.8	37.8	11/18/99	Trichloroethene	92		0.54
EW-99-03	27.8	37.8	11/18/99	Trichloroethene	88		0.54
EW-99-03	27.8	37.8	1/27/00	Trichloroethene	40		0.54
EW-99-03	27.8	37.8	1/27/00	Trichloroethene	37		0.54
EW-99-03	27.8	37.8	12/6/99	Trichloroethene	96		0.54
EW-99-03	27.8	37.8	12/21/99	Trichloroethene	37		0.54
EW-99-03	27.8	37.8	1/27/00	Trichloroethene	55		0.54
EW-99-03	27.8	37.8	12/11/99	Trichloroethene	80	J	0.54
EW-99-03	27.8	37.8	1/21/00	Trichloroethene	58		0.54
EW-99-03	27.8	37.8	12/2/99	Trichloroethene	130		0.54
EW-99-03	27.8	37.8	12/9/99	Trichloroethene	78	J	0.54
EW-99-03	27.8	37.8	12/3/99	Trichloroethene	90	J	0.54
EW-99-03	27.8	37.8	12/4/99	Trichloroethene	85	J	0.54
EW-99-03	27.8	37.8	12/5/99	Trichloroethene	120	J	0.54
EW-99-03	27.8	37.8	12/5/99	Trichloroethene	97		0.54
EW-99-03	27.8	37.8	1/22/00	Trichloroethene	61		0.54
EW-99-03	27.8	37.8	12/8/99	Trichloroethene	80		0.54
EW-99-03	27.8	37.8	12/10/99	Trichloroethene	76		0.54
EW-99-03	27.8	37.8	12/7/99	Trichloroethene	87		0.54
EW-99-03	27.8	37.8	12/1/99	Trichloroethene	93		0.54
EW-99-03	27.8	37.8	12/5/99	Trichloroethene	95		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
IW-99-01	25	35	11/18/99	Trichloroethene	260		0.54
IW-99-02	23	33	11/18/99	Trichloroethene	44		0.54
IW-99-03	25	35	8/9/00	Trichloroethene	74		0.54
IW-99-03	25	35	4/12/00	Trichloroethene	0.96		0.54
IW-99-03	25	35	8/9/00	Trichloroethene	66	D	0.54
IW-99-03	25	35	5/9/00	Trichloroethene	3.9		0.54
IW-99-03	25	35	6/20/00	Trichloroethene	31	D	0.54
IW-99-03	25	35	6/20/00	Trichloroethene	32	E	0.54
IW-99-03	25	35	11/18/99	Trichloroethene	350		0.54
IW-99-04	25	35	6/19/00	Trichloroethene	160	D	0.54
IW-99-04	25	35	12/20/99	Trichloroethene	26		0.54
IW-99-04	25	35	2/8/00	Trichloroethene	0.77		0.54
IW-99-04	25	35	8/9/00	Trichloroethene	230		0.54
IW-99-04	25	35	11/18/99	Trichloroethene	150		0.54
IW-99-04	25	35	3/9/00	Trichloroethene	0.66		0.54
IW-99-04	25	35	5/10/00	Trichloroethene	130	D	0.54
IW-99-04	25	35	5/10/00	Trichloroethene	150	E	0.54
IW-99-04	25	35	6/19/00	Trichloroethene	190	E	0.54
IW-99-05	27	37	11/18/99	Trichloroethene	95		0.54
IW-99-06	27	37	11/18/99	Trichloroethene	84		0.54
IW-99-07	27	37	11/18/99	Trichloroethene	88		0.54
IW-99-07	27	37	11/18/99	Trichloroethene	73		0.54
IW-99-08	27	37	11/18/99	Trichloroethene	94		0.54
LW-3S	0	10	9/29/99	Vinyl Chloride	0.0027	J	0.002
LW-3S	0	10	9/25/00	Vinyl Chloride	0.0023		0.002
LW-3S	0	10	3/21/00	Vinyl Chloride	0.0034		0.002
LW-3S	0	10	5/23/95	Vinyl Chloride	0.005	J	0.002
LW-3S	0	10	9/25/00	Vinyl Chloride	0.0024		0.002
LW-3S	0	10	3/23/99	Vinyl Chloride	0.0043		0.002
LW-4	24	34	3/23/99	Vinyl Chloride	0.011		0.002
LW-4	24	34	9/29/99	Vinyl Chloride	0.0058		0.002
LW-4	24	34	5/23/95	Vinyl Chloride	0.015		0.002
LW-4	24	34	3/21/00	Vinyl Chloride	0.0069		0.002
LW-5DI	38	48	5/23/95	Vinyl Chloride	0.12		0.002
LW-5DI	38	48	9/29/99	Vinyl Chloride	0.0045		0.002
LW-5DI	38	48	3/21/00	Vinyl Chloride	0.0089		0.002
LW-5S	0	10	3/23/99	Vinyl Chloride	0.76		0.002
LW-5S	0	10	9/25/00	Vinyl Chloride	2.3	D	0.002
LW-5S	0	10	5/23/95	Vinyl Chloride	0.49	D	0.002
LW-5S	0	10	3/21/00	Vinyl Chloride	0.92	D	0.002
LW-5S	0	10	9/29/99	Vinyl Chloride	3.2	D	0.002
LW-5SI	17	27	3/23/99	Vinyl Chloride	0.0029		0.002
LW-5SI	17	27	5/23/95	Vinyl Chloride	0.058		0.002
MW-2	2	15	7/12/99	Vinyl Chloride	0.0022	J	0.002
MW-4	5	15	7/31/92	Vinyl Chloride	0.022		0.002
MW-4	5	15	9/25/00	Vinyl Chloride	0.007		0.002
MW-4	5	15	10/30/92	Vinyl Chloride	0.01		0.002
PZ-11D	24	34	5/18/95	1,1-Dichloroethene	0.24	JD	0.006
PZ-11D	24	34	4/1/99	1,1-Dichloroethene	0.26		0.006
PZ-11D	24	34	4/1/99	1,1-Dichloroethene	0.26		0.006
PZ-11D	24	34	7/1/99	1,1-Dichloroethene	0.34		0.006
PZ-13D	21.5	31.5	7/7/99	1,1-Dichloroethene	0.026		0.006
PZ-13D	21.5	31.5	7/7/99	Trichloroethene	0.97		0.54
PZ-13D	21.5	31.5	7/7/99	Vinyl Chloride	0.004		0.002
PZ-16D	19	29	7/1/99	1,1-Dichloroethene	0.065		0.006
PZ-16D	19	29	7/1/99	Vinyl Chloride	0.092		0.002
PZ-16D	21	31	5/16/95	1,1-Dichloroethene	0.13		0.006
PZ-16D	21	31	7/1/99	1,1-Dichloroethene	0.073		0.006
PZ-16D	21	31	3/29/99	1,1-Dichloroethene	0.1		0.006
PZ-16D	21	31	3/29/99	Vinyl Chloride	0.13		0.002
PZ-16D	21	31	7/1/99	Vinyl Chloride	0.1		0.002
PZ-16D	21	31	5/16/95	Vinyl Chloride	0.087		0.002
PZ-17D	22	32	5/16/95	1,1-Dichloroethene	0.01		0.006
PZ-17D	22	32	7/2/99	1,1-Dichloroethene	0.06		0.006
PZ-17D	22	32	7/2/99	Vinyl Chloride	0.014		0.002
PZ-17D	29	39	7/2/99	1,1-Dichloroethene	0.045		0.006
PZ-17D	29	39	7/2/99	Trichloroethene	0.64		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
PZ-1D	24	34	7/6/99	1,1-Dichloroethene	0.11		0.006
PZ-1D	24	34	7/6/99	1,1-Dichloroethene	0.14		0.006
PZ-1D	24	34	7/6/99	Trichloroethene	2.5		0.54
PZ-1D	24	34	7/6/99	Trichloroethene	2.3		0.54
PZ-1D	24	34	7/6/99	Vinyl Chloride	0.025		0.002
PZ-4D	29	39	3/17/99	1,1-Dichloroethene	0.013		0.006
PZ-4D	29	39	7/6/99	Vinyl Chloride	2.7		0.002
PZ-4D	29	39	3/17/99	Vinyl Chloride	2.6		0.002
PZ-4D	29	39	7/6/99	Vinyl Chloride	3.4		0.002
PZ-8D	20	30	3/29/99	1,1-Dichloroethene	1.9		0.006
PZ-8D	20	30	3/29/99	Trichloroethene	2.5		0.54
PZ-8D	20	30	3/29/99	Vinyl Chloride	0.006		0.002
PZ-8D	23.5	33.5	7/7/99	1,1-Dichloroethene	3.7		0.006
PZ-8D	23.5	33.5	7/7/99	1,1-Dichloroethene	3.1		0.006
PZ-8D	23.5	33.5	7/7/99	Trichloroethene	6.8		0.54
PZ-8D	23.5	33.5	7/7/99	Trichloroethene	5.9		0.54
PZ-8D	23.5	33.5	7/7/99	Vinyl Chloride	0.018		0.002
PZ-99-01A	4	9	1/24/00	1,1-Dichloroethene	0.11		0.006
PZ-99-01A	4	9	6/19/00	Trichloroethene	75		0.54
PZ-99-01A	4	9	6/19/00	Trichloroethene	93	E	0.54
PZ-99-01B	30	35	1/25/00	Trichloroethene	42		0.54
PZ-99-01B	30	35	1/24/00	Trichloroethene	150		0.54
PZ-99-01B	30	35	1/27/00	Trichloroethene	3.4		0.54
PZ-99-01B	30	35	12/6/99	Trichloroethene	430		0.54
PZ-99-01B	30	35	5/9/00	Trichloroethene	120	D	0.54
PZ-99-01B	30	35	1/25/00	Trichloroethene	43		0.54
PZ-99-01B	30	35	1/21/00	Trichloroethene	290		0.54
PZ-99-01B	30	35	12/20/99	Trichloroethene	370		0.54
PZ-99-01B	30	35	4/12/00	Trichloroethene	8.5		0.54
PZ-99-01B	30	35	12/4/99	Trichloroethene	250	J	0.54
PZ-99-01B	30	35	2/8/00	Trichloroethene	140		0.54
PZ-99-01B	30	35	12/8/99	Trichloroethene	280	J	0.54
PZ-99-01B	30	35	12/7/99	Trichloroethene	360		0.54
PZ-99-01B	30	35	1/23/00	Trichloroethene	160		0.54
PZ-99-01B	30	35	12/10/99	Trichloroethene	120		0.54
PZ-99-01B	30	35	12/5/99	Trichloroethene	500		0.54
PZ-99-01B	30	35	1/22/00	Trichloroethene	260		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	220		0.54
PZ-99-01B	30	35	8/9/00	Trichloroethene	170		0.54
PZ-99-01B	30	35	12/3/99	Trichloroethene	240	J	0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	260	EJ	0.54
PZ-99-01B	30	35	5/9/00	Trichloroethene	120	D	0.54
PZ-99-01B	30	35	1/26/00	Trichloroethene	48	J	0.54
PZ-99-01B	30	35	12/1/99	Trichloroethene	220		0.54
PZ-99-01B	30	35	5/9/00	Trichloroethene	150	E	0.54
PZ-99-01B	30	35	12/7/99	Trichloroethene	370		0.54
PZ-99-01B	30	35	1/25/00	Trichloroethene	86		0.54
PZ-99-01B	30	35	11/18/99	Trichloroethene	200		0.54
PZ-99-01B	30	35	3/9/00	Trichloroethene	150	E	0.54
PZ-99-01B	30	35	3/9/00	Trichloroethene	130	D	0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	240		0.54
PZ-99-01B	30	35	12/9/99	Trichloroethene	190	J	0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	230		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	220		0.54
PZ-99-01B	30	35	1/20/00	Trichloroethene	230		0.54
PZ-99-01B	30	35	1/28/00	Trichloroethene	8		0.54
PZ-99-01B	30	35	12/7/99	Trichloroethene	350		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	230		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	220		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	230		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	240		0.54
PZ-99-01B	30	35	11/30/99	Trichloroethene	64		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	240		0.54
PZ-99-01B	30	35	12/2/99	Trichloroethene	220		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
PZ-99-01C	45	50	12/4/99	Trichloroethene	2.6		0.54
PZ-99-01C	45	50	8/9/00	Trichloroethene	0.99		0.54
PZ-99-01C	45	50	3/9/00	Trichloroethene	2.2		0.54
PZ-99-01C	45	50	4/12/00	Trichloroethene	1.7		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.8	J	0.54
PZ-99-01C	45	50	12/3/99	Trichloroethene	2.8		0.54
PZ-99-01C	45	50	12/8/99	Trichloroethene	2.6	J	0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.1		0.54
PZ-99-01C	45	50	12/7/99	Trichloroethene	2.6		0.54
PZ-99-01C	45	50	12/6/99	Trichloroethene	3		0.54
PZ-99-01C	45	50	12/9/99	Trichloroethene	2.8	J	0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.7		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.8	J	0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.6		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	12/5/99	Trichloroethene	2.9		0.54
PZ-99-01C	45	50	11/18/99	Trichloroethene	2.8		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.5		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	12/1/99	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	1/30/00	Trichloroethene	2.2		0.54
PZ-99-01C	45	50	2/1/00	Trichloroethene	1.9		0.54
PZ-99-01C	45	50	1/31/00	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	11/30/99	Trichloroethene	2.2		0.54
PZ-99-01C	45	50	12/10/99	Trichloroethene	2.7		0.54
PZ-99-01C	45	50	1/26/00	Trichloroethene	2.8		0.54
PZ-99-01C	45	50	1/25/00	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	1/26/00	Trichloroethene	2.7	J	0.54
PZ-99-01C	45	50	1/27/00	Trichloroethene	2.3		0.54
PZ-99-01C	45	50	1/28/00	Trichloroethene	2		0.54
PZ-99-01C	45	50	1/29/00	Trichloroethene	2		0.54
PZ-99-01C	45	50	12/20/99	Trichloroethene	4		0.54
PZ-99-01C	45	50	2/8/00	Trichloroethene	3		0.54
PZ-99-01C	45	50	6/19/00	Trichloroethene	1.4		0.54
PZ-99-01C	45	50	1/26/00	Trichloroethene	3	J	0.54
PZ-99-01C	45	50	1/24/00	Trichloroethene	2.6		0.54
PZ-99-01C	45	50	1/22/00	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	1/21/00	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	5/9/00	Trichloroethene	2		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.4		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	2.3		0.54
PZ-99-01C	45	50	12/2/99	Trichloroethene	3.5		0.54
PZ-99-01I	14	19	2/11/99	1,1-Dichloroethene	0.0076		0.006
PZ-99-01I	14	19	2/11/99	Trichloroethene	2.2		0.54
PZ-99-02A	4	9	11/18/99	Trichloroethene	14		0.54
PZ-99-02B	25	30	8/19/99	Trichloroethene	82		0.54
PZ-99-02B	30	35	11/18/99	Trichloroethene	77		0.54
PZ-99-02C	45	50	11/18/99	Trichloroethene	27		0.54
PZ-99-03	4	9	8/18/99	1,1-Dichloroethene	9.4		0.006
PZ-99-03	4	9	8/18/99	Trichloroethene	1.7		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	41		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	24		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	62		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	51		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	51		0.54
PZ-99-04	22.5	32.5	11/30/99	Trichloroethene	39		0.54
PZ-99-04	22.5	32.5	12/6/99	Trichloroethene	190		0.54
PZ-99-04	22.5	32.5	11/18/99	Trichloroethene	23		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	55		0.54
PZ-99-04	22.5	32.5	12/9/99	Trichloroethene	1.2		0.54
PZ-99-04	22.5	32.5	12/7/99	Trichloroethene	99		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	51		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	74		0.54
PZ-99-04	22.5	32.5	12/5/99	Trichloroethene	85		0.54
PZ-99-04	22.5	32.5	1/24/00	Trichloroethene	220		0.54
PZ-99-04	22.5	32.5	11/30/99	Trichloroethene	37		0.54
PZ-99-04	22.5	32.5	8/9/00	Trichloroethene	8		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	33		0.54
PZ-99-04	22.5	32.5	6/19/00	Trichloroethene	15		0.54
PZ-99-04	22.5	32.5	11/30/99	Trichloroethene	43		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	30		0.54
PZ-99-04	22.5	32.5	4/12/00	Trichloroethene	3.6		0.54
PZ-99-04	22.5	32.5	12/4/99	Trichloroethene	84	J	0.54
PZ-99-04	22.5	32.5	1/19/00	Trichloroethene	27		0.54
PZ-99-04	22.5	32.5	12/3/99	Trichloroethene	64	J	0.54
PZ-99-04	22.5	32.5	1/26/00	Trichloroethene	26		0.54
PZ-99-04	22.5	32.5	12/2/99	Trichloroethene	77	J	0.54
PZ-99-04	22.5	32.5	1/25/00	Trichloroethene	61		0.54
PZ-99-04	22.5	32.5	1/23/00	Trichloroethene	320		0.54
PZ-99-04	22.5	32.5	12/1/99	Trichloroethene	45		0.54
PZ-99-04	22.5	32.5	1/22/00	Trichloroethene	32		0.54
PZ-99-04	22.5	32.5	1/21/00	Trichloroethene	110		0.54
PZ-99-04	22.5	32.5	1/20/00	Trichloroethene	140		0.54
PZ-99-04	22.5	32.5	1/19/00	Trichloroethene	27		0.54
PZ-99-04	22.5	32.5	1/19/00	Trichloroethene	26		0.54
PZ-99-04	22.5	32.5	5/9/00	Trichloroethene	14		0.54
PZ-99-04I	30	35	2/11/99	1,1-Dichloroethene	0.32		0.006
PZ-99-04I	30	35	2/11/99	Trichloroethene	45		0.54
PZ-99-04I	30	35	2/11/99	Vinyl Chloride	0.0023		0.002
PZ-99-05	25	35	12/10/99	Trichloroethene	65		0.54
PZ-99-05	25	35	6/19/00	Trichloroethene	100	E	0.54
PZ-99-05	25	35	4/12/00	Trichloroethene	11		0.54
PZ-99-05	25	35	6/19/00	Trichloroethene	85	D	0.54
PZ-99-05	25	35	12/3/99	Trichloroethene	200	J	0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	210	J	0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	210	J	0.54
PZ-99-05	25	35	12/8/99	Trichloroethene	76		0.54
PZ-99-05	25	35	5/9/00	Trichloroethene	18		0.54
PZ-99-05	25	35	12/10/99	Trichloroethene	64		0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	210	J	0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	210	J	0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	180	J	0.54
PZ-99-05	25	35	12/9/99	Trichloroethene	68	J	0.54
PZ-99-05	25	35	11/18/99	Trichloroethene	74		0.54
PZ-99-05	25	35	12/7/99	Trichloroethene	150		0.54
PZ-99-05	25	35	12/6/99	Trichloroethene	200		0.54
PZ-99-05	25	35	12/5/99	Trichloroethene	170		0.54
PZ-99-05	25	35	8/9/00	Trichloroethene	150		0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	170		0.54
PZ-99-05	25	35	11/30/99	Trichloroethene	91		0.54
PZ-99-05	25	35	12/20/99	Trichloroethene	8.1		0.54
PZ-99-05	25	35	1/23/00	Trichloroethene	64		0.54
PZ-99-05	25	35	1/24/00	Trichloroethene	48		0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	200		0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	190		0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	160		0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	160		0.54
PZ-99-05	25	35	12/2/99	Trichloroethene	200	J	0.54
PZ-99-05	25	35	1/25/00	Trichloroethene	12		0.54
PZ-99-05	25	35	1/20/00	Trichloroethene	120		0.54
PZ-99-05	25	35	12/1/99	Trichloroethene	170		0.54
PZ-99-05	25	35	12/4/99	Trichloroethene	180		0.54
PZ-99-06	25	35	1/26/00	Trichloroethene	160		0.54
PZ-99-06	25	35	1/22/00	Trichloroethene	240		0.54
PZ-99-06	25	35	12/8/99	Trichloroethene	150		0.54
PZ-99-06	25	35	2/1/00	Trichloroethene	92		0.54
PZ-99-06	25	35	12/3/99	Trichloroethene	78		0.54
PZ-99-06	25	35	1/29/00	Trichloroethene	68		0.54
PZ-99-06	25	35	1/31/00	Trichloroethene	74		0.54
PZ-99-06	25	35	2/8/00	Trichloroethene	40		0.54
PZ-99-06	25	35	12/4/99	Trichloroethene	190		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	130		0.54
PZ-99-06	25	35	1/31/00	Trichloroethene	69		0.54
PZ-99-06	25	35	11/30/99	Trichloroethene	100		0.54
PZ-99-06	25	35	12/2/99	Trichloroethene	180	J	0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
PZ-99-06	25	35	12/20/99	Trichloroethene	90		0.54
PZ-99-06	25	35	1/30/00	Trichloroethene	77		0.54
PZ-99-06	25	35	12/3/99	Trichloroethene	95		0.54
PZ-99-06	25	35	12/3/99	Trichloroethene	96		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	150		0.54
PZ-99-06	25	35	1/28/00	Trichloroethene	130		0.54
PZ-99-06	25	35	1/27/00	Trichloroethene	140		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	160		0.54
PZ-99-06	25	35	12/6/99	Trichloroethene	200		0.54
PZ-99-06	25	35	8/9/00	Trichloroethene	94		0.54
PZ-99-06	25	35	1/31/00	Trichloroethene	96		0.54
PZ-99-06	25	35	1/24/00	Trichloroethene	280		0.54
PZ-99-06	25	35	12/9/99	Trichloroethene	150	J	0.54
PZ-99-06	25	35	12/10/99	Trichloroethene	95		0.54
PZ-99-06	25	35	6/19/00	Trichloroethene	120	E	0.54
PZ-99-06	25	35	6/19/00	Trichloroethene	96	D	0.54
PZ-99-06	25	35	5/9/00	Trichloroethene	170	E	0.54
PZ-99-06	25	35	5/9/00	Trichloroethene	140	D	0.54
PZ-99-06	25	35	4/12/00	Trichloroethene	35		0.54
PZ-99-06	25	35	3/9/00	Trichloroethene	25	D	0.54
PZ-99-06	25	35	1/22/00	Trichloroethene	200		0.54
PZ-99-06	25	35	1/25/00	Trichloroethene	190		0.54
PZ-99-06	25	35	1/20/00	Trichloroethene	660		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	160		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	140		0.54
PZ-99-06	25	35	3/9/00	Trichloroethene	31	E	0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	170		0.54
PZ-99-06	25	35	11/18/99	Trichloroethene	110		0.54
PZ-99-06	25	35	1/22/00	Trichloroethene	200		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	100		0.54
PZ-99-06	25	35	1/21/00	Trichloroethene	290		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	93		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	94		0.54
PZ-99-06	25	35	1/23/00	Trichloroethene	290		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	170		0.54
PZ-99-06	25	35	12/7/99	Trichloroethene	230		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	150		0.54
PZ-99-06	25	35	12/5/99	Trichloroethene	180		0.54
PZ-99-06	25	35	12/1/99	Trichloroethene	150		0.54
PZ-99-07	25	35	11/18/99	1,1-Dichloroethene	0.025		0.006
PZ-99-07	25	35	12/1/99	Trichloroethene	190		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	180		0.54
PZ-99-07	25	35	11/18/99	Trichloroethene	41		0.54
PZ-99-07	25	35	12/5/99	Trichloroethene	180		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	210		0.54
PZ-99-07	25	35	12/2/99	Trichloroethene	220	J	0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	200		0.54
PZ-99-07	25	35	11/30/99	Trichloroethene	240		0.54
PZ-99-07	25	35	12/4/99	Trichloroethene	140		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	180		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	180		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	190		0.54
PZ-99-07	25	35	12/3/99	Trichloroethene	80	J	0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	260		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	190		0.54
PZ-99-07	25	35	11/18/99	Trichloroethene	28		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	180		0.54
PZ-99-07	25	35	12/1/99	Trichloroethene	190		0.54
PZ-99-08	27	37	11/18/99	Trichloroethene	93		0.54
PZ-99-09	27	37	11/18/99	Trichloroethene	86		0.54
PZ-99-10	27	37	11/18/99	Trichloroethene	88		0.54
PZ-99-11	27	37	11/18/99	Trichloroethene	93		0.54
PZ-99-12I	16	21	2/11/99	1,1-Dichloroethene	1.2		0.006
PZ-99-12I	16	21	2/11/99	Vinyl Chloride	0.025		0.002

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
PZ-9D	27	37	5/16/95	1,1-Dichloroethene	0.042		0.006
PZ-9D	27	37	7/30/92	1,1-Dichloroethene	0.74	J	0.006
PZ-9D	27	37	7/1/99	1,1-Dichloroethene	0.032	J	0.006
PZ-9D	27	37	5/16/95	Trichloroethene	1.3	D	0.54
PZ-9D	27	37	10/29/92	Trichloroethene	1.6		0.54
PZ-9D	27	37	7/30/92	Trichloroethene	31		0.54
PZ-9D	27	37	7/1/99	Trichloroethene	1.5		0.54
PZ-9D	27	37	7/1/99	Vinyl Chloride	0.0032		0.002
WC-10S	3	13	10/26/92	1,1-Dichloroethene	0.009		0.006
WC-10S	3	13	7/7/99	1,1-Dichloroethene	0.28		0.006
WC-10S	3	13	5/15/95	1,1-Dichloroethene	0.021		0.006
WC-12S	3	13	10/26/92	1,1-Dichloroethene	1.1		0.006
WC-12S	3	13	5/16/95	1,1-Dichloroethene	4.7	D	0.006
WC-12S	3	13	7/8/99	1,1-Dichloroethene	0.96		0.006
WC-12S	3	13	7/29/92	1,1-Dichloroethene	0.13		0.006
WC-12S	3	13	10/26/92	Vinyl Chloride	0.011		0.002
WC-13S	3	13	5/17/95	Vinyl Chloride	0.006	J	0.002
WC-13S	3	13	7/29/92	Vinyl Chloride	0.017		0.002
WC-13S	3	13	10/26/92	Vinyl Chloride	0.018		0.002
WC-14S	3	13	7/28/92	1,1-Dichloroethene	0.011		0.006
WC-14S	3	13	7/28/92	Vinyl Chloride	0.012		0.002
WC-15S	3	13	10/27/92	1,1-Dichloroethene	0.038		0.006
WC-15S	3	13	7/28/92	1,1-Dichloroethene	0.099		0.006
WC-15S	3	13	5/17/95	Vinyl Chloride	0.012	J	0.002
WC-15S	3	13	10/27/92	Vinyl Chloride	0.19		0.002
WC-15S	3	13	7/28/92	Vinyl Chloride	0.18		0.002
WC-18D1	30	50	2/21/95	1,1-Dichloroethene	0.062		0.006
WC-18D1	30	50	5/17/95	1,1-Dichloroethene	0.059		0.006
WC-18D1	30	50	5/17/95	Vinyl Chloride	0.014		0.002
WC-18D1	30	50	2/21/95	Vinyl Chloride	0.012		0.002
WC-18D3	30	50	11/18/99	Trichloroethene	0.67		0.54
WC-19D1	30	50	5/17/95	1,1-Dichloroethene	0.029	J	0.006
WC-19D1	30	50	6/30/99	1,1-Dichloroethene	0.02	J	0.006
WC-19D1	30	50	2/21/95	1,1-Dichloroethene	0.12		0.006
WC-19S	5	15	5/17/95	1,1-Dichloroethene	0.01	J	0.006
WC-19S	5	15	6/29/99	1,1-Dichloroethene	0.011		0.006
WC-19S	5	15	6/29/99	1,1-Dichloroethene	0.0068	J	0.006
WC-19S	5	15	6/29/99	Vinyl Chloride	0.02		0.002
WC-1S	4	14	7/8/99	1,1-Dichloroethene	0.052		0.006
WC-1S	4	14	7/29/92	1,1-Dichloroethene	0.014		0.006
WC-1S	4	14	10/28/92	1,1-Dichloroethene	0.01		0.006
WC-1S	4	14	7/8/99	Vinyl Chloride	0.037		0.002
WC-1S	4	14	10/28/92	Vinyl Chloride	0.0077		0.002
WC-20D1	30	50	2/22/95	Trichloroethene	0.72		0.54
WC-21D1	30	50	2/21/95	1,1-Dichloroethene	0.019		0.006
WC-21D1	30	50	11/10/99	1,1-Dichloroethene	0.017		0.006
WC-21D1	30	50	5/18/95	1,1-Dichloroethene	0.025		0.006
WC-21D1	30	50	5/18/95	Trichloroethene	0.73	D	0.54
WC-21D1	30	50	11/10/99	Vinyl Chloride	0.0031		0.002
WC-2D	24.5	34.5	7/31/92	1,1-Dichloroethene	0.016		0.006
WC-2D	24.5	34.5	5/18/95	1,1-Dichloroethene	0.017		0.006
WC-2D	24.5	34.5	5/18/95	Vinyl Chloride	1	D	0.002
WC-2D	24.5	34.5	7/31/92	Vinyl Chloride	0.59		0.002
WC-2D	24.5	34.5	7/7/99	Vinyl Chloride	1.9		0.002
WC-2D	24.5	34.5	7/7/99	Vinyl Chloride	1.8		0.002
WC-2D	24.5	34.5	10/30/92	Vinyl Chloride	1.9		0.002
WC-4S	3	13	5/16/95	1,1-Dichloroethene	0.007	J	0.006
WC-4S	3	13	10/29/92	1,1-Dichloroethene	0.094		0.006
WC-4S	3	13	7/8/99	1,1-Dichloroethene	0.73		0.006
WC-4S	3	13	7/29/92	1,1-Dichloroethene	0.01		0.006
WC-4S	3	13	7/29/92	Vinyl Chloride	0.24		0.002
WC-4S	3	13	5/16/95	Vinyl Chloride	0.005	J	0.002
WC-4S	3	13	10/29/92	Vinyl Chloride	0.064		0.002
WC-5S	3	13	7/8/99	Vinyl Chloride	3		0.002
WC-5S	3	13	7/8/99	Vinyl Chloride	3		0.002

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
WC-6S	3	13	7/30/92	1,1-Dichloroethene	0.28	J	0.006
WC-6S	3	13	10/29/92	1,1-Dichloroethene	0.04		0.006
WC-6S	3	13	10/29/92	Vinyl Chloride	0.004	J	0.002
WC-8S	3	13	7/29/92	1,1-Dichloroethene	0.022		0.006
WC-8S	3	13	5/16/95	1,1-Dichloroethene	0.87	D	0.006
WC-8S	3	13	5/16/95	1,1-Dichloroethene	0.87	D	0.006
WC-8S	3	13	10/28/92	1,1-Dichloroethene	0.024		0.006
WC-8S	3	13	5/16/95	Vinyl Chloride	0.048	JD	0.002
WC-8S	3	13	7/29/92	Vinyl Chloride	0.043		0.002
WC-8S	3	13	5/16/95	Vinyl Chloride	0.031		0.002
WC-8S	3	13	10/28/92	Vinyl Chloride	0.011		0.002
WC2-2I	45	55	7/8/99	Vinyl Chloride	0.036		0.002
WC2-3D	74.5	84.5	7/7/99	Trichloroethene	3.1		0.54
WC2-3D	74.5	84.5	7/7/99	Trichloroethene	0.62		0.54
WC2-3I	45	55	7/13/99	1,1-Dichloroethene	0.0099		0.006
WC2-3I	45	55	7/13/99	Vinyl Chloride	0.062		0.002
WC2-3S	2	12	7/13/99	Vinyl Chloride	0.0021		0.002
WC2-4I	25	35	11/15/99	1,1-Dichloroethene	0.034		0.006
WC2-4I	25	35	11/15/99	Vinyl Chloride	0.037		0.002
WC2-5I	30	40	11/15/99	1,1-Dichloroethene	0.1		0.006
WC2-5I	30	40	11/15/99	Vinyl Chloride	0.086		0.002
WC2-5S	2	12	7/13/99	1,1-Dichloroethene	0.015		0.006
WC2-5S	2	12	7/13/99	Vinyl Chloride	0.012		0.002
WC2-6I	40	50	11/15/99	1,1-Dichloroethene	0.021		0.006
WC2-6I	40	50	11/15/99	Trichloroethene	3.7		0.54
WC2-6I	40	50	11/15/99	Vinyl Chloride	0.021		0.002
WC3-1D	75	85	11/18/99	Trichloroethene	0.68		0.54
WC3-1I	30	40	11/17/99	1,1-Dichloroethene	2.8		0.006
WC3-1I	30	40	11/17/99	1,2-Dichloroethane	0.15		0.09
WC3-1I	30	40	11/17/99	Vinyl Chloride	0.0033		0.002
WC3-2I	30	40	11/17/99	1,1-Dichloroethene	0.024		0.006
WC5-1S	1.5	11.5	7/6/99	1,1-Dichloroethene	0.057		0.006
WC5-1S	1.5	11.5	7/6/99	1,1-Dichloroethene	0.057		0.006
WP-99-08	8	12	2/9/99	1,1-Dichloroethene	0.017	H	0.006
WP-99-08	26	30	2/9/99	Trichloroethene	110	H	0.54
WP-99-09	25	29	1/27/99	Trichloroethene	130	H	0.54
WP-99-33	26	30	3/8/99	Trichloroethene	830		0.54
WP-99-33	36	40	3/8/99	Trichloroethene	12		0.54
WP-99-33	46	50	3/8/99	Trichloroethene	2.9		0.54
WP-99-33	62	66	3/8/99	Trichloroethene	1.4		0.54
WP-99-33	76	80	3/9/99	1,1-Dichloroethene	0.1		0.006
WP-99-33	76	80	3/9/99	1,1-Dichloroethene	0.24		0.006
WP-99-34	16	20	3/9/99	Trichloroethene	0.6		0.54
WP-99-34	16	20	3/9/99	Trichloroethene	0.63		0.54
WP-99-34	26	30	3/9/99	2-Butanone	78		50
WP-99-34	26	30	3/9/99	Trichloroethene	220		0.54
WP-99-34	26	30	3/9/99	Trichloroethene	170	E	0.54
WP-99-34	36	40	3/9/99	Trichloroethene	31		0.54
WP-99-34	36	40	3/9/99	Trichloroethene	29	E	0.54
WP-99-35	22	26	3/9/99	1,1-Dichloroethene	2.5		0.006
WP-99-35	22	26	3/9/99	Trichloroethene	12		0.54
WP-99-35	22	26	3/9/99	Vinyl Chloride	0.004		0.002
WP-99-36	18	22	3/9/99	Trichloroethene	1.4		0.54
WP-99-36	30	34	3/9/99	Trichloroethene	23		0.54
WP-99-36	44	48	3/9/99	Trichloroethene	10		0.54
WP-99-36	44	48	3/9/99	Trichloroethene	11		0.54
WP-99-37	16	20	3/9/99	1,1-Dichloroethene	1	J	0.006
WP-99-37	16	20	3/9/99	Trichloroethene	1	J	0.54
WP-99-37	16	20	3/9/99	Vinyl Chloride	1	J	0.002
WP-99-37	26	30	3/9/99	Trichloroethene	18		0.54
WP-99-37	40	44	3/9/99	Trichloroethene	17		0.54
WP-99-38	22	26	3/10/99	Trichloroethene	5		0.54
WP-99-40	16	20	3/11/99	Trichloroethene	1.1		0.54
WP-99-40	27	31	3/11/99	Trichloroethene	29		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
WP-99-41	6	10	3/11/99	1,1-Dichloroethene	1.4		0.006
WP-99-41	6	10	3/11/99	Trichloroethene	0.98		0.54
WP-99-41	18	22	3/11/99	1,1-Dichloroethene	3.7		0.006
WP-99-41	18	22	3/11/99	Trichloroethene	1.9		0.54
WP-99-41	26	30	3/11/99	1,1-Dichloroethene	0.11		0.006
WP-99-41	26	30	3/11/99	Trichloroethene	48		0.54
WP-99-41	26	30	3/11/99	Trichloroethene	23		0.54
WP-99-41	36	40	3/11/99	1,1-Dichloroethene	0.065		0.006
WP-99-41	36	40	3/11/99	Trichloroethene	7.6		0.54
WP-99-41	36	40	3/11/99	Vinyl Chloride	0.013		0.002
WP-99-41	77	81	3/11/99	1,1-Dichloroethene	0.01		0.006
WP-99-41	77	81	3/11/99	1,1-Dichloroethene	0.011		0.006
WP-99-41	77	81	3/11/99	1,1-Dichloroethene	0.0092		0.006
WP-99-42	19	23	3/11/99	1,1-Dichloroethene	0.16		0.006
WP-99-43	6	10	3/11/99	1,1-Dichloroethene	1.5		0.006
WP-99-43	6	10	3/11/99	Trichloroethene	1.2		0.54
WP-99-43	16	20	3/11/99	1,1-Dichloroethene	2.4		0.006
WP-99-43	16	20	3/11/99	Trichloroethene	1.8		0.54
WP-99-43	26	30	3/11/99	1,1-Dichloroethene	0.43		0.006
WP-99-43	26	30	3/11/99	1,1-Dichloroethene	0.44		0.006
WP-99-43	26	30	3/11/99	Trichloroethene	1.8		0.54
WP-99-43	26	30	3/11/99	Trichloroethene	1.7		0.54
WP-99-43	36	40	3/11/99	Trichloroethene	0.75		0.54
WP-99-43	56	60	3/11/99	1,1-Dichloroethene	0.017		0.006
WP-99-43	78	82	3/11/99	1,1-Dichloroethene	0.05		0.006
WP-99-44	25	29	3/12/99	1,1-Dichloroethene	0.2		0.006
WP-99-44	25	29	3/12/99	Trichloroethene	4.9		0.54
WP-99-44	25	29	3/12/99	Vinyl Chloride	0.11		0.002
WP-99-44	46	50	3/12/99	Trichloroethene	0.64		0.54
WP-99-45	11	15	3/16/99	1,1-Dichloroethene	4.5		0.006
WP-99-45	11	15	3/16/99	Trichloroethene	5.9		0.54
WP-99-45	26	30	3/16/99	Trichloroethene	264		0.54
WP-99-45	36	40	3/16/99	Trichloroethene	246		0.54
WP-99-46	31	35	3/17/99	Vinyl Chloride	1		0.002
WP-99-46	31	35	3/17/99	Vinyl Chloride	1.1		0.002
WP-99-47	6	10	3/17/99	1,1-Dichloroethene	2.2		0.006
WP-99-47	17	21	3/17/99	1,1-Dichloroethene	4.8		0.006
WP-99-47	17	21	3/17/99	1,1-Dichloroethene	3.9		0.006
WP-99-47	17	21	3/17/99	Trichloroethene	1.9		0.54
WP-99-48	5	9	3/18/99	1,1,1-Trichloroethane	100		50
WP-99-48	5	9	3/18/99	1,1-Dichloroethene	8.5		0.006
WP-99-48	5	9	3/18/99	Trichloroethene	1.5		0.54
WP-99-48	15	19	3/18/99	1,1,1-Trichloroethane	82		50
WP-99-48	15	19	3/18/99	1,1-Dichloroethene	14		0.006
WP-99-48	15	19	3/18/99	Trichloroethene	5.9		0.54
WP-99-49	17	21	3/18/99	1,1-Dichloroethene	0.25		0.006
WP-99-49	39	43	3/18/99	Trichloroethene	7.1		0.54
WP-99-50	9	13	3/18/99	Trichloroethene	8.4		0.54
WP-99-50	50	54	3/18/99	Trichloroethene	44		0.54
WP-99-53	6	10	3/22/99	1,1-Dichloroethene	0.41		0.006
WP-99-53	16	20	3/22/99	1,1-Dichloroethene	4.4		0.006
WP-99-53	16	20	3/22/99	Trichloroethene	1.3		0.54
WP-99-53	28	32	3/22/99	1,1-Dichloroethene	0.11		0.006
WP-99-53	28	32	3/22/99	Trichloroethene	7.9		0.54
WP-99-54	46	50	3/23/99	Trichloroethene	3		0.54
WP-99-60	16	20	3/24/99	Vinyl Chloride	0.15		0.002
WP-99-61	16	20	3/25/99	1,1-Dichloroethene	0.16		0.006
WP-99-61	24	28	3/25/99	1,1-Dichloroethene	0.53		0.006
WP-99-62	46	50	3/25/99	1,1-Dichloroethene	0.12		0.006
WP-99-62	46	50	3/25/99	Trichloroethene	11		0.54
WP-99-62	59	63	3/25/99	Trichloroethene	0.57		0.54
WP-99-63	26	30	3/26/99	Trichloroethene	4.4		0.54
WP-99-63	36	40	3/26/99	Trichloroethene	1.6		0.54
WP-99-68	6	10	3/31/99	1,1-Dichloroethene	0.21		0.006
WP-99-68	16	20	3/31/99	1,1-Dichloroethene	0.74		0.006
WP-99-68	26	30	3/31/99	Trichloroethene	0.61		0.54

TABLE 2-4

VOCs in GROUNDWATER EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

SITE ID	START DEPTH (feet bgs)	END DEPTH (feet bgs)	SAMPLE DATE	PARAMETER	VALUE (MG/L)	QUAL	CTDEP I/C VC (MG/L)
WP-99-69	6	10	3/31/99	1,1-Dichloroethene	0.34		0.006
WP-99-69	16	20	3/31/99	1,1-Dichloroethene	0.64		0.006
WP-99-69	16	20	3/31/99	Trichloroethene	2.3		0.54
WP-99-69	26	30	3/31/99	1,1-Dichloroethene	0.75		0.006
WP-99-69	26	30	3/31/99	Trichloroethene	2.5		0.54
WP-99-70	26	30	3/31/99	1,1-Dichloroethene	0.85		0.006
WP-99-70	26	30	3/31/99	Trichloroethene	1.4		0.54
WP-99-71	16	20	4/1/99	1,1-Dichloroethene	1.2		0.006
WP-99-72	30	34	4/1/99	Trichloroethene	28		0.54

TABLE 2-5
VOCs IN SOIL VAPOR EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

		SAMPLE ID:	SG9901003XF	SG9902003XF	SG9903003XF	SG9904003XF	SG99040032F	SG9905003XF	SG9906003XF	SG9906003XD
		SITE ID:	SG-99-01	SG-99-02	SG-99-03	SG-99-04	SG-99-04	SG-99-05	SG-99-06	SG-99-06
		DATE SAMPLED:	8/4/99	8/4/99	8/4/99	8/4/99	8/9/99	8/4/99	8/4/99	8/4/99
		DATE ANALYZED:	8/5/99	8/5/99	8/5/99	8/5/99	8/9/99	8/5/99	8/5/99	8/5/99
		UNITS:	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
Compound	RL	I/C VC								
Vinyl chloride	0.01	6.1	0.05	0.03	0.03	0.14	0.27	0.04	0.02	0.02
1,1-Dichloroethene	0.01	0.35	0.47	0.07	0.01 U	1.4	4.4	0.19	0.04	0.01 U
Trichloroethene	0.02	16	1.6	0.08	0.13	100	210	0.34	65	57
Tetrachloroethene	0.03	27	0.04	0.03 U	0.03 U	0.03 U	0.03 U	0.05	0.08	0.04

		SAMPLE ID:	SG9907003XF	SG9908003XF	SG9909003XF	SG9910003XF	SG99100032F	SG9911003XF	SG9912003XF	SG9913003XF
		SITE ID:	SG-99-07	SG-99-08	SG-99-09	SG-99-10	SG-99-10	SG-99-11	SG-99-12	SG-99-13
		DATE SAMPLED:	8/4/99	8/4/99	8/5/99	8/5/99	8/9/99	8/5/99	8/5/99	8/5/99
		DATE ANALYZED:	8/5/99	8/5/99	8/5/99	8/5/99	8/9/99	8/5/99	8/5/99	8/5/99
		UNITS:	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
Compound	RL	I/C VC								
Vinyl chloride	0.01	6.1	0.01 U	0.01 U	0.01	0.14	0.77	0.01 U	0.01 U	0.01
1,1-Dichloroethene	0.01	0.35	0.01 U	0.01 U	0.01 U	0.80	3.9	0.01 U	0.01 U	0.01 U
Trichloroethene	0.02	16	0.25	0.06	0.07	20	130	0.02	0.02 U	0.16
Tetrachloroethene	0.03	27	0.03 U	0.03 U	0.03 U	0.03	0.13	0.03 U	0.03 U	0.03 U

		SAMPLE ID:	SG9914003XF	SG9915003XF	SG9916003XF	SG9917003XF	SG9918003XF	SG9919003XF	SG9920003XF	SG9921003XF
		SITE ID:	SG-99-14	SG-99-15	SG-99-16	SG-99-17	SG-99-18	SG-99-19	SG-99-20	SG-99-21
		DATE SAMPLED:	8/5/99	8/5/99	8/5/99	8/5/99	8/5/99	8/6/99	8/6/99	8/6/99
		DATE ANALYZED:	8/5/99	8/5/99	8/5/99	8/5/99	8/5/99	8/6/99	8/6/99	8/6/99
		UNITS:	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
Compound	RL	I/C VC								
Vinyl chloride	0.01	6.1	0.01 U	1.0	0.02	0.03	0.02	0.01	0.01 U	0.01 U
1,1-Dichloroethene	0.01	0.35	0.01 U	0.01 U	0.06	2.1	1.4	0.01 U	0.01 U	0.01 U
Trichloroethene	0.02	16	0.02	0.24	0.17	1.0	1.5	1.4	3.8	0.04
Tetrachloroethene	0.03	27	0.03 U	0.18	0.03 U	0.04	0.03	0.23	0.12	0.03

TABLE 2-5
VOCs IN SOIL VAPOR EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

		SAMPLE ID:	SG9922003XF	SG9922003XD	SG9923003XF	SG9924003XF	SG9925003XF	SG9925003XD	SG9926003XF	SG9927003XF
		SITE ID:	SG-99-22	SG-99-22	SG-9923	SG-99-24	SG-99-25	SG-99-25	SG-99-26	SG-99-27
		DATE SAMPLED:	8/6/99	8/6/99	8/6/99	8/6/99	8/9/99	8/9/99	8/9/99	8/9/99
		DATE ANALYZED:	8/6/99	8/6/99	8/6/99	8/6/99	8/9/99	8/9/99	8/9/99	8/9/99
		UNITS:	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
Compound	RL	I/C VC								
Vinyl chloride	0.01	6.1	0.01	0.01	0.01 U	0.01	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	0.01	0.35	0.07	0.07	0.01 U	0.01 U	0.01 U	0.02	0.01 U	0.01 U
Trichloroethene	0.02	16	1.7	1.7	0.33	0.20	3.0	2.9	0.05	0.52
Tetrachloroethene	0.03	27	3.5	3.5	0.33	0.11	3.5	3.3	1.9	0.03 U

		SAMPLE ID:	SG9928003XF	SG9929003XF	SG9930003XF	SG9931003XF	SG9932003XF	SG9933003XF	SG9934003XF	SG9935003XF
		SITE ID:	SG-99-28	SG-99-29	SG-99-30	SG-99-31	SG-99-32	SG-99-33	SG-99-34	SG-99-35
		DATE SAMPLED:	8/9/99	8/9/99	8/9/99	8/9/99	8/10/99	8/10/99	8/10/99	8/10/99
		DATE ANALYZED:	8/9/99	8/9/99	8/9/99	8/9/99	8/10/99	8/10/99	8/10/99	8/10/99
		UNITS:	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
Compound	RL	I/C VC								
Vinyl chloride	0.01	6.1	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	0.01	0.35	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Trichloroethene	0.02	16	0.02 U	1.1	0.51	0.02 U	1.1	2.3	0.11	0.02 U
Tetrachloroethene	0.03	27	0.03 U	0.05	0.03 U	0.03 U	0.21	1.1	0.13	0.03 U

		SAMPLE ID:	SG9936003XF	SG9937003XF	SG9937003XD	SG9938003XF	SG9939003XF	SG9940003XF	SG9941003XF	SG9942003XF
		SITE ID:	SG-99-36	SG-99-37	SG-99-37	SG-99-38	SG-99-39	SG-99-40	SG-99-41	SG-99-42
		DATE SAMPLED:	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99
		DATE ANALYZED:	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99
		UNITS:	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
Compound	RL	I/C VC								
Vinyl chloride	0.01	6.1	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.06	0.01 U
1,1-Dichloroethene	0.01	0.35	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.15	2.1	0.01 U
Trichloroethene	0.02	16	0.03	0.02 U	0.02 U	0.02 U	0.02 U	1.3	5.7	0.02 U
Tetrachloroethene	0.03	27	0.09	0.03 U	0.03 U	0.05	0.03 U	0.03	1.1	0.03 U

TABLE 2-5
VOCs IN SOIL VAPOR EXCEEDING CTDEP I/C VOLATILIZATION CRITERIA

OU2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

		SAMPLE ID:	SG9943003XF	SG9944003XF	SG9945003XF	SG9946003XF	SG9947003XF	SG9948003XF	SG9948003XD	SG9949003XF
		SITE ID:	SG-99-43	SG-99-44	SG-99-45	SG-99-46	SG-99-47	SG-99-48	SG-99-48	SG-99-49
		DATE SAMPLED:	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99
		DATE ANALYZED:	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99	8/10/99
		UNITS:	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
Compound	**RL**	**I/C VC**								
Vinyl chloride	0.01	6.1	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	1.7	1.6	0.11
1,1-Dichloroethene	0.01	0.35	0.10	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	**5.1**
Trichloroethene	0.02	16	0.54	0.27	0.22	0.09	**16**	1.2	1.1	14
Tetrachloroethene	0.03	27	0.08	0.03 U	0.03 U	0.03 U	0.16	0.46	0.42	0.63

		SAMPLE ID:	SG9950003XF	SG9951003XF	SG9951003XD	SG9952003XF
		SITE ID:	SG-99-50	SG-99-51	SG-99-51	SG-99-52
		DATE SAMPLED:	8/10/99	8/10/99	8/10/99	8/10/99
		DATE ANALYZED:	8/10/99	8/10/99	8/10/99	8/10/99
		UNITS:	ppmv	ppmv	ppmv	ppmv
Compound	**RL**	**I/C VC**				
Vinyl chloride	0.01	6.1	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	0.01	0.35	**4.2**	0.01 U	0.01 U	0.01 U
Trichloroethene	0.02	16	8.1	**110**	**120**	0.02 U
Tetrachloroethene	0.03	27	0.86	0.32	0.33	0.03 U

NOTES:
I/C VC = INDUSTRIAL/COMMERCIAL VOLATILIZATION CRITERIA FOR SOIL VAPOR (CTDEP REMEDIATION STANDARD REGULATION)
RL = REPORTING LIMIT (ppmv)
U = NOT DETECTED ABOVE REPORTING LIMIT
RESULTS IN BOLD AND SHADED EXCEED THE CTDEP INDUSTRIAL/COMMERCIAL VOLATILIZATION CRITERIA FOR SOIL VAPOR

TABLE 3-1
REMOVAL ACTION GOALS

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Media/Location	Removal Action Goal	Source of Goal
Chromium on facility structures	Total Chromium = 210,000 mg/m^2 Hexavalent Chromium = 0.53 mg/m^2	Risk-based clean-up goals developed by HLA
Hexavalent chromium in site groundwater	110 μg/L	CTDEP RSR SWPC
VOCs in indoor air	PCE = 1.61 ppbv TCE = 0.92 ppbv 1,1,1-TCA = 266 ppbv 1,1-DCE = 0.02 ppbv Vinyl chloride = 0.019 ppbv	CTDEP RSR I/C Indoor Air Target Concentrations
VOCs in hot-spot groundwater	PCE = 88 μg/L TCE = 540 μg/L 1,1,1-TCA = 50,000 μg/L 1,1-DCE = 6 μg/L Vinyl chloride = 2 μg/L	The lower of CTDEP RSR I/C VC or CTDEP RSR SWPC

Notes:

CTDEP	=	Connecticut Department of Environmental Protection
DCE	=	dichloroethylene
HLA	=	Harding Lawson Associates
I/C	=	Industrial/Commercial
mg/m^2	=	milligrams per square meter
PCE	=	tetrachloroethylene
ppbv	=	parts per billion by volume
RSR	=	Remediation Standard Regulation
SWPC	=	Surface Water Protection Criteria
TCA	=	trichloroethane
TCE	=	trichloroethylene
μg/L	=	microgram per liter
VC	=	Groundwater Volatilization Criteria
VOC	=	volatile organic compound

TABLE 3-2
CHEMICAL-SPECIFIC ARARs CRITERIA, ADVISORIES, AND GUIDANCE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
GROUNDWATER				
State	Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (CGS §§ 22a-133k; RCSA §§ 22a-133k-1 through 22a-133k-3)	Applicable	Remediation standards have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in soil and groundwater. RCSA § 22a-133k-3 and Appendices D and E provide Surface-Water Protection Criteria and Volatilization Criteria for groundwater. RCSA § 22a-133k-3 also includes provisions to develop Alternate Surface-Water Protection Criteria and Site-specific Volatilization Criteria for groundwater.	The removal action alternatives will provide a reduction in groundwater contaminant concentrations within the groundwater hot-spot areas. It is not anticipated that the removal action alternatives will reduce contaminant concentrations to achieve the RSR criteria because the contaminant concentrations outside the groundwater hot-spot areas will still be in exceedance of the RSR criteria. However, the alternatives are anticipated to be consistent with the long-term groundwater remedy for the Site.
	CTDEP Environmental Land Use Restrictions (CGS §§ 22a-133n through 22a-133r; RCSA § 22a-133q)	Applicable	RCSA § 22a-133q-1 provides requirements for the execution and recording of any environmental land use restriction.	An environmental land use restriction will be implemented in accordance with these requirements.
WASTE MATERIAL				
Federal				
	USEPA Risk Reference Doses (RfDs)	To Be Considered	RfDs are estimates of a daily exposure level for the human population without an appreciable risk of deleterious effects during a lifetime.	These values were used during development of risk-based cleanup goals for indoor building surface decontamination of chromium-contaminated material.
	USEPA Cancer Slope Factors (CSFs)	To Be Considered	CSFs are upper-bound estimates of excess cancer risk per unit of intake over a lifetime.	These values were used during development of risk-based cleanup goals for indoor building surface decontamination of chromium-contaminated material.

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR

Notes:

ARAR	= Applicable or Relevant and Appropriate Requirement
CGS	= Connecticut General Statutes
CSF	= Cancer Slope Factor
CTDEP	= Connecticut Department of Environmental Protection
RCSA	= Regulations of Connecticut State Agencies
RfD	= Reference Dose
USEPA	= United States Environmental Protection Agency
VOC	= volatile organic compound

Groundwater beneath the SAEP site is classified as GB groundwater, which is defined by CTDEP Water Quality Standards as, "Groundwater within a historically highly urbanized area or an area of intense industrial activity and where public water supply service is available. Such groundwater may not be suitable for human consumption without treatment due to waste discharges, spills, or leaks of chemicals or land use impacts." Promulgated federal standards are applicable to groundwater that is or may be used as a source of drinking water. Therefore, the federal standards are not considered applicable for the OU 2 Source Area Non-Time-Critical Removal Action.

Table 3-3
Location-specific ARARs, Criteria, Advisories, and Guidance

OU 2 Engineering Evaluation/Cost Analysis
Stratford Army Engine Plant

Media	Requirement	Status	Requirement Synopsis	Action To Be Taken To Attain ARAR
WETLAND/FLOODPLAINS				
Federal	Flood Plains Management – Executive Order 11988 (40 CFR 6, Appendix A)	Applicable	Under this order, federal agencies are required to avoid long-term and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid support of floodplain development wherever there is a practicable alternative.	Removal action alternatives will be designed and implemented to minimize adverse impacts on the floodplains. If adverse impacts cannot be avoided, appropriate actions will be taken to restore the floodplain.
	Coastal Zone Management Act (16 USC 1451, et seq.)	Applicable	The Coastal Zone Management Act requires activities affecting the coastal zone, including lands therein and thereunder and adjacent shorelands, be conducted in accordance with approved state management programs.	It is not anticipated that the removal action activities will directly affect the coastal waters or intertidal flats of the Housatonic River. However, the removal action alternatives will be designed and implemented to avoid coastal flooding and erosion.
State	Flood Management (CGS §§ 25-68h; RCSA §§ 25-68h-1 through 25-68h-3)	Applicable	This requirement regulates activities in floodplains to minimize flood risk and prevent flood hazards.	Removal action activities will be conducted to minimize impacts on natural coastal resources including the potential impact of coastal flooding and erosion, and damage to and destruction of life and property.
	Coastal Management Act (CGS §§ 22a-90 through 22a-112)	Applicable	This act requires that actions be taken to insure that the development, preservation, or use of land and water resources of the coastal area is conducted without significantly disrupting either the natural environment or sound economic growth.	It is not anticipated that the removal action activities will directly affect the coastal waters or intertidal flats of the Housatonic River. However, the removal action alternatives will be designed and implemented to minimize adverse impacts on natural coastal resources, including the potential impact of coastal flooding and erosion, degradation of tidal wetlands, and alteration of the coastal shoreline.

TA… 3-3
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
OTHER NATURAL RESOURCES				
Federal	National Historic Preservation Act (16 USC 470, et seq.)	Applicable	This act requires that actions be taken to preserve historic properties, recover and preserve artifacts, and minimize harm to National Historic Landmarks.	It is not anticipated that historic properties or artifacts are located within areas where removal action activities will be conducted. However, if historic properties or artifacts are encountered during the removal actions, efforts will be taken to recover and preserve the artifacts and minimize harm to the historic properties in accordance with these requirements.

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CGS = Connecticut General Statutes
RCSA = Regulations of Connecticut State Agencies
USC = United States Code

TABLE 3-4
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
AIR				
Federal	CAA National Emissions for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61)	Relevant and Appropriate	This requirement provides emission standards for specific pollutants for which no ambient air quality standard exists. The NESHAP has been promulgated for specific source types emitting certain pollutants, including vinyl chloride.	Although these standards do not directly apply because the Site does not contain any of the specific source categories regulated, these standards will be considered during design and implementation of removal action activities.
	RCRA Air Emissions Standards for Process Vents (40 CFR 264, Subpart AA)	Relevant and Appropriate	This rule contains pollution emission standards for process vents associated with distillation, fractionation, thin-film extraction, or air or steam stripping. This rule is applicable to operations that manage hazardous wastes with organic concentrations of at least 10 ppmw.	If steam stripping is selected as a treatment method and it involves management of hazardous waste with organic concentrations of at least 10 ppmw in off-gases, equipment used in removal action activities will meet these standards and be monitored for compliance.
	RCRA Air Emissions Standards for Equipment Leaks (40 CFR 264, Subpart BB)	Relevant and Appropriate	This rule contains pollutant emissions standards for equipment leaks at hazardous waste TSDFs. This rule contains design specifications and requirements for monitoring for leak detection for equipment that contains hazardous wastes with organic concentrations of at least 10% by weight.	If groundwater treatment involves management of hazardous wastes in equipment with organic concentrations of at least 10% by weight, equipment will meet the design specifications, and will be monitored for leaks.
State	Connecticut Department of Environmental Protection (CTDEP) Abatement of Air Pollution (CGS Title 22a, Chapter 446(c); RCSA §§ 22a-174-1, et seq.)	Applicable	These regulations require permits to construct and operate specified types of emission sources and contain emission standards that must be met prior to issuance of a permit (RCSA §§22a-174-3 and 22a-174-29). Pollutant abatement controls may be required. Specific standards pertain to fugitive dust (RCSA §22a-174-18(b)) and control of odors (RCSA §22a-174-23)	Air emissions from the treatment systems (e.g., SVE) will meet the emission standards for hazardous air pollutants listed in these regulations. Emission standards for fugitive dust will be met with dust control measures during removal action activities, including excavation and transportation, to comply with substantive requirements.

TABLE 3-4
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
	Noise Pollution Control Act (CGS §22a-69; RCSA §§ 22a-69-1 through 69-7.4)	Applicable	These regulations establish allowable noise levels.	Removal action activities will be conducted to comply with these regulations.
SURFACE WATER				
Federal	Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) (40 CFR Parts 122, 125, 131, and 136)	Applicable	This rule requires permits for the discharge of pollutants from any point source into U.S. waters.	Extracted and treated groundwater will be routed through the on-site Chemical Waste Treatment Plant (CWTP) prior to discharge to surface water. Effluent will meet the CWTP discharge limitations, monitoring requirements, and best management practices.
	CWA National Pretreatment Standards (40 CFR Part 403)	Relevant and Appropriate	This regulation sets pretreatment standards for the introduction of pollutants from non-domestic sources into POTWs. These regulations are designed to control pollutants that pass through, cause interference, or are otherwise incompatible with treatment processes at a POTW.	Any discharge of treated groundwater that goes to the CWTP will meet discharge limitations and pretreatment requirements imposed on POTWs.
State	Water Pollution Control Act (CGS §§22a-416 through 22a-438; RCSA §§22a-430-1 through 22a-430-7)	Applicable	This act requires permits for any discharge of water, substance, or material into the waters of the state.	Extracted and treated groundwater will be routed through the on-site CWTP prior to discharge to surface water. This activity will be conducted in accordance with the requirements of this act (e.g., monitoring requirements and discharge limitations).

TABLE 3-4
POTENTIAL ACTION-SPECIFIC ARARs, CRITERIA, ADVISORIES, AND GUIDANCE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
GROUNDWATER				
Federal	SDWA Underground Injection Control (UIC) Program (40 CFR Parts 144 and 146)	Applicable	These regulations outline minimum program and performance standards for underground injection programs. Technical criteria and standards for siting, operation and maintenance, closure, and reporting and recordkeeping as required for permitting are set forth in Part 146.	Removal action alternatives involving injection wells will be implemented in accordance with the criteria and standards set forth in these regulations.
State	Regulations for the Well Drilling Industry (CGS §§ 25-126 through 131; RCSA §§ 25-126 through 25-131)	Applicable	These regulations specify that non-water supply wells must be constructed so that they are not a source or cause of groundwater contamination. These regulations also include procedures for abandonment of both water wells and other types or wells.	The installation and abandonment of any injection, extraction, or monitoring wells associated with removal action activities will be conducted in accordance with these regulations.
WASTE MATERIAL				
Federal	RCRA Identification and Listing of Hazardous Waste; Toxicity Characteristic (40 CFR 261.24)	Applicable	This requirement defines those wastes that are subject to regulation as hazardous waste under 40 CFR Parts 124 and 264.	Analytical results will be evaluated against the criteria and definitions of hazardous waste. The criteria and definition of hazardous waste will be referred to and utilized in development of alternatives and during removal action actions.
	RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262)	Applicable	These standards govern storage, labeling, accumulation times, and disposal of hazardous waste.	Any hazardous waste generated during removal action activities will be managed in accordance with these standards.
	RCRA Container Storage Requirements (40 CFR Part 264, Subpart I)	Applicable	These requirements apply to owners and operators of facilities that use container storage to store hazardous waste.	If containers are used to store materials that are hazardous wastes, the containers will be managed according to these rules.

TABLE 3-4
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
	RCRA Miscellaneous Units Requirements (40 CFR Part 264, Subpart X)	Applicable	These requirements apply to owners and operators of facilities that treat, store, or dispose of hazardous waste in miscellaneous units.	If miscellaneous units are used to store materials that are hazardous wastes, the units will be managed according to these requirements.
	RCRA Tanks Systems Requirements (40 CFR Part 264, Subpart J)	Applicable	These requirements apply to owners and operators of facilities that use tank systems for storing or treating hazardous waste.	If tank systems are used to store materials that are hazardous wastes, the tank systems will be managed according to these requirements.
	USEPA OSWER Publication 9345.3 - 03 FS, January 1992	To Be Considered	Management of IDW must ensure protection of human health and the environment.	IDW that may be produced from well installation and groundwater sampling will comply with ARARs.
State	CTDEP Hazardous Waste Management (CGS §§ 22a-454 and 22a-449(c); RCSA §§ 22a-449(c)-100 through 110 and 22a-449(c)-11)	Relevant and Appropriate	This regulation specifies requirements for the design, operation, and closure of hazardous waste facilities. This regulation incorporates by reference the RCRA requirements for hazardous waste facilities.	The design of remediation systems and the management of hazardous wastes generated during removal action activities will meet the minimum standards of this regulation.
	CTDEP Solid Waste Management (CGS Title 22a, Chapters 446d and 446k; RCSA §§ 22a-208a-1 and 22a-209-1 through 22a-209-16)	Relevant and Appropriate	These regulations specify requirements for operation and closure of solid waste disposal facilities, including monitoring requirements.	Contaminated soil and debris not regulated as RCRA hazardous waste will be transported to and disposed of at a licensed solid waste disposal facility.
	Guidelines for Soil Erosion and Sediment Control; The Connecticut Council on Soil and Water Conservation	To Be Considered	These guidelines provide technical and administrative guidance for the development, adoption, and implementation of erosion and sediment control program.	These guidelines will be incorporated into any remedial designs for OU 2. Erosion and sediment control measures will be implemented during removal action construction activities.

TABLE 3-4
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR

Notes:

ARAR	=	Applicable or Relevant and Appropriate Requirement
CAA	=	Clean Air Act
CFR	=	Code of Federal Regulations
CGS	=	Connecticut General Statutes
CTDEP	=	Connecticut Department of Environmental Protection
CWA	=	Clean Water Act
CWTP	=	Chemical Waste Treatment Plant
IDW	=	Investigation-Derived Waste
NESHAP	=	National emission Standards for Hazardous Air Pollutants
NPDES	=	National Pollutant Discharge Elimination System
OSWER	=	Office of Solid Waste and Emergency Response
OU	=	Operable Unit
POTW	=	Publicly Owned Treatment Works
ppmw	=	parts per million by weight
RCRA	=	Resource Conservation and Recovery Act
RCSA	=	Regulations of Connecticut State Agencies
SDWA	=	Safe Drinking Water Act
TSDF	=	treatment, storage, disposal facility
UIC	=	Underground Injection Control
USEPA	=	United States Environmental Protection Agency

TABLE 4-1
DESCRIPTION OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Technology Category/Technology	Contaminant	Technology Description
Limited Action		
Groundwater Monitoring	Hex/VOC	Install and sample groundwater monitoring wells to provide information on contaminant distributions and movement in groundwater.
Institutional Controls	Hex/VOC	Implementation of ELURs would restrict the use of groundwater in the vicinity of SAEP for any reason.
Containment		
Slurry Wall	Hex/VOC	Excavate a trench in the overburden and fill it with impervious backfill to provide a low-permeability cutoff wall.
Sheet Piling	Hex/VOC	Install grouted-joint steel sheet piles into the overburden to provide a low-permeability cutoff wall.
In-Situ Treatment		
Air Sparging	VOC	Air sparging removes VOCs and high vapor pressure SVOCs from groundwater and saturated soil by forcing air into the saturated zone and inducing air flow through the soil matrix. Contaminants partition to the air stream, and are transported to the vadose zone where they can be collected by a SVE system, if treatment is required.
Dynamic Underground Stripping	VOC	Steam is forced into an aquifer through injection wells to vaporize VOCs . Vaporized components rise to the unsaturated zone where they can be removed with an SVE system.
Six-phase Heating	VOC	Electric probes are installed in arrays in the subsurface, then heated using a six-phase electric current. The surrounding soil and groundwater are heated such that VOC contaminants are volatilized and rise to the vadose zone where they are collected with an SVE system.
Soil Vapor Extraction	VOC	Contaminated vapors in the vadose zone are collected using a surface vacuum and underground piping and treated on the surface. This technology can also be used to collect vapors generated from air sparging or thermal treatment systems.

TABLE 4-1
DESCRIPTION OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Technology Category/Technology	Contaminant	Technology Description
Passive Treatment Walls	Hex/VOC	A permeable wall is constructed by excavating a trench and backfilling with reactive materials such as iron filings. The wall is placed across the path of contaminated groundwater flow to degrade or sorb contaminants in groundwater.
Recirculation Wells	VOC	Air is injected into a dual-screen well, lifting contaminated groundwater and allowing additional groundwater to flow into the well through the lower screen. VOCs in groundwater are transferred to the air stream and collected using in-well vapor extraction. Partially treated groundwater is forced into the unsaturated zone through the upper screen, and the process is repeated.
Surfactant/Cosolvent Flushing	VOC	A surfactant or cosolvent is injected into the subsurface to increase the solubility of contaminants and reduce interfacial tension, thereby increasing mobility. Groundwater containing increased concentrations of contaminants is then extracted and treated using a pump and treat technology.
Chemical Oxidation (Fenton's Reaction)	VOC	Hydrogen peroxide and a catalyst (usually iron-based) are injected into the subsurface. Hydroxl radicals are generated, which break organic chemical bonds to create carbon dioxide and water. The reaction is complete in approximately two to five days.
Chemical Oxidation (potassium permanganate)	VOC	Potassium permanganate is injected into the subsurface. Permanganate breaks the organic chemical bonds and create carbon dioxide, chlorine, and manganese dioxide.
Chemical Reduction	Hex	Chemicals are injected into the groundwater to change the oxidation-reduction potential in the subsurface and render inorganic contaminants immobile. Reductants that can be used for hexavalent chromium reduction to trivalent chromium include ferrous sulfate and molasses.

TABLE 4-1
DESCRIPTION OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Technology Category/Technology	Contaminant	Technology Description
Enhanced Degradation	VOC	Reagents are added to the subsurface to promote naturally occurring biotic or abiotic degradation mechanisms.
Groundwater Collection		
Extraction Wells	Hex/VOC	Wells are installed to collect groundwater through pumping. Wells are typically installed using augers in unconsolidated soils and completed by placing a well screen and a sandpack to the desired depth.
Ex-situ Treatment		
Activated Carbon	VOC	Activated carbon adsorption is a physical separation process in which contaminants are removed from groundwater by sorption on granular-activated carbon.
Air Stripping	VOC	Air Stripping removes VOCs and high-vapor pressure SVOCs from extracted groundwater by contacting contaminated water with large volumes of air to promote a change from liquid to vapor phase.
Ultraviolet (UV) Oxidation	VOC	UV oxidation involves the simultaneous application of UV radiation and chemical oxidants to degrade low concentrations of aqueous organics. Ozone and hydrogen peroxide have been used as chemical oxidants.
Chemical Waste Treatment Plant (CWTP)	Hex	Transport groundwater containing hexavalent chromium to the SAEP CWTP through discharge to the Building 63 sump. High concentrations may require pre-treatment with sodium metabisulfite.
Discharge		
Outfall 008	Hex/VOC	Groundwater sent to the CWTP for treatment will be discharged to Outfall 008, which empties to the Housatonic River.
Publicly-owned Treatment Works	Hex/VOC	Discharge treated groundwater to the Town of Stratford storm sewer system through an on-site sewer manhole.

Notes:

CWTP = Chemical Waste Treatment Plant
ELURs = Environmental Land Use Restrictions
Hex = hexavalent chromium
SAEP = Stratford Army Engine Plant
SVE = soil vapor extraction
SVOC = semi-volatile organic compound
UV = ultraviolet
VOC = volatile organic compound

TABLE 4-2
SCREENING OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

TECHNOLOGY CATEGORY/TECHNOLOGY	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Limited Action				
Groundwater Monitoring	None.	None.	Retained.	May be used to evaluate potential long-term actions.
Institutional Controls	None.	None.	Retained.	Will prevent the use of groundwater in the vicinity of SAEP for any purpose.
Containment				
Slurry Wall	May require building demolition to complete installation.	Backfill material would need to be designed to consider the possibility of barrier degradation from organic contaminants.	Eliminated.	This technology is not consistent with the definition of a removal action.
Sheet Piling	May require building demolition to complete installation.	Must consider contaminant interaction with steel-piling grout during design.	Eliminated.	This technology is not consistent with the definition of a removal action.

TABLE 4-2
SCREENING OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

TECHNOLOGY CATEGORY/TECHNOLOGY	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
In-situ Treatment				
Air Sparging	Elevated pressures could induce contaminant migration.	High concentrations of inorganics in groundwater may contribute to fouling.	Retained for VOC Hot-spot No. 3.	Would potentially reduce 1,1,1-TCA concentrations in-situ at VOC Hot-spot No. 3.
	Contaminant volatilization may cause an increase in vapors inside SAEP buildings.	High concentrations of organic contaminants would likely require vapor capture and treatment.		Eliminated for other VOC hot-spots because it is not as likely to be effective as thermal treatment options.
	Depth of groundwater contamination may limit the effectiveness of this technology.			
	Vapors generated during stripping may migrate to underground utilities and present an explosion hazard.			
Dynamic Underground Stripping	Contaminant volatilization may cause an increase in vapor concentrations inside SAEP buildings.	High concentrations of inorganics in groundwater may contribute to fouling of the system.	Retained for VOC hotspots.	May be able to use steam generated from the existing SAEP boiler system.
	Vapors generated during stripping may migrate to underground utilities and present an explosion hazard.	High concentrations of organic contaminants would likely require vapor capture and treatment.		

TABLE 4-2
SCREENING OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

TECHNOLOGY CATEGORY/TECHNOLOGY	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Six-phase Heating	Contaminant volatilization may cause an increase in vapor concentrations inside SAEP buildings. Vapors generated during stripping may migrate to underground utilities and present an explosion hazard.	High concentrations of organic contaminants would likely require vapor capture and treatment.	Retained for VOC hotspots.	Electric costs are likely to be high.
Soil Vapor Extraction	High groundwater elevations may cause extraction of water and will likely necessitate the use of horizontal wells.	None.	Retained for VOC hotspots.	This technology would limit the migration of vapors to site buildings. This technology could also be used in conjunction with other technologies.
Passive Treatment Walls	Due to flat gradients, groundwater is not likely to flow through the walls.	High concentrations of inorganics in groundwater may contribute to fouling of system.	Eliminated.	Passive walls are not likely to be effective in the short term due to flat groundwater gradients.

TABLE 4-2
SCREENING OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

TECHNOLOGY CATEGORY/TECHNOLOGY	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Recirculation Wells	The shallow aquifer in the area requiring groundwater treatment may limit the effectiveness of this process. "Reinjection" of partially treated groundwater above the water table may be regulated.	High concentrations of inorganics in groundwater may contribute to fouling of well screens. Vapors generated during stripping may migrate to underground utilities and SAEP buildings.	Eliminated.	No additional advantages with this system versus other technologies. Technology will not effectively reduce VOC vapor concentrations in a short time period.
Surfactant/Cosolvent Flushing	Flat groundwater gradients necessitate the use of injection and extraction wells to create an artificial gradient. Would not be able to discharge directly to the CWTP without pre-treatment for surfactants.	None.	Eliminated.	No additional advantages with this system versus other technologies.
Chemical Oxidation (Fenton's Reaction)	Flat groundwater gradients necessitate the use of injection and extraction wells to create an artificial gradient. Short reaction time (2 - 5 days) may require the use of several injection wells.	Innovative technology that is not well demonstrated.	Eliminated.	Eliminated based on bench-scale treatability testing.

TABLE 4-2
SCREENING OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

TECHNOLOGY CATEGORY/TECHNOLOGY	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
	Pre-treatment of VOCs may be required prior to discharge of extracted groundwater to CWTP.			
Chemical Oxidation (potassium permanganate)	Flat groundwater gradients necessitate the use of injection and extraction wells to create an artificial gradient. Pre-treatment of VOCs may be required prior to discharge of extracted groundwater to CWTP.	Innovative technology that is not well demonstrated.	Retained for VOC Hot-spot Nos. 1 and 2.	This technology will destroy organic contamination (e.g., chlorinated ethenes) in-situ. Retained based on bench-scale treatability testing.
Chemical Reduction	Flat groundwater gradients necessitate the use of injection and extraction wells to create an artificial gradient. Fouling of injection wells due to high concentrations of inorganics is common.	Significant concentrations of manganese dioxide in site soil could cause re-oxidation of hexavalent chromium.	Retained for hexavalent chromium hot-spot.	This technology could provide large reductions in hexavalent chromium concentrations.

TABLE 4-2
SCREENING OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

TECHNOLOGY CATEGORY/TECHNOLOGY	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Enhanced Degradation	Flat groundwater gradients necessitate the use of injection and extraction wells to create an artificial gradient.	Current contaminant concentrations are too high for enhanced degradation to be effective in a short time period.	Eliminated.	This technology will not provide significant reductions in contaminant concentrations in a short time period.
Groundwater Collection				
Extraction Wells	Access to certain areas inside buildings may be limited.	Extraction of high concentrations of VOC contamination without enhancement generally requires long-term operation.	Retained.	This technology will be used in combination with injection wells to maintain hydraulic control for other technologies.
Ex-situ Treatment				
Activated Carbon	Spent carbon may be more toxic than influent water. May require special disposal, regeneration, or destruction.	High concentrations of contaminants may foul the system, requiring frequent replacement or regeneration.	Retained for ex-situ VOC removal.	
Air Stripping	Air stripping would require activated carbon to polish the vapors generated prior to discharge.	High concentrations of inorganics may foul the system.	Eliminated.	No additional advantages over other identified technologies.

TABLE 4-2
SCREENING OF POTENTIAL GROUNDWATER REMOVAL ACTION TECHNOLOGIES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

TECHNOLOGY CATEGORY/TECHNOLOGY	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Chemical Waste Treatment Plant (CWTP)	None.	The CWTP cannot accept surfactants and must comply with the Emergency Discharge Authorization for VOC discharge limits.	Retained.	Groundwater extracted during removal actions can be pre-treated for VOCs and discharged to the CWTP.
<u>Discharge</u>				
Outfall 008	None.	The CWTP, which discharges to Outfall 008, cannot accept surfactants and must comply with the Emergency Discharge Authorization for VOC discharge limits.	Retained.	Groundwater extracted during removal actions can be pre-treated for VOCs and sent to the CWTP for treatment and ultimate discharge to Outfall 008.
Publicly-owned Treatment Works	Discharge area has not been identified; would need to negotiate discharge concentrations and access with the Town of Stratford.	May not be capable of receiving high concentrations of hexavalent chromium and VOCs.	Retained.	May be a cost-effective type of groundwater disposal.

Notes:

CWTP	=	Chemical Waste Treatment Plant	SVOC	=	semi-volatile organic compound
HRC	=	hydrogen release compound	UV	=	ultraviolet
SAEP	=	Stratford Army Engine Plant	VOC	=	volatile organic compound
SVE	=	Soil vapor extraction			

TABLE 5-1
ALTERNATIVE CR-S-1
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components:

- Remove Contaminated Wall
- Rewash, Sandblast, and Paint Beams
- Excavate and Replace Concrete Floor
- Land Use Restrictions

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units		Unit Cost		Present Worth
Wall Demolition, Clean Beams, Demolish/Replace Floor						
Preparation	1	LS	$	49,500	$	49,500
Mobilization	1	LS	$	6,805	$	6,805
Wall Demolition	2,190	SF	$	5	$	11,169
Demolish/Replace Floor & Vapor Barrier	281	CY	$	665	$	186,951
Clean/Sand Blast/Paint Overhead Beams	1,000.0	LF	$	19	$	19,163
Sampling and Analysis	1	LS	$	10,545	$	10,545
Off-Site Disposal	616	Ton	$	74	$	45,400
Equipment Decontamination	1	LS	$	4,875	$	4,875
PPC/PPE	120	Mandays	$	35	$	4,200
Demobilization	1	LS	$	1,900	$	1,900
Home Office Expense	3	Months	$	10,890	$	32,670
Site Office Expense	3	Months	$	34,093	$	102,280
Subtotal					$	475,457
Fee @ 10%					$	47,546
Subtotal					$	523,003
Contingency @ 15%					$	78,450
TOTAL CAPITAL COSTS (YEARS 1&2)					$	601,453

TABLE 5-1
ALTERNATIVE CR-S-1
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

O&M COSTS

Item Description	Years	Unit Cost	Present Worth
Five Year Site Reviews	6	$ 14,795	$ 31,924
Subtotal			$ 31,924
Fee	10%		$ 3,192
Subtotal			$ 35,116
Contingency	15%		$ 5,267
TOTAL O&M COSTS			$ 40,384
TOTAL FOR ALTERNATIVE CR-S-1 (Years 1-30)			**$ 641,837**
Annualized cost			$ 51,723

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.

2. Present worth assumes 7% annual discount rate

3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 5-2
ALTERNATIVE CR-S-2
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components:
- Remove Contaminated Wall
- Rewash, Sandblast, and Paint Beams
- Place Vapor Barrier and Pour a New Concrete Floor
- Land Use Restrictions

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Worth
Wall Demolition, Clean Beams, Vapor Barrier/New Floor				
Preparation	1	LS	$ 49,500	$ 49,500
Mobilization	1	LS	$ 6,805	$ 6,805
Wall Demolition	2,190	SF	$ 5	$ 11,169
Clean/Sand Blast/Paint Overhead Beams	1,000	LF	$ 20	$ 20,123
Sampling and Analysis	1	LS	$ 4,125	$ 4,125
Off-Site Disposal	54	Ton	$ 60	$ 3,250
New Vapor Barrier/Concrete Floor Slab	281	CY	$ 614	$ 172,624
Equipment Decontamination	1	LS	$ 4,875	$ 4,875
PPC/PPE	100	Mandays	$ 35	$ 3,500
Demobilization	1	LS	$ 1,900	$ 1,900
Home Office Expense	3	Months	$ 10,890	$ 32,670
Site Office Expense	3	Months	$ 34,093	$ 102,280
Subtotal				$ 412,820
Fee @ 10%				$ 41,282
Subtotal				$ 454,102
Contingency @ 10%				$ 68,115
TOTAL CAPITAL COSTS (YEARS 1&2)				$ 522,218

TABLE 5-2
ALTERNATIVE CR-S-2
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

O&M COSTS

Item Description	Years	Unit Cost		Present Worth
Five Year Site Reviews	6	$ 14,795	$	31,924
Subtotal			$	31,924
Fee	10%		$	3,192
Subtotal			$	35,116
Contingency	15%		$	5,267
TOTAL O&M COSTS			$	40,384
TOTAL FOR ALTERNATIVE CR-S-2 (Years 1-30)			**$**	**562,601**
Annualized cost			$	45,338

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.

2. Present worth assumes 7% annual discount rate

3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 5-3
ALTERNATIVE CR-GW-1 - IN-SITU REDUCTION
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components:

- Install Extraction Well System
- Install Injection Well System
- Install Chemical Make-up and Delivery System
- Pressure Test Pipeline to CWTP
- Install Organics Treatment System
- Operate System for 1.5 Years

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Worth
In-Situ Reduction				
Preparation	1	LS	$ 194,200	$ 194,200
Mobilization	1	LS	$ 5,650	$ 5,650
Extraction System	4	Wells	$ 15,433	$ 61,730
Injection System	66	Wells	$ 2,954	$ 194,995
Install Monitoring System	72	Wells	$ 1,242	$ 89,415
Chemical Makeup and Delivery System	1	LS	$ 63,061	$ 63,061
Pressure Test Pipeline to CWTP	1	LS	$ 2,356	$ 2,356
Organics Treatment System	1	LS	$ 145,095	$ 145,095
Sampling and Analysis	1	LS	$ 329,868	$ 329,868
Report Preparation	480	Hours	$ 104	$ 50,140
Plant Operation	18	Months	$ 46,638	$ 839,483
Deconstruct Extraction/Injection Systems	48	Wells	$ 459	$ 22,051
Equipment Decontamination	1	LS	$ 4,035	$ 4,035
PPC/PPE	500	Mandays	$ 35	$ 17,500
Demobilization	1	LS	$ 5,650	$ 5,650
Home Office Expense	24	Months	$ 11,067	$ 265,613
Site Office Expense	24	Months	$ 7,571	$ 181,700
Subtotal				$ 2,472,542
Fee	10%			$ 247,254
Subtotal				$ 2,719,796
Contingency	15%			$ 407,969
TOTAL CAPITAL COSTS (YEARS 1&2)				$ 3,127,765

TABLE 5-3
ALTERNATIVE CR-GW-1 - IN-SITU REDUCTION
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

O&M COSTS

Item Description	Years	Unit Cost	Present Worth
Sampling and Analysis: Years 3-30	28	$ 17,538	$ 212,855
Five Year Site Reviews	6	$ 14,795	$ 31,924
Subtotal			$ 244,778
Fee	10%		$ 24,478
Subtotal			$ 269,256
Contingency	15%		$ 40,388
TOTAL O&M COSTS			$ 309,645
TOTAL FOR ALTERNATIVE CR-GW-1 (Years 1-30)			**$ 3,437,410**
Annualized cost			$ 277,008

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.
2. Present worth assumes 7% annual discount rate
3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 5-4
ALTERNATIVE CR-GW-2 PROPOSED MONITORING WELL RATIONALE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

WELL IDENTIFICATION	SCREEN INTERVAL (BGS)	RATIONALE
New 1A	30-35	Upgradient, co-located with New 1B
New 1B	55-60	Upgradient, co-located with New 1A
New 2	30-35	Lateral to plume
New 3A	30-35	Interplume for larger plume, co-located with New 3B
New 3B	55-60	Interplume for larger plume, co-located with New 3A
New 4	30-35	Located to monitor conditions between the two separate plumes – Lateral
New 5	30-35	Located at the downgradient edge of the larger plume to monitor for changes in concentrations
New 6A	30-35	Downgradient, co-located with New 6B
New 6B	55-60	Downgradient, co-located with New 6A
ECD-4	8-18	Existing well, interplume for smaller plume, co-located with PZ-99-04I
PZ-99-04I	30-35	Existing well, interplume for smaller plume, co-located with ECD-4

Notes:
bgs = below ground surface

TABLE 5-5
ALTERNATIVE CR-GW-2 - GROUNDWATER MONITORING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components: Install Groundwater Monitoring Wells
Conduct Groundwater Sampling and Analysis

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Worth
Groundwater Sampling				
Preparation	1	LS	$ 32,300	$ 32,300
Mobilization	1	LS	$ 5,000	$ 5,000
Install Monitoring System	8	Wells	$ 2,028	$ 16,225
Sampling and Analysis	104	Each	$ 1,669	$ 173,536
PPC/PPE	50	Mandays	$ 43	$ 2,150
Demobilization	1	LS	$ 5,000	$ 5,000
Home Office Expense	2	Months	$ 10,890	$ 21,780
Site Office Expense	2	Months	$ 28,552	$ 57,104
Subtotal				$ 313,095
Fee @ 10%				$ 31,310
Subtotal				$ 344,405
Contingency @ 15%				$ 51,661
TOTAL CAPITAL COSTS (YEARS 1&2)				$ 396,065

TABLE 5-5
ALTERNATIVE CR-GW-2 - GROUNDWATER MONITORING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

O&M COSTS

Item Description	Years	Unit Cost	Present Worth
Sampling and Analysis: Years 3-10	8	$ 41,762	$ 217,812
Sampling and Analysis: Years 11-30	20	$ 20,681	$ 111,377
Five Year Site Reviews	6	$ 14,795	$ 31,924
Subtotal			$ 361,113
Fee	10%		$ 36,111
Subtotal			$ 397,224
Contingency	15%		$ 59,584
TOTAL O&M COSTS			$ 456,808
TOTAL FOR ALTERNATIVE CR-GW-1 (Years 1-30)			**$ 852,873**
Annualized cost			$ 68,730

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.

2. Present worth assumes 7% annual discount rate

3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 5-6
ALTERNATIVE VOC-1 PROPOSED MONITORING WELL RATIONALE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

WELL IDENTIFICATION	SCREEN INTERVAL (FT BGS)	RATIONALE
New 1	105-110	Upgradient central, deep well co-located with WC-11S and PZ-11D
New 2	35-40	Interplume shallow (VOC Hot-spot No. 3), co-located with New 3
New 3	140-145	Interplume deep (VOC Hot-spot No. 3), co-located with New 2
New 4	40-45	Interplume deep (TCA Hot-spot), co-located with PZ-99-03
New 5	25-35	Interplume (VOC Hot-spot No. 1)
New 6	25-30	Interplume (VOC Hot-spot No. 2)
New 7A	18-28	Downgradient North (intermediate), co-located with WC-4S and New 7B
New 7B	110-115	Downgradient North (deep), co-located with WC-4S and New 7A
New 8	60-65	Downgradient Central (deep), co-located with MW-4 and WC2-6I
WC5-3S	2-12	Upgradient South (shallow), co-located with WC5-2I and WC5-1D
WC5-2I	30-40	Upgradient South (intermediate), co-located with WC5-3S and WC5-1D
WC5-1D	75-85	Upgradient South (deep), co-located with WC5-3S and WC5-2I
WC-11S	4-14	Upgradient Central (shallow), co-located with PZ-11D and New 1
PZ-11D	24-34	Upgradient Central (intermediate), co-located with WC-11S and New 1
WC-9S	4-14	Upgradient North (shallow), co-located with PZ-9D and WC-9D2
PZ-9D	24-34	Upgradient North (intermediate), co-located with WC-9S and WC-9D2
WC-9D2	145-155	Upgradient North (deep), co-located with WC-9S and PZ-9D
PZ-99-03	4-9	Interplume shallow (TCA Hot-spot), co-located with New 4
PZ-99-02B	30-35	Interplume (VOC Hot-spot No. 1)
PZ-99-04I	30-35	Downgradient/Lateral (VOC Hot-spot No. 1)
PZ-8D	24-34	Downgradient Hot-spot No. 1 and upgradient Hot-spot No. 2, co-located with WC2-3D

TABLE 5-6
ALTERNATIVE VOC-1 PROPOSED MONITORING WELL RATIONALE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

WELL IDENTIFICATION	SCREEN INTERVAL (FT BGS)	RATIONALE
WC2-3D	75-85	Downgradient VOC Hot-spot No. 1 and upgradient VOC Hot-spot No. 2, co-located with PZ-8D
WC-4S	3-13	Downgradient North (shallow), co-located with PZ-4D and New 7
WC2-3I	45-55	Downgradient Central
MW-4	5-15	Downgradient Central (shallow), co-located with WC2-6I and New 8
WC2-6I	40-50	Downgradient Central (intermediate), co-located with MW-4 and New 8
WC-1S	4-14	Downgradient South (shallow), co-located with PZ-1D and WC2-2D
PZ-1D	24-34	Downgradient South (intermediate), co-located WC-1S and WC2-2D
WC2-2D	52-62	Downgradient South (deep), co-located with WC-1S and PZ-1D

Notes:
ft bgs = feet below ground surface

TABLE 5-7
ALTERNATIVE VOC-1 - GROUNDWATER MONITORING/SVE
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components:

- Install Subsurface Vapor Collection Pipes
- Install Vapor Collection and Treatment System
- Operate Indefinately
- Install Groundwater Monitoring Wells
- Conduct Groundwater Sampling and Analysis

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units		Unit Cost		Present Worth
Groundwater Monitoring						
Preparation	1	LS	$	16,900	$	16,900
Mobilization	1	LS	$	18,309	$	18,309
Install Monitoring System	8	Wells	$	2,553	$	20,423
Sampling and Analysis Years 1 and 2	256	Each	$	1,313	$	336,120
PPC/PPE	50	Mandays	$	47	$	2,350
Demobilization	1	LS	$	9,809	$	9,809
Home Office Expense	2	Months	$	10,890	$	21,780
Site Office Expense	2	Months	$	28,552	$	57,104
Subtotal - Groundwater Monitoring					$	482,795
SVE System						
Pilot Test Design	1	LS	$	16,900	$	16,900
Mobilization for Pilot Test	1	LS	$	14,809	$	14,809
Demolish/Replace Floor Slab	7	CY	$	2,917	$	21,606
Pilot Test Treatment System	1	Each	$	23,173	$	23,173
Pilot Test Monitoring Wells, 5 VF Each	15	Wells	$	332	$	4,976
Pilot Test Operation	20	Days	$	2,288	$	45,756
Pilot Test Sampling and Analysis	74	Each	$	150	$	11,100
Full-Scale Alternative Design	1	LS	$	262,000	$	262,000
Full-Scale Alternative Permitting	1	LS	$	354,700	$	354,700
Full-Scale Alternative Mobilization	1	LS	$	1,500	$	1,500
Demolish/Replace Floor Slab	291	CY	$	1,302	$	378,966
SVE Treatment System	1	Each	$	373,744	$	373,744
Monitoring Points, to 5 VF BGS	100	Wells	$	275	$	27,500
Sampling and Analysis - Start-Up	126	Each	$	150	$	18,900
Plant Operation - Start-Up	18	Months	$	2,400	$	43,200
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	500	Mandays	$	35	$	17,500
Demobilization	1	LS	$	8,959	$	8,959
Home Office	24	Months	$	14,421	$	346,113
Site Office - includes Reports	6	Months	$	42,450	$	254,700
SVE Operation and Maintenance - Year 1	1	LS	$	412,465	$	412,465
SVE Operation and Maintenance - Year 2	1	LS	$	234,357	$	234,357
Subtotal - SVE					$	2,876,961

TABLE 5-7
ALTERNATIVE VOC-1 - GROUNDWATER MONITORING/SVE
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units	Unit Cost		Present Worth
Subtotal				$	3,359,755
Fee	10%			$	335,976
Subtotal				$	3,695,731
Contingency	15%			$	554,360
TOTAL CAPITAL COST (YEARS 1&2)				$	4,250,091

O&M COSTS

Item Description	Years		Unit Cost		Present Worth
Sampling and Analysis Years 3 - 10	8	$	81,220	$	423,608
Sampling and Analysis Years 11 - 30	20	$	40,610	$	218,704
SVE Operation and Mainenance - Years 3-30	28	$	234,357	$	2,484,426
Five-Year Site Reviews	6	$	14,795	$	31,924
Subtotal				$	3,158,661
Fee	10%			$	315,866
Subtotal				$	3,474,528
Contingency	15%			$	521,179
TOTAL O&M COSTS				$	3,995,707

TOTAL FOR ALTERNATIVE VOC-1 (Years 1-30)	**$**	**8,245,797**
Annualized cost	$	664,499

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.
2. Present worth assumes 7% annual discount rate
3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 5-8
ALTERNATIVE VOC-2 - GROUNDWATER MONITORING/SVE/IN-SITU OXIDATION/AIR SPARGING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components:

Install Subsurface Vapor Collection Pipes
Install Vapor Collection and Treatment System
Operate Indefinately
Install Groundwater Monitoring Wells
Conduct Groundwater Sampling and Analysis
Install Exctraction Well System
Install Injection Well System
Install Chemical Make-up and Delivery System
Rebuild Chemical Waste Line to Treatment Plant
Install Organics Treatment System
Operate System
Install Air Sparging Wells
Install Subsurface Vapor Collection System
Install Sparg. and Vapor Coll. Mechanical Systems
Operate Until Clean-up Goals are Met

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Worth
Groundwater Monitoring				
Preparation	1	LS	$ 16,900	$ 16,900
Mobilization	1	LS	$ 18,309	$ 18,309
Install Monitoring System	8	Wells	$ 2,553	$ 20,423
Sampling and Analysis Years 1 and 2	256	Each	$ 1,313	$ 336,120
PPC/PPE	50	Mandays	$ 47	$ 2,350
Demobilization	1	LS	$ 9,809	$ 9,809
Home Office Expense	2	Months	$ 10,890	$ 21,780
Site Office Expense	2	Months	$ 28,552	$ 57,104
Subtotal - Groundwater Monitoring				$ 482,795
SVE System				
Pilot Test Design	1	LS	$ 16,900	$ 16,900
Mobilization for Pilot Test	1	LS	$ 14,809	$ 14,809
Demolish/Replace Floor Slab	7	CY	$ 2,917	$ 21,606
Pilot Test Treatment System	1	Each	$ 23,173	$ 23,173
Pilot Test Monitoring Wells, 5 VF Each	15	Wells	$ 332	$ 4,976
Pilot Test Operation	20	Days	$ 2,288	$ 45,756
Pilot Test Sampling and Analysis	74	Each	$ 150	$ 11,100
Full-Scale Alternative Design	1	LS	$ 262,000	$ 262,000
Full-Scale Alternative Permitting	1	LS	$ 354,700	$ 354,700
Full-Scale Alternative Mobilization	1	LS	$ 1,500	$ 1,500
Demolish/Replace Floor Slab	291	CY	$ 1,302	$ 378,966
SVE Treatment System	1	Each	$ 373,744	$ 373,744
Monitoring Points, to 5 VF BGS	100	Wells	$ 275	$ 27,500
Sampling and Analysis - Start-Up	126	Each	$ 150	$ 18,900

TABLE 5-8
ALTERNATIVE VOC-2 - GROUNDWATER MONITORING/SVE/IN-SITU OXIDATION/AIR SPARGING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units	Unit Cost	Present Worth
Plant Operation - Start-Up	18	Months	$ 2,400	$ 43,200
Equipment Decontamination	1	LS	$ 4,035	$ 4,035
PPC/PPE	500	Mandays	$ 35	$ 17,500
Demobilization	1	LS	$ 8,959	$ 8,959
Home Office	24	Months	$ 14,421	$ 346,113
Site Office - includes Reports	6	Months	$ 42,450	$ 254,700
SVE Operation and Maintenance - Year 1	1	LS	$ 412,465	$ 412,465
SVE Operation and Maintenance - Year 2	1	LS	$ 234,357	$ 234,357
Subtotal - SVE				$ 2,876,961
In-Situ Oxidation - Hot Spot No. 1				
Preparation	1	LS	$ 168,950	$ 168,950
Mobilization	1	LS	$ 28,459	$ 28,459
Extraction System	4	Wells	$ 19,409	$ 77,638
Injection System	48	Wells	$ 3,717	$ 178,407
Install Monitoring System	24	Wells	$ 2,956	$ 70,940
Chemical Makeup and Delivery System	1	LS	$ 65,761	$ 65,761
Pressure Test Pipeline to CWTP	1	LS	$ 2,356	$ 2,356
Rebuild Pipeline to CWTP	1,100	LF	$ 31	$ 34,051
Organics Treatment System	1	LS	$ 148,098	$ 148,098
Sampling and Analysis	15,766	Each	$ 23	$ 369,739
Report Preparation	480	Hours	$ 104	$ 50,140
Plant Operation	18	Months	$ 51,204	$ 921,676
Deconstruct Extraction/Injection Systems	34	Wells	$ 669	$ 22,741
Equipment Decontamination	1	LS	$ 4,035	$ 4,035
PPC/PPE	650	Mandays	$ 35	$ 22,750
Demobilization	1	LS	$ 10,459	$ 10,459
Home Office Expense	24	Months	$ 15,126	$ 363,015
Site Office Expense	6	Months	$ 45,533	$ 273,200
Subtotal - In-Situ Oxidation Hot Spot No. 1				$ 2,812,416
In-Situ Oxidation - Hot Spot No. 2				
Preparation	1	LS	$ 32,300	$ 32,300
Extraction System	4	Wells	$ 14,625	$ 58,502
Injection System	30	Wells	$ 3,606	$ 108,179
Install Monitoring System	36	Wells	$ 1,696	$ 61,070
Chemical Makeup and Delivery System	1	LS	$ 65,761	$ 65,761
Organics Treatment System	1	LS	$ 161,997	$ 161,997
Sampling and Analysis	5,350	Each	$ 26	$ 140,556
Report Preparation	320	Hours	$ 106	$ 34,060
Plant Operation	18	Months	$ 34,609	$ 622,954
Deconstruct Extraction/Injection Systems	22	Wells	$ 484	$ 10,651
Equipment Decontamination	1	LS	$ 4,035	$ 4,035

TABLE 5-8
ALTERNATIVE VOC-2 - GROUNDWATER MONITORING/SVE/IN-SITU OXIDATION/AIR SPARGING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units		Unit Cost		Present Worth
PPC/PPE	450	Mandays	$	35	$	15,750
Demobilization -- Covered by Hot Spot No. 1	1	LS	$	-	$	-
Home Office Expense	18	Months	$	11,685	$	210,330
Site Office Expense	6	Months	$	45,533	$	273,200
Subtotal - In-Situ Oxidation Hot Spot No. 2					$	1,799,344
Air Sparging - Hot Spot No. 3						
Pre-Design Investigation	56	Wells	$	506	$	28,335
Sampling and Analysis - Pre-Design	17	Each	$	150	$	2,550
Data Validation	1	LS	$	3,200	$	3,200
Technical Report - Findings	1	LS	$	4,000	$	4,000
Pilot Test Design	1	LS	$	32,300	$	32,300
Mobilization for Pilot Test	1	LS	$	1,500	$	1,500
Demolish/Replace Floor Slab, Pilot Test	2	CY	$	5,197	$	11,549
Pilot Test Treatment System	1	Each	$	19,273	$	19,273
Pilot Test Monitoring System	11	Wells	$	1,514	$	16,658
Pilot Test Operation	25	Days	$	2,724	$	68,090
Pilot Test Sampling and Analysis	116	Each	$	150	$	17,400
Full-Scale Alternative Design	1	LS	$	243,000	$	243,000
Full-Scale Alternative Permitting	1	LS	$	82,700	$	82,700
Full-Scale Alternative Mobilization	1	LS	$	1,500	$	1,500
Air Sparging System Wells	46	Wells	$	1,714	$	78,825
Demolish/Replace Floor Slab, Air Sparging System	46	CY	$	1,070	$	49,199
Demolish/Replace Floor Slab, SVE System	71	CY	$	1,026	$	72,817
Air Sparging Equipment Installation	1	Each	$	172,492	$	172,492
SVE Treatment System Installation	1	Each	$	175,466	$	175,466
Monitoring Points, to 5 VF BGS	150	Wells	$	816	$	122,457
Sampling and Analysis - Start-Up	108	Each	$	150	$	16,200
Plant Operation - Start-Up	2	Months	$	137,868	$	275,736
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	400	Mandays	$	35	$	14,000
Demobilization	1	LS	$	4,150	$	4,150

TABLE 5-8
ALTERNATIVE VOC-2 - GROUNDWATER MONITORING/SVE/IN-SITU OXIDATION/AIR SPARGING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units	Unit Cost	Present Worth
Home Office	6	Months	$ 17,007	$ 102,042
Site Office - includes Reports	6	Months	$ 45,533	$ 273,200
Air Sparging System Operation - Year 1	1	LS	$ 907,805	$ 907,805
Air Sparging System Operation - Year 2	1	LS	$ 423,837	$ 423,837
Subtotal - Air Sparging Hot Spot No. 3				$ 3,224,316
Subtotal				$ 11,195,831
Fee	10%			$ 1,119,583
Subtotal				$ 12,315,414
Contingency	15%			$ 1,847,312
TOTAL CAPITAL COST (YEARS 1&2)				$ 14,162,726

O&M COSTS

Item Description	Years	Unit Cost	Present Worth
Sampling and Analysis Years 3 - 10	8	$ 81,220	$ 423,608
Sampling and Analysis Years 11 - 30	20	$ 40,610	$ 218,704
SVE Operation and Maintenance - Years 3-5	3	$ 234,357	$ 537,189
Air Sparging Operation and Maintenance - Years 3-30	28	$ 327,837	$ 3,475,410
Five-Year Site Reviews	6	$ 14,795	$ 31,924
Subtotal			$ 4,686,834
Fee	10%		$ 468,683
Subtotal			$ 5,155,517
Contingency	15%		$ 773,328
TOTAL O&M COSTS			$ 5,928,845

TOTAL FOR ALTERNATIVE VOC-2 (Years 1-30)	**$ 20,091,571**
Annualized cost	$ 1,619,107

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.

2. Present worth assumes 7% annual discount rate

3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 5-9
ALTERNATIVE VOC-3A - GROUNDWATER MONITORING/SVE/SIX-PHASE HEATING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components:

Install Subsurface Vapor Collection Pipes
Install Vapor Collection and Treatment System
Operate Indefinately
Install Groundwater Monitoring Wells
Conduct Groundwater Sampling and Analysis
Install Thermal Points
Install Electrical Systems
Install Vapor Collection System
Install Monitoring System
Install Vapor Treatment System
Operate System
Verify Treatment

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units		Unit Cost		Present Worth
Groundwater Monitoring						
Preparation	1	LS	$	16,900	$	16,900
Mobilization	1	LS	$	18,309	$	18,309
Install Monitoring System	8	Wells	$	2,553	$	20,423
Sampling and Analysis Years 1 and 2	256	Each	$	1,313	$	336,120
PPC/PPE	50	Mandays	$	47	$	2,350
Demobilization	1	LS	$	9,809	$	9,809
Home Office Expense	2	Months	$	10,890	$	21,780
Site Office Expense	2	Months	$	28,552	$	57,104
Subtotal - Groundwater Monitoring					$	482,795
SVE System						
Pilot Test Design	1	LS	$	16,900	$	16,900
Mobilization for Pilot Test	1	LS	$	14,809	$	14,809
Demolish/Replace Floor Slab	7	CY	$	2,917	$	21,606
Pilot Test Treatment System	1	Each	$	23,173	$	23,173
Pilot Test Monitoring Wells, 5 VF Each	15	Wells	$	332	$	4,976
Pilot Test Operation	20	Days	$	2,288	$	45,756
Pilot Test Sampling and Analysis	74	Each	$	150	$	11,100
Full-Scale Alternative Design	1	LS	$	262,000	$	262,000
Full-Scale Alternative Permitting	1	LS	$	354,700	$	354,700
Full-Scale Alternative Mobilization	1	LS	$	1,500	$	1,500
Demolish/Replace Floor Slab	291	CY	$	1,302	$	378,966
SVE Treatment System	1	Each	$	373,744	$	373,744
Monitoring Points, to 5 VF BGS	100	Wells	$	275	$	27,500
Sampling and Analysis - Start-Up	126	Each	$	150	$	18,900
Plant Operation - Start-Up	18	Months	$	2,400	$	43,200
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	500	Mandays	$	35	$	17,500

TABLE 5-9
ALTERNATIVE VOC-3A - GROUNDWATER MONITORING/SVE/SIX-PHASE HEATING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units		Unit Cost		Present Worth
Demobilization	1	LS	$	8,959	$	8,959
Home Office	24	Months	$	14,421	$	346,113
Site Office - includes Reports	6	Months	$	42,450	$	254,700
SVE Operation and Maintenance - Year 1	1	LS	$	412,465	$	412,465
SVE Operation and Maintenance - Year 2	1	LS	$	234,357	$	234,357
Subtotal - SVE	0	0	$	-	$	2,876,961
Six-Phase Heating - Hot Spot No. 1						
Design	1	LS	$	287,000	$	287,000
Mobilization	1	LS	$	16,809	$	16,809
Installation of Electrodes	97	Each	$	2,581	$	250,340
Installation of Electrical Equipment	1	Lot	$	218,744	$	218,744
Vapor Collection Wells (Same boring as electrodes)	97	Wells	$	120	$	11,640
Collection System Piping	4,300	LF	$	6	$	26,097
Monitoring System	18	Wells	$	2,498	$	44,960
Vapor Treatment Equipment Installation	1	Each	$	150,374	$	150,374
System Operation	200	Days	$	6,389	$	1,277,819
Sampling and Analysis (assumes collection by operators)	584	Each	$	150	$	87,600
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	300	Mandays	$	35	$	10,500
Demobilization	1	LS	$	46,959	$	46,959
Home Office	6	Months	$	16,538	$	99,225
Site Office - includes Reports	6	Months	$	45,533	$	273,200
Subtotal - Six-Phase Heating Hot Spot No. 1					$	2,805,303
Six-Phase Heating - Hot Spot No. 2						
Design - Based on Hot Spot No. 1 as pilot test	1	LS	$	160,500	$	160,500
Mobilization - based on Hot Spot No. 1 as pilot	1	LS	$	3,350	$	3,350
Demolish Building 48	1	LS	$	14,144	$	14,144
Installation of Electrodes	40	Each	$	1,778	$	71,100
Installation of Electrical Equipment	1	Lot	$	219,544	$	219,544
Vapor Collection Wells (Same boring as electrodes)	56	Wells	$	159	$	8,920
Collection System Piping	1,920	LF	$	6	$	12,268
Monitoring System	8	Wells	$	3,728	$	29,820
Vapor Treatment Equipment Installation	1	Each	$	147,374	$	147,374
System Operation	70	Days	$	9,155	$	640,818
Sampling and Analysis (assumes collection by operators)	217	Each	$	150	$	32,550
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	150	Mandays	$	35	$	5,250
Demobilization	1	LS	$	19,350	$	19,350
Home Office	6	Months	$	16,538	$	99,225
Site Office - includes Reports	6	Months	$	45,533	$	273,200
Subtotal - Six-Phase Heating Hot Spot No. 2					$	1,741,450

TABLE 5-9
ALTERNATIVE VOC-3A - GROUNDWATER MONITORING/SVE/SIX-PHASE HEATING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units	Unit Cost	Present Worth
Six-Phase Heating - Hot Spot No. 3				
Pre-Design Investigation	56	Wells	$ 506	$ 28,335
Sampling and Analysis - Pre-Design	17	Each	$ 150	$ 2,550
Data Validation	1	LS	$ 3,200	$ 3,200
Technical Report - Findings	1	LS	$ 4,000	$ 4,000
Design - Based on this being addition to Hot Spot 2	1	LS	$ 82,300	$ 82,300
Installation of Electrodes	262	Each	$ 3,112	$ 815,390
Installation of Electrical Equipment	1	Lot	$ 598,800	$ 598,800
Vapor Collection Wells (Same boring as electrodes)	322	Wells	$ 64	$ 20,608
Collection System Piping	17,680	LF	$ 5	$ 95,684
Monitoring System	46	Wells	$ 2,188	$ 100,650
Vapor Treatment Equipment Installation	1	Each	$ 267,941	$ 267,941
System Operation	365	Days	$ 11,296	$ 4,123,004
Sampling and Analysis (assumes collection by operators)	899	Each	$ 150	$ 134,850
Equipment Decontamination	1	LS	$ 4,035	$ 4,035
PPC/PPE	800	Mandays	$ 35	$ 28,000
Demobilization	1	LS	$ 104,000	$ 104,000
Home Office	12	Months	$ 16,538	$ 198,450
Site Office - based on in addition to Hot Spot 2	12	Months	$ 22,767	$ 273,200
Subtotal - Six-Phase Heating Hot Spot No. 3				$ 6,884,998
Subtotal				$ 14,791,506
Fee	10%			$ 1,605,215
Subtotal				$ 16,396,721
Contingency	15%			$ 2,459,508
TOTAL CAPITAL COST (YEARS 1&2)				$ 18,856,229

TABLE 5-9
ALTERNATIVE VOC-3A - GROUNDWATER MONITORING/SVE/SIX-PHASE HEATING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

O&M COSTS

Item Description	Years		Unit Cost		Present Worth
Sampling and Analysis Years 3 - 10	8	$	81,220	$	423,608
Sampling and Analysis Years 11 - 30	20	$	40,610	$	218,704
SVE Operation and Maintenance - Years 3-5	3	$	234,357	$	537,189
Five-Year Site Reviews	6	$	14,795	$	31,924
Subtotal				$	1,211,424
Fee	10%			$	121,142
Subtotal				$	1,332,567
Contingency	15%			$	199,885
TOTAL O&M COSTS				$	1,532,451
TOTAL FOR ALTERNATIVE VOC-3A (Years 1-30)				**$**	**20,388,681**
Annualized cost				$	1,643,050

Notes:
1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.
2. Present worth assumes 7% annual discount rate
3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 5-10
ALTERNATIVE VOC-3B - GROUNDWATER MONITORING/SVE/DYNAMIC UNDERGROUND STRIPPING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Key Components:
- Install Subsurface Vapor Collection Pipes
- Install Vapor Collection and Treatment System
- Operate Indefinately
- Install Groundwater Monitoring Wells
- Conduct Groundwater Sampling and Analysis
- Install Injection Wells
- Install Steam Generation Equipment
- Install Vapor Collection System
- Install Monitoring System
- Install Vapor Treatment System
- Operate System

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units		Unit Cost		Present Worth
Groundwater Monitoring						
Preparation	1	LS	$	16,900	$	16,900
Mobilization	1	LS	$	18,309	$	18,309
Install Monitoring System	8	Wells	$	2,553	$	20,423
Sampling and Analysis Years 1 and 2	256	Each	$	1,313	$	336,120
PPC/PPE	50	Mandays	$	47	$	2,350
Demobilization	1	LS	$	9,809	$	9,809
Home Office Expense	2	Months	$	10,890	$	21,780
Site Office Expense	2	Months	$	28,552	$	57,104
Subtotal - Groundwater Monitoring					$	482,795
SVE System						
Pilot Test Design	1	LS	$	16,900	$	16,900
Mobilization for Pilot Test	1	LS	$	14,809	$	14,809
Demolish/Replace Floor Slab	7	CY	$	2,917	$	21,606
Pilot Test Treatment System	1	Each	$	23,173	$	23,173
Pilot Test Monitoring Wells, 5 VF Each	15	Wells	$	332	$	4,976
Pilot Test Operation	20	Days	$	2,288	$	45,756
Pilot Test Sampling and Analysis	74	Each	$	150	$	11,100
Full-Scale Alternative Design	1	LS	$	262,000	$	262,000
Full-Scale Alternative Permitting	1	LS	$	354,700	$	354,700
Full-Scale Alternative Mobilization	1	LS	$	1,500	$	1,500
Demolish/Replace Floor Slab	291	CY	$	1,302	$	378,966
SVE Treatment System	1	Each	$	373,744	$	373,744
Monitoring Points, to 5 VF BGS	100	Wells	$	275	$	27,500
Sampling and Analysis - Start-Up	126	Each	$	150	$	18,900
Plant Operation - Start-Up	18	Months	$	2,400	$	43,200
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	500	Mandays	$	35	$	17,500
Demobilization	1	LS	$	8,959	$	8,959

TABLE 5-10
ALTERNATIVE VOC-3B - GROUNDWATER MONITORING/SVE/DYNAMIC UNDERGROUND STRIPPING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units		Unit Cost		Present Worth
Home Office	24	Months	$	14,421	$	346,113
Site Office - includes Reports	6	Months	$	42,450	$	254,700
SVE Operation and Maintenance - Year 1	1	LS	$	412,465	$	412,465
SVE Operation and Maintenance - Year 2	1	LS	$	234,357	$	234,357
Subtotal - SVE					$	2,876,961
Dynamic Underground Stripping - Hot Spot No. 1						
Design	1	LS	$	287,000	$	287,000
Permitting	1	LS	$	82,700	$	82,700
Mobilization	1	LS	$	16,309	$	16,309
Installation of Injection Wells	11	Wells	$	8,427	$	92,700
Installation of Steam Generation Equipment	1	Lot	$	134,615	$	134,615
Vapor Collection Wells	11	Wells	$	9,528	$	104,806
Monitoring System	14	Wells	$	2,386	$	33,400
Liquid & Vapor Treatment Equipment Installation	1	Each	$	175,152	$	175,152
System Operation	200	Days	$	7,059	$	1,411,705
Sampling and Analysis	193	Each	$	150	$	28,950
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	70	Mandays	$	35	$	2,450
Demobilization	1	LS	$	18,209	$	18,209
Home Office	6	Months	$	16,538	$	99,225
Site Office - includes Reports	6	Months	$	45,533	$	273,200
Subtotal - DUS Hot Spot No. 1					$	2,764,457
Dynamic Underground Stripping - Hot Spot No. 2						
Design - Based on Hot Spot 1 being a pilot	1	LS	$	160,500	$	160,500
Permitting -- based on Hot Spot 1 as pilot	1	LS	$	44,050	$	44,050
Mobilization -- based on Hot Spot 1 as pilot	1	LS	$	2,850	$	2,850
Demolish Building 48	1	LS	$	14,144	$	14,144
Installation of Injection Wells	7	Wells	$	4,897	$	34,280
Installation of Steam Generation Equipment	1	Lot	$	134,615	$	134,615
Vapor Collection Wells	1	Wells	$	14,853	$	14,853
Monitoring System	7	Wells	$	2,821	$	19,750
Liquid & Vapor Treatment Equipment Installation	1	Each	$	175,152	$	175,152
System Operation	80	Days	$	6,486	$	518,900
Sampling and Analysis	99	Each	$	150	$	14,850
Equipment Decontamination	1	LS	$	4,035	$	4,035
PPC/PPE	30	Mandays	$	35	$	1,050
Demobilization -- Based on additional to Hot Spot No. 1	1	LS	$	6,600	$	6,600
Home Office	6	Months	$	16,538	$	99,225
Site Office - includes Reports	6	Months	$	45,533	$	273,200
Subtotal - DUS Hot Spot No. 2					$	1,518,055

TABLE 5-10
ALTERNATIVE VOC-3B - GROUNDWATER MONITORING/SVE/DYNAMIC UNDERGROUND STRIPPING CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

CAPITAL AND FIXED COSTS (continued)

Item Description	Quantity	Units	Unit Cost	Present Worth
Dynamic Underground Stripping - Hot Spot No. 3				
Pre-Design Investigation	13	Wells	$ 8,990	$ 116,870
Sampling and Analysis - Pre-Design	17	Each	$ 150	$ 2,550
Data Validation - Pre-Design	1	LS	$ 3,200	$ 3,200
Technical Report - Findings, Pre-Design	1	LS	$ 4,000	$ 4,000
Design - Based on this being addition to Hot Spot 2	1	LS	$ 82,300	$ 82,300
Installation of Injection Wells	7	Wells	$ 25,743	$ 180,200
Installation of Steam Generation Equipment	1	Lot	$ 317,115	$ 317,115
Vapor Collection Wells	19	Wells	$ 12,841	$ 243,973
Monitoring System	26	Wells	$ 2,877	$ 74,800
Liquid & Vapor Treatment Equipment Installation	1	Each	$ 254,152	$ 254,152
System Operation	160	Days	$ 16,396	$ 2,623,283
Sampling and Analysis	495	Each	$ 150	$ 74,250
Equipment Decontamination	1	LS	$ 4,035	$ 4,035
PPC/PPE	90	Mandays	$ 35	$ 3,150
Demobilization -- Based on additional to Hot Spot 1&2	1	LS	$ 17,750	$ 17,750
Home Office	6	Months	$ 33,075	$ 198,450
Site Office - based on in addition to Hot Spot 2	12	Months	$ 22,767	$ 273,200
Subtotal - DUS Hot Spot No. 3				$ 4,473,279
Subtotal				$ 12,115,547
Fee	10%			$ 1,211,555
Subtotal				$ 13,327,102
Contingency	15%			$ 1,999,065
TOTAL CAPITAL COST (YEARS 1&2)				$ 15,326,167

TABLE 5-10
ALTERNATIVE VOC-3B - GROUNDWATER MONITORING/SVE/DYNAMIC UNDERGROUND STRIPPING
CONCEPTUAL COST ESTIMATE

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

O&M COSTS

Item Description	Years	Unit Cost	Present Worth
Sampling and Analysis Years 3 - 10	8	$ 81,220	$ 423,608
Sampling and Analysis Years 11 - 30	20	$ 40,610	$ 218,704
SVE Operation and Maintenance - Years 3-5	3	$ 234,357	$ 537,189
Five-Year Site Reviews	6	$ 14,795	$ 31,924
Subtotal			$ 1,211,424
Fee	10%		$ 121,142
Subtotal			$ 1,332,567
Contingency	15%		$ 199,885
TOTAL O&M COSTS			$ 1,532,451
TOTAL FOR ALTERNATIVE VOC-3B (Years 1-30)			**$ 16,858,619**
Annualized cost			$ 1,358,575

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.

2. Present worth assumes 7% annual discount rate

3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

Table 6-1
Comparative Analysis of Former Chromium Plating Facility Structures Alternatives

OU 2 Engineering Evaluation/Cost Analysis
Stratford Army Engine Plant

Alternative	Threshold Criteria: Overall Protection of Human Health and the Environment	Threshold Criteria: Compliance with ARARs	Balancing Criteria: Long-Term Effectiveness and Permanence	Balancing Criteria: Reduction of Toxicity, Mobility, or Volume through Treatment	Balancing Criteria: Short-Term Effectiveness	Balancing Criteria: Implementability	Balancing Criteria: Cost
Alternative CR-S-1: Removal and Off-site Disposal of Floor and Wall/Decontamination of Beams	Employs engineering controls and institutional controls to reduce risk Removes the majority of contaminated structures and encapsulates residual contamination, if necessary Removes a greater portion of contaminated structures from the facility compared to Alternative CR-S-2	Alternative will be designed to comply with ARARs Will meet chemical-specific ARARs; contamination in excess of risk-based goals removed from site	Will provide long-term effectiveness by removing the majority of contamination from the site Recontamination of the new concrete as a result of leaching from the underlying soil is possible, however unlikely due to the presence of an impermeable barrier Because the majority of contamination is removed from the facility, contaminant reduction is permanent This alternative provides more long-term protection than Alternative CR-S-2 because a majority of contaminated structures will be transported off-site	Does not satisfy CERCLA preference for treatment	Site workers will be protected with a SSHP during alternative implementation Engineering controls will be used, as necessary, to provide worker protection Dump truck covers and dust control measures will be used during debris transport Effects to the environment are not expected Will require 12 weeks to complete alternative	Traditional demolition and construction activities are necessary for completion of the alternative No administrative barriers are anticipated Construction and disposal services are available in the area State and community acceptance will be evaluated following EE/CA review	Removal Action: $601,000 NPW Post-Removal O&M: $40,000
Alternative CR-S-2: Removal and Off-site Disposal of Wall/ Impermeable Cover on Floor/Decontamination of Beams	Employs engineering controls and institutional controls to reduce risk Removes the contaminated wall and encapsulates remaining contamination (floor)	Alternative will be designed to comply with ARARs Placement of a vapor barrier and concrete will eliminate exposure to contamination on the floor	Will provide long-term effectiveness by removing the contaminated wall and providing a physical barrier to remaining contamination Recontamination of the new concrete as a result of leaching from the underlying contaminated concrete is possible, however unlikely due to the presence of an impemeable barrier A large quantity of contamination (the existing floor) will remain on site; however, ELURs and annual maintenance of the new floor will prevent receptor exposure	Does not satisfy CERCLA preference for treatment	Site workers will be protected with a SSHP during alternative implementation Engineering controls will be used, as necessary, to provide worker protection Dump truck covers and dust control measures will be used during debris transport Effects to the environment are not expected Will require 12 weeks to complete alternative	Traditional demolition and construction activities are necessary for completion of the alternative No administrative barriers are anticipated Construction and disposal services are available in the area State and community acceptance will be evaluated following EE/CA review	Removal Action: $522,000 NPW Post-Removal O&M: $40,000

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
EE/CA = Engineering Evaluation/Cost Analysis
ELURs = Environmental Land Use Restrictions
NPW = net present worth
O&M = operation and maintenance
SSHP = Site Safety and Health Plan

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TABLE 6-2
COMPARATIVE ANALYSIS OF HEXAVALENT CHROMIUM GROUNDWATER ALTERNATIVES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

	THRESHOLD CRITERIA		BALANCING CRITERIA				
ALTERNATIVE	OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	COMPLIANCE WITH ARARs	LONG-TERM EFFECTIVENESS AND PERMANENCE	REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT	SHORT-TERM EFFECTIVENESS	IMPLEMENTABILITY	COST
Alternative CR-GW-1: In-situ Reduction using Ferrous Sulfate	Employs contaminated media treatment and institutional controls to reduce and control risks Treatment will reduce hexavalent chromium concentrations to levels protective of human health and the environment ELURs will prevent groundwater use until objectives are met This alternative is more protective than Alternative CR-GW-2 because contamination will be reduced to a less toxic form	Treatment is expected to reduce contaminant concentrations to the CTDEP RSR SWPC Installation and operation of the treatment system will be designed to comply with ARARs	In-situ hexavalent chromium will be chemically reduced to the less toxic trivalent form It is possible for certain subsurface conditions to oxidized trivalent chromium to hexavalent chromium (i.e., reversible process) Treatment of extracted groundwater at the CWTP will irreversibly remove chromium from the medium of concern Chromium sludge generated during ex-situ treatment will be disposed off-site It is anticipated that no residual contamination will remain on-site following treatment	Satisfies CERCLA preference for treatment Is anticipated to effectively treat the entire volume of hexavalent chromium-contaminated groundwater to the CTDEP RSR SWPC In-situ treatment will reduce contaminant toxicity and mobility Ex-situ treatment will reduce contaminant toxicity, mobility, and volume	Groundwater near SAEP is not used or proposed for use for any purpose Short-term risks to site workers during system installation and operation will be controlled with a SSHP Groundwater monitoring will ensure contamination is not migrating toward the tidal flats Monitoring of CWTP discharge will be necessary to ensure discharge is free of contamination Hexavalent chromium concentrations are anticipated to be reduced to RSRs in 2 years	A pilot-scale treatability study demonstrated the effectiveness of in-situ chemical reduction at SAEP A discharge to groundwater permit and a discharge to surface water permit will be required. Permits should be attainable based on pilot-testing at the site Services and materials are available in the area of SAEP This alternative will require a greater amount of design detail than Alternative CR-GW-2 In-situ reduction of hexavalent chromium will require the aquifer to remain in a reduced state to prevent oxidation of trivalent chromium	Removal Action: $3,128,000 NPW Post-Removal O&M: $310,000
Alternative CR-GW-2: Groundwater Monitoring	Employs institutional controls to control risks ELURs will prevent the use of contaminated groundwater Data evaluation will be used in support of future actions designed to provide protection to potential receptors	Installation of the monitoring network and sample collection will be conducted in compliance with ARARs Chemical-specific ARARs will not be met by this alternative; however, data evaluation will be used in support of future remedial actions that if implemented, may attain ARARs	Data evaluation will be used in support of future actions that when implemented will provide receptor protection ELURs will restrict the use of groundwater for any purpose It is estimated that a significant amount of residual contamination will be present following completion of groundwater monitoring	Does not satisfy CERCLA preference for treatment Groundwater monitoring will not reduce contaminant toxicity, mobility, or volume. Data evaluation will be used in support of future remedial actions that when implemented, may result in reductions of toxicity, mobility, or volume	Groundwater near SAEP is not used or proposed for use for any purpose Short-term risks to site workers during monitoring system installation will be controlled with a SSHP Groundwater monitoring will ensure contamination is not migrating toward the tidal flats Monitoring will be conducted for 2 years; RSRs likely will not be met in this time period	Monitoring well installation and sampling is considered technically feasible A discharge to surface water permit will be required for groundwater purged from monitoring wells and discharged to the CWTP for treatment Services and materials are available in the area of SAEP	Removal Action: $396,000 NPW Post-Removal O&M: $457,000

Notes:

ARAR	= Applicable or Relevant and Appropriate Requirement	O&M	= operation and maintenance
CERCLA	= Comprehensive Environmental Response, Compensation, and Liability Act	RSRs	= Remediation Standard Regulations
CTDEP	= Connecticut Department of Environmental Protection	SAEP	= Stratford Army Engine Plant
CWTP	= Chemical Waste Treatment Plant	SSHP	= Site Safety and Health Plan
ELURs	= Environmental Land Use Restrictions	SWPC	= Surface Water Protection Criteria
NPW	= net present worth		

TABLE 6-3
COMPARATIVE ANALYSIS OF VOC GROUNDWATER ALTERNATIVES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

	Threshold Criteria		Balancing Criteria				
Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-term Effectiveness	Implementability	Cost
Alternative VOC-1: In-situ SVE and Groundwater Monitoring	Employs contaminated media treatment, engineering controls, and institutional controls to reduce and control risks Site-wide SVE will prevent contaminated vapors from migrating to site buildings Groundwater monitoring will ensure VOC contamination is not discharging to the tidal flats ELURs will prevent the use of groundwater near SAEP VOC contamination above RSRs will remain in groundwater hot-spots	I/C IATC are anticipated to be met by the site-wide SVE system Chemical-specific ARARs for VOCs in groundwater will not be met within the 2 year timeframe Location- and action-specific ARARs pertaining to this alternative will be met during implementation Future remedial actions will be designed to attain chemical-specific ARARs for residual contamination and areas outside groundwater hot-spots	Operation of the SVE system will control vapor migration to SAEP buildings for as long as the system is operating Removal of contamination from the subsurface is irreversible and permanent Groundwater data will be used to support future remedial actions that when implemented, will provide long-term protection ELURs will prevent the use of groundwater near SAEP	Satisfies CERCLA preference for treatment Contamination removed from the subsurface with the SVE system will be immobilized during carbon treatment, then destroyed during off-site regeneration Removal of contamination from the subsurface is irreversible Significant amounts of residual VOC contamination likely would remain in groundwater hot-spots Future remedial actions will address residual VOC contamination and contamination located outside of the hot-spots	Access to the facility is restricted and activities will be conducted within facility boundaries Groundwater near SAEP is not used or proposed for use for any purpose and ELURs will prevent future use Risks to site workers minimized by a SSHP SVE system operation will provide an immediate improvement to indoor air quality Discharge of contaminated vapors may occur; however, monitoring will be conducted Groundwater monitoring will confirm contamination is not being discharged to the tidal flats	Proposed technologies are well demonstrated The details of SVE well installation will be addressed during system design Implementation will not interfere with future actions Air discharge and surface water discharge permits will be required Necessary services and materials (construction, lab, electricity) are available near SAEP	Removal Action: $4,250,000 NPW Post-Removal O&M: $3,996,000

TABLE 6-3
COMPARATIVE ANALYSIS OF VOC GROUNDWATER ALTERNATIVES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

	THRESHOLD CRITERIA		BALANCING CRITERIA				
ALTERNATIVE	OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	COMPLIANCE WITH ARARS	LONG-TERM EFFECTIVENESS AND PERMANENCE	REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT	SHORT-TERM EFFECTIVENESS	IMPLEMENTABILITY	COST
Alternative VOC2: In-situ Chemical Oxidation using Potassium Permanganate In-situ Air Sparging, In-situ SVE, and Groundwater Monitoring	Employs contaminated media treatment, engineering controls, and institutional controls to reduce and control risks Hot-spot treatment will reduce VOC source area concentrations; although treatment to RSRs likely will not be achieved Site-wide SVE will prevent contaminated vapors from migrating to site buildings Groundwater monitoring will ensure VOC contamination is not discharging to the tidal flats ELURs will prevent the use of groundwater near SAEP	I/C IATC are anticipated to be met by the site-wide SVE system Actions are not anticipated to meet all chemical-specific ARARs within the 2 year timeframe Future remedial actions will be designed to attain chemical-specific ARARs for areas outside groundwater hot-spots Location- and action-specific ARARs pertaining to this alternative will be met during implementation	Hot-spot treatment will reduce VOC source area concentrations; although removal action goals likely will not be met Operation of the SVE system will prevent vapor migration; effective as long as the system is operating Destruction of contamination in-situ or removal of contamination is irreversible and permanent Groundwater data will be used to support future remedial actions that will provide long-term protection ELURs will prevent the use of groundwater near SAEP	Satisfies CERCLA preference for treatment The destruction (oxidation) or removal (sparging/SVE) of hot-spot contamination will result in an irreversible reduction in contaminant toxicity, mobility, and volume Moderate amounts of residual VOC contamination likely would remain in hot-spot groundwater Future remedial actions will address residual VOC contamination and contamination located outside of the hot-spots	Access to the facility is restricted and activities will be conducted within facility boundaries (except for potential discharge to the POTW) Groundwater near SAEP is not used or proposed for use for any purpose and ELURs will prevent future use Risks to site workers during installation and operation minimized by a SSHP Active treatment of hot-spots may increase vapor concentrations in the subsurface, causing potential hazards in underground utilities and structures Injection of air under pressure may cause migration of contamination SVE system operation will provide an immediate improvement to indoor air quality Discharge of contaminated vapors may occur; however, monitoring will be conducted Groundwater monitoring will confirm contamination is not being discharged to the tidal flats	A pilot-scale treatability study was completed at SAEP for in-situ chemical oxidation The details of system installations will be addressed during system designs Implementation will not interfere with future actions Required permits should be attainable Necessary services and materials (construction, lab, electricity) are available near SAEP	Removal Action: $14,163,000 NPW Post-Removal O&M: $5,929,000

TABLE 6-3
COMPARATIVE ANALYSIS OF VOC GROUNDWATER ALTERNATIVES

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

	Threshold Criteria		Balancing Criteria				
Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-term Effectiveness	Implementability	Cost
Alternative VOC-3: In-situ Thermal Treatment, In-situ SVE, and Groundwater Monitoring	Employs contaminated media treatment, engineering controls, and institutional controls to reduce and control risks Hot-spot treatment will reduce VOC source area concentrations; although treatment to RSRs may not be achieved Site-wide SVE will prevent contaminated vapors from migrating to site buildings Groundwater monitoring will ensure VOC contamination is not discharging to the tidal flats ELURs will prevent the use of groundwater near SAEP This alternative will provide for a greater amount of VOC removal from groundwater hot-spots within the 2 year timeframe, as compared to the other alternatives	I/C IATC are anticipated to be met by the site-wide SVE system Thermal treatment may meet chemical-specific ARARs within the 2 year timeframe Future remedial actions will be designed to attain chemical-specific ARARs for areas outside groundwater hot-spots Location- and action-specific ARARs pertaining to this alternative will be met during implementation	Hot-spot treatment will reduce VOC source area concentrations; although removal action goals may not be met Operation of the SVE system will prevent vapor migration; effective as long as the system is operating Destruction and removal of contamination from the subsurface is irreversible and permanent Groundwater data will be used to support future remedial actions that will provide long-term protection ELURs will prevent the use of groundwater near SAEP	Satisfies CERCLA preference for treatment The destruction and removal of contamination will result in an irreversible reduction in contaminant toxicity, mobility, and volume Limited amounts of residual VOC contamination may remain in groundwater hot-spots Future remedial actions will address VOC contamination located outside of the hot-spots This alternative likely will result in the least amount of VOC residual remaining in hot-spots	Access to the facility is restricted and activities will be conducted within facility boundaries Groundwater near SAEP is not used or proposed for use for any purpose and ELURs will prevent future use Risks to site workers during installation and operation minimized by a SSHP Active treatment of hot-spots may increase vapor concentrations in the subsurface, causing potential hazards in underground utilities and structures Injection of air under pressure (DUS only) may cause migration of contamination SVE system operation will provide an immediate improvement to indoor air quality Discharge of contaminated vapors may occur; however, monitoring will be conducted Groundwater monitoring will confirm contamination is not being discharged to the tidal flats	The details of system installations will be addressed during system designs Pilot testing for SPH and DUS will be required to confirm the suitability, as well as the effectiveness, of the technologies under site-specific conditions Implementation will not interfere with future actions Required permits should be attainable Necessary services and materials (construction, lab, electricity) are available near SAEP It has not been confirmed whether there is adequate electrical power available for treatment of all three hot-spots simultaneously. However, electrical capacity at SAEP should be adequate for treatment of individual hot-spots	SPH: Removal Action: $18,856,000 NPW Post-Removal O&M: $1,532,000 DUS: Removal Action: $15,326,000 NPW Post-Removal O&M: $1,532,000

Notes:

ARAR	=	Applicable or Relevant and Appropriate Requirement	POTW	=	publicly-owned treatment works
CERCLA	=	Comprehensive Environmental Response, Compensation, and Liability Act	RSRs	=	Remediation Standard Regulations
CTDEP	=	Connecticut Department of Environmental Protection	SAEP	=	Stratford Army Engine Plant
CWTP	=	Chemical Waste Treatment Plant	SPH	=	Six-phase Heating
DUS	=	Dynamic Underground Stripping	SSHP	=	Site Safety and Health Plan
ELURs	=	Environmental Land Use Restrictions	SWPC	=	Surface Water Protection Criteria
NPW	=	net present worth	VOC	=	volatile organic compound
O&M	=	operation and maintenance			

PLATING FACILITY INTERIOR DECONTAMINATION
RISK-BASED CLEANUP GOALS

TABLE
RISK ASSESSMENT
RESIDENTIAL EXPOSURE
INDOOR BUILDING SURFACE DECONTAMINATION
BUILDING B-2 CHROMIUM PLATING FACILITY
STRATFORD ARMY ENGINE PLANT, STRATFORD, CONNECTICUT

CPC	EPC	CANCER RISK				HAZARD INDEX						
	(mg/m2)	Oral	Inhalation*	Dermal	Total	Oral-Chr	Oral-Sub	Inh-Chr	Inh-Sub	Der-Chr	Der-Sub	Total
Chromium, Total	210,000	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	1.20E+01	1.92E+01			1.95E+00	2.24E+00	**33.11**
Chromium VI	0.53	0.00E+00	6.48E-06	0.00E+00	**6.48E-06**	1.01E-02	1.61E-02	3.18E-02	5.10E-02	3.69E-03	4.25E-03	**0.11**
Total		**0E+00**	**6E-06**	**0E+00**	**6.48E-06**	**1E+01**		**3E-02**		**2E+00**		**33.23**

* EPC is multiplied by a resuspension factor of 1E-05

Source: Risk calculations taken from *Revised Indoor Risk Assessment for Mixed Use Scenario, Chemical Decontamination of Indoor Building Surfaces, U.S. Army Research Laboratory, Watertown, Massachusetts* (ABB Environmental Services, Inc, July 1996) and updated by R.F. Weston in 1997 as part of the Indoor Remediation of Building Surfaces.

TABLE A-1
RISK ASSESSMENT
COMMERCIAL EXPOSURE
INDOOR BUILDING SURFACE DECONTAMINATION
BUILDING B-2 CHROMIUM PLATING FACILITY
STRATFORD ARMY ENGINE PLANT, STRATFORD, CONNECTICUT

CPC	EPC	CANCER RISK				HAZARD INDEX			
	(mg/m2)	Oral	Inhalation*	Dermal	Total	Oral	Inhalation*	Dermal	Total
Chromium, Total	210,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-01		7.78E-01	0.98
Chromium VI	0.53	0.00E+00	1.49E-06	0.00E+00	1.49E-06	1.73E-04	3.50E-03	1.47E-03	0.01
Total		0E+00	1E-06	0E+00	1.49E-06	2E-01	3E-03	8E-01	0.99

* EPC is multiplied by a resuspension factor of 1E-05

Source: Risk calculations taken from *Revised Indoor Risk Assessment for Mixed Use Scenario, Chemical Decontamination of Indoor Building Surfaces, U.S. Army Research Laboratory, Watertown, Massachusetts* (ABB Environmental Services, Inc, July 1996) and updated by R.F. Weston in 1997 as part of the Indoor Remediation of Building Surfaces.

TABLE A-2
RISK ASSESSMENT
RENOVATION WORKER EXPOSURE
INDOOR BUILDING SURFACE DECONTAMINATION
BUILDING B-2 CHROMIUM PLATING FACILITY
STRATFORD ARMY ENGINE PLANT, STRATFORD, CONNECTICUT

CPC	EPC (mg/m2)	CANCER RISK Oral	CANCER RISK Inhalation*	CANCER RISK Dermal	Total	HAZARD INDEX Oral	HAZARD INDEX Inhalation*	HAZARD INDEX Dermal	Total
Chromium, Total	210,000	0.0E+00	0.0E+00	0.0E+00	0.00E+00	2.1E-01		0.0E+00	0.21
Chromium VI	0.53	0.0E+00	1.2E-06	0.0E+00	1.24E-06	1.7E-04	7.3E-02	0.0E+00	0.07
Total		0E+00	1E-06	0E+00	1.24E-06	2E-01	7E-02	0E+00	0.28

* EPC is multiplied by a resuspension factor of 1E-04

Source: Risk calculations taken from *Revised Indoor Risk Assessment for Mixed Use Scenario, Chemical Decontamination of Indoor Building Surfaces, U.S. Army Research Laboratory, Watertown, Massachusetts* (ABB Environmental Services, Inc, July 1996) and updated by R.F. Weston in 1997 as part of the Indoor Remediation of Building Surfaces.

Population	ORAL			INHALATION			DERMAL		
	Subchronic	Chronic	Lifetime	Subchronic	Chronic	Lifetime	Subchronic	Chronic	Lifetime
Commercial	0.00E+00	9.78E-07	3.49E-07	0.00E+00	1.88E-02	6.71E-03	0.00E+00	9.26E-05	3.31E-05
Renovation	9.78E-07	0.00E+00	1.40E-08	3.91E-02	0.00E+00	5.59E-04	0.00E+00	0.00E+00	0.00E+00
Resident	9.13E-05	5.71E-05	9.72E-06	2.74E-01	1.71E-01	2.91E-02	2.67E-04	2.32E-04	9.19E-05

Chemical	Oral Subchronic RfD	Oral Chronic RfD	Oral Slope Factor	Inhalation Subchronic RfD	Inhalation Chronic RfD	Inhalation Slope Factor	Dermal Subchronic RfD	Dermal Chronic RfD	Dermal Slope Factor	noncancer ABS-s	cancer ABS-c
2,4-Dinitrotoluene	2.0E-03	2.0E-03	6.8E-01	0.0E+00	0.0E+00	0.0E+00	2.0E-03	2.0E-03	6.8E-01	1.3E-01	1.3E-01
2-Methylnaphthalene	4.0E-02	4.0E-02	0.0E+00	2.0E-02	2.0E-02	0.0E+00	4.0E-02	4.0E-02	0.0E+00	1.0E-01	1.0E-01
4,4'-DDD	0.0E+00	0.0E+00	2.4E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.4E-01	2.0E-01	2.0E-01
4,4'-DDE	0.0E+00	0.0E+00	3.4E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.4E-01	2.0E-01	2.0E-01
4,4'-DDT	5.0E-04	5.0E-04	3.4E-01	0.0E+00	0.0E+00	3.4E-01	5.0E-04	5.0E-04	3.4E-01	2.0E-01	2.0E-01
Acenaphthene	6.0E-01	6.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-01	6.0E-02	0.0E+00	2.0E-01	2.0E-01
Acenaphthylene	4.0E-02	4.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	0.0E+00	1.8E-01	1.8E-01
Aldrin	3.0E-05	3.0E-05	1.7E+01	0.0E+00	0.0E+00	1.7E+01	3.0E-05	3.0E-05	1.7E+01	2.5E-01	2.5E-01
Aluminum	1.0E+00	1.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E+00	1.0E-01	0.0E+00	1.0E-03	1.0E-03
Anthracene	3.0E+00	3.0E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.0E+00	3.0E-01	0.0E+00	2.9E-01	2.9E-01
Antimony	4.0E-04	4.0E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-04	4.0E-04	0.0E+00	1.0E-01	1.0E-01
Arsenic	3.0E-04	3.0E-04	1.5E+00	8.6E-07	8.6E-07	1.5E+01	3.0E-04	3.0E-04	1.8E+00	3.0E-02	3.0E-02
Barium	7.0E-02	7.0E-02	0.0E+00	1.4E-03	1.4E-04	0.0E+00	7.0E-02	7.0E-02	0.0E+00	1.0E-03	1.0E-03
Benzo(a)Anthracene	4.0E-02	4.0E-02	7.3E-01	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	7.3E-01	1.8E-01	2.0E-01
Benzo(a)Pyrene	4.0E-02	4.0E-02	7.3E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	7.3E+00	1.8E-01	2.0E-01
Benzo(b)Fluoranthene	4.0E-02	4.0E-02	7.3E-01	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	7.3E-01	1.8E-01	2.0E-01
Benzo(g,h,i)perylene	4.0E-02	4.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	0.0E+00	1.8E-01	1.8E-01
Benzo(k)Fluoranthene	4.0E-02	4.0E-02	7.3E-02	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	7.3E-02	1.8E-01	1.0E-02
Beryllium	5.0E-03	5.0E-03	4.3E+00	2.9E-05	2.9E-05	8.4E+00	5.0E-03	5.0E-03	8.6E+02	3.0E-02	3.0E-02
bis(2-Ethylhexyl)phthalate	2.0E-02	2.0E-02	1.4E-02	0.0E+00	0.0E+00	0.0E+00	2.0E-02	2.0E-02	1.4E-02	2.0E-02	2.0E-02
Butylbenzylphthalate	2.0E+00	2.0E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.0E+00	2.0E-01	0.0E+00	2.5E-01	2.5E-01
Cadmium	5.0E-04	5.0E-04	0.0E+00	5.7E-06	5.7E-06	6.3E+00	5.0E-04	5.0E-04	0.0E+00	1.4E-01	1.4E-01
Chromium VI	3.0E-03	3.0E-03	0.0E+00	2.9E-05	2.9E-05	4.2E+01	3.0E-03	3.0E-03	0.0E+00	9.0E-02	9.0E-02
Chromium, Total	1.0E+00	1.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E+00	1.0E+00	0.0E+00	4.0E-02	4.0E-02
Chrysene	4.0E-02	4.0E-02	7.3E-03	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	7.3E-03	1.8E-01	2.0E-01
Cobalt	6.0E-02	1.8E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-03	1.8E-02	0.0E+00	1.0E-03	1.0E-03
Cyanide	2.0E-02	2.0E-02	0.0E+00	2.9E-04	2.0E-03	0.0E+00	2.0E-02	2.0E-02	0.0E+00	3.0E-01	3.0E-01
Di-n-butylphthalate	1.0E+00	1.0E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E+00	1.0E-01	0.0E+00	0.0E+00	0.0E+00
Di-n-octylphthalate	2.0E-02	2.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.0E-02	2.0E-02	0.0E+00	0.0E+00	0.0E+00
Dibenz(a,h)Anthracene	4.0E-02	4.0E-02	7.3E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	7.3E+00	8.0E-02	9.0E-02
Dieldrin	5.0E-05	5.0E-05	1.6E+01	0.0E+00	0.0E+00	1.6E+01	5.0E-05	5.0E-05	1.6E+01	2.5E-01	2.5E-01
Diisopropylmethylphosphonate	8.0E-02	8.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.0E-02	8.0E-02	0.0E+00	1.0E-01	1.0E-01
1,3-Dinitrobenzene	1.0E-03	1.0E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E-03	1.0E-04	0.0E+00	1.0E-02	1.0E-02
2,4-Dinitrotoluene	2.0E-03	2.0E-03	6.8E-01	0.0E+00	0.0E+00	0.0E+00	2.0E-03	2.0E-03	6.8E-01	1.3E-01	1.3E-01
Endosulfan I	6.0E-03	6.0E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-03	6.0E-03	0.0E+00	1.0E-02	1.0E-02
Endosulfan II	6.0E-03	6.0E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-03	6.0E-03	0.0E+00	1.0E-02	1.0E-02
Endrin	3.0E-04	3.0E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.0E-04	3.0E-04	0.0E+00	2.5E-01	2.5E-01
Endrin Ketone	3.0E-04	3.0E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.0E-04	3.0E-04	0.0E+00	1.0E-02	1.0E-02
Fluoranthene	4.0E-01	4.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-01	4.0E-02	0.0E+00	2.0E-01	2.0E-01
Fluorene	4.0E-01	4.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-01	4.0E-02	0.0E+00	2.0E-01	2.0E-01
Heptachlor	5.0E-04	5.0E-04	4.5E+00	2.0E-04	2.0E-04	4.5E+00	5.0E-04	5.0E-04	4.5E+00	2.0E-01	2.0E-01

Chemical	Oral Subchronic RfD	Oral Chronic RfD	Oral Slope Factor	Inhalation Subchronic RfD	Inhalation Chronic RfD	Inhalation Slope Factor	Dermal Subchronic RfD	Dermal Chronic RfD	Dermal Slope Factor	noncancer ABS-s	cancer ABS-c
Heptachlor Epoxide	1.3E-05	1.3E-05	9.1E+00	0.0E+00	0.0E+00	9.1E+00	1.3E-05	1.3E-05	9.1E+00	2.0E-01	2.0E-01
Indeno(1,2,3-c,d)Pyrene	4.0E-02	4.0E-02	7.3E-01	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	7.3E-01	1.8E-01	2.0E-01
Isodrin	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Lindane	3.0E-03	3.0E-04	1.3E+00	0.0E+00	0.0E+00	0.0E+00	3.0E-03	3.0E-04	1.3E+00	1.0E-02	1.0E-02
Mercury	3.0E-04	3.0E-04	0.0E+00	8.6E-05	8.6E-05	0.0E+00	3.0E-04	3.0E-04	0.0E+00	5.0E-02	5.0E-02
Methoxychlor	5.0E-03	5.0E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.0E-03	5.0E-03	0.0E+00	0.0E+00	0.0E+00
Naphthalene	4.0E-02	4.0E-02	0.0E+00	2.0E-02	2.0E-02	0.0E+00	4.0E-02	4.0E-02	0.0E+00	1.0E-01	1.0E-01
Nickel	2.0E-02	2.0E-02	0.0E+00	2.9E-04	2.9E-04	8.4E-01	2.0E-02	2.0E-02	0.0E+00	3.5E-01	3.5E-01
Nitrite/Nitrate	1.6E+00	1.6E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.6E+00	1.6E+00	0.0E+00	1.0E-03	1.0E-03
2-Nitrotoluene	1.0E-01	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E-01	1.0E-02	0.0E+00	1.0E-02	1.0E-02
3-Nitrotoluene	1.0E-01	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E-01	1.0E-02	0.0E+00	1.0E-02	1.0E-02
4-Nitrotoluene	1.0E-01	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E-01	1.0E-02	0.0E+00	1.0E-02	1.0E-02
Aroclor-1254	2.0E-05	2.0E-05	2.0E+00	5.7E-06	5.7E-06	2.0E+00	2.0E-05	2.0E-05	2.0E+00	6.0E-02	6.0E-02
Aroclor-1260	2.0E-05	2.0E-05	2.0E+00	5.7E-06	5.7E-06	2.0E+00	2.0E-05	2.0E-05	2.0E+00	6.0E-02	6.0E-02
Phenanthrene	4.0E-02	4.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-02	4.0E-02	0.0E+00	1.8E-01	1.8E-01
Pyrene	3.0E-01	3.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.0E-01	3.0E-02	0.0E+00	2.0E-01	2.0E-01
RDX	3.0E-03	3.0E-03	1.1E-01	0.0E+00	0.0E+00	0.0E+00	3.0E-03	3.0E-03	1.1E-01	1.0E-02	1.0E-02
Silver	5.0E-03	5.0E-03	0.0E+00	4.6E-05	4.0E-05	0.0E+00	5.0E-03	5.0E-03	0.0E+00	2.5E-01	2.5E-01
Thiodiglycol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Vanadium	7.0E-03	7.0E-03	0.0E+00	2.9E-04	2.9E-04	0.0E+00	7.0E-03	7.0E-03	0.0E+00	1.0E-03	1.0E-03

DETAILED COST ESTIMATES

APPENDIX B
COST DETAIL
ENGINEERING EVALUATION/COST ANALYSIS
FOR THE OU 2 SOURCE AREAS
STRATFORD ARMY ENGINE PLANT

LIST OF FIGURES

Figure	Title
B-1	Alternative CR-S-1
B-2	Alternative CR-S-2
B-3	Alternative CR-GW-1
B-4	Alternative CR-GW-2
B-5	VOC Groundwater Monitoring
B-6	SVE
B-7	SVE Operation Year 1
B-8	SVE Operation Year 2
B-9	SVE Operation Years 3-30
B-10	In-Situ Oxidation Hot Spot No. 1
B-11	In-Situ Oxidation Hot Spot No. 2
B-12	Air Sparging Hot Spot No. 3
B-13	Air Sparging Operation, Hot Spot No. 3 Year 1
B-14	Air Sparging Operation, Hot Spot No. 3 Year 2
B-15	Air Sparging Operation, Hot Spot No. 3 Years 3-30
B-16	Six-Phase Heating, Hot Spot No. 1
B-17	Six-Phase Heating, Hot Spot No. 2
B-18	Six-Phase Heating, Hot Spot No. 3
B-19	Dynamic Underground Stripping, Hot Spot No. 1
B-20	Dynamic Underground Stripping, Hot Spot No. 2
B-21	Dynamic Underground Stripping, Hot Spot No. 3

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation								
Structural Analysis w/ Report								
Structural Engineer, P.E.	15	Hours	200.00	3,000	0	0	0	3,000
Other Engineering Support	105	Hours	100.00	10,500	0	0	0	10,500
Other non-Engineer Support	40	Hours	40.00	1,600	0	0	0	1,600
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
Design & Planning								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
TOTAL - Preparation	1	LS		44,700	0	0	4,800	49,500
Mobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Construct Stockpile Area								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Haybales, Covers, etc.	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Mobilization								
Move-in T-L-B & Demol. Hammer	1	LS	600.00	0	0	0	600	600
Move-in Air Compressor, Sandpot, etc.	1	LS	500.00	0	0	0	500	500
Move-in Boomlift	1	LS	250.00	0	0	0	250	250
Move-in Pressure Washer, Torches, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Mobilization	1	LS		2,125	280	2,500	1,900	6,805
Wall Demolition								
Northwesternmost Wall, 2190 SF, 8"CMU								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	80	Hours	32.72	2,618	0	0	0	2,618
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Demolition Hammer	20	Hours	28.00	0	560	0	0	560
Torches, Gases, etc.	2	Days	200.00	0	0	400	0	400
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
New Building Entry/Exit Doors, 3 Each								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Torches, Gases, etc.	1	Days	200.00	0	0	200	0	200
New Hollow Metal Frames, Doors & Hardware	3	Each	350.00	0	0	1,050	0	1,050
TOTAL - Wall Demolition	2,190	SF		5,899	1,120	4,150	0	11,169
Demolish/Replace Floor, t=6", 15,200 SF								
Electrical Disconnects/Remove Control Boxes	1	LS	1,500.00	0	0	0	1,500	1,500
Remove Elevator Platforms, 2 Each								
Labor Foreman	35	Hours	34.05	1,192	0	0	0	1,192
Laborer	35	Hours	32.72	1,145	0	0	0	1,145
Operator	35	Hours	47.51	1,663	0	0	0	1,663
Tractor-Loader-Backhoe	35	Hours	28.00	0	980	0	0	980
Remove Sump Covers, 12 Each								
Labor Foreman	21	Hours	34.05	715	0	0	0	715
Laborer	21	Hours	32.72	687	0	0	0	687
Operator	21	Hours	47.51	998	0	0	0	998
Tractor-Loader-Backhoe	21	Hours	28.00	0	588	0	0	588
Well Abandonment	13	Each	1,500.00	0	0	0	19,500	19,500
Well Extensions	12	Each	500.00	0	0	0	6,000	6,000
Sawcut Perimeter @ Existing Walls	600	LF	3.00	0	0	0	1,800	1,800
Break-up Floor Slab/Haul to Stockpile, 281 CY								
Labor Foreman	100	Hours	34.05	3,405	0	0	0	3,405
Laborers	100	Hours	32.72	3,272	0	0	0	3,272
Operator	100	Hours	47.51	4,751	0	0	0	4,751
Tractor-Loader-Backhoe	100	Hours	28.00	0	2,800	0	0	2,800
Demolition Hammer	100	Hours	28.00	0	2,800	0	0	2,800
Torches, Gases, etc.	10	Days	200.00	0	0	2,000	0	2,000
Tandem Axle Dump Truck & Driver	100	Hours	60.60	3,560	2,500	0	0	6,060
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
New Vapor Barrier, 40 mill HDPE, Seamed, Booted	15,200	SF	0.50	0	0	0	7,600	7,600

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Formwork/Welded Wire Fabric								
Carpenter/IW Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Carpenter/IW	30	Hours	37.00	1,110	0	0	0	1,110
Forms	1	LS	2,500.00	0	0	0	2,500	2,500
Welded Wire Fabric	15,200	SF	0.15	0	0	0	2,280	2,280
Place Concrete Floor Slab								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	120	Hours	32.72	3,927	0	0	0	3,927
Cement Mason Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Cement Mason	30	Hours	37.00	1,110	0	0	0	1,110
Concrete, 3000 psi, 3/4" Aggregate	295	CY	70.00	0	0	20,650	0	20,650
Project Engineer/HSO	520	Hours	77.00	40,040	0	0	0	40,040
Q.C. Engineer	520	Hours	77.00	40,040	0	0	0	40,040
TOTAL - Demolish/Replace Floor	281	CY		110,953	9,668	25,150	41,180	186,951
Clean Overhead Beams								
Mobilize/Demobilize	1	LS	2,500.00	0	0	0	2,500	2,500
Steam Washing of Overhead Beams								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Boomlift	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
Sand Blast Overhead Beams								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Boomlift	30	Hours	10.00	0	300	0	0	300
Air Compressor, Sandblast Gun, Sandpot, etc.	30	Hours	40.00	0	1,200	0	0	1,200
Paint Overhead Beams								
Painter Foreman	40	Hours	34.05	1,362	0	0	0	1,362
Painter	40	Hours	32.72	1,309	0	0	0	1,309
Boomlift	40	Hours	10.00	0	400	0	0	400
Paint	25	Gallons	30.00	0	0	750	0	750

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Final Steam Cleaning of Building								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Pressure Washer	30	Hours	10.00	0	300	0	0	300
Boomlift	30	Hours	10.00	0	300	0	0	300
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Clean Overhead Beams	1,000	LF		8,013	2,900	5,750	2,500	19,163
Sampling and Analysis								
Off-Site disposal Characterization Sample Analysis								
VOCs	17	Each	150.00	0	0	0	2,550	2,550
Total Chromium	17	Each	15.00	0	0	0	255	255
Hexavalent Chromium	17	Each	35.00	0	0	0	595	595
TCLP VOCs	17	Each	150.00	0	0	0	2,550	2,550
TCLP Metals	17	Each	135.00	0	0	0	2,295	2,295
Cyanide	17	Each	50.00	0	0	0	850	850
Wipe Sample Analysis - Overhead Beams								
Total Chromium	8	Each	15.00	0	0	0	120	120
Hexavalent Chromium	8	Each	35.00	0	0	0	280	280
Air Monitoring Sample Analysis								
VOCs	10	Each	75.00	0	0	0	750	750
Total Chromium	10	Each	15.00	0	0	0	150	150
Dust	10	Each	15.00	0	0	0	150	150
TOTAL - Sampling and Analysis	1	LS		0	0	0	10,545	10,545

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Off-Site Disposal								
RCRA Non-Hazardous Materials								
Wall	43	Ton	50.00	0	0	0	2,150	2,150
Floor	281	Ton	50.00	0	0	0	14,050	14,050
RCRA Hazardous Materials								
Wall	11	Ton	100.00	0	0	0	1,100	1,100
Floor	281	Ton	100.00	0	0	0	28,100	28,100
TOTAL - Off-Site Disposal	616	Ton		0	0	0	45,400	45,400
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Boomlift	20	Hours	42.00	0	840	0	0	840
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	1,040	2,500	0	4,875
PPC/PPE								
PPC/PPE, Mandays	120	Mandays	35.00	0	0	4,200	0	4,200
TOTAL - PPC/PPE	120	Mandays		0	0	4,200	0	4,200
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Equipment Demobilization								
Move-out T-L-B & Demol. Hammer	1	LS	600.00	0	0	0	600	600
Move-out Air Compressor, Sandpot, etc.	1	LS	500.00	0	0	0	500	500
Move-out Boomlift	1	LS	250.00	0	0	0	250	250
Move-out Pressure Washer, Torches, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Demobilization	1	LS		0	0	0	1,900	1,900

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office								
Project Manager	120	Hours	148.50	17,820	0	0	0	17,820
Other Personnel	150	Hours	99.00	14,850	0	0	0	14,850
TOTAL - Home Office	3	Months		32,670	0	0	0	32,670
Site Office - includes Final Report & Land Use Restrictions								
Project Superintendent	520	Hours	99.00	51,480	0	0	0	51,480
Per Diems	270	Days	100.00	0	0	0	27,000	27,000
Project Vehicles	1,560	Hours	7.50	0	11,700	0	0	11,700
Storage Box	6	Months	100.00	0	0	0	600	600
Copier, Fax, Computers	3	Months	500.00	0	0	0	1,500	1,500
Surveyor	1	LS	10,000.00	0	0	0	10,000	10,000
TOTAL - Site Office	3	Months		51,480	11,700	0	39,100	102,280

TABLE B-1
ALTERNATIVE CR-S-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Five-Year Site Reviews								
Engineering Manager, P.E.	8	Hours	200.00	1,600	0	0	0	1,600
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	20	Hours	40.00	800	0	0	0	800
Computers, etc.	80	Hours	10.00	0	0	0	800	800
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
Travel to Site	300	Miles	0.32	0	0	0	95	95
TOTAL - Five Year Review	1	Report		12,400	0	0	2,395	14,795

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation								
Structural Analysis w/ Report								
Structural Engineer, P.E.	15	Hours	200.00	3,000	0	0	0	3,000
Other Engineering Support	105	Hours	100.00	10,500	0	0	0	10,500
Other non-Engineer Support	40	Hours	40.00	1,600	0	0	0	1,600
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
Design & Planning								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
TOTAL - Preparation	1	LS		44,700	0	0	4,800	49,500
Mobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Construct Stockpile Area								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Haybales, Covers, etc.	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Mobilization								
Move-in T-L-B & Demol. Hammer	1	LS	600.00	0	0	0	600	600
Move-in Air Compressor, Sandpot, etc.	1	LS	500.00	0	0	0	500	500
Move-in Boomlift	1	LS	250.00	0	0	0	250	250
Move-in Pressure Washer, Torches, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Mobilization	1	LS		2,125	280	2,500	1,900	6,805
Wall Demolition								
Northwesternmost Wall, 2190 SF, 8"CMU								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	80	Hours	32.72	2,618	0	0	0	2,618
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Demolition Hammer	20	Hours	28.00	0	560	0	0	560
Torches, Gases, etc.	2	Days	200.00	0	0	400	0	400
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
New Building Entry/Exit Doors, 3 Each								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Torches, Gases, etc.	1	Days	200.00	0	0	200	0	200
New Hollow Metal Frames, Doors & Hardware	3	Each	350.00	0	0	1,050	0	1,050
TOTAL - Wall Demolition	2,190	SF		5,899	1,120	4,150	0	11,169
Clean Overhead Beams								
Mobilize/Demobilize	1	LS	2,500.00	0	0	0	2,500	2,500
Steam Washing of Overhead Beams								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Boomlift	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
Sand Blast Overhead Beams								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Boomlift	30	Hours	42.00	0	1,260	0	0	1,260
Air Compressor, Sandblast Gun, Sandpot, etc.	30	Hours	40.00	0	1,200	0	0	1,200
Paint Overhead Beams								
Painter Foreman	40	Hours	34.05	1,362	0	0	0	1,362
Painter	40	Hours	32.72	1,309	0	0	0	1,309
Boomlift	40	Hours	10.00	0	400	0	0	400
Paint	25	Gallons	30.00	0	0	750	0	750
Final Steam Cleaning of Building								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Pressure Washer	30	Hours	10.00	0	300	0	0	300
Boomlift	30	Hours	10.00	0	300	0	0	300
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Clean Overhead Beams	1,000	LF		8,013	3,860	5,750	2,500	20,123

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis								
Off-Site disposal Characterization Sample Analysis								
VOCs	5	Each	150.00	0	0	0	750	750
Total Chromium	5	Each	15.00	0	0	0	75	75
Hexavalent Chromium	5	Each	35.00	0	0	0	175	175
TCLP VOCs	5	Each	150.00	0	0	0	750	750
TCLP Metals	5	Each	135.00	0	0	0	675	675
Cyanide	5	Each	50.00	0	0	0	250	250
Wipe Sample Analysis - Overhead Beams								
Total Chromium	8	Each	15.00	0	0	0	120	120
Hexavalent Chromium	8	Each	35.00	0	0	0	280	280
Air Monitoring Sample Analysis								
VOCs	10	Each	75.00	0	0	0	750	750
Total Chromium	10	Each	15.00	0	0	0	150	150
Dust	10	Each	15.00	0	0	0	150	150
TOTAL - Sampling and Analysis	1	LS		0	0	0	4,125	4,125
Off-Site Disposal								
RCRA Non-Hazardous Materials	43	Ton	50.00	0	0	0	2,150	2,150
RCRA Hazardous Materials	11	Ton	100.00	0	0	0	1,100	1,100
TOTAL - Off-Site Disposal	54	Ton		0	0	0	3,250	3,250
New Vapor Barrier/Concrete Floor Slab, t=6", 15,200 SF								
Electrical Disconnects/Remove Control Boxes	1	LS	1,500.00	0	0	0	1,500	1,500
Relocate Existing Piping, 5 Each								
Pipefitter Foreman	50	Hours	38.60	1,930	0	0	0	1,930
Pipefitter	50	Hours	37.00	1,850	0	0	0	1,850
Pipe, Fittings, Miscellaneous Supplies	5	Each	250.00	0	0	1,250	0	1,250

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Rebuild Existing Entry/Exit Doors, 4 Each								
Carpenter Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Carpenter	40	Hours	37.00	1,480	0	0	0	1,480
Miscellaneous Supplies	4	Each	250.00	0	0	1,000	0	1,000
Remove Elevator Platforms, 2 Each								
Labor Foreman	35	Hours	34.05	1,192	0	0	0	1,192
Laborer	35	Hours	32.72	1,145	0	0	0	1,145
Operator	35	Hours	47.51	1,663	0	0	0	1,663
Tractor-Loader-Backhoe	35	Hours	28.00	0	980	0	0	980
Remove Sump Covers, 12 Each								
Labor Foreman	21	Hours	34.05	715	0	0	0	715
Laborer	21	Hours	32.72	687	0	0	0	687
Operator	21	Hours	47.51	998	0	0	0	998
Tractor-Loader-Backhoe	21	Hours	28.00	0	588	0	0	588
Seal Sumps, 12 Each								
Labor Foreman	72	Hours	34.05	2,451	0	0	0	2,451
Laborer	72	Hours	32.72	2,356	0	0	0	2,356
Miscellaneous Supplies	12	Each	100.00	0	0	1,200	0	1,200
Well Abandonment	13	Each	1,500.00	0	0	0	19,500	19,500
Well Extensions	12	Each	500.00	0	0	0	6,000	6,000
New Vapor Barrier, 40 mill HDPE, Seamed, Booted	15,200	SF	0.50	0	0	0	7,600	7,600
Formwork/Welded Wire Fabric								
Carpenter/IW Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Carpenter/IW	30	Hours	37.00	1,110	0	0	0	1,110
Forms	1	LS	2,500.00	0	0	0	2,500	2,500
Welded Wire Fabric	15,200	SF	0.15	0	0	0	2,280	2,280
Place Concrete Floor Slab								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	120	Hours	32.72	3,927	0	0	0	3,927
Cement Mason Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Cement Mason	30	Hours	37.00	1,110	0	0	0	1,110
Concrete, 3000 psi, 3/4" Aggregate	295	CY	70.00	0	0	20,650	0	20,650
Project Engineer/HSO	520	Hours	77.00	40,040	0	0	0	40,040
Q.C. Engineer	520	Hours	77.00	40,040	0	0	0	40,040

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
TOTAL - New Vapor Barrier/Concrete Floor Slab	281	CY		107,576	1,568	24,100	39,380	172,624
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Boomlift	20	Hours	42.00	0	840	0	0	840
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	1,040	2,500	0	4,875
PPC/PPE								
PPC/PPE, Mandays	100	Mandays	35.00	0	0	3,500	0	3,500
TOTAL - PPC/PPE	100	Mandays		0	0	3,500	0	3,500
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Demobilization								
Move-out T-L-B & Demol. Hammer	1	LS	600.00	0	0	0	600	600
Move-out Air Compressor, Sandpot, etc.	1	LS	500.00	0	0	0	500	500
Move-out Boomlift	1	LS	250.00	0	0	0	250	250
Move-out Pressure Washer, Torches, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Demobilization	1	LS		0	0	0	1,900	1,900
Home Office								
Project Manager	120	Hours	148.50	17,820	0	0	0	17,820
Other Personnel	150	Hours	99.00	14,850	0	0	0	14,850
TOTAL - Home Office	3	Months		32,670	0	0	0	32,670
Site Office - includes Final Report & Land Use Restrictions								
Project Superintendent	520	Hours	99.00	51,480	0	0	0	51,480
Per Diems	270	Days	100.00	0	0	0	27,000	27,000
Project Vehicles	1,560	Hours	7.50	0	11,700	0	0	11,700
Storage Box	6	Months	100.00	0	0	0	600	600
Copier, Fax, Computers	3	Months	500.00	0	0	0	1,500	1,500
Surveyor	1	LS	10,000.00	0	0	0	10,000	10,000
TOTAL - Site Office	3	Months		51,480	11,700	0	39,100	102,280

TABLE B-2
ALTERNATIVE CR-S-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Five-Year Site Reviews								
Engineering Manager, P.E.	8	Hours	200.00	1,600	0	0	0	1,600
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	20	Hours	40.00	800	0	0	0	800
Computers, etc.	80	Hours	10.00	0	0	0	800	800
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
Travel to Site (18 Mo, 5/Mo, 300 miles each)	300	Miles	0.32	0	0	0	95	95
TOTAL - Five Year Review	1	Report		12,400	0	0	2,395	14,795

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation								
Pre-design Investigation								
Mobilize	1	LS	500.00	0	500	0	0	500
Geoprobe with operator	5	Days	1,200.00	0	6,000	0	0	6,000
Scientist/Engineer	50	Hours	100.00	5,000	0	0	0	5,000
Per Diems	5	Days	100.00	0	0	0	500	500
Project Vehicles	50	Hours	7.50	0	375	0	0	375
Analytical								
Total Chromium	50	Sample	15.00	0	0	0	750	750
Hexavalent Chromium	50	Sample	35.00	0	0	0	1,750	1,750
Sulfate	50	Sample	17.50	0	0	0	875	875
Total Iron	50	Sample	15.00	0	0	0	750	750
Alkalinity	50	Sample	15.00	0	0	0	750	750
Data Validation	40	Hours	100.00	4,000	0	0	0	4,000
Report								
Scientist/Engineer	40	Hours	100.00	4,000	0	0	0	4,000
Design & Planning								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	1,000	Hours	100.00	100,000	0	0	0	100,000
Other non-Engineer Support	400	Hours	40.00	16,000	0	0	0	16,000
Computers, etc.	350	Hours	10.00	0	0	0	3,500	3,500
Drawings, Specifications Copies, etc.	1	LS	10,000.00	0	0	0	10,000	10,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
Preparation of Plans								
Engineering Manager, P.E.	20	Hours	200.00	4,000	0	0	0	4,000
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	25	Hours	40.00	1,000	0	0	0	1,000
Computers, etc.	45	Hours	10.00	0	0	0	450	450
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
TOTAL - Preparation	1	LS		164,000	6,875	0	23,325	194,200

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Mobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Mobilization	1	LS		0	0	0	5,650	5,650
Install Extraction System								
Drill & Install Extraction Wells								
Drilling	140	VF	10.00	0	0	0	1,400	1,400
Screen, 6" Dia., SS, 0.020" Slot Screens	25	VF	10.00	0	0	0	250	250
Screen, 8" Dia., SS, 0.020" Slot Screens	10	VF	10.00	0	0	0	100	100
Riser, 6" Dia., SS	85	VF	10.00	0	0	0	850	850
Riser, 8" Dia., SS	20	VF	10.00	0	0	0	200	200
Miscellaneous Materials	4	Wells	100.00	0	0	0	400	400
Well Development	4	Wells	500.00	0	0	0	2,000	2,000
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000
Manhole Structure								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborer	20	Hours	32.72	654	0	0	0	654
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Precast Manhole, 6' Diameter	2	Each	500.00	0	0	0	1,000	1,000
Frame and Cover	2	Each	250.00	0	0	0	500	500
Miscellaneous Materials	2	Each	100.00	0	0	0	200	200
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	9	Drums	100.00	0	0	0	900	900

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Extraction Pump System								
Plumber Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Plumber	40	Hours	37.00	1,480	0	0	0	1,480
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Submersible Well Pump, 5 gpm	1	Each	500.00	0	0	500	0	500
Submersible Well Pump, 15 gpm	1	Each	600.00	0	0	600	0	600
Submersible Well Pump, 40 gpm	1	Each	750.00	0	0	750	0	750
1.5" HDPE Well Pipe and Fittings	120	LF	5.00	0	0	600	0	600
3" HDPE Well Pipe and Fittings	30	LF	10.00	0	0	300	0	300
Sample Ports	4	Each	100.00	0	0	400	0	400
Transducers	5	Each	500.00	0	0	2,500	0	2,500
Junction Boxes in Well Vault	2	Each	500.00	0	0	1,000	0	1,000
Level Control System	2	Each	1,250.00	0	0	2,500	0	2,500
Flow Meters	5	Each	1,000.00	0	0	5,000	0	5,000
Flow Control Valves	5	Each	500.00	0	0	2,500	0	2,500
Check Valves	5	Each	250.00	0	0	1,250	0	1,250
Recorders	4	Each	1,500.00	0	0	6,000	0	6,000
Miscellaneous Materials	4	Each	200.00	0	0	800	0	800
Pipe from Wells to Building 63 Sump								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Pipe and Fittings	380	LF	5.00	0	0	1,900	0	1,900
Power Conduit and Wire	380	LF	5.00	0	0	0	1,900	1,900
Control Signal Conduit and Wire	380	LF	7.00	0	0	0	2,660	2,660
Pavement Restoration, t = 3"	126	SY	15.00	0	0	0	1,890	1,890
TOTAL - Extraction System	4	Wells		9,200	11,680	26,600	14,250	61,730

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Injection System								
Drill & Install Injection Wells - Phase 1								
Drilling	1,155	VF	10.00	0	0	0	11,550	11,550
Screen, 1" Dia., SS, 0.020" Slot Screens	380	VF	10.00	0	0	0	3,800	3,800
Riser, 1" Dia., SS	1,135	VF	10.00	0	0	0	11,350	11,350
Miscellaneous Materials	44	Wells	100.00	0	0	0	4,400	4,400
Well Development	44	Wells	500.00	0	0	0	22,000	22,000
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000
Drill & Install Injection Wells - Phase 2								
Drilling	578	VF	10.00	0	0	0	5,780	5,780
Screen, 1" Dia., SS, 0.020" Slot Screens	190	VF	10.00	0	0	0	1,900	1,900
Riser, 1" Dia., SS	568	VF	10.00	0	0	0	5,680	5,680
Miscellaneous Materials	22	Wells	100.00	0	0	0	2,200	2,200
Well Development	22	Wells	500.00	0	0	0	11,000	11,000
Frac Tank	2	Month	2,500.00	0	5,000	0	0	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	105	Drums	100.00	0	0	0	10,500	10,500
Well Installation - Phase 1								
Plumber Foreman	176	Hours	38.60	6,794	0	0	0	6,794
Plumber	176	Hours	37.00	6,512	0	0	0	6,512
Pressure Guage	44	Each	50.00	0	0	2,200	0	2,200
Flow Meters	44	Each	500.00	0	0	22,000	0	22,000
Flow Control Valves	44	Each	250.00	0	0	11,000	0	11,000
Hose Bibb Connection	44	Each	10.00	0	0	440	0	440
Miscellaneous Materials	44	Each	25.00	0	0	1,100	0	1,100
Well Installation - Phase 2								
Plumber Foreman	88	Hours	38.60	3,397	0	0	0	3,397
Plumber	88	Hours	37.00	3,256	0	0	0	3,256
Pressure Guage	22	Each	50.00	0	0	1,100	0	1,100
Flow Meters	22	Each	500.00	0	0	11,000	0	11,000
Flow Control Valves	22	Each	250.00	0	0	5,500	0	5,500
Hose Bibb Connection	22	Each	10.00	0	0	220	0	220
Miscellaneous Materials	22	Each	25.00	0	0	550	0	550

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Infiltration Gallery								
Labor Foreman	40	Hours	34.05	1,362	0	0	0	1,362
Laborer	40	Hours	32.72	1,309	0	0	0	1,309
Operator	40	Hours	47.51	1,901	0	0	0	1,901
Tractor-Loader-Backhoe	40	Hours	28.00	0	1,120	0	0	1,120
Coarse Sand	30	CCY	20.00	0	0	600	0	600
1" Perforated PVC Pipe	1,500	LF	1.25	0	0	1,875	0	1,875
Miscellaneous Fittings	1	LS	50.00	0	0	50	0	50
Pavement Restoration, t = 3"	170	SY	15.00	0	0	0	2,550	2,550
Characterization & Disposal, Concrete & Soil	40	CY	100.00	0	0	0	4,000	4,000
TOTAL - Injection System	66	Wells		24,530	16,120	57,635	96,710	194,995
Install Monitoring System								
Drill & Install Piezometers								
Drilling	2,400	VF	10.00	0	0	0	24,000	24,000
Screen, 1" Dia., PVC Slot Screens	630	VF	1.50	0	0	0	945	945
Riser, 1" Dia., PVC	1,770	VF	1.00	0	0	0	1,770	1,770
Flush Mount Cover	72	Wells	100.00	0	0	0	7,200	7,200
Well Development	72	Wells	500.00	0	0	0	36,000	36,000
Frac Tank	2	Month	2,500.00	0	5,000	0	0	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	145	Drums	100.00	0	0	0	14,500	14,500
TOTAL - Install Monitoring System	72	Wells		0	5,000	0	84,415	89,415
Install Chemical Makeup and Delivery System								
Ferrous Sulfate Bulk Bag Dump Station w/ Dust Control								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Dump Station w/ Dust Control	1	Each	2,500.00	0	0	2,500	0	2,500

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Ferrous Sulfate Hopper								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Ferrous Sulfate Hopper	1	Each	1,500.00	0	0	1,500	0	1,500
Ferrous Sulfate Feeder								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Ferrous Sulfate Feeder	1	Each	2,500.00	0	0	2,500	0	2,500
Ferrous Sulfate Conveyor								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Ferrous Sulfate Conveyor	1	Each	2,500.00	0	0	2,500	0	2,500
Ferrous Sulfate Flash Mix Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Ferrous Sulfate Flash Mix Tank, 100 Gallon	1	Each	500.00	0	0	500	0	500
Ferrous Sulfate Mix Tank Mixer	1	Each	500.00	0	0	500	0	500
Ferrous Sulfate Solution Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Ferrous Sulfate Solution Storage Tank, 5000 Gal.	1	Each	10,000.00	0	0	10,000	0	10,000
Ferrous Sulfate Solution Storage Tank Mixer	1	Each	1,500.00	0	0	1,500	0	1,500

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sulfuric Acid Containment Area								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Sulfuric Acid Containment Area	1	Each	2,500.00	0	0	2,500	0	2,500
Sulfuric Acid Metering Pump								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Sulfuric Acid Metering Pump	1	Each	2,000.00	0	0	2,000	0	2,000
Ferrous Sulfate Solution Distribution								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Ferrous Sulfate Solution Distribution Manifold	1	Each	1,000.00	0	0	1,000	0	1,000
Ferrous Sulfate Solution Distribution Pump	2	Each	1,500.00	0	0	3,000	0	3,000
Ferrous Sulfate Solution Pressure Hoses	100	LF	3.00	0	0	300	0	300
Chemical Mixing and Feeding Control System								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Mixing and Feeding Control System	1	Each	10,000.00	0	0	10,000	0	10,000
Process Piping								
Plumber Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Plumber	100	Hours	37.00	3,700	0	0	0	3,700
2" CPVC Pipe & Fittings, Schedule 80	500	LF	10.00	0	0	5,000	0	5,000
TOTAL - Chemical Makeup and Delivery System	1	LS		16,081	1,680	45,300	0	63,061

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pressure Test Pipeline to Chemical Waste Treatment Plant (CWTP)								
Pressure Test Pipeline, 1100 LF	1	LS	500.00	0	0	0	500	500
Pull New Control Wire through Existing Conduit, 1100 LF								
Electrician Foreman	10	Hours	38.60	386	0	0	0	386
Electrician	10	Hours	37.00	370	0	0	0	370
New Control Wire	1,100	LF	1.00	0	0	1,100	0	1,100
TOTAL - Pressure Test Pipeline to CWTP	1	LS		756	0	1,100	500	2,356
Rebuild Pipeline to CWTP (Contingency cost in case pressure test fails - not included in summary cost for alternative)								
Permit for Work in Public Road	1	LS	2,500.00	0	0	0	2,500	2,500
Excavate & Remove Existing Pipe, 1100 LF, includes 100 BCY of Overexcavation								
Labor Foreman	25	Hours	34.05	851	0	0	0	851
Laborers	25	Hours	32.72	818	0	0	0	818
Operator	25	Hours	47.51	1,188	0	0	0	1,188
Tractor-Loader-Backhoe	25	Hours	28.00	0	700	0	0	700
Pipe Bedding	41	CCY	20.00	0	0	820	0	820
4" SDR 11 HDPE Pipe	1,100	LF	2.00	0	0	2,200	0	2,200
Pressure Test Pipeline, 1100 LF	1	LS	500.00	0	0	0	500	500
New Conduit & Control Wire, 1100 LF								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
New Conduit with Control Wire	1,100	LF	3.00	0	0	3,300	0	3,300
Pull Boxes	6	Each	50.00	0	0	300	0	300
Backfill & Compaction, 1100 LF								
Labor Foreman	25	Hours	34.05	851	0	0	0	851
Laborers	25	Hours	32.72	818	0	0	0	818
Operator	25	Hours	47.51	1,188	0	0	0	1,188
Tractor-Loader-Backhoe	25	Hours	28.00	0	700	0	0	700
Characterization & Disposal, Contaminated Soil	100	CY	100.00	0	0	0	10,000	10,000
Pavement Restoration, t = 3"	367	SY	15.00	0	0	0	5,505	5,505
Curb Repair @ Road Crossing	12	LF	25.00	0	0	0	300	300
TOTAL - Rebuild Pipeline to CWTP	1,100	LF		7,226	1,400	6,620	18,805	34,051

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Organics Treatment System @ CWTP								
pH Adjustment Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
pH Adjustment Tank, 1000 Gallon	1	Each	1,500.00	0	0	1,500	0	1,500
pH Adjustment Tank Mixer	1	Each	750.00	0	0	750	0	750
Acid Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
2" CPVC Pipe & Fittings, Schedule 80	100	LF	10.00	0	0	1,000	0	1,000
Heat Tracing								
Electrician Foreman	10	Hours	38.60	386	0	0	0	386
Electrician	10	Hours	37.00	370	0	0	0	370
New Conduit with Control Wire	100	LF	20.00	0	0	2,000	0	2,000
UV/Oxidation Feed Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
UV/Oxidation Feed Pump, 75 gpm, 50 Ft. TDH	1	Each	2,500.00	0	0	2,500	0	2,500
UV/Oxidation Unit								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
UV/Oxidation Unit, 60 KW	1	Each	50,000.00	0	0	50,000	0	50,000

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Hydrogen Peroxide Tank and Feed System								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrogen Peroxide Tank and Feed System	1	Each	20,000.00	0	0	20,000	0	20,000
Secondary Containment	1	Each	2,500.00	0	0	2,500	0	2,500
Process Water/Miscellaneous Piping								
Plumber Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Plumber	40	Hours	37.00	1,480	0	0	0	1,480
2" CPVC Pipe & Fittings, Schedule 80	500	LF	10.00	0	0	5,000	0	5,000
Motor Starters and Controls								
Electrician Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Electrician	100	Hours	37.00	3,700	0	0	0	3,700
Motor Starters and Controls	1	LS	10,000.00	0	0	10,000	0	10,000
Equipment Pad/Slab-on-Grade, 20'x20'x1'								
Carpenter/IW Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Carpenter/IW	30	Hours	37.00	1,110	0	0	0	1,110
Forms	1	LS	1,000.00	0	0	1,000	0	1,000
Anchor Bolts	20	Each	5.00	0	0	100	0	100
Place Concrete Floor Slab								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	120	Hours	32.72	3,927	0	0	0	3,927
Cement Mason Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Cement Mason	30	Hours	37.00	1,110	0	0	0	1,110
Concrete, 3000 psi, 3/4" Aggregate	16	CY	70.00	0	0	1,120	0	1,120
Pre-Engineered Metal Building, 20'x20'x12' high	1	Each	20,000.00	0	0	20,000	0	20,000
TOTAL - Organics Treatment System	1	LS		26,645	980	117,470	0	145,095

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis - Years 1&2								
Perforamance Evaluation Sample Collection								
Sample Technicians (3)	2,700	Hours	55.00	148,500	0	0	0	148,500
Travel to Site (18 Mo, 1/Mo, 300 miles each)	5,400	Miles	0.32	0	0	0	1,701	1,701
Hotels, Meals at Site (18 Mo, 1/Mo, 5 Days each)	270	Days	125.00	0	0	0	33,750	33,750
Shipping	18	Each		0	0	0	1,800	1,800
Discharge Performance Monitoring Sample Collection								
Shipping	60	Each	100.00	0	0	0	6,000	6,000
Off-Site Confirmation Sample Analysis								
VOCs	281	Each	150.00	0	0	0	42,150	42,150
Total Chromium	198	Each	15.00	0	0	0	2,970	2,970
Hexavalent Chromium	198	Each	35.00	0	0	0	6,930	6,930
Sulfate	198	Each	17.50	0	0	0	3,465	3,465
Ferrous Iron	198	Each	25.00	0	0	0	4,950	4,950
Total Iron	198	Each	15.00	0	0	0	2,970	2,970
Dissolved Iron	198	Each	15.00	0	0	0	2,970	2,970
Alkalinity	198	Each	15.00	0	0	0	2,970	2,970
Salinity	198	Each	15.00	0	0	0	2,970	2,970
On-Site Analysis using Field Test Kits								
Total Chromium	1,566	Each	5.00	0	0	0	7,830	7,830
Hexavalent Chromium	1,566	Each	5.00	0	0	0	7,830	7,830
Sulfate	1,566	Each	5.00	0	0	0	7,830	7,830
Ferrous Iron	1,566	Each	5.00	0	0	0	7,830	7,830
Total Iron	1,566	Each	5.00	0	0	0	7,830	7,830
Dissolved Iron	1,566	Each	5.00	0	0	0	7,830	7,830
Alkalinity	1,566	Each	5.00	0	0	0	7,830	7,830
Salinity	1,566	Each	1.00	0	0	0	1,566	1,566
Dissolved Oxygen	1,566	Each	1.00	0	0	0	1,566	1,566
Redox Potential	1,566	Each	1.00	0	0	0	1,566	1,566
Specific Conductivity	1,566	Each	1.00	0	0	0	1,566	1,566
Temperature	1,566	Each	1.00	0	0	0	1,566	1,566
Turbidity	1,566	Each	1.00	0	0	0	1,566	1,566
pH	1,566	Each	1.00	0	0	0	1,566	1,566
TOTAL - Sampling and Analysis - Years 1&2	1	LS		148,500	0	0	181,368	329,868

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis (Annual cost for years 3-30)								
Sample Collection								
Sample Technicians (2)	60	Hours	55.00	3,300	0	0	0	3,300
Travel to Site (300 miles each)	300	Miles	0.32	0	0	0	95	95
Hotels, Meals at Site (5 Days each)	6	Days	125.00	0	0	0	750	750
Shipping	1	Each		0	0	0	100	100
Off-Site Sample Analysis								
Total Chromium	12	Each	15.00	0	0	0	180	180
Hexavalent Chromium	12	Each	35.00	0	0	0	420	420
Sulfate	12	Each	17.50	0	0	0	210	210
Ferrous Iron	12	Each	25.00	0	0	0	300	300
Total Iron	12	Each	15.00	0	0	0	180	180
Dissolved Iron	12	Each	15.00	0	0	0	180	180
Alkalinity	12	Each	15.00	0	0	0	180	180
Salinity	12	Each	15.00	0	0	0	180	180
On-Site Analysis using Field Test Kits								
Salinity	9	Each	1.00	0	0	0	9	9
Dissolved Oxygen	9	Each	1.00	0	0	0	9	9
Redox Potential	9	Each	1.00	0	0	0	9	9
Specific Conductivity	9	Each	1.00	0	0	0	9	9
Temperature	9	Each	1.00	0	0	0	9	9
Turbidity	9	Each	1.00	0	0	0	9	9
pH	9	Each	1.00	0	0	0	9	9
Data Report								
Data Validator	40	Hours	100.00	4,000	0	0	0	4,000
Engineering Manager, P.E.	4	Hours	200.00	800	0	0	0	800
Other Engineering Support	40	Hours	100.00	4,000	0	0	0	4,000
Other non-Engineer Support	20	Hours	40.00	800	0	0	0	800
Computers, etc.	80	Hours	10.00	0	0	0	800	800
Report Copying, etc.	1	LS	500.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
TOTAL - Annual Sampling and Analysis - Years 3-30	1	LS		12,900	0	0	4,638	17,538

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Report Preparation								
Engineering Manager, P.E.	24	Hours	200.00	4,800	0	0	0	4,800
Other Engineering Support	320	Hours	100.00	32,000	0	0	0	32,000
Other non-Engineer Support	136	Hours	40.00	5,440	0	0	0	5,440
Computers, etc.	190	Hours	10.00	0	0	0	1,900	1,900
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	1,000.00	0	0	0	1,000	1,000
TOTAL - Report Preparation	480	Hours		42,240	0	0	7,900	50,140
Plant Operation								
Plant Operator	3,120	Hours	40.00	124,800	0	0	0	124,800
Electricity								
Extraction Pumps	55,000	kWhr	0.06	0	0	0	4,400	4,400
Ferrous Sulfate Makeup System	50,000	kWhr	0.06	0	0	0	4,000	4,000
Injection Pumps	50,000	kWhr	0.06	0	0	0	4,000	4,000
Building 63 Sump Pumps	50,000	kWhr	0.06	0	0	0	4,000	4,000
pH Adjustment Tank Mixer	5,000	kWhr	0.06	0	0	0	400	400
UV/Oxidation Feed Pump	10,000	kWhr	0.06	0	0	0	800	800
UV/Oxidation System	800,000	kWhr	0.06	0	0	0	64,000	64,000
Miscellaneous	30,000	kWhr	0.06	0	0	0	2,400	2,400
Ferrous Sulfate-heptahydrate	300,000	lb.	0.16	0	0	48,000	0	48,000
Sufuric Acid	25,000	lb.	0.28	0	0	7,000	0	7,000
Hydrogen Peroxide	74,000	lb.	0.60	0	0	44,400	0	44,400
Water Supply (City Water)	35,000	MGallon	1.00	0	0	35,000	0	35,000
Replacement/Maintenance Parts	1	LS	25,000.00	0	0	25,000	0	25,000
CWTP Charges	59,000	MGallon	1.00	0	0	59,000	0	59,000

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Well Maintenance/Cleaning	1	LS	50,000.00	0	0	50,000	0	50,000
Project Engineer/HSO	1,720	Hours	77.00	132,440	0	0	0	132,440
Q.C. Engineer	1,720	Hours	77.00	132,440	0	0	0	132,440
Hotels, Meals at Site (18 Mo, 5/Mo, 3 Days each)	270	Days	125.00	0	0	0	33,750	33,750
Other Personnel (25 Hours/Mo.)	600	Hours	99.00	59,400	0	0	0	59,400
Travel to Site (18 Mo, 5/Mo, 300 miles each)	13,500	Miles	0.32	0	0	0	4,253	4,253
TOTAL - Plant Operation	18	Months		449,080	0	268,400	122,003	839,483
Deconstruct Extraction Wells/Injection Wells Systems								
Labor Foreman	100	Hours	34.05	3,405	0	0	0	3,405
Laborer	200	Hours	32.72	6,545	0	0	0	6,545
Operator	100	Hours	47.51	4,751	0	0	0	4,751
Tractor-Loader-Backhoe	100	Hours	28.00	0	2,800	0	0	2,800
Disposal - Pipe, Pavement & Other Debris	40	Tons	50.00	0	2,000	0	0	2,000
Pavement Restoration, t = 3"	170	SY	15.00	0	0	0	2,550	2,550
TOTAL - Deconstruct Extraction/Injection Systems	48	Wells		14,701	4,800	0	2,550	22,051
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	500	Mandays	35.00	0	0	17,500	0	17,500
TOTAL - PPC/PPE	500	Mandays		0	0	17,500	0	17,500

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		0	0	0	5,650	5,650
Home Office								
Project Manager (40 Hours/Mo.)	960	Hours	148.50	142,560	0	0	0	142,560
Support Personnel (Timekeeping, Procurement)	720	Hours	82.50	59,400	0	0	0	59,400
Other Personnel (50 Hours/Mo.)	600	Hours	99.00	59,400	0	0	0	59,400
Travel to Site (18 Mo, 5/Mo, 300 miles each)	13,500	Miles	0.32	0	0	0	4,253	4,253
TOTAL - Home Office	24	Months		261,360	0	0	4,253	265,613
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Per Diems	540	Days	100.00	0	0	0	54,000	54,000
Project Vehicles	3,000	Hours	7.50	0	22,500	0	0	22,500
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	24	Months		99,000	22,500	0	60,200	181,700

TABLE B-3
ALTERNATIVE CR-GW-1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Five-Year Site Reviews								
Engineering Manager, P.E.	8	Hours	200.00	1,600	0	0	0	1,600
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	20	Hours	40.00	800	0	0	0	800
Computers, etc.	80	Hours	10.00	0	0	0	800	800
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
Travel to Site (18 Mo, 5/Mo, 300 miles each)	300	Miles	0.32	0	0	0	95	95
TOTAL - Five Year Review	1	Report		12,400	0	0	2,395	14,795

TABLE B-4
ALTERNATIVE CR-GW-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation								
Design & Planning								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Drawings, Specifications Copies, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
TOTAL - Preparation	1	LS		29,600	0	0	2,700	32,300
Mobilization								
Storage Box	1	Each	150.00	0	0	0	150	150
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Mobilization	1	LS		0	0	0	5,000	5,000

TABLE B-4
ALTERNATIVE CR-GW-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Monitoring System								
Drill & Install Monitoring Wells								
Drilling	355	VF	10.00	0	0	0	3,550	3,550
Screen, 2" Dia., PVC, 0.010" Slot Screens	40	VF	1.50	0	0	0	60	60
Riser, 2" Dia., PVC	315	VF	1.00	0	0	0	315	315
Flush Mount Cover	8	Wells	100.00	0	0	0	800	800
Well Development	8	Wells	500.00	0	0	0	4,000	4,000
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	23	Drums	100.00	0	0	0	2,300	2,300
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Install Monitoring System	8	Wells		0	0	0	16,225	16,225

TABLE B-4
ALTERNATIVE CR-GW-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis (Years 1 and 2)								
Off-Site disposal Characterization Sample Analysis								
Groundwater Sampling (8 Events)								
Sampling Technicians (2)	480	Hours	55.00	26,400	0	0	0	26,400
Sampling Equipment	1	LS	13,720.00	0	13,720	0	0	13,720
Per Diem	48	Days	100.00	0	0	0	4,800	4,800
Vehicle	4,800	Miles	0.32	0	1,536	0	0	1,536
Shipping	32	Each	100.00	0	0	0	3,200	3,200
Groundwater Analysis								
Total Chromium	104	Each	15.00	0	0	0	1,560	1,560
Hexavalent Chromium	104	Each	35.00	0	0	0	3,640	3,640
Total Organic Carbon	104	Each	50.00	0	0	0	5,200	5,200
Nitrate	104	Each	17.50	0	0	0	1,820	1,820
Sulfate	104	Each	17.50	0	0	0	1,820	1,820
Ferrous Iron	104	Each	25.00	0	0	0	2,600	2,600
Dissolved Iron	104	Each	15.00	0	0	0	1,560	1,560
Dissolved Manganese	104	Each	15.00	0	0	0	1,560	1,560
Alkalinity	104	Each	15.00	0	0	0	1,560	1,560
Salinity	104	Each	15.00	0	0	0	1,560	1,560
Chemical Oxygen Demand	104	Each	35.00	0	0	0	3,640	3,640
On-Site Analysis using Field Test Kits								
Dissolved Oxygen	104	Each	15.00	0	0	0	1,560	1,560
Redox Potential	104	Each	15.00	0	0	0	1,560	1,560
Specific Conductivity	104	Each	15.00	0	0	0	1,560	1,560
Temperature	104	Each	15.00	0	0	0	1,560	1,560
Turbidity	104	Each	15.00	0	0	0	1,560	1,560
pH	104	Each	15.00	0	0	0	1,560	1,560
Letter Report/ Data Deliverable	8	Each	11,000.00				88,000	88,000
TOTAL - Sampling and Analysis (Years 1 and 2)	1,776	Each		26,400	15,256	0	131,880	173,536

TABLE B-4
ALTERNATIVE CR-GW-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis (Annual Cost Years 3 - 10)								
Groundwater Sampling (2 Events)								
Sampling Technicians (2)	120	Hours	55.00	6,600	0	0	0	6,600
Sampling Equipment	2	LS	1,000.00	0	2,000	0	0	2,000
Per Diem	12	Days	100.00	0	0	0	1,200	1,200
Vehicle	600	Miles	0.32	0	192	0	0	192
Shipping	8	Each	100.00	0	0	0	800	800
Groundwater Analysis	26	Each	345.00	0	0	0	8,970	8,970
Letter Report/ Data Deliverable	2	Each	11,000.00	0	0	0	22,000	22,000
TOTAL - Sampling and Analysis (Annual Cost Years 3 - 10)				6,600	2,192	0	32,970	41,762
Sampling and Analysis (Annual Cost Years 11 - 30)								
Groundwater Sampling								
Sampling Technicians (2)	60	Hours	55.00	3,300	0	0	0	3,300
Sampling Equipment	1	LS	1,000.00	0	1,000	0	0	1,000
Per Diem	6	Days	100.00	0	0	0	600	600
Vehicle	300	Miles	0.32	0	96	0	0	96
Shipping	2	Each	100.00	0	0	0	200	200
Groundwater Analysis	13	Each	345.00	0	0	0	4,485	4,485
Letter Report/ Data Deliverable	1	Each	11,000.00	0	0	0	11,000	11,000
TOTAL - Sampling and Analysis (Annual Cost Years 11 - 30)				3,300	1,096	0	16,285	20,681
PPC/PPE								
PPC/PPE, Mandays	50	Mandays	35.00	0	0	1,750	0	1,750
IDW Disposal, PPE	4	Drums	100.00	0	0	0	400	400
TOTAL - PPC/PPE	50	Mandays		0	0	1,750	400	2,150

TABLE B-4
ALTERNATIVE CR-GW-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Demobilization								
Storage Box	1	Each	150.00	0	0	0	150	150
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		0	0	0	5,000	5,000
Home Office								
Project Manager (40 Hours/Mo.)	80	Hours	148.50	11,880	0	0	0	11,880
Other Personnel (50 Hours/Mo.)	100	Hours	99.00	9,900	0	0	0	9,900
TOTAL - Home Office	2	Months		21,780	0	0	0	21,780

TABLE B-4
ALTERNATIVE CR-GW-2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Site Office - includes Final Report & Land Use Restrictions								
Project Engineer (also Q.C., HSO)	352	Hours	77.00	27,104	0	0	0	27,104
Support Personnel (Timekeeping, Procurement)	352	Hours	55.00	19,360	0	0	0	19,360
Per Diems	60	Days	100.00	0	0	0	6,000	6,000
Project Vehicles	352	Hours	7.50	0	2,640	0	0	2,640
Copier, Fax, Computers	2	Months	500.00	0	0	0	1,000	1,000
Surveyor	1	LS	1,000.00	0	0	0	1,000	1,000
TOTAL - Site Office	2	Months		46,464	2,640	0	8,000	57,104
Five-Year Site Reviews								
Engineering Manager, P.E.	8	Hours	200.00	1,600	0	0	0	1,600
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	20	Hours	40.00	800	0	0	0	800
Computers, etc.	80	Hours	10.00	0	0	0	800	800
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
Travel to Site (18 Mo, 5/Mo, 300 miles each)	300	Miles	0.32	0	0	0	95	95
TOTAL - Five Year Review	1	Report		12,400	0	0	2,395	14,795

TABLE B-5
VOC GROUNDWATER MONITORING, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation								
Design & Planning								
Engineering Manager, P.E.	7	Hours	200.00	1,400	0	0	0	1,400
Other Engineering Support	50	Hours	100.00	5,000	0	0	0	5,000
Other non-Engineer Support	25	Hours	40.00	1,000	0	0	0	1,000
Computers, etc.	30	Hours	10.00	0	0	0	300	300
Drawings, Specifications Copies, etc.	1	LS	500.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	250.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	7	Hours	200.00	1,400	0	0	0	1,400
Other Engineering Support	50	Hours	100.00	5,000	0	0	0	5,000
Other non-Engineer Support	25	Hours	40.00	1,000	0	0	0	1,000
Computers, etc.	30	Hours	10.00	0	0	0	300	300
Report Copying, etc.	1	LS	500.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	250.00	0	0	0	250	250
TOTAL - Preparation	1	LS		14,800	0	0	2,100	16,900
Mobilization								
Showers/Change Rooms - Build in Existing Bldg	1	LS	5,000.00	0	0	0	5,000	5,000
Storage Box	1	Each	150.00	0	0	0	150	150
Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	1,000.00	0	0	1,000	0	1,000
Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-5
VOC GROUNDWATER MONITORING, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Mobilization	1	LS		4,249	560	3,500	10,000	18,309
Install Monitoring System								
Drill & Install Monitoring Wells								
Drilling	600	VF	10.00	0	0	0	6,000	6,000
Screen, 2" Dia., PVC, 0.010" Slot Screens	45	VF	1.50	0	0	0	68	68
Riser, 2" Dia., PVC	555	VF	1.00	0	0	0	555	555
Flush Mount Cover	8	Wells	100.00	0	0	0	800	800
Well Development	8	Wells	500.00	0	0	0	4,000	4,000
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	36	Drums	100.00	0	0	0	3,600	3,600
IDW - Water w/ Surfacants	4	Drums	100.00	0	0	0	400	400
TOTAL - Install Monitoring System	8	Wells		0	0	0	20,423	20,423
Sampling and Analysis (Years 1 and 2)								
Off-Site disposal Characterization Sample Analysis								
Groundwater Sampling (8 Events)								
Sampling Technicians (2)	960	Hours	55.00	52,800	0	0	0	52,800
Sampling Equipment	1	LS	23,080.00	0	23,080	0	0	23,080
Per Diem	96	Days	100.00	0	0	0	9,600	9,600
Vehicle	480	Hours	7.50	0	3,600	0	0	3,600
Shipping	80	Each	100.00	0	0	0	8,000	8,000

TABLE B-5
VOC GROUNDWATER MONITORING, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Groundwater Analysis								
Chlorinated VOCs (TCA, DCA, PCE, TCE, DCE, V(	256	Each	150.00	0	0	0	38,400	38,400
Total Organic Carbon	256	Each	50.00	0	0	0	12,800	12,800
Nitrate	256	Each	17.50	0	0	0	4,480	4,480
Sulfate	256	Each	17.50	0	0	0	4,480	4,480
Ethane	256	Each	80.00	0	0	0	20,480	20,480
Ethylene	256	Each	80.00	0	0	0	20,480	20,480
Ferrous Iron	256	Each	25.00	0	0	0	6,400	6,400
Dissolved Manganese	256	Each	15.00	0	0	0	3,840	3,840
Alkalinity	256	Each	15.00	0	0	0	3,840	3,840
Salinity	256	Each	15.00	0	0	0	3,840	3,840
Chemical Oxygen Demand	256	Each	35.00	0	0	0	8,960	8,960
On-Site Analysis using Field Test Kits								
Dissolved Oxygen	256	Each	15.00	0	0	0	3,840	3,840
Redox Potential	256	Each	15.00	0	0	0	3,840	3,840
Specific Conductivity	256	Each	15.00	0	0	0	3,840	3,840
Temperature	256	Each	15.00	0	0	0	3,840	3,840
Turbidity	256	Each	15.00	0	0	0	3,840	3,840
pH	256	Each	15.00	0	0	0	3,840	3,840
Letter Report/Data Deliverable	8	Each	11,000.00				88,000	88,000
TOTAL - Sampling and Analysis (Years 1 and 2)	4,360	Each		52,800	26,680	0	256,640	336,120
Sampling and Analysis (Annual Cost Years 3 - 10)								
Groundwater Sampling (2 Events/Year)								
Sampling Technicians (2)	240	Hours	55.00	13,200	0	0	0	13,200
Sampling Equipment	1	LS	2,000.00	0	2,000	0	0	2,000
Per Diem	24	Days	100.00	0	0	0	2,400	2,400
Vehicle	120	Hours	7.50	0	900	0	0	900
Shipping	20	Each	100.00	0	0	0	2,000	2,000

TABLE B-5
VOC GROUNDWATER MONITORING, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Groundwater Analysis	64	Each	605.00	0	0	0	38,720	38,720
Letter Report/ Data Deliverable	2	Each	11,000.00	22,000	0	0	0	22,000
TOTAL - Sampling and Analysis (Years 3 - 10)				35,200	2,900	0	43,120	81,220
Sampling and Analysis (Annual Cost Years 11 - 30)								
Groundwater Sampling (1 Event/Year)								
Sampling Technicians (2)	120	Hours	55.00	6,600	0	0	0	6,600
Sampling Equipment	1	LS	20,000.00	0	1,000	0	0	1,000
Per Diem	12	Days	100.00	0	0	0	1,200	1,200
Vehicle	60	Hours	7.50	0	450	0	0	450
Shipping	10	Each	100.00	0	0	0	1,000	1,000
Groundwater Analysis	32	Each	605.00	0	0	0	19,360	19,360
Letter Report/ Data Deliverable	1	Each	11,000.00	11,000	0	0	0	11,000
TOTAL - Sampling and Analysis (Years 11 - 30)				17,600	1,450	0	21,560	40,610
PPC/PPE								
PPC/PPE, Mandays	50	Mandays	35.00	0	0	1,750	0	1,750
IDW Disposal, PPE	6	Drums	100.00	0	0	0	600	600
TOTAL - PPC/PPE	50	Mandays		0	0	1,750	600	2,350
Demobilization								
Storage Box	1	Each	150.00	0	0	0	150	150
Remove Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280

TABLE B-5
VOC GROUNDWATER MONITORING, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Remove Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		4,249	560	0	5,000	9,809
Home Office								
Project Manager (40 Hours/Mo.)	80	Hours	148.50	11,880	0	0	0	11,880
Other Personnel (50 Hours/Mo.)	100	Hours	99.00	9,900	0	0	0	9,900
TOTAL - Home Office	2	Months		21,780	0	0	0	21,780
Site Office - includes Reports								
Project Engineer (also Q.C., HSO)	352	Hours	77.00	27,104	0	0	0	27,104
Support Personnel (Timekeeping, Procurement)	352	Hours	55.00	19,360	0	0	0	19,360
Per Diems	60	Days	100.00	0	0	0	6,000	6,000
Project Vehicles	352	Hours	7.50	0	2,640	0	0	2,640
Copier, Fax, Computers	2	Months	500.00	0	0	0	1,000	1,000
Surveyor	1	LS	1,000.00	0	0	0	1,000	1,000
TOTAL - Site Office	2	Months		46,464	2,640	0	8,000	57,104

TABLE B-5
VOC GROUNDWATER MONITORING, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Five-Year Site Reviews								
Engineering Manager, P.E.	8	Hours	200.00	1,600	0	0	0	1,600
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	20	Hours	40.00	800	0	0	0	800
Computers, etc.	80	Hours	10.00	0	0	0	800	800
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
Travel to Site (18 Mo, 5/Mo, 300 miles each)	300	Miles	0.32	0	0	0	95	95
TOTAL - Five Year Review	1	Report		12,400	0	0	2,395	14,795

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pilot Test Design								
Design & Planning								
Engineering Manager, P.E.	7	Hours	200.00	1,400	0	0	0	1,400
Other Engineering Support	50	Hours	100.00	5,000	0	0	0	5,000
Other non-Engineer Support	25	Hours	40.00	1,000	0	0	0	1,000
Computers, etc.	30	Hours	10.00	0	0	0	300	300
Report Copying, etc.	1	LS	500.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	250.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	7	Hours	200.00	1,400	0	0	0	1,400
Other Engineering Support	50	Hours	100.00	5,000	0	0	0	5,000
Other non-Engineer Support	25	Hours	40.00	1,000	0	0	0	1,000
Computers, etc.	30	Hours	10.00	0	0	0	300	300
Report Copying, etc.	1	LS	500.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	250.00	0	0	0	250	250
TOTAL - Pilot Test Design	1	LS		14,800	0	0	2,100	16,900
Mobilization for Pilot Test								
Showers/Change Rooms - Build in Existing Bldg	1	LS	5,000.00	0	0	0	5,000	5,000
Storage Box	1	Each	150.00	0	0	0	150	150
Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	1,000.00	0	0	1,000	0	1,000
Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Mobilization for Pilot Test	1	LS		4,249	560	3,500	6,500	14,809
Demolish/Replace Floor Slab for Pilot Test, t = 6", L = 400 LF								
Sawcut Slab Perimeter for Pipe Trenches	804	LF	3.00	0	0	0	2,412	2,412
Break-up Floor Slab/Haul to Stockpile, 10 CY								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Air Compressor, Pavement Breakers (2)	20	Hours	40.00	0	800	0	0	800
Torches, Gases, etc.	2	Days	200.00	0	0	400	0	400
Tandem Axle Dump Truck & Driver	20	Hours	60.60	712	500	0	0	1,212
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
Install Horizontal Vapor Extraction Wells and Header, 500 LF								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
2" Fabric-Wrapped Perforated Corrugated HDPE	400	LF	2.00	0	0	800	0	800
2" HDPE Caps	2	Each	10.00	0	0	20	0	20
4"x2" HDPE Tees	2	Each	25.00	0	0	50	0	50
4" HDPE Pipe and Fittings, SDR 11	100	LF	5.00	0	0	500	0	500
Coarse Sand	20	CCY	20.00	0	0	400	0	400
Sample Ports	2	Each	100.00	0	0	200	0	200
Flow Control Valves	2	Each	500.00	0	0	1,000	0	1,000

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Concrete Floor Slab Repair								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Welded Wire Fabric	500	SF	0.15	0	0	0	75	75
Concrete, 3000 psi, 3/4" Aggregate	10	CY	70.00	0	0	700	0	700
Characterization & Disposal, Concrete & Soil	40	CY	50.00	0	0	0	2,000	2,000
TOTAL - Demolish/Replace Floor Slab	7.4	CY		7,569	2,980	6,570	4,487	21,606
Pilot Test Treatment System								
50-Gallon Knock-Out Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
50-Gallon Knock-Out Tank	1	Each	500.00	0	0	500	0	500
Blower								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Tractor-Loader-Backhoe	5	Hours	28.00	0	140	0	0	140
Blower, Varialbe Speed, 50 SCFM	1	Each	1,000.00	0	0	1,000	0	1,000
Piping								
Plumber Foreman	5	Hours	38.60	193	0	0	0	193
Plumber	5	Hours	37.00	185	0	0	0	185
Pipe and Fittings	30	LF	5.00	0	0	150	0	150
Liquid Pumps								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Liquid Pumps	2	Each	1,000.00	0	0	2,000	0	2,000

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Vapor Treatment System								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
1000-pound Activated Carbon Canister	1	Each	2,500.00	0	0	2,500	0	2,500
Sample Ports	2	Each	100.00	0	0	200	0	200
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
1000-pound Activated Carbon Canister	2	Each	2,500.00	0	0	5,000	0	5,000
Sample Ports	4	Each	100.00	0	0	400	0	400
Pilot Test Electrical Power and Control System								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Pilot Test Conduit, Wire, Control System	1	LS	5,000.00	0	0	5,000	0	5,000
TOTAL - Pilot Test Treatment System	1	Each		5,583	840	16,750	0	23,173
Pilot Test Monitoring Wells, 5 VF Each								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe w/ Auger	20	Hours	45.00	0	900	0	0	900
Screen, 1/2" Dia., PVC Slot Screens	30	LF	1.00	0	0	0	30	30
Riser, 1/2" Dia., Schedule 40 PVC	45	LF	0.50	0	0	0	23	23
Plastic Tubing	75	LF	0.50	0	0	0	38	38
Flush Mount Cover	15	Wells	100.00	0	0	0	1,500	1,500

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Characterization & Disposal, Concrete & Soil	2	CY	100.00	0	0	0	200	200
TOTAL - Pilot Test Monitoring Wells	15	Wells		2,286	900	0	1,790	4,976
Pilot Test Operation								
Personnel								
Engineering Support	400	Hours	100.00	40,000	0	0	0	40,000
Travel to Site (4 Wk, 2/Wk, 300 miles each)	2,400	Miles	0.32	0	0	0	756	756
Hotels, Meals at Site (4 Wk, 10/Wk)	40	Days	125.00	0	0	0	5,000	5,000
Electricity								
Pilot Test System		kWhr	0.06	0	0	0	0	0
TOTAL - Pilot Test Operation	20	Days		40,000	0	0	5,756	45,756
Pilot Test Sampling and Analysis								
Off-Site Analytical - Soil Vapor								
VOCs	68	Each	150.00	0	0	0	10,200	10,200
Off-Site Analytical - Indoor Air Quality								
VOCs	6	Each	150.00	0	0	0	900	900
TOTAL - Pilot Test Sampling and Analysis	74	Each		0	0	0	11,100	11,100
Full-Scale Alternative Design								
Design & Planning								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	1,000	Hours	100.00	100,000	0	0	0	100,000
Other non-Engineer Support	400	Hours	40.00	16,000	0	0	0	16,000
Computers, etc.	350	Hours	10.00	0	0	0	3,500	3,500
Drawings, Specifications Copies, etc.	1	LS	10,000.00	0	0	0	10,000	10,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
GPR Survey	10	Days	2,500.00	0	0	0	25,000	25,000

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation of Plans								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	125	Hours	40.00	5,000	0	0	0	5,000
Computers, etc.	250	Hours	10.00	0	0	0	2,500	2,500
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Full-Scale Alternative Design	1	LS		211,000	0	0	51,000	262,000
Full-Scale Alternative Permitting								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	125	Hours	40.00	5,000	0	0	0	5,000
Computers, etc.	250	Hours	10.00	0	0	0	2,500	2,500
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	200.00	0	0	0	200	200
TOTAL - Full-Scale Alternative Permitting	1	LS		286,000	0	0	68,700	354,700
Full-Scale Alternative Mobilization								
Storage Box	1	Each	150.00	0	0	0	150	150
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Full-Scale Alternative Mobilization	1	LS		0	0	0	1,500	1,500

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Demolish/Replace Floor Slab, t = 6", L = 15,750 LF								
Sawcut Slab Perimeter for Pipe Trenches	32,000	LF	2.00	0	0	0	64,000	64,000
Break-up Floor Slab/Haul to Stockpile, 300 CY								
Labor Foreman	200	Hours	34.05	6,810	0	0	0	6,810
Laborers	800	Hours	32.72	26,179	0	0	0	26,179
Operator	200	Hours	47.51	9,503	0	0	0	9,503
Tractor-Loader-Backhoe	200	Hours	28.00	0	5,600	0	0	5,600
Air Compressor, Pavement Breakers (4)	200	Hours	60.00	0	12,000	0	0	12,000
Torches, Gases, etc.	20	Days	200.00	0	0	4,000	0	4,000
Tandem Axle Dump Truck & Driver	200	Hours	60.60	7,120	5,000	0	0	12,120
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
Install Horizontal Vapor Extraction Wells and Header, 15,750 LF								
Labor Foreman	200	Hours	34.05	6,810	0	0	0	6,810
Laborers	800	Hours	32.72	26,179	0	0	0	26,179
Operator	200	Hours	47.51	9,503	0	0	0	9,503
Tractor-Loader-Backhoe	200	Hours	28.00	0	5,600	0	0	5,600
4" Fabric-Wrapped Perforated Corrugated HDPE	10,500	LF	2.00	0	0	21,000	0	21,000
6" HDPE Pipe, SDR 11	5,700	LF	3.00	0	0	17,100	0	17,100
4" HDPE Caps	50	Each	50.00	0	0	2,500	0	2,500
4" HDPE Elbows	2	Each	25.00	0	0	50	0	50
4" HDPE Tees	6	Each	35.00	0	0	210	0	210
6" HDPE Elbows	6	Each	40.00	0	0	240	0	240
6" HDPE Tees	43	Each	65.00	0	0	2,795	0	2,795
6" HDPE Crosses	4	Each	85.00	0	0	340	0	340
6"x4" HDPE Tees	44	Each	65.00	0	0	2,860	0	2,860
2'x2' Subsurface Vaults	55	Each	100.00	0	0	5,500	0	5,500
Coarse Sand	650	CCY	20.00	0	0	13,000	0	13,000
Sample Ports	55	Each	100.00	0	0	5,500	0	5,500
Flow Control Valves, Vacuum Transmitters	55	Each	500.00	0	0	27,500	0	27,500
Concrete Floor Slab Repair								
Labor Foreman	40	Hours	34.05	1,362	0	0	0	1,362
Laborers	160	Hours	32.72	5,236	0	0	0	5,236
Concrete Pump	40	Hours	100.00	0	0	0	4,000	4,000
Welded Wire Fabric	16,500	SF	0.15	0	0	0	2,475	2,475
Concrete, 3000 psi, 3/4" Aggregate	310	CY	70.00	0	0	21,700	0	21,700

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Caulk Joint in Concrete Floor Slab where New meets Existing								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Caulk	32,000	LF	0.03	0	0	0	960	960
Characterization & Disposal, Concrete & Soil	1,050	CY	50.00	0	0	0	52,500	52,500
TOTAL - Demolish/Replace Floor Slab	291	CY		100,036	28,200	126,795	123,935	378,966
SVE Treatment System								
50-Gallon Knock-Out Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
50-Gallon Knock-Out Tank	2	Each	500.00	0	0	1,000	0	1,000
Blower								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Blower, Varialbe Speed, 1000 SCFM	3	Each	7,500.00	0	0	22,500	0	22,500
Particular Filter and Silencers								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Particular Filter	3	Each	1,000.00	0	0	3,000	0	3,000
Silencers	3	Each	500.00	0	0	1,500	0	1,500
Piping								
Plumber Foreman	20	Hours	38.60	772	0	0	0	772
Plumber	20	Hours	37.00	740	0	0	0	740
Pipe and Fittings	500	LF	5.00	0	0	2,500	0	2,500

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Liquid Pumps								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Liquid Pumps	3	Each	1,000.00	0	0	3,000	0	3,000
Vapor Treatment System								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Air to Air Heat Exchanger	1	Each	5,000.00	0	0	5,000	0	5,000
5000-pound Activated Carbon Canister	2	Each	10,000.00	0	0	20,000	0	20,000
Sample Ports	5	Each	100.00	0	0	500	0	500
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
200-pound Activated Carbon Canister	2	Each	1,000.00	0	0	2,000	0	2,000
Sample Ports	4	Each	100.00	0	0	400	0	400
SVE Treatment System Electrical								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
SVE Treatment System Electrical Materials	1	Lot	5,000.00	0	0	5,000	0	5,000
SVE Treatment Control System								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
SVE Treatment Control System	1	Each	10,000.00	0	0	10,000	0	10,000

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pre-Engineered Metal Building, 20'x20'x12' high	1	Each	20,000.00	0	0	20,000	0	20,000
Project Engineer/HSO	1,720	Hours	77.00	132,440	0	0	0	132,440
Q.C. Engineer	1,720	Hours	77.00	132,440	0	0	0	132,440
TOTAL - SVE Treatment System	1	Each		275,194	1,400	97,150	0	373,744
Monitoring Points, to 5 VF Below Ground Surface (BGS)								
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
Install Monitoring Points	100	Wells	250.00	0	0	0	25,000	25,000
TOTAL - Monitoring Points	100	Wells		0	0	0	27,500	27,500
Sampling and Analysis - Start-Up								
Off-Site Analytical - Indoor Air Quality								
VOCs	96	Each	150.00	0	0	0	14,400	14,400
Off-Site Analytical - Soil Vapor								
VOCs	30	Each	150.00	0	0	0	4,500	4,500
TOTAL - Sampling and Analysis - Start-Up	126	Each		0	0	0	18,900	18,900
Plant Operation - Start-Up								
Plant Operator	960	Hours	40.00	38,400	0	0	0	38,400
Electricity								
SVE Treatment System	60,000	kWhr	0.06	0	0	0	4,800	4,800
TOTAL - Plant Operation - Start-Up	18	Months		38,400	0	0	4,800	43,200

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	500	Mandays	35.00	0	0	17,500	0	17,500
TOTAL - PPC/PPE	500	Mandays		0	0	17,500	0	17,500
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Remove Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Remove Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250

TABLE B-6
SVE, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		4,249	560	0	4,150	8,959
Home Office								
Project Manager (40 Hours/Mo.)	960	Hours	148.50	142,560	0	0	0	142,560
Support Personnel (Timekeeping, Procurement)	720	Hours	82.50	59,400	0	0	0	59,400
Other Personnel (50 Hours/Mo.)	1,200	Hours	99.00	118,800	0	0	0	118,800
Travel to Site (18 Mo, 3/Mo, 300 miles each)	16,200	Miles	0.32	0	0	0	5,103	5,103
Hotels, Meals at Site (18 Mo, 3/Mo, 3 Days each)	162	Days	125.00	0	0	0	20,250	20,250
TOTAL - Home Office	24	Months		320,760	0	0	25,353	346,113
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	55.00	55,000	0	0	0	55,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	3,000	Hours	7.50	0	22,500	0	0	22,500
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		154,000	22,500	0	78,200	254,700

TABLE B-7
SVE OPERATION YEAR 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation - Year 1								
Plant Operator	4,000	Hours	40.00	160,000	0	0	0	160,000
Electricity								
SVE Treatment System	120,000	kWhr	0.06	0	0	0	9,600	9,600
Vapor Treatment Activated Carbon Changeout	10,000	lb.	1.50	0	0	15,000	0	15,000
Liquid Treatment Activated Carbon Changeout	400	lb.	1.50	0	0	600	0	600
Replacement/Maintenance Parts & Equipment	1	LS	10,000.00	0	0	10,000	0	10,000
TOTAL - Plant Operation - Year 1	12	Months		160,000	0	25,600	9,600	195,200
Sampling and Analysis - Year 1								
Off-Site Analytical - Soil Vapor								
VOCs	160	Each	150.00	0	0	0	24,000	24,000
Off-Site Analytical - Indoor Air Quality								
VOCs	560	Each	150.00	0	0	0	84,000	84,000
TOTAL - Sampling and Analysis - Year 1	720	Each		0	0	0	108,000	108,000
Floor Inspection and Maintenance - Year 1								
Labor Foreman	80	Hours	31.75	2,540	0	0	0	2,540
Laborers	80	Hours	30.54	2,443	0	0	0	2,443
Pressure Washer	80	Hours	10.00	0	800	0	0	800
TOTAL - Floor Inspection and Maintenance - Year 1	12	Months		4,983	800	0	0	5,783

TABLE B-7
SVE OPERATION YEAR 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office - Year 1								
Project Manager (10 Hours/Mo.)	120	Hours	148.50	17,820	0	0	0	17,820
Project Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Q.C. Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Field Engineer	120	Hours	99.00	11,880	0	0	0	11,880
HSO	120	Hours	99.00	11,880	0	0	0	11,880
Support Personnel (Timekeeping, Procurement)	120	Hours	82.50	9,900	0	0	0	9,900
Other Personnel (10 Hours/Mo.)	120	Hours	99.00	11,880	0	0	0	11,880
Travel to Site (12 Mo, 3/Mo, 300 miles each)	10,800	Miles	0.32	0	0	0	3,402	3,402
Hotels, Meals at Site (12 Mo, 3/Mo, 2 Days each)	72	Days	125.00	0	0	0	9,000	9,000
TOTAL - Home Office - Year 1	12	Months		91,080	0	0	12,402	103,482

TABLE B-8
SVE OPERATION YEAR 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation - Year 2								
Plant Operator	2,400	Hours	40.00	96,000	0	0	0	96,000
Electricity								
SVE Treatment System	120,000	kWhr	0.06	0	0	0	9,600	9,600
Vapor Treatment Activated Carbon Changeout	10,000	lb.	1.50	0	0	15,000	0	15,000
Liquid Treatment Activated Carbon Changeout	400	lb.	1.50	0	0	600	0	600
Replacement/Maintenance Parts & Equipment	1	LS	10,000.00	0	0	10,000	0	10,000
TOTAL - Plant Operation - Year 2	12	Months		96,000	0	25,600	9,600	131,200
Sampling and Analysis - Year 2								
Off-Site Analytical - Soil Vapor								
VOCs	40	Each	150.00	0	0	0	6,000	6,000
Off-Site Analytical - Indoor Air Quality								
VOCs	212	Each	150.00	0	0	0	31,800	31,800
TOTAL - Sampling and Analysis - Year 2	252	Each		0	0	0	37,800	37,800
Floor Inspection and Maintenance - Year 2								
Labor Foreman	80	Hours	31.75	2,540	0	0	0	2,540
Laborers	80	Hours	30.54	2,443	0	0	0	2,443
Pressure Washer	80	Hours	10.00	0	800	0	0	800
TOTAL - Floor Inspection and Maintenance - Year 2	12	Months		4,983	800	0	0	5,783

TABLE B-8
SVE OPERATION YEAR 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office - Year 2								
Project Manager (10 Hours/Mo.)	120	Hours	148.50	17,820	0	0	0	17,820
Project Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Q.C. Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Support Personnel (Timekeeping, Procurement)	120	Hours	82.50	9,900	0	0	0	9,900
Travel to Site (12 Mo, 1/Mo, 300 miles each)	3,600	Miles	0.32	0	0	0	1,134	1,134
Hotels, Meals at Site (12 Mo, 1/Mo, 2 Days each)	24	Days	125.00	0	0	0	3,000	3,000
TOTAL - Home Office - Year 2	12	Months		55,440	0	0	4,134	59,574

TABLE B-9
SVE OPERATION YEARS 3 - 30, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation - Years 3-30								
Plant Operator	2,400	Hours	40.00	96,000	0	0	0	96,000
Electricity								
SVE Treatment System	120,000	kWhr	0.06	0	0	0	9,600	9,600
Vapor Treatment Activated Carbon Changeout	10,000	lb.	1.50	0	0	15,000	0	15,000
Liquid Treatment Activated Carbon Changeout	400	lb.	1.50	0	0	600	0	600
Replacement/Maintenance Parts & Equipment	1	LS	10,000.00	0	0	10,000	0	10,000
TOTAL - Plant Operation - Years 3-30	12	Months		96,000	0	25,600	9,600	131,200
Sampling and Analysis - Years 3-30								
Off-Site Analytical - Soil Vapor								
VOCs	40	Each	150.00	0	0	0	6,000	6,000
Off-Site Analytical - Indoor Air Quality								
VOCs	212	Each	150.00	0	0	0	31,800	31,800
TOTAL - Sampling and Analysis - Years 3-30	252	Each		0	0	0	37,800	37,800
Floor Inspection and Maintenance - Years 3-30								
Labor Foreman	80	Hours	31.75	2,540	0	0	0	2,540
Laborers	80	Hours	30.54	2,443	0	0	0	2,443
Pressure Washer	80	Hours	10.00	0	800	0	0	800
TOTAL - Floor Inspection and Maintenance - Years 3-30	12	Months		4,983	800	0	0	5,783

TABLE B-9
SVE OPERATION YEARS 3 - 30, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office - Years 3-30								
Project Manager (10 Hours/Mo.)	120	Hours	148.50	17,820	0	0	0	17,820
Project Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Q.C. Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Support Personnel (Timekeeping, Procurement)	120	Hours	82.50	9,900	0	0	0	9,900
Travel to Site (12 Mo, 1/Mo, 300 miles each)	3,600	Miles	0.32	0	0	0	1,134	1,134
Hotels, Meals at Site (12 Mo, 1/Mo, 2 Days each)	24	Days	125.00	0	0	0	3,000	3,000
TOTAL - Home Office - Years 3-30	12	Months		55,440	0	0	4,134	59,574

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation								
Design & Planning								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	1,000	Hours	100.00	100,000	0	0	0	100,000
Other non-Engineer Support	400	Hours	40.00	16,000	0	0	0	16,000
Computers, etc.	350	Hours	10.00	0	0	0	3,500	3,500
Drawings, Specifications Copies, etc.	1	LS	10,000.00	0	0	0	10,000	10,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
Preparation of Plans								
Engineering Manager, P.E.	20	Hours	200.00	4,000	0	0	0	4,000
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	25	Hours	40.00	1,000	0	0	0	1,000
Computers, etc.	45	Hours	10.00	0	0	0	450	450
Report Copying, etc.	1	LS	1,000.00	0	0	0	1,000	1,000
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	500	500
TOTAL - Preparation	1	LS		151,000	0	0	17,950	168,950
Mobilization								
Showers/Change Rooms - Build in Existing Bldg	1	LS	5,000.00	0	0	0	5,000	5,000
Storage Box	2	Each	150.00	0	0	0	300	300
Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	1,000.00	0	0	1,000	0	1,000
Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Mobilize Driller	1	LS	12,000.00	0	0	0	12,000	12,000
TOTAL - Mobilization	1	LS		4,249	560	3,500	20,150	28,459
Install Extraction System								
Drill & Install Extraction Wells								
Drilling	80	VF	45.00	0	0	0	3,600	3,600
Screen, 6" Dia., SS, 0.020" Slot Screens	20	VF	80.00	0	0	0	1,600	1,600
Screen, 8" Dia., SS, 0.020" Slot Screens	20	VF	115.00	0	0	0	2,300	2,300
Riser, 6" Dia., SS	60	VF	60.00	0	0	0	3,600	3,600
Riser, 8" Dia., SS	40	VF	90.00	0	0	0	3,600	3,600
Miscellaneous Materials	4	Wells	625.00	0	0	0	2,500	2,500
Well Development	4	Wells	3,000.00	0	0	0	12,000	12,000
Frac Tank	4	Months	2,500.00	0	10,000	0	0	10,000
Manhole Structure								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborer	20	Hours	32.72	654	0	0	0	654
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Precast Manhole, 6' Diameter	2	Each	500.00	0	0	0	1,000	1,000
Frame and Cover	2	Each	250.00	0	0	0	500	500
Miscellaneous Materials	2	Each	100.00	0	0	0	200	200
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	11	Drums	100.00	0	0	0	1,100	1,100

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Extraction Pump System								
Submersible Well Pump, 5 gpm	2	Each	975.00	0	0	0	1,950	1,950
Submersible Well Pump, 30 gpm	2	Each	2,850.00	0	0	0	5,700	5,700
1.5" HDPE Well Pipe and Fittings	70	LF	10.00	0	0	0	700	700
3" HDPE Well Pipe and Fittings	50	LF	19.00	0	0	0	950	950
Sample Ports	4	Each	100.00	0	0	0	400	400
Transducers	4	Each	375.00	0	0	0	1,500	1,500
Junction Boxes in Well Vault	2	Each	350.00	0	0	0	700	700
Level Control System	4	Each	250.00	0	0	0	1,000	1,000
Flow Meters	4	Each	675.00	0	0	0	2,700	2,700
Flow Control Valves	4	Each	78.00	0	0	0	312	312
Check Valves	4	Each	65.00	0	0	0	260	260
Recorders	4	Each	1,500.00	0	0	0	6,000	6,000
Miscellaneous Materials	4	Each	625.00	0	0	0	2,500	2,500
Pipe from Wells to Building 63 Sump								
Labor Foreman	15	Hours	34.05	511	0	0	0	511
Laborers	30	Hours	32.72	982	0	0	0	982
Operator	15	Hours	47.51	713	0	0	0	713
Tractor-Loader-Backhoe	15	Hours	28.00	0	420	0	0	420
Pipe and Fittings	250	LF	5.00	0	0	1,250	0	1,250
Power Conduit and Wire	250	LF	5.00	0	0	0	1,250	1,250
Control Signal Conduit and Wire	250	LF	7.00	0	0	0	1,750	1,750
Pavement Restoration, t = 3"	83	SY	15.00	0	0	0	1,245	1,245
TOTAL - Extraction System	4	Wells		4,491	10,980	1,250	60,917	77,638

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Injection System								
Drill & Install Injection Wells - Phase 1								
Drilling	640	VF	30.00	0	0	0	19,200	19,200
Screen, 1" Dia., SS, 0.020" Slot Screens	320	VF	30.00	0	0	0	9,600	9,600
Riser, 1" Dia., SS	800	VF	18.00	0	0	0	14,400	14,400
Flush Mount Cover	32	Wells	150.00	0	0	0	4,800	4,800
Miscellaneous Materials	1	LS	2,000.00	0	0	0	2,000	2,000
Well Development	32	Wells	700.00	0	0	0	22,400	22,400
Frac Tank	4	Months	2,500.00	0	10,000	0	0	10,000
Drill & Install Injection Wells - Phase 2								
Drilling	320	VF	30.00	0	0	0	9,600	9,600
Screen, 1" Dia., SS, 0.020" Slot Screens	160	VF	30.00	0	0	0	4,800	4,800
Riser, 1" Dia., SS	400	VF	18.00	0	0	0	7,200	7,200
Flush Mount Cover	16	Wells	150.00	0	0	0	2,400	2,400
Miscellaneous Materials	1	LS	2,000.00	0	0	0	2,000	2,000
Well Development	16	Wells	700.00	0	0	0	11,200	11,200
Frac Tank	4	Months	2,500.00	0	10,000	0	0	10,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	59	Drums	100.00	0	0	0	5,900	5,900
Well Installation								
Pressure Guage	48	Each	48.00	0	0	0	2,304	2,304
Flow Meters	48	Each	375.00	0	0	0	18,000	18,000
Flow Control Valves	48	Each	48.00	0	0	0	2,304	2,304
Hose Bibb Connection	48	Each	25.00	0	0	0	1,200	1,200
Install Infiltration Gallery								
Labor Foreman	40	Hours	34.05	1,362	0	0	0	1,362
Laborer	40	Hours	32.72	1,309	0	0	0	1,309
Operator	40	Hours	47.51	1,901	0	0	0	1,901
Tractor-Loader-Backhoe	40	Hours	28.00	0	1,120	0	0	1,120
Coarse Sand	24	CCY	20.00	0	0	480	0	480
1" Perforated PVC Pipe	1,950	LF	1.25	0	0	2,438	0	2,438
Miscellaneous Fittings	1	LS	50.00	0	0	50	0	50

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pavement Restoration, t = 3"	216	SY	15.00	0	0	0	3,240	3,240
Characterization & Disposal, Concrete & Soil	72	CY	100.00	0	0	0	7,200	7,200
TOTAL - Injection System	48	Wells		4,571	21,120	2,968	149,748	178,407
Install Monitoring System								
Drill & Install Piezometers								
Drilling	960	VF	30.00	0	0	0	28,800	28,800
Screen, 1" Dia., PVC Slot Screens	540	VF	4.00	0	0	0	2,160	2,160
Riser, 1" Dia., PVC	1,260	VF	3.00	0	0	0	3,780	3,780
Flush Mount Cover	24	Wells	150.00	0	0	0	3,600	3,600
Well Development	24	Wells	700.00	0	0	0	16,800	16,800
Frac Tank	4	Months	2,500.00	0	10,000	0	0	10,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	58	Drums	100.00	0	0	0	5,800	5,800
TOTAL - Install Monitoring System	24	Wells		0	10,000	0	60,940	70,940
Install Chemical Makeup and Delivery System								
Potassium Permanganate Bulk Bag Dump Station w/ Dust Control								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Dump Station w/ Dust Control	1	Each	2,500.00	0	0	2,500	0	2,500
Potassium Permanganate Hopper								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Hopper	1	Each	1,500.00	0	0	1,500	0	1,500

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Potassium Permanganate Feeder								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Feeder	1	Each	2,500.00	0	0	2,500	0	2,500
Potassium Permanganate Conveyor								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Conveyor	1	Each	2,500.00	0	0	2,500	0	2,500
Potassium Permanganate Flash Mix Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Mix Tank, 100 Gallon	1	Each	500.00	0	0	500	0	500
Potassium Permanganate Mix Tank Mixer	1	Each	500.00	0	0	500	0	500
Potassium Permanganate Solution Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Permanganate Solution Storage Tank, 5000 Gal.	1	Each	10,000.00	0	0	10,000	0	10,000
Potassium Permanganate Storage Tank Mixer	1	Each	1,500.00	0	0	1,500	0	1,500
Sulfuric Acid Containment Area								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Sulfuric Acid Containment Area	1	Each	2,500.00	0	0	2,500	0	2,500

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sulfuric Acid Metering Pump								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Sulfuric Acid Metering Pump	1	Each	2,000.00	0	0	2,000	0	2,000
Potassium Permanganate Solution Distribution								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Permanganate Solution Distribution Manifold	1	Each	1,000.00	0	0	1,000	0	1,000
Permanganate Solution Distribution Pump	2	Each	1,500.00	0	0	3,000	0	3,000
Permanganate Solution Pressure Hoses	1,000	LF	3.00	0	0	3,000	0	3,000
Chemical Mixing and Feeding Control System								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Mixing and Feeding Control System	1	Each	10,000.00	0	0	10,000	0	10,000
Process Piping								
Plumber Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Plumber	100	Hours	37.00	3,700	0	0	0	3,700
2" CPVC Pipe & Fittings, Schedule 80	500	LF	10.00	0	0	5,000	0	5,000
TOTAL - Chemical Makeup and Delivery System	1	LS		16,081	1,680	48,000	0	65,761
Pressure Test Pipeline to Chemical Waste Treatment Plant (CWTP)								
Pressure Test Pipeline, 1100 LF	1	LS	500.00	0	0	0	500	500

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pull New Control Wire through Existing Conduit, 1100 LF								
Electrician Foreman	10	Hours	38.60	386	0	0	0	386
Electrician	10	Hours	37.00	370	0	0	0	370
New Control Wire	1,100	LF	1.00	0	0	1,100	0	1,100
TOTAL - Pressure Test Pipeline to CWTP	1	LS		756	0	1,100	500	2,356
Rebuild Pipeline to CWTP (Contingency cost in case pressure test fails - not included in summary cost for alternative)								
Permit for Work in Public Road	1	LS	2,500.00	0	0	0	2,500	2,500
Excavate & Remove Existing Pipe, 1100 LF, includes 100 BCY of Overexcavation								
Labor Foreman	25	Hours	34.05	851	0	0	0	851
Laborers	25	Hours	32.72	818	0	0	0	818
Operator	25	Hours	47.51	1,188	0	0	0	1,188
Tractor-Loader-Backhoe	25	Hours	28.00	0	700	0	0	700
Pipe Bedding	41	CCY	20.00	0	0	820	0	820
4" SDR 11 HDPE Pipe	1,100	LF	2.00	0	0	2,200	0	2,200
Pressure Test Pipeline, 1100 LF	1	LS	500.00	0	0	0	500	500
New Conduit & Control Wire, 1100 LF								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
New Conduit with Control Wire	1,100	LF	3.00	0	0	3,300	0	3,300
Pull Boxes	6	Each	50.00	0	0	300	0	300
Backfill & Compaction, 1100 LF								
Labor Foreman	25	Hours	34.05	851	0	0	0	851
Laborers	25	Hours	32.72	818	0	0	0	818
Operator	25	Hours	47.51	1,188	0	0	0	1,188
Tractor-Loader-Backhoe	25	Hours	28.00	0	700	0	0	700
Characterization & Disposal, Contaminated Soil	100	CY	100.00	0	0	0	10,000	10,000
Pavement Restoration, t = 3"	367	SY	15.00	0	0	0	5,505	5,505
Curb Repair @ Road Crossing	12	LF	25.00	0	0	0	300	300
TOTAL - Rebuild Pipeline to CWTP	1,100	LF		7,226	1,400	6,620	18,805	34,051

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Organics Treatment System @ CWTP								
pH Adjustment Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
pH Adjustment Tank, 1000 Gallon	1	Each	1,500.00	0	0	1,500	0	1,500
pH Adjustment Tank Mixer	1	Each	750.00	0	0	750	0	750
Acid Piping								
Plumber Foreman	12	Hours	38.60	463	0	0	0	463
Plumber	12	Hours	37.00	444	0	0	0	444
2" CPVC Pipe & Fittings, Schedule 80	200	LF	10.00	0	0	2,000	0	2,000
Heat Tracing								
Electrician Foreman	12	Hours	38.60	463	0	0	0	463
Electrician	12	Hours	37.00	444	0	0	0	444
New Conduit with Control Wire	200	LF	20.00	0	0	4,000	0	4,000
UV/Oxidation Feed Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
UV/Oxidation Feed Pump, 60 gpm, 50 Ft. TDH	1	Each	2,200.00	0	0	2,200	0	2,200
UV/Oxidation Unit								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
UV/Oxidation Unit, 60 KW	1	Each	50,000.00	0	0	50,000	0	50,000
Hydrogen Peroxide Tank and Feed System								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrogen Peroxide Tank and Feed System	1	Each	20,000.00	0	0	20,000	0	20,000
Secondary Containment	1	Each	2,500.00	0	0	2,500	0	2,500

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Process Water/Miscellaneous Piping								
Plumber Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Plumber	40	Hours	37.00	1,480	0	0	0	1,480
2" CPVC Pipe & Fittings, Schedule 80	500	LF	10.00	0	0	5,000	0	5,000
Motor Starters and Controls								
Electrician Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Electrician	100	Hours	37.00	3,700	0	0	0	3,700
Motor Starters and Controls	1	LS	10,000.00	0	0	10,000	0	10,000
Equipment Pad/Slab-on-Grade, 20'x20'x1'								
Carpenter/IW Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Carpenter/IW	30	Hours	37.00	1,110	0	0	0	1,110
Forms	1	LS	1,000.00	0	0	1,000	0	1,000
Anchor Bolts	20	Each	5.00	0	0	100	0	100
Place Concrete Floor Slab								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	120	Hours	32.72	3,927	0	0	0	3,927
Cement Mason Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Cement Mason	30	Hours	37.00	1,110	0	0	0	1,110
Concrete, 3000 psi, 3/4" Aggregate	16	CY	70.00	0	0	1,120	0	1,120
Pre-Engineered Metal Building, 20'x20'x12' high	1	Each	20,000.00	0	0	20,000	0	20,000
TOTAL - Organics Treatment System	1	LS		26,948	980	120,170	0	148,098
Sampling and Analysis								
Perforamance Evaluation Sample Collection								
Sample Technicians (3)	2,700	Hours	55.00	148,500	0	0	0	148,500
Travel to Site (18 Mo, 1/Mo, 300 miles each)	5,400	Miles	0.32	0	0	0	1,701	1,701
Hotels, Meals at Site (18 Mo, 1/Mo, 5 Days each)	270	Days	125.00	0	0	0	33,750	33,750
Shipping	18	Each		0	0	0	1,800	1,800
Discharge Performance Monitoring Sample Collection								
Shipping	60	Each	100.00	0	0	0	6,000	6,000

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Off-Site Confirmation Sample Analysis								
VOCs	686	Each	150.00	0	0	0	102,900	102,900
Iron (Ferrous Iron)	206	Each	25.00	0	0	0	5,150	5,150
Manganese	206	Each	25.00	0	0	0	5,150	5,150
Alkalinity	206	Each	15.00	0	0	0	3,090	3,090
Salinity	206	Each	15.00	0	0	0	3,090	3,090
On-Site Analysis using Field Test Kits								
Dissolved Manganese	1,584	Each	15.00	0	0	0	23,760	23,760
Alkalinity	1,584	Each	15.00	0	0	0	23,760	23,760
Salinity	1,584	Each	1.00	0	0	0	1,584	1,584
Dissolved Oxygen	1,584	Each	1.00	0	0	0	1,584	1,584
Redox Potential	1,584	Each	1.00	0	0	0	1,584	1,584
Specific Conductivity	1,584	Each	1.00	0	0	0	1,584	1,584
Temperature	1,584	Each	1.00	0	0	0	1,584	1,584
Turbidity	1,584	Each	1.00	0	0	0	1,584	1,584
pH	1,584	Each	1.00	0	0	0	1,584	1,584
TOTAL - Sampling and Analysis	15,766	Each		148,500	0	0	221,239	369,739
Report Preparation								
Engineering Manager, P.E.	24	Hours	200.00	4,800	0	0	0	4,800
Other Engineering Support	320	Hours	100.00	32,000	0	0	0	32,000
Other non-Engineer Support	136	Hours	40.00	5,440	0	0	0	5,440
Computers, etc.	190	Hours	10.00	0	0	0	1,900	1,900
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	1,000.00	0	0	0	1,000	1,000
TOTAL - Report Preparation	480	Hours		42,240	0	0	7,900	50,140

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation								
Plant Operator	3,900	Hours	40.00	156,000	0	0	0	156,000
Plant Operations ODCs	390	Days	50.00	0	0	0	19,500	19,500
Engineering Support	1,560	Hours	100.00	156,000	0	0	0	156,000
Per Diems	195	Days	100.00	0	0	0	19,500	19,500
Project Vehicles	1,560	Hours	7.50	0	11,700	0	0	11,700
Electricity								
Extraction Pumps	60,000	kWhr	0.06	0	0	0	4,800	4,800
Potassium Permanganate Makeup System	20,000	kWhr	0.06	0	0	0	1,600	1,600
Injection Pumps	50,000	kWhr	0.06	0	0	0	4,000	4,000
Building 63 Sump Pumps	50,000	kWhr	0.06	0	0	0	4,000	4,000
pH Adjustment Tank Mixer	5,000	kWhr	0.06	0	0	0	400	400
UV/Oxidation Feed Pump	10,000	kWhr	0.06	0	0	0	800	800
UV/Oxidation System	800,000	kWhr	0.06	0	0	0	64,000	64,000
Miscellaneous	30,000	kWhr	0.06	0	0	0	2,400	2,400
Potassium Permanganate	38,884	lb.	1.36	0	0	52,882	0	52,882
Sufuric Acid	308	lb.	0.28	0	0	86	0	86
Hydrogen Peroxide	11,441	lb.	0.60	0	0	6,865	0	6,865
Water Supply (City Water)	31,536	MGallon	1.00	0	0	31,536	0	31,536
Replacement/Maintenance Parts	1	LS	25,000.00	0	0	25,000	0	25,000
CWTP Charges	45,727	MGallon	1.00	0	0	45,727	0	45,727
Well Maintenance/Cleaning	1	LS	50,000.00	0	0	50,000	0	50,000
Project Engineer/HSO	1,720	Hours	77.00	132,440	0	0	0	132,440
Q.C. Engineer	1,720	Hours	77.00	132,440	0	0	0	132,440
TOTAL - Plant Operation	18	Months		576,880	11,700	212,096	121,000	921,676
Deconstruct Extraction Wells/Injection Wells Systems								
Labor Foreman	100	Hours	34.05	3,405	0	0	0	3,405
Laborer	200	Hours	32.72	6,545	0	0	0	6,545
Operator	100	Hours	47.51	4,751	0	0	0	4,751
Tractor-Loader-Backhoe	100	Hours	28.00	0	2,800	0	0	2,800
Disposal - Pipe, Pavement & Other Debris	40	Tons	50.00	0	2,000	0	0	2,000
Pavement Restoration, t = 3"	216	SY	15.00	0	0	0	3,240	3,240

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
TOTAL - Deconstruct Extraction/Injection Systems	34	Wells		14,701	4,800	0	3,240	22,741
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	650	Mandays	35.00	0	0	22,750	0	22,750
TOTAL - PPC/PPE	650	Mandays		0	0	22,750	0	22,750
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Remove Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Remove Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		4,249	560	0	5,650	10,459
Home Office								
Project Manager (40 Hours/Mo.)	960	Hours	148.50	142,560	0	0	0	142,560
Support Personnel (Timekeeping, Procurement)	720	Hours	82.50	59,400	0	0	0	59,400
Other Personnel (50 Hours/Mo.)	1,200	Hours	99.00	118,800	0	0	0	118,800
Travel to Site (18 Mo, 5/Mo, 300 miles each)	27,000	Miles	0.32	0	0	0	8,505	8,505
Hotels, Meals at Site (18 Mo, 5/Mo, 3 Days each)	270	Days	125.00	0	0	0	33,750	33,750
TOTAL - Home Office	24	Months		320,760	0	0	42,255	363,015

TABLE B-10
IN-SITU OXIDATION HOT SPOT NO.1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		165,000	30,000	0	78,200	273,200

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation - Based on this being addition to Hot Spot 1								
Design & Planning								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
TOTAL - Preparation	1	LS		29,600	0	0	2,700	32,300
Mobilization -- Covered by Hot Spot 1								
Install Extraction System								
Drill & Install Extraction Wells								
Drilling	40	VF	155.00	0	0	0	6,200	6,200
Screen, 6" Dia., SS, 0.020" Slot Screens	10	VF	80.00	0	0	0	800	800
Screen, 8" Dia., SS, 0.020" Slot Screens	10	VF	115.00	0	0	0	1,150	1,150
Riser, 6" Dia., SS	30	VF	60.00	0	0	0	1,800	1,800
Riser, 8" Dia., SS	20	VF	90.00	0	0	0	1,800	1,800
Miscellaneous Materials	4	Wells	625.00	0	0	0	2,500	2,500
Well Development	4	Wells	3,000.00	0	0	0	12,000	12,000
Frac Tank	1	Months	2,500.00	0	2,500	0	0	2,500

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Manhole Structure								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborer	20	Hours	32.72	654	0	0	0	654
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Precast Manhole, 6' Diameter	2	Each	500.00	0	0	0	1,000	1,000
Frame and Cover	2	Each	250.00	0	0	0	500	500
Miscellaneous Materials	2	Each	100.00	0	0	0	200	200
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	3	Drums	100.00	0	0	0	300	300
Extraction Pump System								
Submersible Well Pump, 15 gpm	1	Each	1,250.00	0	0	0	1,250	1,250
Submersible Well Pump, 40 gpm	1	Each	2,850.00	0	0	0	2,850	2,850
1.5" HDPE Well Pipe and Fittings	35	LF	10.00	0	0	0	350	350
3" HDPE Well Pipe and Fittings	25	LF	19.00	0	0	0	475	475
Sample Ports	2	Each	100.00	0	0	0	200	200
Transducers	2	Each	375.00	0	0	0	750	750
Junction Boxes in Well Vault	1	Each	350.00	0	0	0	350	350
Level Control System	2	Each	250.00	0	0	0	500	500
Flow Meters	2	Each	675.00	0	0	0	1,350	1,350
Flow Control Valves	2	Each	78.00	0	0	0	156	156
Check Valves	2	Each	65.00	0	0	0	130	130
Recorders	2	Each	1,500.00	0	0	0	3,000	3,000
Miscellaneous Materials	2	Each	625.00	0	0	0	1,250	1,250
Pipe from Wells to Building B-10								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Pipe and Fittings	400	LF	5.00	0	0	2,000	0	2,000
Power Conduit and Wire	400	LF	5.00	0	0	0	2,000	2,000
Control Signal Conduit and Wire	400	LF	7.00	0	0	0	2,800	2,800
Pavement Restoration, t = 3"	133	SY	15.00	0	0	0	1,995	1,995
TOTAL - Extraction System	4	Wells		5,226	3,620	2,000	47,656	58,502

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Injection System								
Drill & Install Injection Wells - Phase 1								
Drilling	400	VF	30.00	0	0	0	12,000	12,000
Screen, 1" Dia., SS, 0.020" Slot Screens	200	VF	30.00	0	0	0	6,000	6,000
Riser, 1" Dia., SS	500	VF	18.00	0	0	0	9,000	9,000
Flush Mount Cover	20	Wells	150.00	0	0	0	3,000	3,000
Miscellaneous Materials	1	LS	2,000.00	0	0	0	2,000	2,000
Well Development	20	Wells	700.00	0	0	0	14,000	14,000
Frac Tank	4	Months	2,500.00	0	10,000	0	0	10,000
Drill & Install Injection Wells - Phase 2								
Drilling	200	VF	30.00	0	0	0	6,000	6,000
Screen, 1" Dia., SS, 0.020" Slot Screens	100	VF	30.00	0	0	0	3,000	3,000
Riser, 1" Dia., SS	250	VF	18.00	0	0	0	4,500	4,500
Flush Mount Cover	10	Wells	150.00	0	0	0	1,500	1,500
Miscellaneous Materials	1	LS	2,000.00	0	0	0	2,000	2,000
Well Development	10	Wells	700.00	0	0	0	7,000	7,000
Frac Tank	2	Months	2,500.00	0	5,000	0	0	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	24	Drums	100.00	0	0	0	2,400	2,400
Well Installation								
Pressure Guage	30	Each	48.00	0	0	0	1,440	1,440
Flow Meters	30	Each	375.00	0	0	0	11,250	11,250
Flow Control Valves	30	Each	48.00	0	0	0	1,440	1,440
Hose Bibb Connection	30	Each	25.00	0	0	0	750	750
Install Infiltration Gallery								
Labor Foreman	15	Hours	34.05	511	0	0	0	511
Laborer	15	Hours	32.72	491	0	0	0	491
Operator	15	Hours	47.51	713	0	0	0	713
Tractor-Loader-Backhoe	15	Hours	28.00	0	420	0	0	420
Coarse Sand	7	CCY	20.00	0	0	140	0	140
1" Perforated PVC Pipe	540	LF	1.25	0	0	675	0	675
Miscellaneous Fittings	1	LS	50.00	0	0	50	0	50

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pavement Restoration, t = 3"	60	SY	15.00	0	0	0	900	900
Characterization & Disposal, Concrete & Soil	20	CY	100.00	0	0	0	2,000	2,000
TOTAL - Injection System	30	Wells		1,714	15,420	865	90,180	108,179
Install Monitoring System								
Drill & Install Piezometers								
Drilling	600	VF	30.00	0	0	0	18,000	18,000
Screen, 1" Dia., PVC Slot Screens	360	VF	4.00	0	0	0	1,440	1,440
Riser, 1" Dia., PVC	810	VF	3.00	0	0	0	2,430	2,430
Flush Mount Cover	36	Wells	150.00	0	0	0	5,400	5,400
Well Development	36	Wells	700.00	0	0	0	25,200	25,200
Frac Tank	2	Months	2,500.00	0	5,000	0	0	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	36	Drums	100.00	0	0	0	3,600	3,600
TOTAL - Install Monitoring System	36	Wells		0	5,000	0	56,070	61,070
Install Chemical Makeup and Delivery System								
Potassium Permanganate Bulk Bag Dump Station w/ Dust Control								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Dump Station w/ Dust Control	1	Each	2,500.00	0	0	2,500	0	2,500
Potassium Permanganate Hopper								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Hopper	1	Each	1,500.00	0	0	1,500	0	1,500

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Potassium Permanganate Feeder								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Feeder	1	Each	2,500.00	0	0	2,500	0	2,500
Potassium Permanganate Conveyor								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Conveyor	1	Each	2,500.00	0	0	2,500	0	2,500
Potassium Permanganate Flash Mix Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Potassium Permanganate Mix Tank, 100 Gallon	1	Each	500.00	0	0	500	0	500
Potassium Permanganate Mix Tank Mixer	1	Each	500.00	0	0	500	0	500
Potassium Permanganate Solution Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Permanganate Solution Storage Tank, 5000 Gal.	1	Each	10,000.00	0	0	10,000	0	10,000
Potassium Permanganate Storage Tank Mixer	1	Each	1,500.00	0	0	1,500	0	1,500
Sulfuric Acid Containment Area								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Sulfuric Acid Containment Area	1	Each	2,500.00	0	0	2,500	0	2,500

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sulfuric Acid Metering Pump								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Sulfuric Acid Metering Pump	1	Each	2,000.00	0	0	2,000	0	2,000
Potassium Permanganate Solution Distribution								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Permanganate Solution Distribution Manifold	1	Each	1,000.00	0	0	1,000	0	1,000
Permanganate Solution Distribution Pump	2	Each	1,500.00	0	0	3,000	0	3,000
Permanganate Solution Pressure Hoses	1,000	LF	3.00	0	0	3,000	0	3,000
Chemical Mixing and Feeding Control System								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Mixing and Feeding Control System	1	Each	10,000.00	0	0	10,000	0	10,000
Process Piping								
Plumber Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Plumber	100	Hours	37.00	3,700	0	0	0	3,700
2" CPVC Pipe & Fittings, Schedule 80	500	LF	10.00	0	0	5,000	0	5,000
TOTAL - Chemical Makeup and Delivery System	1	LS		16,081	1,680	48,000	0	65,761

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Organics Treatment System @ Building B-10								
pH Reduction Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
pH Adjustment Tank, 1000 Gallon	1	Each	1,500.00	0	0	1,500	0	1,500
pH Adjustment Tank Mixer	1	Each	750.00	0	0	750	0	750
Acid Storage Tank and Acid Metering System								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Acid Storage Tank and Acid Metering System	1	Each	20,000.00	0	0	20,000	0	20,000
Secondary Containment	1	Each	2,500.00	0	0	2,500	0	2,500
Acid Piping								
Plumber Foreman	5	Hours	38.60	193	0	0	0	193
Plumber	5	Hours	37.00	185	0	0	0	185
2" CPVC Pipe & Fittings, Schedule 80	50	LF	10.00	0	0	500	0	500
UV/Oxidation Feed Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
UV/Oxidation Feed Pump, 60 gpm, 50 Ft. TDH	1	Each	2,200.00	0	0	2,200	0	2,200
UV/Oxidation Unit								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
UV/Oxidation Unit, 60 KW	1	Each	50,000.00	0	0	50,000	0	50,000

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
pH Increase Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
pH Adjustment Tank, 1000 Gallon	1	Each	1,500.00	0	0	1,500	0	1,500
pH Adjustment Tank Mixer	1	Each	750.00	0	0	750	0	750
Caustic Storage Tank and Caustic Metering System								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Caustic Storage Tank and Caustic Metering Systen	1	Each	20,000.00	0	0	20,000	0	20,000
Secondary Containment	1	Each	2,500.00	0	0	2,500	0	2,500
Hydrogen Peroxide Tank and Feed System								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrogen Peroxide Tank and Feed System	1	Each	20,000.00	0	0	20,000	0	20,000
Secondary Containment	1	Each	2,500.00	0	0	2,500	0	2,500
Process Water/Miscellaneous Piping								
Plumber Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Plumber	40	Hours	37.00	1,480	0	0	0	1,480
2" CPVC Pipe & Fittings, Schedule 80	500	LF	10.00	0	0	5,000	0	5,000
Motor Starters and Controls								
Electrician Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Electrician	100	Hours	37.00	3,700	0	0	0	3,700
Motor Starters and Controls	1	LS	10,000.00	0	0	10,000	0	10,000
TOTAL - Organics Treatment System	1	LS		20,617	1,680	139,700	0	161,997

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis								
Perforamance Evaluation Sample Collection (Based on in addition to Hot Spot No. 1)								
Sample Technicians (3)	1,080	Hours	55.00	59,400	0	0	0	59,400
Shipping	18	Each		0	0	0	1,800	1,800
Discharge Performance Monitoring Sample Collection								
Shipping	60	Each	100.00	0	0	0	6,000	6,000
Off-Site Confirmation Sample Analysis								
VOCs	322	Each	150.00	0	0	0	48,300	48,300
Iron (Ferrous Iron)	69	Each	25.00	0	0	0	1,725	1,725
Manganese	69	Each	25.00	0	0	0	1,725	1,725
Alkalinity	69	Each	15.00	0	0	0	1,035	1,035
Salinity	69	Each	15.00	0	0	0	1,035	1,035
On-Site Analysis using Field Test Kits								
Dissolved Iron	528	Each	15.00	0	0	0	7,920	7,920
Alkalinity	528	Each	15.00	0	0	0	7,920	7,920
Salinity	528	Each	1.00	0	0	0	528	528
Dissolved Oxygen	528	Each	1.00	0	0	0	528	528
Redox Potential	528	Each	1.00	0	0	0	528	528
Specific Conductivity	528	Each	1.00	0	0	0	528	528
Temperature	528	Each	1.00	0	0	0	528	528
Turbidity	528	Each	1.00	0	0	0	528	528
pH	528	Each	1.00	0	0	0	528	528
TOTAL - Sampling and Analysis	5,350	Each		59,400	0	0	81,156	140,556
Report Preparation								
Engineering Manager, P.E.	16	Hours	200.00	3,200	0	0	0	3,200
Other Engineering Support	220	Hours	100.00	22,000	0	0	0	22,000
Other non-Engineer Support	84	Hours	40.00	3,360	0	0	0	3,360
Computers, etc.	125	Hours	10.00	0	0	0	1,250	1,250
Report Copying, etc.	1	LS	3,500.00	0	0	0	3,500	3,500
Other non-Itemized Direct Costs	1	LS	750.00	0	0	0	750	750
TOTAL - Report Preparation	320	Hours		28,560	0	0	5,500	34,060

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation								
Plant Operator	2,600	Hours	40.00	104,000	0	0	0	104,000
Plant Operations ODCs	260	Days	50.00	0	0	0	13,000	13,000
Engineering Support	1,040	Hours	100.00	104,000	0	0	0	104,000
Per Diems	130	Days	100.00	0	0	0	13,000	13,000
Project Vehicles	1,040	Hours	7.50	0	7,800	0	0	7,800
Electricity								
Extraction Pumps	33,000	kWhr	0.06	0	0	0	2,640	2,640
Potassium Permanganate Makeup System	13,000	kWhr	0.06	0	0	0	1,040	1,040
Injection Pumps	33,000	kWhr	0.06	0	0	0	2,640	2,640
pH Adjustment Tank Mixers	7,000	kWhr	0.06	0	0	0	560	560
UV/Oxidation Feed Pump	7,000	kWhr	0.06	0	0	0	560	560
UV/Oxidation System	444,000	kWhr	0.06	0	0	0	35,520	35,520
Miscellaneous	20,000	kWhr	0.06	0	0	0	1,600	1,600
Potassium Permanganate	13,673	lb.	1.36	0	0	18,595	0	18,595
Sufuric Acid	136	lb.	0.28	0	0	38	0	38
Hydrogen Peroxide	6,312	lb.	0.60	0	0	3,787	0	3,787
Water Supply (City Water)	21,024	MGallon	1.00	0	0	21,024	0	21,024
Replacement/Maintenance Parts	1	LS	15,000.00	0	0	15,000	0	15,000
POTW Charges	25,229	MGallon	1.00	0	0	25,229	0	25,229
Well Maintenance/Cleaning	1	LS	25,000.00	0	0	25,000	0	25,000
Project Engineer/HSO	1,480	Hours	77.00	113,960	0	0	0	113,960
Q.C. Engineer	1,480	Hours	77.00	113,960	0	0	0	113,960
TOTAL - Plant Operation	18	Months		435,920	7,800	108,674	70,560	622,954

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Deconstruct Extraction Wells/Injection Wells Systems								
Labor Foreman	50	Hours	34.05	1,702	0	0	0	1,702
Laborer	100	Hours	32.72	3,272	0	0	0	3,272
Operator	50	Hours	47.51	2,376	0	0	0	2,376
Tractor-Loader-Backhoe	50	Hours	28.00	0	1,400	0	0	1,400
Disposal - Pipe, Pavement & Other Debris	20	Tons	50.00	0	1,000	0	0	1,000
Pavement Restoration, t = 3"	60	SY	15.00	0	0	0	900	900
TOTAL - Deconstruct Extraction/Injection Systems	22	Wells		7,351	2,400	0	900	10,651
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	450	Mandays	35.00	0	0	15,750	0	15,750
TOTAL - PPC/PPE	450	Mandays		0	0	15,750	0	15,750
Demobilization -- Covered by Hot Spot No. 1								
TOTAL - Demobilization	1	LS		0	0	0	0	0

TABLE B-11
IN-SITU OXIDATION HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office								
Project Manager (20 Hours/Mo.)	360	Hours	148.50	53,460	0	0	0	53,460
Support Personnel (Timekeeping, Procurement)	480	Hours	82.50	39,600	0	0	0	39,600
Other Personnel (50 Hours/Mo.)	900	Hours	99.00	89,100	0	0	0	89,100
Travel to Site (12 Mo, 5/Mo, 300 miles each)	18,000	Miles	0.32	0	0	0	5,670	5,670
Hotels, Meals at Site (12 Mo, 5/Mo, 3 Days each)	180	Days	125.00	0	0	0	22,500	22,500
TOTAL - Home Office	18	Months		182,160	0	0	28,170	210,330
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		165,000	30,000	0	78,200	273,200

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pre-Design Investigation								
Drill & Install Vapor Collection Wells								
Drilling	1,270	VF	10.00	0	0	0	12,700	12,700
Screen, 2" Dia., SS, 0.010" Slot Screens	130	VF	1.50	0	0	0	195	195
Riser, 2" Dia., SS	1,140	VF	1.00	0	0	0	1,140	1,140
Flush Mount Cover	6	Wells	100.00	0	0	0	600	600
Well Development	13	Wells	500.00	0	0	0	6,500	6,500
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	20	Drums	100.00	0	0	0	2,000	2,000
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Pre-Design Investigation	56	Wells		0	0	0	28,335	28,335
Sampling and Analysis - Pre-Design								
Off-Site Analytical - Water								
VOCs	17	Each	150.00	0	0	0	2,550	2,550
TOTAL - Sampling and Analysis - Pre-Design	17	Each		0	0	0	2,550	2,550
Data Validation								
Other Engineering Support	32	Hours	100.00	3,200	0	0	0	3,200
TOTAL - Data Validation	1	LS		3,200	0	0	0	3,200
Technical Report - Findings								
Other Engineering Support	40	Hours	100.00	4,000	0	0	0	4,000
TOTAL - Technical Report - Findings	1	LS		4,000	0	0	0	4,000

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pilot Test Design								
Design & Planning								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
TOTAL - Pilot Test Design	1	LS		29,600	0	0	2,700	32,300
Mobilization for Pilot Test								
Showers/Change Rooms -- Covered in Hot Spot No. 1								
Storage Box	1	Each	150.00	0	0	0	150	150
Personnel Decon Pad -- Covered in Hot Spot No. 1								
Equipment Decon Pad -- Covered in Hot Spot No. 1								
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Mobilization for Pilot Test	1	LS		0	0	0	1,500	1,500
Demolish/Replace Floor Slab for Pilot Test, t = 6", L = 120 LF								
Sawcut Slab Perimeter for Pipe Trenches	242	LF	3.00	0	0	0	726	726

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Break-up Floor Slab/Haul to Stockpile, 2 CY								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	10	Hours	32.72	327	0	0	0	327
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Air Compressor, Pavement Breakers (2)	10	Hours	40.00	0	400	0	0	400
Torches, Gases, etc.	1	Days	200.00	0	0	200	0	200
Tandem Axle Dump Truck & Driver	10	Hours	60.60	356	250	0	0	606
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
Install Horizontal Vapor Extraction Wells (120 LF), Header (60 LF) and Air Sparging Header (50 LF)								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	10	Hours	32.72	327	0	0	0	327
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
2" Fabric-Wrapped Perforated Corrugated HDPE	120	LF	2.00	0	0	240	0	240
2" HDPE Caps	2	Each	10.00	0	0	20	0	20
4"x2" HDPE Tees	2	Each	25.00	0	0	50	0	50
2" HDPE Pipe and Fittings, SDR 11	60	LF	2.00	0	0	120	0	120
4" HDPE Pipe and Fittings, SDR 11	60	LF	5.00	0	0	300	0	300
Coarse Sand	6	CCY	20.00	0	0	120	0	120
Sample Ports	2	Each	100.00	0	0	200	0	200
Flow Control Valves	2	Each	500.00	0	0	1,000	0	1,000

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Concrete Floor Slab Repair								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	10	Hours	32.72	327	0	0	0	327
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Welded Wire Fabric	120	SF	0.15	0	0	0	18	18
Concrete, 3000 psi, 3/4" Aggregate	4	CY	70.00	0	0	280	0	280
Characterization & Disposal, Concrete & Soil	10	CY	50.00	0	0	0	500	500
TOTAL - Demolish/Replace Floor Slab	2.2	CY		3,785	1,490	5,030	1,244	11,549
Pilot Test Treatment System								
50-Gallon Knock-Out Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
50-Gallon Knock-Out Tank	1	Each	500.00	0	0	500	0	500
Blower								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Tractor-Loader-Backhoe	5	Hours	28.00	0	140	0	0	140
Blower, Varialbe Speed, 20 SCFM @ 10 psi	1	Each	500.00	0	0	500	0	500
Piping								
Plumber Foreman	5	Hours	38.60	193	0	0	0	193
Plumber	5	Hours	37.00	185	0	0	0	185
Pipe and Fittings	50	LF	5.00	0	0	250	0	250
Liquid Pumps								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Liquid Pumps	2	Each	1,000.00	0	0	2,000	0	2,000

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Vapor Treatment System								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
1000-pound Activated Carbon Canister	1	Each	2,500.00	0	0	2,500	0	2,500
Sample Ports	2	Each	100.00	0	0	200	0	200
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
200-pound Activated Carbon Canister	2	Each	1,000.00	0	0	2,000	0	2,000
Sample Ports	4	Each	100.00	0	0	400	0	400
500-Gallon Holding Tank	1	Each	500.00	0	0	500	0	500
Pilot Test Electrical Power and Control Systems								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Pilot Test Conduit and Wire	1	LS	500.00	0	0	500	0	500
Pilot Test SVE Control System	1	LS	2,000.00	0	0	2,000	0	2,000
Pilot Test Air Sparging Control System	1	LS	1,500.00	0	0	1,500	0	1,500
TOTAL - Pilot Test Treatment System	1	Each		5,583	840	12,850	0	19,273

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pilot Test Monitoring System								
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
Drill & Install Monitoring Wells								
Drilling	245	VF	10.00	0	0	0	2,450	2,450
Screen, 2" Dia., PVC, 0.010" Slot Screens	25	VF	1.50	0	0	0	38	38
Riser, 2" Dia., PVC	220	VF	1.00	0	0	0	220	220
Flush Mount Cover	6	Wells	100.00	0	0	0	600	600
Well Development	6	Wells	500.00	0	0	0	3,000	3,000
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Install Vapor Monitoring Points	5	Wells	250.00	0	0	0	1,250	1,250
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	14	Drums	100.00	0	0	0	1,400	1,400
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Pilot Test Monitoring System	11	Wells		0	0	0	16,658	16,658
Pilot Test Operation								
Personnel								
Engineering Support	600	Hours	100.00	60,000	0	0	0	60,000
Travel to Site (5 Wk, 2/Wk, 300 miles each)	3,000	Miles	0.32	0	0	0	945	945
Hotels, Meals at Site (5 Wk, 10/Wk)	50	Days	125.00	0	0	0	6,250	6,250
Electricity								
Pilot Test System	7,457	kWhr	0.06	0	0	0	895	895
TOTAL - Pilot Test Operation	25	Days		60,000	0	0	8,090	68,090

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pilot Test Sampling and Analysis								
Off-Site Analytical - Soil Vapor								
VOCs	55	Each	150.00	0	0	0	8,250	8,250
Off-Site Analytical - Groundwater								
VOCs	55	Each	150.00	0	0	0	8,250	8,250
Off-Site Analytical - Indoor Air Quality								
VOCs	6	Each	150.00	0	0	0	900	900
TOTAL - Pilot Test Sampling and Analysis	116	Each		0	0	0	17,400	17,400
Full-Scale Alternative Design								
Design & Planning								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	1,000	Hours	100.00	100,000	0	0	0	100,000
Other non-Engineer Support	400	Hours	40.00	16,000	0	0	0	16,000
Computers, etc.	350	Hours	10.00	0	0	0	3,500	3,500
Drawings, Specifications Copies, etc.	1	LS	10,000.00	0	0	0	10,000	10,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
GPR Survey	2	Days	3,000.00	0	0	0	6,000	6,000
Preparation of Plans								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	125	Hours	40.00	5,000	0	0	0	5,000
Computers, etc.	250	Hours	10.00	0	0	0	2,500	2,500
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Full-Scale Alternative Design	1	LS		211,000	0	0	32,000	243,000

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Full-Scale Alternative Permitting								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	125	Hours	40.00	5,000	0	0	0	5,000
Computers, etc.	250	Hours	10.00	0	0	0	2,500	2,500
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	200.00	0	0	0	200	200
TOTAL - Full-Scale Alternative Permitting	1	LS		75,000	0	0	7,700	82,700
Full-Scale Alternative Mobilization								
Storage Box	1	Each	150.00	0	0	0	150	150
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
TOTAL - Full-Scale Alternative Mobilization	1	LS		0	0	0	1,500	1,500
Air Sparging System Wells								
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
Drill & Install Monitoring Wells								
Drilling	2,430	VF	10.00	0	0	0	24,300	24,300
Screen, 2" Dia., PVC, 0.010" Slot Screens	230	VF	1.50	0	0	0	345	345
Riser, 2" Dia., PVC	2,430	VF	1.00	0	0	0	2,430	2,430
Flush Mount Cover	46	Wells	100.00	0	0	0	4,600	4,600
Well Development	46	Wells	500.00	0	0	0	23,000	23,000
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Install Vapor Monitoring Points	5	Wells	250.00	0	0	0	1,250	1,250

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	152	Drums	100.00	0	0	0	15,200	15,200
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Air Sparging System Wells	46	Wells		0	0	0	78,825	78,825
Demolish/Replace Floor Slab, t = 6", L = 2,195 LF, Air Sparging System								
Sawcut Slab Perimeter for Pipe Trenches	4,410	LF	2.00	0	0	0	8,820	8,820
Break-up Floor Slab/Haul to Stockpile, 37 CY								
Labor Foreman	15	Hours	34.05	511	0	0	0	511
Laborers	60	Hours	32.72	1,963	0	0	0	1,963
Operator	15	Hours	47.51	713	0	0	0	713
Tractor-Loader-Backhoe	15	Hours	28.00	0	420	0	0	420
Air Compressor, Pavement Breakers (4)	15	Hours	60.00	0	900	0	0	900
Torches, Gases, etc.	1.50	Days	200.00	0	0	300	0	300
Tandem Axle Dump Truck & Driver	15	Hours	60.60	534	375	0	0	909
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
Install Horizontal Air Sparging System Headers (2,195 LF, Underground)								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	80	Hours	32.72	2,618	0	0	0	2,618
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
4" HDPE Pipe, SDR 11	2,250	LF	1.75	0	0	3,938	0	3,938
4" HDPE Caps	10	Each	50.00	0	0	500	0	500
4" HDPE Elbows	6	Each	25.00	0	0	150	0	150
4" HDPE Tees	69	Each	35.00	0	0	2,415	0	2,415
Coarse Sand	100	CCY	20.00	0	0	2,000	0	2,000
Concrete Floor Slab Repair								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	80	Hours	32.72	2,618	0	0	0	2,618
Concrete Pump	20	Hours	100.00	0	0	0	2,000	2,000
Welded Wire Fabric	2,100	SF	0.15	0	0	0	315	315
Concrete, 3000 psi, 3/4" Aggregate	46	CY	70.00	0	0	3,220	0	3,220

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Caulk Joint in Concrete Floor Slab where New meets Existing								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Caulk	4,410	LF	0.03	0	0	0	132	132
Characterization & Disposal, Concrete & Soil	161	CY	50.00	0	0	0	8,050	8,050
TOTAL - Demolish/Replace Floor Slab	46	CY		12,604	2,255	15,023	19,317	49,199
Demolish/Replace Floor Slab, t = 6", L = 3,405 LF, SVE System								
Sawcut Slab Perimeter for Pipe Trenches	6,824	LF	2.00	0	0	0	13,648	13,648
Break-up Floor Slab/Haul to Stockpile, 58 CY								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	80	Hours	32.72	2,618	0	0	0	2,618
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
Air Compressor, Pavement Breakers (4)	20	Hours	60.00	0	1,200	0	0	1,200
Torches, Gases, etc.	2.00	Days	200.00	0	0	400	0	400
Tandem Axle Dump Truck & Driver	20	Hours	60.60	712	500	0	0	1,212
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Install Horizontal Vapor Extraction Wells (3,150 LF) and Header (255 LF)								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	80	Hours	32.72	2,618	0	0	0	2,618
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
4" Fabric-Wrapped Perforated Corrugated HDPE	3,200	LF	2.00	0	0	6,400	0	6,400
6" HDPE Pipe, SDR 11	270	LF	3.00	0	0	810	0	810
4" HDPE Caps	12	Each	50.00	0	0	600	0	600
6" HDPE Elbows	2	Each	40.00	0	0	80	0	80
6" HDPE Tees	3	Each	65.00	0	0	195	0	195
6"x4" HDPE Tees	8	Each	65.00	0	0	520	0	520
6"x4" HDPE Reducers	4	Each	35.00	0	0	140	0	140
2'x2' Subsurface Vaults	13	Each	100.00	0	0	1,300	0	1,300
Coarse Sand	163	CCY	20.00	0	0	3,260	0	3,260
Sample Ports	12	Each	100.00	0	0	1,200	0	1,200
Flow Control Valves, Vacuum Transmitters	12	Each	500.00	0	0	6,000	0	6,000
Concrete Floor Slab Repair								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	80	Hours	32.72	2,618	0	0	0	2,618
Concrete Pump	20	Hours	100.00	0	0	0	2,000	2,000
Welded Wire Fabric	3,500	SF	0.15	0	0	0	525	525
Concrete, 3000 psi, 3/4" Aggregate	71	CY	70.00	0	0	4,970	0	4,970
Caulk Joint in Concrete Floor Slab where New meets Existing								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Caulk	6,824	LF	0.03	0	0	0	205	205
Characterization & Disposal, Concrete & Soil	228	CY	50.00	0	0	0	11,400	11,400
TOTAL - Demolish/Replace Floor Slab	71	CY		13,845	2,820	28,375	27,778	72,817

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Air Sparging Equipment Installation								
Blowers								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Blower, Varialbe Speed, 500 SCFM @ 35 psi	1	Each	5,000.00	0	0	5,000	0	5,000
Blower, Varialbe Speed, 750 SCFM @ 45 psi	1	Each	6,500.00	0	0	6,500	0	6,500
Receiver Tanks								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Receiver Tanks	2	Each	500.00	0	0	1,000	0	1,000
Piping								
Plumber Foreman	5	Hours	38.60	193	0	0	0	193
Plumber	5	Hours	37.00	185	0	0	0	185
Pipe and Fittings	20	LF	5.00	0	0	100	0	100
Air Sparging Equipment Electrical								
Electrician Foreman	10	Hours	38.60	386	0	0	0	386
Electrician	10	Hours	37.00	370	0	0	0	370
Air Sparging Equipment Electrical Materials	1	Lot	2,000.00	0	0	2,000	0	2,000
Air Sparging Equipment Control System								
Electrician Foreman	5	Hours	38.60	193	0	0	0	193
Electrician	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Air Sparging Equipment Control System	1	Each	2,500.00	0	0	2,500	0	2,500
Pre-Engineered Metal Building, 40'x40'x12' high	1	Each	35,000.00	0	0	35,000	0	35,000
Pre-Engineered Metal Building, 20'x20'x12' high	1	Each	20,000.00	0	0	20,000	0	20,000
Project Engineer/HSO	620	Hours	77.00	47,740	0	0	0	47,740
Q.C. Engineer	620	Hours	77.00	47,740	0	0	0	47,740
TOTAL - Air Sparging Equipment Installation	1	Each		99,692	700	72,100	0	172,492

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
SVE Treatment System Installation								
50-Gallon Knock-Out Tank								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
50-Gallon Knock-Out Tank	2	Each	500.00	0	0	1,000	0	1,000
Blower								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Blower, Varialbe Speed, 1500 SCFM @ 10 psi	2	Each	9,000.00	0	0	18,000	0	18,000
Particular Filter and Silencers								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Particular Filter	1	Each	1,000.00	0	0	1,000	0	1,000
Silencers	1	Each	500.00	0	0	500	0	500
Piping								
Plumber Foreman	15	Hours	38.60	579	0	0	0	579
Plumber	15	Hours	37.00	555	0	0	0	555
Pipe and Fittings	300	LF	5.00	0	0	1,500	0	1,500
Liquid Pumps								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Liquid Pumps	3	Each	1,000.00	0	0	3,000	0	3,000

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Vapor Treatment System								
Millwright Foreman	5	Hours	38.60	193	0	0	0	193
Millwright	5	Hours	37.00	185	0	0	0	185
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Air to Air Heat Exchanger	1	Each	5,000.00	0	0	5,000	0	5,000
5000-pound Activated Carbon Canister	2	Each	10,000.00	0	0	20,000	0	20,000
Sample Ports	5	Each	100.00	0	0	500	0	500
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
200-pound Activated Carbon Canister	2	Each	1,000.00	0	0	2,000	0	2,000
Sample Ports	4	Each	100.00	0	0	400	0	400
SVE Treatment System Electrical								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
SVE Treatment System Electrical Materials	1	Lot	5,000.00	0	0	5,000	0	5,000
SVE Treatment Control System								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
SVE Treatment Control System	1	Each	10,000.00	0	0	10,000	0	10,000
Project Engineer/HSO	620	Hours	77.00	47,740	0	0	0	47,740
Q.C. Engineer	620	Hours	77.00	47,740	0	0	0	47,740
TOTAL - SVE Treatment System Installation	1	Each		105,416	1,400	68,650	0	175,466

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Monitoring Points, to 5 VF Below Ground Surface (BGS)								
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
Drill & Install Monitoring Wells								
Drilling	3,000	VF	10.00	0	0	0	30,000	30,000
Screen, 2" Dia., PVC, 0.010" Slot Screens	13	VF	1.50	0	0	0	20	20
Riser, 2" Dia., PVC	2,987	VF	1.00	0	0	0	2,987	2,987
Flush Mount Cover	75	Wells	100.00	0	0	0	7,500	7,500
Well Development	75	Wells	500.00	0	0	0	37,500	37,500
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Install Vapor Monitoring Points	75	Wells	250.00	0	0	0	18,750	18,750
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	180	Drums	100.00	0	0	0	18,000	18,000
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Monitoring Points	150	Wells		0	0	0	122,457	122,457
Sampling and Analysis - Start-Up								
Off-Site Analytical - Soil Vapor								
VOCs	30	Each	150.00	0	0	0	4,500	4,500
Off-Site Analytical - Groundwater								
VOCs	30	Each	150.00	0	0	0	4,500	4,500
Off-Site Analytical - Indoor Air Quality								
VOCs	48	Each	150.00	0	0	0	7,200	7,200
TOTAL - Sampling and Analysis - Start-Up	108	Each		0	0	0	16,200	16,200
Plant Operation - Start-Up								
Plant Operator	320	Hours	40.00	12,800	0	0	0	12,800
Engineering Support	1,840	Hours	100.00	184,000	0	0	0	184,000
Travel to Site (8 Wk, 6/Wk, 300 miles each)	14,400	Miles	0.32	0	0	0	4,536	4,536
Hotels, Meals at Site (8 Wk, 30/Wk)	240	Days	125.00	0	0	0	30,000	30,000
GC Rental	4	Months	10,000.00	0	0	0	40,000	40,000

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Electricity								
Air Sparging/SVE Treatment System	55,000	kWhr	0.06	0	0	0	4,400	4,400
TOTAL - Plant Operation - Start-Up	2	Months		196,800	0	0	78,936	275,736
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	400	Mandays	35.00	0	0	14,000	0	14,000
TOTAL - PPC/PPE	400	Mandays		0	0	14,000	0	14,000
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Remove Personnel Decon Pad -- Covered in Hot Spot No. 1								
Remove Equipment Decon Pad -- Covered in Hot Spot No. 1								

TABLE B-12
AIR SPARGING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		0	0	0	4,150	4,150
Home Office								
Project Manager (40 Hours/Mo.)	240	Hours	148.50	35,640	0	0	0	35,640
Support Personnel (Timekeeping, Procurement)	240	Hours	82.50	19,800	0	0	0	19,800
Other Personnel (50 Hours/Mo.)	300	Hours	99.00	29,700	0	0	0	29,700
Travel to Site (12 Mo, 3/Mo, 300 miles each)	10,800	Miles	0.32	0	0	0	3,402	3,402
Hotels, Meals at Site (12 Mo, 3/Mo, 3 Days each)	108	Days	125.00	0	0	0	13,500	13,500
TOTAL - Home Office	6	Months		85,140	0	0	16,902	102,042
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		165,000	30,000	0	78,200	273,200

TABLE B-13
AIR SPAGING OPERATION, HOT SPOT NO. 3, YEAR 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation - Year 1								
Plant Operator	6,000	Hours	40.00	240,000	0	0	0	240,000
Chemist Support	2,400	Hours	100.00	240,000	0	0	0	240,000
GC Rental	20	Months	10,000.00	0	0	0	200,000	200,000
Electricity								
SVE Treatment System	330,000	kWhr	0.06	0	0	0	26,400	26,400
Vapor Treatment Activated Carbon Changeout	40,000	lb.	1.50	0	0	60,000	0	60,000
Liquid Treatment Activated Carbon Changeout	1,600	lb.	1.50	0	0	2,400	0	2,400
Replacement/Maintenance Parts & Equipment	1	LS	10,000.00	0	0	10,000	0	10,000
TOTAL - Plant Operation - Year 1	12	Months		480,000	0	72,400	226,400	778,800
Sampling and Analysis - Year 1								
Off-Site Analytical - Groundwater								
VOCs	85	Each	150.00	0	0	0	12,750	12,750
Off-Site Analytical - Soil Vapor								
VOCs	85	Each	150.00	0	0	0	12,750	12,750
Off-Site Analytical - Indoor Air Quality								
VOCs	120	Each	150.00	0	0	0	18,000	18,000
TOTAL - Sampling and Analysis - Year 1	290	Each		0	0	0	43,500	43,500

TABLE B-13
AIR SPAGING OPERATION, HOT SPOT NO. 3, YEAR 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Floor Inspection and Maintenance - Year 1								
Labor Foreman	80	Hours	31.75	2,540	0	0	0	2,540
Laborers	80	Hours	30.54	2,443	0	0	0	2,443
Pressure Washer	80	Hours	10.00	0	800	0	0	800
TOTAL - Floor Inspection and Maintenance - Year 1	12	Months		4,983	800	0	0	5,783
Home Office - Year 1								
Project Manager (10 Hours/Mo.)	120	Hours	148.50	17,820	0	0	0	17,820
Project Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Q.C. Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Support Personnel (Timekeeping, Procurement)	120	Hours	82.50	9,900	0	0	0	9,900
Other Personnel (10 Hours/Mo.)	120	Hours	99.00	11,880	0	0	0	11,880
Travel to Site (12 Mo, 3/Mo, 300 miles each)	10,800	Miles	0.32	0	0	0	3,402	3,402
Hotels, Meals at Site (12 Mo, 3/Mo, 2 Days each)	72	Days	125.00	0	0	0	9,000	9,000
TOTAL - Home Office - Year 1	12	Months		67,320	0	0	12,402	79,722

TABLE B-14
AIR SPAGING OPERATION, HOT SPOT NO. 3, YEAR 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation - Year 2								
Plant Operator	3,600	Hours	40.00	144,000	0	0	0	144,000
Electricity								
SVE Treatment System	330,000	kWhr	0.06	0	0	0	26,400	26,400
Vapor Treatment Activated Carbon Changeout	40,000	lb.	1.50	0	0	60,000	0	60,000
Liquid Treatment Activated Carbon Changeout	1,600	lb.	1.50	0	0	2,400	0	2,400
Replacement/Maintenance Parts & Equipment	1	LS	10,000.00	0	0	10,000	0	10,000
TOTAL - Plant Operation - Year 2	12	Months		144,000	0	72,400	26,400	242,800
Sampling and Analysis - Year 2								
Off-Site Analytical - Groundwater								
VOCs	340	Each	150.00	0	0	0	51,000	51,000
Off-Site Analytical - Soil Vapor								
VOCs	340	Each	150.00	0	0	0	51,000	51,000
Off-Site Analytical - Indoor Air Quality								
VOCs	12	Each	150.00	0	0	0	1,800	1,800
TOTAL - Sampling and Analysis - Year 2	692	Each		0	0	0	103,800	103,800

TABLE B-14
AIR SPAGING OPERATION, HOT SPOT NO. 3, YEAR 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Floor Inspection and Maintenance - Year 2								
Labor Foreman	80	Hours	31.75	2,540	0	0	0	2,540
Laborers	80	Hours	30.54	2,443	0	0	0	2,443
Pressure Washer	80	Hours	10.00	0	800	0	0	800
TOTAL - Floor Inspection and Maintenance - Year 2	12	Months		4,983	800	0	0	5,783
Home Office - Year 2								
Project Manager (10 Hours/Mo.)	120	Hours	148.50	17,820	0	0	0	17,820
Project Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Q.C. Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Support Personnel (Timekeeping, Procurement)	120	Hours	82.50	9,900	0	0	0	9,900
Other Personnel (10 Hours/Mo.)	120	Hours	99.00	11,880	0	0	0	11,880
Travel to Site (12 Mo, 1/Mo, 300 miles each)	3,600	Miles	0.32	0	0	0	1,134	1,134
Hotels, Meals at Site (12 Mo, 1/Mo, 2 Days each)	24	Days	125.00	0	0	0	3,000	3,000
TOTAL - Home Office - Year 2	12	Months		67,320	0	0	4,134	71,454

TABLE B-15
AIR SPAGING OPERATION, HOT SPOT NO. 3, YEARS 3-30, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Plant Operation - Annual Cost Years 3-30								
Plant Operator	1,200	Hours	40.00	48,000	0	0	0	48,000
Electricity								
SVE Treatment System	330,000	kWhr	0.06	0	0	0	26,400	26,400
Vapor Treatment Activated Carbon Changeout	40,000	lb.	1.50	0	0	60,000	0	60,000
Liquid Treatment Activated Carbon Changeout	1,600	lb.	1.50	0	0	2,400	0	2,400
Replacement/Maintenance Parts & Equipment	1	LS	10,000.00	0	0	10,000	0	10,000
TOTAL - Plant Operation - Years 3-30	12	Months		48,000	0	72,400	26,400	146,800
Sampling and Analysis - Annual Cost Years 3-30								
Off-Site Analytical - Groundwater								
VOCs	340	Each	150.00	0	0	0	51,000	51,000
Off-Site Analytical - Soil Vapor								
VOCs	340	Each	150.00	0	0	0	51,000	51,000
Off-Site Analytical - Indoor Air Quality								
VOCs	12	Each	150.00	0	0	0	1,800	1,800
TOTAL - Sampling and Analysis - Years 3-30	692	Each		0	0	0	103,800	103,800

TABLE B-15
AIR SPAGING OPERATION, HOT SPOT NO. 3, YEARS 3-30, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Floor Inspection and Maintenance - Annual Cost Years 3-30								
Labor Foreman	80	Hours	31.75	2,540	0	0	0	2,540
Laborers	80	Hours	30.54	2,443	0	0	0	2,443
Pressure Washer	80	Hours	10.00	0	800	0	0	800
TOTAL - Floor Inspection and Maintenance - Years 3-	12	Months		4,983	800	0	0	5,783
Home Office - Annual Cost Years 3-30								
Project Manager (10 Hours/Mo.)	120	Hours	148.50	17,820	0	0	0	17,820
Project Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Q.C. Engineer	120	Hours	115.50	13,860	0	0	0	13,860
Support Personnel (Timekeeping, Procurement)	120	Hours	82.50	9,900	0	0	0	9,900
Other Personnel (10 Hours/Mo.)	120	Hours	99.00	11,880	0	0	0	11,880
Travel to Site (12 Mo, 1/Mo, 300 miles each)	3,600	Miles	0.32	0	0	0	1,134	1,134
Hotels, Meals at Site (12 Mo, 1/Mo, 2 Days each)	24	Days	125.00	0	0	0	3,000	3,000
TOTAL - Home Office - Years 3-30	12	Months		67,320	0	0	4,134	71,454

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Design								
Design & Planning								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	1,000	Hours	100.00	100,000	0	0	0	100,000
Other non-Engineer Support	400	Hours	40.00	16,000	0	0	0	16,000
Computers, etc.	350	Hours	10.00	0	0	0	3,500	3,500
Drawings, Specifications Copies, etc.	1	LS	10,000.00	0	0	0	10,000	10,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
Preparation of Plans								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	125	Hours	40.00	5,000	0	0	0	5,000
Computers, etc.	250	Hours	10.00	0	0	0	2,500	2,500
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
Six-Phase Technology License Fee	1	LS	50,000.00	0	0	0	50,000	50,000
TOTAL - Design	1	LS		211,000	0	0	76,000	287,000
Mobilization								
Showers/Change Rooms - Build in Existing Bldg	1	LS	5,000.00	0	0	0	5,000	5,000
Storage Box	1	Each	150.00	0	0	0	150	150
Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	1,000.00	0	0	1,000	0	1,000
Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	2,500.00	0	0	2,500	0	2,500

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Boomlift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
TOTAL - Mobilization	1	LS		4,249	560	3,500	8,500	16,809
Installation of Electrodes								
Mobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
Drill & Install Electrodes								
Drilling (10" Borehole)	3,880	VF	45.00	0	0	0	174,600	174,600
6" Galvanized Steel Casing (Electrode)	3,880	VF	10.00	0	0	0	38,800	38,800
8" CPVC Pipe (Electrode Insulator)	970	VF	7.00	0	0	0	6,790	6,790
Graphite Backfill	40	CY	50.00	0	0	0	2,000	2,000
Sand Backfill	13	CY	50.00	0	0	0	650	650
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000
Drill Cuttings Characterization & Disposal								
IDW - Soil	130	Tons	100.00	0	0	0	13,000	13,000
IDW - PPE	20	Drums	100.00	0	0	0	2,000	2,000
TOTAL - Installation of Electrodes	97	Each		0	10,000	0	240,340	250,340
Installation of Electrical Equipment								
Six-Phase Transformer								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Forklift	20	Hours	28.00	0	560	0	0	560
Six-Phase Transformer	1	Each	150,000.00	0	0	150,000	0	150,000

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Cable to 13.8 kv Transformer								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Boomlift	20	Hours	40.00	0	800	0	0	800
Cable, #1 Guage	600	LF	4.00	0	0	2,400	0	2,400
Cable to Electrodes								
Electrician Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Electrician	100	Hours	37.00	3,700	0	0	0	3,700
Boomlift	100	Hours	40.00	0	4,000	0	0	4,000
Cable, 2-wire 500 MCM	4,200	LF	12.00	0	0	50,400	0	50,400
TOTAL - Installation of Electrical Equipment	1	Lot		10,584	5,360	202,800	0	218,744
Vapor Collection Wells (Same boring as electrodes)								
Install Vapor Collection Wells								
Screen, 2" Dia., SS, 0.010" Slot Screens	388	VF	22.50	0	0	8,730	0	8,730
Riser, 2" Dia., SS	194	VF	15.00	0	0	2,910	0	2,910
TOTAL - Vapor Collection Wells	97	Wells		0	0	11,640	0	11,640
Collection System Piping								
2" CPVC Piping, Above Ground								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	120	Hours	32.72	3,927	0	0	0	3,927
2" CPVC Piping	2,600	LF	2.00	0	0	5,200	0	5,200
2" CPVC Valves	126	Each	50.00	0	0	6,300	0	6,300
6" CPVC Piping, Above Ground								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	120	Hours	32.72	3,927	0	0	0	3,927
6" CPVC Piping	1,900	LF	2.00	0	0	3,800	0	3,800
6" CPVC Valves	18	Each	50.00	0	0	900	0	900
TOTAL - Collection System Piping	4,300	LF		9,897	0	16,200	0	26,097

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Monitoring System								
Drill & Install Piezometers								
Drilling	720	VF	10.00	0	0	0	7,200	7,200
Screen, 1" Dia., SS, 0.010" Slot Screens	540	VF	12.00	0	0	6,480	0	6,480
Riser, 1" Dia., SS	180	VF	8.00	0	0	1,440	0	1,440
Thermocouples	54	Each	10.00	0	0	0	540	540
Flush Mount Cover	18	Wells	100.00	0	0	0	1,800	1,800
Cooling Loop for Sample Collection	1	LS	10,000.00	0	0	0	10,000	10,000
Well Development	18	Wells	500.00	0	0	0	9,000	9,000
Frac Tank	2	Months	2,500.00	0	5,000	0	0	5,000
Computer for Thermocouple Monitoring	1	Each	2,500.00	0	2,500	0	0	2,500
Drill Cuttings Characterization & Disposal								
IDW - Soil	4	Tons	100.00	0	0	0	400	400
IDW - PPE	4	Drums	100.00	0	0	0	400	400
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Monitoring System	18	Wells		0	7,500	7,920	29,540	44,960
Vapor Treatment Equipment Installation								
Condenser, 50 ton								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Water Cooled Steam Condenser, 50 ton	1	Each	25,000.00	0	0	25,000	0	25,000
Blowers								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Blower, Variable Speed, 480 SCFM, 40 HP	1	Each	5,000.00	0	0	5,000	0	5,000

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Particulate Filter and Silencers								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Particulate Filter	1	Each	1,000.00	0	0	1,000	0	1,000
Silencers	2	Each	500.00	0	0	1,000	0	1,000
Natural Gas Fired Catalytic Oxidizer								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Catalytic Oxidizer, 500 SCFM	1	Each	50,000.00	0	0	50,000	0	50,000
Scrubber								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrochloric Acid Scrubber	1	Each	15,000.00	0	0	15,000	0	15,000
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
1000-pound Activated Carbon Canister	2	Each	4,000.00	0	0	8,000	0	8,000
Centrifugal Pump, 1/2 HP	1	Each	800.00	0	0	800	0	800
Sample Ports	4	Each	100.00	0	0	400	0	400
Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
Pipe and Fittings	40	LF	5.00	0	0	200	0	200

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Control System								
Electrician Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Electrician	40	Hours	37.00	1,480	0	0	0	1,480
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Control System with MCCs and PLC	1	Each	25,000.00	0	0	25,000	0	25,000
Security Fence, 6' high	400	Each	12.50	0	0	5,000	0	5,000
TOTAL - Vapor Treatment Equipment Installation	1	Each		11,404	1,820	137,150	0	150,374
System Operation								
Personnel								
Engineering Support	2,000	Hours	100.00	200,000	0	0	0	200,000
Per Diems	200	Days	100.00	0	0	0	20,000	20,000
Project Vehicles	2,000	Hours	7.50	0	15,000	0	0	15,000
Six-Phase Subcontractor Personnel	2,000	Hours	60.00	0	0	0	120,000	120,000
Six-Phase Subcontractor ODCs	200	Days	125.00	0	0	0	25,000	25,000
Project Engineer/HSO	1,240	Hours	77.00	95,480	0	0	0	95,480
Q.C. Engineer	1,240	Hours	77.00	95,480	0	0	0	95,480
Liquid Treatment Activated Carbon Changeout	4,000	lb.	1.50	0	0	6,000	0	6,000
Methane for Catalytic Oxidation	396,000	CF	0.02	0	0	7,920	0	7,920
Sodium Hydroxide for Scrubber	1,800	lb.	0.25	0	0	450	0	450
Condensate Disposal Fee	2,500,000	Gallon	0.01	0	0	25,000	0	25,000
Electricity								
Heating System	8,000,000	kWhr	0.06	0	0	0	640,000	640,000
SVE/Vapor Treatment System	343,618	kWhr	0.06	0	0	0	27,489	27,489
TOTAL - Pilot Test Operation	200	Days		390,960	15,000	39,370	832,489	1,277,819

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis (assumes collection by operators)								
Off-Site Analytical - Water								
VOCs	336	Each	150.00	0	0	0	50,400	50,400
Off-Site Analytical - Air								
VOCs	144	Each	150.00	0	0	0	21,600	21,600
HCl	104	Each	150.00	0	0	0	15,600	15,600
TOTAL - Sampling and Analysis	584	Each		0	0	0	87,600	87,600
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	300	Mandays	35.00	0	0	10,500	0	10,500
TOTAL - PPC/PPE	300	Mandays		0	0	10,500	0	10,500
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Remove Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Remove Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Boomlift	1	LS	500.00	0	0	0	500	500
Move-out Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Abandon SVE/Thermal Points	126	Each	250.00	0	0	0	31,500	31,500
Abandon Monitoring Wells	18	Each	250.00	0	0	0	4,500	4,500
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		4,249	560	0	42,150	46,959
Home Office								
Project Manager (40 Hours/Mo.)	240	Hours	148.50	35,640	0	0	0	35,640
Support Personnel (Timekeeping, Procurement)	240	Hours	82.50	19,800	0	0	0	19,800
Other Personnel (50 Hours/Mo.)	300	Hours	99.00	29,700	0	0	0	29,700
Travel to Site (6 Mo, 5/Mo, 300 miles each)	9,000	Miles	0.32	0	0	0	2,835	2,835
Hotels, Meals at Site (6 Mo, 5/Mo, 3 Days each)	90	Days	125.00	0	0	0	11,250	11,250
TOTAL - Home Office	6	Months		85,140	0	0	14,085	99,225

TABLE B-16
SIX-PHASE HEATING HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		165,000	30,000	0	78,200	273,200

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Design - Based on Hot Spot No. 1 as pilot test								
Design & Planning								
Engineering Manager, P.E.	50	Hours	200.00	10,000	0	0	0	10,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	200	Hours	40.00	8,000	0	0	0	8,000
Computers, etc.	175	Hours	10.00	0	0	0	1,750	1,750
Report Copying, etc.	1	LS	5,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	1,250.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	50	Hours	200.00	10,000	0	0	0	10,000
Other Engineering Support	250	Hours	100.00	25,000	0	0	0	25,000
Other non-Engineer Support	75	Hours	40.00	3,000	0	0	0	3,000
Computers, etc.	125	Hours	10.00	0	0	0	1,250	1,250
Report Copying, etc.	1	LS	2,500.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	1,250.00	0	0	0	250	250
Six-Phase Technology License Fee	1	LS	50,000.00	0	0	0	50,000	50,000
TOTAL - Design	1	LS		106,000	0	0	54,500	160,500
Mobilization - based on Hot Spot No. 1 as pilot								
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Boomlift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
TOTAL - Mobilization	1	LS		0	0	0	3,350	3,350

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Demolish Building 48 (Quonset Hut, Carpentry Shed, Paint Storage)								
Labor Foreman	50	Hours	34.05	1,702	0	0	0	1,702
Laborers	50	Hours	32.72	1,636	0	0	0	1,636
Operator	50	Hours	47.51	2,376	0	0	0	2,376
Tractor-Loader-Backhoe	50	Hours	28.00	0	1,400	0	0	1,400
Air Compressor, Pavement Breakers (2)	50	Hours	40.00	0	2,000	0	0	2,000
Torches, Gases, etc.	5	Days	200.00	0	0	1,000	0	1,000
Tandem Axle Dump Truck & Driver	50	Hours	60.60	1,780	1,250	0	0	3,030
Dump Charge	100	CY	10.00	0	0	0	1,000	1,000
TOTAL - Demolish Building 48	1.0	LS		7,494	4,650	1,000	1,000	14,144
Installation of Electrodes								
Drill & Install Electrodes								
Drilling (10" Borehole)	1,600	VF	25.00	0	0	0	40,000	40,000
6" Galvanized Steel Casing (Electrode)	1,600	VF	10.00	0	0	0	16,000	16,000
8" CPVC Pipe (Electrode Insulator)	400	VF	7.00	0	0	0	2,800	2,800
Graphite Backfill	17	CY	50.00	0	0	0	850	850
Sand Backfill	5	CY	50.00	0	0	0	250	250
Frac Tank	2	Month	2,500.00	0	5,000	0	0	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil	54	Tons	100.00	0	0	0	5,400	5,400
IDW - PPE	8	Drums	100.00	0	0	0	800	800
TOTAL - Installation of Electrodes	40	Each		0	5,000	0	66,100	71,100
Installation of Electrical Equipment								
Six-Phase Transformer								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Forklift	20	Hours	28.00	0	560	0	0	560
Six-Phase Transformer	1	Each	150,000.00	0	0	150,000	0	150,000

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Cable to 13.8 kv Transformer								
Electrician Foreman	20	Hours	38.60	772	0	0	0	772
Electrician	20	Hours	37.00	740	0	0	0	740
Boomlift	20	Hours	40.00	0	800	0	0	800
Cable, #1 Guage	800	LF	4.00	0	0	3,200	0	3,200
Cable to Electrodes								
Electrician Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Electrician	100	Hours	37.00	3,700	0	0	0	3,700
Boomlift	100	Hours	40.00	0	4,000	0	0	4,000
Cable, 2-wire, 500 MCM	4,200	LF	12.00	0	0	50,400	0	50,400
TOTAL - Installation of Electrical Equipment	1	Lot		10,584	5,360	203,600	0	219,544
Vapor Collection Wells (Same boring as electrodes)								
Install Vapor Collection Wells								
Screen, 2" Dia., SS, 0.010" Slot Screens	224	VF	22.50	0	0	5,040	0	5,040
Riser, 2" Dia., SS	112	VF	15.00	0	0	1,680	0	1,680
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	20	Drums	100.00	0	0	0	2,000	2,000
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Vapor Collection Wells	56	Wells		0	0	6,720	2,200	8,920
Collection System Piping								
2" CPVC Piping, Above Ground								
Labor Foreman	15	Hours	34.05	511	0	0	0	511
Laborers	60	Hours	32.72	1,963	0	0	0	1,963
2" CPVC Piping	1,200	LF	2.00	0	0	2,400	0	2,400
2" CPVC Valves	56	Each	50.00	0	0	2,800	0	2,800

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
6" CPVC Piping, Above Ground								
Labor Foreman	15	Hours	34.05	511	0	0	0	511
Laborers	60	Hours	32.72	1,963	0	0	0	1,963
6" CPVC Piping	860	LF	2.00	0	0	1,720	0	1,720
6" CPVC Valves	8	Each	50.00	0	0	400	0	400
TOTAL - Collection System Piping	1,920	LF		4,948	0	7,320	0	12,268
Monitoring System								
Drill & Install Piezometers								
Drilling	320	VF	10.00	0	0	0	3,200	3,200
Screen, 1" Dia., SS, 0.010" Slot Screens	240	VF	12.00	0	0	2,880	0	2,880
Riser, 1" Dia., SS	80	VF	8.00	0	0	640	0	640
Thermocouples	24	Each	10.00	0	0	0	240	240
Flush Mount Cover	8	Wells	100.00	0	0	0	800	800
Cooling Loop for Sample Collection	1	LS	10,000.00	0	0	0	10,000	10,000
Well Development	8	Wells	500.00	0	0	0	4,000	4,000
Frac Tank	2	Months	2,500.00	0	5,000	0	0	5,000
Computer for Thermocouple Monitoring	1	Each	2,500.00	0	2,500	0	0	2,500
Drill Cuttings Characterization & Disposal								
IDW - Soil	1.6	Tons	100.00	0	0	0	160	160
IDW - PPE	2	Drums	100.00	0	0	0	200	200
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Monitoring System	8	Wells		0	7,500	3,520	18,800	29,820
Vapor Treatment Equipment Installation								
Condenser, 50 ton								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Water Cooled Steam Condenser, 50 ton	1	Each	25,000.00	0	0	25,000	0	25,000

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Blowers								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Blower, Variable Speed, 480 SCFM, 40 HP	1	Each	5,000.00	0	0	5,000	0	5,000
Particulate Filter and Silencers								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Particulate Filter	1	Each	1,000.00	0	0	1,000	0	1,000
Silencers	2	Each	500.00	0	0	1,000	0	1,000
Natural Gas Fired Catalytic Oxidizer								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Catalytic Oxidizer, 500 SCFM	1	Each	50,000.00	0	0	50,000	0	50,000
Scrubber								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrochloric Acid Scrubber	1	Each	15,000.00	0	0	15,000	0	15,000
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
1000-pound Activated Carbon Canister	2	Each	2,500.00	0	0	5,000	0	5,000
Centrifugal Pump, 1/2 HP	1	Each	800.00	0	0	800	0	800
Sample Ports	4	Each	100.00	0	0	400	0	400

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
Pipe and Fittings	40	LF	5.00	0	0	200	0	200
Control System								
Electrician Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Electrician	40	Hours	37.00	1,480	0	0	0	1,480
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Control System with MCCs and PLC	1	Each	25,000.00	0	0	25,000	0	25,000
Security Fence, 6' high	400	Each	12.50	0	0	5,000	0	5,000
TOTAL - Vapor Treatment Equipment Installation	1	Each		11,404	1,820	134,150	0	147,374
System Operation								
Personnel								
Engineering Support	700	Hours	100.00	70,000	0	0	0	70,000
Per Diems	70	Days	100.00	0	0	0	7,000	7,000
Project Vehicles	700	Hours	7.50	0	5,250	0	0	5,250
Six-Phase Subcontractor Personnel	700	Hours	60.00	0	0	0	42,000	42,000
Six-Phase Subcontractor ODCs	70	Days	125.00	0	0	0	8,750	8,750
Project Engineer/HSO	1,240	Hours	77.00	95,480	0	0	0	95,480
Q.C. Engineer	1,240	Hours	77.00	95,480	0	0	0	95,480
Liquid Treatment Activated Carbon Changeout	1,000	lb.	1.50	0	0	1,500	0	1,500
Methane for Catalytic Oxidation	148,500	CF	0.10	0	0	14,850	0	14,850
Sodium Hydroxide for Scrubber	800	lb.	0.25	0	0	200	0	200
Condensate Disposal Fee	1,000,000	Gallon	0.01	0	0	10,000	0	10,000
Electricity								
Heating System	3,500,000	kWhr	0.06	0	0	0	280,000	280,000
SVE/Vapor Treatment System	128,856	kWhr	0.06	0	0	0	10,308	10,308
TOTAL - Pilot Test Operation	70	Days		260,960	5,250	26,550	348,058	640,818

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis (assumes collection by operators)								
Off-Site Analytical - Water								
VOCs	131	Each	150.00	0	0	0	19,650	19,650
Off-Site Analytical - Air								
VOCs	50	Each	150.00	0	0	0	7,500	7,500
HCl	36	Each	150.00	0	0	0	5,400	5,400
TOTAL - Sampling and Analysis	217	Each		0	0	0	32,550	32,550
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	150	Mandays	35.00	0	0	5,250	0	5,250
TOTAL - PPC/PPE	150	Mandays		0	0	5,250	0	5,250
Demobilization								
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Boomlift	1	LS	500.00	0	0	0	500	500
Move-out Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Abandon SVE/Thermal Points	56	Each	250.00	0	0	0	14,000	14,000
Abandon Monitoring Wells	8	Each	250.00	0	0	0	2,000	2,000
TOTAL - Demobilization	1	LS		0	0	0	19,350	19,350

TABLE B-17
SIX-PHASE HEATING HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office								
Project Manager (40 Hours/Mo.)	240	Hours	148.50	35,640	0	0	0	35,640
Support Personnel (Timekeeping, Procurement)	240	Hours	82.50	19,800	0	0	0	19,800
Other Personnel (50 Hours/Mo.)	300	Hours	99.00	29,700	0	0	0	29,700
Travel to Site (6 Mo, 5/Mo, 300 miles each)	9,000	Miles	0.32	0	0	0	2,835	2,835
Hotels, Meals at Site (6 Mo, 5/Mo, 3 Days each)	90	Days	125.00	0	0	0	11,250	11,250
TOTAL - Home Office	6	Months		85,140	0	0	14,085	99,225
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		165,000	30,000	0	78,200	273,200

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pre-Design Investigation								
Drill & Install Vapor Collection Wells								
Drilling	1,270	VF	10.00	0	0	0	12,700	12,700
Screen, 2" Dia., SS, 0.010" Slot Screens	130	VF	1.50	0	0	0	195	195
Riser, 2" Dia., SS	1,140	VF	1.00	0	0	0	1,140	1,140
Flush Mount Cover	6	Wells	100.00	0	0	0	600	600
Well Development	13	Wells	500.00	0	0	0	6,500	6,500
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil, 1 Drum/20 VF + 20%	20	Drums	100.00	0	0	0	2,000	2,000
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Pre-Design Investigation	56	Wells		0	0	0	28,335	28,335
Sampling and Analysis - Pre-Design								
Off-Site Analytical - Water								
VOCs	17	Each	150.00	0	0	0	2,550	2,550
TOTAL - Sampling and Analysis - Pre-Design	17	Each		0	0	0	2,550	2,550
Data Validation								
Other Engineering Support	32	Hours	100.00	3,200	0	0	0	3,200
TOTAL - Data Validation	1	LS		3,200	0	0	0	3,200
Technical Report - Findings								
Other Engineering Support	40	Hours	100.00	4,000	0	0	0	4,000
TOTAL - Technical Report - Findings	1	LS		4,000	0	0	0	4,000

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Design - Based on this being addition to Hot Spot 2								
Design & Planning								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Six-Phase Technology License Fee	1	LS	50,000.00	0	0	0	50,000	50,000
TOTAL - Design	1	LS		29,600	0	0	52,700	82,300
Mobilization -- Covered under Hot Spot 1 and 2								
Installation of Electrodes								
Drill & Install Electrodes								
Drilling (10" Borehole)	12,910	VF	45.00	0	0	0	580,950	580,950
6" Galvanized Steel Casing (Electrode)	12,910	VF	10.00	0	0	0	129,100	129,100
8" CPVC Pipe (Electrode Insulator)	2,620	VF	7.00	0	0	0	18,340	18,340
Graphite Backfill	130	CY	50.00	0	0	0	6,500	6,500
Sand Backfill	34	CY	50.00	0	0	0	1,700	1,700
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000
Drill Cuttings Characterization & Disposal								
IDW - Soil	636	Tons	100.00	0	0	0	63,600	63,600
IDW - PPE	52	Drums	100.00	0	0	0	5,200	5,200
TOTAL - Installation of Electrodes	262	Each		0	10,000	0	805,390	815,390

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Installation of Electrical Equipment								
Six-Phase Transformer								
Electrician Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Electrician	100	Hours	37.00	3,700	0	0	0	3,700
Forklift	100	Hours	28.00	0	2,800	0	0	2,800
Six-Phase Transformer	2	Each	150,000.00	0	0	300,000	0	300,000
Cable to 13.8 kv Transformer								
Electrician Foreman	50	Hours	38.60	1,930	0	0	0	1,930
Electrician	50	Hours	37.00	1,850	0	0	0	1,850
Boomlift	50	Hours	40.00	0	2,000	0	0	2,000
Cable, #1 Guage	2,000	LF	4.00	0	0	8,000	0	8,000
Cable to Electrodes								
Electrician Foreman	100	Hours	38.60	3,860	0	0	0	3,860
Electrician	400	Hours	37.00	14,800	0	0	0	14,800
Boomlift	100	Hours	40.00	0	4,000	0	0	4,000
Cable, 2-wire 500 MCM	21,000	LF	12.00	0	0	252,000	0	252,000
TOTAL - Installation of Electrical Equipment	1	Lot		30,000	8,800	560,000	0	598,800
Vapor Collection Wells (Same boring as electrodes)								
Install Vapor Collection Wells								
Screen, 2" Dia., SS, 0.010" Slot Screens	1,288	VF	12.00	0	0	15,456	0	15,456
Riser, 2" Dia., SS	644	VF	8.00	0	0	5,152	0	5,152
TOTAL - Vapor Collection Wells	322	Wells		0	0	20,608	0	20,608
Collection System Piping								
2" CPVC Piping, Above Ground								
Labor Foreman	90	Hours	34.05	3,064	0	0	0	3,064
Laborers	360	Hours	32.72	11,781	0	0	0	11,781
2" CPVC Piping	7,500	LF	2.00	0	0	15,000	0	15,000
2" CPVC Valves	364	Each	50.00	0	0	18,200	0	18,200

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
6" CPVC Piping, Above Ground								
Labor Foreman	100	Hours	34.05	3,405	0	0	0	3,405
Laborers	600	Hours	32.72	19,634	0	0	0	19,634
6" CPVC Piping	11,000	LF	2.00	0	0	22,000	0	22,000
6" CPVC Valves	52	Each	50.00	0	0	2,600	0	2,600
TOTAL - Collection System Piping	17,680	LF		37,884	0	57,800	0	95,684
Monitoring System								
Drill & Install Piezometers								
Drilling	2,235	VF	10.00	0	0	0	22,350	22,350
Screen, 1" Dia., SS, 0.010" Slot Screens	1,775	VF	12.00	0	0	21,300	0	21,300
Riser, 1" Dia., SS	460	VF	8.00	0	0	3,680	0	3,680
Thermocouples	92	Each	10.00	0	0	0	920	920
Flush Mount Cover	46	Wells	100.00	0	0	0	4,600	4,600
Cooling Loop for Sample Collection	1	LS	10,000.00	0	0	0	10,000	10,000
Well Development	46	Wells	500.00	0	0	0	23,000	23,000
Frac Tank	4	Months	2,500.00	0	10,000	0	0	10,000
Computer for Thermocouple Monitoring	1	Each	2,500.00	0	2,500	0	0	2,500
Drill Cuttings Characterization & Disposal								
IDW - Soil	12	Tons	100.00	0	0	0	1,200	1,200
IDW - PPE	9	Drums	100.00	0	0	0	900	900
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Monitoring System	46	Wells		0	12,500	24,980	63,170	100,650
Vapor Treatment Equipment Installation								
Condenser, 100 ton								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Water Cooled Steam Condenser, 100 ton	1	Each	45,000.00	0	0	45,000	0	45,000

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Blowers								
Millwright Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Millwright	40	Hours	37.00	1,480	0	0	0	1,480
Operator	40	Hours	47.51	1,901	0	0	0	1,901
Forklift	40	Hours	28.00	0	1,120	0	0	1,120
Blower, Variable Speed, 800 SCFM, 50 HP	2	Each	7,500.00	0	0	15,000	0	15,000
Particulate Filter and Silencers								
Millwright Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Millwright	40	Hours	37.00	1,480	0	0	0	1,480
Operator	40	Hours	47.51	1,901	0	0	0	1,901
Forklift	40	Hours	28.00	0	1,120	0	0	1,120
Particulate Filter	4	Each	1,000.00	0	0	4,000	0	4,000
Silencers	8	Each	500.00	0	0	4,000	0	4,000
Natural Gas Fired Catalytic Oxidizer								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Catalytic Oxidizer, 1000 SCFM	1	Each	75,000.00	0	0	75,000	0	75,000
Scrubber								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrochloric Acid Scrubber	1	Each	30,000.00	0	0	30,000	0	30,000
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
10000-pound Activated Carbon Canister	2	Each	12,500.00	0	0	25,000	0	25,000
Centrifugal Pump, 3/4 HP	1	Each	1,000.00	0	0	1,000	0	1,000
Sample Ports	4	Each	100.00	0	0	400	0	400

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
Pipe and Fittings	100	LF	5.00	0	0	500	0	500
Control System								
Electrician Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Electrician	40	Hours	37.00	1,480	0	0	0	1,480
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Control System with MCCs and PLC	1	Each	40,000.00	0	0	40,000	0	40,000
Security Fence, 6' high	400	Each	12.50	0	0	5,000	0	5,000
TOTAL - Vapor Treatment Equipment Installation	1	Each		18,791	3,500	245,650	0	267,941
System Operation								
Personnel								
Engineering Support	6,000	Hours	100.00	600,000	0	0	0	600,000
Per Diems	600	Days	100.00	0	0	0	60,000	60,000
Project Vehicles	6,000	Hours	7.50	0	45,000	0	0	45,000
Six-Phase Subcontractor Personnel	9,000	Hours	60.00	0	0	0	540,000	540,000
Six-Phase Subcontractor ODCs	900	Days	125.00	0	0	0	112,500	112,500
Project Engineer	1,480	Hours	77.00	113,960	0	0	0	113,960
Q.C. Engineer	1,480	Hours	77.00	113,960	0	0	0	113,960
Liquid Treatment Activated Carbon Changeout	40,000	lb.	1.50	0	0	60,000	0	60,000
Methane for Catalytic Oxidation	1,188,000	CF	0.10	0	0	118,800	0	118,800
Sodium Hydroxide for Scrubber	15,135	lb.	0.25	0	0	3,784	0	3,784
Condensate Disposal Fee	7,500,000	Gallon	0.01	0	0	75,000	0	75,000
Electricity								
Heating System	26,000,000	kWhr	0.06	0	0	0	2,080,000	2,080,000
SVE/Vapor Treatment System	2,500,000	kWhr	0.06	0	0	0	200,000	200,000
TOTAL - System Operation	365	Days		827,920	45,000	257,584	2,992,500	4,123,004

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis (assumes collection by operators)								
Off-Site Analytical - Water								
VOCs	645	Each	150.00	0	0	0	96,750	96,750
Off-Site Analytical - Air								
VOCs	187	Each	150.00	0	0	0	28,050	28,050
HCl	67	Each	150.00	0	0	0	10,050	10,050
TOTAL - Sampling and Analysis	899	Each		0	0	0	134,850	134,850
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	800	Mandays	35.00	0	0	28,000	0	28,000
TOTAL - PPC/PPE	800	Mandays		0	0	28,000	0	28,000
Demobilization								
Abandon SVE/Thermal Points	364	Each	250.00	0	0	0	91,000	91,000
Abandon Monitoring Wells	52	Each	250.00	0	0	0	13,000	13,000
TOTAL - Demobilization	1	LS		0	0	0	104,000	104,000

TABLE B-18
SIX-PHASE HEATING HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office								
Project Manager (40 Hours/Mo.)	480	Hours	148.50	71,280	0	0	0	71,280
Support Personnel (Timekeeping, Procurement)	480	Hours	82.50	39,600	0	0	0	39,600
Other Personnel (50 Hours/Mo.)	600	Hours	99.00	59,400	0	0	0	59,400
Travel to Site (6 Mo, 5/Mo, 300 miles each)	18,000	Miles	0.32	0	0	0	5,670	5,670
Hotels, Meals at Site (6 Mo, 5/Mo, 3 Days each)	180	Days	125.00	0	0	0	22,500	22,500
TOTAL - Home Office	12	Months		170,280	0	0	28,170	198,450
Site Office - based on in addition to Hot Spot 2								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	12	Months		165,000	30,000	0	78,200	273,200

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Design								
Design & Planning								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	1,000	Hours	100.00	100,000	0	0	0	100,000
Other non-Engineer Support	400	Hours	40.00	16,000	0	0	0	16,000
Computers, etc.	350	Hours	10.00	0	0	0	3,500	3,500
Drawings, Specifications Copies, etc.	1	LS	10,000.00	0	0	0	10,000	10,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
Preparation of Plans								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	125	Hours	40.00	5,000	0	0	0	5,000
Computers, etc.	250	Hours	10.00	0	0	0	2,500	2,500
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	2,500.00	0	0	0	2,500	2,500
DUS Technology License Fee	1	LS	50,000.00	0	0	0	50,000	50,000
TOTAL - Design	1	LS		211,000	0	0	76,000	287,000
Permitting								
Engineering Manager, P.E.	100	Hours	200.00	20,000	0	0	0	20,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	125	Hours	40.00	5,000	0	0	0	5,000
Computers, etc.	250	Hours	10.00	0	0	0	2,500	2,500
Report Copying, etc.	1	LS	5,000.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	200.00	0	0	0	200	200
TOTAL - Permitting	1	LS		75,000	0	0	7,700	82,700
Mobilization								
Showers/Change Rooms - Build in Existing Bldg	1	LS	5,000.00	0	0	0	5,000	5,000
Storage Box	1	Each	150.00	0	0	0	150	150

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	1,000.00	0	0	1,000	0	1,000
Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Liner, Stone, Drums, etc.	1	LS	2,500.00	0	0	2,500	0	2,500
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
TOTAL - Mobilization	1	LS		4,249	560	3,500	8,000	16,309
Installation of Injection Wells								
Mobilize Driller	1	LS	12,000.00	0	0	0	12,000	12,000
Drill & Install Injection Wells								
Drilling (10" Borehole)	630	VF	45.00	0	0	0	28,350	28,350
4" SS Screen	70	VF	25.00	0	0	0	1,750	1,750
4" SS Well Sump and Riser	560	VF	20.00	0	0	0	11,200	11,200
Sand Backfill	6	CY	50.00	0	0	0	300	300
Bentonite Seal	2	CY	100.00	0	0	0	200	200
Grout	3	CY	100.00	0	0	0	300	300
Wellhead Steam Fitting Connection/Instrumentatior	14	Each	500.00	0	0	0	7,000	7,000
Thermocouples, 5 @ 5' o.c. vertically	14	Sets	100.00	0	0	0	1,400	1,400
Flush Mount Cover	14	Wells	150.00	0	0	0	2,100	2,100
Well Development	14	Wells	1,000.00	0	0	0	14,000	14,000
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Drill Cuttings Characterization & Disposal								
IDW - Soil	31	Tons	100.00	0	0	0	3,100	3,100
IDW - PPE	3	Drums	100.00	0	0	0	300	300
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Installation of Injection Wells	11	Wells		0	10,000	0	82,700	92,700
Installation of Steam Generation Equipment								
Boiler, Water Treatment System & Water Pump								
Millwright Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Millwright	40	Hours	37.00	1,480	0	0	0	1,480
Operator	40	Hours	47.51	1,901	0	0	0	1,901
Forklift	40	Hours	28.00	0	1,120	0	0	1,120
Boiler, 8,000,000 BTU/hr.	1	Each	100,000	0	0	100,000	0	100,000
Boiler Manifold	1	Each	2,500	0	0	2,500	0	2,500
Steam Hose	1,000	LF	10	0	0	10,000	0	10,000
Water Service								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Tractor-Loader-Backhoe	30	Hours	28.00	0	840	0	0	840
2" Cu Piping	200	LF	3.00	0	0	600	0	600
Natural Gas Service								
Plumber Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Plumber	30	Hours	37.00	1,110	0	0	0	1,110
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Tractor-Loader-Backhoe	30	Hours	28.00	0	840	0	0	840
2" Gas Service	200	LF	2.00	0	0	400	0	400

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Surface Protection - Jersey Barriers								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Forklift	30	Hours	28.00	0	840	0	0	840
Jersey Barriers - Delivery	200	LF	10.00	0	0	2,000	0	2,000
TOTAL - Steam Generation Equipment	1	Lot		15,475	3,640	115,500	0	134,615
Vapor Collection Wells								
Drill & Install Vapor Collection Wells								
Drilling (10" Borehole)	440	VF	45.00	0	0	0	19,800	19,800
Screen, 6" Dia., SS, 0.010" Slot Screens	385	VF	80.00	0	0	0	30,800	30,800
Riser, 6" Dia., SS	55	VF	60.00	0	0	0	3,300	3,300
Wellhead Fitting and Instrumentation	11	Each	50.00	0	0	0	550	550
Well Pump, 2 HP	11	Each	2,500.00	0	0	0	27,500	27,500
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000
Liquid System Piping								
Plumber Foreman	20	Hours	38.60	772	0	0	0	772
Plumber	20	Hours	37.00	740	0	0	0	740
Operator	20	Hours	47.51	950	0	0	0	950
Tractor-Loader-Backhoe	20	Hours	28.00	0	560	0	0	560
2" Black Pipe	350	LF	1.00	0	0	350	0	350
2" Valve	10	Each	35.00	0	0	350	0	350
Vapor System Piping								
Plumber Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Plumber	30	Hours	37.00	1,110	0	0	0	1,110
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Tractor-Loader-Backhoe	30	Hours	28.00	0	840	0	0	840
6" Black Pipe	1,000	LF	2.00	0	0	2,000	0	2,000
6" Valve	10	Each	150.00	0	0	1,500	0	1,500
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Drill Cuttings Characterization & Disposal								
IDW - Soil	2	Tons	100.00	0	0	0	200	200
IDW - PPE	2	Drums	100.00	0	0	0	200	200
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Vapor Collection Wells	11	Wells		6,156	11,400	4,200	83,050	104,806
Monitoring System								
Drill & Install Electrical Resistance Tomography (ERT) Wells								
Drilling	560	VF	20.00	0	0	0	11,200	11,200
2" Fiberglass Casing	560	VF	10.00	0	0	0	5,600	5,600
Fittings	14	Wells	100.00	0	0	0	1,400	1,400
Sand Filter Pack	14	Wells	100.00	0	0	0	1,400	1,400
Grout & Bentonite Seal	14	Wells	100.00	0	0	0	1,400	1,400
Flush Mount Cover	14	Wells	100.00	0	0	0	1,400	1,400
10 ERT Electrodes/Wire across Treatment Interval	14	Sets	250.00	0	0	0	3,500	3,500
Thermocouples and Wire	14	Sets	100.00	0	0	0	1,400	1,400
ERT Computer Equipment	1	LS	2,500.00	0	0	0	2,500	2,500
Thermocouple Monitoring Equipment	1	LS	2,500.00	0	0	0	2,500	2,500
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Drill Cuttings Characterization & Disposal								
IDW - Soil	2	Tons	100.00	0	0	0	200	200
IDW - PPE	2	Drums	100.00	0	0	0	200	200
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Monitoring System	14	Wells		0	0	0	33,400	33,400
Liquid & Vapor Treatment Equipment Installation								
Air Compressor								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Air Compressor	1	Each	5,000.00	0	0	5,000	0	5,000

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Condenser, 80 Ton								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Water Cooled Steam Condenser, 80 Ton	1	Each	35,000.00	0	0	35,000	0	35,000
Condensate Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Condensate Storage Tank	1	Each	1,000.00	0	0	1,000	0	1,000
Product Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Product Storage Tank	1	Each	1,000.00	0	0	1,000	0	1,000
Condensate Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Condensate Pump	1	Each	1,000.00	0	0	1,000	0	1,000
Product Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Product Pump	1	Each	1,000.00	0	0	1,000	0	1,000
Blowers/Vacuum Pumps								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	20	Hours	47.51	950	0	0	0	950
Forklift	20	Hours	28.00	0	560	0	0	560
Blower, Varialbe Speed, 500 SCFM, 5 HP	1	Each	1,000.00	0	0	1,000	0	1,000

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Particulate Filter and Silencers								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	20	Hours	47.51	950	0	0	0	950
Forklift	20	Hours	28.00	0	560	0	0	560
Particulate Filter	1	Each	1,000.00	0	0	1,000	0	1,000
Silencers	2	Each	500.00	0	0	1,000	0	1,000
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
1000-pound Activated Carbon Canister	2	Each	4,000.00	0	0	8,000	0	8,000
Sample Ports	4	Each	100.00	0	0	400	0	400
Natural Gas Fired Catalytic Oxidizer								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Catalytic Oxidizer, 500 SCFM	1	Each	50,000.00	0	0	50,000	0	50,000
Scrubber								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrochloric Acid Scrubber, 1000 SCFM	1	Each	15,000.00	0	0	15,000	0	15,000
Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
Pipe and Fittings	40	LF	5.00	0	0	200	0	200

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Control System								
Electrician Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Electrician	40	Hours	37.00	1,480	0	0	0	1,480
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Control System with MCCs and PLC	1	Each	25,000.00	0	0	25,000	0	25,000
Security Fence, 6' high	400	Each	12.50	0	0	5,000	0	5,000
TOTAL - Liquid & Vapor Treatment Equipment	1	Each		20,022	3,780	151,350	0	175,152
System Operation								
Personnel								
Engineering Support	1,800	Hours	100.00	180,000	0	0	0	180,000
Per Diems	180	Days	100.00	0	0	0	18,000	18,000
Project Vehicles	1,800	Hours	7.50	0	13,500	0	0	13,500
DUS Subcontractor Personnel	1,800	Hours	60.00	0	0	0	108,000	108,000
DUS Subcontractor ODCs	180	Days	125.00	0	0	0	22,500	22,500
Geophysicist's Support	1,600	Hours	100.00	160,000	0	0	0	160,000
Per Diems	160	Days	100.00	0	0	0	16,000	16,000
Plant Operator	12,096	Hours	40.00	483,840	0	0	0	483,840
Plant Operations ODCs	1,280	Days	50.00	0	0	0	64,000	64,000
Electrician Foreman	256	Hours	38.60	9,882	0	0	0	9,882
Project Engineer/HSO	1,240	Hours	77.00	95,480	0	0	0	95,480
Q.C. Engineer	1,240	Hours	77.00	95,480	0	0	0	95,480
Natural Gas								
Boiler	5,000,000	CF	0.02	0	0	0	100,000	100,000
Catalytic Oxidization	396,000	CF	0.02	0	0	0	7,920	7,920
Electricity								
Boiler	10,560	kWhr	0.06	0	0	0	845	845
Other	50,000	kWhr	0.06	0	0	0	4,000	4,000
Boiler Water	950,400	Gallon	0.01	0	0	0	9,504	9,504
Liquid Treatment Activated Carbon Changeout	4,000	lb.	1.50	0	0	6,000	0	6,000
Sodium Hydroxide for Scrubber	1,700	lb.	0.25	0	0	425	0	425
Condensate Disposal Fee	1,633,000	Gallon	0.01	0	0	16,330	0	16,330

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
TOTAL - System Operation	200	Days		1,024,682	13,500	22,755	350,769	1,411,705
Sampling and Analysis								
Off-Site Analytical - Water								
VOCs	112	Each	150.00	0	0	0	16,800	16,800
Off-Site Analytical - Air								
VOCs	47	Each	150.00	0	0	0	7,050	7,050
HCl	34	Each	150.00	0	0	0	5,100	5,100
TOTAL - Sampling and Analysis	193	Each		0	0	0	28,950	28,950
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	70	Mandays	35.00	0	0	2,450	0	2,450
TOTAL - PPC/PPE	70	Mandays		0	0	2,450	0	2,450
Demobilization								
Storage Box	2	Each	150.00	0	0	0	300	300
Remove Personnel Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Remove Equipment Decon Pad								
Labor Foreman	10	Hours	34.05	340	0	0	0	340
Laborers	40	Hours	32.72	1,309	0	0	0	1,309
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Abandon Extraction/Injection Wells	21	Each	250.00	0	0	0	5,250	5,250
Abandon Monitoring Wells	10	Each	250.00	0	0	0	2,500	2,500
Demobilize Driller	1	LS	2,500.00	0	0	0	2,500	2,500
TOTAL - Demobilization	1	LS		4,249	560	0	13,400	18,209
Home Office								
Project Manager (40 Hours/Mo.)	240	Hours	148.50	35,640	0	0	0	35,640
Support Personnel (Timekeeping, Procurement)	240	Hours	82.50	19,800	0	0	0	19,800
Other Personnel (50 Hours/Mo.)	300	Hours	99.00	29,700	0	0	0	29,700
Travel to Site (6 Mo, 5/Mo, 300 miles each)	9,000	Miles	0.32	0	0	0	2,835	2,835
Hotels, Meals at Site (6 Mo, 5/Mo, 3 Days each)	90	Days	125.00	0	0	0	11,250	11,250
TOTAL - Home Office	6	Months		85,140	0	0	14,085	99,225

TABLE B-19
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 1, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		165,000	30,000	0	78,200	273,200

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Design - Based on Hot Spot 1 being a pilot								
Design & Planning								
Engineering Manager, P.E.	50	Hours	200.00	10,000	0	0	0	10,000
Other Engineering Support	500	Hours	100.00	50,000	0	0	0	50,000
Other non-Engineer Support	200	Hours	40.00	8,000	0	0	0	8,000
Computers, etc.	175	Hours	10.00	0	0	0	1,750	1,750
Report Copying, etc.	1	LS	5,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	1,250.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	50	Hours	200.00	10,000	0	0	0	10,000
Other Engineering Support	250	Hours	100.00	25,000	0	0	0	25,000
Other non-Engineer Support	75	Hours	40.00	3,000	0	0	0	3,000
Computers, etc.	125	Hours	10.00	0	0	0	1,250	1,250
Report Copying, etc.	1	LS	2,500.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	1,250.00	0	0	0	250	250
DUS Technology License Fee	1	LS	50,000.00	0	0	0	50,000	50,000
TOTAL - Design	1	LS		106,000	0	0	54,500	160,500
Permitting -- based on Hot Spot 1 as pilot								
Engineering Manager, P.E.	50	Hours	200.00	10,000	0	0	0	10,000
Other Engineering Support	250	Hours	100.00	25,000	0	0	0	25,000
Other non-Engineer Support	65	Hours	40.00	2,600	0	0	0	2,600
Computers, etc.	125	Hours	10.00	0	0	0	1,250	1,250
Report Copying, etc.	1	LS	2,500.00	0	0	0	5,000	5,000
Other non-Itemized Direct Costs	1	LS	100.00	0	0	0	200	200
TOTAL - Permitting	1	LS		37,600	0	0	6,450	44,050

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Mobilization -- based on Hot Spot 1 as pilot								
Equipment Mobilization								
Move-in T-L-B	1	LS	600.00	0	0	0	600	600
Move-in Forklift	1	LS	500.00	0	0	0	500	500
Move-in Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-in Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
TOTAL - Mobilization	1	LS		0	0	0	2,850	2,850
Demolish Building 48 (Quonset Hut, Carpentry Shed, Paint Storage)								
Labor Foreman	50	Hours	34.05	1,702	0	0	0	1,702
Laborers	50	Hours	32.72	1,636	0	0	0	1,636
Operator	50	Hours	47.51	2,376	0	0	0	2,376
Tractor-Loader-Backhoe	50	Hours	28.00	0	1,400	0	0	1,400
Air Compressor, Pavement Breakers (2)	50	Hours	40.00	0	2,000	0	0	2,000
Torches, Gases, etc.	5	Days	200.00	0	0	1,000	0	1,000
Tandem Axle Dump Truck & Driver	50	Hours	60.60	1,780	1,250	0	0	3,030
Dump Charge	100	CY	10.00	0	0	0	1,000	1,000
TOTAL - Demolish Building 48	1.0	LS		7,494	4,650	1,000	1,000	14,144
Installation of Injection Wells								
Mobilize Driller -- Covered by Hot Spot 1	1	LS	0.00	0	0	0	0	0

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Drill & Install Injection Wells								
Drilling (10" Borehole)	315	VF	25.00	0	0	0	7,875	7,875
4" SS Screen	35	VF	25.00	0	0	0	875	875
4" SS Well Sump and Riser	280	VF	20.00	0	0	0	5,600	5,600
Sand Backfill	4	CY	50.00	0	0	0	200	200
Bentonite Seal	1	CY	100.00	0	0	0	100	100
Grout	2	CY	100.00	0	0	0	200	200
Wellhead Steam Fitting Connection/Instrumentation	7	Each	500.00	0	0	0	3,500	3,500
Thermocouples, 7 @ 5' o.c. vertically	7	Sets	140.00	0	0	0	980	980
Flush Mount Cover	7	Wells	150.00	0	0	0	1,050	1,050
Well Development	7	Wells	1,000.00	0	0	0	7,000	7,000
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Frac Tank	2	Month	2,500.00	0	5,000	0	0	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil	10	Tons	100.00	0	0	0	1,000	1,000
IDW - PPE	2	Drums	100.00	0	0	0	200	200
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Installation of Injection Wells	7	Wells		0	5,000	0	29,280	34,280
Installation of Steam Generation Equipment								
Boiler, Water Treatment System & Water Pump								
Millwright Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Millwright	40	Hours	37.00	1,480	0	0	0	1,480
Operator	40	Hours	47.51	1,901	0	0	0	1,901
Forklift	40	Hours	28.00	0	1,120	0	0	1,120
Boiler, 8,000,000 BTU/hr.	1	Each	100,000	0	0	100,000	0	100,000
Boiler Manifold	1	Each	2,500	0	0	2,500	0	2,500
Steam Hose	1,000	LF	10	0	0	10,000	0	10,000
Water Service								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Tractor-Loader-Backhoe	30	Hours	28.00	0	840	0	0	840
2" Cu Piping	200	LF	3.00	0	0	600	0	600

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Natural Gas Service								
Plumber Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Plumber	30	Hours	37.00	1,110	0	0	0	1,110
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Tractor-Loader-Backhoe	30	Hours	28.00	0	840	0	0	840
2" Gas Service	200	LF	2.00	0	0	400	0	400
Surface Protection - Jersey Barriers								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Forklift	30	Hours	28.00	0	840	0	0	840
Jersey Barriers - Delivery	200	LF	10.00	0	0	2,000	0	2,000
TOTAL - Steam Generation Equipment	1	Lot		15,475	3,640	115,500	0	134,615
Vapor Collection Wells								
Drill & Install Vapor Collection Wells								
Drilling (10" Borehole)	40	VF	25.00	0	0	0	1,000	1,000
Screen, 6" Dia., SS, 0.010" Slot Screens	35	VF	80.00	0	0	0	2,800	2,800
Riser, 6" Dia., SS	5	VF	60.00	0	0	0	300	300
Wellhead Fitting and Instrumentation	1	Each	50.00	0	0	0	50	50
Well Pump, 2 HP	1	Each	2,500.00	0	0	0	2,500	2,500
Frac Tank	1	Month	2,500.00	0	2,500	0	0	2,500
Liquid System Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Tractor-Loader-Backhoe	10	Hours	28.00	0	280	0	0	280
2" Black Pipe	40	LF	1.00	0	0	40	0	40
2" Valve	1	Each	35.00	0	0	35	0	35

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Vapor System Piping								
Plumber Foreman	15	Hours	38.60	579	0	0	0	579
Plumber	15	Hours	37.00	555	0	0	0	555
Operator	15	Hours	47.51	713	0	0	0	713
Tractor-Loader-Backhoe	15	Hours	28.00	0	420	0	0	420
6" Black Pipe	400	LF	2.00	0	0	800	0	800
6" Valve	1	Each	150.00	0	0	150	0	150
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Drill Cuttings Characterization & Disposal								
IDW - Soil	1	Tons	100.00	0	0	0	100	100
IDW - PPE	1	Drums	100.00	0	0	0	100	100
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Vapor Collection Wells	1	Wells		3,078	3,200	1,025	7,550	14,853
Monitoring System								
Drill & Install Electrical Resistance Tomography (ERT) Wells								
Drilling	280	VF	20.00	0	0	0	5,600	5,600
2" Fiberglass Casing	280	VF	10.00	0	0	0	2,800	2,800
Fittings	7	Wells	100.00	0	0	0	700	700
Sand Filter Pack	7	Wells	100.00	0	0	0	700	700
Grout & Bentonite Seal	7	Wells	100.00	0	0	0	700	700
Flush Mount Cover	7	Wells	100.00	0	0	0	700	700
10 ERT Electrodes/Wire across Treatment Interval	7	Sets	250.00	0	0	0	1,750	1,750
Thermocouples and Wire	7	Sets	100.00	0	0	0	700	700
ERT Computer Equipment	1	LS	2,500.00	0	0	0	2,500	2,500
Thermocouple Monitoring Equipment	1	LS	2,500.00	0	0	0	2,500	2,500
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Drill Cuttings Characterization & Disposal								
IDW - Soil	2	Tons	100.00	0	0	0	200	200
IDW - PPE	2	Drums	100.00	0	0	0	200	200
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Monitoring System	7	Wells		0	0	0	19,750	19,750

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Liquid & Vapor Treatment Equipment Installation								
Air Compressor								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Air Compressor	1	Each	5,000.00	0	0	5,000	0	5,000
Condenser, 80 Ton								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Water Cooled Steam Condenser, 80 Ton	1	Each	35,000.00	0	0	35,000	0	35,000
Condensate Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Condensate Storage Tank	1	Each	1,000.00	0	0	1,000	0	1,000
Product Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Product Storage Tank	1	Each	1,000.00	0	0	1,000	0	1,000
Condensate Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Condensate Pump	1	Each	1,000.00	0	0	1,000	0	1,000

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Product Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Product Pump	1	Each	1,000.00	0	0	1,000	0	1,000
Blowers/Vacuum Pumps								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	20	Hours	47.51	950	0	0	0	950
Forklift	20	Hours	28.00	0	560	0	0	560
Blower, Varialbe Speed, 500 SCFM, 5 HP	1	Each	1,000.00	0	1,000	0	0	1,000
Particulate Filter and Silencers								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	20	Hours	47.51	950	0	0	0	950
Forklift	20	Hours	28.00	0	560	0	0	560
Particulate Filter	1	Each	1,000.00	0	0	1,000	0	1,000
Silencers	2	Each	500.00	0	0	1,000	0	1,000
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
1000-pound Activated Carbon Canister	2	Each	4,000.00	0	0	8,000	0	8,000
Sample Ports	4	Each	100.00	0	0	400	0	400
Natural Gas Fired Catalytic Oxidizer								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Catalytic Oxidizer, 500 SCFM	1	Each	50,000.00	0	0	50,000	0	50,000

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Scrubber								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrochloric Acid Scrubber, 1000 SCFM	1	Each	15,000.00	0	0	15,000	0	15,000
Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
Pipe and Fittings	40	LF	5.00	0	0	200	0	200
Control System								
Electrician Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Electrician	40	Hours	37.00	1,480	0	0	0	1,480
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Control System with MCCs and PLC	1	Each	25,000.00	0	0	25,000	0	25,000
Security Fence, 6' high	400	Each	12.50	0	0	5,000	0	5,000
TOTAL - Liquid & Vapor Treatment Equipment	1	Each		20,022	4,780	150,350	0	175,152
System Operation								
Personnel								
Engineering Support	550	Hours	100.00	55,000	0	0	0	55,000
Per Diems	55	Days	100.00	0	0	0	5,500	5,500
Project Vehicles	550	Hours	7.50	0	4,125	0	0	4,125
DUS Subcontractor Personnel	550	Hours	60.00	0	0	0	33,000	33,000
DUS Subcontractor ODCs	55	Days	125.00	0	0	0	6,875	6,875
Geophysicist's Support	350	Hours	100.00	35,000	0	0	0	35,000
Per Diems	35	Days	100.00	0	0	0	3,500	3,500
Plant Operator	2,646	Hours	40.00	105,840	0	0	0	105,840
Plant Operations ODCs	280	Days	50.00	0	0	0	14,000	14,000
Electrician Foreman	56	Hours	38.60	2,162	0	0	0	2,162
Project Engineer/HSO	1,240	Hours	77.00	95,480	0	0	0	95,480
Q.C. Engineer	1,240	Hours	77.00	95,480	0	0	0	95,480

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Natural Gas								
Boiler	1,900,000	CF	0.02	0	0	0	38,000	38,000
Catalytic Oxidization	186,400	CF	0.02	0	0	0	3,728	3,728
Electricity								
Boiler	4,072	kWhr	0.06	0	0	0	326	326
Other	20,000	kWhr	0.06	0	0	0	1,600	1,600
Boiler Water	366,500	Gallon	0.01	0	0	0	3,665	3,665
Liquid Treatment Activated Carbon Changeout	2,000	lb.	1.50	0	0	3,000	0	3,000
Sodium Hydroxide for Scrubber	800	lb.	0.25	0	0	200	0	200
Condensate Disposal Fee	1,242,000	Gallon	0.01	0	0	12,420	0	12,420
TOTAL - System Operation	80	Days		388,962	4,125	15,620	110,194	518,900
Sampling and Analysis								
Off-Site Analytical - Water								
VOCs	47	Each	150.00	0	0	0	7,050	7,050
Off-Site Analytical - Air								
VOCs	39	Each	150.00	0	0	0	5,850	5,850
HCl	13	Each	150.00	0	0	0	1,950	1,950
TOTAL - Sampling and Analysis	99	Each		0	0	0	14,850	14,850
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
PPC/PPE								
PPC/PPE, Mandays	30	Mandays	35.00	0	0	1,050	0	1,050
TOTAL - PPC/PPE	30	Mandays		0	0	1,050	0	1,050
Demobilization -- Based on additional to Hot Spot No. 1								
Equipment Demobilization								
Move-out T-L-B	1	LS	600.00	0	0	0	600	600
Move-out Forklift	1	LS	500.00	0	0	0	500	500
Move-out Air Compressor, Pvm't Brkrs, Tools, etc.	1	LS	250.00	0	0	0	250	250
Move-out Frac Tanks	2	Each	750.00	0	0	0	1,500	1,500
Abandon Extraction/Injection Wells	8	Each	250.00	0	0	0	2,000	2,000
Abandon Monitoring Wells	7	Each	250.00	0	0	0	1,750	1,750
TOTAL - Demobilization	1	LS		0	0	0	6,600	6,600
Home Office								
Project Manager (40 Hours/Mo.)	240	Hours	148.50	35,640	0	0	0	35,640
Support Personnel (Timekeeping, Procurement)	240	Hours	82.50	19,800	0	0	0	19,800
Other Personnel (50 Hours/Mo.)	300	Hours	99.00	29,700	0	0	0	29,700
Travel to Site (6 Mo, 5/Mo, 300 miles each)	9,000	Miles	0.32	0	0	0	2,835	2,835
Hotels, Meals at Site (6 Mo, 5/Mo, 3 Days each)	90	Days	125.00	0	0	0	11,250	11,250
TOTAL - Home Office	6	Months		85,140	0	0	14,085	99,225

TABLE B-20
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 2, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Site Office - includes Reports								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	6	Months		165,000	30,000	0	78,200	273,200

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Pre-Design Investigation								
Drill & Install Monitoring Well Clusters								
Drilling	1,270	VF	55.00	0	0	0	69,850	69,850
Screen, 2" Dia., SS, 0.010" Slot Screens	130	VF	25.00	0	0	0	3,250	3,250
Riser, 2" Dia., SS	1,140	VF	23.00	0	0	0	26,220	26,220
Flush Mount Cover	6	Each	250.00	0	0	0	1,500	1,500
Well Development	13	Wells	750.00	0	0	0	9,750	9,750
Carbon Drum to treat Well Development Water	2	Drums	2,500.00	0	0	0	5,000	5,000
Drill Cuttings Characterization & Disposal								
IDW - Soil	7	Tons	100.00	0	0	0	700	700
IDW - PPE	4	Drums	100.00	0	0	0	400	400
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Pre-Design Investigation	13	Wells		0	0	0	116,870	116,870
Sampling and Analysis - Pre-Design								
Off-Site Analytical - Water								
VOCs	17	Each	150.00	0	0	0	2,550	2,550
TOTAL - Sampling and Analysis - Pre-Design	17	Each		0	0	0	2,550	2,550
Data Validation - Pre-Design								
Other Engineering Support	32	Hours	100.00	3,200	0	0	0	3,200
TOTAL - Data Validation - Pre-Design	1	LS		3,200	0	0	0	3,200
Technical Report - Findings, Pre-Design								
Other Engineering Support	40	Hours	100.00	4,000	0	0	0	4,000
TOTAL - Technical Report - Findings, Pre-Design	1	LS		4,000	0	0	0	4,000

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Design - Based on this being addition to Hot Spot 2								
Design & Planning								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
Preparation of Plans								
Engineering Manager, P.E.	14	Hours	200.00	2,800	0	0	0	2,800
Other Engineering Support	100	Hours	100.00	10,000	0	0	0	10,000
Other non-Engineer Support	50	Hours	40.00	2,000	0	0	0	2,000
Computers, etc.	60	Hours	10.00	0	0	0	600	600
Report Copying, etc.	1	LS	1,000.00	0	0	0	500	500
Other non-Itemized Direct Costs	1	LS	500.00	0	0	0	250	250
DUS Technology License Fee	1	LS	50,000.00	0	0	0	50,000	50,000
TOTAL - Design	1	LS		29,600	0	0	52,700	82,300
Permitting -- Covered by Hot Spot 2								
Mobilization -- Covered by Hot Spot 1 and 2								

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Installation of Injection Wells								
Mobilize Driller -- Covered by Hot Spot 1	1	LS	0.00	0	0	0	0	0
Drill & Install Injection Wells								
Drilling (10" Borehole)	1,690	VF	45.00	0	0	0	76,050	76,050
4" SS Screen	130	VF	25.00	0	0	0	3,250	3,250
4" SS Well Sump and Riser	1,560	VF	20.00	0	0	0	31,200	31,200
Sand Backfill	20	CY	50.00	0	0	0	1,000	1,000
Bentonite Seal	3	CY	100.00	0	0	0	300	300
Grout	6	CY	100.00	0	0	0	600	600
Wellhead Steam Fitting Connection/Instrumentatio	26	Each	500.00	0	0	0	13,000	13,000
Thermocouples, 10 @ 5' o.c. vertically	26	Sets	200.00	0	0	0	5,200	5,200
Flush Mount Cover	26	Wells	150.00	0	0	0	3,900	3,900
Well Development	26	Wells	1,000.00	0	0	0	26,000	26,000
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000
Drill Cuttings Characterization & Disposal								
IDW - Soil	85	Tons	100.00	0	0	0	8,500	8,500
IDW - PPE	5	Drums	100.00	0	0	0	500	500
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Installation of Injection Wells	7	Wells		0	10,000	0	170,200	180,200
Installation of Steam Generation Equipment								
Boiler, Water Treatment System & Water Pump								
Millwright Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Millwright	40	Hours	37.00	1,480	0	0	0	1,480
Operator	40	Hours	47.51	1,901	0	0	0	1,901
Forklift	40	Hours	28.00	0	1,120	0	0	1,120
Boiler, 32,000,000 BTU/hr.	1	Each	250,000	0	0	250,000	0	250,000
Boiler Manifold	1	Each	5,000	0	0	5,000	0	5,000
Steam Hose	4,000	LF	10	0	0	40,000	0	40,000

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Water Service								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Tractor-Loader-Backhoe	30	Hours	28.00	0	840	0	0	840
2" Cu Piping	200	LF	3.00	0	0	600	0	600
Natural Gas Service								
Plumber Foreman	30	Hours	38.60	1,158	0	0	0	1,158
Plumber	30	Hours	37.00	1,110	0	0	0	1,110
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Tractor-Loader-Backhoe	30	Hours	28.00	0	840	0	0	840
2" Gas Service	200	LF	2.00	0	0	400	0	400
Surface Protection - Jersey Barriers								
Labor Foreman	30	Hours	34.05	1,021	0	0	0	1,021
Laborers	30	Hours	32.72	982	0	0	0	982
Operator	30	Hours	47.51	1,425	0	0	0	1,425
Forklift	30	Hours	28.00	0	840	0	0	840
Jersey Barriers - Delivery	200	LF	10.00	0	0	2,000	0	2,000
TOTAL - Steam Generation Equipment	1	Lot		15,475	3,640	298,000	0	317,115
Vapor Collection Wells								
Drill & Install Vapor Collection Wells								
Drilling (10" Borehole)	1,140	VF	45.00	0	0	0	51,300	51,300
Screen, 6" Dia., SS, 0.010" Slot Screens	1,045	VF	80.00	0	0	0	83,600	83,600
Riser, 6" Dia., SS	95	VF	60.00	0	0	0	5,700	5,700
Wellhead Fitting and Instrumentation	19	Each	50.00	0	0	0	950	950
Well Pump, 2 HP	19	Each	2,500.00	0	0	0	47,500	47,500
Frac Tank	4	Month	2,500.00	0	10,000	0	0	10,000
Liquid System Piping								
Plumber Foreman	80	Hours	38.60	3,088	0	0	0	3,088
Plumber	80	Hours	37.00	2,960	0	0	0	2,960
Operator	80	Hours	47.51	3,801	0	0	0	3,801
Tractor-Loader-Backhoe	80	Hours	28.00	0	2,240	0	0	2,240
2" Black Pipe	1,200	LF	1.00	0	0	1,200	0	1,200
2" Valve	20	Each	35.00	0	0	700	0	700

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Vapor System Piping								
Plumber Foreman	120	Hours	38.60	4,632	0	0	0	4,632
Plumber	120	Hours	37.00	4,440	0	0	0	4,440
Operator	120	Hours	47.51	5,702	0	0	0	5,702
Tractor-Loader-Backhoe	120	Hours	28.00	0	3,360	0	0	3,360
6" Black Pipe	4,000	LF	2.00	0	0	8,000	0	8,000
6" Valve	20	Each	150.00	0	0	3,000	0	3,000
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Drill Cuttings Characterization & Disposal								
IDW - Soil	7	Tons	100.00	0	0	0	700	700
IDW - PPE	4	Drums	100.00	0	0	0	400	400
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Vapor Collection Wells	19	Wells		24,623	15,600	12,900	190,850	243,973
Monitoring System								
Drill & Install Electrical Resistance Tomography (ERT) Wells								
Drilling	1,560	VF	20.00	0	0	0	31,200	31,200
2" Fiberglass Casing	1,560	VF	10.00	0	0	0	15,600	15,600
Fittings	26	Wells	100.00	0	0	0	2,600	2,600
Sand Filter Pack	26	Wells	100.00	0	0	0	2,600	2,600
Grout & Bentonite Seal	26	Wells	100.00	0	0	0	2,600	2,600
Flush Mount Cover	26	Wells	150.00	0	0	0	3,900	3,900
10 ERT Electrodes/Wire across Treatment Interval	26	Sets	250.00	0	0	0	6,500	6,500
Thermocouples and Wire	26	Sets	100.00	0	0	0	2,600	2,600
ERT Computer Equipment	1	LS	2,500.00	0	0	0	2,500	2,500
Thermocouple Monitoring Equipment	1	LS	2,500.00	0	0	0	2,500	2,500
Miscellaneous Materials	1	LS	500.00	0	0	0	500	500
Drill Cuttings Characterization & Disposal								
IDW - Soil	11	Tons	100.00	0	0	0	1,100	1,100
IDW - PPE	4	Drums	100.00	0	0	0	400	400
IDW - Water w/ Surfacants	2	Drums	100.00	0	0	0	200	200
TOTAL - Monitoring System	26	Wells		0	0	0	74,800	74,800

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Liquid & Vapor Treatment Equipment Installation								
Air Compressor								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Air Compressor	1	Each	5,000.00	0	0	5,000	0	5,000
Condenser, 120 Ton								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Water Cooled Steam Condenser, 120 Ton	1	Each	50,000.00	0	0	50,000	0	50,000
Condensate Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Condensate Storage Tank	1	Each	1,000.00	0	0	1,000	0	1,000
Product Storage Tank								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Product Storage Tank	1	Each	1,000.00	0	0	1,000	0	1,000
Condensate Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Condensate Pump	1	Each	1,000.00	0	0	1,000	0	1,000
Product Pump								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Product Pump	1	Each	1,000.00	0	0	1,000	0	1,000

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Blowers/Vacuum Pumps								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	20	Hours	47.51	950	0	0	0	950
Forklift	20	Hours	28.00	0	560	0	0	560
Blower, Varialbe Speed, 1000 SCFM, 10 HP	1	Each	3,000.00	0	0	3,000	0	3,000
Particulate Filter and Silencers								
Millwright Foreman	20	Hours	38.60	772	0	0	0	772
Millwright	20	Hours	37.00	740	0	0	0	740
Operator	20	Hours	47.51	950	0	0	0	950
Forklift	20	Hours	28.00	0	560	0	0	560
Particulate Filter	1	Each	1,000.00	0	0	1,000	0	1,000
Silencers	2	Each	500.00	0	0	1,000	0	1,000
Liquid Treatment System								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
500-Gallon Holding Tank	1	Each	750.00	0	0	750	0	750
10000-pound Activated Carbon Canister	2	Each	12,500.00	0	0	25,000	0	25,000
Sample Ports	4	Each	100.00	0	0	400	0	400
Natural Gas Fired Catalytic Oxidizer								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Catalytic Oxidizer, 1000 SCFM	1	Each	75,000.00	0	0	75,000	0	75,000
Scrubber								
Millwright Foreman	10	Hours	38.60	386	0	0	0	386
Millwright	10	Hours	37.00	370	0	0	0	370
Operator	10	Hours	47.51	475	0	0	0	475
Forklift	10	Hours	28.00	0	280	0	0	280
Hydrochloric Acid Scrubber, 1000 SCFM	1	Each	20,000.00	0	0	20,000	0	20,000
Piping								
Plumber Foreman	10	Hours	38.60	386	0	0	0	386
Plumber	10	Hours	37.00	370	0	0	0	370
Pipe and Fittings	40	LF	5.00	0	0	200	0	200

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Control System								
Electrician Foreman	40	Hours	38.60	1,544	0	0	0	1,544
Electrician	40	Hours	37.00	1,480	0	0	0	1,480
Operator	5	Hours	47.51	238	0	0	0	238
Forklift	5	Hours	28.00	0	140	0	0	140
Control System with MCCs and PLC	1	Each	40,000.00	0	0	40,000	0	40,000
Security Fence, 6' high	400	Each	12.50	0	0	5,000	0	5,000
TOTAL - Liquid & Vapor Treatment Equipment	1	Each		20,022	3,780	230,350	0	254,152
System Operation								
Personnel								
Engineering Support	2,800	Hours	100.00	280,000	0	0	0	280,000
Per Diems	280	Days	100.00	0	0	0	28,000	28,000
Project Vehicles	2,800	Hours	7.50	0	21,000	0	0	21,000
DUS Subcontractor Personnel	2,800	Hours	60.00	0	0	0	168,000	168,000
DUS Subcontractor ODCs	280	Days	125.00	0	0	0	35,000	35,000
Geophysicist's Support	2,600	Hours	100.00	260,000	0	0	0	260,000
Per Diems	260	Days	100.00	0	0	0	26,000	26,000
Plant Operator	19,656	Hours	40.00	786,240	0	0	0	786,240
Plant Operations ODCs	1,560	Days	50.00	0	0	0	78,000	78,000
Electrician Foreman	416	Hours	38.60	16,058	0	0	0	16,058
Project Engineer/HSO	1,480	Hours	77.00	113,960	0	0	0	113,960
Q.C. Engineer	1,480	Hours	77.00	113,960	0	0	0	113,960
Natural Gas								
Boiler	21,750,000	CF	0.02	0	0	0	435,000	435,000
Catalytic Oxidization	1,188,000	CF	0.02	0	0	0	23,760	23,760
Electricity								
Boiler	104,400	kWhr	0.06	0	0	0	8,352	8,352
Other	130,000	kWhr	0.06	0	0	0	10,400	10,400
Boiler Water	4,077,000	Gallon	0.01	0	0	0	40,770	40,770
Liquid Treatment Activated Carbon Changeout	40,000	lb.	1.50	0	0	60,000	0	60,000
Sodium Hydroxide for Scrubber	15,135	lb.	0.25	0	0	3,784	0	3,784
Condensate Disposal Fee	11,500,000	Gallon	0.01	0	0	115,000	0	115,000
TOTAL - System Operation	160	Days		1,570,218	21,000	178,784	853,282	2,623,283

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Sampling and Analysis								
Off-Site Analytical - Water								
VOCs	297	Each	150.00	0	0	0	44,550	44,550
Off-Site Analytical - Air								
VOCs	115	Each	150.00	0	0	0	17,250	17,250
HCl	83	Each	150.00	0	0	0	12,450	12,450
TOTAL - Sampling and Analysis	495	Each		0	0	0	74,250	74,250
Equipment Decontamination								
Labor Foreman	20	Hours	34.05	681	0	0	0	681
Laborers	20	Hours	32.72	654	0	0	0	654
Pressure Washer	20	Hours	10.00	0	200	0	0	200
Breathing Air	1	LS	2,500.00	0	0	2,500	0	2,500
TOTAL - Equipment Decontamination	1	LS		1,335	200	2,500	0	4,035
PPC/PPE								
PPC/PPE, Mandays	90	Mandays	35.00	0	0	3,150	0	3,150
TOTAL - PPC/PPE	90	Mandays		0	0	3,150	0	3,150
Demobilization -- Based on additional to Hot Spot 1&2								
Abandon Extraction/Injection Wells	45	Each	250.00	0	0	0	11,250	11,250
Abandon Monitoring Wells	26	Each	250.00	0	0	0	6,500	6,500
TOTAL - Demobilization	1	LS		0	0	0	17,750	17,750

TABLE B-21
DYNAMIC UNDERGROUND STRIPPING, HOT SPOT NO. 3, COST DETAIL

OU 2 ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Home Office								
Project Manager (40 Hours/Mo.)	480	Hours	148.50	71,280	0	0	0	71,280
Support Personnel (Timekeeping, Procurement)	480	Hours	82.50	39,600	0	0	0	39,600
Other Personnel (50 Hours/Mo.)	600	Hours	99.00	59,400	0	0	0	59,400
Travel to Site (6 Mo, 5/Mo, 300 miles each)	18,000	Miles	0.32	0	0	0	5,670	5,670
Hotels, Meals at Site (6 Mo, 5/Mo, 3 Days each)	180	Days	125.00	0	0	0	22,500	22,500
TOTAL - Home Office	6	Months		170,280	0	0	28,170	198,450
Site Office - based on in addition to Hot Spot 2								
Project Superintendent	1,000	Hours	99.00	99,000	0	0	0	99,000
Support Personnel (Timekeeping, Procurement)	1,000	Hours	66.00	66,000	0	0	0	66,000
Per Diems	720	Days	100.00	0	0	0	72,000	72,000
Project Vehicles	4,000	Hours	7.50	0	30,000	0	0	30,000
Storage Box	12	Months	100.00	0	0	0	1,200	1,200
Copier, Fax, Computers	6	Months	500.00	0	0	0	3,000	3,000
Surveyor	1	LS	2,000.00	0	0	0	2,000	2,000
TOTAL - Site Office	12	Months		165,000	30,000	0	78,200	273,200

ENGINEERING CALCULATIONS

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SHEET 1 OF 2
JOB NO. 47254 / 20053
DATE 3/27/00
PROJECT Stratford Army Engine Plant - OU2 EE/CA
COMPUTED BY SCP
SUBJECT Chemical Usage Calcs
CHECKED BY GLR

Purpose: Estimate the chemical quantities necessary for the in-situ reduction alternative

Inputs: Water table is located at 5 ft bgs
Chrome distribution as shown on attached figures
porosity = 0.3 (assumed)
average soil density = 110 lb/cf (assumed)
Ferrous Sulfate to Cr(VI) molar ratio = 30

Calculations:

Ferrous Sulfate

Ferrous sulfate use is based on the estimated mass of hexavalent chromium present in the subsurface and the stoichiometric relationship determined from the pilot test.

Mass of Cr(VI)

Shallow zone (0-30 bgs)
Area = 63,000 sf
Average Cr(VI) conc. in water = 50 mg/L
Average Cr(VI) conc. in soil = 0.5 mg/kg
Mass Cr(VI) water = 63,000 ft² × 25 ft × 0.3 × 7.48 gal/ft³ · 3.7854 · 50/10⁶ = 669 kg
Mass Cr(VI) soil = 63000 · 30 · 110 · 0.4539 kg/lb · 0.5/10⁶ = 47 kg
Mass Cr(VI) shallow = 716 kg

Intermediate Zone (30-35 ft bgs)
Area = 25,000 sf
Average Cr(VI) conc. in water = 500 mg/L
Average Cr(VI) conc. in soil = 1.0 mg/kg
Mass Cr(VI) water = 25,000 · 5 · 0.3 · 7.48 · 3.7854 · 500/10⁶ = 531 kg
Mass Cr(VI) soil = 25000 · 5 · 110 · 0.4539 · 1.0/10⁶ = 6 kg
Mass Cr(VI) intermediate = 537 kg

Deep Zon (35-45 ft bgs)
Area = 11,500 sf
Average Cr(VI) conc. in water = 500 mg/L
Average Cr(VI) conc. in Soil = 1.0 mg/kg
Mass Cr(VI) water = 11,500 · 10 · 0.3 · 3.7854 · 7.48 · 500/10⁶ = 488 kg
Mass Cr(VI) soil = 11,500 · 10 · 110 · 0.4539 · 1.0/10⁶ = 6 kg
Mass Cr(VI) deep = 494 kg

PROJECT Stratford Army Engine Plant - OU 2 EE/CA
SUBJECT Chemical usage calcs - In-situ Red. Alt.
COMPUTED BY Scp
CHECKED BY GLR

Total mass Cr(VI) = 716 + 537 + 494 = 1,744 kg

Ferrous sulfate required

~~1,744~~ 1,747 kg Cr(VI) · 1000 · $\frac{mole}{52\ g}$ · $\frac{30\ moles\ FeSO_4}{mole\ Cr(VI)}$ = 1,00~~6~~8,000 moles $FeSO_4$

1,006,000 · $\frac{278\ g}{mole}$ · $\frac{lb}{453.9\ g}$ = ~~616,000~~ 617,000 lbs of $FeSO_4 \cdot 7H_2O$

Sulfuric Acid

The ratio of sulfuric acid : ferrous sulfate used in the make up of ferrous sulfate solution during the pilot test was approximately 1:100. Assume the same usage ratio at full scale

616,000 lbs / 100 = 6,160 lbs H_2SO_4 (93%)

Hydrogen Peroxide

Assume that 30 mg/L are required for extraction flow rate of 75 gpm

75 $\frac{gal}{min}$ · $\frac{3.7854\ L}{gal}$ · $\frac{30\ mg}{L}$ · $\frac{1440\ min}{day}$ · $\frac{365\ days}{yr}$ · 1.5 yrs · $\frac{kg}{10^6\ mg}$ = 6,715 kg

6715 kg · 2.2 lb/kg = 14,772 lbs H_2O_2

assume 20% H_2O_2 solution = 73,864 lbs H_2O_2

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SHEET 1 OF 1
JOB NO. 47254 20053
DATE 3/28/00
PROJECT Stratford Army Engine Plant OO2 EE/CA
COMPUTED BY SCP
SUBJECT Electrical Usage Estimates – In-situ Red Alt.
CHECKED BY GLL

Purpose: Estimate the kWhr required for various treatment equipment over the operation period of the alternative

Calculations

Extraction Pumps:

5 pumps - assume 1 at 1.5 HP and 4 at 1 HP
5.5 HP total · 0.7457 kW/HP = 4.1 kW
continuous operation
4.1 kW · 1.5 years · 365 days/yr · 24 hr/day = 53,891 kWhr

Injection Pump

Assume 1 large 5 HP pump running continuously

53,891 kWhr · 5/5.5 = 48,991 kWhr

Building 63 sump Pumps

Assume same as injection pump (5 HP continiously)

UV/Ox feed Pump
1 HP 48,991 · 1/5 = 9,798

pH Adjustment mixer
1/2 HP 9,798 · 1/2 = 4899

UV/Ox System
60 kW · 1.5 · 365 · 24 = 788,400

Miscellaneous (lights, controls, etc.
– equivalent to 3 HP

48,991 · 3/5 = 29,394

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SHEET 1 OF 1
JOB NO. 47254/20053
DATE 4/5/00
COMPUTED BY SCP
CHECKED BY GLF

PROJECT Stratford Army Engine Plant - OU2 EE/CA
SUBJECT Sizing of UV/ox unit - In-situ chrome Altern.

Purpose: Determine the appropriate size for a UV/oxidation unit to treat water extracted during the in-situ chrome reduction alternative.

Inputs: Flow rate: 75 gpm
Influent TCE concentration: 100,000 ug/L
Effluent TCE concentration: 50 ug/L
EE/O for TCE: 2-4 (from Calgon literature) (use 4)

Calculation:
Equation

$$\text{UV Power (kW)} = \frac{EE/O \cdot 60 \cdot \text{flow(gpm)} \cdot \log\left(\frac{\text{initial conc}}{\text{final conc}}\right)}{1000}$$

from Calgon literature

EE/O = electrical energy required to reduce concentration one order of magnitude for 1,000 gallons
units: kWh/1000 gal. · order

$$\frac{4 \cdot 60 \cdot 75 \cdot \log(100000/50)}{1000} = 59.4 \text{ kW}$$

used a 60 kW unit.

35 – 40 ft bgs ~~start~~ depth

G:\PROJECTS\TERCS\PROJECTS\D020\DU2\PREDESIGN\FIGURES\47254043.DWG 2-09-2000 DEL

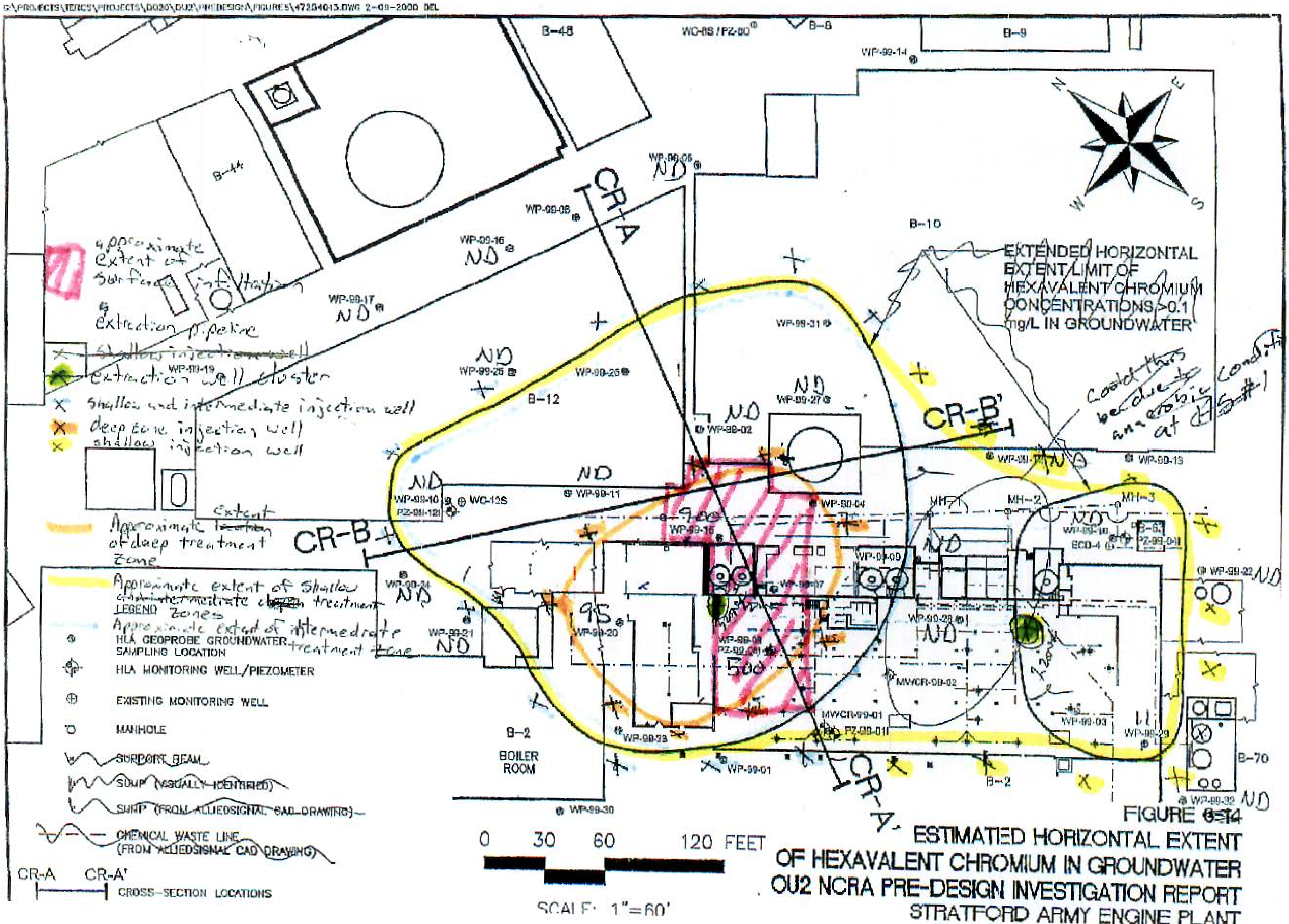

FIGURE 6-14
ESTIMATED HORIZONTAL EXTENT OF HEXAVALENT CHROMIUM IN GROUNDWATER
OU2 NCRA PRE-DESIGN INVESTIGATION REPORT
STRATFORD ARMY ENGINE PLANT

Harding Lawson Associates
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SHEET 1 OF 3
JOB NO. 47254/20053
DATE 4/11/00
COMPUTED BY SCP
CHECKED BY GUL

PROJECT Stratford Army Engine Plant
SUBJECT OU 2 EE/CA - Mass Estimates

Purpose: Estimate the mass of contaminat for each area

Inputs
- Porosity = 0.3
- Soil contains 3 times the mass found in the water (approximate observed relationship from TCE pilot test)

Calculation:

VOC Area #1
- 100 ppm area is roughly a cylinder 130 ft in diameter and 15 ft thick
- the other 13 ft of the treated interval contains on average 10 ppm TCE in groundwater
- Assume soil contains 3 times the mass in the water
- Assume area outside the 100 ppm line that gets treated contains 10 ppm TCE

Water contains

$$100\,\frac{mg}{L}\cdot\left(\frac{130\,ft}{2}\right)^2\pi\cdot 15\cdot 0.3\cdot 7.48\cdot 3.785\cdot\frac{kg}{10^6 mg} = 169.1\,kg$$

$$10\,\frac{mg}{L}\cdot\left(\frac{130}{2}\right)^2\pi\cdot 13\cdot 0.3\cdot 7.48\cdot 3.785\cdot\frac{1}{10^6} = 14.6\,kg$$

$$10\,\frac{mg}{L}\cdot\left[\left(\frac{180}{2}\right)^2-\left(\frac{130}{2}\right)^2\right]\cdot\pi\cdot 28\cdot 0.3\cdot 7.48\cdot 3.7854\,\frac{1}{10^6} = 29.0\,kg$$

212.7 kg

Soil = 3 × 212.7 = 638 kg
total = 850.8 kg or 1,874 pounds TCE

VOC Area #2
- 100 ppm area is roughly a cylinder 80 ft in diameter and 20 ft thick
- the 15 ft of water above the 100 ppm area has approximately 1 ppm TCE (includes area outside 100 ppm footprint)
- treated areas outside the 100 ppm limit have approximately 10 ppm TCE and encompasses a cylinder of diameter about 100 ft
- Assume soil contains 3 times the mass found in water.

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SHEET 2 OF 3
JOB NO. 47254/20053
DATE 4/12/00
PROJECT Stratford Army Engine Plant
COMPUTED BY SCP
SUBJECT OU 2 EE/CA ~ Mass Estimates
CHECKED BY GLL

VOC Area #2 (continued)

water contains:

$$100 \cdot \left(\frac{80}{2}\right)^2 \pi \cdot 20 \cdot 0.3 \cdot 7.48 \cdot 3.785 \cdot \frac{1}{10^6} = 85 \text{ kg}$$

$$10 \left(\left(\frac{100}{2}\right)^2 - \left(\frac{80}{2}\right)^2\right) \pi \cdot 20 \cdot 0.3 \cdot 7.48 \cdot 3.785 \cdot \frac{1}{10^6} = 4.8 \text{ kg}$$

$$1 \left(\frac{100}{2}\right)^2 \pi \cdot 20 \cdot 0.3 \cdot 7.48 \cdot 3.785 \cdot \frac{1}{10^6} = 4.40 \text{ kg}$$

TOTAL = 94.2 kg

Soil contains 3 · 94 = 282 kg

Total = 376.8 kg

VOC Area #3

- Assume TCE mass is approximately 10% of TCA mass ✓
- Assume DCE mass is approximately 3% of TCA mass ✓
- 100 ppm TCA area in the shallow area has an average thickness of 25 ft
- 10 ppm TCA area in the shallow area has an average thickness of 10 ft
- 1 ppm TCA area in the shallow zone has an average thickness of 5 ft
- 100 ppm TCA area in the deep zone has an average thickness of 30 ft
- 10 ppm TCA in the deep zone has an average thickness of 20 ft
- 1 ppm TCA in the deep zone has an average thickness of 40 ft
- Foot print of shallow area equivalent to ~~52~~ 46 ✓ rings of diameter 46 ft
- Foot print of deep area equivalent to 24 rings of diameter 46 ft

(delete — bracketed: the three deep zone items and the deep area foot print)

Shallow zone

$$\sout{52}\ 46 \cdot \left(\frac{46}{2}\right)^2 \pi = \sout{86,420}\ 76,450 \text{ ft}^2$$

$$100 \cdot \sout{86,420}\ 76,450 \text{ ft}^2 \cdot 25 \cdot 0.3 \cdot 7.48 \cdot 3.7854 \cdot \frac{1}{10^6} = \sout{1,835}\ 1,623 \text{ kg}$$

$$10 \cdot \sout{86,420}\ 76,450 \cdot 10 \cdot 0.3 \cdot 7.48 \cdot 3.7854 \cdot \frac{1}{10^6} = \sout{73}\ 65 \text{ kg}$$

$$1 \cdot \sout{86,420}\ 76,450 \cdot 5 \cdot 0.3 \cdot 7.48 \cdot 3.7854 \cdot \frac{1}{10^6} = \sout{3.7}\ 3.2 \text{ kg}$$

Total Shallow Water = ~~1,911~~ 1,691 kg

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SHEET 3 OF 3
JOB NO. 47254/20053
DATE 4/14/00
COMPUTED BY SCP
CHECKED BY GLR

PROJECT Stratford Army Engine Plant
SUBJECT OU2 EE/CA – Mass Estimates

VOC Area #3 (continued)

deep zone

$24 \cdot \left(\frac{46}{2}\right)^2 \pi = 39,885\ ft^2$

$100 \cdot 39,885 \cdot 30 \cdot 0.3 \cdot 7.48 \cdot 3.785 \cdot \frac{1}{10^6} = 1,016\ kg$

$10 \cdot 39,885 \cdot 20 \cdot 0.3 \cdot 7.48 \cdot 3.785 \cdot \frac{1}{10^6} = 67.8\ kg$

$1 \cdot 39,885 \cdot 40 \cdot 0.3 \cdot 7.48 \cdot 3.785 \cdot \frac{1}{10^6} = 13.6\ kg$

total deep water = 1,097 kg

total TCA mass in water = 1911 + 1097 = 3008 kg

(delete)

x3 for soil = 9,025 kg

total TCA VOC Area #3 = 12,033 kg = 26,500 lbs

total TCE VOC Area #3 = 0.1 · 12033 kg = 1,203 kg = 2,650 lbs

(delete)

Total DCE VOC Area #3 = 0.03 · 12033 = 361 kg = 795 lbs

x 3 for soil = 1691 x 3 = 5,073

Total TCA VOC Area #3 = 6,764 kg

Total TCE VOC Area #3 = 0.1 · 6,764 = 676 kg

Total DCE VOC Area #3 = 0.03 · 6764 = 203 kg

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SHEET 1 OF 2
JOB NO. 47254/20053
DATE 4/11/00
PROJECT Stratford Army Engine Plant
COMPUTED BY SCP
SUBJECT OU 2 EE/CA - NaOH usage
CHECKED BY GLR

Purpose: Estimate the mass of NaOH required in the scrubber to neutralize HCl from the thermal oxidizer

Input: VOC Area #1 mass of TCE = 850.8 kg or 1,874 pounds
VOC Area #2 mass of TCE = 374.8 Kg
~~VOC Area #3 mass of TCA =~~

Calculations

VOC Area #1

$$850.8 \text{ kg TCE} \cdot \frac{1000\text{g}}{\text{kg}} \cdot \frac{\text{mole TCE}}{131.39\text{g}} \cdot \frac{3 \text{ moles HCl}}{\text{mole TCE}} = 19,426 \text{ moles HCl}$$

$$19,426 \text{ moles HCl} \cdot \frac{1 \text{ mole NaOH}}{1 \text{ mole HCl}} \cdot \frac{40\text{g NaOH}}{\text{mole}} \cdot \frac{\text{kg}}{1000\text{g}} = 777 \text{ kg}$$

or 1,712 lbs

Say 1800 pounds

VOC Area #2

$$\frac{376.8 \text{ kg}}{850.8 \text{ kg}} \cdot 777 \text{ kg} = 344 \text{ kg} \text{ or } 758 \text{ lbs}$$

VOC Area #3

$$\text{~~12,033~~ } 6764 \text{ kg TCA} \cdot \frac{1 \text{ mole TCA}}{133.40\text{g}} \cdot 1000 \cdot \frac{3 \text{ moles HCl}}{\text{mole TCA}} = \text{~~270,607~~ moles HCl} = 152,114$$

$$\text{~~1,203~~ } 676.4 \text{ kg TCE} \cdot \frac{1}{131.39} \cdot 1000 \cdot 3 = \text{~~27,467~~ moles HCl} = 15,444$$

$$\text{~~361~~ } 203 \text{ kg DCE} \cdot \frac{1}{96.94} \cdot 1000 \cdot 2 = \text{~~7,448~~ moles HCl} \; 4,188$$

~~305521~~ moles HC
171,746

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SHEET 2 OF 2
JOB NO. 47254/20053
DATE 4/14/00
PROJECT Stratford Army Engine Plant
COMPUTED BY scp
SUBJECT OU 2 EE/CA - NaOH usage
CHECKED BY GLR

VOC Area #3 (continued)

~~305521~~ 171,746 · 40/1000 = ~~12,221~~ 6,870 kg or ~~26,924~~ 15,135 lbs

PROJECT Stratford Army Engine Plant
SUBJECT OU 2 EE/CA

Purpose: Estimate the quantity of methane required for the catalytic oxidizer

Input: - A 500 scfm catox unit consumes 137,500 BTU/hr if the influent contains no BTU content itself (vendor literature)
- Assume that average consumption is 50% of max
- Natural gas contains 1000 BTU/cubic foot

Calculation:

VOC Area #1
Operation period: 8 months

$$8\text{ months} \cdot \frac{30\text{ days}}{\text{month}} \cdot \frac{24\text{ hrs}}{\text{day}} \cdot 0.5 \cdot \frac{137{,}500\text{ BTU}}{\text{hr}} \cdot \frac{\text{c.f.}}{1000\text{ BTU}} = 396{,}000\text{ c.f. for 8 months}$$ ✓

VOC Area #2
Operation period 3 months

$$3\text{ months} \cdot 30 \cdot 24 \cdot 0.5 \cdot 137500 \cdot \frac{1}{1000} = 148{,}500\text{ cf}$$ ✓

VOC Area #3
Operation period 12 months
Flow = ~~2,500~~ 1,000 scfm (Double)

$$12 \cdot 30 \cdot 24 \cdot 0.5 \cdot 137500 \cdot \frac{1}{1000} \cdot \frac{1{,}000 \ (\text{~~2500~~})}{500} = 1{,}188{,}000 \ (\text{~~2,970,000~~})$$ ✓

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SHEET 1 OF 1
JOB NO. 47254/20053
DATE 4/13/00
COMPUTED BY SCP
CHECKED BY CAK

PROJECT Stratford Army Engine Plant
SUBJECT OU 2 EE/CA - Steam estimates

Purpose: Estimate steam injection pressures

Inputs: Maximum injection pressure = 0.5 psi/foot overburden

Calculation

Injection pressures
VOC Areas 1 + 2
35 ft · 0.5 psi/foot + 14.7 = 32.3 psi absolute
VOC Area 3 - shallow
55 ft · 0.5 + 14.7 = 42.2 psi absolute
VOC Area 3 - deep
155' · 0.5 + 14.7 = 92.2 psi absolute

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and
Environmental Services

SHEET 1 OF 1
JOB NO. 47254/20053
DATE 4/18/00
COMPUTED BY SCP
CHECKED BY GLR

PROJECT Stratford Army Engine Plant
SUBJECT OU2 - EE/CA - Methane Calc - DUS

Purpose: Estimate the quantity of methane required for the catalytic oxidizer - Dynamic Underground Stripping

Input: Same as for six-phase heating methane calc
- 500 cfm unit consumes 137,500 BTU/hr for Oppm influent
- assume average consumption is 50% of value for Oppm
- 1000 BTU/cubic foot of natural gas

Calculation:

VOC Area #1
Cat-Ox size 1000 cfm
13 weeks

$$13 \text{ weeks} \cdot \frac{7 \text{ days}}{\text{wk}} \cdot \frac{24 \text{ hrs}}{\text{day}} \cdot 0.5 \cdot \frac{137500 \text{ BTU}}{\text{hr}} \cdot \frac{1000 \text{ cfm}}{500 \text{ cfm}} \cdot \frac{\text{c.f.}}{1000 \text{ BTU}}$$

$$= 300,300 \text{ c.f.}$$

VOC Area #2
Cat-Ox size 1000 cfm
5 weeks

$$5 \cdot 7 \cdot 24 \cdot 0.5 \cdot 137500 \cdot 2 \cdot 1/1000 = 115,500 \text{ c.f.}$$

VOC Area #3
Cat-Ox size 4000 cfm
32 weeks

$$32 \cdot 7 \cdot 24 \cdot 0.5 \cdot 137500 \cdot 8 \cdot 1/1000 = 2,956,800 \text{ c.f.}$$

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Engineering and Environmental Services

PROJECT: OU 2 EE/CA	SHEET 1 OF 4
SUBJECT: AIR SPARGING	JOB NO. 47254 20053
	DATE 4-3-00
	COMPUTED BY GLR
	CHECKED BY SCP

I. Sparging Applicability

TCA S_G = 1.44

TCA VP = 96 mm Hg (= 0.13 atm) Recommended > 0.5 mm Hg

TCA H = 0.6 (@ 20°C → 837 atm) Recommended > 100 atm

TCA ρ_v = 4.5 (relative to air)

TCA Kow = 150

TCA B.P = 74.1°C Recommended < 100°C

Soil Intrinsic Permeability = 14.4 ft/d
(calculated for SVE system)

In the area of HOT-SPOT #3, soil is fairly free of horizontal low permeability layers.

Dissolved Fe Conc: Less than 50 mg/L average Recommended < 10 mg/L

Assumption: Air sparging is potentially capable of reducing 1,1,1-TCA concentrations in hot-spot #3. May have to address iron fouling in wells.

II. System Design

A. Injection Wells

1. Depth - Generally a screen should be one to two feet below the deepest contamination, however, current information is based on depths 30 to 60 feet. One must consider the air pressures needed to overcome pressures in deeper screens.

∴ To address 1,1,1-TCA > 100 ppm, wells shall be set at a maximum depth of 60 ft bgs in HOT-SPOT #3 (near CP-99-08) shallowing to 15 ft bgs (near WP-99-48)

2. Spacing - Determined by the estimated cone of influence, which is dependent upon geology and injection air flow rate. Literature suggests 15° for coarse gravels - 60° for silty sands

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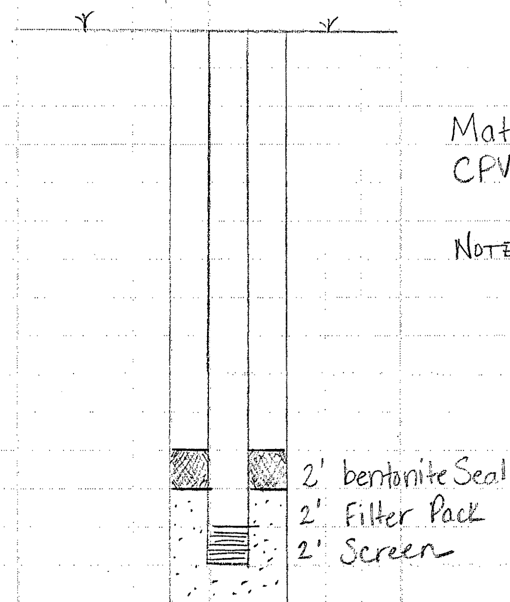
SHEET 2 OF 4
JOB NO. 47254 20053
DATE 4-3-00
PROJECT 002 EE/CA
COMPUTED BY GLR
SUBJECT AIR SPARGING
CHECKED BY Scp

3) Size (a) Ideal size is the smallest possible well; however, so that conventional well development can be performed 2" wells are preferred.

(b) A 2' screen is generally recommended - no advantage to longer screens.

(c) Installation can be completed using HSA. Continuous split spoon sampling is recommended. The average grain-size of the filter pack should be as close to the native soil as possible.



Material is generally PVC or CPVC (SCH 40 or SCH 80)

NOTE: Due to depth, SCH 80 PVC shall be used.

4) Injection Pressure

(a) Wells manifolded together on a common header should be set to the same depth to prevent most or all of the air from exiting the shallowest wells. Or, a throttle or solenoid valve may be used.

(b) Need to overcome:
Depth of Water column at point of injection (D)
Frictional Losses (f)
Capillary Entry Restistance (c)

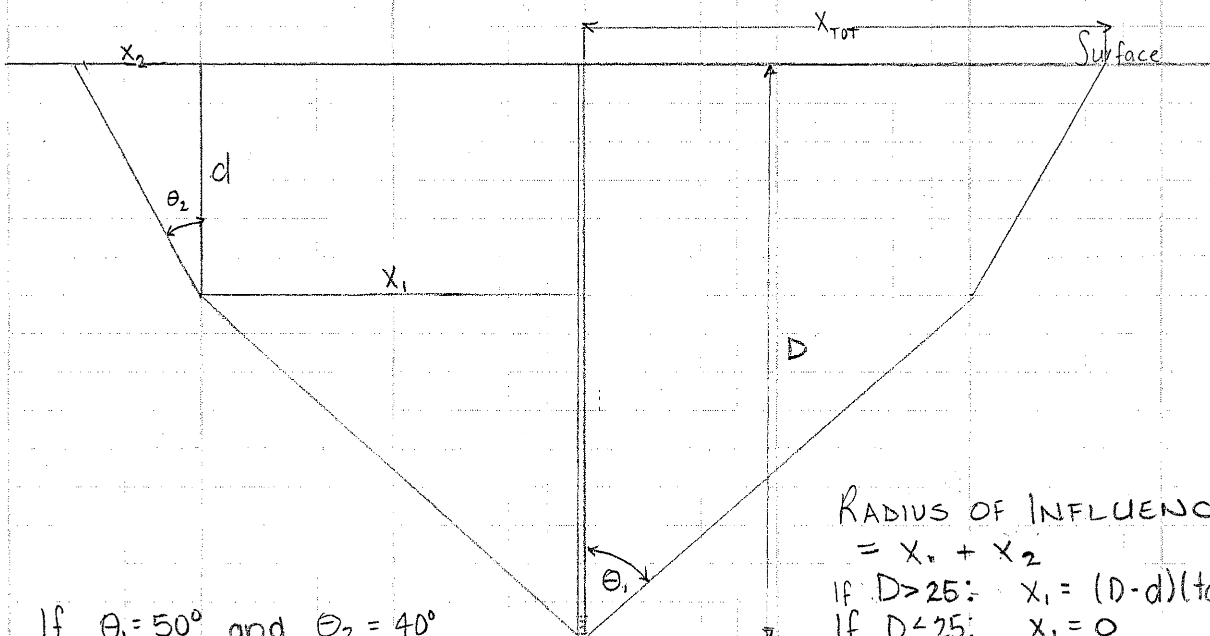
$P_i = D + (f + c)$ where $f + c = P_R$ = release pressure generally ≃ 2.3ft for every 3 feet

D (feet)	P_R	P_i (feet/psi)
20	15.3	35.3/15.3
30	23	53/23
45	34.5	79.5/34.5
60	46	106/46

PROJECT: OU 2 EE/CA
SUBJECT: AIR SPARGING

Soils are: (1) fine to medium sand with silt (~25' to 60' bgs)
(2) fine to medium sand with gravel (~15' to 25' bgs)

$\theta = 50^\circ$ used for (1)
$\theta = 40^\circ$ used for (2)



RADIUS OF INFLUENCE:
$= X_1 + X_2$
If $D > 25$: $X_1 = (D - d)(\tan \theta_1)$
If $D < 25$: $X_1 = 0$
$X_2 = d (\tan \theta_2)$

If $\theta_1 = 50^\circ$ and $\theta_2 = 40^\circ$

D (feet)	d (feet)	X_1	X_2	X_{TOT}	
15	15	0	12.6	12.6	
20	20	0	16.8	16.8	
25	25	0	21.0	21.0	
30	25	6.0	21.0	27.0	✓
35	25	11.9	21.0	32.9	
40	25	17.9	21.0	38.9	
45	25	23.8	21.0	44.8	✓
50	25	29.8	21.0	50.8	
55	25	35.7	21.0	56.7	
60	25	41.7	21.0	62.7	✓

Based on the above table and Figures 5-__ and 5-__

There will be 19 wells placed to 60 feet bgs
9 wells placed to 45 feet bgs
33 wells placed to 30' feet bgs

Harding Lawson Associates
Engineering and Environmental Services

JOB NO. 47254-20053
DATE 4-3-00
COMPUTED BY GLR
CHECKED BY SCP

PROJECT OU 2 EE/CA
SUBJECT AIR SPARGING

5) Injection Flow Rate

Typical flow rates ~4scfm for D < 10 feet
~10scfm for 10 < D < 30feet

D	F (scfm)
20	7
30	10
45	13
60	15

Injection Pressure & Flow Rate should not be high enough to hydraulically fracture formation.

6) SUMMARY

DEPTH (D) (feet)	INFUENCE (X) (feet)	Pressure (P_i) (psi)	Flow Rate (F) scfm)
20	16.8	15.3	7
30	27.0	23	10
45	44.8	34.5	13
60	62.7	46	15

B) Blowers

2 blowers (+ 1 back-up) will be used in the system.
1 blower for wells 60' bgs (Blower A)
1 blower for wells 30' and 45' bgs (Blower B)

Blower A: 19 wells @ 60' bgs @ 15 cfm/well = [19(15scfm)]·1.5
= 427scfm

Blower B: 9 wells @ 45' bgs @ 13 cfm/well = 9(13scfm)·1.5
+ 33 wells @ 30' bgs @ 10 cfm/well 33(10scfm)·1.5
= ([9·13scfm]·1.5) + [(33·10scfm)·1.5]
= 670scfm

SOIL VAPOR EXTRACTION SYSTEM AIR FLOW MODEL

Air Modeling for Proposed SVE System at SAEP

Introduction

Preliminary modeling of air flow in response to proposed soil vapor extraction at SAEP was performed using the USGS groundwater modeling code MODFLOW, but adjusting the hydraulic conductivities determined for the site soils to equivalent air permeabilities. This adjustment is made by ratioing the viscosities and densities of water and air, which results in an approximate 10-fold decrease in the numerical value of the hydraulic conductivity when converting the parameter to air. The purpose of the modeling was to determine approximate allowable spacing of trenches and expected total air flow rates to maintain at least a 0.25-inch pressure differential between the indoor air and the soil vapor beneath the building. In addition to collection of solvent vapors in soils, the system would maintain an outward pressure differential preventing migration of vapors into the building.

Conceptual Model

The principal area of concern is the main on-site building, covering an approximately 1200 by 500-foot area. Some smaller areas outside, to the northeast of the building may also be of concern. The entire focus area is covered either with buildings (concrete slabs on grade) or asphalt pavement. This provides a natural vertical barrier to airflow to the subsurface, enhancing applications of soil vapor extraction (SVE) in this area. Soil beneath the flooring and pavement is largely fill materials of a potentially high air or water permeability. The unsaturated zone (ground surface to water table) is about 6 feet thick. Much of the air withdrawn from an SVE system, then, is likely to originate from some distance and be pulled laterally through the unsaturated fill. The embankment north of the plant area leading down to the wetland provides a nearby vertical face where air can readily enter the subsurface. There are open (uncovered ground) areas further to the south, east and west of the building, but air sources are more restricted here. Due to the thin unsaturated zone, SVE extraction points are likely to be horizontal collector pipes placed in shallow trenches rather than vertical wells.

Model Area and Boundary Conditions

The attached working drawing shows the outer perimeter of the model, covering about 1900 by 2300 feet. The model is gridded uniformly into 20-foot elements, yielding a model with 95 rows and 115 columns. The model is specified as no-flow (inactive) in the wetland area. The model has three layers. The uppermost layer, without a defined thickness, represents the atmosphere itself. Layer 2 represents the concrete floor and asphalt pavement, and is taken as a uniform 0.5-foot thick. Layer 3 represents the underlying fill material, taken as a uniform 6-foot thickness.

The atmospheric pressure is taken as constant throughout all of Layer 1, at an arbitrary and numerically convenient pressure of 6000 units, i.e., would be equivalent to 760 mm Hg. Flows in the model are dependent on pressure differentials, which can be converted to absolute units if and when necessary. Constant heads of 6000 were also placed at the active perimeter of the model in Layers 2 and 3 to represent availability of air at a distance from the building (about 400 to 500 feet in most areas).

As another convenience, the SVE extraction locations have been represented as a constant head boundary rather than individual wells. This allowed rapid inclusion in the model as well as easy altering of heads for the various runs. The model summary budget then provides the resultant total airflow to the simulated collectors.

Note that an initially smaller model (1400 by 1100 feet) was attempted, but that the perimeter boundary heads were too close to the simulated collectors, resulting in absurdly high air flow rates. This resulted in moving the model boundaries back so than boundary effects are not significant.

Model Input Parameter Values

The base of the model was assigned an arbitrary elevation of 0 feet. The top of Layer 3 was then assigned as a uniform 6 feet. The thickness of Layer 2 was taken as 0.5 feet, setting the top of Layer 2 and bottom of Layer 1 at a 6.5-foot elevation.

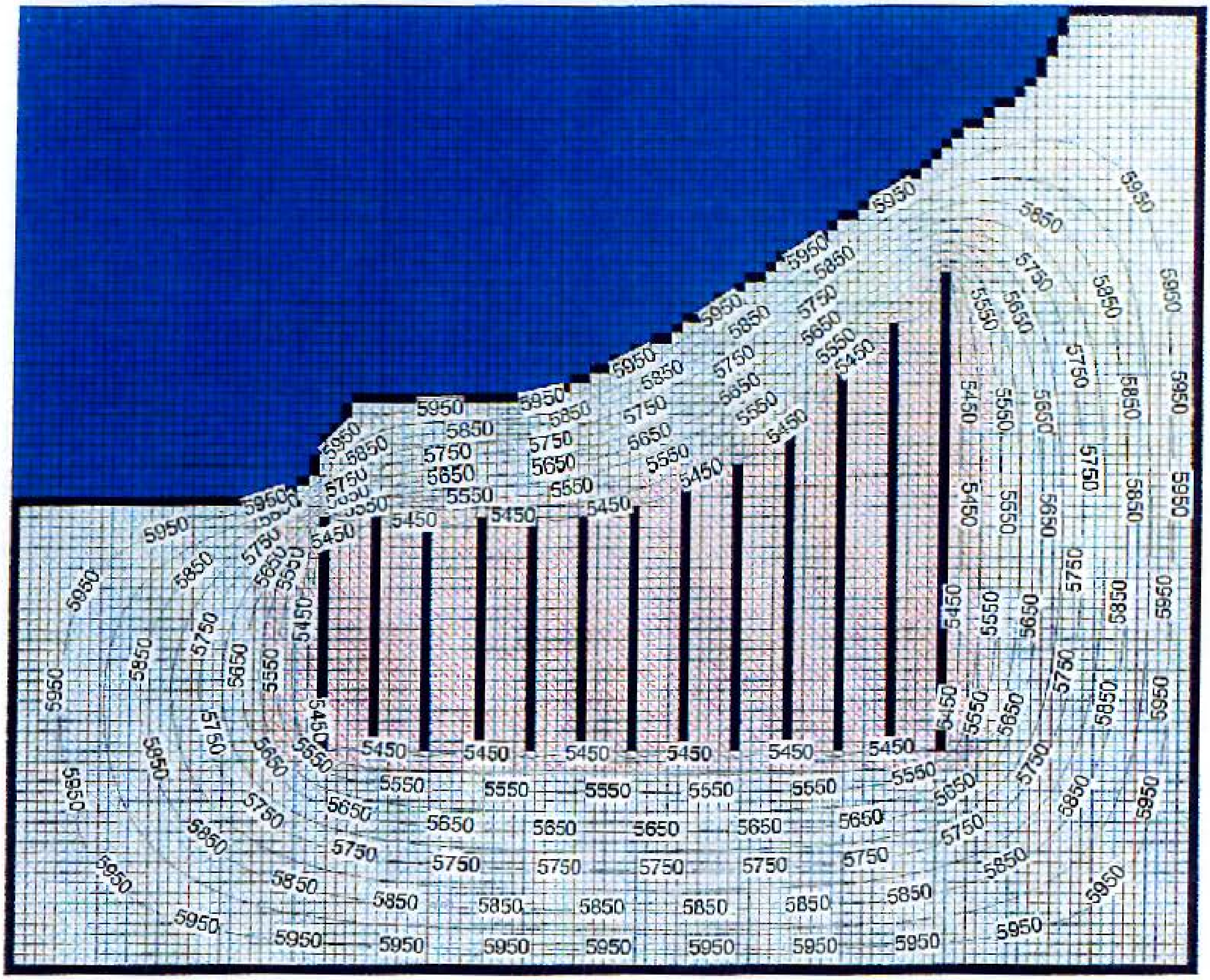
The reported hydraulic conductivity for the fill (Layer 3) material varied up to 0.1 ft/min, or 144 ft/d. The corresponding permeability to air is then about 14.4 ft/d. Literature reports hydraulic conductivity of concrete from lE-8 to lE-6 cm/sec, or 0.000283 ft/d at an average lE-7 cm/sec. This value for conductivity then becomes 0.0000283 ft/d for air as initially assigned to Layer 2. A large value of 1000 ft/d was assigned to Layer 1 since it is an air layer, and it was desired to let the conductivity of Layer 2 by itself determine the vertical flow rate. The air layer is allowed to present no resistance in the model to vertical flow.

Model Runs and Results

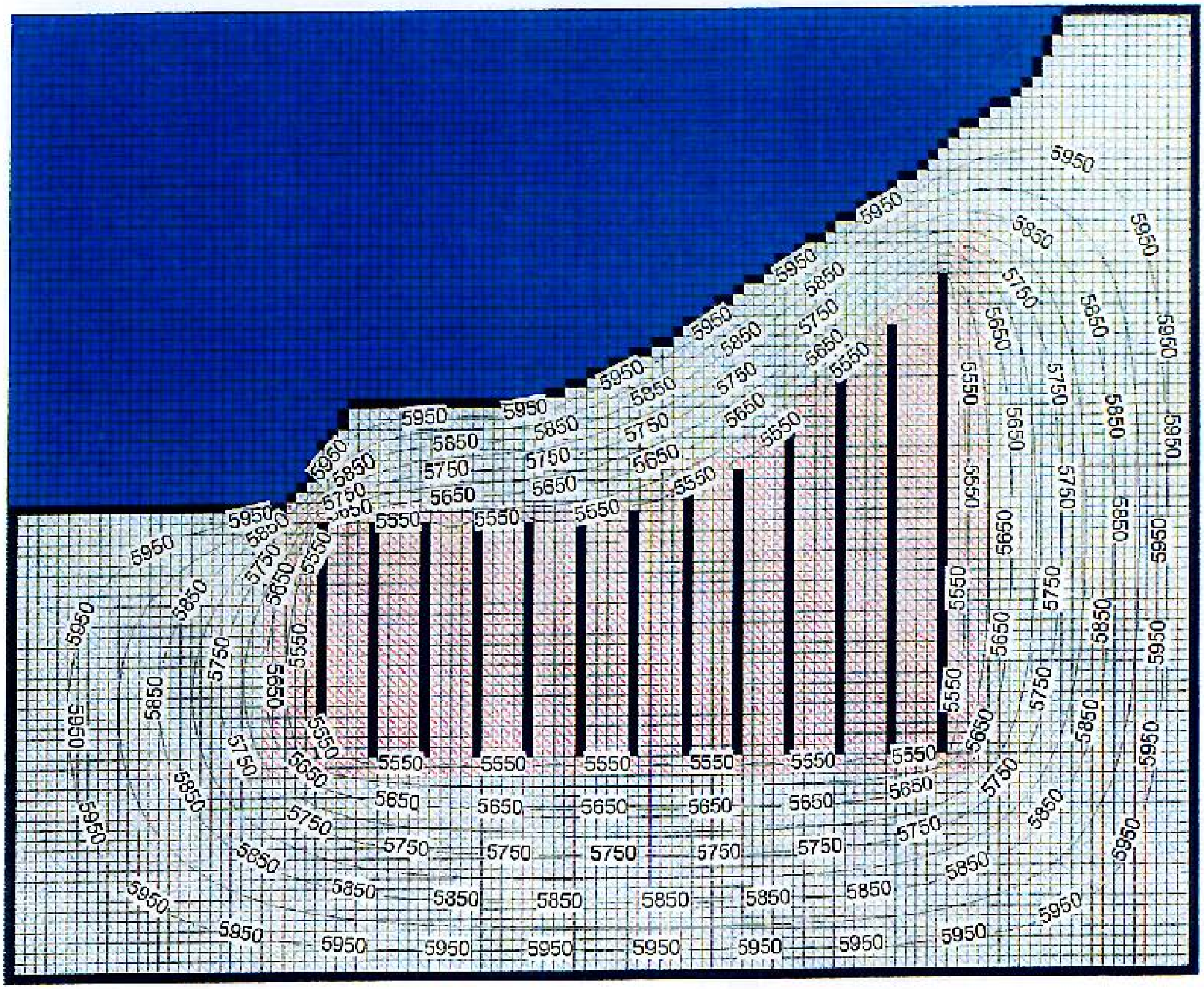
Several model runs were made (Air2 through Air9) varying the collector spacing, the heads in the simulated collectors, and the conductivity of Layer 2. The changes in the model inputs and the resultant simulated air flows are summarized in Table 1.

The results for Air9 suggested, for a most likely selection of input variables, that a spacing of 200 feet would be adequate. Results for run Air9, and sensitivity runs Air10 and Air11 for the conductivity in Layer 3, indicated that an air flow rate of from 100 to 200 standard cubic feet per minute (scfm) could be expected. A negative pressure differential (partial vacuum) is easily maintained beneath the buildings. The final used collector pressure differential of 100 represents 1/60 th of atmospheric pressure, or about 7.5 inches of water vacuum.

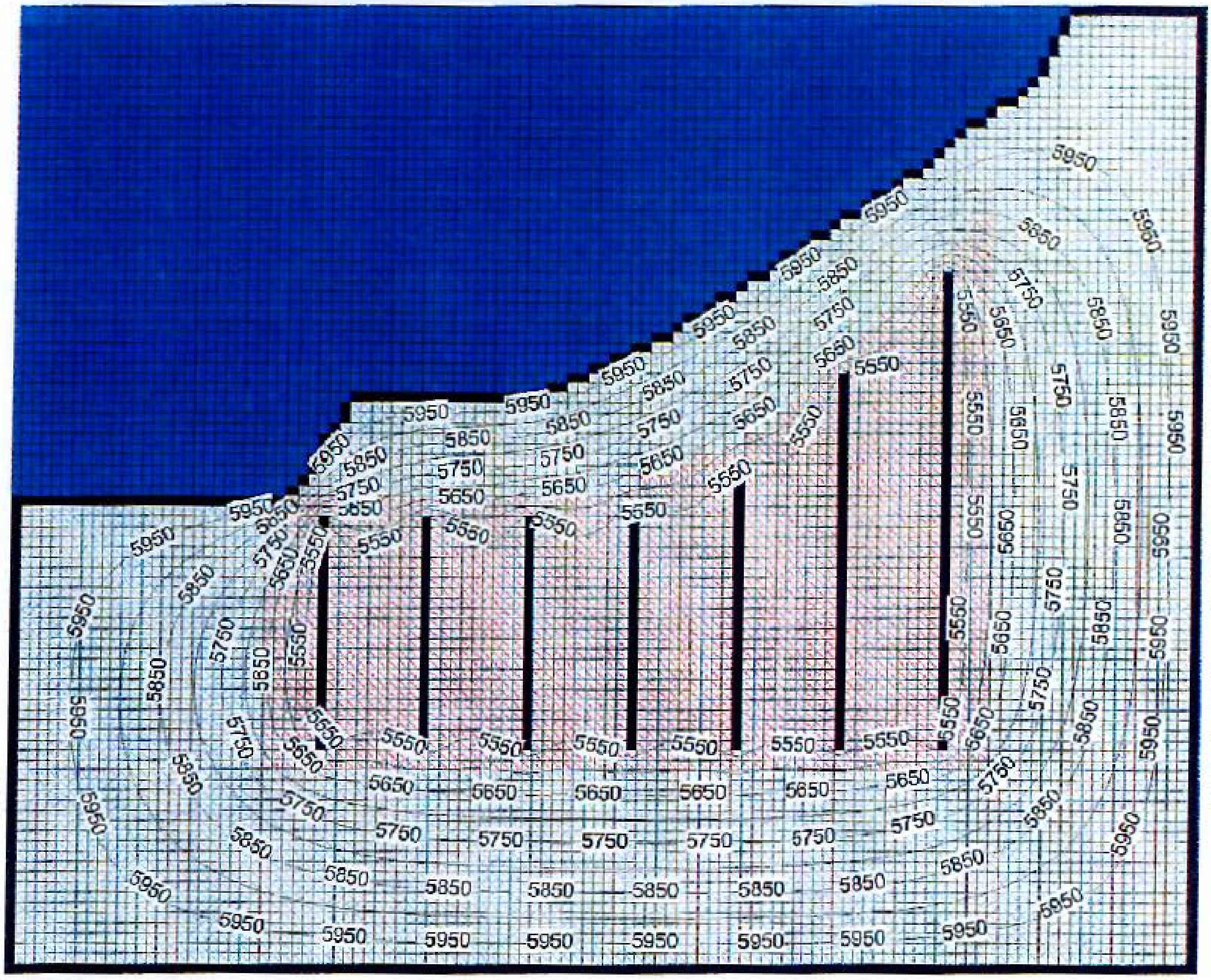
Outputs of heads for Layer 3 are contoured on the accompanying figures from the model post-processor.



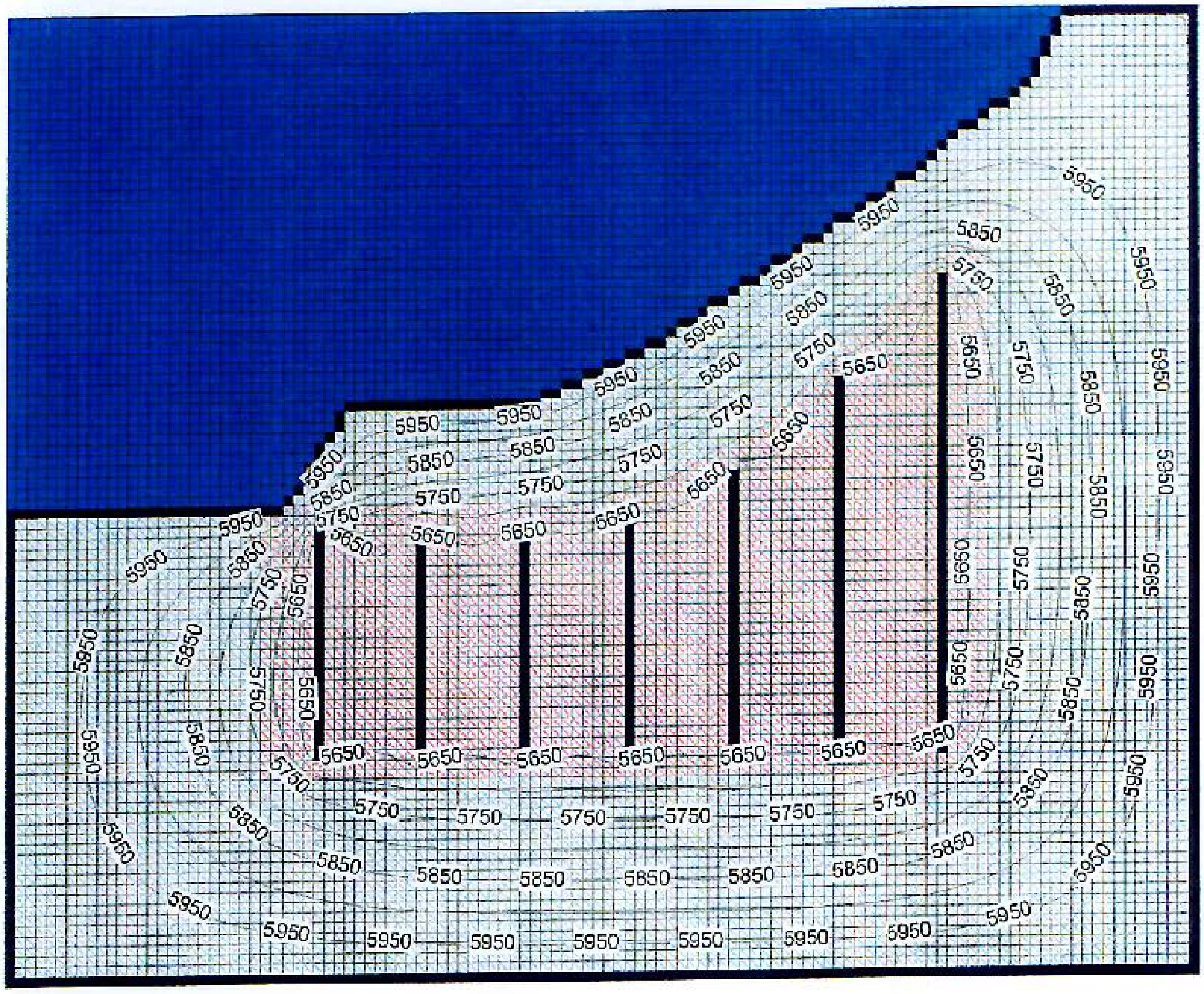
Air 2
@ collector heads of 5400
Airflow = 514 cfm



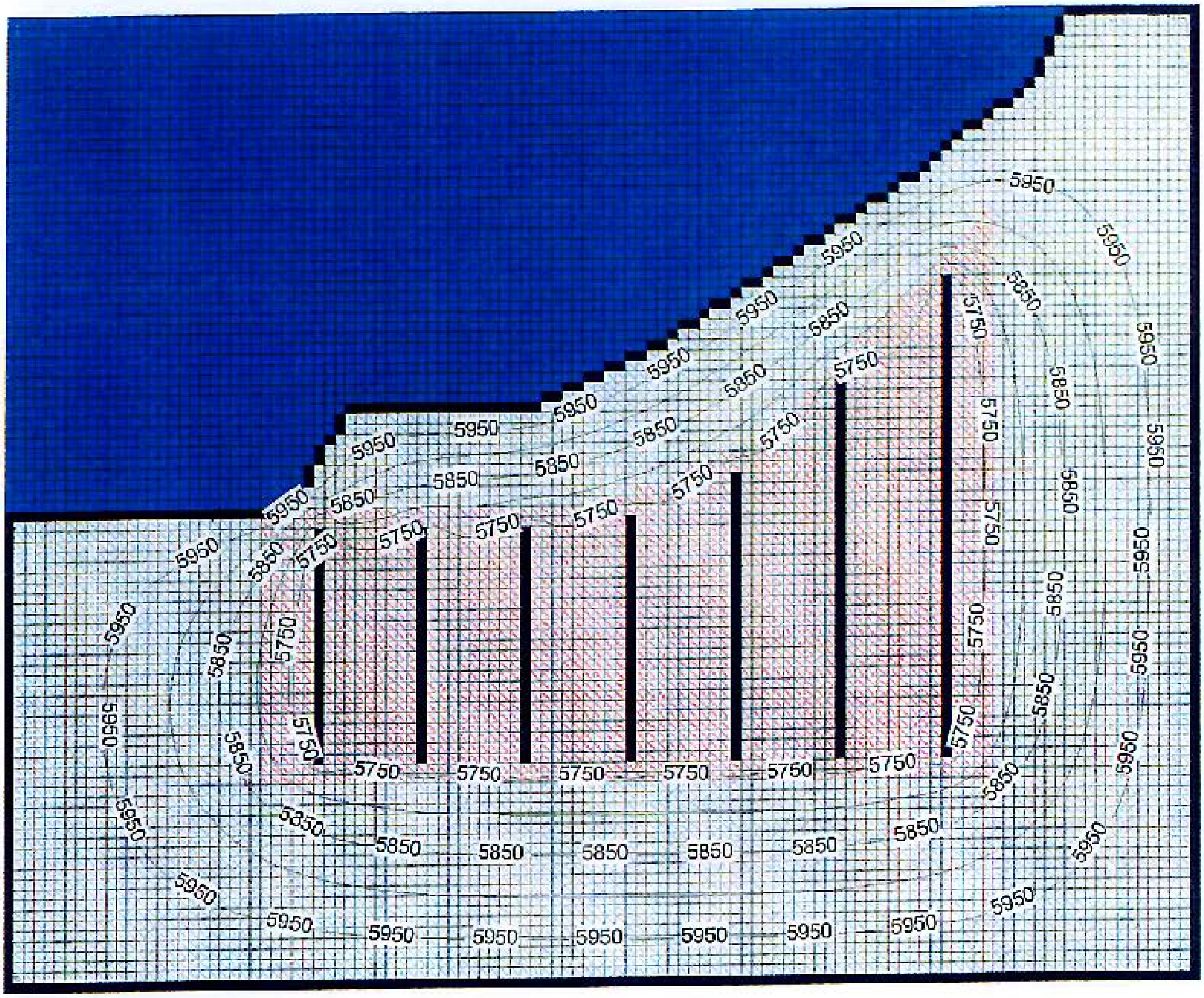
Air 3
collector heads @ 5500
Airflow = 420 cfm



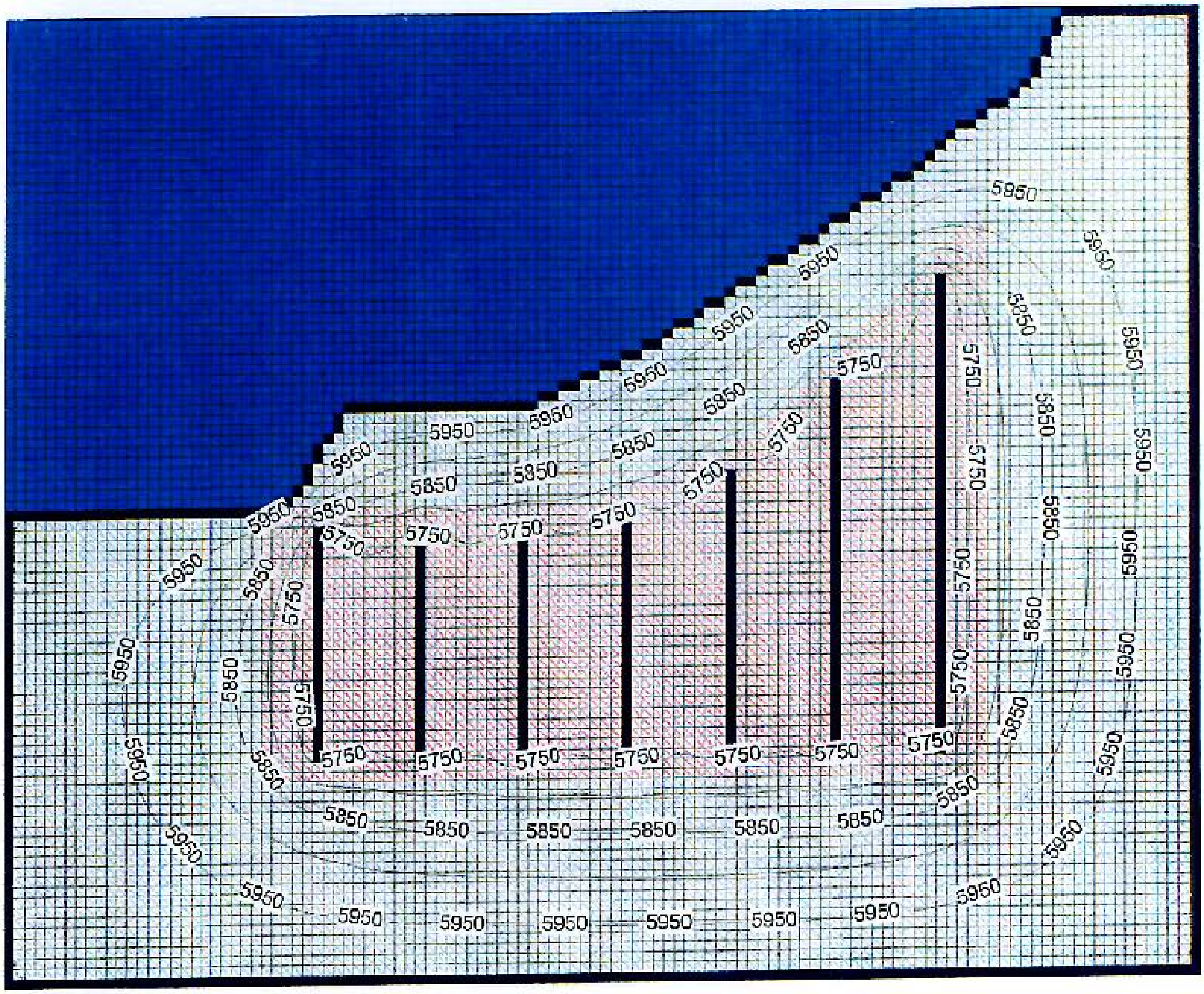
Arr H
Collector heads @ 5500
Airflow = 410.7 scfm



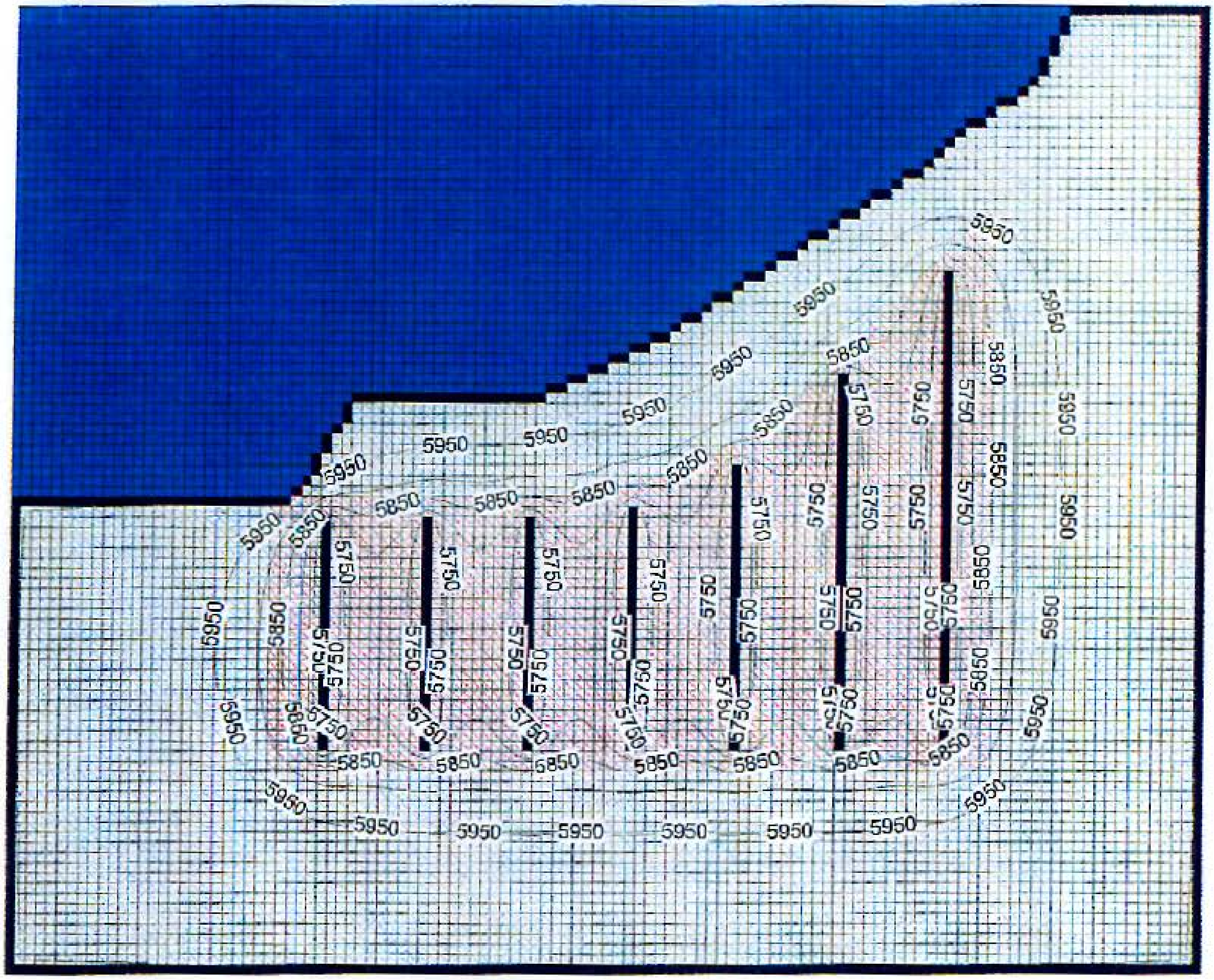
Air 5
Collector heads @ 5600
Airflow = 328.6 scfm



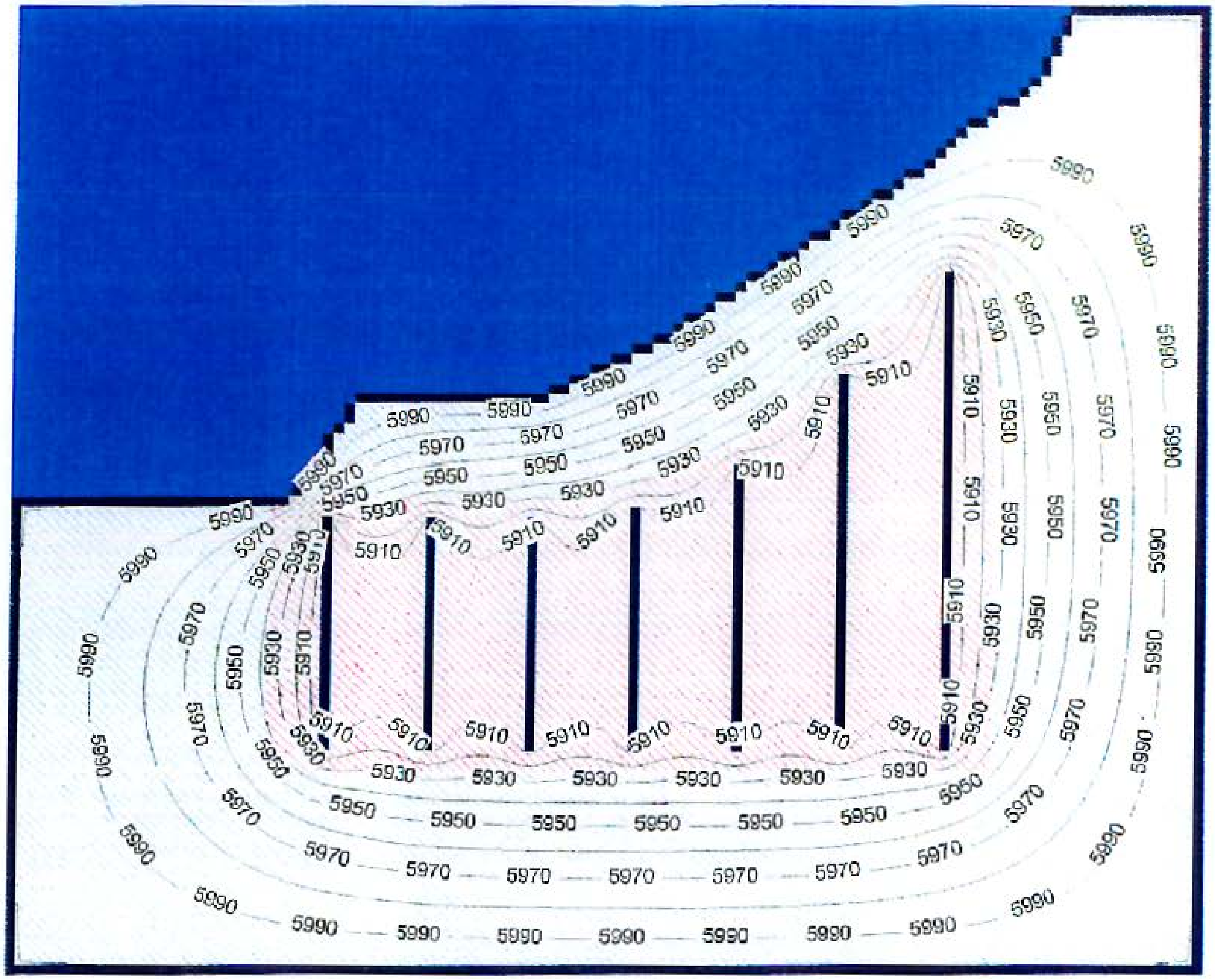
Arr 6
collector beds @ 5700
airflow = 246.4 scfm



Air 7
collector heads @5700
airflow = 352.5 scfm
K_w layer = 10^{-6} cm/sec

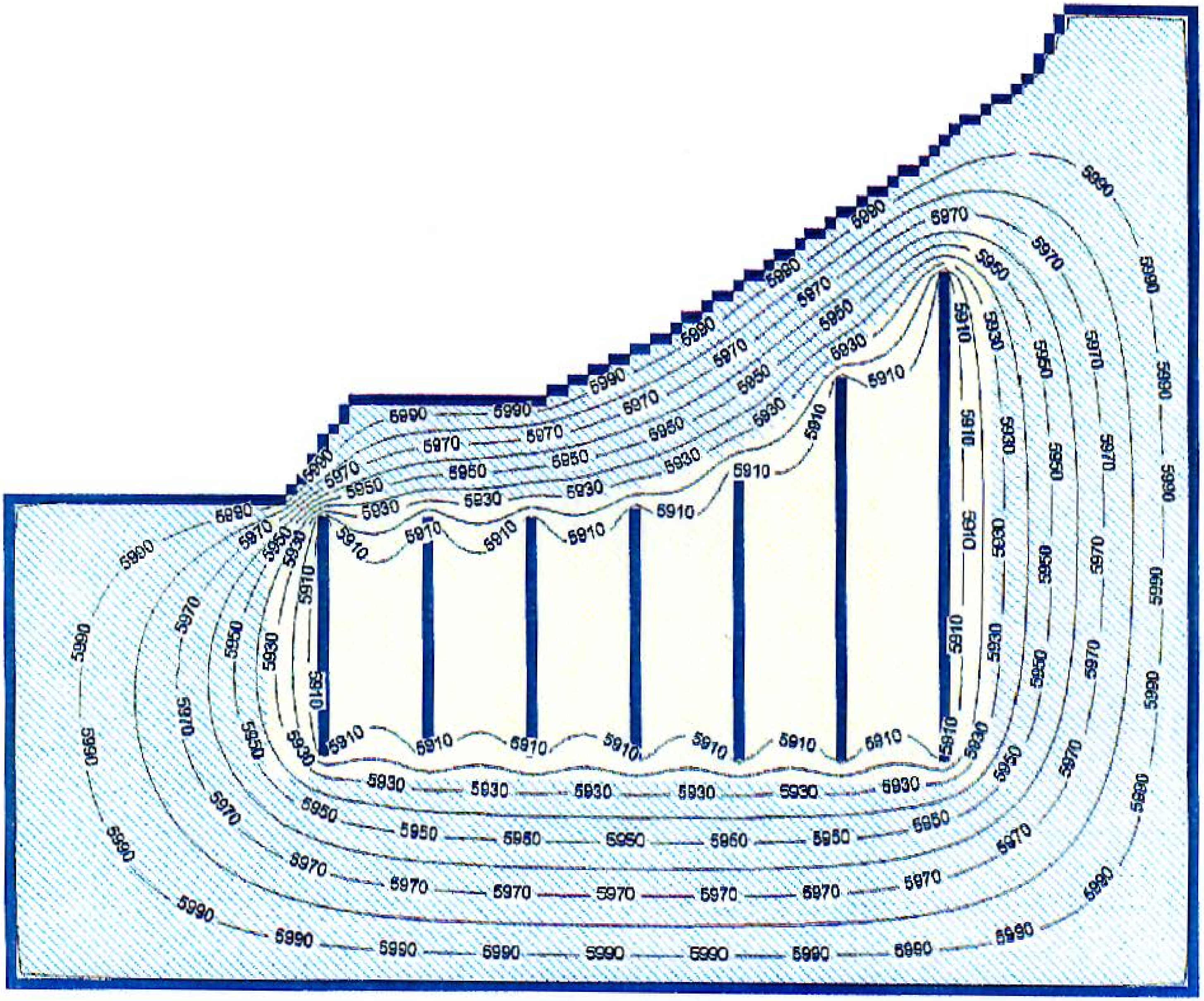


Air B
collector heads @ 5750
[illegible] = 1106 scfm
Kv layer 2 ≈ 10^{-5} cm/sec



Air 2
collector head @ 5900
(0.0167 vacuum)
airflow = 117 scfm
Kv layer 2 = 1x5 [illegible]

Air 10 5/6/01
CH = 5900 in collectors
K_3 = 21.6 ft/d (air perm)
Flow = 157.2 scfm

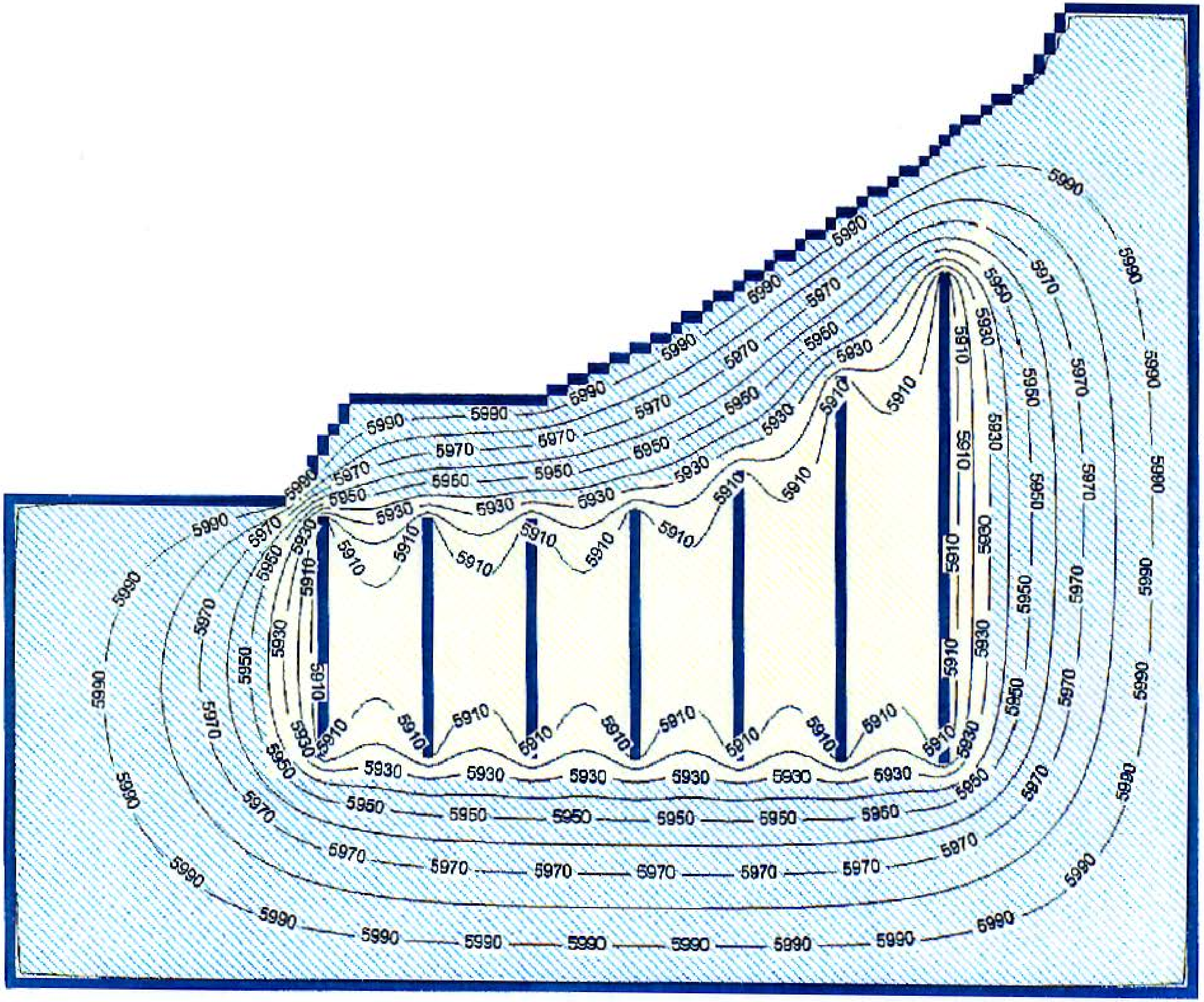


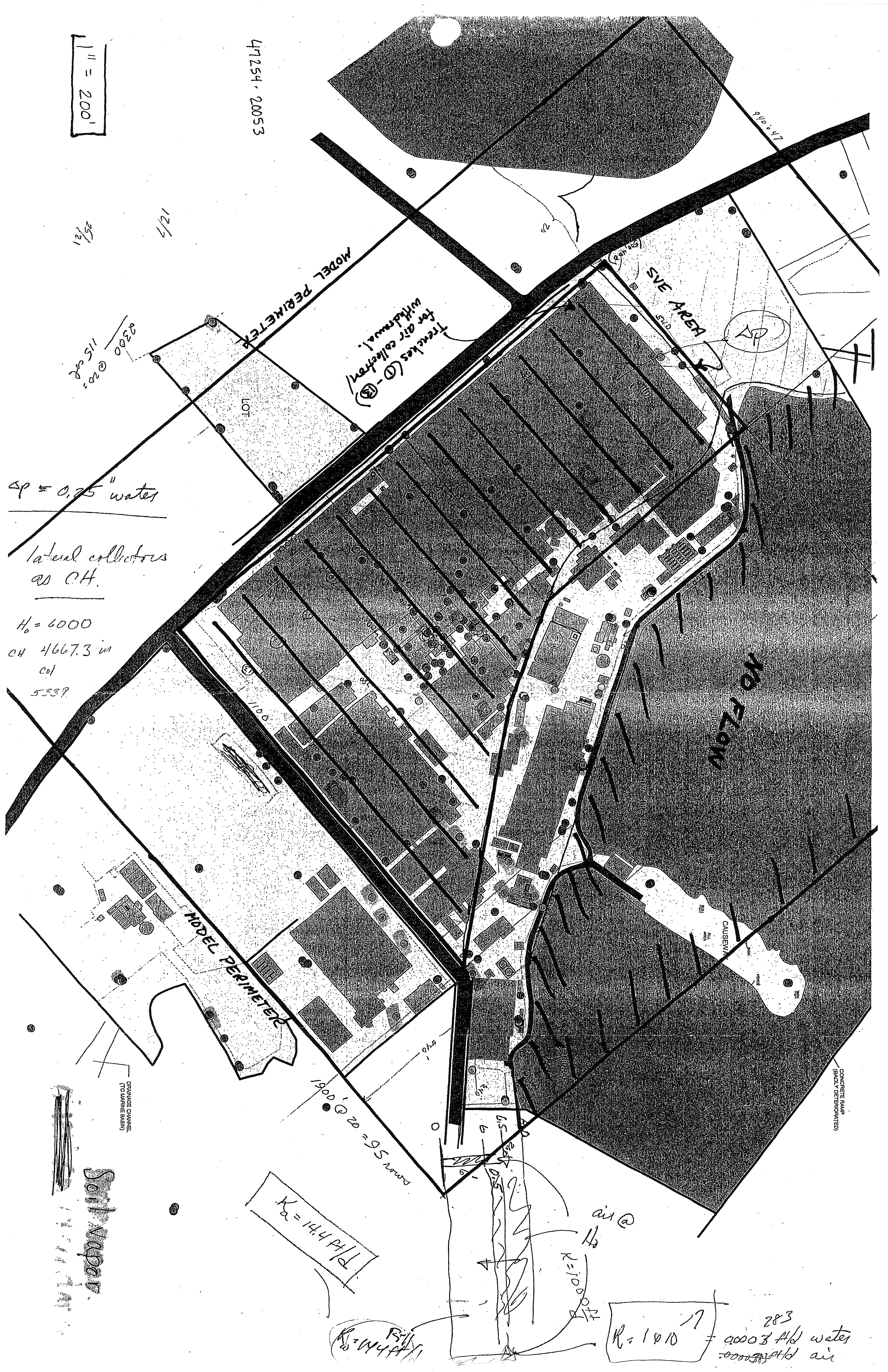
Air 11 5/6/01

CH = 5900 in collectors

K_3 = 7.2 ft/d (air perm)

Flow = 76.7 scfm





1" = 200'
47254-20053
MODEL PERIMETER
SVE AREA
Trenches (1)-(13) for air collection/withdrawal.
LOT
NO FLOW
CAUSEWAY
Δp = 0.25" water
lateral collectors as CH.
H₀ = 6000
MODEL PERIMETER
DRAINAGE CHANNEL (TO MARINE BASIN)
CONCRETE RAMP (BADLY DETERIORATED)
1900' @ 20 = 95 rows
Soil Vapor

Table 1
Air Model Input Parameters and Results
Stratford Army Engine Plant

	Air Permeabilities, ft/d			Collector pressure	Collector spacing, ft	Air flow scfm
	Layer 1	Layer 2	Layer 3			
Air 2	1000	0.0000283	14.4	5400	100	514
Air 3	1000	0.0000283	14.4	5500	100	429
Air 4	1000	0.0000283	14.4	5500	200	411
Air 5	1000	0.0000283	14.4	5600	200	329
Air 6	1000	0.0000283	14.4	5700	200	246
Air 7	1000	0.000283	14.4	5700	200	352
Air 8	1000	0.00283	14.4	5700	200	1106
Air 9	1000	0.000283	14.4	5900	200	117
Air 10	1000	0.000283	21.6	5900	200	157
Air 11	1000	0.000283	7.2	5900	200	77

Notes:

1. Layer thicknesses were 0.5 feet (Layer 2) and 6 feet (Layer 3). Layer 1 is unconfined (thickness undefined) and represents the constant atmospheric pressure.
2. Atmospheric pressure is taken as an arbitrary reference value of 6000 which corresponds to 760 mm Hg. Flows in the model are governed by pressure differentials which can be converted to actual pressures using the reference value.
3. Flow volumes in the model assume air is incompressible, an acceptable approximation at low pressure differentials.
4. Layer 1 air permeability is taken as a high number for purposes of calculating vertical air flow, and is a constant head layer. Vertical air flow is controlled by the low air permeability for Layer 2 which represents concrete and asphalt. Layer 3 permeability represents the maximum value of hydraulic conductivity reported for the fill and converted to an air permeability.
5. The initial permeability for Layer 2 is taken as an average reported literature value for concrete (1 E-7 cm/sec) and converted to an air permeability.

RESPONSE TO REGULATORY AGENCY COMMENTS

USACE CONTRACT NO. DACW33-94-D-0002
TASK ORDER NO. 020
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

RESPONSE TO COMMENTS ON THE DRAFT FINAL ENGINEERING EVALUATION/COST ANALYSIS FOR THE OU 2 SOURCE AREAS (DATED NOVEMBER 17, 2000) STRATFORD ARMY ENGINE PLANT STRATFORD, CONNECTICUT

Prepared for:

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

Prepared by:

Foster Wheeler Environmental Corporation
Boston, Massachusetts

and

Harding Lawson Associates
Portland, Maine

JUNE 2001

RESPONSE TO COMMENTS ON THE DRAFT FINAL OU 2 NCRA ENGINEERING EVALUATION/COST ANALYSIS REPORT (DATED NOVEMBER 17, 2000) STRATFORD ARMY ENGINE PLANT STRATFORD, CONNECTICUT

Comment #	Comment/Response

USEPA Comments dated January 16, 2001 on the Draft Final EE/CA Report OU 2 Source Areas, SAEP, Stratford, CT

GENERAL COMMENTS

1. **Comment:** The EE/CA should state more clearly how the removal action is expected to integrate with the on-going remedial investigation (RI) at the site. For example, will the completion of the RI be postponed until monitoring results from the selected removal action can be incorporated into the RI and Feasibility Study (FS) reports? Will a separate report, detailing the results of investigations following the removal action, be prepared as a supplement to the RI/FS report and available for consideration during design of the selected remedy? It is not clear how the results of the removal action will be considered, as a remedy for this site is crafted. Please add a discussion to the document to address this issue.

   Response: Completion of the RI will not be postponed until the removal actions have been completed. A Removal Action Report is typically prepared to document the results of a removal action. If monitoring data are collected following a removal action, these results are typically presented in periodic monitoring reports. The frequency of these reports is usually dependent upon the type and frequency of monitoring data collected. The EE/CA has been revised to reflect that the results of any removal actions, including any monitoring data that are available, will be incorporated into the FS and considered during design of the final remedy for the site.

2. **Comment:** Please indicate in this document what the schedule is for completion of the RI and FS reports for the site. Due to the extent of contamination at this site, EPA believes it is particularly critical at this juncture for the Army to present an overall strategy and schedule for work at SAEP.

   Response: As of September 2001, the proposed RI completion date is February 2002, and the proposed FS completion date is April 2002.

3. **Comment:** The cost terminology used throughout the document is unconventional and may be confusing to the reader. For example, all short-term costs associated with the removal action are referred to as capital costs even though operation and maintenance (O&M) costs

are also included. By conventional definition, O&M costs are not capital costs. Also, net present worth (NPW), when used without qualification, conventionally refers to the total cost (capital and O&M costs) expressed in present dollars. However, this document uses the term NPW when referring only to the net present worth of post-removal O&M costs. It is recommended that the text be edited to avoid the unconventional terminology. For example, the costs referred to as capital costs in this document could be called removal action costs, and costs referred to as NPW costs in this document could be called post-removal O&M costs, for which a NPW can be presented.

Response: The suggested terminology changes have been made.

4. **Comment:** Because the removal action is not expected to be the final remedy for the site, the long-term activities associated with each removal action alternative will actually become a part of the final remedial alternative. The EE/CA should clearly discuss this, indicating the cost liability imposed on the final remedy by each removal action. Perhaps this is only a matter of how the information is organized and presented, but this point should be clarified in the EE/CA.

   Response: The EE/CA has been revised to reflect the cost impact imposed by the removal actions on the final remedies.

5. **Comment:** It is not clear why the removal action goals for this EE/CA include the CTDEP RSR SWPC for VOCs. In light of the scope of this removal action, it would seem more logical to use the removal action to reduce the hot-spot concentrations to levels that would achieve CTDEP RSR I/C VC, then address overall site groundwater contamination in the remedial action selected for the site. The election of SWPC as removal action goals suggests that there may be a predisposition to the selection of Monitored Natural Attenuation as the remedial action for the site. EPA does not believe that there is adequate information available to consider this at this time. Please address this issue by editing the EE/CA to describe in more detail the rationale for the removal action goals selected.

   Response: Consistent with the CTDEP RSRs and CTDEP review comments on the Draft OU 2 EE/CA, the Removal Action Goals for VOCs in groundwater have been revised to consist of the lower of the CTDEP RSR I/C VC or SWPC.

Comment #	Comment/Response

6. **Comment:** There are a number of assumptions presented throughout the EE/CA that have an impact on the evaluation, but that are not supported by calculations, modeling results, or other explanations (some examples are provided in the Specific Comments listed below). A number of these assumptions are obviously the result of some type of calculation. Please provide supporting documentation for these assumptions.

   Response: Supporting documentation for the assumptions that are cited in the specific comments have been added when indicated by the response to the specific comments.

SPECIFIC COMMENTS

1. **Comment:** Executive Summary, Page ES-1, Paragraph 1. Add a sentence prior to the last sentence stating that the Non-time Critical Removal Action is not expected to be the final remedy for the site. Incorporate the same sentence into the first paragraph of Section 1.0.

   Response: The requested changes have been made to the referenced text sections.

2. **Comment:** Executive Summary, Page ES-2, Paragraph 4. The first sentence states that one subsurface soil sample had a hexavalent chromium concentration exceeding the CTDEP RSR DEC. Based on a review of Figure 2-3, that appears to be true, but based on a review of Table 2-1, a total of four samples from three soil borings exceeded the standard. Please correct the discrepancy between Figure 2-3 and Table 2-1 and edit the referenced text as appropriate.

   Response: The referenced text, table and figure have been reviewed and revised as necessary.

3. **Comment:** Executive Summary, Page ES-2, Paragraph 5. In the second sentence, clarify that the second area of groundwater contamination also has hexavalent chromium concentrations in excess of the SWPC standard.

   Response: The requested change has been made to the referenced text.

Comment #	Comment/Response
4.	**Comment:** Executive Summary, Page ES-5, Paragraph 2. The deep 1,1,1-TCA contamination is discussed in this paragraph. The last sentence states that this contamination is not expected to migrate with groundwater. The basis for this statement is not presented, and because of the magnitude of the 1,1,1-TCA concentrations in this area (>100,000 μg/L), the statement is not intuitively obvious. Rather, it is likely that this hot spot will function as a continuing source of 1,1,1-TCA contamination for groundwater. If this hot spot will not be addressed in the removal action resulting from this EE/CA, as stated in the text, it will need to be addressed in the FS. The text should state this. **Response:** Current groundwater hydraulic data indicate that there is limited groundwater flow at the depth interval of the deeper 1,1,1-TCA contamination. The EE/CA has been revised to reflect that the deep 1,1,1-TCA contamination will not be addressed in the removal action as it is not likely to impact indoor air quality due to its depth (see Comment No. 9). This deep groundwater contamination will be addressed in the FS.
5.	**Comment:** Executive Summary, Page ES-5, Paragraph 4. Under **Removal Action Alternatives**, Groundwater Monitoring is not a removal action and, if implemented by itself, would not be a removal action alternative. Please clarify why Groundwater Monitoring was presented as a removal action alternative rather than evaluating another removal action technology, such as pump and treat. **Response:** As defined by Section 101(23) of CERCLA, "remove or removal means the cleanup or removal of released hazardous substances from the environment; such actions as may be necessary taken in the event of the threat of release of hazardous substances into the environment; <u>such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances;</u> the disposal of removed material; or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare of the United States or to the environment, which may otherwise result from a release or threat of release." (underline added). Groundwater monitoring was included as an alternative to monitor, assess, and evaluate the release to ensure that contaminant migration and exposure to receptors does not occur before a remedial action can be implemented. As described in the report, the in-situ chromium reduction alternative includes extraction and treatment as the initial phase of

Comment #	Comment/Response

the alternative.

6. **Comment:** Executive Summary, Page ES-7, Paragraph 2. In the last two sentences, costs are discussed for thermal treatment technologies. The cost to complete Six-phase Heating or Dynamic Underground Stripping at each hot-spot is reported, but the cost is actually for all three hot-spots for each technology. Please correct the ambiguous language of the text.

   Response: The phrase "each hot spot" has been replaced with "all three VOC hot spots".

7. **Comment:** Section 2.4.2, Chromium in Soils, Page 2-14, Paragraph 3. In the last sentence, "... soil is not considered...." would be more appropriate if it read "... vadose zone soil is not considered...." Please review and revise as appropriate..

   Response: The requested revision has been made to the referenced text.

8. **Comment:** Section 2.6, p. 2-23, §2.6. The first sentence in the third paragraph is not a complete sentence and its meaning is not clear. Please correct.

   Response: The first and second sentences of the referenced paragraph have been deleted and replaced by the following sentence: "Although a risk evaluation has not been performed under the scope of the OU 2 NCRA for the media of subsurface soil, groundwater, and soil gas, contaminant concentrations in these media have been compared to the appropriate CTDEP RSR criteria."

9. **Comment:** Section 3.2, Determination of Removal Action Scope, Page 3-2, Paragraph 2. Deep VOC contamination is discussed in this paragraph. It would be more appropriate to state that deep VOC contamination, although a continuing source of groundwater contamination, is not an immediate threat to indoor air and surface water quality.

   Response: The recommended additional text has been added to clarify the determination of removal action scope.

10. **Comment:** Section 3.5, Removal Action Goals, Page 3-3. Please clarify that the alternate RSR criteria will be developed in support of the long-term remedy for the site, not for this

Comment #	Comment/Response

removal action, but that they will be used for the removal action if they are available in time to incorporate them, if that is what is planned.

Response: The referenced text has been revised to include the recommended clarification.

11. **Comment:** Section 3.6, Extent of Contamination, Page 3-4, Paragraph 3. Please edit the text to clarify how the estimated potential to significantly contribute to ongoing indoor air contamination was determined. If this is based on a calculation, a model, or a standard, please provide the supporting documentation.

    Response: The potential to significantly contribute to ongoing indoor air contamination was determined by comparison of the groundwater data relative to CTDEP I/C VC, and the presence of documented indoor air contamination. All three groundwater VOC hot-spots contain VOCs in groundwater from zero to 15 feet bgs at concentrations exceeding the CTDEP I/C VC. In addition, the RI did not find any significant vadose zone VOC contamination.

12. **Comment:** Section 5.1.1, Description of the Alternative, Page 5-3, Paragraph 1. In the last sentence, please clarify how doorways will be constructed when no wall exists.

    Response: The text has been revised as requested.

13. **Comment:** Section 5.1.1, Description of the Alternative, Page 5-3, Paragraph 3. Please clarify that "for off-site characterization analysis" actually means "to characterize the debris for off-site disposal." Please edit the text as appropriate.

    Response: The text has been revised as requested.

14. **Comment:** Section 5.1.1, Description of the Alternative, Page 5-3, Paragraph 4. The text is describing a landfill cap because contaminated soil and characteristically-hazardous waste will remain buried beneath the floor unless the removal action also includes sampling and removal of the contaminated soil and characteristically-hazardous waste. Regulatory requirements associated with such a landfill cap should also be discussed in this EE/CA.

Comment #	Comment/Response

Response: The proposed alternative is not considered a landfill cap and therefore, it is not appropriate to discuss regulatory requirements relative to landfills and landfill cover systems.

The CTDEP RSR, Regulations of Connecticut State Agencies (RCSA) §§ 22a-133k-1 through 22a-133k-3, has been identified as chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs). RCSA § 22a-133k-2(b)(3) states that the direct exposure criteria do not apply to inaccessible soil provided that the soil is less than 15 feet below ground surface and an environmental land use restriction (ELUR) is in effect. The contaminated soil beneath the former Chromium Plating Facility meets the definition of "inaccessible soil" as defined in RCSA § 22a-133k-1(28) and the proposed alternative includes an ELUR. RCSA § 22a-133k-2(c)(4)(B) states that the pollutant mobility criteria do not apply to environmentally isolated soil provided that an ELUR is in effect. The contaminated soil beneath the former Chromium Plating Facility meets the definition of "environmentally isolated soil" as defined in RCSA § 22a-133k-1(15) and the proposed alternative includes an ELUR.

Therefore, with an appropriate ELUR in effect to establish restrictions on the future use of the former Chromium Plating Facility (e.g., prevent floor penetration, subsurface work within the limits of the facility, and demolition of the building), the chromium-contaminated soil may remain in place. The vapor barrier included as a component of the alternative is not being installed as a landfill cap; rather its purpose is to prevent the underlying contaminated soil from contaminating the new floor slab.

15. **Comment:** Section 5.1.4, Cost, Page 5-7. Edit the text, here and in other pertinent locations, to state that the inflation rate has been assumed to be 0%.

    Response: In accordance with USEPA guidance (EPA 540-R-00-002; July 2000), the text has been revised to state "Consistent with USEPA guidance, a discount rate of seven percent was used to prepare the cost estimate (USEPA, 1993a)."

16. **Comment:** Section 5.1.4, Cost, Page 5-8. Under **General Cost Assumptions**, add a bullet stating that it has been assumed that no actions will be necessary to maintain the building stability during removal actions. Make the same edit for Alternative CR-S-2.

Comment #	Comment/Response

Response: The text has been revised as requested.

17. **Comment:** Section 5.1.4, Cost, Page 5-8. Under **Floor Removal and Re-pouring**, add a bullet stating that new extraction, injection, or monitoring wells required for other components of the selected removal action will be installed prior to placement of the vapor barrier and pouring of the new concrete floor. Make the same edit for Alternative CR-S-2.

    Response: The U.S. Army agrees with the comment, provided that the OU 2 NCRA is implemented to address groundwater contamination and chromium-contaminated structures concurrently. However, the contaminated structures may be addressed prior to implementing a pilot- or full-scale treatment system to address the groundwater hot-spot areas. If wells or floor penetrations are installed after the floor replacement is complete, they will be done in a manner to minimize damage to the vapor barrier.

18. **Comment:** Section 5.14.4, Cost, Page 5-9. In the first sentence of the third bullet under **Debris Sampling, Analysis, and Off-site Disposal**, the hazardous concrete will likely be hazardous debris, not hazardous waste. The regulatory requirements are somewhat different. Please edit the text accordingly. Make the same edit for Alternative CR-S-2.

    Response: The text has been revised as requested.

19. **Comment:** Section 5.2.2, Effectiveness, Page 5-13, Paragraph 5. Please explain why Alternative CR-S-2 will require the same execution time as CR-S-1 even though it does not include removal of the floor.

    Response: The amount of time estimated to remove the floor slab (Alternative CR-S-1) is approximately equal to the amount of time estimated to conduct other activities associated with pouring a new floor slab over the existing floor (Alternative CR-S-2) (e.g., relocating existing piping, rebuilding entry and exit doorways, and sealing the existing sumps). Therefore, the overall duration of both alternatives is estimated to be approximately 12 weeks.

20. **Comment:** Section 5.2.4, Cost, Page 5-16. Under **Long-term O&M**, add the text for the third bullet, as per Alternative CR-S-1.

Comment # **Comment/Response**

Response: The text has been revised as requested.

21. **Comment:** Section 5.3.2, Effectiveness, Page 5-22, Paragraph 3. The second sentence should mention total chromium and other pertinent parameters in addition to hexavalent chromium. Please edit the text accordingly.

    Response: The following text has been added to the end of the sentence, "and other permit-required parameters."

22. **Comment:** Section 5.3.4, Cost, Page 5-24. Under **In-situ Reduction System**, <u>Installation of extraction system</u>, the second bullet implies that the piping will be inside Building 2 and will therefore not need to be installed below frost level; however, Figure 5-2 indicates that extraction system discharge piping runs outside between Building 2 and Building 63. Please edit the text to clarify this apparent discrepancy.

    Response: The following text has been added to the end of the bullet, "within the building. Buried piping outside the building will be installed below the frost depth."

23. **Comment:** Section 5.3.4, Cost, Page 5-24. Under **In-situ Reduction System**, <u>Installation of injection system</u>, the second bullet discusses injection well accessories. It should be noted that Figure 5-2 indicates that 12 injection wells will be installed outside. It therefore appears that freeze protection will be required for these 12 wells if they will actually be installed above grade as indicated. Do the costs include freeze protection for these wells?

    Response: Insulation and heat tape is included with the outside injection piping. See the last bullet under <u>installation of chemical make-up system</u>. This insulation and heat tape may be extended to the wells; however, the design would further evaluate the benefits of this approach compared to subsurface connections.

24. **Comment:** Section 5.3.4, Cost, Page 5-24. Under **In-situ Reduction System**, <u>Installation of injection system</u>, the fourth bullet should mention that wells added inside Building 2 in the area of the vapor barrier will be installed so as to keep the vapor barrier intact. Costs for these wells should account for this installation procedure.

Comment #	**Comment/Response**

Response: The purpose of the "vapor barrier" is to prevent the new concrete floor from contacting the underlying soils. Well installations will incorporate methods consistent with this purpose.

25. **Comment:** Section 5.3.4, Cost, Page 5-25. Under **In-situ Reduction System,** Installation of Organics Treatment System, add a bullet stating that the CWTP has the capacity to handle a flow rate of 75 gpm for this system plus any flows from other activities.

    Response: The requested bullet has been added. The Chemical Waste Treatment Plant (CWTP) peak design capacity is 400 gallons per minute (gpm).

26. **Comment:** Section 5.4.2, Effectiveness, Page 5-28, Paragraph 2. Under **Overall protection of human health and the environment**, an ELUR is not protective of the environment as the text states, and; therefore, CR-GW-2 protects only against human health risks associated with the hexavalent chromium contamination in groundwater.

    Response: It is agreed that an ELUR does not provide protection of the environment. The words "and the environment" have been removed from the sentence. The following paragraph has been added after the first paragraph.

    "Currently, there is no significant exposure of environmental receptors to the groundwater. The monitoring program provides protection of the environment in so far that it will identify if the contamination is migrating closer to the point where it could result in exposure to environmental receptors and additional actions are needed."

27. **Comment:** Section 5.4.2, Effectiveness, Page 5-29, Paragraph 5. Under **Short-term effectiveness**, a potential short-term risk for CR-GW-2 is the transport of contamination to greater depths during well installation.

    Response: The last sentence of the first paragraph has been replaced with the following, "Negative impacts on the environment are limited to the small potential that installation of wells could result in transport of contamination to greater depths. This potential impact would be minimized by proper well design and installation."

28. **Comment:** Section 5.6.1, Description of the Alternative, Page 5-44, Paragraph 3. Ferrous sulfate is erroneously referenced twice in the fourth and fifth sentences. Please delete these references.

    Response: The references have been corrected.

29. **Comment:** Section 5.6.1, Description of the Alternative, Page 5-45, Paragraph 1. The last sentence erroneously references VOC Hot-spot No. 1 when it should be referencing VOC Hot-spot No. 2. Please correct.

    Response: The reference has been corrected.

30. **Comment:** Section 5.6.1, Description of the Alternative, Page 5-47, Paragraph 1. In the last sentence, operation of the air sparging system is discussed. The text should present some basis for the 15-year time estimate and include supporting documentation, such as calculations or modeling results. Please edit the EE/CA accordingly.

    Response: The following text has been added after the first paragraph on page 5-47 of the Draft OU 2 EE/CA. "Dissolved-phase groundwater contamination downgradient from a source area can frequently be remediated by air sparging in a period of 2 years or less. Models that predict the cleanup time in these situations are available, but may not be fully accepted. For VOC Hot-spot No. 3, air sparging is proposed for what is considered to be a source area. The source area is likely to contain significant contaminant mass that is sorbed to soil in addition to dissolved-phase contamination. Application of air sparging at such locations generally requires much longer timeframes due to limitations imposed by the rate of dissolution/desorption and contaminant diffusion. Application of air sparging in similar situations has shown reasonably rapid reduction in dissolved-phase contamination only to have concentrations rebound when the system is shut down. Therefore, a longer treatment timeframe has been assumed than the typical 1 to 2 years for dissolved-phase treatment by air sparging. Lacking detailed information on the mass and distribution of sorbed contaminants in the soil and accepted models for predicting cleanup times in this situation, the 15-year cleanup time was selected based on professional judgement. However, for cost estimating purposes, it has been assumed that the air sparging system will operate for 30 years."

31. **Comment:** Section 5.6.2, Effectiveness, Page 5-50, Paragraph 3. It is stated that, for evaluation, the SVE system will operate for 2 years. However, the costs in Table 5-8 and the text on page 5-47 indicate that the SVE system will operate for 5 years for this alternative. Please review and correct as appropriate.

Response: All of the alternatives have been evaluated as removal actions based on a two-year period. After this time, the RI/FS and remedial action process should be complete and the on-going operation would be incorporated into the remedial action alternative or would be replaced by a different alternative. For this reason all of the evaluation criteria except cost are based on the two-year period only. Because some alternatives incur significant operation and maintenance costs beyond two years, whereas, others may not, costs were provided for the two-year period only and the total cost includes operation and maintenance. The phrase, "it is assumed the SVE system will operate for 2 years," has been replaced with, "2 years of operation are considered," to clarify the meaning.

32. **Comment:** Section 5.6.4, Cost, Page 5-56. Under **In-Situ Air Sparging**, <u>Full-scale Air Sparging System</u>, blowers capable of providing 500 to 750 scfm and 35 to 45 psi are discussed. These are uncommon blowers. Please verify that they are available and for the cost suggested in Table B-12.

Response: Agreed, blowers of this size are uncommon and, if available are certainly significantly more expensive than estimated. R. S. Means lists an air sparging blower capable of 426 scfm at 30 psi for $32,444. More likely, it will be necessary to have a greater number of blowers at a lower rated flow rate. The bullets have been revised to state the following:

- The header pipe for the 45-foot wells will run underground and connect to two 250 scfm blowers capable of producing 35 pounds per square inch (psi) of pressure. A spare blower will be provided for backup.
- The header pipe for the 60-foot wells will run underground and connect to two 250 scfm blowers capable of producing 45 psi of pressure. A spare blower will be provided for backup.

These changes would result in an increased cost of approximately $229,000 or approximately two percent of the overall cost of the alternative. This cost would be covered by the "contingency costs" included in the cost estimate. Additionally, this minor cost difference is well within the USEPA guidance range of +50% to –30% regarding the accuracy of cost estimates. Therefore, changes to the cost estimate were not made.

33. **Comment:** Section 5.7.2, Effectiveness, Page 5-64, Paragraph 5. In the last paragraph under **Long-term effectiveness**, the text states that no residual VOC contamination will remain in groundwater hot-spots after operation of this alternative for 2 years. Please provide a basis for this statement, including calculations or modeling results.

Response: The statement was intended to relate to the source of groundwater contamination. Following treatment it is not anticipated that the source of groundwater and soil vapor contamination in the hot spots will remain. This observation is based on case studies for application of the technologies at other sites. Calculations/modeling have not been performed. In reality, contaminated groundwater from outside the hot spots will flow into the hot spots following treatment; therefore, residual contamination will be present. The text has been changed as follows: "Following completion of this alternative (two-year operation), it is anticipated that the primary sources of VOC contamination in groundwater and soil gas will be removed. VOC-contaminated water from outside the hot-spots will flow into the hot-spots following treatment. Subsequent remedial actions will address the residual VOC contamination in groundwater. Removal of the contamination source will greatly improve the effectiveness of addressing the residual groundwater contamination as part of the long-term remedy."

34. **Comment:** Section 5.7.4, Cost, Page 5-68. Under **Six-Phase Heating**, please provide a basis for the equipment sizes presented in bullets 5 through 8, including appropriate calculations. Also, will the subsurface temperature be monitored during six-phase heating?

Response: Due to the innovative and proprietary nature of these technologies (six-phase heating and DUS) detailed design calculation and methods are not published. Therefore, equipment sizes were based on published results of previous case studies for the technology pro-rated to the size of the hot spots at SAEP. These estimates were presented to the

Comment # **Comment/Response**

technology vendors for their review. Vendors for both technologies generally consider the sizing/estimates to be conservative but appropriate for the purposes of an EE/CA. Costs are included for subsurface temperature to be monitored during six-phase heating.

35. **Comment:** Section 7.3, VOCs in Groundwater, Page 7-2, Paragraph 1. The text states that thermal treatment achieves the greatest contaminant reduction in the shortest time, but provides no documentation for this statement. Please provide a basis for this statement, including appropriate calculations or modeling results.

Response: The statement is based on the following: Thermal treatment (Alternative VOC-3) is estimated to remove the primary source contamination from all three hot spots in a two-year operation period. Alternative VOC-2 requires significantly greater than 2 years to remove source area contamination from Hot Spot No. 3 (assumed to be 30 years for costing purposes). Alternative VOC-1 does not remove source contamination.

36. **Comment:** Table ES-1, Removal Action Goals. This table should indicate that the Media/Locations of interest for this EE/CA are the hot-spots, not general site groundwater.

Response: Media/Location descriptions for VOC groundwater have been changed to "VOCs in hot-spot groundwater…".

37. **Comment:** Table 2-1, Inorganics in Soil Exceeding CTDEP Criteria. The data presented in this table differs from the data presented in Figure 2-3. Please review and correct as appropriate.

Response: Table 2-1 and Figure 2-3 have been reviewed and revised as necessary.

38. **Comment:** Table 2-5, VOCs in Soil Vapor Exceeding CTDEP I/C Volatilization Criteria. For the benefit of the reader, please include the CTDEP I/C Volatilization Criteria in this table.

Response: Table 2-5 has been revised as requested.

39. **Comment:** Table 3-2, Chemical-Specific ARARs, Criteria, Advisories, and Guidance. The

Comment #	Comment/Response
	actions to be taken to achieve the ARARs, as presented in this table, discuss future remedial actions for the site rather than what will be done during the removal actions to address the ARARs. Please review and revise the text in this table to address the removal action not the remedial action. **Response:** Table 3-2 has been revised as requested.
40.	**Comment:** Table 3-3, Location-Specific ARARs, Criteria, Advisories, and Guidance. Rather than providing generic compliance statements for actions to be taken to achieve ARARs, specific actions should be identified to address the regulatory requirements cited. Although the coastal management regulations are applicable, will the removal actions evaluated actually trigger any of these requirements? If so, that should be addressed here. Also, research for this EE/CA should have evaluated the possible existence of historic properties, as well as the likelihood that artifacts might be found during the removal action. If no historic properties exist at or adjacent to the site, that should be stated here. **Response:** Table 3-3 has been revised as requested.
41.	**Comment:** Table 4-2, Screening of Potential Groundwater Removal Action Technologies. On page 2 of 7, Air Sparging has been eliminated for VOC Hot-spots Nos. 1 and 2 because it is not as likely to be effective as thermal treatment options. This statement should be supported with calculations or modeling results that provide a basis for this statement. Please edit the EE/CA accordingly. **Response:** Based on the groundwater concentrations measured, the presence of residual product at the hot-spots is possible. The air sparging technology is an effective technology for addressing dissolved volatile contamination. However, for residual product in soil below groundwater the contaminant removal rate is limited by the phase transfer of contaminants to the sparged air. Thermal treatment methods (six-phase heating and DUS) are specifically intended to remediate source areas with residual product contamination. They are brute-force methods to remove the product and are much more aggressive than air sparging. The advantages of thermal techniques for source areas are generally well documented in recent literature. Based on these advantages the statement is qualitatively justified. Air sparging was retained for Hot Spot No. 3 due to the need for a treatment technology to include in

Alternative VOC-2 since in-situ oxidation for the 1,1,1-TCA was not appropriate.

42. **Comment:** Table 5-8, Alternative VOC-2. This table appears to indicate that air sparging would continue for 30 years while SVE would be terminated after 5 years. This does not seem to be appropriate because of the potential recontamination of indoor air in the site buildings. It would seem to be necessary to operate the SVE system for as long as the air sparging system is operated to avoid releasing VOCs to the site buildings. Please provide information as appropriate to support this position.

    Response: SVE refers to the site-wide sub-slab venting system. The air sparging system has its own separate vapor extraction system that would continue to operate as long as air sparging continues.

43. **Comment:** Table 6-3, Comparative Analysis of VOC Groundwater Alternatives. On page 1 of 3, add to Long-term Effectiveness and Permanence the first item from Long-term Effectiveness and Permanence for Alternative VOC-2 (on page 2 of 3).

    Response: Page 1 of 3 is Alternative VOC-1, which does not include hot-spot treatment. It is not appropriate to add the first item from page 2 of 3, which references hot-spot treatment.

44. **Comment:** Table 6-3, Comparative Analysis of VOC Groundwater Alternatives. On page 3 of 3, in the last item for Overall Protection of Human Health and the Environment, please clarify to what this item is being compared.

    Response: The comparison is to other alternatives, which has been clarified. Further clarification that the comparison is specific to the 2-year time frame has been added.

45. **Comment:** Table 6-3, Comparative Analysis of VOC Groundwater Alternatives. On page 3 of 3, under implementability, add that pilot testing for both six phase heating and dynamic underground stripping will be required to confirm the suitability of the technologies for the site and their effectiveness at the site. Also, the EE/CA text suggested that the availability of necessary electrical power at the site had not been confirmed, contrary to what this table states. Please clarify.

Response: A statement concerning pilot tests has been added. There is an assumption for the cost estimate that adequate power is available. It is not confirmed that there is adequate power available to run six-phase transformers for all three hot-spots simultaneously; however, based on the electrical capacity at the facility no difficulties are anticipated for treatment of individual hot-spots. This has been clarified in the table.

46. **Comment:** Table 6-3, Comparative Analysis of VOC Groundwater Alternatives. On page 3 of 3, Alternatives 3A and 3B should be identified separately where necessary, such as for costs.

Response: Almost all of the assessments apply to both technologies. Where an assessment applies to only one technology, it is specified in the table.

47. **Comment:** Appendix A, Plating Facility Interior Decontamination Risk-Based Clean-Up Goals. In the Risk Assessment Table for Residential Exposure, please review and edit as necessary, the Hazard Index values in the Total column, as there appears to be a calculation error.

Response: What appears to be a calculation error is actually a result of the equations in the spreadsheet, the number of significant figures, and rounding (i.e., 33.1128 + 0.1127 = 33.2255, which rounded to two significant figures is 33.23).

48. **Comment:** Appendix B, Detailed Cost Estimates. On page 3 of 8 in Table B-2, the boomlift hourly rate for sand blasting overhead beams appears to be incorrect; it should apparently be $10 not $42. Please review and correct.

Response: The comment is correct. This change would result in a decreased cost of approximately $960, or approximately 0.2 percent of the total cost of the alternative. Due to the insignificant change in cost of the alternative, changes to the cost estimate were not made.

49. **Comment:** Appendix B, Detailed Cost Estimates. On page 12 of 18 for Table B-12, no backup blowers are included. If blowers of this capacity and pressure are available, they will need regular routine maintenance and probably frequent repair maintenance. Backup blowers

should be included. Also, verify the price, which appears to be much too low for blowers of this uncommon size.

Response: Agreed, see response to Specific Comment 32.

50. **Comment:** Appendix C, Engineering Calculations. On page 1 of 2 of Chemical Usage Calcs, the mass of Cr(VI) in water uses a 25-foot depth rather than the correct 30-foot depth. Please correct.

Response: There is no water in the 0-5 foot interval.

51. **Comment:** Appendix C, Engineering Calculations. On page 2 of 2 of Chemical Usage Calcs, please provide a basis for the assumption that 30 mg/L of hydrogen peroxide will be required.

Response: The basis is UV/Ox vendor catalogs.

52. **Comment:** Appendix C, Engineering Calculations. On page 1 of 1 for the Electrical Usage Estimate, 5 extraction pumps are shown, however, only 4 are discussed on page 5-17 of the EE/CA text. Please review and correct as appropriate.

Response: The conceptual design includes four extraction pumps as discussed on page 5-17 of the Draft OU 2 EE/CA. This would result in a difference in the cost estimate of approximately $1,100 or approximately 0.04 percent of the total cost of the alternative. Due to the insignificant change in the cost of the alternative, changes to the cost estimate were not made.

53. **Comment:** Appendix C, Engineering Calculations. On page 2 of 3 for the OU2 EE/CA Mass Estimates, the third calculation line contains an error; the calculated value is not 4.4 Kg. Please review and correct.

Response: The corrected value is 1.3 kg. Due to the small change in mass (<5%), changes to the cost estimate were not made.

Comment #	Comment/Response
54.	**Comment:** Appendix D, Soil Vapor Extraction System Air Flow Model. The air modeling for the SVE system does not include a case that closely matches the case selected for the removal action, as shown in Figure 5-7 and as discussed in the EE/CA text on pages 5-40 and 5-41, which indicates the design conditions are: 100-foot SVE pipe spacing, 2,000 scfm air flow, and 6-inch to 12-inch vacuum (5800-5900 pressure). This configuration, as shown in Figure 5-7, needs to be run through the model and presented in the EE/CA report. **Response:** The cases presented in Appendix D show that the effect of pipe spacing has a minimal effect on flow rates (see results of Air 3 and Air 4 in Table 1 of Appendix D). Therefore, results from the 200-foot spacing cases are fair representations of the 100-foot spacing cases. Runs Air 6, Air 7, and Air 8 show the effect of permeability at an approximate vacuum of 18-inches. The conceptual design was based on more frequent spacing as a safety factor and an approximate safety factor of 2x for the highest air flow rate. Due to these safety factors applied in the conceptual design, the model will not generate a 2,000 cfm flow at the design parameters. Ultimately, an SVE pilot test is required to refine the design and model.
55.	**Comment:** Appendix D, Soil Vapor Extraction System Air Flow Model. On the second page of the text in this appendix, in the second paragraph under **Model Runs and Results**, the second sentence states that a positive pressure is easily maintained beneath the buildings. Because this is referring to an SVE design, it appears that the intent is to maintain a vacuum, or negative pressure beneath the buildings. Please review and correct as appropriate. **Response:** The text meant to imply that the pressure gradient was positive outward. However, the concept of maintaining a partial vacuum beneath the building is less confusing. The text has been revised for clarification.
56.	**Comment:** Appendix D, Soil Vapor Extraction System Air Flow Model. In Table 1, the model should evaluate the impact of varying the layer 3 permeability, as in a sensitivity analysis. Please include additional model runs presenting this variability for layer 3. **Response:** Model runs for layer 3 have been added with variation of the air permeability by ±50%.

Comment #	Comment/Response

57. **Comment:** Figure 2-18, Interpretive Vertical Distribution of TCE in Groundwater Chlorinated VOC Hot-Spot No. 1. The eastern-most well, WP-99-05, should be WP-99-50 according to Figure 2-16. Please review and correct as appropriate.

    Response: Figure 2-18 has been revised. The eastern-most monitoring well is WP-99-50, consistent with Figure 2-16.

58. **Comment:** Figure 5-1, Removal Actions for Chromium Plating Facility Structures. This figure should also show the limits of the floor removal or reconstruction. Please add that to the figure.

    Response: Figure 5-1 has been revised as requested.

59. **Comment:** Figure 5-3, In-Situ Reduction Process Flow Diagram. This flow diagram shows that extracted groundwater containing VOCs will be discharged to the sump in Building 63 before treatment to remove VOCs. It seems that this would defeat the purpose of the VOC treatment by allowing VOCs to volatilize into Building 63. Please review and correct as appropriate, or explain why the flow diagram does not require editing.

    Response: Building 63 is an electrical/control building for the pumps that transfer water from the sump. The building is normally unoccupied. The design would consider additional measures as necessary to seal penetrations between the sump and the building.

60. **Comment:** Figure 5-5, Rationale for Selection of SVE System Coverage. Soil gas point SG-99-48 is missing from this figure. Please add it.

    Response: Only those sample locations where contaminant concentrations exceed CTDEP RSR soil vapor volatilization criteria or indoor air target concentrations are shown on Figure 5-5. Based on review of the data, there are no exceedances of these criteria at location SG-99-48. Therefore, it is not necessary to add this location to Figure 5-5.

61. **Comment:** Figure 5-7, Soil Vapor Extraction System Plan View. Please review the relative sizes of the SVE header pipes (6 inch) and the horizontal wells (4 inch). For flow control purposes, the pressure loss in the headers should be very small compared to the losses in the

horizontal wells. Please include in the EE/CA the support calculations used to size the pipes.

Response: Headloss calculations are typically beyond the detail appropriate for an EE/CA. The pipe sizes were estimates for cost purposes only.

62. **Comment:** Figure 5-8, Proposed VOC Groundwater Monitoring Locations. It appears that most of the new monitoring wells proposed are outside the VOC hot-spots. However, if the intention is to evaluate the reduction of the size of the hot-spots and the VOC concentrations in the hot-spots, more of the monitoring wells should be located in the hot-spots. Please review the new monitoring well locations and revise as appropriate, providing better justification for the locations selected (i.e., what is the purpose of each well).

Response: The intention of the proposed groundwater monitoring is not to monitor the reduction of the size of the hot spots but more to monitor the overall migration and change in concentration of the entire groundwater plume. Additional detail is provided in the description for Alternative VOC-1, Subsection 5.5.1. Table 5-6 provides the rationale for each of the proposed wells, identifying upgradient, downgradient, and interplume wells at various depths such that movement and changes in the entire groundwater plume can be monitored.

63. **Comment:** Figure 5-8, Proposed VOC Groundwater Monitoring Locations. At the well cluster: WC-4S, PZ-4D, and New 7, there is a gap between elevation 13 feet and 29 feet. It appears that this gap is located exactly at the VOC plume elevation. This suggests that another well, covering this gap, is warranted. Please review and edit as appropriate.

Response: The OU 2 EE/CA has been revised to replace the originally proposed intermediate monitoring well PZ-4D (29-39 ft. bgs) with a new monitoring well (New 7A at 18-28 ft. bgs). Additionally, the original proposed monitoring well New 7 has been re-numbered as New 7B.

Comment #	Comment/Response

CTDEP Comments dated April 2, 2001 on the Draft Final EE/CA Report OU 2 Source Areas, SAEP, Stratford, CT

1. **Comment:** The ARAR list should also include the following:

   Injection wells, for chemicals or steam, also require permitting under the Regulations of Connecticut State Agencies (RCSA) Section 22a-430-1 et seq.; expectably the permitting mechanism would be an emergency authorization.

   A general permit registration for storm-water discharge associated with construction may be required if the disturbed acreage exceeds the threshold value.

   Management of debris and polluted media that are not regulated as RCRA hazardous waste is subject to the State's Solid Waste Management Regulations at RCSA 22a-209-1 et seq.

   Specifically note the applicability of RCSA 22a 174 sections -3 and -29 for air discharges of toxic compounds associated with the SVE, water treatment, and in-situ volatile pollution treatment systems.

   Response: Table 3-4 (Potential Action-specific ARARs) has been revised to include the Regulations of Connecticut State Agencies identified in the comments, as well as the corresponding Connecticut General Statutes.

2. **Comment:** The depth limit on applicability of the volatilization criteria for groundwater is not correctly applied. The presence of polluted groundwater within 15 feet of the structure triggers applicability of the volatilization criteria to all polluted groundwater, regardless of depth. Remediation compliance, however, may be determined by several approaches outlined in the Remediation Standard Regulations (RSRs), and the full body of polluted groundwater may not require remediation to the volatilization criteria for groundwater for compliance to be achieved. The Soil Gas Volatilization criteria should be defined as an alternative NCRA objective. Please note that DEP has revised some criteria applicable to SAEP, a copy of the revision is enclosed.

   Response: Subsection 3.7.1 of the OU 2 EE/CA has been revised to include a discussion of

Comment #	Comment/Response
	the Soil Gas Volatilization Criteria and how the criteria relate to the proposed OU 2 removal actions.
3.	**Comment:** Drinking water standards apply specifically to delivered water at the tap. The GB groundwater classification implies the aquifer is not expected to be used as a source of drinking water, and thus the RSR groundwater protection criteria are not applicable GB areas. To fully close the exposure pathway, the DoD should also indicate their intention to restrict withdrawal of groundwater for any purpose, which would preclude possible imprudent use of the aquifer as a water source that is potentially consumed.
	Response: The U.S. Army agrees with the comment regarding the statement that the RSR groundwater protection criteria are not applicable to the groundwater beneath the SAEP because the groundwater is classified as a GB area. As such, the Draft OU 2 EE/CA references the RSR SWPC and the I/C VC.
	Regarding the request that the U.S. Army indicate their intention to restrict withdrawal of groundwater for any purpose, the Draft OU 2 EE/CA states that implementation of an ELUR will prevent the use of groundwater for any purpose.
4.	**Comment:** The EE/CA should clarify that references to risk-assessment-based cleanup levels (sections 2.4.5, 2.6) and alternative remediation criteria (section 3.5) are for criteria that must be approved by the Commissioner within the RSR framework. DEP expects that this approval would occur in conjunction with the RI/FS, rather than the NCRA.
	Response: The text has been revised to clarify that alternative SWPC and site-specific I/C VC may be developed during the RI/FS in support of the long-term groundwater remedy for OU 2 at SAEP. The text also states that the Commissioner of Environmental Protection must approve these alternative criteria.
5.	**Comment:** It is appropriate to use the Surface Water Protection Criteria, which include an attenuation factor, as an evaluation criteria for triggering interim actions. Note, however, that DEP's Remediation Standard Regulations preclude use of the Surface Water Protection Criteria listed in RSR Appendix D in cases where a groundwater plume discharges directly to a wetland (such as the tidal flat), and require instead the use of applicable aquatic life

criteria in DEP's Water Quality Standards. The long term remedy must satisfy the aquatic life criteria, and, in the case of volatile organic pollution, such criteria must be developed in consultation with DEP staff. DEP expects that the long term remedy will address this issue through the ecological risk study and groundwater model being developed in conjunction with the RI. Several options also exist in the RSRs for demonstration of compliance through groundwater monitoring, and these should be noted as means for evaluation of the NCRA activity.

Response: The U.S. Army agrees that if groundwater discharges to the tidal flats of the Housatonic River, the aquatic life criteria presented in the CTDEP Water Quality Standards would apply to the long-term groundwater remedy, rather than the Surface Water Protection Criteria. Therefore, Subsection 3.7.1 of the OU 2 EE/CA has been revised to include a discussion that if the numerical, groundwater-contaminant fate and transport modeling, conducted in conjunction with the RI/FS, determines that groundwater discharges to the tidal flats of the Housatonic River, the long-term groundwater remedy will comply with the aquatic life criteria presented in the CTDEP Water Quality Standards. However, the CTDEP RSR SWPC (and I/C VC) are being used for the OU 2 "hot-spot areas proposed for the OU 2 Non-Time-Critical Removal Action.

6. **Comment:** DEP has not approved the cited interior cleanup standard for hexavalent chrome. DEP does not explicitly regulate indoor environments, and recommends you contact the local director of health for specific guidance. Please note that the EE/CA Appendix A lacks supporting details of exposure assumptions from the referenced cleanup criterion development document, and also lacks an evaluation of how the exposure assumptions incorporated in that document are consistent with those typically used in Connecticut, as exemplified by the remediation standard regulations. Note also that Connecticut uses the 10E-6 risk level as a threshold for evaluations of potential risk associated with pollutants. To support establishment of criteria for use in the NCRA, DEP would be willing to coordinate any risk evaluation review with the state Department of Health, if the supporting documentation is updated for Connecticut's risk assumptions and submitted for review concurrently with the design stage of the NCRA.

Response: Supporting documentation relative to the development of the risk-based cleanup criteria for indoor building surface decontamination will be submitted to the CTDEP for review.

7. **Comment:** The staging of the various actions proposed for the chrome plating area should be carefully examined. Additional information should be developed on the potential interaction of the actions in implementation, and on the most cost effective sequencing of the removal actions. For example, subsurface installation of the SVE system and injection/extraction wells should precede installation of a new floor with a barrier liner. Will the heat of the thermal extraction methods adversely affect the SVE system or barrier integrity? Will the disruption of the aquifer condition associated with any in-situ action addressing the solvent plume fundamentally change the chrome distribution and require further characterization to design an effective remedy for the in-situ chrome reduction? Will manganese precipitation associated with organic oxidation adversely affect effectiveness of delivery of the ferrous sulfate reductant for chrome oxidation?

   Response: The U.S. Army agrees that the sequencing and interaction of the OU 2 removal actions is a critical. However, the issues associated with the sequencing of the removal actions cannot be fully addressed until the removal action alternatives to be implemented have been selected. Therefore, this issue will be addressed in the OU 2 Decision Document.

8. **Comment:** The presence of a sub-slab liner in the chrome plating area could limit the ability to install or service below-grade supply and waste lines, which could be a long-term limiting condition affecting building re-use. Alternative means of preventing recontamination of the new slab should be evaluated.

   Response: The area of concrete floor to be removed and replaced is approximately 15,000 square feet (s.f.), which is less than two-percent of the total area of Building 2 (approximately 900,000 s.f.). Therefore, the U.S. Army does not believe that a vapor barrier beneath the former Chromium Plating Facility will significantly affect the overall potential future use of Building 2.

9. **Comment:** DEP recommends that areas of shallow soil contamination greater than the Industrial/Commercial direct exposure criteria that are present under the plating room floor be removed when the floor of the plating area is removed.

Comment #	Comment/Response

Response: As presented on Figure 2-3 of the OU 2 EE/CA, there are only two sampling locations within the former Chromium Plating Facility where the concentrations of hexavalent chromium in soil beneath the floor slab exceeds the CTDEP RSR I/C DEC. These locations are SP-99-11 and SP-99-14, located at the northern end of the former Chromium Plating Facility. Location SP-99-11 is located outside the limits of the floor slab proposed to be removed and replaced. Removal of contaminated soil in the vicinity of sampling location SP-99-14 will be considered during design of the alternative, should Alternative CR-S-1 be selected as the removal action alternative.

10. **Comment:** The proposed floor removal area for the chrome plating area is not shown on figures.

Response: Figure 5-1 has been revised to depict the extent of the concrete floor in the former Chromium Plating Facility to be remediated.

11. **Comment:** Flooding to stabilize shallow chrome contamination does not seem to address the eastern areas of shallow soil contamination by chrome. How might this potential source later be addressed in the final remedy, since it would be under the barrier-protected slab? If the slab is to be interpreted as an engineered control under the RSRs an approval would be required.

Response: Flooding was primarily intended to address shallow groundwater contamination located above the first injection/extraction interval. As such, flooding was not included in the eastern part of the chrome plating facility. However, some treatment of shallow soil contamination is likely by the flooding mechanism. Given that shallow soil in the eastern part of the chrome plating facility contains hexavalent chromium at concentrations that could potentially cause recontamination of groundwater, consideration to flooding in this area may be considered during the design. A statement will be added to the alternative to describe this possibility. The replacement of the slab is occurring due to contamination of the slab itself, not the soil contamination beneath the slab. This slab is not intended to be interpreted as an engineered control under the CTDEP RSRs.

12. **Comment:** It is unclear if an initial flush, which has been discussed, will be implemented prior to treatment for in-situ chrome reduction. DEP recommends that at least one pore

Comment #	Comment/Response

volume be extracted for treatment and discharge through the CWTP prior to initiation of the in-situ treatment process.

Response: An initial flush is discussed as a possible strategy for implementation of the alternative. The U.S. Army agrees that an initial period of extraction and treatment would be advantageous. These details would be defined during the design of the alternative. The CTDEP will have additional opportunities to provide comments on the operational strategy of the alternative during the design process.

13. **Comment:** The design phase of the NCRA must demonstrate that the chemical injections are within hydrogeologically controlled "cells" to provide the basis for issuance of a discharge permit. DEP must be presented with a flowpath analysis demonstrating the limited number of extraction wells, especially for the chrome pollution, adequately maintain hydraulic control on injected chemicals.

    Response: Commented noted.

14. **Comment:** The discussion of reversibility of the stabilizing reaction should be expanded to show how this NCRA is potentially consistent with a final remedy.

    Response: The text has been revised to indicate that the irreversible reduction in contaminant toxicity, mobility, and volume will likely be consistent with the long-term groundwater remedy.

15. **Comment:** Although this NCRA does not address treatment of volatile organic chemicals in the vadose zone, this may be key to achieving compliance with target indoor air concentrations in the final remedy. Consider ensuring that SVE trench spacing over hotspot/release areas is sufficient to allow such treatment without re-excavation/modification.

    Response: The SVE system presented in the Draft OU 2 EE/CA is intended to prevent the migration of contaminated soil vapor into indoor air. Closer trench spacing is not required to meet this objective even if a source exists in the vadose zone (i.e., higher concentrations do not significantly affect the extraction rate and spacing required to prevent soil gas migration into the building). Installation of additional extraction trenches to potentially treat vadose zone soils above the hot spots, if necessary, may be considered during the design if there appears to be significant potential savings. Design of VOC-hot spot treatment alternatives may attempt to address vadose zone soils, if possible.

16. **Comment:** Condensate back-drain in the SVE system as proposed may require a groundwater discharge permit, and is generally discouraged by DEP. A preferable alternative would be to collect condensate backdrain in a sump for disposal or pumpage to the sanitary sewer after pretreatment.

    Response: Collection of condensate in a sump is possible and can be incorporated into the system design if required by the CTDEP. A sentence has been added to the alternative description to identify this method as an alternative to condensate back drain that may be preferable to the regulatory agencies

17. **Comment:** Some of the artificial fill on the site may have been placed hydraulically. If the areas of likely hydraulic fill are coincident with the SVE system proposed, please review your model to ensure the possibly lower permeability of the hydraulic fill is included in the sensitivity analysis and system design.

    Response: The location of the SVE system does not significantly overlap with the areas that were filled; however fill locations compared to SVE system location and consideration of lower permeability hydraulic fill will be evaluated during the detailed design.

18. **Comment:** The SVE system is not shown on cross-sections of the thermal actions. How will the SVE system interrelate to the vapor recovery wells associated with the thermal action options?

    Response: The two systems are not intended to interrelate, other than occupying the same location. The vapor recovery system for the thermal actions must be significantly more robust and has a different configuration than the SVE system required to prevent soil vapor infiltration to indoor air. It is not anticipated that the thermal treatment vapor recovery system will be incorporated into the site-wide SVE system. Design details and construction sequences will be developed at a later stage in the project; however, it is likely that the SVE

Comment #	Comment/Response

system would only be installed in the hot spot areas after the thermal treatment to avoid the unnecessary use of higher cost materials that can withstand the higher temperatures possible during the thermal treatment.

19. **Comment:** Provide for developing an estimate of potential concentrations of toxic organic compounds in air wastestreams early in the design process. The potential concentrations and mass loading per day for the system emissions may affect selection of the required air treatment technology.

    Response: Comment noted.

20. **Comment:** Will the presence of a silt layer, especially in the lower half of the target treatment interval at the chrome plating area, affect chemical contact efficiency for either the chrome reduction or volatile oxidation? Please further evaluate details of chemical circulation where significant thickness of silt is targeted for in-situ chemical treatment.

    Response: The presence of silt will affect the chemical contact efficiency of both in-situ reduction of chromium and in-situ oxidation of VOCs. To minimize this effect, the conceptual designs include injection intervals that correspond with changes in stratigraphy, such that the silt layers of significant thickness are targeted as a separate injection interval. Never the less, effective distribution of chemical reagent in these layers will be more difficult to achieve and will take longer than the sand/gravel layers.

21. **Comment:** The need for additional characterization during design development should be discussed more fully. The shallow soil and concrete chrome contamination extent investigation has been limited to the footprint of the chrome plating area, however the rational for this limitation is not presented, especially for soil pollution, which may have spread laterally. Also, there may be need to further delimit the southern extent of deeper chrome contamination, since only shallow data is available. Clearly state that the lateral extent of VOC Hot Spot 2 requires further delineation, possibly affecting design and cost as presented in the EE/CA.

    Response: The EE/CA has been revised to indicate: 1) additional shallow soil characterization for chromium contamination outside the footprint of the chromium plating

Comment #	Comment/Response

facility will be considered during the design phase; 2) additional groundwater characterization for deeper chromium contamination in the southern/eastern portion of the chromium plating facility will be considered during the design phase; and 3) the lateral extent of VOC Hot Spot 2 requires further delineation, possibly affecting design and cost as presented in the EE/CA.

22. **Comment:** Discuss the rational for delineation of the hot spot treatment area boundaries. Consider physical extent of source, percent of total contaminant mass, and how the bounding concentration contour relates to potential severe effects on indoor air quality.

Response: The 100 ppm contaminant concentration contour used to delineate the groundwater hot-spots is interpreted to include all of the probable physical location of the source (i.e., NAPL). Existing data is not adequate to estimate the percent of contaminant mass within the hot-spots. The correlation between groundwater and indoor air concentrations will be performed as part of the proposed dynamic underground stripping pilot test work plan process.

23. **Comment:** Additional monitoring may be required. The description of the monitoring program should be expanded in development of a long-range monitoring plan. The specific monitoring objective of each well should be identified as it relates to the monitoring program. Similarly, the data objectives for the proposed analytical parameters should be identified. Note that these may vary between the various action options. Also, the monitoring program should be designed to both monitor longterm conditions in the aquifer and document performance of the actions implemented. Please note DEP rarely considers long-term monitoring less than semiannually.

Response: The U.S. Army believes that the groundwater monitoring program presented in the Draft OU 2 EE/CA is adequate for the proposed removal actions to address the hot-spot groundwater contamination. However, the groundwater monitoring program may need to be modified and expanded in support of a long-term remedy for the Site, which will be addressed in the FS for SAEP.

The rationale for the proposed monitoring well locations is presented in Tables 5-5-4 and 5-6 of the Draft OU 2 EE/CA. The groundwater monitoring parameters proposed in the Draft

OU 2 EE/CA include (1) total and hexavalent chromium; (2) target volatile organic compounds (VOCs) previously detected in Site groundwater; or (3) a combination of both, depending on the location of the proposed monitoring well relative to the chromium or VOC groundwater hot-spot areas and the current understanding of Site groundwater contamination. Other standard groundwater parameters (e.g., dissolved oxygen, turbidity, and pH) will also be monitored. In addition, several other parameters (e.g., total organic carbon, nitrate, iron, and ethane) are proposed to monitor and evaluate natural attenuation processes.

Comment noted regarding the CTDEP's preference for a minimum of semiannual groundwater monitoring. For clarification, the groundwater monitoring program proposed in the Draft OU 2 EE/CA includes quarterly monitoring for the first two years followed by semiannual monitoring for years three through ten. For cost estimating purposes, the EE/CA proposes annual groundwater monitoring for years 11 and beyond. However, the actual monitoring frequency, as well as analytical parameters and monitoring locations, may change over time based on the continued evaluation of groundwater monitoring data collected.

24. **Comment:** Please describe treatment capacity of the CWTP as it relates to proposed flows, especially the pre-treatment capability for hexavalent chromium.

Response: The CWTP has a maximum design flow of 400 gpm and was designed for removal of hexavalent chromium from the wastewater generated during the former chromium plating operations. The CWTP has a current operating permit to discharge a maximum of 150 gpm, but only handles minimal flow from non-remediation sources. The CWTP is anticipated to be adequate for the proposed alternatives.

25. **Comment:** DEP has not specifically reviewed the cost and design calculation appendices in detail, further development of this information in the design documents may result in review comments. Detailed comments on in-situ remedial action may also arise during review of design documents.

Response: Comment noted.

26. **Comment:** It is appropriate to use a 30 year O & M period as a basis for cost comparisons however the long term responsible party and funding mechanism should be identified, as the

Comment #	Comment/Response
	actual period may be longer if pollution remains in place, governed by Environmental Land Use Restrictions.
	Response: The text has been revised to indicate that the U.S. Army is responsible for the jurisdiction, control, and accountability of the SAEP facility, as well as the operation and maintenance (O&M) activities associated with the removal actions. The text also states that funding for the removal actions, including long-term O&M, will be provided through the U.S. Army.