U.S. Environmental Protection Agency
Region 2

Response Action Contract

FEASIBILITY STUDY REPORT
FOR
OU-2 REMEDIAL INVESTIGATION AND
FEASIBILITY STUDY
LITTLE VALLEY SUPERFUND SITE
CATTARAUGUS COUNTY, NEW YORK

APRIL 2005

Contract Number: 68-W-98-214

TETRA TECH FW, INC.

EPA WORK ASSIGNMENT NUMBER: 103-RICO-02GP
EPA CONTRACT NUMBER: 68-W-98-214
TETRA TECH FW, INC.
RAC II PROGRAM

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TETRA TECH FW, INC.

8 April 2005
RAC II-2005-046

Ms. Patricia Simmons Pierre
Work Assignment Manager
U.S. Environmental Protection Agency
290 Broadway, 20th Floor
New York, NY 10007-1866

SUBJECT: USEPA RAC II CONTRACT NUMBER 68-W-98-214
WORK ASSIGNMENT NUMBER 103-RICO-02GP
LITTLE VALLEY RI/FS
FEASIBILITY STUDY REPORT

Dear Patricia:

Enclosed are five (5) copies of the final Feasibility Study Report for the Little Valley Site.

This document is an update to the July 2004 Revised Draft Feasibility Study Report for OU-2 incorporating the resolution of comments we received.

On behalf of our technical staff that worked on finalizing this document, we appreciate EPA's cooperation and responsiveness in enabling us to do so.

Please let me know if you have any comments or questions to this submittal.

Sincerely,

Richard J. Feeney, PE
Project Manager
(973) 630-8092

cc: W. Colvin

enclosure

1000 The American Road, Morris Plains, NJ 07950
Tel 973.630.8000 Fax 973.630.8025
www.ttfwi.com

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APRIL 2005

Prepared by:

Robert Chozick, Ph.D., PE
Feasibility Study Lead
Tetra Tech FW, Inc.

Reviewed by:

Mark Sielski, P.G.
RAC II Quality Control Manager
Tetra Tech FW, Inc.

Reviewed by:

Richard Feeney, P.E.
Project Manager
Tetra Tech FW, Inc.

Approved by:

William R. Colvin, PMP, P.G.
RAC II Program Manager
Tetra Tech FW, Inc.

TABLE OF CONTENTS

Section	Title	Page No.
	EXECUTIVE SUMMARY	ES-1
1.0	**INTRODUCTION**	1-1
1.1	**Purpose and Organization of the Report**	1-1
1.2	**Site Background**	1-2
1.2.1	Site Description	1-2
1.2.2	Site History	1-11
1.2.3	Nature and Extent of Contamination	1-13
1.2.4	Contaminant Fate and Transport	1-15
1.2.5	Baseline Human Health Risk Assessment	1-16
1.2.6	Ecological Risk Assessment	1-17
2.0	**IDENTIFICATION AND SCREENING OF TECHNOLOGIES**	2-1
2.1	**Introduction**	2-1
2.2	**Remedial Action Objectives**	2-2
2.2.1	Exposure Based on Risk Assessment	2-2
2.2.2	ARARs and TBCs	2-2
2.2.3	Development of Remedial Action Objectives	2-4
2.3	**General Response Actions**	2-4
2.4	**Identification and Screening of Technology Types and Process Options**	2-5
2.4.1	Identification and Screening Guidances for Technologies	2-5
2.4.2	Screening of Soil Remediation Technologies	2-5
2.4.3	Screening of Groundwater Remediation Technologies	2-17
2.4.4	Evaluation and Selection of Representative Process Options	2-29
3.0	**DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES**	3-1
4.0	**DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES**	4-1
4.1	**Evaluation Processes**	4-1
4.2	**Alternative Analysis for Soils**	4-4
4.2.1	Alternative S-1: No Action	4-4
4.2.2	Alternative S-2:Institutional Controls	4-6
4.2.3	Alternative S-3: *In-Situ* Soil Vapor Extraction	4-8
4.2.4	Alternative S-5: Excavation/Off-Site Disposal	4-11

TABLE OF CONTENTS (Cont'd)

Section	Title	Page No.
4.3	**Alternative Analysis for Groundwater (GW)**	4-14
4.3.1	Alternative GW-1: No Action	4-14
4.3.2	Alternative GW-2: Site-wide Monitored Natural Attenuation/ Institutional Controls	4-15
4.3.3	Alternative GW-3: Source Area Extraction/Treatment/Discharge/ Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume	4-18
4.3.4	Alternative GW-4: Source Area *In-Situ* Air Sparging/ Vapor Treatment/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume	4-22
4.3.5	Alternative GW-5: Source Area *In-Situ* Chemical Oxidation/ Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume	4-26
	4.4 Comparison of Soil Remedial Alternatives	4-29
4.4.1	Overall Protection of Human Health and the Environment	4-30
4.4.2	Compliance with ARARs	4-30
4.4.3	Long-Term Effectiveness and Permanence	4-30
4.4.4	Reduction of Toxicity, Mobility, or Volume through Treatment	4-31
4.4.5	Short-Term Effectiveness	4-31
4.4.6	Implementability	4-31
4.4.7	Cost	4-32
	4.5 Comparison of Groundwater Remedial Alternatives	4-32
4.5.1	Overall Protection of Human Health and the Environment	4-32
4.5.2	Compliance with ARARs	4-33
4.5.3	Long-Term Effectiveness and Permanence	4-33
4.5.4	Reduction of Toxicity, Mobility, or Volume through Treatment	4-33
4.5.5	Short-Term Effectiveness	4-33
4.5.6	Implementability	4-34
4.5.7	Cost	4-34
5.0	**REFERENCES**	5-1

TABLE OF CONTENTS (Cont'd)

Section	Title	Page No.
6.0	GLOSSARY OF ABBREVIATIONS AND ACRONYMS	6-1

LIST OF APPENDICES

Appendix A List of Major Facilities and Construction Components for Remedial Alternatives

Appendix B Breakdown of Capital and Operation and Maintenance Cost Estimate for Remedial Alternatives

Appendix C MNA Report

Appendix D Comparison of Individual Water Treatment Systems and Permanent Water Supply Line Alternatives

LIST OF TABLES

Table No.	Title
2-1	Contaminant-Specific ARARs and TBCs
2-2	Action-Specific ARARs and TBCs
2-3	Location-Specific ARARs and TBCs
2-4	General Response Actions, Technology Types and Process Options for Soils
2-5	General Response Actions, Technology Types and Process Options for Groundwater
2-6	Initial Screening of Remedial Technologies and Process Options for Soils
2-7	Initial Screening of Remedial Technologies and Process Options for Groundwater
2-8	Evaluation of Process Options for Soil
2-9	Evaluation of Process Options for Groundwater
4-1	Comparative Analysis of Alternatives for Soils
4-2	Comparative Analysis of Alternatives for Groundwater

LIST OF FIGURES

Figure No.	Title
1-1	Site Boundary Map
1-2	Historic TCE Sampling Results in Residential Wells
1-3	Cattaraugus Cutlery Area Contaminants in Soil Exceeding Criteria Comparison Levels
1-4	Bush Industries Area Contaminants in Soil Exceeding Criteria Comparison Levels
1-5	TCE Sampling Results from Residential Wells, Piezometers and Monitoring Wells, 2003
4-1	Cattaraugus Cutlery Area (CCA) Alternative S-3 *In-Situ* Treatment
4-2	Cattaraugus Cutlery Area (CCA) Alternative S-4 Excavation/Off-Site Disposal
4-3	Site-Wide Groundwater Monitoring Alternative GW-2 Monitored Natural Attenuation
4-4a	Cattaraugus Cutlery Area (CCA) Alternative GW-3 Extraction/Treatment/Discharge/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
4-4b	Bush Industries Area (BIA) Alternative GW-3 Extraction/Treatment/Discharge/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
4-5a	Cattaraugus Cutlery Area (CCA) Alternative GW-4 *In-Situ* Air Sparging/Vapor Treatment/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
4-5b	Bush Industries Area (BIA) Alternative GW-4 *In-Situ* Air Sparging/Vapor Treatment/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
4-6a	Cattaraugus Cutlery Area (CCA) Alternative GW-5 *In-Situ* Chemical Oxidation/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
4-6b	Bush Industries Area (BIA) Alternative GW-5 *In-Situ* Chemical Oxidation/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume

EXECUTIVE SUMMARY

This Feasibility Study (FS) Report was prepared by Tetra Tech FW, Inc. (TtFW) for Operable Unit (OU)-2 of the Little Valley Superfund Site (the Site) in response to Work Assignment 103-RICO-02GP, issued under the United States Environmental Protection Agency (EPA) Response Action Contract Number 68-W-98-214. This FS was conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C.§9601 *et seq.*, TtFW's Final Work Plan Letter Addendum dated 15 May 2003 and current EPA guidance.

Site Background

The Site is located in the Town of Little Valley and City of Salamanca in Cattaraugus County, New York. Since 1982, chemical analyses of groundwater samples collected from monitoring and private wells throughout the Site have indicated the presence of trichloroethene (TCE). The boundaries of the Site have been defined by EPA, New York State Department of Environmental Conservation (NYSDEC), and the Cattaraugus County Health Department (CCHD), and are based on the locations of the monitoring and residential wells that have been sampled. The TCE plume extends approximately eight miles from the Village of Little Valley (within the Town of Little Valley) to the northern edge of the Town of Salamanca (within the City of Salamanca), which is part of the Allegheny Indian Reservation.

Nature and Extent of Contamination

The nature and extent of contamination present in potential source areas at the Site were assessed through the sampling of soils, sediments, surface water, and groundwater from the following locations: Ninth Street Landfill; Bush Industries; Cattaraugus Cutlery; King Windows (Second Street); First Street; the Great Triangle; Whig Street; Luminite; and Railroad Avenue areas. In addition, sediments adjacent to the Cattaraugus Cutlery and Bush Industries Areas and surface water at various locations of Little Valley Creek and interconnected waterways were sampled.

The highest concentrations of TCE in the soils were detected in the Cattaraugus Cutlery Area. The Cattaraugus Cutlery Area soils were identified in the Remedial Investigation Report for OU-2 (TtFW, 2005) as a current source of TCE contamination in the groundwater at the Site.

The groundwater beneath the Site was found to contain TCE in seven of the sampled areas (*i.e.*, Ninth Street Landfill, Bush Industries, Cattaraugus Cutlery, King Windows (Second Street), Great Triangle, Whig Street, and Luminite Areas). Concentrations of TCE exceeding most conservative criteria values occurred in the following five areas: Ninth Street Landfill; Bush Industries; Cattaraugus Cutlery; Great Triangle; and Luminite.

Human Health and Ecological Risk Assessment

A Baseline Human Health Risk Assessment (BHHRA) was performed to assess potential risks associated with site soils, groundwater, surface water, and sediment. Human health risks were found to be associated with soils at the Cattaraugus Cutlery Area and groundwater at the Cattaraugus Cutlery and Bush Industries areas. Only TCE was identified as a chemical of concern that poses an unacceptable human health risk.

The findings of the Screening Level Ecological Risk Assessment (SLERA) indicate that, the potential risks to ecological receptors from TCE are low.

Development of Remedial Alternatives

Based on the results of the BHHRA, the SLERA, and a comparison of contaminant concentrations to regulatory cleanup criteria (*e.g.*, NYSDEC TAGM 4046), remedial action objectives were identified and remedial technologies were screened, evaluated, and combined into remedial alternatives to address TCE contamination associated with soils at the Cattaraugus Cutlery Area and the groundwater at the Cattaraugus Cutlery and Bush Industries areas. Four remedial alternatives were developed for TCE-contaminated soil (S) and five remedial alternatives were developed for TCE-contaminated groundwater (GW), as follows:

- Alternative S-1: No Action
- Alternative S-2: Institutional Controls
- Alternative S-3: *In-Situ* Soil Vapor Extraction
- Alternative S-4: Excavation/Off-Site Disposal
- Alternative GW-1: No Action
- Alternative GW-2: Site-Wide Monitored Natural Attenuation/Institutional Controls
- Alternative GW-3: Source Area Extraction/Treatment/Discharge/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
- Alternative GW-4: Source Area *In-Situ* Air Sparging/Vapor Treatment/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
- Alternative GW-5: Source Area *In-Situ* Chemical Oxidation/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume

Comparative Analysis of Remedial Alternatives for Soils

A detailed evaluation of remedial alternatives for soils using the CERCLA criteria was performed, followed by a comparative analysis of alternatives. These analyses are summarized in the following paragraphs.

Overall Protection of Human Health and the Environment

Alternatives S-1 and S-2 would not be protective of human health and the environment, since they would not actively address the contaminated soils, which present unacceptable risks of exposure and are a source of groundwater contamination. Alternatives S-3 and S-4 would be protective of human

health and the environment, since each alternative relies upon a remedial strategy or treatment technology capable of eliminating human exposure and removing the source of groundwater contamination.

Compliance with ARARs

There are currently no federal or state promulgated standards for contaminant levels in soils, only New York State soil cleanup objectives as specified in the soil TAGM (which are used as "To-Be-Considered" criteria).

Since the contaminated soils would not be addressed under Alternatives S-1 and S-2, they would not comply with the soil cleanup objectives. Alternatives S-3 and S-4 would attain the soil cleanup objectives specified in the TAGM.

Alternative S-4 would involve the excavation of contaminated soils and would, therefore, require compliance with fugitive dust and VOC emission regulations. In addition, this alternative would be subject to New York State and federal regulations related to the transportation and off-site treatment/disposal of wastes. In the case of Alternative S-3, compliance with air emission standards would be required for the ISVE system. Specifically, treatment of off-gases would have to meet the substantive requirements of New York State Regulations for Prevention and Control of Air Contamination and Air Pollution (6 NYCRR Part 200 *et seq.*) and comply with the substantive requirements of other state and federal air emission standards.

Long-Term Effectiveness and Permanence

Alternatives S-1 and S-2 would involve no active remedial measures and, therefore, would not be effective in eliminating the potential exposure to contaminants in soil and would allow the continued migration of contaminants from the soil to the groundwater. Alternatives S-3 and S-4 would both be effective in the long term and would provide permanent remediation by either removing the contaminated soils from the site or treating them in place.

Alternative S-3 would generate treatment residuals (e.g., spent carbon) which would have to be appropriately handled. Alternatives S-1, S-2 and S-4 would not generate such residuals.

Reduction of Toxicity, Mobility or Volume through Treatment

Alternatives S-1 and S-2 would provide no reduction in toxicity, mobility or volume. Under Alternative S-3, the toxicity, mobility, and volume of contaminants would be reduced or eliminated through on-site by treatment. Under Alternative S-4, the toxicity, mobility, and volume of the contaminants would be eliminated by removing the contaminated soil from the property.

Short-Term Effectiveness

Alternatives S-1 and S-2 do not include any physical construction measures in any areas of contamination and, therefore, would not present any potential adverse impacts to on-property workers or the community as a result of its implementation. Alternative S-3 could also result in some adverse impacts to on-property workers through dermal contact and inhalation related to the installation of ISVE wells through contaminated soils. Alternative S-4 could present some limited adverse impacts to on-property workers through dermal contact and inhalation related to excavation activities. Noise from the treatment unit and the excavation work associated with Alternatives S-3 and S-4 could present some limited adverse impacts to on-property workers and nearby residents. In addition, interim and post-remediation soil sampling activities would pose some risk. The risks to on-property workers and nearby residents under all of the alternatives could, however, be mitigated by following appropriate health and safety protocols, by exercising sound engineering practices, and by utilizing proper protective equipment.

Alternative S-4 would require the off-Site transport of contaminated soil (approximately 6 truck loads), which may pose the potential for traffic accidents, which in turn could result in releases of hazardous substances. For Alternative S-4, there is a potential for increased stormwater runoff and erosion during construction and excavation activities that would have to be properly managed to prevent or minimize any adverse impacts. For this alternative, appropriate measures would have to be taken during excavation activities to prevent transport of fugitive dust and exposure of workers and downgradient receptors to VOCs.

Since no actions would be performed under Alternatives S-1 and S-2, there would be no implementation time.

It is estimated that Alternative S-3 would require nine months to install the ISVE system and 12 months to achieve the soil cleanup objectives. It is estimated that it would take three months to excavate and transport the contaminated soils to an EPA-approved treatment/disposal facility under Alternative S-4.

Implementability

Alternatives S-1 and S-2 would be the easiest to implement, as there are no activities to undertake.

Both Alternatives S-3 and S-4 would employ technologies known to be reliable and that can be readily implemented. In addition, equipment, services, and materials needed for these alternatives are readily available, and the actions under these alternatives would be administratively feasible. Sufficient facilities are available for the treatment/disposal of the excavated materials under Alternative S-4.

Monitoring the effectiveness of the ISVE system under Alternative S-3 would be easily accomplished through soil and soil-vapor sampling and analysis. Under Alternative S-4, determining the extent of the excavation could be easily accomplished through post-excavation soil sampling and analysis.

Cost

There would be no capital or O&M costs associated with Alternative S-1. The net present worths of Alternatives S-2, S-3 and S–4 are $20,250, $275,265 and $135,825, respectively.

Comparative Analysis of Alternatives for Groundwater

A detailed evaluation of remedial alternatives for groundwater using the CERCLA criteria was performed, followed by a comparative analysis of alternatives. These analyses are summarized in the following paragraphs.

Overall Protection of Human Health and the Environment

Alternatives GW-1 and GW-2 would meet state and federal groundwater standards through natural attenuation in reasonable time frames (estimated to be 10 years following mitigation of the current source of TCE in the soil). While no current risk is associated with the groundwater, Alternative GW-2 is more protective of human health than Alternative GW-1, since institutional controls would be implemented to prevent the installation and use of groundwater wells. Alternatives GW-3, GW-4, and GW-5 would actively address the contaminants in the groundwater at the source areas until concentrations are reduced to federal and state groundwater standards (estimated to be 8 years, 2 years, and 6 months, respectively). It would take an estimated 8 years to address the plume downgradient of the source areas under all of the alternatives. Although Alternatives GW-3, GW-4, and GW-5 would be more protective of human health than Alternatives GW-1 and GW-2 and would minimize the migration of contaminated groundwater, the groundwater is only marginally contaminated and there is no current risk associated with the groundwater, since many affected residential wells have treatment systems installed.

Until groundwater standards are met under Alternatives GW-2, GW-3, GW-4, and GW-5, there would be a continued risk of human exposure to the contaminated groundwater. For each of the alternatives this risk could be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

Compliance with ARARs

EPA and NYSDOH have promulgated health-based protective MCLs (40 CFR Part 141, and 10 NYCRR, Chapter 1), which are enforceable standards for various drinking water contaminants (chemical-specific ARARs). The aquifer at the site is classified as Class GA (6 NYCRR 701.18), meaning that it is designated as a potable water supply. Alternatives GW-1 and GW-2 do not include any active groundwater remediation; groundwater ARARs would be achieved through natural attenuation within an estimated 10 years after the source control remedy is implemented. For Alternatives GW-3, GW-4, and GW-5, ARARs would be achieved through the removal and treatment of contaminants in the groundwater at the source area and through natural attenuation in downgradient areas. Alternatives GW-3, GW-4, and GW-5 would have to comply with surface water discharge requirements and the disposition of treatment residuals would have to be consistent

with RCRA. Any air emissions associated with the treatment system would have to comply with air emission standards.

Long-Term Effectiveness and Permanence

It is anticipated that the groundwater alternatives would achieve groundwater ARARs within a reasonable time frame (i.e., 10 years). It is estimated that all of the alternatives would maintain reliable protection of human health and the environment over time.

Alternatives GW-3 and GW-4 would generate treatment residues (e.g., spent carbon) which would have to be appropriately handled; Alternatives GW-1, GW-2 andGW-5 would not.

Reduction of Toxicity, Mobility or Volume through Treatment

Alternatives GW-1 and GW-2 would not use active treatment to reduce toxicity, mobility, or volume of the groundwater contaminants. The other alternatives would provide a reduction of toxicity, mobility, and volume of the contaminated groundwater through treatment of the contaminated groundwater at the source area. All of the groundwater alternatives would rely upon natural attenuation to address the downgradient plume.

Short-Term Effectiveness

Alternatives GW-1 and GW-2 do not include any active remediation, therefore, they would not present an additional risk to the community or workers resulting from activities at the site. Alternatives GW-1 and GW-2 would present some risk to on-site workers through dermal contact and inhalation from groundwater sampling activities, which could be minimized by utilizing proper protective equipment. Alternatives GW-3, GW-4, and GW-5, which would require the installation of groundwater extraction, air sparging, and/or oxidation agent injection wells through potentially contaminated soils and groundwater, would present some risk to on-site workers through dermal contact and inhalation from construction and groundwater sampling activities. Noise from the treatment units associated with Alternatives GW-3, GW-4 and GW-5 could present some limited adverse impacts to on-site workers and nearby residents. The risks to on-site workers and nearby residents under all of these alternatives could, however, be minimized by following appropriate health and safety protocols, exercising sound engineering practices, and utilizing proper protective equipment.

Based upon preliminary groundwater modeling, it has been estimated that the contaminated groundwater would naturally attenuate to groundwater standards at the source area in approximately 10 years (after mitigation of the current source of TCE in the soil) and downgradient of the source areas within 8 years. By comparison, Alternative GW-3 would achieve groundwater standards at the source area in an estimated 8 years, Alternative GW-4 would achieve groundwater standards at the source area in an estimated two years, and Alternative GW-5 would achieve groundwater standards at the source area in an estimated six months. Alternatives GW-3, GW-4, and GW-5 would achieve groundwater standards downgradient of the source areas in an estimated 8 years.

Implementability

Alternative GW-1 would be the easiest alternative to implement, since it would require no activities other than long-term monitoring. With the implementation of institutional controls, Alternative GW-2 would be slightly more difficult to implement than Alternative GW-1. Alternative GW-3 (groundwater extraction and treatment) would be the most difficult to implement in that it would require the construction of a groundwater extraction system and pipelines. The services and materials that would be required for the implementation of all of the groundwater remedial alternatives are readily available.

All treatment equipment that would be used in Alternatives GW-3, GW-4, and GW-5 are proven and commercially available. Transportation and disposal of treatment residues could be easily implemented using commercially-available equipment. Under these alternatives, sampling for treatment effectiveness and groundwater monitoring would be necessary, but could be easily implemented. For Alternative GW-5, the oxidant application rate and the rate of the oxidation reaction would need to be carefully monitored and adjusted, as needed, during implementation to ensure that the oxidants do not reach the private water supply wells and that the amount of heat and gases generated during the application of the oxidants are properly controlled.

Cost

There would be no capital or O&M costs associated with Alternative GW-1. The remaining alternatives have net present worth costs as follows: GW-2 ($238,205); GW-3 ($5,915,164); GW-4 ($1,556,465); and GW-5 ($1,744,265).

1.0 INTRODUCTION

Tetra Tech FW, Inc. (TtFW) has prepared this Feasibility Study (FS) Report for Operable Unit 2 (OU-2) at the Little Valley Superfund Site (the Site) for the United States Environmental Protection Agency (EPA) under Work Assignment Number 103-RICO-02GP of RAC II Contract Number 68-W-98-214. This report was prepared pursuant to the Final Work Plan Letter Addendum dated 15 May 2003.

1.1 Purpose and Organization of the Report

The purpose of the FS is to develop and screen feasible alternatives to remediate trichloroethene (TCE) contamination present at OU-2 of the Little Valley Site. Combinations of technologies were assembled into alternatives for remediation of the TCE contamination. The remedial alternatives were then evaluated against seven of the nine EPA evaluation criteria (evaluation against the remaining criteria is done subsequent to issue of the FS Report) and compared against one another. This evaluation provides a basis for EPA to select a preferred alternative, prepare a Proposed Plan, and ultimately issue a Record of Decision (ROD) for OU-2.

This FS Report has been prepared using the data and information presented in the Remedial Investigation (RI) Report for OU-2 (TtFW, 2005) and follows the guidance in: EPA's "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (EPA, 1988a); Technical Format Guidelines for Superfund Documents (EPA, 1992); and "Directive on Presumptive Remedies for Sites with VOCs in Soils," PB93-963346 (EPA, 1993).

This Feasibility Study Report is divided into six sections as described below:

- Section 1.0 (Introduction) provides background information on the Site and outlines the purpose and organization of this report.

- Section 2.0 (Identification and Screening of Technologies) presents the remedial action objectives (RAOs); general response actions (GRAs); feasible technologies identified to meet the GRAs; the technical criteria and site-specific requirements that were used in the technology selection process; and the results of the remedial technology screening.

- Section 3.0 (Development and Screening of Remedial Alternatives) provides the remedial alternatives that were developed by combining the technologies that passed the screening. When necessary to reduce the number of alternatives subject to detailed evaluation, a preliminary screening of remedial alternatives is typically presented in this section, including descriptions of the effectiveness, implementability, and cost screening for each alternative. However, the number of feasible alternatives developed was not sufficiently large to require a screening of alternatives, and therefore, all developed alternatives were carried forward for detailed analysis.

- Section 4.0 (Detailed Analysis of Remedial Alternatives) presents a detailed description and evaluation of each of the alternatives identified in Section 3.0. The analysis of each alternative was performed against the first seven of the nine assessment criteria (EPA,

1988a). This section also presents the comparative analysis of alternatives relative to these seven evaluation criteria.

- Section 5.0 (References) provides a list of the references and previous studies cited in this report.

- Section 6.0 (Glossary of Abbreviations and Acronyms) presents a list of the acronyms and abbreviations cited throughout the report.

This Feasibility Study Report has four appendices (Appendices A through D). Appendix A identifies the major construction components for the remedial alternatives. Appendix B provides the conceptual estimates of the capital and operation and maintenance (O&M) costs. Appendix C is a copy of the Monitored Natural Attenuation (MNA) Report, and Appendix D is a copy of the Comparison of Individual Water Treatment Systems and Permanent Water Supply Line Alternatives for the Site.

1.2 Site Background

1.2.1 Site Description

The Site (Figure 1-1) is located in the Towns of Little Valley and Salamanca in Cattaraugus County, New York. Since 1982, chemical analyses of groundwater samples collected from monitoring and private wells throughout the Little Valley study area have indicated the presence of TCE. The boundaries of the Site have been defined by EPA, the New York State Department of Environmental Conservation (NYSDEC), and the Cattaraugus County Health Department (CCHD), and are based on the locations of the monitoring and residential wells that have been sampled. The study area overlies a TCE plume, which extends approximately seven to eight miles from the Village of Little Valley to the northern edge of the City of Salamanca, which is part of the Allegheny Indian Reservation. The Site area is located in a rural, agricultural area with a number of active and inactive small industries located within one mile of the Site. There are more than 200 residential properties situated in the study area along Route 353, the main transportation route between Little Valley and Salamanca.

The nearest surface water bodies associated with the Site are the Little Valley Creek and its tributaries. Little Valley Creek flows southeast, then south through the Little Valley Superfund Site for approximately eight miles before joining the Allegheny River.

1.2.1.1 Climate

The region containing the Little Valley area is characterized by humid climatic conditions, typical of the northeastern United States. Prevailing winds, strongly influenced by Lake Erie, are constant year round and typically from the west, with average velocities of 8 to 10 miles per hour (mph).

Mean annual precipitation in the area is approximately 37.5 inches. Typical lake evaporation is 27 inches per year. The 1-year, 24-hour rainfall event equals 2.2 inches. The mean snowfall in January is 14.6 inches at a mean temperature of 21°F.

1.2.1.2 Population

Based on the 2000 census, approximately 3,000 people reside within the Little Valley Superfund Site (including 1,788 in the Town of Little Valley and 1,130 in the Village of Little Valley). The residents of the Towns of Little Valley and Salamanca obtain their potable water from private wells, and the residents of the Village of Little Valley, the City of Salamanca, and the Jimerstontown resettlement area of the Seneca Nation of Indians acquire their potable water from municipal wells. In total, a population of approximately 13,000 within four miles of the Little Valley Superfund Site utilizes groundwater as the sole source for their potable water.

1.2.1.3 Regional Geology

The local bedrock geology consists of flat to slightly southward dipping Devonian Age gray to black siltstones and shales (Rickard et. al., 1970), which are mapped as part of the Chadoikin Formation. Bedding and perpendicular fractures provide secondary porosity, which transmits groundwater that provides domestic water supply at the edge of, and above, the valley plain.

The area has been affected by at least two advances of continental glaciation during the Pleistocene Epoch (between 1 million and 10 thousand years ago; Frimpter, 1974). As a result, a mantle of unconsolidated material, known generally as glacial drift, covers much of the region. The mantle is thin on hilltops and thickest in valleys (Zarriello, 1987). The glacial advance altered the region through glacial erosional processes. As a result, hilltops were rounded, and valleys parallel to the advance direction were deepened and later filled with outwash sediments as the glaciers receded.

As the glaciers receded, meltwater streams developed and transported previously ice-entrapped sediment loads downgradient where they were deposited as alluvial fan type deposits. The valley areas affected by recent glaciation are typically occupied by present day stream drainage, consisting of creeks or streams with occasional small lakes interconnected by stream segments. As a result of fluvial processes, alluvial sediments (i.e., reworked glacial sediments) have been deposited on top of glacially-derived sediments. The thickest accumulations of glacially-derived sediments (up to 500 feet in some places) are located in central valley areas which thin toward the valley walls (Frimpter, 1974). Typical glacial deposits consist of alternating sequences of glaciofluvial deposits, which are underlain in some valley areas by thick accumulations of glaciolacustrine sediments. In general, glaciofluvial deposits consist of lenses of gravel and sand, while glaciolacustrine deposits contain more silt and clay. The basal unit of glacial valley type deposits often consists of a coarse till of coarser gravels to cobble size bedrock material. In this area, the unconsolidated sediments consisting of recent alluvial stream deposits, underlain by mostly Wisconsin age glacial deposits, are frequently used as aquifers (Frimpter, 1974).

1.2.1.4 Site-Wide Geology

Little Valley is a U-shaped glacial valley (in cross-section) filled with glacially-derived outwash deposits (i.e., glaciofluvial sediments), which are frequently overlain by more recent alluvial deposits (Cadwell et al., 1988). The recent alluvial deposits are described as glacially-derived, reworked sediments and are representative of the stream bed and floodplain deposits of the Little Valley Creek (Zarriello, 1987). Literature review of surficial geology of the Little Valley site (Zarriello, 1987;

Frimpter, 1974; 1986) indicates that the furthest extent of the last glaciation (Wisconsin) advanced as an ice tongue to about 0.8 mile south of Elkdale (see Figure 1-1). An area extending north of Hollow Road to Elkdale has been mapped surficially as the terminal moraine associated with the ice tongue that occupied the valley (Frimpter, 1986). Some lateral moraine deposits are mapped at a few valley head locations to the north and west of the town of Little Valley. Regional moraine deposits are described as silty clay till to sandy till, including mixtures of poorly sorted gravel and cobbles (Zarriello, 1987). The rest of the valley surficial deposits are mapped predominantly as mixtures of sand and gravel, with some sporadic silty clay to clayey silt lenses.

Many of the regional glacial valleys have thick basal accumulations of glaciolacustrine sediments. From boring activities associated with this investigation and literature review (Frimpter, 1974), the deposits in Little Valley show no indication that a postglacial lake filled the valley, and no laterally-extensive thickness of silt and clay has been found. The unconsolidated deposits of Little Valley are predominantly sand and gravel, with isolated lenses of silt and clay. Based on review of Site geology, the valley morphology is similar to Figure 3-2 in the RI Report, which represents a general cross section of a glaciated valley where a relatively thin ice tongue stagnated, and sediment was deposited in smaller lakes and braided streambeds (MacNish and Randall, 1982).

Deep, fine-grained glaciolacustrine deposits are common basal units of glacial valley deposits in this region. However, these deposits were not encountered during investigative activities (TtFW, 1998), indicating that even the deep borings were completed above the bottom of the sand and gravel aquifer and little to no laterally extensive thick accumulations of glaciolacustrine clay exists. It is possible that large amounts of the glaciolacustrine clay were eroded as a result of outwash erosion during ice tongue recession, leaving behind isolated lenses. Conversely, Frimpter has speculated that a large glacial lake may not have affected the area at all, and most of the valley is filled with outwash sand and gravels, and end morainal deposits (Frimpter, 1974). Whether deep lacustrine, laterally extensive deposits of clay are found at depth cannot be said with certainty due to the limited number of deep borings in the Study Area.

Figure 3-3 of the RI Report illustrates the locations of the numerous cross-sections (Figures 3-4 to 3-14 of the RI Report) across the Little Valley Superfund Site. Boring logs for the respective monitoring wells, piezometers and soil borings are included in Appendix B of the RI Report. Further discussion on the locations of these cross-sections is provided in the following paragraphs.

Twelve generalized cross-sections were generated for the Site using existing boring logs, boring logs from related investigations, and logs of RI soil borings and monitoring wells. The lithological data in the boring logs were segregated into sands and gravels, silts and clays, and bedrock to develop the cross-sections. It was not the intent to have detailed information in an individual boring log depicted in the generalized cross sections.

Cross-sections A-B, B-C, C-D, and D-E (Figures 3-4 through 3-7 of the RI Report) can be considered as one continuous cross-section (A-E). Cross-section A-E stretches approximately 8 miles along the length of the valley, from the northwest corner of the Village of Little Valley south to just north of the City of Salamanca. Cross-sections F-G, H-I, and J-K (Figures 3-8 through 3-9 of the RI Report) are spurs connecting to cross-section A-E. The Cattaraugus Cutlery Area is transected by cross-section A-B. Cross-section F-G connects to and runs sub-parallel to cross-section A-B,

showing a more southerly portion of the upper valley, including the Bush Industries Area. Cross-section H-I connects to and runs parallel to cross-section B-C, showing a more easterly portion of the Great Triangle Area. Cross-section J-K connects to and runs sub-parallel to cross-sections B-C and H-I.

Cross-sections L-M, N-O, and P-Q (Figures 3-10 through 3-12 of the RI Report) traverse the width of the valley and illustrate the U shape of the valley and underlying bedrock, to the extent that data exists. Cross-section L-M transects the valley at the northwestern-most end of cross-section A-B and proceeds through Little Valley Municipal Well No. 1. Approximately 3,500 feet southeast of cross-section L-M, cross-section N-O transects the central portion of the Village of Little Valley and includes the Bush Industries and Cattaraugus Cutlery areas. Approximately 8,400 feet north of the City of Salamanca, cross-section P-Q transects the lower portion of the valley through the Luminite Plant Area.

The remaining two cross-sections, R-S and T-U (Figures 3-13 and 3-14 of the RI Report) transect the Railroad Avenue Area within the Village of Little Valley. These two cross-sections, which are relatively short and do not show general valley geometry or bedrock configuration, are discussed in more detail in Section 3.2.2.1 of the RI Report.

The cross-sections indicate that glacial outwash with high gravel content is the predominant subsurface stratigraphic unit encountered to the depths drilled. This stratigraphic unit typically consists of gravel with sand or sand with gravel and varying amounts of fines. These units are laterally extensive throughout the length of the valley and thin toward the walls of the valley. They are frequently encountered below alluvial silts and fine sands associated with more recent streambed deposits.

Depths to gravel range from 0 to 30 feet bgs, and gravel is found closer to the surface at locations topographically near creek level. In the Great Triangle Area, the top of the gravel is encountered at greater than 30 feet below ground surface (bgs) at a point midway between Little Valley Creek and its tributary to the west, Dublin Creek (Figures 3-5, 3-9, and 3-10 of the RI Report). Alluvial silts have accumulated in greater thicknesses in this area due to sediment loads of the two creeks (or two outwash fans) being deposited in the area where the valley widens and water velocities decrease. This may also happen where the Whig Street Creek joins Little Valley Creek; however, due to the limited number of borings in the area, accumulation of alluvial sediment is not as apparent.

In some areas of the valley, the sand and gravel unit is overlain by glaciolacustrine silty clay or clay lenses (Figure 3-13, cross-section R-S of the RI Report). These thin lenses are not laterally or vertically extensive and may represent areas where small historic lakes formed due to damming behind morainal till deposits.

Along the northeast-southwest spine of the Great Triangle Area (Route 242), glacial till deposits consisting of dense clayey silt with some gravel and sand were encountered. These till deposits may alternate with outwash deposits to considerable depths (i.e., 30 feet or more in borings PZ-18, PZ-19, PZ-29, PZ-31, and PZ-41).

1.2.1.5 Geology Within Areas of Concern

The RI Report concluded that soils at the Cattaraugus Cutlery Area and groundwater at the Cattaraugus Cutlery and Bush Industries areas pose unacceptable risks that need to be evaluated. The geology of these specific areas is discussed below.

Bush Industries Area

Gravel and sand with varying amounts of fines are present from the surface down to bedrock across the majority of the Bush Industries Area. Cross sections F-G and N-O (Figures 3-8 and 3-11 of the RI Report), created using data from borings MW-5, MW-2, MW-D1, MWBIA-8, MW-7, SBBIA-1, and LV-7, transect parts of the source area at the Bush Industries property. Bedrock was encountered in five borings in the Bush Industries Area at depths of 15 feet (MW-5), 49 feet (MW-2), 46 feet (MW-4), 61 feet (SBBIA-5), and 110 feet (MWBIA-8). The gravel and sand unit ranges in thickness from approximately 15 feet (MW-6) to approximately 47 feet (SBBIA-5). In the eastern portion of the Bush Industries Area, in the vicinity of monitoring wells MW-4, MW-6, MW-7, MWBIA-8, and soil borings SBBIA-1 through SBBIA-5, silt with clay and gravel is present from the surface to 3 to 12 feet below grade. The silt typically overlies the gravel and sand. Silt and clay were observed at depth and overlie the bedrock at locations MW-4, MWBIA-8, SBBIA-4, and SBBIA-5. This silt and clay unit ranged from approximately 5 (MW-4) to 45 (MWBIA-8) feet thick.

One soil sample collected from a soil boring completed at the Bush Industries Area in January 2001 was submitted to a geotechnical laboratory for grain size analysis, and two samples were submitted for Atterberg Limits, to confirm field observations (data presented in Appendix C of the RI Report). These samples were collected from deep boring BIAMW-3. The sample submitted for grain size analysis from 100 to 102 feet bgs indicated a clayey silt (USCS Symbol "ML") which confirmed the field observations. Atterberg Limits confirmed the description for a silty clay at 75 to77 feet and a clayey silt at 85 to 87 feet bgs.

Cattaraugus Cutlery Area

In the Cattaraugus Cutlery Area, three monitoring wells (MWCCA-1, MWCCA-2 and MWCCA-3) were installed in 1998 on Cattaraugus County-owned property just east of the former Cattaraugus Cutlery property. Upon obtaining property access, monitoring wells MWCCA-4, MWCCA-5, MWCCA-6, and MWCCA-7 were installed in 1999. Six direct push soil borings (CCA GEO-1 through CCA GEO-6) and four monitoring wells (MWCCA-9D, MWCCA-10, MWCCA-11D and MWCCA-12) were installed during the Phase IV field activities in 2003. Figures 3-4 and 3-11 of the RI Report present cross sections that transect the Cattaraugus Cutlery Area and were created using geologic data from borings PZ-17, PZ-20D, MWCCA-1, MWCCA-2, and MWCCA-8. Borings for the area indicate a relatively thin silt layer over a portion of the Site underlain by gravel and sand with varying amounts of fines. Based on the data from soil boring for MWCCA-8, the gravel and sand unit directly overlies till or bedrock.

Nine soil samples from the soil borings completed in 1998 and four soil samples from the soil borings drilled in 1999, were submitted to a geotechnical laboratory for grain size analyses. Two of the samples from 1998 and all four of the samples from 1999 were also submitted for Atterberg

Limits. These analyses were performed to confirm field observations. These samples were collected from soil borings for MWCCA-1 through MWCCA-7. Analytical results identify these samples as belonging to the following USCS groups: silty gravel (GM), poorly graded gravel with silt (GP-GM), well graded gravel with silt (GW-GM), poorly graded gravel with clay (GP-GC), clayey gravel (GC), silty sand (SM), and well-graded sand and silt (SW-SP). The results of the geotechnical analysis are presented in Appendix C of the RI Report.

1.2.1.6 Regional Hydrogeology

The regional hydrogeology of the bedrock in this geologic setting of valleys and ridges is depicted in a simplified form in Figure 3-15 of the RI Report (Freeze and Cherry, 1979). The figure represents a two-dimensional cross-section through a set of parallel ridges and valleys in a homogeneous and isotropic system. The water table tends to be a subdued replica of the topography, being close to the surface in the valleys and furthest below the surface at the tops of the ridges. The dashed lines represent equipotential lines that join points in the bedrock aquifer of equal head. The solid lines represent the groundwater flow lines that are perpendicular to the equipotential lines. The flow lines illustrate that groundwater moves from the highlands to the valleys and discharges into the glacial sediments in the valleys. The groundwater in the system is replenished from rainwater infiltrating into the ground during rain events. The symmetry of the system creates vertical boundaries beneath the valleys and ridges across which there is no flow (lines AB and CD in Figure 3-15 of the RI Report). These boundaries are known as groundwater divides. In this simplified case, the divides are vertical. However, in nature, these divides will be more complex.

The regional hydrogeology of the glacial drift in this geologic setting of valleys and ridges is depicted in simplified form in Figure 3-16 of the RI Report (Fetter, 1994). The glacial drift-filled valley aquifers are recharged from the discharge of groundwater from the bedrock aquifer to the glacial drift, from direct precipitation, and in many cases, from the infiltration of water from losing streams where the water table is not coincident with the elevation of the streams. In glacial drift-filled valleys where the material is very permeable (sands and gravels), the water table may be 10 to 50 feet or more below the surface. The groundwater in the central portion of the valley, in general, moves in the same direction as the surface water streams (down slope), which is perpendicular to the direction of movement in the bedrock aquifer. The groundwater in the valley eventually discharges to a surface water body or is extracted by other means such as groundwater withdrawal by wells or evapotranspiration.

1.2.1.7 Site-Wide Hydrogeology

The site-specific geology as outlined in Section 1.2.1.4 consists of a U-shaped glacial valley filled with glacially derived outwash deposits that are frequently overlain by more recent alluvial deposits. The glacial-derived deposits of Little Valley are predominately coarse sand and gravel with isolated lenses of silt and clay. Typically, there is 5 to 30 feet of alluvial silts and fine sands over the gravels. In some areas, the sand and gravel aquifer is overlain by glaciolacustrine silty clay or clay. These thin lenses are not laterally or vertically extensive.

During the period of the RI, the water table in the valley ranged from near ground surface to approximately 50 feet bgs. In general, the water table is deepest in the upper (northern) portion of

the valley and gets progressively closer to the ground surface proceeding down the valley toward the Allegheny River. From 1997 through 2003, the water table was observed to be below the base of Little Valley Creek in the northern part of the valley and intersecting Little Valley Creek in the southern part of the valley. Therefore, Little Valley Creek is a losing stream in the northern part of the valley and a gaining stream in the southern part of the valley. The line between losing and gaining streams is considered to be dynamic and affected by seasonal and annual precipitation amounts. For example, based on groundwater and surface water elevation data from 1997, the groundwater surface elevation was below the surface water elevation in Little Valley Creek to the north of its confluence with Dublin Creek. This relationship between the groundwater and surface water can be observed in cross-sections A-B and B-C (Figures 3-4 and 3-5 of the RI Report). However, during the period of the Little Valley Creek Seepage Investigation that was performed by the United States Geologic Survey (USGS) on 25 September 2002 (see Appendix H of the RI Report), Little Valley Creek was a losing stream to the north of its intersection with Woodworth Hollow Road south of Elkdale, New York (approximately 1.5 miles south of the confluence of Little Valley Creek and Dublin Creek). The above illustration is a good example of the dynamic nature of the line between a gaining and losing stream.

The overall groundwater flow direction in the gravel and sand aquifer is from north to south, following the slope of the valley topography. The resulting groundwater elevation contours are across the valley, as depicted in Figures 3-17A and 3-17B of the RI Report, and the overall direction of groundwater flow is toward the south. In the central portion of the valley, the gravel and sand unit is the thickest and the most permeable. This depresses the water table elevation in the central portion of the valley, compared to the edges of the valley. Along the eastern and western boundaries of the valley, the flow is toward the center of the valley. This phenomenon is also depicted schematically in Figure 3-16 of the RI Report.

The vertical hydraulic gradient throughout the thickness of the central portion of the valley aquifer, as measured in shallow and deep piezometers, is not highly significant. Therefore, the flow in the central portion of the valley aquifer is basically horizontal. This would be expected due to the geometry of the aquifer and high permeability of the sands and gravels. More significant vertical hydraulic gradients would be expected at the outer edges of the valley, between the bedrock and overburden sands and gravel, and in the upstream (upgradient) reaches of the valley. In the center of the valley, the gradients between the bedrock and the overburden would be expected to be upward as well. A downward component of gradient would be expected as groundwater moves through the sands and gravel from the edges of the valley to the central portion of the valley.

Data collected in December 2003 confirm a downward hydraulic gradient in the upstream reaches of the valley. Groundwater monitoring data from adjacent monitoring wells, MWRRAA-1 and MWRRAA-2D, located in the Railroad Avenue Area near the head of the valley, indicate there is a downward hydraulic gradient of approximately 0.0928 ft/ft in this area. Groundwater monitoring data from nearby monitoring wells MWCCA-9D and MWCCA-10, also in the upgradient portion of the valley, indicate a downward vertical gradient of 0.0034 ft/ft.

One estimate of hydraulic conductivity, K, for the aquifer was calculated using stream base flow measurements (measurements during extremely dry periods) in Little Valley Creek (TtFW, 1998). The measurements were taken in 1967/1968, at the end of a long drought during the mid-1960s. In

that analysis, stream base flow measurements are assumed to represent groundwater recharge from their respective drainage areas. Assuming this base flow is predominately from the sand and gravel aquifer, and knowing the approximate aquifer dimensions, a hydraulic conductivity value was calculated for the low-flow conditions of 1967/1968. The value calculated at the south end of the valley was 655 ft/day. Based on geologic data from the boring logs which indicate a similar overburden geology throughout the valley, the value of 655 ft/day is used for the whole length of the aquifer. This estimate is within the range of K values mentioned in published and unpublished sources. At a nearby site in the Allegheny River Valley, the hydraulic conductivity of the sand and gravel aquifer ranged from 300 to 1,400 ft/day (Yager and Bergerson, 1988). Freeze and Cherry (1979) noted that K values for clean sand with gravel ranges from about 150 ft/day to 1,300 ft/day. The City of Salamanca commissioned a pump test in Great Valley, the valley immediately east of Little Valley (Simpson, 1981). From the results of this pump test, TtFW calculated a K value of 731 ft/day for the sand and gravel aquifer in which the pumping well was screened.

The hydraulic gradient down the valley can be calculated by measuring the distance between the potentiometric contours in Figures 3-17A and 3-17B of the RI Report. In Figure 3-17A, the gradient for the upper valley (PZ-14 to PZ-25) is approximately 0.0031 ft/ft, and the gradient for the lower valley (PZ-25 to PZ-56) is approximately 0.0055 ft/ft. In Figure 3-17B, the gradient for the upper valley (PZ-14 to PZ-25) is approximately 0.0031 ft/ft and the gradient for the lower valley (PZ-25 to PZ-56) is approximately 0.0056 ft/ft. During 1998 and 2003, the average hydraulic gradient for the upper valley was 0.0031 ft/ft and the average hydraulic gradient for the lower valley was 0.0056 ft/ft. The effective aquifer porosity of sands and gravels ranges from 25 to 40 percent (Freeze and Cherry, 1979). A porosity of 30 percent has been assumed for the Little Valley aquifer.

The average linear groundwater velocities in the valley were calculated using the following formula:

$$V=KI/p$$

where:

V	average linear groundwater velocity
K	hydraulic conductivity
I	is hydraulic gradient
p	effective aquifer porosity

Using the above values, an average linear groundwater velocity, V, was calculated for the upper and lower valley. In the upper valley, V = ((655 ft/day)(0.0031 ft/ft))/0.30 = 6.77 ft/day. Using the estimated hydraulic properties for the upper reach of the valley, represented as the distance from PZ-14 to PZ-25 (approximately 16,141 feet), the estimated average groundwater travel time is 6.5 year [(16,141 ft)(1 day/6.77 ft)(1 year/365 day) = 6.5 years]. In the lower valley, V = ((655 ft/day)(0.0056 ft/ft))/0.30 = 12.23 ft/day. For the lower reach of the valley, represented by the distance from PZ-25 to PZ-56 (approximately 22,200 feet), the estimated average groundwater travel time is 5.0 years [(22,200 ft)(1 day/12.23 ft)(1 year/365 day) = 5.0 years]. Combining the travel times together, the estimated average groundwater travel time for the length of the valley for a complete volume of water to flush through the valley is 11.5 years.

Perched water tables exist in isolated areas in the vicinity of the Village of Little Valley, including the Cattaraugus Cutlery Area, the King Windows (Second Street) Area, and the Ninth Street Landfill Area. These perched zones are a result of silty layers in the unsaturated zone, and are of minor significance in regards to the site-wide hydrogeology.

1.2.1.8 Hydrogeology within Areas of Concern

The RI Report concluded that contamination at the Bush Industries and Cattaraugus Cutlery Areas pose unacceptable risks that need to be evaluated. The hydrogeology of these specific areas is discussed below.

Bush Industries Area

The Bush Industries Area is located on the edge of the valley aquifer. A bedrock ridge borders the southern boundary of the property, with a small creek (an unnamed tributary to Little Valley Creek) flowing along the bedrock-glacial drift interface. The bedrock dips steeply, so the glacial drift thickens northward across the site toward the center of the valley. The glacial drift at this area consists predominantly of gravel and sand in excess of 60 feet in thickness on the northern boundary. The water table ranges from 5 to 50 feet bgs, with the depth to the water table increasing towards the north edge of the Area (CRA, 2000).

Groundwater beneath the Bush Industries Area is moving in a northerly direction toward the center of the valley. This is consistent with the discussion above on groundwater flow in the valley, where groundwater flows from the edges of the valley, toward the center of the valley and gradually turns to flow down the valley in the same direction as the topography and flow in Little Valley Creek. Figure 3-18 of the RI Report illustrates the direction of groundwater flow across the property on 5 May 1999. The flow is in a northerly direction toward the center of the valley under a gradient of 0.03 ft/ft.

Figure 3-19 of the RI Report presents the groundwater flow across the Bush Industries Area based on data collected between 14 and 16 October 2003. The groundwater flow is generally toward the east in the western portion of the area and northward in the southern portion of the area. The groundwater gradient ranges from approximately 0.03 ft/ft to 0.15 ft/ft.

Cattaraugus Cutlery Area

The Cattaraugus Cutlery Area is located in the central portion of the valley aquifer. The glacial drift in this area consists predominately of gravel and sand, with a thin layer of silty material at the surface, and is in excess of 60 feet thick. The water table ranges from 30 to 40 feet bgs, which is typical for the valley.

The groundwater beneath the Cattaraugus Cutlery Area is moving in an easterly direction, paralleling the long axis of the valley. This is consistent with the discussion above on groundwater flow in the valley. Figure 3-20 of the RI Report illustrates the direction of groundwater flow across the Cattaraugus Cutlery Area from 28 October 1999. The groundwater is flowing under a gradient of 0.0025 ft/ft.

Figure 3-21 of the RI Report presents the groundwater flow across the Cattaraugus Cutlery Area based on data collected on 3 December 2003. This figure also depicts an easterly groundwater flow direction, with a groundwater gradient of approximately 0.002 ft/ft. Based on data collected from monitoring wells MWCCA-9D (screened from 59 ft to 69 ft bgs) and MWCCA-10 (screened from 25 ft to 45 ft bgs), located approximately 20 feet apart, there is a downward vertical hydraulic gradient of approximately 0.0034 ft/ft.

1.2.2 Site History

Figure 1-2 illustrates the potential source areas valley wide and summarizes the TCE concentrations from 1998/1999 for numerous residential wells across the valley. The potential source areas evaluated during previous investigations, as well as those assessed during the multiple phases of the RI, include:

- Bush Industries (Area A, Figure 1-2);
- Ninth Street Landfill (Area B, Figure 1-2);
- Cattaraugus Cutlery (Area C, Figure 1-2);
- King Windows-Second Street (Area D, Figure 1-2);
- First Street (Area E, Figure 1-2);
- Great Triangle (Area F, Figure 1-2), which includes four smaller areas: Envirotech Drum Storage Area (Area F1), Western Burnt House (Area F2), Winship Circle/Baker Road (Area F3) and Triangle Southwest (Area F4);
- Whig Street (Area G, Figure 1-2);
- Luminite (Area H, Figure 1-2), which is comprised of three smaller areas, the Luminite North Area (Area H1), the Luminite South Area (Area H3), and the Luminite Plant Area (Area H2);
- State Street Area (Area I, Figure 1-2); and
- Railroad Avenue Area (Area J, Figure 1-2).

The following paragraphs provide a brief summary of the areas. Historical information was obtained based on a review of Sanborn Fire Insurance maps, available tax parcel maps, and available site documents.

The Bush Industries facility (Figure 1-2, Area A), located on Fair Oak Street, was formerly used for the manufacture of cutlery by Kinfolks, Inc. (Kinfolks) from approximately 1926 through 1958. Bush Industries (Bush) currently assembles and manufactures furniture on the parcel. Bush maintains that it has no record of ever having used TCE in its operations, but general industry information indicates that TCE was a common degreaser used in the manufacture of cutlery products [Sources per EPA: Bush 104(e) Response, Sanborn Maps]. Zoning for the Bush Industries property is

commercial/industrial, and the Village of Little Valley stated that there are no plans to change the property zoning in the future.

The Ninth Street Landfill (Figure 1-2, Area B) was a municipal landfill used by the Village of Little Valley from 1950 to 1972 for the disposal of sanitary and industrial wastes. It was alleged that solvent-containing wastes in containers that originated at the Cattaraugus Cutlery/Knowles-Fisher/AVM/King Windows facilities were disposed in the landfill by village refuse collection employees. More specific time frames for the disposal activities have not been determined.

The Cattaraugus Cutlery Area (Figure 1-2, Area C) consists of several parcels used to manufacture cutlery from approximately 1900 until the 1950s. The W.W. Wilson Cutlery Company (W.W. Wilson Manufacturing Co.) was formed in the 1890s and operated out of a brick building on the parcel. Around 1900, the company was sold to the Cattaraugus Cutlery company. Subsequent owners or operators have included Knowles-Fischer (auto parts stamping) and AVM (a.k.a. American Voting Machines), which both owned portions of the property between February 1970 and September 1977. King Windows, which manufactured stamped metal window parts, may have operated on portions of the parcel between 1977 and 1993, based on property ownership records. The Cattaraugus Cutlery Area has been utilized for storage and industrial actions since 1993. As noted above, general industry information indicates that TCE was commonly used as a degreaser in the manufacture of cutlery products. Allegations were made by former employees of AVM and King Windows that improper disposal of chemicals took place on the property. At present, no one resides at the property (H. Whitmore, 1991 and Sanborn Maps). According to the Village of Little Valley, the cutlery property is zoned for commercial/industrial use only, and there are no plans to change the zoning in the future.

The Cattaraugus Department of Public Works (CDPW) parcel, located adjacent to the Cattaraugus Cutlery Area on Sixth Street (Figure 1-2, Area C), was formerly used for the manufacture of cutlery. The Korn Razor Manufacturing Company was built in approximately 1890 and operated as a cutlery, producing straight razors until the mid-1930s. In 1939, the building reverted to Cattaraugus County for non-payment of taxes and has been used for storage and equipment repair since that time (H. Whitmore, 1991 and Sanborn Maps).

The inactive King Windows facility (Figure 1-2, Area D), located at the north end of Second Street, was used for the assembly and finishing of metal doors and windows from approximately 1965 through the early 1990s. Prior to that time, the parcel was used as a Borden Milk Plant and had also been owned by the Veteran's Administration [Source per EPA: King Windows' 104(e) Response, 1/18/91]. King Windows, which operated several facilities in the area (two of which were the subject of removal actions by NYSDEC and EPA) has not been operational for several years, and the whereabouts of its former owner/operator are unknown. During previous investigations at the window manufacturer, a well located adjacent to a subsurface fuel storage tank was sampled by NYSDEC and found to contain thick oil. Analysis of the oil did not reveal the presence of TCE.

A former underground storage tank, a transformer, and a vehicle maintenance and storage facility were noted on a property along First Street, between Route 353 and the former railroad tracks. The First Street Area (Figure 1-2, Area E) is located to the southeast of the Cattaraugus Cutlery and King Windows (Second Street) Areas.

The Envirotech Drum Storage Area within the Great Triangle Area (Figure 1-2, Area F1) is a parcel of vacant land approximately one acre in size, located along the southeastern right-of-way of Route 242, and east of the unimproved access road to the Foster residence south of the area. This parcel was used as a temporary staging area for drums of solvent wastes brought from three other temporary drum storage areas operated by Envirotech. NYSDEC's records indicate that up to 310 drums were stored on this property in 1980 or early 1981, prior to their transport to the Town of Tonawanda for final disposal.

The Whig Street Area (Figure 1-2, Area G) consists of the properties in the vicinity of the intersection of Route 353 and Whig Street. Operations in this area included an electrical business; a heavy construction and farm equipment sales/repair business; a small airplane maintenance and storage facility; a former lumber mill operation converted to a tractor trailer maintenance and storage facility; and an alleged drum disposal area.

The Luminite Products Corporation (Luminite) is a small manufacturing facility along Route 353 (Figure 1-2, Area H). A plant production well and a septic tank are located on the property. The Luminite Area encompasses the North Area (Area H1), the Plant Area (Area H2), and the South Area (Area H3).

Several residential wells were noted to have elevated levels of TCE in the State Street Area (Figure 1-2, Area I). Located along Route 353 at the intersection with State Street, this area included the following during the Phase I screening investigation in 1997: a tanker truck and box-type trailer on one of the residential properties; and a construction company containing building structures, unlabelled tanks, and 55-gallon drums.

In July 2001, CCHD notified NYSDEC and EPA of a new potential source area, denoted as the Railroad Avenue Area (RRAA; Figure 1-2, Area J). It is alleged that a dry cleaning business was operated out of the residence located at 300 Railroad Avenue during the 1950s, and disposal to the ground surface of "dry cleaning fluid" occurred.

1.2.3 Nature and Extent of Contamination

The nature and extent of contamination present at the Site was assessed through the sampling of soils, sediments, surface water, and groundwater from the following nine areas of the Little Valley Superfund Site: Ninth Street Landfill, Bush Industries, Cattaraugus Cutlery, King Windows (Second Street), First Street, the Great Triangle, Whig Street, Luminite, and Railroad Avenue Areas. In addition, the sediments (adjacent to the Cattaraugus Cutlery and Bush Industries Areas only) and surface water at various locations of Little Valley Creek were sampled. A complete discussion of the nature and extent of contamination found at the Site is presented in the Remedial Investigation Report for OU-2 (TtFW, 2005). A summary of these findings is presented below. The RI Report also contains a detailed discussion of the specific screening criteria that were used for comparison to surface/subsurface soils, sediments, surface water, and groundwater.

1.2.3.1 Soils

Soil exceedances for TCE were only found at the Cattaraugus Cutlery Area, and to a lesser extent the Bush Industries Area. Soil exceedances for TCE were not found in any of the other potential source areas investigated. Figures 1-3 and 1-4 show the soil exceedances at the Cattaraugus Cutlery and Bush Industries Areas, respectively. The highest concentrations of TCE detected in the soils in the Cattaraugus Cutlery and Bush Industries Areas were, respectively, 72,000 ug/kg (MWCCA-5 at 1.5 to 2 feet bgs) and 61 ug/kg (SB-104 at 8 to 10 feet bgs). In contrast, maximum TCE concentrations in all other areas ranged from 1 ug/kg to 4 ug/kg. Specific source area(s) were generally not identified by the distribution and concentration of constituent occurrences (*i.e.*, there were no elevated concentrations "clustered" in any specific sampling area) during the soils investigation. Exceptions include locations around the subsurface vault and the leach field/concrete pad/drain at the Cattaraugus Cutlery Area. This is illustrated in Figure 4-8 of the RI Report, which shows the potential extent of TCE contamination in the soils at the Cattaraugus Cutlery Area, utilizing isoconcentration contouring, based on the maximum concentration detected at a sampling location (regardless of depth). Due to the high mobility of TCE, it is possible that migration away from past original source areas may have already occurred.

1.2.3.2 Sediment and Surface Water

TCE was not present in the sediments in the vicinity of the Bush Industries Area. Cis-1,2 dichloroethene (cis-1,2-DCE), a degradation product of TCE, was detected between 6 J ug/kg and 19 J ug/kg in the sediments, in the drainage channel from location SD03. Surface waters from this location contained TCE and cis-1,2-DCE at concentrations of 12 ug/L and 19 ug/L, respectively.

TCE was not detected in the sediments or surface water of Little Valley Creek in the vicinity of the Cattaraugus Cutlery Area. Potential TCE dechlorination reaction products (*e.g.*, chloromethane, chloroethane and 1,2-dichloroethane (1,2-DCA)) were present in the surface water at concentrations up to 12 ug/L.

Surface waters around the Little Valley Superfund Site contained little to no VOCs during the 2003 investigation. TCE was detected at 0.37 J ug/L, in the vicinity of the Great Triangle Area. In addition, TCE occurred in Little Valley Creek near the Luminite Area (0.31 J ug/L).

1.2.3.3 Groundwater

The groundwater beneath the Little Valley Superfund Site contained TCE in seven of the sampled areas (*i.e.*, Ninth Street Landfill, Bush Industries, Cattaraugus Cutlery, King Windows (Second Street), Great Triangle, Whig Street, and Luminite Areas). Concentrations of TCE exceeding most conservative criteria values occurred in the following five areas from either SimulProbe™/direct push or installed monitoring well/piezometer locations: Ninth Street Landfill, Bush Industries, Cattaraugus Cutlery, Great Triangle, and Luminite. These areas are located throughout the Site, indicating a valley-wide distribution of TCE. Figure 4-9 of the RI Report illustrates the potential horizontal extent of TCE for the groundwater across the valley, based on the maximum concentration detected at a well/piezometer sampling location during the 2003 investigation. Figure 1-5 shows the

potential TCE groundwater contamination across the Site, based on the most recent data from residential wells, piezometers, and monitoring wells.

The most elevated TCE concentrations were present in the Bush Industries and Cattaraugus Cutlery Areas, where the maximum detected concentrations were 230 ug/L in the Bush Industries Area and 71 D ug/L in the Cattaraugus Cutlery Area. Isoconcentration contour plots, which show the principal areas of groundwater TCE contamination, for the Bush Industries and Cattaraugus Cutlery Areas, are presented on Figures 4-10 and 4-11, respectively, in the RI Report. The TCE contours are based on the maximum concentration value detected in a well location in either the 2000/2001 or 2003 investigations (*i.e.*, the most recent rounds).

The analytical results from 102 residential wells sampled between 1989 and 1996 indicated that 79 wells had TCE concentration levels ranging from 0.5 microgram per liter (ug/L) to 50 ug/L. Sixty-one of these contaminated wells had TCE concentrations equal to or greater than the federal and state Maximum Contaminant Levels (MCLs) of 5 ug/L (EPA, 2004).

TCE, which has been demonstrated to be mutagenic and carcinogenic in several strains of mice by the inhalation and oral routes, is classified by EPA as a possible human carcinogen. The exposure pathways related to the existing groundwater contamination include ingestion of groundwater, direct contact via washing or bathing, and inhalation of the volatilized contaminant during bathing. The TCE-contaminated groundwater at the Site poses a potential threat to the public health and the environment.

To mitigate the Site problem along the length of the groundwater plume, the EPA began installing air stripping treatment units in late 1997 on the affected private water supply wells as the first operable unit (OU-1). This remedy was selected in the ROD for OU-1 (signed in September 1996) and is protective of human health. As the second operable unit (OU-2) for the Site, this Feasibility Study has been undertaken to consider alternatives to reduce and minimize the downgradient migration of contaminants in the groundwater. The air stripping treatment units installed at residential locations are currently maintained by New York State and will continue to be maintained by New York State and used in conjunction with the selected remedy to provide treatment of the contaminated plume downgradient of the Bush Industries and Cattaraugus Cutlery Areas.

1.2.4 Contaminant Fate and Transport

The migration of contaminants to underlying soils and groundwater by the percolation of rainwater/snowmelt through contaminated soils and/or buried material within the suspected potential source areas is expected to be a major environmental fate and transport mechanism at the Site.

Upon entering groundwater, TCE will migrate with the local groundwater flow until dilution and removal mechanisms such as adsorption, degradation, precipitation, and limited volatilization result in their eventual non-detection or until the contaminated groundwater discharges to local streams, particularly if this migration occurs within the upper bedrock fractures. Based upon the local groundwater flow directions and groundwater quality data, contaminants in groundwater will migrate predominantly toward the south-southeast following the valley's topography, and to a lesser extent,

to the three perennial streams (Little Valley, Whig Street, and Dublin Creeks) due to recharging groundwater at the south end of the valley.

The migration of contaminants within stormwater/snowmelt surface runoff is considered a principal environmental fate and transport mechanism at the Site, particularly within the Bush Industries and Cattaraugus Cutlery Areas, and especially if the existing vegetation and soils are disturbed. This migration occurs in the stormwater or snowmelt runoff/perennial streams via contaminants dissolved within the waters and/or adsorbed onto entrained soils particles. Since most of the Site's stormwater/snowmelt runoff discharges to drainage ditches/swales/tributaries, the three permanent streams, and/or low lying areas, act as contaminant sinks where entrained particulates become incorporated into sediments and/or underlying soils, and/or dissolved contaminants infiltrate the underlying soils until they are adsorbed to surrounding soil/stream sediment particles or enter the groundwater with subsequent transport mediated by groundwater flow. This migration pathway is important for TCE; however, TCE is expected to dissipate rapidly into the atmosphere.

Contaminant migration within transitory ponded storm and/or snowmelt water on the Little Valley Superfund Site may occur, however, TCE contamination would be short-lived due to its loss into the atmosphere via volatilization.

The emission of TCE into the atmosphere from contaminated soils, surface runoff/perennial streams, and transitory ponded stormwater, and its concomitant migration via the prevailing wind, would be a viable transport mechanism. However, considering the low concentrations of TCE, volatile emissions are assessed to be an insignificant transport process.

TCE would exhibit little persistence in contaminated matrices; however, TCE may persist in groundwater under certain hydrologic conditions. As a direct result of the aforementioned contaminant fate characteristics and transport mechanisms, TCE concentrations in environmental media are expected to gradually diminish over time as long as no additional sources introduce contaminants in the future.

1.2.5 Baseline Human Health Risk Assessment

The Baseline Human Health Risk Assessment (BHHRA) for the Little Valley Superfund Site examined potential exposures of current and possible future receptors to the Site soils, groundwater, surface water, and sediment in accordance with the conceptual site model developed for the Site. The following summary presents the findings of the BHHRA. A complete discussion of these results can be found in the RI Report.

Cattaraugus Cutlery Area:

TCE was identified as a chemical of concern for receptors in the Cattaraugus Cutlery Area relative to projected exposures to surface soil and all soil.

TCE in groundwater was also identified as a chemical of concern for vapor migration from groundwater to indoor air relative to the Cattaraugus Cutlery Area.

Bush Industries Area:

TCE in groundwater was identified as a chemical of concern for vapor migration from groundwater to indoor air relative to the Bush Industries Area.

Site-Wide Groundwater:

TCE was highlighted as a chemical of concern in the site-wide groundwater when used as process water in wash down and car wash scenarios.

1.2.6 Ecological Risk Assessment

An ecological habitat characterization was conducted for the Cattaraugus Cutlery and Bush Industries Areas. The wooded, wetland and field areas, and the stream corridors, may all be potential wildlife habitats for ecological receptors at both areas. Most of the wildlife species identified from the ecological characterizations were associated with the wooded areas, and the stream corridor at the Cattaraugus Cutlery Area, and the wooded areas, the stream corridor, and the successional field at the Bush Industries Area. However, a large portion ($\geq$ 50%) of both areas is developed. These developed portions include buildings, paved areas, and gravel driveways/access roads. This development will limit the utilization of large portions of the areas by eco-receptors. Human activity at both areas will also inhibit the use of these areas by wildlife, particularly at the Bush Industries Area. In addition, the maximum concentrations of contamination at both areas were detected in soil samples collected from areas adjacent to buildings or along gravel driveways/access roads and not in undeveloped areas of the sites.

The potential exposure of ecological receptors would likely result from the migration of area-related contaminants to aquatic habitats or by direct exposure of terrestrial receptors to site-related contaminants. The principle ecological exposure media are surface water and sediments in the aquatic habitats, which potentially receive contaminants via surface runoff, and surface soils at both areas.

Contaminant concentrations in abiotic media sampled from the Cattaraugus Cutlery Area were lower than those observed at the Bush Industries Area, and Ecological Toxicity Quotients (ETQs) for compounds and elements detected were low.

At the Bush Industries Area, sediment samples revealed the presence of volatile and semi-volatile compounds, but no TCE, at maximum concentrations exceeding corresponding screening level values. The maximum concentration of contaminants detected in surface water and sediment at the Bush Industries Area were detected at two locations in the wetland swale. The swale is located in a Palustrine Emergent/Palustrine Scrub Shrub (PEM/PSS) wetland community and is fed from surface water runoff from the facility's gravel parking and roadway areas. The swale runs from the gravel areas southeast to the tributary, and is only seasonally connected to the unnamed tributary of Little Valley Creek. This swale acts as a sink, or depositional area for contaminants discharging via surface runoff. This is indicated by the high concentration of contaminants detected in surface water and sediment in the swale, relative to sample locations in the unnamed tributary. In addition, benthic macroinvertebrate and fish surveys conducted at the Bush Industries and Cattaraugus Cutlery areas

indicate diverse benthic and fish communities that did not exhibit overt indications of impact from contaminants related to the Bush Industries Area. The potential risk to receptors from exposure to surface water and sediments at either area is expected to be low.

Results of the supplemental surface water sampling from multiple locations and water bodies near other potential sources of Volatile Organic Compounds (VOCs) to Little Valley Creek indicate that TCE was not detected in the samples collected and all detection limits for source related compounds remained below conservative ecological screening levels. No significant risk from VOCs was determined for ecological receptors present in the surface water sampled from the Cattaraugus Cutlery and Bush Industries Areas. VOCs in sediments were not analyzed and sampling for Target Compound List (TCL) and Target Analyte List (TAL) compounds was not performed.

At the Railroad Avenue Area, maximum detected concentrations of organic contaminants, including TCE, remained below corresponding ecological screening level benchmarks. All ETQs for these compounds remained less than one and were considered to represent minimal ecological risk. The surface soils collected from the Railroad Avenue Area were collected from around the house foundation and mowed lawn area. The developed nature of this area limits the value of the existing habitat to support a diverse assemblage of ecological receptors.

Results of the supplemental surface water sampling also indicate that TCE was not detected in the samples collected and all detection limits for source related compounds remained below conservative ecological screening levels. No significant risk was determined for ecological receptors present in the surface waters sampled from the Railroad Avenue Area.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 Introduction

Results from the RI revealed that soil and groundwater at the Cattaraugus Cutlery Area and groundwater at the Bush Industries Area have TCE concentrations that pose unacceptable risks. The purpose of this section is to present the development of Remedial Action Objectives (RAOs) and the identification, screening, and selection of the most appropriate technologies to address the TCE contamination. The most appropriate technologies and/or process options will be combined into remedial alternatives in Section 3.0.

The screening of technologies consisted of the following steps:

- Development of RAOs specifying the contaminants and media of interest, exposure pathways, compliance with Applicable or Relevant and Appropriate Requirements (ARARs), and preliminary remediation goals (PRGs) that permit a range of treatment and containment alternatives to be developed. The PRGs are developed on the basis of available contaminant-specific ARARs, health-based risk calculations drawing upon toxicity data, and site-specific risk-related factors.

- Development of General Response Actions (GRAs), including engineering and institutional controls, removal, treatment, or other actions, singly or in combination, which may be taken to satisfy the RAOs for the Site.

- Identification of volumes of contaminated soil and flow rates of contaminated groundwater, to which GRAs might be applied, taking into account the requirements for protection of human health and the environment as identified in the RAOs and the chemical and physical characterization of the Site.

- Identification and screening of the technologies applicable to each GRA to eliminate those that cannot be implemented technically. The GRAs are further defined to specify remedial technology types (*e.g.*, the GRA of treatment can be further defined to include physical, chemical, or biological technology types).

- Identification and evaluation of process options to select a representative process option for each technology type retained for consideration. Although specific process options are selected for alternative development and evaluation, they are intended to represent the broader range of process options within a general technology type. Utilizing process options provides a greater flexibility in the final design while simplifying the FS process. During the final design, any of the process options within a technology type can be substituted for another, thereby providing a broader range of viable alternatives.

2.2 Remedial Action Objectives

RAOs are identified to protect human health and the environment based on consideration of the chemicals of concern, exposure routes, receptors, and acceptable contaminant levels for each exposure pathway, including risk-based levels and ARARs/to be considered (TBCs).

2.2.1 Exposure Based on Risk Assessment

The OU-2 RI Report identifies current and future populations potentially exposed to site contaminants and the potential exposure pathways. The following potential exposures were identified:

- Inhalation of TCE in soil via multiple exposure routes in the Cattaraugus Cutlery Area.
- Inhalation of TCE released from groundwater in a washdown or car wash scenario, and vapor migration from groundwater to indoor air at the Bush Industries and Cattaraugus Cutlery areas.

No current or future population is identified as potentially exposed to groundwater as tap water because of the interim OU-1 remedy, which resulted in the installation of individual point-of-use groundwater treatment systems on the affected and potentially affected wells.

2.2.2 ARARs and TBCs

EPA developed the ARAR concept to govern compliance with environmental and public health statutes. ARARs are used in the FS process to characterize the performance level that a remedial alternative or a treatment process is capable of achieving. Each remedial alternative and treatment process option must be assessed to evaluate whether it attains or exceeds federal and state ARARs.

ARARs include: "applicable" and "relevant and appropriate" requirements of federal and state environmental laws. Applicable requirements are those clean-up 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 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. Relevant and appropriate requirements are those clean-up 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 CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. When establishing performance goals for remedial alternative selection, relevant and appropriate requirements are given equal weight and consideration as applicable requirements. State requirements are ARARs when promulgated, identified in a timely manner, and at least as strict as existing equivalent federal ARARs. Section 121 of CERCLA requires that EPA select remedial actions that will comply with ARARs, unless the criteria for a waiver are met, as discussed below, and EPA waives one or more ARARs.

If no ARARs address a particular situation, other federal and state criteria, advisories, guidance, or proposed rules may be considered for developing remedial alternative performance goals. These TBCs may provide useful information or recommended procedures that supplement, explain, or amplify the content of ARARs.

Each type of ARAR/TBC can be characterized further as contaminant-specific, action-specific, or location-specific. A contaminant-specific ARAR/TBC sets health and risk-based concentration limits in various environmental media for specific hazardous substances or contaminants. An action-specific ARAR/TBC sets performance, design, or other similar action-specific controls on particular remedial activities. A location-specific ARAR/TBC sets restrictions for conducting activities in particular locations, such as wetlands, floodplains, national historic districts, and others. The Federal and New York ARARs and TBCs utilized in the FS are presented in Tables 2-1 through 2-3. EPA's migration-to-groundwater soil screening level of 60 ug/kg for TCE would result in a groundwater concentration of TCE that would meet groundwater standards. NYSDEC's Technical and Administrative Guidance Memorandum No. 94-HWR-4046 (TAGM) objectives are soil levels that are either a human-health protection value or a value based on protection of groundwater, whichever is more stringent. The New York State soil TAGM objective for TCE of 700 ug/kg would be protective of human health and would result in a groundwater concentration of TCE equal to both the EPA and New York State MCLs (5 ug/L). Therefore, the TAGM objective will be used to address the TCE-contaminated soils at the Site, rather than the more conservative EPA soil screening level.

Under Section 121 of CERCLA, EPA may waive the need to attain an ARAR if one of the following conditions can be demonstrated:

- **Selection of Interim Remedy** - The remedial action selected is only part of a total remedial action that will attain the ARAR level or standard of control when completed.

- **Greater Risk to Human Health and Environment** - Compliance with the ARAR at the site will result in greater risk to human health and the environment than the alternative option chosen.

- **Technical Impracticability** - Compliance with the requirement is technically impracticable from an engineering perspective.

- **Equivalent Standard of Performance Attained** - The remedial action selected will attain a standard of performance that is equivalent to that required under the ARAR through use of another method or approach.

- **Inconsistent Application of State Requirements Would Result** - The state has not consistently applied, or demonstrated intention to apply consistently, the ARAR in similar circumstances at other remedial actions.

- **Fund Balancing** - Attainment of the ARAR would not provide a balance between the need for protection of public health or welfare and the environment and availability of fund

amounts to respond to other sites presenting a threat to the public or environment, for fund financed cleanups only.

2.2.3 Development of Remedial Action Objectives

The following RAOs have been developed to address human health risks and environmental concerns related to elevated TCE concentrations in soil and groundwater:

- Minimize or eliminate TCE migration from contaminated soils to the groundwater.
- Restore groundwater to levels which meet state and federal standards for TCE within a reasonable time frame.
- Mitigate the migration of the affected groundwater.
- Reduce or eliminate any direct contact, ingestion, or inhalation threat associated with TCE-contaminated soils and groundwater.
- Reduce or eliminate exposure of aquatic life to TCE-contaminated groundwater that discharges to surface water.
- Reduce or eliminate any terrestrial receptor direct contact threat associated with exposure to TCE-contaminated surface soils.

2.3 General Response Actions

The following GRAs for soils and groundwater were identified to address the RAOs presented above: No Action, Limited Action, Containment, Removal/Treatment, and Disposal Actions.

No Action includes no monitoring, containment, or removal and does not achieve the RAOs; however, a No Action alternative is required under CERCLA as a baseline for comparison of other alternatives.

Limited Action responses includes engineering and/or institutional controls. Engineering controls include access restrictions such as soil or asphalt caps and fencing and signage. Institutional controls include public information programs to educate the community about potential hazards, and access and use restrictions for the contaminated soils and groundwater. Continued monitoring of groundwater over time would facilitate determination of natural restoration rates.

Containment actions include technologies that involve little or no treatment, but provide protection of human health and the environment by reducing mobility of contaminants and/or eliminating exposure pathways.

Removal/Treatment actions include excavation (for soils only) and treatment technologies (both *in-situ* and *ex-situ*) that actively reduce the volume, mobility and/or toxicity of contaminants. Treatment technologies include physical, chemical, or biological treatment.

Monitored natural attenuation (MNA), wherein monitoring of the water quality of the aquifer is performed to monitor and evaluate the national restoration of the aquifer is also considered as a Limited Action response.

Disposal actions include construction of on-site RCRA landfill, existing off-site landfill, and on-site redeposition.

2.4 Identification and Screening of Technology Types and Process Options

The screening of remedial technologies and process options was performed in two steps: 1) identification and screening of technology types and process options within each of the GRAs; and 2) evaluation and selection of representative process options for alternative development.

2.4.1 Identification and Screening Guidance for Technologies

The remedial technology types associated with each of the GRAs typically considered for the cleanup of contaminated soil were developed from the "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988a), the "Technology Screening Guide for Treatment of CERCLA Soils and Sludges" (EPA, 1988b), the "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites" (EPA, 1988c), the "Revised Handbook for Remedial Action at Waste Disposal Sites" (EPA, 1985), the "Directive on Presumptive Remedies for Sites with VOCs in Soils" (EPA, 1993), and experience on other hazardous waste projects.

Remedial technology types associated with each GRA are identified in Table 2-4 for soils and Table 2-5 for groundwater. Most of these remedial technology types contain several different process options that could apply to the contaminated soil and groundwater. The screening of technology types and process options was based on technical implementability and effectiveness considering site-specific conditions, contaminant types and concentrations summarized in Section 1.0 of this report, and the RI Report (TtFW, 2005).

2.4.2 Screening of Soil Remediation Technologies

In the following section, potential remedial technologies are briefly described and summarized with the results of the initial screening. For those technologies that were not retained for further evaluation, the rationale for their elimination is included. The screening evaluations for each identified technology for contaminated soil are summarized in Table 2-6.

2.4.2.1 No Action

No Action is not a category of technologies but an approach that does not include implementation of any remediation measures and is included in the FS as a baseline remedial option as required by CERCLA. No Action includes five-year reviews of site conditions to assess the need for future remedial actions.

Initial Screening: No Action would not provide for any remedial action. Natural attenuation would be an insignificant contributor to any reduction in contaminant toxicity, mobility, or volume. The No Action alternative would not limit community exposure to the contaminants. Although No Action would not meet the remedial objectives, it is retained for further consideration as a baseline for comparison to other alternatives.

2.4.2.2 Limited Action

Limited Action is a group of activities which would not treat contaminants in the soil, but would restrict or minimize exposure to contaminants in the soil. The Limited Action response includes institutional and engineering controls.

Institutional Controls

Institutional controls include administrative measures, such as public meetings and notifications to inform the public about potential risks associated with the Site and deed restrictions to prohibit future unrestricted use inconsistent with site conditions. It would be necessary to obtain the property owner's consent prior to imposing deed restrictions on any property.

Initial Screening: Institutional controls would not meet all of the remedial objectives for the Site, but would potentially reduce public exposure to contaminated soil through public information programs and/or use restrictions placed on the property. Institutional controls are therefore retained for further consideration.

Engineering Controls

Engineering controls include physical measures to restrict access to contaminated media, including fencing, signage, soil or asphalt covers, etc. These measures are most effective when implemented in conjunction with institutional controls.

Initial Screening: Engineering controls would not meet all of the remedial objectives for the Site, but would mitigate exposure to contaminants, thereby reducing risk to human health and the environment. Engineering controls are therefore retained for further consideration.

2.4.2.3 Containment

Containment is a remedial action providing isolation of contaminated soil from potential receptors and/or uncontaminated media. Capping technologies can be used to contain contaminated soil, minimize human exposure to soil, reduce leaching of contaminants from the soil to groundwater, and/or minimize exposure to ecological receptors. Capping of contaminated soil could be achieved by utilizing any one (single barrier) or a combination of clay caps, asphalt caps, synthetic membranes, chemical sealants and multi-layer caps.

Capping

Soil Cap

A soil cap can be installed over contaminated soil to prevent direct contact with contaminants. A soil cap would have a high permeability relative to clay, and would allow percolation of surface water, runoff, etc.

Initial Screening: Soil caps are susceptible to erosion from climatic and storm forces which can be mitigated with a properly maintained vegetative cover. Soil caps are also susceptible to settling, ponding of liquids, and naturally occurring invasions by burrowing animals and deep rooted vegetation if not properly maintained. In addition, a soil cap would not limit further leaching of TCE from the soil into the groundwater and would not comply with closure requirements. Therefore, this option was eliminated from further consideration.

Clay Cap

Clay layers are commonly used as cover for landfills that contain both hazardous and nonhazardous wastes. Bentonite, a natural clay with high swelling properties, is often mixed with soil and water to produce a low permeability layer. A low permeability clay cap would not only physically isolate the source, but also reduce the potential for leaching of contaminants to groundwater by creating a low permeability barrier.

Initial Screening: Clay, which consists of fine material, is susceptible to erosion from climatic and storm forces, which can be mitigated with a properly maintained vegetative cover. Proper particle distribution, moisture content and compaction is essential to create a low permeability cap. Clay caps are also susceptible to cracking, settling, ponding of liquids, and naturally occurring invasions by burrowing animals and deep rooted vegetation if not properly maintained. Capping the limited area of TCE-impacted soil at the Cattaraugus Cutlery Area would not effectively mitigate TCE migration to groundwater and a larger cap that would achieve this objective would significantly impact site operations. Therefore, this technology was eliminated from further consideration.

Asphalt Cap

An asphalt cap consists of a gravel sub-base with asphalt paving as a final cover. The cap minimizes wind and rain erosion, preserves slope stability, provides protection from the elements for layers below it, provides an effective component for the Site's stormwater management program, and reduces the potential for direct contact soil. An asphalt cap would not comply with closure requirements.

Initial Screening: An asphalt cap it is less susceptible to erosion from climatic and storm forces than a soil or clay cap. An asphalt cap is subject to cracking and settling if not properly maintained. Asphalt capping the limited area of TCE-impacted soil at Cattaraugus Cutlery Area would not effectively contain the contaminated soils and mitigate TCE migration to groundwater. In addition, an asphalt cap would not comply with closure requirements. Therefore, this technology was eliminated from further consideration.

Synthetic Membrane

Synthetic membranes (*i.e.*, geomembranes) serve as low permeability layers that reduce surface water infiltration into the underlying waste material. The synthetic membrane is usually overlain by a drainage layer and a vegetative protective layer. Any synthetic membrane should be located below the maximum depth of frost penetration, and the type of membrane material should be a minimum of 40 mils in thickness.

Initial Screening: A synthetic membrane provides a low permeability barrier that prevents infiltration of rainfall and therefore the leaching of contaminants to the groundwater. It has a longer life than a clay or asphalt cap, if properly maintained. A synthetic liner would have a significant impact on active site operations, and this technology was eliminated from further consideration.

Chemical Sealants

Chemical stabilizers and cements can be added to on-site soils thereby creating a less permeable surface sealant. Portland cement or bitumen is suitable for mixing with sandy soils to stabilize and waterproof them. Other soil additives include chemical dispersants and swell reducers. Soluble salts such as sodium chloride, tetrasodium pyrophosphate, and sodium polyphosphate are added primarily to fine grained soils with clay to deflocculate the soils, increase their density, reduce permeability, and facilitate compaction. The low permeable surface sealants can minimize leaching of contaminants to groundwater through percolation of precipitation.

Initial Screening: Extensive mixing, spreading and compaction are required to achieve a low permeability cap. Proper combination of sealant chemicals and strict moisture control of the sealant mixture is essential to ensure the desired results. The on-site soil is contaminated and therefore an outside soil source would be required to mix with stabilizing agents. Some chemical additive might leach into groundwater. This technology would limit current site use/operation, and was therefore eliminated from further consideration.

Multi-Layer Cap

The multi-layer cap is a combination of two or more of the single layer capping technologies. The disadvantage of one can be compensated by the advantage of another. Most caps recommended for hazardous waste projects are multi-layer caps, such as a three-layered system. Contaminated soil is covered with a composite cap consisting of a vegetative layer, drainage layer, and a low permeability layer.

Initial Screening: The performance of a properly installed, multi-layered cap is generally excellent. However, over time, the integrity of the low permeability synthetic layer becomes uncertain and should be investigated regularly. Unforeseen settling, invasions by burrowing animals, and deep rooted plants also contribute to the need for periodic monitoring and maintenance of the cap. This technology would limit current site use/operation, and was therefore eliminated from further consideration.

Barriers

Barrier technology prevents lateral migration of contaminants from within a contaminated soil zone using vertical enclosure techniques. The options under this technology are grout curtains, sheet piling, and slurry walls.

Grout Curtains

Grout curtains are subsurface barriers created in unconsolidated materials by pressure injection of grout material and can be applied in various configurations. Circumferential placement offers the most complete containment but requires that grouting take place in contaminated groundwater downgradient of the source. This could cause problems with grout set and durability and requires extensive compatibility testing.

Initial Screening: The major limitation of grout curtains is the potential for gaps due to non-penetration of the grout. Even a few small gaps in an otherwise low permeability curtain can increase its overall permeability significantly. A grout curtain is feasible as a barrier when it can key into a horizontal confining layer. However, a relatively impermeable confining layer is not available at a reasonable depth to key in the grout curtain. This technology was therefore eliminated from further consideration.

Sheet Piling

Sheet piles can be made of wood, pre-cast concrete, or steel. Wood is an ineffective water barrier and concrete is used when strength is required. Steel is the most effective in terms of groundwater cut-off and can be employed as a groundwater barrier. One drawback to sheet piling is damage to, or deflection of, the piles during installation, thereby rendering any such wall ineffective as a groundwater barrier.

Initial Screening: Sheet piling is feasible as a barrier when it can key into a horizontal confining layer. However, a relatively impermeable confining zone (aquitard) beneath the contaminated area is not available at reasonable depth at the Site. Therefore, this technology was eliminated from further consideration as a principal containment technology. However, this technology may be used in excavation/construction activities such as trench construction.

Slurry Walls

Slurry walls are the most common subsurface barriers because they are a relatively inexpensive means of vastly reducing the groundwater flow. Slurry walls are constructed in a vertical trench that is excavated under a slurry. The slurry mixture acts essentially like a drilling fluid. It hydraulically shores the trench to prevent collapse, and at the same time, forms a filter cake on the trench walls to prevent high fluid losses into the surrounding soil. In some cases, soil or cement is added to the bentonite slurry to form a soil-bentonite or cement-bentonite slurry wall.

Initial Screening: Slurry walls are typically used when they can be "keyed" into a confining clay or bedrock layer. Since there is no relatively impermeable confining layer (aquitard) to key into at a reasonable depth, the slurry wall technology was eliminated from further consideration.

2.4.2.4 Removal

This process involves physical removal of contaminated soil, usually with the intention of subsequent treatment and/or disposal. This category employs typical construction equipment such as backhoes, bulldozers, front-end leaders, and drag lines. Excavation is a preliminary or support technology and is often utilized in conjunction with remedial actions, which first require removal of the contaminated soils.

Initial Screening: Excavation is required as the initial materials handling step in other remedial actions. One or more types of excavation equipment would be used in excavation of contaminated soil for final treatment and/or disposal. Removal was therefore retained for further consideration.

2.4.2.5 Treatment

Treatment technologies are used to change the physical or chemical state of a contaminant, destroy the contaminant completely, or reduce contaminant volume, toxicity or mobility. The treatment technologies considered are physical treatment, chemical treatment, biological treatment, thermal treatment, and *in-situ* treatment.

Physical Treatment

Physical treatment is a category of technologies which utilize change of physical properties or contaminants to reduce their toxicity, volume, or mobility. The one technology to be included in this category is mechanical aeration.

Mechanical Aeration

VOCs can be extracted from soil by mechanical aeration and air or steam stripping. Air or steam stripping can be performed in an enclosed mechanical aeration system or a pneumatic conveyor system. VOCs are released from the soil matrix by the churning action (air or steam/soil contact). Induced air flow within the chamber captures the volatile organics emissions and passes them through an air pollution control device. The VOCs emission control device can be a water scrubber, a vapor phase carbon adsorption unit, or an afterburner combustion unit.

Initial Screening: Mechanical aeration without thermal heating can be used to strip VOCs, but may not reduce contaminants to cleanup levels required for disposal. Steam stripping would provide better removal of organics, but is not practical at the Site due to space limitations. This technology was therefore eliminated from further consideration.

Chemical Treatment

Chemical treatment is a category of technologies which utilize chemical reactions to reduce the toxicity, mobility, or volume of contaminants. This category of technologies includes the use of soil washing, supercritical fluid extraction and solidification/stabilization.

Soil Washing

Soil washing is a separation process whereby contaminants sorbed onto the fines portion of soil are separated in a water-based system from the containing medium. The water wash may be augmented with a leaching agent, surfactant, pH adjustment, or a chelating agent to help in removal. The process separates contaminants from soil in one of two ways: 1) by dissolving/suspending contaminants in the wash solution, or 2) by concentrating the contaminants into a smaller volume of soil through screening, gravity separation, and attrition scrubbing.

Initial Screening: The use of soil washing and extraction for VOCs would require a closed loop washer with aeration and vapor emissions control system. Large volumes of contaminated wash water and/or spent extraction solution would be generated which would require further treatment. Because of space limitations and the generation of large volumes of secondary waste requiring further treatment, this technology was eliminated from further consideration.

Supercritical Fluid Extraction

In supercritical fluid extraction, a combination of temperature and pressure is used to promote solvents to or beyond their critical point, under which conditions they exhibit the properties of non-polar solvents. Typical systems operate at 70°F to 100°F and 200 to 1,000 psi. This allows more efficient extraction of organics than processes using distillation or conventional solvent extraction methods. Carbon dioxide and propane are the potential solvents to be used in supercritical fluid extraction processes. This technology consists of four components: extraction, separation, compression, and disposal of extracted contaminants. The contaminants can generally be recovered in very small volumes compared with the original soil volumes, and therefore be treated by off-site incineration.

Initial Screening: Supercritical fluid extraction is applicable for removing volatile organics and non-polar compounds including semivolatiles and polychlorinated biphenyls (PCBs) from soils. Supercritical fluid extraction is currently available from a limited number of vendors. The treated material would require further treatment for metals. This technology also requires pumpable waste-like sludge. Therefore, a soil slurry mix would have to be prepared. It requires a high capital cost, involves processes and equipment that are more complex than other technologies, and is space limited. Therefore it was eliminated from further consideration.

Solidification/Stabilization

Stabilization/solidification is a chemical process whereby contaminated soils are converted into a stable cement type matrix in which contaminants are bound or trapped and become immobile. Cement, lime, flyash, organic polymers, pozzolan, asphalt or silicates can stabilize contaminants

such as metals, waste oil and some organics in soil. Commercial proprietary agents are available for both organic and inorganic contaminant stabilization. It has been demonstrated that chemical fixation products of certain silicate-base mixtures can meet the hazardous waste Toxicity Characteristic Leaching Procedure (TCLP) tests. Stabilization/solidification is not generally effective for volatile organics.

Initial Screening: The principal soil contaminant at the Site is TCE. This technology would not be effective for stabilization of TCE, and would interfere with use/operations at the Site. It was therefore eliminated from further consideration. It may be used off-site as required treatment to meet Land Disposal Restrictions (LDRs) prior to disposal.

Biological Treatment

Biological treatment is a biochemical process in which organics are broken down to simpler substances by microorganisms.

Biodegradation

Native microbes or selectively adapted bacteria are used to degrade a variety of organic compounds. The biological processes may involve the addition of microbes, nutrients, oxygen (aerobic bioreclamation only), and/or moisture. The applicability of a bioreclamation approach is determined by the biodegradability of the organic contaminants, and environmental factors affecting microbial activity. Biodegradation could be done *in-situ* or *ex-situ*. Biodegradation can be either aerobic or anaerobic, depending upon the contaminants present on the Site.

Initial Screening: Bench- and pilot-scale testing to verify effectiveness of biodegradation is required. While aerobic biodegradation has been demonstrated to be effective on some organics, such as benzene, toluene and xylene, uncertainty exists regarding its effectiveness in remediating the chlorinated organics known to be present at the Site. Anaerobic biodegradation might be effective on chlorinated organics under controlled conditions. Biological treatment would require long-term operation. Due to the uncertainties regarding treatment reliability for chlorinated organics, biodegradation was eliminated from further consideration.

Thermal Treatment

Thermal treatment is a technology category which employs thermal energy to treat contaminated media and reduces the volume, toxicity, or mobility of contaminants. The process options included in this technology category are incineration and thermal desorption.

Incineration

Incineration is a thermally destructive method used to volatilize and combust (in the presence of oxygen) all forms of combustible waste materials and organic contaminants in soil. Incineration units such as multiple hearth, rotary kiln, infrared incineration, and fluidized bed incineration systems treat organic contaminants at high temperatures (1,200°F to 2,400°F). The destruction and

removal efficiency (DRE) for properly maintained/operated incinerators exceeds the 99.99 percent requirement for hazardous wastes.

Initial Screening: High temperature incineration is well suited for the destruction of TCE. Off-gases and combustion residuals generally require further treatment. Incineration can be performed either by on-site mobile units or at off-site commercial facilities. Incineration, although technically feasible to remediate organic contaminants in soil, was eliminated from further consideration, based on the financial impracticality to incinerate a small volume of soil on site. This technology could be implemented at an off-site disposal facility to meet LDRs.

Thermal Desorption

The thermal desorption technology is a thermal stripping process. Prepared soils are introduced into the enclosed heated chamber using a heated screw or belt conveyor. Direct or indirect heating methods are used to volatilize organics from soil. The off-gas containing the thermally stripped compounds are then combusted in an afterburner, adsorbed in a carbon adsorption unit, or treated by catalytic oxidation, designed to ensure complete removal of these compounds. Typical operating temperatures for thermal stripping of organics are 400°F-900°F.

Initial Screening: Thermal desorption or thermal stripping is similar to the primary chamber of an incineration system but operates at lower temperatures. This technology can be performed either by on-site mobile units or at off-site commercial facilities. Thermal desorption, although technically feasible to remediate the contaminated soil at the Site, was eliminated from further consideration, based on the financial impracticality to treat a small volume of soil. This technology could be used at an off-site facility to meet LDRs.

In-Situ Treatment

In-situ treatment is a technology category in which contaminated soil is treated "in place" without excavation. The technologies evaluated in this category are *in-situ* soil flushing, *in-situ* vitrification, soil vapor extraction, *in-situ* stabilization/solidification, and *in-situ* oxidation.

In-Situ Soil Flushing

The inorganic or organic contaminants are extracted from soil by passing appropriate extractant solutions through the soils to dissolve or solubilize contaminants. The area to be treated must be isolated by vertical and horizontal groundwater containment barriers. Water or an aqueous solution is flooded or injected into the area of contamination and the contaminated elutriate is collected at the surface for removal, recirculation, on-site treatment, or reinjection. During elutriation, sorbed contaminants are mobilized into solution by the formation of an emulsion, or by chemical reaction with the flushing solution. These solutions may include water, surfactants, acids or bases, chelating agents, or oxidation and reducing agents.

Initial Screening: This technology requires the installation of vertical groundwater barriers, such as slurry walls, and usually relies on an underlying nonpermeable layer to act as a horizontal barrier for complete groundwater isolation in the treatment area. Since no such underlying layer exists that

can serve as the horizontal barrier, this technology cannot be effectively implemented at the Site. Without the proper containment, this technology may actually accelerate the spread of contamination. Therefore, this technology was eliminated from further consideration.

In-Situ Vitrification

In-situ vitrification (ISV) typically uses an electric current to melt soil or other earthen materials at extremely high temperatures (1,600 to 2,000°C or 2,900 to 3,650°F) and thereby immobilize most inorganics and destroy organic pollutants by pyrolysis. Inorganic pollutants are incorporated within the vitrified glass and crystalline mass. Water vapor and organic pyrolysis combustion products are captured in a hood, which draws the contaminants into an off-gas treatment system that removes particulates and other pollutants from the gas. The vitrification product is a chemically stable, leach-resistant glass and crystalline material similar to obsidian or basalt rock. The process destroys and/or removes organic materials. Radionuclides and heavy metals are retained within the molten soil.

Initial Screening: The ISV process can destroy or remove organics and immobilize most inorganics in contaminated soils, sludge, or other earthen materials. The process has been tested on a broad range of VOCs and semi-volatile organic compounds (SVOCs), other organics including dioxins and PCBs, and on most priority pollutant metals and radionuclides. However, ISV has a high implementation cost and requires large amounts of power and is typically only used for radiological encapsulation. Therefore, *in-situ* vitrification was eliminated from further consideration as a process option.

Soil Vapor Extraction

In-situ soil vapor extraction (ISVE) removes VOCs from soils. The basic components include vapor extraction wells, monitoring wells, and high vacuum pumps. The vacuum pumps are connected via a piping system to a series of production wells. The system operates by applying a vacuum through the production wells. A negative pressure gradient (vacuum) is applied within the unsaturated zone to collect volatile organics from the soil. The emissions from that system would be collected and sent through an air pollution control device where the organics would be destroyed in an afterburner or adsorbed on vapor phase activated carbon. Pilot testing is required for development of final design parameters.

Initial Screening: Vapor extraction systems have been proven to be effective in the removal of VOCs. In addition, TCE contamination at the Site is in the vadose zone. This technology requires the least space of all soil treatment technologies for volatile organics removal and will result in minimal interruption to current activities at the Site. This technology was therefore retained for further consideration.

In-Situ Solidification/Stabilization

In-situ solidification/stabilization is a process whereby contaminated soils are converted in-place into a stable cement type matrix in which contaminants are bound or trapped and become immobile. Silicates can stabilize contaminants such as metals and some organics, including low concentrations

of polyaromatic hydrocarbons (PAHs). It has been demonstrated that chemical fixation products of certain silicate-base mixtures can control the leaching of metals and organics.

Initial Screening: This technology would immobilize contaminants in the soil matrix and would require long-term monitoring at the Site. Field testing is required to identify the Site-specific additives and dosage rates. This technology is generally considered for inorganics, and would interfere with use/operations at the Site, and was therefore eliminated from further consideration.

In-Situ Oxidation

This technology involves the use of a chemical reagent that is injected into the contaminants media via constructed wells or driven well points to break down the organic constituents. The amount of reagent needed, spacing of injection points, and the frequency of addition to achieve cleanup goals are dependent upon constituent concentrations and hydrogeologic factors.

Initial Screening: The treatment technology can best be applied to contaminated media impacted with high molecular weight organic constituents, although field pilot studies would be necessary to further refine the operational conditions of this technology. Proprietary catalysts for hydrogen peroxide oxidation are available that can accelerate hydroxyl radicals to dechlorinate chlorinated solvents. The Cattaraugus Cutlery Area soils are relatively permeable and *in-situ* oxidation could be applied with the use of fluid flushing in the vadose zone. However, there would be a risk that contaminants could migrate downward with the flushing fluids in an uncontrolled manner and negatively impact the groundwater. Therefore, this technology was eliminated from further consideration.

Vapor Phase Emission Control

The application and operation of certain treatment technologies may potentially involve vapor phase emissions. Air emission regulations may require that gaseous streams containing organic and inorganic contaminants undergo treatment or removal prior to discharge to the atmosphere. Potential treatment technologies include vapor phase carbon adsorption, thermal oxidation, and catalytic oxidation.

Carbon Adsorption

Adsorption treats vapor phase emissions by essentially transferring and concentrating volatile organics (the adsorbate) from one medium (vapor/gaseous stream) to another (adsorbent). The adsorbent is typically granular activated carbon (GAC).

Initial Screening: Vapor phase carbon adsorption is a well-established technology for treating vapor emissions. It is a highly effective technology and provides a flexible method to comply with air regulations. This technology does not destroy contaminants, but decreases contaminant mobility and volume while increasing contaminant concentration in the adsorbent. Off-site disposal or regeneration of GAC is required. This technology was retained for further evaluation.

Thermal Oxidation

The thermal oxidation process is a thermal destruction method which can be used to destroy organic contaminants in the vapor phase. Thermal oxidation destroys the organics in the vapor phase prior to discharge to the atmosphere.

Initial Screening: This technology may be used as a final vapor phase treatment for the organic vapors generated in different treatment process options. An external energy source may be required for this technology. This technology would destroy the organic contaminants in the vapor phase rather than treatment by sorption, as in the case of vapor phase carbon adsorption. This technology may not be cost effective unless on-site incineration was selected to treat contaminated soil. This technology was therefore eliminated from further consideration.

Catalytic Oxidation

Catalytic oxidation is a destructive technology in which vapor phase contaminants are oxidized in the presence of a catalyst.

Initial Screening: This technology may be employed as a final vapor phase treatment for organic vapors generated during different treatment process options. An external energy source is generally required for this technology. This technology was retained for further evaluation.

2.4.2.6 Disposal

This category of remedial technologies refers to disposal of contaminated soil or secondary wastes generated from treatment systems, with or without additional treatment. The disposal technologies included are construction of a new on-site Resource Conservation and Recovery Act (RCRA) landfill, existing off-site RCRA landfill, and on-site redeposition.

On-Site RCRA Landfill

Some typical components of a RCRA landfill facility would be a double liner system, a leachate detection system, a leachate collection system, and a soil capping system including grass seeding. The collected leachate is either treated on-site or disposed of at an off-site treatment facility.

Initial Screening: The land area available at the contaminated area cannot be considered for landfill construction due to the buffer zone considerations along property boundary lines, thereby creating space limitations. LDRs would also prohibit disposal of untreated soils. Therefore, an on-site RCRA landfill was eliminated from further consideration.

Off-Site RCRA Landfill

Some contaminated and/or treated soil, sediment and debris, along with secondary wastes (*e.g.*, sludge and spent carbon from the groundwater treatment system) generated on-site could be transported to an existing RCRA Subtitle C landfill facility that is already permitted to accept hazardous materials.

Initial Screening: The LDRs prohibit landfilling of RCRA listed or characteristic wastes that do not meet the standards specified in the LDR. Commercial landfill facilities including Subtitle C and Subtitle D landfills are available for both hazardous and non-hazardous wastes. Off-site treatment facilities associated with landfill facilities are available commercially. Additionally, the volume of contaminated soil at the Site is relatively small. This technology was retained for further consideration.

On-Site Redeposition

This technology would allow for the on-site redeposition or disposal of treated soil.

Initial Screening: The treated soil would be redeposited to fill the excavation area. Redeposition of treated soil would reduce the demand of clean soil from off-site sources and reduce the off-site disposal cost. However, space limitations preclude the use of on-site treatment technologies. Therefore, this technology was eliminated for further consideration.

2.4.3 Screening of Groundwater Remediation Technologies

In the following subsections, potential groundwater remedial technologies are briefly described and summarized with the results of the initial screening. For those technologies that were not retained for further evaluation, the rationale for their elimination is included. The screening evaluations for each identified groundwater technology are summarized in Table 2-7.

2.4.3.1 No Action

No Action is not a category of technologies but an approach that does not include implementation of any remedial measures and is included in the FS as a baseline remedial option as required by CERCLA. No Action includes five-year reviews of site conditions to assess the need for future remedial actions.

Initial Screening: No Action would not provide for any remedial action. The No Action alternative would not limit community exposure to the contaminants. Although No Action would not meet the remedial objectives, it was retained for further consideration as a baseline for comparison of other alternatives.

2.4.3.2 Limited Action

Limited Action is a group of activities, which would not treat the groundwater contamination, but would restrict or minimize exposure to contaminated groundwater. The Limited Action response is based on groundwater monitoring and institutional controls, which includes public awareness programs and well permit requirements.

Institutional Controls

Institutional Controls would regulate the placement of new wells and the continuing use of existing wells at and around the Site by the use of well permit requirements. This type of institutional control

could be implemented by the local government or the state. Public meetings and notifications to the public are provided to make the public aware of the hazards associated with the contaminated groundwater. Well permit requirements might require that the residences, water supply company, and the county have their wells monitored on a regular basis to determine if contaminants have migrated to their wells. Additionally, if an existing well is found to be contaminated, it may require a treatment system to allow for its continued use.

Initial Screening: Institutional controls would not meet all of the remedial objectives for OU-2, but would potentially reduce public exposure to contaminated groundwater through public awareness programs and/or use restrictions. Institutional controls were therefore retained for further consideration.

Groundwater Monitoring

A groundwater monitoring program is established to monitor contaminant migration and degradation (including monitored natural attenuation).

Initial Screening: Groundwater monitoring would not meet all of the remedial objectives for OU-2, but would assist in monitoring potential public exposure to contaminated groundwater through a groundwater monitoring program. Groundwater monitoring was therefore retained for further consideration.

2.4.3.3 Containment

Containment is a remedial action providing isolation of contaminated groundwater from the uncontaminated groundwater. Containment technologies include vertical barriers such as sheet piling, slurry walls, grout curtains, or bottom sealing in order to form a significant barrier to lateral and vertical contaminant migration. In order to successfully prevent lateral migration it is usually necessary for the barriers to be sealed into a horizontal confinement zone (*e.g.*, using geological features such as a clay layer or bedrock beneath the contaminated area). In addition, for the vertical barriers to be effective, the contaminated area needs to be capped.

Sheet Piling

Steel sheet piles can be driven into the soil and used as a barrier to limit the spread of contaminants via groundwater when used with an effective interlock sealant. Steel sheet piling cutoffs require minimal maintenance.

Initial Screening: Using sheet piling for hydraulic control is effective when it can be keyed into a low permeability bottom layer. The Site does not have a continuous confining clay layer underneath the contaminated areas. Therefore, the technology was eliminated from further consideration.

Slurry Walls

Most slurry walls are constructed of a soil, bentonite, and water mixture. The bentonite slurry is used primarily for wall stabilization during trench excavation. A soil-bentonite backfill material is then

placed into the trench (displacing the slurry) to create the cutoff wall. Walls of this composition provide a barrier with low permeability and chemical resistance at low cost. Other wall compositions, such as cement/bentonite, pozzolan/bentonite, attapulgite, organically modified bentonite, or slurry/geomembrane composite, may be used if greater structural strength is required or if chemical incompatibilities between bentonite and site contaminants exist.

Initial Screening: The most effective application of the slurry wall for site remediation is to base (or key) the slurry wall 2 to 3 feet into a low permeability layer such as clay or fractured bedrock. This "keying-in" provides for an effective foundation with minimal leakage potential. There is no confining layer for keying in the slurry wall at the Site. Therefore, this technology was eliminated from further consideration.

Grout Curtains

Grouting refers to a process whereby one of a variety of fluids is injected into a rock or soil mass where it is set in place to reduce water flow and strengthen the formation. Numerous types of grouting materials are available and their applicability is often dictated by the soil grain size or size of the fractures, fissures, and voids in the rock.

Initial Screening: Because of costs, grouted barriers and grout curtains are seldom used for containing groundwater flow in unconsolidated materials around hazardous waste sites. Furthermore, there is no confining layer for keying the grout curtain. This technology was eliminated from further consideration.

Bottom Sealing

Bottom sealing refers to techniques used to place a horizontal barrier beneath the contaminated area to act as a floor and prevent downward migration of contaminants. Emplacement of a bottom seal by grouting involves drilling through the Site or directional drilling from the Site perimeter, and injecting grout to form a horizontal barrier.

Initial Screening: Groundwater underlying the Site is contaminated to more than 60 feet below grade (deepest well). Therefore, bottom sealing is technically not feasible. This technology was therefore eliminated from further consideration.

2.4.3.4 Extraction

Pumping

Groundwater pumping and collection technologies involve extraction of contaminated groundwater for subsequent treatment and prevention of downgradient migration. This type of groundwater extraction depends upon the depth of contamination and the hydrogeologic factors of the aquifer. This category includes pumping, and is a preliminary or support technology for the remedial actions that require initial extraction of the contaminated groundwater. Pumping wells evaluated for management of contaminated groundwater are suction wells, well points, deep wells, and French drains.

Suction Wells

Suction wells are used as extraction wells, where the contaminated groundwater to be pumped is near the water table. These wells can be used for extraction depths that are less than 20 feet.

Initial Screening: The contaminated groundwater underlying the contaminated areas is approximately 40 to 60 feet below grade. In addition, the thickness of contaminated aquifer is approximately 40 feet. Therefore this technology was eliminated from further consideration.

Well Points

Well point extraction systems are best suited for shallow aquifers that are less than 20 to 25 feet below grade.

Initial Screening: Based on the evaluation above for suction wells the well point system is not conducive for extracting contaminated groundwater underlying the Site. Therefore, this technology was eliminated from further consideration.

Deep Wells

Deep well pumping is applicable for pumping contaminated groundwater from deeper aquifers. These wells can be used for extraction depths greater than 20 feet.

Initial Screening: Deep well pumping is needed to extract the contaminated groundwater underlying the Site. This technology was therefore retained for further evaluation.

French Drain

A French drain system may be used for the collection of subsurface water downgradient of contaminated plumes. It creates a continuous zone of influence in which groundwater flow is directed toward the drain. The major activities associated with construction of subsurface drains are trench excavation, trench stabilization, and installation of a perforated drain pipe, filter, and envelope materials. If French drains fail due to clogging, breaks in the pipes, or sinkhole formation, they can be costly and time consuming to rehabilitate.

Initial Screening: Evaluation of the suitability of subsurface drains as a remedial technology is generally made by comparing the effectiveness and cost of this alternative with pumping. They are generally more effective in areas with low hydraulic conductivity. The contaminated groundwater underlying the Site is approximately 40 to 60 feet below grade. Construction of a French drain deeper than 30 feet is not feasible. In addition, the thickness of the contaminated aquifer is approximately 40 feet. Therefore, this technology was eliminated from further consideration.

2.4.3.5 Treatment

Treatment technologies change the physical and/or chemical state of a contaminant or destroy the contaminant completely in order to reduce toxicity, mobility and/or volume of the contaminants present in site groundwater. This category of technologies includes physical treatment, chemical treatment, and biological treatment.

Physical Treatment

Physical treatment is a category of technologies which utilize changes in physical properties of contaminants to reduce their volume, toxicity, or mobility. The physical technologies considered for contaminated groundwater treatment include clarification, flocculation, filtration, air stripping, carbon adsorption, sludge dewatering, and ion exchange.

Clarification

The primary function of clarification is to remove suspended solids from a waste stream. The clarifier is equipped with a solids removal device to facilitate the removal of settled solids on a continuous basis. The performance of a clarifier is based on design criteria such as surface loading rate and detention time.

Initial Screening: Clarification, which is a sedimentation process, has been shown to be applicable for the removal of suspended solids from groundwater. Although the concentrations of metals in site groundwater are not of concern, the metals and suspended solids concentrations in extracted groundwater may need to be reduced to meet discharge criteria. This technology can be applied in order to meet discharge criteria for metals and suspended solids, and was retained for further evaluation.

Flocculation

Flocculation is a physical treatment technology that is used to enhance sedimentation and could be used as a pretreatment technology for removal of suspended solids and metals in extracted groundwater to meet applicable discharge criteria. The contaminated water is slowly mixed (following rapid mixing and addition of a chemical precipitant) by a paddle while a flocculating chemical is added. Flocculants adhere readily to suspended solids so that the resultant particles are too heavy to remain in suspension. The effectiveness of flocculation is dependent upon the flow rate of the contaminated water, its composition, and pH.

Initial Screening: Although the concentrations of metals in site groundwater are not of concern, the metals and suspended solids concentrations in extracted groundwater may need to be reduced to meet discharge criteria. This technology is well-developed and used in many physical/chemical treatment systems. Therefore, this technology was retained for further consideration.

Filtration

Filtration is used to remove fine suspended particles that are not easily settleable. Filtration is typically used after clarification to remove nonsettleable suspended solids. The most common methods of filtration are sand filtration or mixed media filters. A mixed media filtration system consists of a layer of anthracite and a layer of sand to effect the filtration and adsorption of fine particles, including those that would be generated during chemical precipitation. Fluid flow through the filter medium may be accomplished by gravity or under pressure.

Initial Screening: Granular media filtration is typically used after gravity separation for additional removal of suspended solids prior to other treatment processes. Pretreatment by filtration is appropriate prior to the application of air stripping or carbon plugging. Therefore, it was retained for further consideration.

Air Stripping

Air stripping is a mass transfer process where VOCs in groundwater are transferred to the gaseous phase. Generally, organic compounds with a Henry's Law constant greater than 0.003 can effectively be removed by air stripping. Factors affecting the removal of specific organics from groundwater include temperature, pressure, air to water ratio, and surface area available for mass transfer. Air to water volumetric ratios may range from 10:1 up to 300:1, and are typically 50:1. A packed column or tower with an air blower and counter-current flow of air to water is commonly used. The products are the stripped effluent (treated groundwater) and contaminated off-gas.

Initial Screening: Air stripping is an easily implementable technology and has been used to remove VOCs in groundwater. This technology was retained for further consideration.

Carbon Adsorption

Activated carbon selectively adsorbs constituents in hazardous waste streams by a surface attraction phenomenon where the organic molecules and some metals are attracted to the internal pores of the carbon granules. Activated carbon can be used for the adsorption of VOCs, SVOCs, pesticides, and herbicides in groundwater. Adsorption efficiency is chemical-specific, depending upon the strength of the molecular attraction between adsorbent and adsorbate, molecular weight, electrokinetic charge, pH, and surface area. Once the micropore surfaces are saturated with organics, the carbon is "spent" and must be replaced with fresh carbon or regenerated. Activated carbon is an effective and reliable means of removing low solubility organics.

Initial Screening: Granular activated carbon adsorption is a highly developed organic removal technology. It is not particularly sensitive to changes in concentrations or flow rate, and is not adversely affected by toxics. Therefore, this technology was retained for further consideration.

Sludge Dewatering

Sludge dewatering is a treatment process where the water content of a dilute sludge can be reduced, so that the final volume of the sludge requiring disposal is minimized. Sludge dewatering can be

achieved using vacuum filtration, a belt filter, or a filter press. Vacuum filtration is generally conducted using a horizontal rotating drum covered with a cloth filter medium that is particularly suited for dewatering slurries. The plate and frame filter is operated in batch rather than continuous modes (also suited for sludge dewatering). A variation on this technology is the belt filter press that can be operated continuously.

Initial Screening: Application of these physical treatment methods is anticipated for dewatering sludges generated during the physical-chemical precipitation process. Therefore, sludge dewatering was retained for further evaluation.

Ion Exchange

Ion exchange is a process whereby selected contaminant ions are removed from the aqueous phase by electrostatic exchange with relatively innocuous ions held by ion exchange resins. Ion exchange is used to remove metallic cations, inorganic anions, organic acids, and organic amines. Fixed bed and counter-current systems are the most widely used ion exchangers, while continuous counter-current systems are suitable for high flows.

Initial Screening: Ion exchange would generate spent regeneration solution containing high metal concentrations. Treatment and/or disposal of this waste stream would result in additional costs. Although the metals in extracted groundwater can be reduced to meet discharge criteria by chemical precipitation, ion exchange is also feasible. Therefore, it was retained for further consideration.

Chemical Treatment

Chemical treatment is a category of technologies that utilize chemical reactions to reduce the volume, toxicity or mobility of contaminants. Chemical treatment technologies considered include neutralization/pH adjustment, chemical precipitation, and UV-chemical oxidation.

Neutralization/pH Adjustment

Neutralization is a process used to adjust the pH of a groundwater stream to an acceptable level for discharge, which usually lies in the range of 6.0 to 9.0 pH units. The pH adjustment is a partial neutralization process, which makes the water either more acidic or more alkaline to enhance chemical/biochemical reactions. Adjustment of pH is accomplished by addition of acidic reagents to alkaline streams and vice versa. Adjustment of pH can also be used to optimize other treatment processes. When pH is adjusted by adding carbon dioxide (CO_2), the process is called recarbonation.

Initial Screening: Neutralization/pH adjustment is a conventional and widely demonstrated means of adjusting the pH of a stream before, during and/or after chemical precipitation. Adjustment of pH may also be required to optimize other treatment processes. If excess lime is used for chemical precipitation, recarbonation may be required before discharge. Therefore, neutralization/pH adjustment was retained for further consideration.

Chemical Precipitation

Precipitation agents such as lime, sodium sulfide, or ferric chloride may be added for the removal of metals in groundwater. Metals can be precipitated out of solution as hydroxides, sulfides, carbonates, or other insoluble salts. The resulting products are metal sludges with a generally elevated pH and a small quantity of excess sulfide (in the case of sulfide precipitation).

Initial Screening: Limitations to be considered during design include the fact that not all metals have a common pH at which they precipitate. If present, chelating and complexing agents can interfere with the process. Chemical precipitation is used effectively in conventional water treatment to remove metals and suspended solids. Although the concentrations of metals in site groundwater are not of concern, the metals concentrations in extracted groundwater may need to be reduced to meet discharge criteria. Therefore, chemical precipitation was retained for further consideration.

Ultraviolet-Chemical Oxidation

Ultraviolet (UV)-chemical oxidation is a process that can destroy organic contaminants in water by means of chemical oxidation. The chemical oxidants used are either hydrogen peroxide or ozone. Organic contaminants absorb UV (ultraviolet) light and may undergo changes in their chemical structures, or may become more reactive with chemical oxidants. When catalyzed by ultraviolet light, the oxidant (hydrogen peroxide or ozone) forms hydroxyl radicals. The hydroxyl radicals are strong chemical oxidants that react with the organic contaminants. If the reaction is carried to completion, organic compounds can be completely oxidized (broken down) to water and carbon dioxide.

Initial Screening: The UV-chemical oxidation process has been studied over the past several years for its applicability to concentrated aqueous wastes, industrial effluents, and groundwater containing toxic solvents and fuels. Since the Site groundwater is contaminated with VOCs, UV-chemical oxidation may prove to be effective in destruction of these chemicals. This technology was therefore retained for further consideration.

Biological Treatment

Biological treatment is a biochemical process in which organics are broken down to simpler substances by microorganisms using two types of biodegradation processes. These are aerobic respiration and anaerobic respiration. Biological treatment technologies considered are aerobic biodegradation and anaerobic biodegradation.

Aerobic Biodegradation

In aerobic biodegradation, organic molecules are oxidized to CO_2, water, and other end products using molecular oxygen as the terminal electron acceptor. Oxygen may also be incorporated into intermediate products of microbial catabolism through the action of oxidizing enzymes, making them more susceptible to further biodegradation. In general, aerobic biodegradation processes are

used more often for biodegradation because the degradation process is more rapid and complete, and offensive end products (methane, hydrogen sulfide) are not produced.

Initial Screening: While aerobic biodegradation has been demonstrated to be effective on some non-chlorinated organics such as benzene, toluene, and xylene, uncertainty exists regarding its effectiveness in remediating the chlorinated organics such as TCE known to be present at the Site. In addition, aeration during aerobic biodegradation will strip volatile organics potentially resulting in the need for air pollution controls. This technology was therefore eliminated from further consideration.

Anaerobic Biodegradation

Anaerobic biodegradation is a biochemical process where organics are broken down to CO_2, water, methane, cellular biomass, and intermediate organic compounds via anaerobic respiration. This is accomplished by facultative and obligate anaerobes. The strict anaerobes require totally oxygen-free environments and oxidation/reduction potentials of less than -0.2 V.

Initial Screening: Anaerobic biodegradation can degrade certain halogenated organics. However, the contaminated groundwater at the site has an overall organic content likely to be too low to support biological growth. In addition, the typical detention time of several hours required for anaerobic microbial biodegradation would require a large treatment plant. Achieving effluent levels required for the site is uncertain. Therefore, this technology was eliminated from further consideration.

***In-Situ* Treatment**

In-situ treatment is a technology category in which contaminated groundwater is remediated "in place" without extraction/pumping. *In-situ* treatment methods often provide a very direct and effective option for the remediation of contaminants in the groundwater, especially if the target groundwater flow regime is fairly deep as is the case with the Site. The *in-situ* treatment methods considered herein are *in-situ* oxidation, *in-situ* air sparging, in-well stripping, and permeable reactive barrier treatment.

In-Situ Oxidation

In-situ oxidation technology is a process to oxidize volatile organics in groundwater whereby the oxidation process chemically changes the contaminants *in-situ,* resulting in breakdown to carbon dioxide and water. The oxidant and catalyst are injected through injection wells and the chemicals will travel through the aquifer for oxidation contaminants. Pilot testing is required in order to determine applicability of the technology based on site conditions.

Initial Screening: The *in-situ* oxidation in groundwater has been demonstrated at other Superfund sites, particularly for VOC-contaminated groundwater. The Site contaminated area has a relatively high permeability and a high groundwater flow. This would minimize the number of injection wells and the treatment duration. Therefore, this technology was retained for further evaluation.

In-Situ Air Sparging

In-situ air sparging is a process where air is sparged through well screens into an aquifer by supplying compressed air into the wellhead under controlled conditions. The sparged air enters the aquifer in the form of small bubbles after being broken up while passing through the well screen and into the porous media. The bubbles then rise up through the groundwater and perform diffused air stripping in the aquifer. This process removes VOCs from the groundwater and transfers them into the vapor zone. The vapors must be captured soil vapor extraction methods in the vadose zone and treated before being discharge to the atmosphere. Pilot testing is required.

Initial Screening: This technology can be utilized at significant depths below the ground surface, is well established, and is effective as long as non-aqueous phase liquids are not present. A support infrastructure must be established and includes utility trenches, air sparging equipment (compressor and controls), soil vapor extraction equipment, and vapor phase treatment equipment. Therefore, this technology was retained for further evaluation.

In-Well Stripping

In-well stripping is a process where air is sparged through an impinger pipe down into the lower end of a well. Typically, the well would be constructed with a limited screen length at the bottom and another screen length at the top which would extend above the water table. The sparged air would enter the well above the lower screen and begin to rise up through the well. As it rises, it would perform diffused air stripping, and would drive groundwater flow up through the well. The groundwater flowing up in the well would exit through the upper screen, and be replaced with water coming into the well through the lower screen. In this manner, a hydraulic recirculation cell is set up around the well in the aquifer. The radial extent of the cell from the outside of the well would be largely determined by the ratio of horizontal to vertical permeability, by the vertical distance between the two sections of well screen, and by the rate of flow in the aquifer past the well. The outgasses would be captured at the top of the wellhead and treated. Pilot testing is required.

Initial Screening: This technology is most effective under low groundwater flow conditions that allow for the recirculation cell to build up and extend radially, downgradient oxygenation, and capture the outgases at the wellhead. Due to the high groundwater flow rate at the site this technology was eliminated from further consideration.

Permeable Reactive Barrier (PRB)

PRB technology has been in practice for several years and has been proven effective in treating chlorinated contaminants in the groundwater. The treatment is achieved by de-chlorination using a zero valent iron barrier through which the contaminated groundwater flows. The permeable barrier of zero valent iron is installed perpendicular to the direction of groundwater flow and across the flow regime. Under deep groundwater conditions it becomes more difficult to install and assure quality.

Initial Screening: The depth of the aquifer at the site would require that the barrier be installed by slurry wall like construction methods at depths in excess of 20 feet bgs, or that the barrier be placed

by injection methods through injector systems. Due to the difficulty and increased cost in placing the PRB at these depths, this technology was eliminated from further consideration.

Off-Site Treatment

Contaminated groundwater extracted from the site is discharged or transported to an off-site treatment facility for treatment and disposal. A local publicly owned treatment works or a Treatment, Storage and Disposal (TSD) facility are considered for evaluation as off-site treatment options.

Publicly Owned Treatment Works (POTW)

Under this technology, untreated or partially treated groundwater extracted from the site would be discharged to the sanitary sewer for additional treatment and discharge by a local POTW. A pretreatment process may be required before discharging to a POTW.

Initial Screening: Extraction of groundwater and discharge to the POTW would provide a simple solution to groundwater treatment. However, it is unlikely that the municipal POTW could accommodate the discharge flow rate from the site for an extended duration. In addition, incompatible contaminants may pose a problem to the operation of the local POTW. Therefore, this technology was eliminated from further consideration.

Treatment, Storage and Disposal (TSD) Facility

Contaminated groundwater would be extracted and transported to a RCRA TSD facility for treatment, storage, and disposal with the implementation of this technology.

Initial Screening: A nearby operating TSD facility is not available, and therefore the cost for transporting groundwater to an off-site TSD facility would be significant. An additional concern arises from the future capacity of the TSD facility in accepting the large volume of groundwater. Based on these factors, this technology was eliminated from further consideration.

Vapor Phase Emission Control

The application and operation of certain groundwater treatment technologies may potentially involve vapor phase emissions. Air emission regulations require that gaseous streams containing organic compounds undergo treatment prior to discharge to the atmosphere. Potential treatment technologies considered for vapor phase emissions would include vapor phase carbon adsorption, thermal oxidation and catalytic oxidation.

Carbon Adsorption

Treatment of volatile emissions by adsorption is essentially a process of transferring and concentrating volatile organics (the adsorbate) from one medium (gaseous stream) to another (the adsorbent). The most commonly used adsorbent is activated carbon; generally, the granular form of activated carbon (GAC) is used to treat gaseous wastes. Gas treatment systems consist of

containerized beds of activated carbon. Multiple carbon bed vessels are often required to allow adequate contact time and/or to optimize the frequency of the spent carbon regeneration or changeover.

Initial Screening: Vapor phase carbon adsorption is well established for the removal of organic compounds and some inorganic compounds from gaseous streams. It is a highly reliable technique, providing a flexible and effective method for vapor phase volatile emissions control in compliance with regulatory requirements. Since vapor emission controls may be required, this technology was retained for further consideration.

Thermal Oxidation

Organic contaminants are destroyed in the vapor phase by thermal oxidation prior to discharge to the atmosphere.

Initial Screening: Although this technology can be used as a final vapor phase treatment for the volatiles generated in different treatment process options, volatile organic concentrations in vapor phase resulting from groundwater treatment technologies may not be high enough to sustain combustion without auxiliary fuel. In addition, combustion may not completely destroy all organic compounds. This technology would not be cost-effective unless combined with on-site incineration/thermal treatment, which has been eliminated. This technology was therefore eliminated from further consideration.

Catalytic Oxidation

Contaminants in the vapor phase resulting from various process options are oxidized in the presence of a catalyst prior to discharge to the atmosphere. Proper design and initial performance monitoring will be required to reduce the air emissions concerns.

Initial Screening: This technology may be used as a vapor phase treatment for the organic vapors generated in different treatment process options. External energy source may be required for this technology. This technology would reduce the organic contaminants in the vapor phase. Therefore, this technology was retained for consideration.

2.4.3.6 Discharge/Disposal Technologies

If one or more of the pumping/treatment technologies are incorporated into potential alternatives, the discharge/disposal of treated groundwater must also be addressed. The potential discharge/disposal technologies would include surface water discharge, recharge, reinjection and off-site RCRA landfill disposal of treatment residues.

Surface Water Discharge

Under this technology, treated groundwater would be discharged into a nearby body of water. Since a surface water body exists near the Site, the treated effluent would be discharged into the Little Valley Creek. The discharge can be accomplished by means of a small outfall structure.

Initial Screening: The discharge of treated groundwater is a necessary technology in order to dispose of the treated groundwater. Since the discharge flow rate is not anticipated to be high and the discharged water will be treated to ARARs, no adverse impact is anticipated to the Little Valley Creek. Therefore, this technology was retained for further consideration.

Recharge

Recharge of treated groundwater is frequently used to restore the groundwater table from an aquifer where the groundwater is withdrawn. This is accomplished by ponding water in recharge basins where the water percolates into the aquifer by gravity. This is feasible when hydraulic conductivity and transmissivity are high. Recharge basins can also flush residual contaminants in the soil.

Initial Screening: There are no recharge basins in the vicinity of the Site. It would not be feasible to construct a recharge basin or recharge field on site because of space limitations. This technology was therefore eliminated from further evaluation.

Reinjection

Reinjection of treated groundwater is frequently used to restore the groundwater table from an aquifer where the groundwater is withdrawn. This is feasible when hydraulic conductivity and transmissivity are high. Reinjection systems are used to direct contaminants to the extraction systems and to accelerate groundwater restoration. Potential problems involved with the use of reinjection systems include sand clogging, dead spots, air locks, and plugging by chemical precipitation.

Initial Screening: The average hydraulic conductivity and transmissivity of the Site aquifer are relatively high and are suitable for reinjection. This task can be accomplished by constructing reinjection wells either upgradient or downgradient of the Site. This technology was therefore retained for further evaluation.

Off-Site Landfill Disposal of Treatment Residues

The concentrated contaminants in the sludge from chemical precipitation may be transported to an existing hazardous or non-hazardous waste landfill facility, depending on the classification of the waste and the landfill's ability to accept such waste materials. This option provides a straight forward solution to the disposal problem. However, unit costs are high due to transportation and disposal fees. In many instances, these waste materials may have to be treated/stabilized further before final disposal at an off-site facility.

Initial Screening: Final disposal of the concentrated residue material is a necessary process in any treatment alternative. Therefore, this technology is retained for further consideration.

2.4.4 Evaluation and Selection of Representative Process Options

Process options for the technically feasible actions were evaluated prior to selecting a particular process option to represent each technology type. In some cases, more than one process option was

selected for a particular technology type if the process option data indicated sufficient differences in option performance. Process options were evaluated for effectiveness, implementability, and cost as described below:

- The evaluation of technology option effectiveness focused on: 1) effectiveness in handling the estimated areas or volumes of soil and groundwater, and the ability to meet contaminant reduction goals; 2) effectiveness of protecting human health and the environment during the construction and implementation phases; and 3) reliability of the technology with respect to contaminants and conditions.

- The implementability evaluation consisted of an assessment of the technical and administrative difficulty of implementing a technology or process option.

- Cost evaluation relied upon engineering judgment to arrive at the relative cost of process options within a technology type.

For soils, feasible remedial technologies and process options that passed the initial screening were evaluated using effectiveness, implementability, and cost factors. The evaluation and selection of process options for soil treatment technologies are presented on Table 2-8. The process options that were selected for alternative development based on the evaluation are noted on the table with an asterisk (*).

For groundwater, feasible remedial technologies and process options that passed the initial screening were evaluated using effectiveness, implementability, and cost factors. The evaluation and selection of process options for groundwater treatment technologies is summarized on Table 2-9. The process options that were selected for alternative development based on the evaluation are noted on the table with an asterisk (*).

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

EPA's guidance for conducting RI/FSs (EPA, 1988a) recommends that in this phase of the FS, an appropriate range of waste management options be developed that will be analyzed more fully in the detailed analysis phase of the FS. Based on the initial screening and evaluation of process options presented in Section 2.0, four (4) remedial alternatives for soil and five (5) remedial alternatives for groundwater were assembled for further evaluation, as follows:

Soil Remedial Alternatives

S-1: No Action
S-2: Institutional Controls
S-3: *In-Situ* Soil Vapor Extraction (ISVE)
S-4: Excavation/Off-Site Disposal

Groundwater Remedial Alternatives

GW-1: No Action
GW-2: Site-Wide Monitored Natural Attenuation/Institutional Controls
GW-3: Source Area Extraction/Treatment/Discharge/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
GW-4: Source Area *In-Situ* Air Sparging/Vapor Treatment/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume
GW-5: Source Area *In-Situ* Chemical Oxidation/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume

Typically, the next phase of the FS is the screening of remedial alternatives(based on effectiveness, implementability, and cost considerations) to reduce the number of alternatives for detailed analysis when there are a large number of alternatives developed. However, based on the limited number of alternatives developed, all of the soil (S) and groundwater (GW) alternatives were retained for detailed analysis, presented in Section 4.0.

4.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the detailed analysis of the remedial alternatives identified in Section 3.0 with respect to the requirements set forth in CERCLA. The following EPA documents were used during this analysis: *"Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA"* (EPA, 1988a), and *"Revised Handbook for Remedial Actions at Waste Disposal Sites"* (EPA, 1985). Section 4.1 discusses the evaluation process and the criteria against which the remedial alternatives were evaluated. Sections 4.2 and 4.3 present a detailed description of the alternatives and the evaluation of each alternative with respect to the evaluation criteria for soil and groundwater, respectively. Sections 4.4 and 4.5 summarize the comparative analysis of remedial alternatives for soil and groundwater, respectively.

4.1 Evaluation Process

The detailed analysis of remedial alternatives included the following steps:

- The first step was to define each alternative with respect to the volumes and/or areas of TCE-contaminated media to be addressed, the remedial technologies to be used, and any performance requirements associated with those technologies;
- The next step was to evaluate each alternative against seven of the nine evaluation criteria (see below) as defined by the EPA RI/FS Guidance Document (EPA, 1988a); and
- The final step involved performing a comparative analysis of the remedial alternatives to assess the relative performance of each alternative with respect to each evaluation criterion.

The following statutory preferences were considered during the alternative analysis:

- Protection of human health and the environment (CERCLA Section 121 (b));
- Attainment of ARARs of federal and state laws (CERCLA Section 121(d)(2)(A)) to the maximum extent practicable, or waiver of ARARs (CERCLA Section 121(d)(4));
- Provision of a cost-effective solution, taking into consideration short- and long-term costs (CERCLA Section 121(a));
- Use of permanent solutions and treatment technologies or resource recovery technologies to the maximum extent practicable (CERCLA Section 121(b)); and
- Satisfaction of the preference for remedies that employ treatment that permanently and significantly reduces the toxicity, mobility, or volume of TCE as a principal element, or explanation of reasons why such remedies were not selected (CERCLA Section 121(b)).

In order to address the CERCLA requirements, EPA developed nine criteria for the evaluation of alternatives. These criteria are defined in the EPA RI/FS Guidance Document (EPA, 1988a), and are summarized below.

The first two criteria are the "threshold" factors. Any alternative that does not satisfy both of these criteria is eliminated from further consideration in the detailed analysis, with the exception of the No Action alternative, which is required by CERCLA to be carried through the entire evaluation process. The two threshold criteria are:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

Five "primary balancing" criteria are used to make comparisons and to identify the major tradeoffs between the remedial alternatives. Alternatives that satisfy the threshold criteria are evaluated further using the following primary balancing criteria:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

The remaining two criteria are "modifying" factors that are not addressed in this Feasibility Study Report, but are incorporated into the remedy selection process prior to issuance of the ROD. These two criteria are:

- State acceptance; and
- Community acceptance.

A discussion of the evaluation criteria is presented below.

Overall Protection of Human Health and the Environment

This evaluation criterion provides an overall assessment of protection based on a composite of long-term and short-term effectiveness factors. Evaluation of overall protection addresses:

- How well a specific site remedial action achieves protection over time;
- How well site risks are reduced; and
- How each source of contamination (specifically sources of TCE in this instance) is to be eliminated, reduced, or controlled for each remedial alternative.

Compliance with ARARs

This evaluation criterion is used to determine how each remedial alternative complies with applicable or relevant and appropriate federal environmental laws and state environmental or facility siting laws as defined in CERCLA Section 121. Each alternative is evaluated in detail for:

- Compliance with chemical-specific ARARs (*e.g.*, RCRA Standards for TCE in this instance);
- Compliance with action-specific ARARs (*e.g.*, RCRA minimum technology standards);
- Compliance with location-specific ARARs (*e.g.*, preservation of historic sites); and
- Compliance with appropriate criteria, advisories, and guidances (*i.e.*, TBC material).

Section 2.0 presented the ARARs used to evaluate the proposed remedial alternatives.

Long-Term Effectiveness and Permanence

This evaluation criterion addresses the results of the remedial action in terms of the risk remaining at the Site after the response objectives have been met. The components of this criterion include the magnitude of the remaining risks measured by numerical standards such as cancer risk levels; the adequacy and suitability of controls used to manage treatment residuals or untreated soils; and the long-term reliability of management controls for providing continued protection from residuals (*i.e.*, the assessment of potential failure of the technical components).

Reduction of Toxicity, Mobility, or Volume Through Treatment

This evaluation criterion addresses the statutory preference for treatment that results in the reduction of the total mass of TCE, the irreversible reduction in TCE mobility, or the reduction of the total volume of TCE-contaminated media. Factors to be evaluated in this criterion include the treatment process employed; the amount of TCE destroyed or treated; the degree of reduction in toxicity, mobility, or volume expected; and the type and quantity of treatment residuals.

Short-Term Effectiveness

This evaluation criterion addresses the impacts of the remedial action during the construction and implementation phases preceding the attainment of the remedial response objectives. Factors to be evaluated include protection of workers and neighboring communities during the remedial actions, environmental impacts resulting from the implementation of the remedial actions, and the time required to achieve protection.

Implementability

This criterion addresses the technical and administrative feasibility of implementing a remedial action and the availability of services and materials required during its implementation. Technical feasibility factors include construction and operation difficulties, reliability of technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy. The administrative feasibility includes the ability and time required for administrative approvals and to coordinate with other agencies. Factors employed in evaluating the availability of services and materials include availability of treatment, storage, and disposal services with required capacities; availability of equipment and specialists; and availability of prospective technologies for competitive bidding.

Cost

This criterion addresses capital costs, O&M costs, and potential future remedial action costs. Capital costs consist of direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install remedial actions. Indirect costs include expenditures for engineering, financial, and other services required to complete the installation of remedial alternatives.

Annual O&M costs include labor for the operation of the systems as well as maintenance, auxiliary materials and energy, disposal of residues, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, and rehabilitation costs. It is assumed that the O&M costs are incurred after the remedial activities are completed.

The cost assessment evaluates the costs of the remedial actions on the basis of present worth. Present worth analysis allows remedial alternatives to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial alternative over its planned lifetime. A required operating performance period and a discount rate, or a net rate of return on investment, are assumed for calculation of present worth, which is a function of the discount rate and time. For this FS, a discount rate of seven percent was assumed for a base calculation. The "study estimate" costs provided for the remedial actions are intended to reflect actual costs with an accuracy of approximately -30 to +50 percent.

State Acceptance

State acceptance indicates that, based on its review of the RI/FS and Proposed Plan, the state concurs with the preferred remedy.

Community Acceptance

Community acceptance will be addressed in the ROD and refers to the public's general response to the alternatives described in the Proposed Plan and the RI/FS Reports.

4.2 Alternative Analysis for Soils

4.2.1 Alternative S-1: No Action

4.2.1.1 Description

The Superfund program requires that the No Action Alternative be considered as a baseline for comparison with the other alternatives. The No Action Alternative for soil does not include any physical remedial measures that address the problem of soil contamination at the Cattaraugus Cutlery Area.

Because this alternative would result in contaminants remaining on the Cattaraugus Cutlery Area above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years.

4.2.1.2 Assessment

Overall Protection of Human Health and the Environment

The No Action Alternative would entail no monitoring, removal, or treatment of TCE-contaminated soil. There may be a slow reduction of the volume of the TCE-contaminated soils due to natural

volatilization, biodegradation, and flushing during stormwater infiltration. Since any volume contaminated soil reduction would be gradual, the exposure risks would be expected to remain the same. There is an ongoing potential for exposure to TCE-contaminated soils and migration of TCE to groundwater. The No Action Alternative would not be protective of human health and the environment.

Compliance with ARARs

The No Action Alternative does not satisfy action-specific ARARs and no location-specific ARARs would be triggered by this alternative. There are no TCE-specific ARARs. This alternative would not comply with New York State's soil cleanup objectives as specified in the soil TAGM.

Long-Term Effectiveness and Permanence

The No Action Alternative provides no reduction in risk. Long-term risks associated with the No Action alternative are related to the potential baseline human health risks. These risks would still exist through the potential soil exposure pathways (*i.e.*, ingestion, absorption, and inhalation).

As required by CERCLA, review and evaluation of site conditions would be performed every five years. If justified by the review, additional remedial actions could be required. This alternative would not be effective over the long-term because TCE-contaminated soils would remain in place. The risks posed by TCE-contaminated media would not be mitigated.

Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative does not include any containment, treatment, removal, or disposal actions, and would leave the contaminated soils intact. There may be a slow reduction of the toxicity and volume of the TCE-contaminated soils due to natural volatilization, biodegradation, and flushing during stormwater infiltration. However, the mobility of the TCE would remain unchanged during this time period and the potential for continued contribution to the groundwater would also remain unchanged. This alternative would not result in reduction of toxicity, mobility, or volume through treatment.

Short-Term Effectiveness

The No Action Alternative for soils does not include any remedial activities. Since this alternative does not involve construction activities, there are no threats to workers or the community during implementation.

Implementability

- **Technical Feasibility**

The technical feasibility of this alternative would be very high, since no remedial activities or monitoring would be performed.

- **Administrative Feasibility**

This alternative would require administrative coordination for performance of site reviews every five years. Coordination with state and local authorities might be required in the future for making appropriate decisions with regard to additional remedial activities.

- **Availability of Services and Materials**

No services or materials would be required for this alternative.

Cost

There would be no capital or O&M costs associated with this alternative.

4.2.2 Alternative S-2: Institutional Controls

4.2.2.1 Description

Alternative S-2 consists of public awareness and education measures, a deed restriction, and five-year reviews. This alternative would be implemented at the Cattaraugus Cutlery Area, which has been identified in the BHHRA of the RI Report as an area of concern relative to exposure to contaminated soil.

The public awareness and education measures would be for residents and workers in the vicinity of the Cattaraugus Cutlery Area. The program would include the preparation and distribution of informational press releases and circulars and the convening of public meetings. It would also involve the local government, various health departments, and environmental agencies.

Since this alternative does not provide for contaminant removal, a deed restriction would be used to prohibit future unrestricted use inconsistent with site conditions.

Because this alternative would result in contaminants remaining on the Cattaraugus Cutlery Area above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years.

4.2.2.2 Assessment

Overall Protection of Human Health and the Environment

The Institutional Control Alternative would entail no monitoring, removal, or treatment of TCE-contaminated soil. There may be a slow reduction of the volume of the TCE-contaminated soils due to natural volatilization, biodegradation, and flushing during stormwater infiltration. Since any volume contaminated soil reduction would be gradual, the exposure risks would be expected to remain the same. There is an ongoing potential for exposure to TCE-contaminated soils and migration of TCE to groundwater. The deed restriction would mitigate the potential for exposure

to contaminated soils by limiting future site uses. This alternative would not be protective of human health and the environment.

Compliance with ARARs

The Institutional Controls Alternative does not satisfy action-specific ARARs and no location-specific ARARs would be triggered by this alternative, there are no floodplains, wetlands, or endangered species present at the Cattaraugus Cutlery Area that would be impacted by implementation of this alternative. There are no TCE-specific ARARs. This alternative would not comply with New York State's soil cleanup objectives as specified in the soil TAGM.

Long-Term Effectiveness and Permanence

The Institutional Controls Alternative provides minimal reduction in risk. Long-term risks associated with the Institutional Controls Alternative are related to the potential baseline human health risks. These risks would still exist through the potential soil exposure pathways (*i.e.*, ingestion, absorption, and inhalation), but exposures may be mitigated through public awareness and education measures and the deed restriction.

As required by CERCLA, review and evaluation of site conditions would be performed every five years. If justified by the review, additional remedial actions could be required. This alternative would be minimally effective over the long-term because TCE-contaminated soils would remain in place.

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative does not include any containment, treatment, removal, or disposal actions, and would leave the contaminated soils in place. There may be a slow reduction of the toxicity and volume of the TCE-contaminated soils due to natural volatilization, biodegradation, and flushing during stormwater infiltration. However, the mobility of the TCE would remain unchanged during this time period and the potential for continued contribution to the groundwater would also remain unchanged. This alternative would not result in reduction of toxicity, mobility, or volume through treatment.

Short-Term Effectiveness

There are no provisions for remedial action under this alternative. Therefore, there are no short-term impacts and there would be no substantive, anticipated risk to the community or workers.

It is anticipated that it would take approximately three months to develop materials for the public awareness and education measures and the deed restriction, and an additional three months to implement these measures.

Implementability

- **Technical Feasibility**

The public awareness and education measures, five-year reviews, and monitoring program are well developed activities, and would all be easily implemented.

- **Administrative Feasibility**

This alternative would require administrative coordination for performance of site reviews every five years. Coordination with state and local authorities might be required in the future for making appropriate decisions with regard to additional remedial activities. Coordination with property owner would also be required for implementation of the deed restriction.

- **Availability of Services and Materials**

All of the services and materials needed for public awareness and education measures, and implementation of a deed restriction are commercially available and proven. Numerous vendors would be available for competitive bidding.

Costs

Data in support of the cost estimates are provided in Appendices A and B.

The total capital cost for implementing institutional controls at the Cattaraugus Cutlery Area is estimated to be $20,250. There are no O&M costs associated with this alternative.

4.2.3 Alternative S-3: *In-Situ* Soil Vapor Extraction

4.2.3.1 Description

Alternative S-3 would include a pre-design investigation, field pilot testing, and *in-situ* treatment by *in-situ* soil vapor extraction (ISVE). The pre-design investigation would be performed to more completely delineate the extent of TCE-contaminated soil at the Cattaraugus Cutlery Area. This investigation would also include field pilot testing of ISVE. The results of the pre-design investigation will provide the additional data necessary to determine the number and placement of ISVE wells in order to effectively remediate the TCE-contaminated soil at Cattaraugus Cutlery Area.

The implementation of ISVE under Alternative S-3 would address the RAOs through prevention of human exposure to TCE in the soil and removal of a high percentage of TCE from the subsurface. Figure 4-1 shows the conceptual ISVE treatment area, developed based on the currently-available data.

Utilizing grain size analyses and the visual soil classifications presented in the RI Report (TtFW, 2005), the Cattaraugus Cutlery Area subsurface soils have been found to be predominantly granular with estimated typical permeabilities of 2.1 x 10-2 cm/sec. These granular soils are interlayered with

finer-grained soils whose plasticity indices average six percent, and whose permeabilities are estimated to be three orders of magnitude less than those of the granular soils. Because the granular soils are the predominant type, and because the layering is generally horizontal, ISVE within the geologic formation is expected to be effective. However, the effectiveness of soil vapor extraction at the Cattaraugus Cutlery Area would need to be verified during pilot testing. The ISVE system would utilize two 4-inch diameter PVC wells, screened from near surface to approximately 5 to 10 feet bgs. The extracted vapors would be treated to air emissions standards with activated carbon. Note that the conceptual treatment area, and the number of wells, may be modified based on the pre-design investigation results.

Because the contaminated soils would be treated under this alternative there would be no need for institutional controls, five-year reviews, or long-term monitoring.

4.2.3.2 Assessment

Overall Protection of Human Health and the Environment

This alternative would prevent human and ecological exposure to contaminants in the soils and the migration of contaminants from soil to groundwater.

Compliance with ARARs

This alternative would meet the action level with respect to TCE at the Cattaraugus Cutlery Area because ISVE treatment is a proven method for removing volatile organics from the soil, and the extracted vapors would be treated via carbon adsorption. This alternative would be completed in compliance with action- and location-specific ARARs.

Alternative S-3 activities would be performed in accordance with appropriate criteria, advisories and guidances, and would fulfill the RAOs. This alternative fulfills the RAOs because it prevents human exposure to TCE in the surface and subsurface soils at the Cattaraugus Cutlery Area, and mitigates the migration of TCE from soil to groundwater.

Long-Term Effectiveness and Permanence

ISVE is a well established technology and would be effective in removing TCE from the soils within the treatment zone. Pilot testing would be required for the purpose of evaluating and characterizing the extracted soil vapors and determining the radius of influence and other performance parameters. These data would be used in the system design evaluation, and the system performance would be monitored with extracted vapor measurements and soil borings.

This alternative would generate treatment residuals which would have to be appropriately handled.

Reduction of Toxicity, Mobility, and Volume Through Treatment

ISVE would result in the removal of a high percentage of the TCE that is believed to be entrained in the soil. The contaminant would be extracted from the soil in the vapor phase, sorbed onto

activated carbon to achieve air stream removal, and the carbon would be transported off site for treatment and disposal or regeneration in accordance with regulations. Therefore, the volume of soil contaminated with TCE would be reduced. Because ISVE would reduce TCE concentrations significantly, the extent of residual contamination after the treatment would be limited. Therefore, the potential for gravity drainage induced migration from soil to groundwater would be less. Also, at reduced overall concentrations, the potential for vapor phase migration by molecular diffusion driven by concentration gradients, or by vapor flow driven by pressure gradients caused by changes in barometric pressure, would be less. Therefore, the mobility of any residual TCE in the subsurface would also be reduced.

Short-Term Effectiveness

Risk due to inhalation of organic vapors generated during the operation of the ISVE system would exist for construction workers and the public. This risk would be mitigated by multiple measures. First, the ISVE system would be secured. Second, the system would be visited on a periodic basis by a trained operator who would use field instruments to check for fugitive emissions. Third, the captured vapors would be entirely enclosed within sealed vessels and pipes, would be treated with primary and secondary carbon units, and after treatment would be discharged through a vertical stack designed to meet emission requirements.

Other short-term impacts would include the risk of an increase in equipment noise within the Cattaraugus Cutlery Area and the risk of fire. The noise would be mitigated by insulating the interior of the remediation shed that would house the vacuum and treatment systems. The fire potential would be mitigated by isolating the shed in the yard at a distance from other structures and by designing the shed interior as a hazardous location with all appropriate interior equipment to be intrinsically safe or explosion proof.

It is anticipated that the measures planned under Alternative S-3 could be completed/implemented within 9 months subsequent to initiation (6 months for design and 3 months for construction). The ISVE remedial action effort would begin upon completion of the construction and that effort would be ongoing for an estimated treatment period of 12 months.

Implementability

- **Technical Feasibility**

ISVE is well established and is a known viable technology for the removal of VOCs in the unsaturated zone in reasonably permeable soils. The performance of a field pilot test is expected to confirm the viability of ISVE technology for the Cattaraugus Cutlery Area. There is sufficient space in the Cutlery yard for all of the subsurface and aboveground ISVE utilities. All of the components for this technology are commercially available and easy to obtain. The needed wells, remediation compound, equipment, carbon units, and utilities can be installed and operated with standard and readily available equipment, materials, and methods.

- **Administrative Feasibility**

Implementation of ISVE, because the system would be located in a secure remediation compound, would not require site access restrictions other than to the compound. The off-site transportation of the carbon unit for treatment and disposal or regeneration would require compliance activity by the carbon supplier.

- **Availability of Services and Materials**

ISVE would require equipment, materials and supplies, carbon units and suppliers, remediation compound materials and installation, ISVE wells, observation wells, utility trenches, a power drop, and various controls, instruments, and accessories. All of these items are readily available from multiple vendors.

Costs

Data in support of the cost estimates are provided in Appendices A and B.

The total capital cost for this alternative at the Cattaraugus Cutlery Area is estimated to be $275,265. There are no O&M costs associated with this alternative.

4.2.4 Alternative S-4: Excavation/Off-Site Disposal

4.2.4.1 Description

Alternative S-4 for the Cattaraugus Cutlery Area involves excavation of TCE-contaminated soils, protection of adjacent structures during excavation, post-excavation confirmatory sampling, backfilling, and restoration. Alternative S-4 is formulated as a remedial alternative that would address the RAOs by excavation and removal of contaminated soils. Because the contaminated soils would be removed from the Site, there would be no need for institutional controls, five-year reviews, or long-term monitoring. A pre-design investigation would be performed to more completely delineate the extent of TCE-contaminated soil for removal.

Excavation would proceed at the area identified in Figure 4-2 for the Cattaraugus Cutlery Area. It is anticipated that approximately 222 cubic yards of soil would be removed from the Cattaraugus Cutlery Area. Depending on soil properties adjacent to buildings, bracing may be needed to facilitate the excavation while protecting adjacent buildings. Note that these areas and volumes may be modified based on the results of the pre-design investigation.

Upon completion of the excavation to the planned depths, post-excavation confirmatory TCE soil sampling would be performed. In the event that soils with contaminant concentrations exceeding action levels were encountered during the post-excavation sampling, these soils would also be excavated.

After excavation of contaminated soils, the excavations would be backfilled with select fill and compacted, and the surface would be restored to its original condition.

It should be noted that the estimated soil excavation and removal could be greater, due to the inclusion of any contaminated soils encountered during the sampling and during the post-excavation confirmatory sampling.

Any excavated debris would be decontaminated and transported off site for disposal in accordance with disposal regulations. The excavated soil would be subjected to analysis for disposal parameters. The soils would then be containerized and trucked off-site for treatment and disposal.

4.2.4.2 Assessment

Overall Protection of Human Health and the Environment

This alternative would prevent human and ecological exposure to contaminants in the soils and the migration of contaminants from soil to groundwater.

Compliance with ARARs

This alternative would meet the action level with respect to TCE at the Cattaraugus Cutlery Area since the source of contamination would be removed from the Site for off-site treatment and disposal. This alternative would also be completed in compliance with action- and location-specific ARARs. There are no floodplains, wetlands or endangered species present at the Cattaraugus Cutlery Area that would be impacted by implementation of this alternative.

Alternative S-4 activities would all be performed in accordance with appropriate criteria, advisories, and guidances. This alternative fulfills the RAOs because it prevents human exposure to TCE in the surface and subsurface soils at the Cattaraugus Cutlery Area, and mitigates the migration of TCE from soil to groundwater.

Long-Term Effectiveness and Permanence

The excavation and removal of TCE-contaminated soils which exceed action levels from the Cattaraugus Cutlery Area, followed by backfilling and restoration, would prevent human exposure to soil contaminants and mitigate the migration of TCE from soil to groundwater by removal of the TCE-contaminated soils. Therefore, Alternative S-4 would provide a long-term effective means of addressing the RAOs, and would not result in adverse impacts to streams, wetlands, or floodplains.

Reduction of Toxicity, Mobility, or Volume through Treatment

Soils with contaminant concentrations in excess of action levels for TCE would be excavated and removed from the Site, treated on an as-needed basis, and properly disposed of. It would result in a significant reduction of the volume of TCE-contaminated soil.

Short-Term Effectiveness

The potential public health threats to workers and persons in nearby areas would be managed using engineered controls to minimize dust and fugitive emissions and by restricting public access to the

area during remediation. Soil erosion controls would also be implemented to mitigate impacts to nearby waterways.

It is anticipated that the design would be completed within six months and the remedial effort would be complete within three months after that time. Because the contaminated soils would be excavated and removed from the Site, there would be no need for institutional controls, five-year reviews, or long-term monitoring.

Implementability

- **Technical Feasibility**

All of the components of this remedial alternative are well developed and commercially available. Excavation, sheeting and bracing (if necessary), any associated pavement and concrete demolition, testing, containerizing, trucking, off-site treatment and disposal, backfilling and compaction, and restoration can be performed with standard and readily available equipment, materials and methods, including the use of a RCRA permitted treatment and disposal facility, if required.

- **Administrative Feasibility**

The implementation of Alternative S-4 would require public access restrictions during the remediation process. It would be necessary to procure an off-site treatment and disposal facility(s) to handle the types and volumes of debris and soils that are to be excavated and removed from the site. Coordination with state and local agencies would be required. The transportation of hazardous waste to an off-site facility would require appropriate permits and coordination with the United States Department of Transportation (USDOT) and with the local traffic department. Traffic control plans would be required before remediation. The off-site treatment and disposal facility(s) selected would have to be in compliance with federal and state regulations.

- **Availability of Services and Materials**

Permitted treatment and disposal facilities are available with sufficient capacity for landfilling the materials that are to be removed. Earthwork, sheeting and bracing, waste handling, transportation, and testing services are readily available.

Costs

Data in support of the cost estimates are provided in Appendices A and B.

The total capital costs for implementing this alternative at the Cattaraugus Cutlery Area is $135,825. There are no O&M costs associated with this alternative.

4.3 Alternative Analysis for Groundwater (GW)

4.3.1 Alternative GW-1: No Action

4.3.1.1 Description

The Superfund program requires that the No Action Alternative be considered as a baseline for comparison with the other alternatives. The No Action remedial alternative would not include any physical remedial measures to address the groundwater contamination at the Site.

Because this alternative would result in contaminants remaining on-property above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years.

4.3.1.2 Assessment

Overall Protection of Human Health and the Environment

The No Action Alternative would entail no monitoring, removal, or treatment of the contaminated groundwater. Therefore, this alternative would not actively reduce the risk of human exposure to contaminants through ingestion, inhalation, and dermal contact. Additional migration of contaminants would occur over time if the Cattaraugus Cutlery Area source area is not addressed. However, the average concentration of TCE in the private wells is decreasing and all of the affected wells are protected with treatment systems. It is estimated that this alternative would meet state and federal groundwater standards through natural attenuation at the Bush Industries Area in approximately 10 years if the source area is addressed. The time frame for natural attenuation to reduce the groundwater concentration of TCE to the standard (5 ppb) was estimated by graphically evaluating the reduction in TCE concentration from December 2000 to November 2003 at several wells at the Bush Industries Area, specifically MW-D1, MW-D2, MW-2, and MW-3. Although adequate data were not available for other specific wells within the plume to perform this analysis, a similar trend was observed in the median and average concentrations for residential wells located within the downgradient plume. For residential wells in the plume downgradient of the source areas, it was estimated graphically that the TCE standard (5 ppb) may be achieved in approximately 8 years based on median and average concentrations.

Compliance with ARARs

EPA and the New York State Department of Health (NYSDOH) have promulgated health-based protective MCLs (40 CFR Part 141, and 10 NYCRR, Chapter 1), which are enforceable standards for various drinking water contaminants (chemical-specific ARARs). The aquifer at the Site is classified as Class GA (6 NYCRR 701.18), meaning that it is designated as a potable water supply. The No Action Alternative does not include any active groundwater remediation; groundwater ARARs would be achieved through natural attenuation within an estimated 10 years.

Long-Term Effectiveness and Permanence

Alternative GW-1 does not address the RAOs, because no controls would be provided and contaminated groundwater with TCE concentrations in excess of action levels would be left in the area and would continue to migrate downgradient. Potential long-term human exposure and environmental impacts would continue to exist.

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would not use active treatment to reduce toxicity, mobility, or volume of the groundwater contaminants.

Short-Term Effectiveness

Since no remedial activities will be performed under this alternative, no short-term risks to remediation workers or the surrounding community and no significant impacts to public health and the environment will occur during implementation.

Implementability

- **Technical Feasibility**

The technical feasibility of this alternative would be very high, since no remedial activities or monitoring would be performed.

- **Administrative Feasibility**

This alternative would require administrative coordination in performing site reviews every five years. Coordination with state and local authorities may be required in the future making decisions regarding future remedial activities, if any.

- **Availability of Services and Materials**

No services or materials would be required for this alternative.

Costs

There would be no capital or O&M costs associated with this alternative.

4.3.2 Alternative GW-2: Site-Wide Monitored Natural Attenuation/Institutional Controls

4.3.2.1 Description

Alternative GW-2 includes monitored natural attenuation, public awareness and education measures, and deed restrictions. Figure 4-3 shows the existing well locations for the monitored natural attenuation program where wells would be sampled annually to monitor the groundwater plume.

Note that specific wells and parameters for monitoring would be re-evaluated and could be modified during design and implementation of this alternative. Because this alternative would result in contaminants remaining on-property above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years.

The public awareness and education program would include liaison with public officials and authorities, public meeting, mailers, and notices. Institutional controls would be provided to restrict the installation of new wells and to restrict the use of water from existing wells at and around the area.

An MNA report was prepared in May 2004 (Appendix C). Although the report indicates that the Site conditions are not conducive to reductive dechlorination, other natural attenuation mechanisms, such as dispersion and adsorption, are contributing to TCE attenuation.

The MNA long-term monitoring program would utilize approximately 24 existing monitoring wells and piezometers. Groundwater samples would be obtained along with appropriate quality assurance/quality control samples and analyzed for dissolved oxygen, nitrate, iron II, sulfate, methane, chloride, hydrogen, PCE, TCE, cis-1, 2-DCE, vinyl chloride, 1,1,1-TCA, carbon tetrachloride, chlorethane, ethene, ethane, chloroform, ORP, pH, TOC, temperature and alkalinity. The intent of the program would be to monitor the downgradient migration of TCE in the groundwater and to monitor changes in groundwater quality. As discussed in Alternative GW-1, it is estimated that the groundwater standard for TCE (i.e., 5 ppb), could potentially be achieved in approximately 10 years at the Bush Industries Area and approximately 8 years in the plume downgradient of the source areas. This alternative would provide a mechanism to monitor the progress toward that goal.

4.3.2.2 Assessment

Overall Protection of Human Health and the Environment

Alternative GW-2 does not provide for the containment, removal, or treatment of contaminated groundwater in a timely manner and therefore would not be protective of the environment. Therefore, this alternative would not actively reduce the risk of human exposure to contaminants through ingestion, inhalation, and dermal contact. Additional migration of contaminants would occur over time if the Cattaraugus Cutlery Area source area is not addressed. However, the average concentration of TCE in the private wells is decreasing and all of the affected wells are protected with treatment systems. It is estimated that this alternative would meet state and federal groundwater standards through natural attenuation in approximately 10 years if the source area is addressed. Until groundwater standards are met, there would be a continued risk of human exposure to the contaminated groundwater. This risk would be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

Compliance with ARARs

This alternative does not include any active groundwater remediation; groundwater ARARs would be achieved through natural attenuation within an estimated 10 years after a source control remedy is implemented.

Long-Term Effectiveness and Permanence

Alternative GW-2 does not address the RAOs because no controls would be provided. Contaminated groundwater with TCE concentrations in excess of action levels would be left in the area and would continue to migrate downgradient. Potential long-term human exposure and environmental impacts would continue to exist.

Until groundwater standards are met, there would be a continued risk of human exposure to the contaminated groundwater. This risk would be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

Reduction of Toxicity, Mobility or Volume through Treatment

This alternative would not use active treatment to reduce toxicity, mobility, or volume of the groundwater contaminants.

Short-Term Effectiveness

No major construction would be involved in this alternative. Therefore, there would be no short-term threats to neighboring communities and no significant impacts on public health and the environment during implementation activities. A minor potential exists for the groundwater sampling crew to contact contaminated groundwater and soil, but it could be minimized by utilizing proper protective equipment.

It is anticipated that the planned measures could be implemented within three months and that the monitoring program would be ongoing from that time forward.

Implementability

- **Technical Feasibility**

The monitoring program that has been designed for this site, using existing monitoring wells, would be easily implemented and would be effective in monitoring the downgradient migration of groundwater contaminants and the change in groundwater quality across the area. The five-year review program, public awareness, education program would be easily implemented.

- **Administrative Feasibility**

Long-term management would be associated with this alternative. Time would have to be allocated to implement the public awareness and education program, the long-term monitoring program would

have to be implemented, and the five-year review program would have to be maintained. In addition, the development and performance of the monitoring program would necessitate the involvement of environmental and public health agencies, including EPA, NYSDEC, and CCHD. Local government involvement would be required to implement the institutional controls.

- **Availability of Services and Materials**

The monitoring equipment and analytical laboratories that would be needed for the monitoring program are commercially available and utilize proven technologies. Numerous vendors would be available for competitive bidding.

Costs

Data in support of the cost estimates are provided in Appendices A and B. There is no capital cost for this alternative. The annual O&M cost would be approximately $33,915. The present worth, calculated at a discount rate of seven percent, would be approximately $238,205.

4.3.3 Alternative GW-3: Source Area Extraction/Treatment/Discharge/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume

4.3.3.1 Description

Alternative GW-3 includes public awareness and education measures, five-year reviews, long-term monitoring, water use restrictions, field pilot testing (pump testing), groundwater extraction from the Cattaraugus Cutlery and Bush Industries areas by deep well pumping, collection, treatment to discharge standards, discharge to surface water, and performance monitoring including the installation of new monitoring wells and sampling of new and existing wells. It also includes monitored natural attenuation of the downgradient plume. Figures 4-4a and 4-4b show the extraction wells and groundwater treatment system.

The public awareness and education measures, five-year reviews, and long-term monitoring would be as described under Alternative GW-2. Institutional controls would be provided to restrict the installation of new wells and to restrict the use of water from existing wells at and around the area.

Pilot pump testing would be required at the Cattaraugus Cutlery and Bush Industries areas to determine final pumping rates, well spacing, well location, and screen depths.

Conceptually, the extraction system at the Cattaraugus Cutlery Area would consist of two 6-inch diameter stainless steel wells, screened in the regional water table aquifer from depths of 30 to 50 feet bgs, and fitted with electric submersible pumps with float controls. The wellheads would be standard stickup casings with power and control wires feeding into the wellhead through conduit and the discharge pipes.

The groundwater from the Cattaraugus Cutlery Area extraction wells would be pumped out of each of the wells at an estimated 30 gpm, through the collection piping and into the treatment works building. The flow would be combined and would be routed into an equilibration/sedimentation tank

with level controls. The treatment works unit operations after equalization/sedimentation would include chemical precipitation, dual media filtration and sludge management, air stripping, vapor polishing with carbon, and bag media filtration before discharge. The equipment for these operations would be housed within the building.

Conceptually, the extraction system at the Bush Industries Area would consist of two 6-inch diameter stainless steel wells, screened in the regional water table aquifer from depths of 40 to 60 feet bgs, and fitted with electric submersible pumps with float controls.

The groundwater from the Bush Industries Area extraction wells would be pumped out of each of the wells at an estimated 12 gpm, through the collection piping to a pumping station, and conveyed to the treatment works building located in the Cattaraugus Cutlery Area.

A clarifier unit would perform chemical precipitation with mixing tank followed by sediment collection sump and then with an overflow weir and discharge. Polymer flocculants would be added in the mixing tank, the precipitant would be removed from the bottom of the collection sump, and the clarified fluid would overflow the weir and be discharged.

The dual media filtration system would consist of a dual media pressure filter unit equipped with backwash pump and automatic controls. The filter backwash would be sent to a sludge thickener, with polymer flocculant added to enhance the thickening. The thickened sludge would be periodically pumped to a filter press system for dewatering, producing a sludge cake that would be at about 20 to 30 percent solids by weight. This sludge would be containerized for off-site treatment and disposal in accordance with regulations.

The air stripper would be low profile and accessible for inspection, cleaning, and repair. The stripper offgas would be carbon polished before discharge to the stack.

The bag media filter would be a simple, removable bag filter mounted in a pressure vessel and equipped with a pressure gauge.

The treated wastewater would be discharged to the Little Valley Creek, which is adjacent to the Cattaraugus Cutlery Area.

Performance and compliance monitoring would be undertaken, and the extraction, collection, and pumping facilities would be inspected, maintained, and repaired as needed. The pump and treat program is anticipated to last for a period of approximately 8 years. It is also anticipated that 8 years (concurrent with the pump and treat operation) would be required for the downgradient plume to reach federal and state groundwater standards through natural attenuation.

4.3.3.2 Assessment

Overall Protection of Human Health and the Environment

It is estimated that Alternative GW-3 measures could be implemented in approximately 18 months (12 months for design and 6 months for construction). The pump and treat program would last for

8 years. Natural attenuation of the downgradient plume for approximately 8 years is anticipated for the federal and state groundwater standards to be achieved as discussed previously. Under this alternative, timely control of potential human exposure to groundwater contaminants would be achieved, and the downgradient migration of contaminants in the groundwater would be mitigated. Long-term groundwater and system performance monitoring would be required to demonstrate effectiveness, and institutional controls would be maintained until the completion of the remediation. Until groundwater standards are met, there would be a continued risk of human exposure to the contaminated groundwater. This risk would be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

Compliance with ARARs

This alternative would comply with contaminant-specific ARARs because the extraction and treatment alternative is designed to reduce TCE concentrations to below groundwater standards and to mitigate downgradient migration. This alternative would be completed in compliance with action-specific and location-specific ARARs, including permit requirements for discharge to a nearby tributary to Little Valley Creek and would cause no adverse impacts to the stream.

Alternative GW-3 activities would all be performed in accordance with the appropriate criteria, advisories, and guidance.

Long-Term Effectiveness and Permanence

The major benefits associated with this alternative include control of potential human exposure to TCE-contaminated groundwater, mitigation of downgradient migration of contaminated groundwater within the regional water table aquifer, and removal of TCE from the aquifer. There would be a slight increase in the stream base flow during the remediation that would not be harmful. The remediation would continue until the groundwater-monitoring program showed that the concentrations of TCE in the aquifer were below the action level. The long-term risks associated with this alternative would be that workers would be exposed to groundwater contaminants during the operation of the remediation system, and during the handling of treatment chemicals and residuals. These risks would be mitigated by the use of qualified operators utilizing effective procedures and proper personal protection equipment (PPE).

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative includes removal, treatment, and disposal (discharge) actions. Alternative GW-3 would result in removal of contaminated groundwater from the regional water table aquifer. The water would be treated to surface water discharge standards and discharged to an adjacent on-site stream, thereby returning the water to the environment.

Due to the removal (extraction) of TCE-contaminated groundwater from the aquifer, the volume of the contaminated media would be reduced over time.

As the volume of contaminated groundwater decreased (via extraction), the *in-situ* concentrations of the remaining groundwater would begin to decrease. This reduction would lower the potential

for advective and diffusive migration of groundwater contaminants in excess of action levels. Therefore, mobility would be reduced.

While the chemical-specific toxicity of any TCE left resident in the groundwater would remain unchanged, but the overall groundwater toxicity would decline as the concentrations of TCE were reduced.

Short-Term Effectiveness

Short-term risks to workers and to the public would be incurred during the implementation of this alternative. These risks would be from potential direct contact with contaminated groundwater in the event of leaks or accidental discharges, and from potential exposure to fugitive dust or emissions related to the trenching, well, sump, or enclosure installation work. The risks would be mitigated by the use of qualified, trained workers, by the use of process controls such as alarms and failsafe shutdowns, access restrictions, dust control measures such as wind screens and water sprays, and procedural controls and PPE.

Additional short-term risks to workers and the public would occur due to increased traffic during the construction, and from possible traffic conflicts during installation of the utilities. These risks would be mitigated by planning, implementing safety procedures, and by liaison with the public and with associated agencies and authorities.

It is anticipated that the activities associated with this alternative could be implemented/completed within 18 months (12 months for design and 6 months for construction). The institutional controls would then be in place thereafter. The pump and treat program is anticipated to last for a period of approximately 8 years. It is also anticipated that 8 years (concurrent with the pump and treat operation) would be required for the downgradient plume to reach federal and state groundwater standards through natural attenuation.

Implementability

- **Technical Feasibility**

The technical feasibility of the long-term monitoring, five-year review, and public awareness and education components has been previously described under Alternative GW-2. These components would be feasible and easy to implement.

The primary process steps in Alternative GW-3 (removal, treatment, and discharge) are well developed and used extensively in the remediation of groundwater. All of the needed processes, equipment, materials, and services are reliable and readily available. To ensure the effective operation of the system and to comply with ARARs, an experienced, trained operator would be assigned to the system so that the needed monitoring, adjustment, maintenance, and repair activity could take place in a timely manner during operation. Performance monitoring would be implemented in the form of weekly monitoring and monthly discharge sampling and analysis, and the system would be adjusted as needed to respond to the monitoring results.

- **Administrative Feasibility**

Alternative GW-3 would require extensive short-term and long-term institutional management to ensure proper operation, maintenance, and overall execution of the alternative. Compliance with EPA, USDOT, and New York State groundwater withdrawal, treatment works operations, surface water discharge, and residual disposal regulations would be required. Liaison and cooperation with the County, local landowners, officials, and authorities would be required to accomplish the installation of the needed surface and subsurface facilities.

Long-term groundwater monitoring, such as performance and effectiveness sampling, would be required to measure the performance of the remediation system, including frequent reviews that would be essential in assessing the effectiveness of this alternative. The system operation (i.e., pumping rates and cycles) would be adjusted based on evaluations of aquifer extraction stresses, capture effectiveness, changes in groundwater quality, and degree of migration. Local government involvement would be required to implement the institutional controls.

- **Availability of Services and Materials**

Space for the treatment compound and equipment is limited but should be sufficient at the Site, and it is anticipated that the space and access needed to install the subsurface facilities such as wells, utility trenches and the conveyance trench would be forthcoming with minimal difficulty.

All of the materials, equipment, and services needed to implement Alternative GW-3 are readily available, and multiple vendors are available for bidding purposes.

Costs

Data in support of the cost estimates are provided in Appendices A and B. The total capital cost for this alternative is estimated to be $2,563,805. The annual O&M cost would be approximately $553,823 for the first 8 years and $33,915 for years 9 and 10. The present worth, calculated at a discount rate of seven percent, would be approximately $5,915,164.

4.3.4 Alternative GW-4: Source Area *In-Situ* Air Sparging/Vapor Treatment/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume

4.3.4.1 Description

Alternative GW-4 for the Site consists of public awareness and education measures, five-year reviews, water use restrictions, a field pilot test program, *in-situ* air sparging (AS), capture of contaminated vapors with soil vapor extraction methods, treatment of the captured vapors, and MNA of the groundwater plume. This alternative could be implemented at the Cattaraugus Cutlery and Bush Industries Areas to address the elevated TCE concentrations in groundwater beneath these areas. Figures 4-5a and 4-5b show Alternative GW-4 and its components.

The public awareness and education measures, water use restrictions five-year reviews, and long-term monitoring would be as described in Alternative GW-2.

Utilizing grain size analyses and the visual soil classifications presented on the boring logs in the RI Report for the Bush Industries Area, the saturated zone and vadose zone soil permeabilities in the treatment target area are in excess of 10^{-4} cm/sec. It should be noted that, although the permeability of the Bush Industries Area is less than that of the Cattaraugus Cutlery Area (2.1×10^{-2} cm/sec), the difference is not substantial and the subsurface conditions are still believed to be viable for AS supported by ISVE. Pilot testing would be required at the Cattaraugus Cutlery Area and Bush Industries Areas for the purpose of evaluating and characterizing the extracted soil vapors and determining radius of influence and other performance parameters. The data obtained would then be used to optimize the AS and ISVE well design and spacing.

The AS/ISVE remediation program at the Cattaraugus Cutlery Area is expected to utilize 6 AS wells and 3 ISVE wells. A 4-inch diameter PVC pressure manifold pipe would provide sparge air for the AS wells, and a 6-inch diameter PVC vacuum manifold pipe would collect extracted vapors from the ISVE wells. Each AS and ISVE wellhead would be accessible through a lockable well manhole (access box) that would be flush mounted. The well manholes would provide access to the manifold/wellhead connections and the connections would be fitted with metering valves, vacuum/pressure gauges, and sampling ports to provide balancing and control capability.

The AS remediation program at Bush Industries is expected to utilize 18 AS wells and 9 ISVE wells. The system would then be designed and constructed as detailed above for the Cattaraugus Cutlery Area.

Performance and compliance monitoring and testing would be undertaken. A qualified, trained operator would perform periodic inspection, maintenance, and repair activities. Spent carbon canisters would be transported off-site for as-needed treatment and disposal or regeneration.

The AS/ISVE remediation effort would likely be active for two years. The monitoring program would continue for up to 8 years (i.e., 6 years beyond the treatment period) to monitor the attenuation of the downgradient plume after source removal.

4.3.4.2 Assessment

Overall Protection of Human Health and the Environment

The operation of the AS/ISVE system in tandem with institutional controls would provide timely and long-term control of potential human exposure to groundwater contaminants and would mitigate the downgradient migration of contaminants in the groundwater to reduce risks to human health and the environment. Long-term groundwater and system performance monitoring would be required to demonstrate effectiveness and institutional controls would be maintained for the duration of the remediation activity to reduce future health risks with exposure to contaminated groundwater. Until groundwater standards are met, there would be a continued risk of human exposure to the contaminated groundwater. This risk would be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

Compliance with ARARs

This alternative would comply with contaminant-specific ARARs for TCE because air sparging extraction and vapor treatment would reduce TCE contaminant concentrations to below federal and state groundwater standards and would mitigate the migration of contaminated groundwater. This alternative would be completed in compliance with action-specific and location-specific ARARs.

Alternative GW-4 activities would all be performed in accordance with the appropriate criteria, advisories, and guidance.

Long-Term Effectiveness and Permanence

The major benefits associated with this alternative include the control of potential human exposure to groundwater contaminants, the mitigation of downgradient migration of contaminated groundwater within the regional water table aquifer, and the removal of contaminants from the aquifer. The remediation would continue until the groundwater-monitoring program showed that the concentrations of TCE in the aquifer had been reduced below action levels. The long-term risks associated with this alternative would be that workers would be exposed to soil vapor contaminants during the operation of the remediation system and during the handling of the carbon canisters. These risks would be mitigated by proper training, adherence to procedures, and the use of PPE.

Until groundwater standards are met, there would be a continued risk of human exposure to the contaminated groundwater. This risk would be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

Reduction of Toxicity, Mobility or Volume through Treatment

Air sparging and vapor treatment at the Cattaraugus Cutlery and Bush Industries areas would result in the removal of TCE from the groundwater in the regional water table aquifer. The vapors extracted from the groundwater would be treated by carbon adsorption prior to discharge, and the carbon canisters would be transported offsite for treatment and disposal or regeneration.

As the contaminated groundwater was treated by air sparging, the contaminant levels would be decreased to below action levels, and the migration of groundwater contaminants in excess of action levels would essentially cease downgradient of the AS wells. Therefore, the potential for advective and diffusive migration of groundwater contaminants in excess of action levels would be significantly reduced and mobility would be reduced.

The chemical-specific toxicity of any TCE left resident in the groundwater would remain unchanged, but the overall groundwater toxicity would fall as the concentrations of TCE were reduced. Therefore, toxicity would be reduced.

Short-Term Effectiveness

Short-term risks to workers and to the public would be incurred during the implementation of this alternative. These risks would be from potential direct contact with soil vapors in the event of

emissions, and from potential exposure to fugitive dust or emissions related to the trenching, well, or remediation compound installation work. Training would mitigate the risks by the use of process controls such as alarms and failsafe shutdowns.

Additional short-term risks to workers and the public would be from increased traffic during construction and from possible traffic conflicts during installation of the offsite utilities. Planning, implementing safety procedures, and liaison with the public, associated agencies, and authorities would mitigate these risks.

It is anticipated that the remedial construction measures could be completed/implemented within 18 months (12 months for design and 6 months for construction). The institutional controls, monitoring program and AS/ISVE remediation would likely be ongoing from that time forward. The AS/ISVE remediation effort would likely be active for two years. The monitoring program would continue for up to 8 years (i.e., 6 years beyond the treatment period) to monitor the attenuation of the downgradient plume after source removal.

Implementability

- **Technical Feasibility**

The technical feasibility of the long-term monitoring, water use restrictions five-year reviews, and public awareness and education components has been previously described under Alternative GW-2. Institutional controls have been described under Alternative GW-3. These components would all be easy to implement.

The primary process steps in Alternative GW-4, AS and soil vapor extraction, are well developed and have been used extensively in the remediation of groundwater. All of the needed processes, equipment, materials, and services are reliable and readily available. To ensure the effective operation of the system and to comply with ARARs, an experienced, trained operator would be assigned to the system so that the needed monitoring, adjustment, maintenance, and repair activities could take place in a timely manner during the operation. Performance monitoring would be implemented in the form of weekly monitoring and monthly compliance sampling and analysis, and the system would be adjusted as needed to respond to the monitoring results.

- **Administrative Feasibility**

Alternative GW-4 would require extensive short-term and long-term institutional management to ensure proper operation, maintenance, and overall execution of the alternative. Compliance with EPA, USDOT, and New York State rules and regulations would be required. Liaison and cooperation with the County and local landowners, officials, and authorities would be required.

Long-term groundwater monitoring would be required to measure the performance of the remediation system, including frequent reviews that would be essential in assessing the GW-4 effectiveness of Alternative GW-4. The system operation would be adjusted based on its performance. Local government involvement would be required to implement the institutional controls.

- **Availability of Services and Materials**

It is anticipated that the space and access needed to install the subsurface facilities, such as wells, utility trenches, and for the remediation compound, would be available.

All of the materials, equipment and services needed to implement Alternative GW-4 are readily available, and multiple vendors are available for bidding purposes.

Costs

Data in support of the cost estimates are provided in Appendices A and B. The total capital cost for this alternative is estimated to be $860,085. The annual O&M cost would be approximately $287,525 for the first two years and $33,915 for years 3 through 10. The present worth calculated at a discount rate of seven percent, would be approximately $1,556,465.

4.3.5 Alternative GW-5: Source Area *In-Situ* Chemical Oxidation/Institutional Controls with Monitored Natural Attenuation of the Downgradient Plume

4.3.5.1 Description

Alternative GW-5 consists of public awareness and education measures, groundwater monitoring, water use restrictions, bench-scale testing and field pilot testing, *in situ* chemical oxidation, performance monitoring and MNA of the downgradient plume. This alternative could be implemented at the Cattaraugus Cutlery and Bush Industries Areas to address the elevated TCE concentrations in groundwater beneath these areas. Figures 4-6a and 4-6b show Alternative GW-5 and its components.

The public awareness and education measures, water use restrictions, and monitoring would be as described under Alternative GW-2.

In-situ chemical oxidation is based on the fundamental principles of Fenton's chemistry. The process relies upon the *in-situ* creation of a powerful oxidizing agent (hydroxyl radicals) to destroy complex organics. The general approach is to catalyze hydrogen peroxide decomposition with iron (II) to produce the hydroxyl radicals. To produce a controlled reaction in the subsurface, the injected reactants are buffered with different proprietary substances depending on the vendor. The end products of the reaction between the hydroxyl radicals and the contaminants are carbon dioxide and water.

A key step in the program is bench-scale testing, which is performed on a groundwater sample from the target area, and run in tandem with control samples. The bench scale testing would be used early in the alternative implementation to verify the effectiveness of the process on the site-specific groundwater contaminants, and to identify optimum dose rate and catalyst mixes. If the bench testing was successful, then pilot testing would be undertaken.

The field pilot testing at both the Cattaraugus Cutlery and Bush Industries areas would include the installation of oxidant injection wells and performance observation wells, an injection test with

follow-up performance monitoring episodes, and sampling and analysis in the field by an analytical laboratory for oxidation performance parameters. Prior to the pilot testing, baseline conditions would be measured at each area. For this purpose, groundwater sampling would be performed at the injection wells and at the observation wells (which might be used for injection at a later time). The groundwater samples and appropriate quality assurance/quality control samples would be analyzed for TCL VOCs, TAL metals, total dissolved iron, total dissolved solids (TDS), and total organic carbon (TOC). Field parameters would be measured during the sampling and would include turbidity, dissolved oxygen (DO), oxygen reduction potential (ORP), conductivity, and temperature. During the injection testing in the field, the same field parameters would be measured in addition to *in-situ* changes in pressure, temperature, and mounding. At two, two-week intervals after the injection testing, additional groundwater sampling and analysis and field parameter measurement would be performed. In this manner, the oxidant impacts on the aquifer could be evaluated, potential dissolved metal releases could be monitored, and the effectiveness of the injection program could be assessed. If judged to be safe and effective, a full-scale remediation program could be undertaken.

Due to the lack of pilot test data, spacing and radius of impact assumptions must be made to evaluate the full-scale remedy. It is assumed that a 25-foot radius of influence would be effective for the injection effort. Based on this assumption, approximately 8 injection wells would be needed at the Cattaraugus Cutlery Area and approximately 54 injection wells would be needed at the Bush Industries Area for the remediation.

It is anticipated that *in-situ* oxidation would reduce TCE concentration to MCLs within approximately a 6 month treatment period. Groundwater monitoring would continue for approximately 8 years to assess the natural attenuation of the plume downgradient of the source areas.

4.3.5.2 Assessment

Overall Protection of Human Health and the Environment

Under Alternative GW-5, timely control of potential human exposure to groundwater contaminants would be achieved by the institutional controls to reduce risk to human health and the environment. Long-term control of exposure and mitigation of the downgradient migration of contaminants could be achieved based on the bench scale and field pilot testing results followed by full-scale remediation, thereby reducing future health risks with exposure to contaminated groundwater. Until groundwater standards are met, there would be a continued risk of human exposure to the contaminated groundwater. This risk would be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

Compliance with ARARs

This alternative would comply with contaminant-specific ARARs for TCEs because the *in-situ* oxidation is designed to reduce TCE contaminant concentrations to below federal and state groundwater standards and to mitigate downgradient migration. This alternative would be completed in compliance with action-specific and location-specific ARARs.

The Alternative GW-5 activities would all be performed in accordance with the appropriate criteria, advisories, and guidance.

Long-Term Effectiveness and Permanence

The major benefits associated with this alternative include control of potential human exposure to groundwater contaminants, mitigation of downgradient migration of contaminated groundwater within the regional water table aquifer, and removal of contaminants from the aquifer. The groundwater-monitoring program would show the long-term effectiveness of the action. The long-term risks associated with this alternative are primarily associated with the possibility of dissolved metal release into the aquifer. These risks would be mitigated by the use of bench-scale and pilot-scale testing to demonstrate safety and effectiveness prior to remediation.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative GW-5 would treat the groundwater by *in-situ* treatment methods to groundwater quality standards. Due to the treatment of contaminated groundwater in the aquifer, the volume of the contaminated media would be significantly reduced.

As contaminated groundwater is decreased, the *in-situ* concentrations of any remaining untreated adjacent groundwater would also begin to decrease. This reduction would lower the potential for advective and diffusive migration of groundwater contaminants in excess of action levels. Therefore, mobility would be reduced.

The chemical specific toxicity of any TCE left in the groundwater would remain unchanged, but the overall groundwater toxicity would fall as the concentrations of TCE were reduced. Therefore, toxicity would be reduced.

Short-Term Effectiveness

Minimal short-term risks to workers and to the public would be incurred during the implementation of this alternative. These risks would be related to the installation of the new wells and the injection and monitoring of the chemical oxidant. The risks would be mitigated by the use of qualified workers and by the use of process controls and access restriction.

Additional short-term risks to workers and the public would occur due to increased traffic during the remediation. Planning, implementing safety procedures, and liaison with the public, associated agencies, and authorities would mitigate these risks.

It is anticipated that the planned measures could be implemented/completed within 18 months (12 months for design and 6 months for remedial action). The groundwater monitoring program would continue for up to 8 years to monitor the attenuation of the downgradient plume after source removal.

Implementability

- **Technical Feasibility**

The technical feasibility of the monitoring water use restrictions and public awareness and education components has been described under Alternative GW-2.

The primary process steps in the Alternative GW-5, well installation and fluid injection into wells, are well developed and have been used extensively in the remediation of groundwater. The applicability of the process would be based on the bench scale and field pilot testing results. All of the other needed processes, equipment, materials, and services are reliable and readily available. In order to ensure the effectiveness of the remediation and to comply with ARARs, experienced and trained personnel would be assigned so that the needed mixing, injection, performance monitoring, adjustment, and cleaning activities could take place in a timely manner during the operation.

- **Administrative Feasibility**

Alternative GW-5 would require short-term and long-term institutional management to ensure proper operation, maintenance, and overall execution of the alternative. Compliance with EPA, USDOT, and New York State groundwater regulations would be required. Liaison and cooperation with the County and local landowners, officials, and authorities would be required to accomplish the installation of the needed subsurface facilities.

Long-term groundwater monitoring would be required to measure the performance of the remediation system, including reviews that would be essential in assessing the effectiveness of Alternative GW-5, and the natural attenuation of the downgradient plume. Local government involvement would be required to implement the institutional controls.

- **Availability of Services and Materials**

All of the materials, equipment, and services needed to implement Alternative GW-5 are readily available and multiple vendors are available for bidding purposes, including *in-situ* chemical oxidation vendors.

Costs

Data in support of the cost estimates are provided in Appendices A and B. The total capital cost for this alternative is estimated to be $1,506,060. The annual O&M cost would be approximately $33,915. The present worth, calculated at a discount rate of seven percent, would be approximately $1,744,265.

4.4 Comparison of Soil Remedial Alternatives

The results of the evaluation of each soil remedial alternative with respect to the seven evaluation criteria were presented in Section 4.2. This section provides a comparative analysis that evaluates the relative performance of each alternative in relation to each specific evaluation criterion. The

comparative analysis identified advantages and disadvantages of each alternative so that tradeoffs between the alternatives could be evaluated. A discussion of the comparative analysis is presented below and is presented in Table 4-1.

4.4.1 Overall Protection of Human Health and the Environment

Alternatives S-1 and S-2 would not be protective of human health and the environment, since they would not actively address the contaminated soils, which present unacceptable risks of exposure and are a source of groundwater contamination. Alternatives S-3 and S-4 would be protective of human health and the environment, since each alternative relies upon a remedial strategy or treatment technology capable of eliminating human exposure and removing the source of groundwater contamination.

4.4.2 Compliance with ARARs

There are currently no federal or state promulgated standards for contaminant levels in soils, only New York State soil cleanup objectives as specified in the soil TAGM (which are used as "To-Be-Considered" criteria).

Since the contaminated soils would not be addressed under Alternatives S-1 and S-2, they would not comply with the soil cleanup objectives. Alternatives S-3 and S-4 would attain the soil cleanup objectives specified in the TAGM.

Alternative S-4 would involve the excavation of contaminated soils and would, therefore, require compliance with fugitive dust and VOC emission regulations. In addition, this alternative would be subject to New York State and federal regulations related to the transportation and off-site treatment/disposal of wastes. In the case of Alternative S-3, compliance with air emission standards would be required for the ISVE system. Specifically, treatment of off-gases would have to meet the substantive requirements of New York State Regulations for Prevention and Control of Air Contamination and Air Pollution (6 NYCRR Part 200 *et seq.*) and comply with the substantive requirements of other state and federal air emission standards.

4.4.3 Long-Term Effectiveness and Permanence

Alternatives S-1 and S-2 would involve no active remedial measures and, therefore, would not be effective in eliminating the potential exposure to contaminants in soil and would allow the continued migration of contaminants from the soil to the groundwater. Alternatives S-3 and S-4 would both be effective in the long term and would provide permanent remediation by either removing the contaminated soils from the site or treating them in place.

Alternative S-3 would generate treatment residuals (e.g., spent carbon) which would have to be appropriately handled. Alternatives S-1, S-2 and S-4 would not generate such residuals.

4.4.4 Reduction of Toxicity, Mobility or Volume through Treatment

Alternatives S-1 and S-2 would provide no reduction in toxicity, mobility or volume. Under Alternative S-3, the toxicity, mobility, and volume of contaminants would be reduced or eliminated through on-site by treatment. Under Alternative S-4, the toxicity, mobility, and volume of the contaminants would be eliminated by removing the contaminated soil from the property.

4.4.5 Short-Term Effectiveness

Alternatives S-1 and S-2 do not include any physical construction measures in any areas of contamination and, therefore, would not present any potential adverse impacts to on-property workers or the community as a result of its implementation. Alternative S-3 could also result in some adverse impacts to on-property workers through dermal contact and inhalation related to the installation of ISVE wells through contaminated soils. Alternative S-4 could present some limited adverse impacts to on-property workers through dermal contact and inhalation related to excavation activities. Noise from the treatment unit and the excavation work associated with Alternatives S-3 and S-4 could present some limited adverse impacts to on-property workers and nearby residents. In addition, interim and post-remediation soil sampling activities would pose some risk. The risks to on-property workers and nearby residents under all of the alternatives could, however, be mitigated by following appropriate health and safety protocols, by exercising sound engineering practices, and by utilizing proper protective equipment.

Alternative S-4 would require the off-Site transport of contaminated soil (approximately 6 truck loads), which may pose the potential for traffic accidents, which in turn could result in releases of hazardous substances. For Alternative S-4, there is a potential for increased stormwater runoff and erosion during construction and excavation activities that would have to be properly managed to prevent or minimize any adverse impacts. For this alternative, appropriate measures would have to be taken during excavation activities to prevent transport of fugitive dust and exposure of workers and downgradient receptors to VOCs.

Since no actions would be performed under Alternatives S-1 and S-2, there would be no implementation time.

It is estimated that Alternative S-3 would require nine months to install the ISVE system and 12 months to achieve the soil cleanup objectives. It is estimated that it would take three months to excavate and transport the contaminated soils to an EPA-approved treatment/disposal facility under Alternative S-4.

4.4.6 Implementability

Alternatives S-1 and S-2 would be the easiest to implement, as there are no activities to undertake.

Both Alternatives S-3 and S-4 would employ technologies known to be reliable and that can be readily implemented. In addition, equipment, services, and materials needed for these alternatives are readily available, and the actions under these alternatives would be administratively feasible.

Sufficient facilities are available for the treatment/disposal of the excavated materials under Alternative S-4.

Monitoring the effectiveness of the ISVE system under Alternative S-3 would be easily accomplished through soil and soil-vapor sampling and analysis. Under Alternative S-4, determining the extent of the excavation could be easily accomplished through post-excavation soil sampling and analysis.

4.4.7 Cost

There would be no capital or O&M costs associated with Alternative S-1. The net present worths of Alternatives S-2, S-3 and S–4 are $20,250, $275,265 and $135,825, respectively.

4.5 Comparison of Groundwater Remedial Alternatives

The results of the evaluation of each groundwater alternative with respect to the seven evaluation criteria were presented in Section 4.3. This section provides a comparative analysis that evaluates the relative performance of each alternative in relation to each specific evaluation criterion. The comparative analysis identified advantages and disadvantages of each alternative so that tradeoffs between the alternatives could be evaluated. A discussion of the comparative analysis is presented below and is presented in Table 4-2.

4.5.1 Overall Protection of Human Health and the Environment

Alternatives GW-1 and GW-2 would meet state and federal groundwater standards through natural attenuation in reasonable time frames (estimated to be 10 years following mitigation of the current source of TCE in the soil). While no current risk is associated with the groundwater, Alternative GW-2 is more protective of human health than Alternative GW-1, since institutional controls would be implemented to prevent the installation and use of groundwater wells. Alternatives GW-3, GW-4, and GW-5 would actively address the contaminants in the groundwater at the source areas until concentrations are reduced to federal and state groundwater standards (estimated to be 8 years, 2 years, and 6 months, respectively). It would take an estimated 8 years to address the plume downgradient of the source areas under all of the alternatives. Although Alternatives GW-3, GW-4, and GW-5 would be more protective of human health than Alternatives GW-1 and GW-2 and would minimize the migration of contaminated groundwater, the groundwater is only marginally contaminated and there is no current risk associated with the groundwater, since many affected residential wells have treatment systems installed.

Until groundwater standards are met under Alternatives GW-2, GW-3, GW-4, and GW-5, there would be a continued risk of human exposure to the contaminated groundwater. For each of the alternatives this risk could be mitigated by public awareness and education measures and water use restrictions through deed restrictions.

4.5.2 Compliance with ARARs

EPA and NYSDOH have promulgated health-based protective MCLs (40 CFR Part 141, and 10 NYCRR, Chapter 1), which are enforceable standards for various drinking water contaminants (chemical-specific ARARs). The aquifer at the site is classified as Class GA (6 NYCRR 701.18), meaning that it is designated as a potable water supply. Alternatives GW-1 and GW-2 do not include any active groundwater remediation; groundwater ARARs would be achieved through natural attenuation within an estimated 10 years after the source control remedy is implemented. For Alternatives GW-3, GW-4, and GW-5, ARARs would be achieved through the removal and treatment of contaminants in the groundwater at the source area and through natural attenuation in downgradient areas. Alternatives GW-3, GW-4, and GW-5 would have to comply with surface water discharge requirements and the disposition of treatment residuals would have to be consistent with RCRA. Any air emissions associated with the treatment system would have to comply with air emission standards.

4.5.3 Long-Term Effectiveness and Permanence

It is anticipated that the groundwater alternatives would achieve groundwater ARARs within a reasonable time frame (i.e., 10 years). It is estimated that all of the alternatives would maintain reliable protection of human health and the environment over time.

Alternatives GW-3 and GW-4 would generate treatment residues (e.g., spent carbon) which would have to be appropriately handled; Alternatives GW-1, GW-2 and GW-5 would not.

4.5.4 Reduction of Toxicity, Mobility or Volume through Treatment

Alternatives GW-1 and GW-2 would not use active treatment to reduce toxicity, mobility, or volume of the groundwater contaminants. The other alternatives would provide a reduction of toxicity, mobility, and volume of the contaminated groundwater through treatment of the contaminated groundwater at the source area. All of the groundwater alternatives would rely upon natural attenuation to address the downgradient plume.

4.5.5 Short-Term Effectiveness

Alternatives GW-1 and GW-2 do not include any active remediation, therefore, they would not present an additional risk to the community or workers resulting from activities at the site. Alternatives GW-1 and GW-2 would present some risk to on-site workers through dermal contact and inhalation from groundwater sampling activities, which could be minimized by utilizing proper protective equipment. Alternatives GW-3, GW-4, and GW-5, which would require the installation of groundwater extraction, air sparging, and/or oxidation agent injection wells through potentially contaminated soils and groundwater, would present some risk to on-site workers through dermal contact and inhalation from construction and groundwater sampling activities. Noise from the treatment units associated with Alternatives GW-3, GW-4 and GW-5 could present some limited adverse impacts to on-site workers and nearby residents. The risks to on-site workers and nearby residents under all of these alternatives could, however, be minimized by following appropriate

health and safety protocols, exercising sound engineering practices, and utilizing proper protective equipment.

Based upon preliminary groundwater modeling, it has been estimated that the contaminated groundwater would naturally attenuate to groundwater standards at the source area in approximately 10 years (after mitigation of the current source of TCE in the soil) and downgradient of the source areas within 8 years. By comparison, Alternative GW-3 would achieve groundwater standards at the source area in an estimated 8 years, Alternative GW-4 would achieve groundwater standards at the source area in an estimated two years, and Alternative GW-5 would achieve groundwater standards at the source area in an estimated six months. Alternatives GW-3, GW-4, and GW-5 would achieve groundwater standards downgradient of the source areas in an estimated 8 years.

4.5.6 Implementability

Alternative GW-1 would be the easiest alternative to implement, since it would require no activities other than long-term monitoring. With the implementation of institutional controls, Alternative GW-2 would be slightly more difficult to implement than Alternative GW-1. Alternative GW-3 (groundwater extraction and treatment) would be the most difficult to implement in that it would require the construction of a groundwater extraction system and pipelines. The services and materials that would be required for the implementation of all of the groundwater remedial alternatives are readily available.

All treatment equipment that would be used in Alternatives GW-3, GW-4, and GW-5 are proven and commercially available. Transportation and disposal of treatment residues could be easily implemented using commercially-available equipment. Under these alternatives, sampling for treatment effectiveness and groundwater monitoring would be necessary, but could be easily implemented. For Alternative GW-5, the oxidant application rate and the rate of the oxidation reaction would need to be carefully monitored and adjusted, as needed, during implementation to ensure that the oxidants do not reach the private water supply wells and that the amount of heat and gases generated during the application of the oxidants are properly controlled.

4.5.7 Cost

There would be no capital or O&M costs associated with Alternative GW-1. The remaining alternatives have net present worth costs as follows: GW-2 ($238,205); GW-3 ($5,915,164); GW-4 ($1,556,465); and GW-5 ($1,744,265).

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6.0 GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AASHO	American Association of State Highway Officials
ARARs	Applicable or Relevant and Appropriate Requirements
AS	Air Sparging
AVM	American Voting Machine
BACT	Best Available Control Technology
BAT	Best Available Technology
BHHRA	Baseline Human Health Risk Assessment
BMPPT	Best Management Practices, Processes, and Technology
bgs	Below Ground Surface
CCHD	Cattaraugus County Health Department
CDPW	Cattaraugus Department of Public Works
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cf	Cubic Feet
cfm	Cubic Feet Per Minute
CO_2	Carbon Dioxide
CT	Central Tendency
DO	Dissolved Oxygen
DRE	Destruction and Removal Efficiency
DV	Daily Value
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
ETQ	Ecological Toxicity Quotient
fpd	Feet Per Day
FS	Feasibility Study
GAC	Granular Activated Carbon
gal	Gallons
gpm	Gallons Per Minute
GRA	General Response Actions
HAP	Hazardous Air Pollutants
HDPE	High Density Polyethylene
HI	Hazard Index
hp	Horsepower
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
ISOTEC	*In-Situ* Oxidative Technologies, Inc.
ISVE	*In-Situ* Soil Vapor Extraction
ISV	*In-Situ* Vitrification
LDR	Land Disposal Restriction
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
mph	miles per hour
MW	Monitoring Well
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan

NESHAP	National Emission Standards for Hazardous Air Pollutants
NSPS	New Source Performance Standards
NSR	New Source Review
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
O&M	Operation and Maintenance
ORP	Oxygen Reduction Potential
OSHA	Occupational Safety & Health Administration
OU	Operable Unit
PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
P&T	Pump and Treat
PEF	Particulate Emission Factor
PEM	Palustrine Emergent
POTW	Publicly Owned Treatment Works
PPE	Personal Protection Equipment
PRB	Permeable Reactive Barrier
PRG	Preliminary Remediation Goal
PSD	Prevention of Significant Deterioration
PSS	Palustrine Scrub Shrub
PVC	Polyvinyl Chloride
RA	Remedial Action
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDA	Recommended Daily Allowance
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SLERA	Screening Level Ecological Risk Assessment
SSL	Soil Screening Levels
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
TBCs	To be Considered
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TMV	Toxicity, Mobility and Volume
TOC	Total Organic Carbon
TOGS	Technical and Operational Guidance Series
TSD	Treatment, Storage and Disposal

TtFW	Tetra Tech FW, Inc.
UCL	Upper Confidence Limit
ug/L	Microgram per Liter
USDOT	United States Department of Transportation
USGS	United States Geologic Survey
UTS	Universal Treatment Standard
UV	Ultraviolet
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds

TABLE 2-1
LITTLE VALLEY SUPERFUND SITE
CONTAMINANT-SPECIFIC ARARs AND TBCs

	REQUIREMENTS	CITATION	DESCRIPTION	ARAR OR TBC	COMMENT
FEDERAL					
Surface Water	Ambient Water Quality Criteria Guidelines	40 CFR Part 131	Establishes toxicity based surface water quality criteria for protection of aquatic organisms and human health.	ARAR	Ambient water quality criteria are potentially applicable discharge limitations for treated groundwater to Little Valley Creek.
	Ambient Water Quality Criteria Guidelines	40 CFR Part 131	Establishes toxicity-based surface water quality criteria for protection of aquatic organisms and human health.	ARAR	Ambient water quality criteria would be potentially applicable in establishing discharge limitations for treated groundwater.
	New York State Regulations on the State Pollution Discharge Elimination System (SPDES)	6 NYCRR Parts 750-758	SPDES Permitting Requirements.	ARAR	Potentially applicable to discharges of treated groundwater to Little Valley Creek.
	New York State Water Classifications and Quality Standards	6 NYCRR Parts 701, 702, 704	Defines surface water classifications and ambient water quality standards that are the basis for establishing effluent limitations under the SPDES program.	ARAR	Little Valley Creek is classified as Class C surface water body.
	New York State Air Pollution Control Regulations	6 NYCRR Parts 120, 200-203, 207, 211, 211, 212, 219 Air Guide-1	Establishes emissions standards for new sources of air pollutants and specific contaminants.	ARAR	Requirements would be applicable to remediation alternatives that result in emissions of air contaminants, including particulate matter.
STATE					
Soil Contamination	Soil Cleanup Goals	TAGM 4046	Establishes the basis and procedure for determining soil cleanup levels for individual contaminants at Superfund sites.	TBC	Contamination of site soils may be compared to TAGM (Technical and Administrative Guidance Memorandum) levels.
Groundwater Contamination	Drinking Water Standards	10 NYCRR 5	Establishes minimum standards for drinking water quality. Certain contaminant levels are classified as Maximum Contaminant Levels (MCLs).	ARAR	Contamination in groundwater used for drinking water supplies may be compared to these standards.
	Groundwater and Surface Water Quality Standards	6 NYCRR 703	Establishes groundwater quality and surface water standards and provides maximum concentrations for specified parameters.	ARAR	Contamination in excess of groundwater quality standards may require corrective actions. Surface water quality standards are potentially applicable to discharge limitations for treated groundwater to Little Valley Creek.

TABLE 2-2 (Sheet 1 of 5)
LITTLE VALLEY SUPERFUND SITE
ACTION-SPECIFIC ARARs AND TBCs

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	ARAR OR TBC	COMMENT
FEDERAL					
Generation, Management, and Treatment of Hazardous Waste	Identification and Listing of Hazardous Wastes	40 CFR Part 261	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 40 CFR Parts 260-266.	ARAR	These regulations do not set clean-up standards, but would apply during the management of excavated soils.
	Hazardous Waste Determinations	40 CFR Part 262.11	Generators must characterize their wastes to determine if the waste is hazardous by listing (40 CFR 261, Subpart D) by characteristic (40 CFR 261, Subpart C) or excluded from regulation (40 CFR 261.4).	ARAR	Excavated soils may be classified as characteristic or listed hazardous wastes. By-products or residues from the treatment of contaminated soils and groundwater must also be characterized.
	Manifesting	40 CFR 262, Subpart B	Generators must prepare a Hazardous Waste Manifest (EPA form 8700-22) for all off-site shipments of hazardous waste to disposal or treatment facilities.	ARAR	Will apply to all off-site shipments of RCRA/NYSDEC hazardous wastes.
	Recordkeeping	40 CFR 262.40	Generators must retain copies of all hazardous waste manifests used for off-site disposal.	ARAR	Generator must retain copies of waste manifests for a minimum period of three years after shipment date.
	Labeling and Marking	40 CFR 262, Subpart C	Specifies EPA marking, labeling and container requirements for off-site disposal of hazardous waste.	ARAR	Pre-transportation requirements for off-site shipments of hazardous wastes.
	Accumulation Limitations	40 CFR Part 262.34	Allows generators of hazardous waste to store and treat hazardous waste at the generation site for up to 90 days in tanks, containers, and containment buildings without having to obtain a RCRA hazardous waste permit.	ARAR	Hazardous wastes may be stored for up to 90 days on-site without the need to meet storage permit substantive requirements (unless NYSDEC waives the 90-day limit as an administrative requirement).
	General Facility Standards	40 CFR Part 264/265 Subpart B	General requirements for owners/operators of TSD facilities including general waste analysis and compatibility, notices and inspection requirements, location and construction standards, and security.	ARAR	These subpart standards would be applicable to any on-site treatment of excavated soils classified as hazardous waste.

TABLE 2-2 (Sheet 2 of 5)
LITTLE VALLEY SUPERFUND SITE
ACTION-SPECIFIC ARARs AND TBCs

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	ARAR OR TBC	COMMENT
Generation, Management, and Treatment of Hazardous Waste (Cont'd)	Closure and Post-Closure	40 CFR Part 264/265 Subpart G	Established closure and post-closure requirements for TSD facilities, including post-closure property uses.	ARAR	These subpart standards would be applicable to any on-site treatment of soils classified as hazardous waste.
	Container Management	40 CFR Part 264/265 Subpart I	Hazardous waste stored in containers must comply with management requirements, including types of containers used, waste compatibility and inspection requirements.	ARAR	Applicable to storage of hazardous wastes in containers on-site.
	Tank Systems	40 CFR Part 264/265 Subpart J	Tank systems for the treatment or storage of hazardous wastes are to be designed and operated in a manner to prevent releases to the environment.	ARAR	Applicable for the on-site treatment and/or storage in tanks of all site generated wastes classified as a hazardous waste.
Capping of Hazardous Waste	Standards for Capping Landfills	40 CFR Part 264/265 Subpart N	Regulations governing placement of caps or similar barriers over hazardous waste. Requirements for installation, permeability, maintenance of cover, elimination of free liquids or solidification, run-on/run-off damage control, and post-closure use of property.	ARAR	Requirements potentially applicable to the on-site disposal of hazardous waste excavated soils and associated residual waste streams.
Capping of Non-Hazardous Waste	Criteria for Classification of Solid Waste Disposal Facilities	40 CFR Part 257	Minimum criteria for siting, construction, operation, and closure of solid waste disposal facilities. Each state is to develop, permit, and enforce a solid waste management program based on EPA requirements.	ARAR	Requirements potentially applicable to the on-site disposal of non-hazardous contaminated soils and associated residual waste streams.

TABLE 2-2 (Sheet 3 of 5)
LITTLE VALLEY SUPERFUND SITE
ACTION-SPECIFIC ARARs AND TBCs

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	ARAR or TBC	COMMENT
Water Quality Impacts	Clean Water Act Ambient Water Quality Criteria Guidelines	33 CFR Section 1251-1376 40 CFR Part 131	Establishes toxicity-based surface water quality criteria for protection of aquatic organisms and human health.	ARAR	Ambient water quality criteria would be potentially applicable in establishing discharge limitations for treated groundwater.
	Wastewater Discharge Permits, Effluent Guidelines, Best Available Technology (BAT) and Best Management Practices, Processes, and Technology (BMPPT)	40 CFR Parts 122, 125, 401	Permit requirements for point source discharges to waters of the United States, establishes effluent standards and requirements for preventing toxic releases.	ARAR	Potentially applicable for remedial activities involving a direct wastewater discharge to the Little Valley Creek and/or diversions/disruptions to the surface water flows of the Creek that would impact water quality.
Air Emissions from a Point Source	National Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Establishes ambient air quality standards for protection of public health.	ARAR	NAAQS may be applicable in evaluating whether there are air impacts at the Site during remedial activities.
	New Source Review (NSR) and Prevention of Significant Deterioration (PSD) Requirements	40 CFR Part 52	New Sources or modifications which emit greater than the defined threshold for listed pollutants must perform ambient impact analysis and install controls which meet best available control technology (BACT).	ARAR	These regulations are potentially applicable and would require a comparison of potential emissions from the remedial activity to the emission thresholds for NSR.
	National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61 40 CFR Part 63	Source-specific regulations which establish emissions standards for hazardous air pollutants (HAPs).	ARAR	NESHAPs may be applicable if emissions from remediation activities exceed the thresholds for compliance.
	New Source Performance Standards (NSPS)	40 CFR Part 6	Source-specific regulations which establish testing, control monitoring and reporting requirements for new emission sources.	ARAR	NSPS could be relevant and appropriate if regulated new sources of air emissions were to be used on site.

TABLE 2-2 (Sheet 4 of 5)
LITTLE VALLEY SUPERFUND SITE
ACTION-SPECIFIC ARARs AND TBCs

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	ARAR or TBC	COMMENT
Land Disposal of Hazardous Waste	RCRA Subtitle C Land Disposal Restrictions (LDRs)	40 CFR Section 6901 et seq. 40 CFR Part 268	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes Universal Treatment Standards (UTSs) to which hazardous wastes must be treated to prior to land disposal. Phase IV rule revision establishes Alternate Treatment Standards for soils containing hazardous wastes.	ARAR	Wastes exhibiting a hazardous characteristic would need to be treated to meet UTS for all hazardous constituents present in the residuals prior to any upland or off-site disposal. Characteristically hazardous soils can be treated to meet the UTS standards or to meet the alternative treatment standards for RCRA hazardous soils.
STATE					
Remedial Actions	Inactive Hazardous Waste Disposal Sites	Article 27, Title 13	Establishes general cleanup goals for environmental media to levels that will eliminate a significant threat to the environment.	ARAR	Although not applicable, the requirements of the Inactive Hazardous Waste Program may be deemed relevant and appropriate.
	NYSDEC Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites	Division of Fish and Wildlife, 10/94	Provides guidance for evaluating ecological impacts on fish and wildlife in areas contaminated with hazardous waste.	TBC	May be used to evaluate impacts to sensitive species resulting from remedial activities.
Generation, Management, and Treatment of Hazardous Waste	Siting of Industrial Hazardous Waste Facilities	6 NYCRR Part 361	Establishes procedures for selecting appropriate sites for hazardous waste facilities.	ARAR	These regulations are potentially applicable for remediation activities which would involve the construction of hazardous waste management facilities.
	Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 372-376.	ARAR	These regulations do not set clean-up standards, but would apply during the on-site management of excavated hazardous waste soils and residual waste streams generated during remediation activities.

TABLE 2-2 (Sheet 5 of 5)
LITTLE VALLEY SUPERFUND SITE
ACTION-SPECIFIC ARARs AND TBCs

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	ARAR or TBC	COMMENT
Generation, Management, and Treatment of Hazardous Waste (Cont'd)	New York State Hazardous Waste Management Facility Regulations	6 NYCRR Part 370,.372, and 373	Establishes New York State's EPA equivalent hazardous waste management program. Includes regulations for hazardous waste facility construction, operation, and closure, and standards for hazardous waste generation, manifesting, and transport.	ARAR	[See RCRA Hazardous Waste Management Regulations. 40 CFR Parts 263 and 264/265 under Federal ARARs listed in this table].
	New York State Hazardous Waste Management - Land Disposal Restrictions	6 NYCRR Part 376	Restricts land disposal of Hazardous Waste which exceeds specific criteria. Establishes treatment standards to which waste must be treated prior to land disposal.	ARAR	Characteristically hazardous wastes must be treated to meet UTSs for hazardous constituents present in the soils or residues prior to land disposal
Capping of Non-Hazardous Waste	New York State Solid Waste Management Facility Regulations	6 NYCRR Part 360, 364	Establishes New York State's EPA equivalent solid waste management program. Includes regulations governing construction, operation, and closure of solid waste disposal facilities.	ARAR	These regulations are potentially applicable to remediation activities involving the management and disposal of non-hazardous wastes. Excavated soils must be identified as solid and/or hazardous waste in order to determine applicability of waste management requirements.
Water Treatment Discharge	New York State Regulations on the State Pollution Discharge Elimination System (SPDES)	6 NYCRR Parts 750-758	SPDES Permitting Requirements.	ARAR	Potentially applicable to discharges of treated groundwater to Little Valley Creek.
	New York State Water Classifications and Quality Standards	6 NYCRR Parts 701, 702, 704	Defines surface water classifications and ambient water quality standards that are the basis for establishing effluent limitations under the SPDES program.	ARAR	Little Valley Creek is classified as Class C surface water body.
	NYSDEC Ambient Water Quality Standards and Guidance Values	Division of Water, Technical and Operational Guidance Series (TOGS) 1.1.1	Provides a compilation of ambient water quality standards and guidance values for toxic and non-conventional pollutants for use in NYSDEC programs, including the SPDES permit program.	TBC	These standards and guidance values are applicable in establishing discharge limitations to surface waters.
Air Emissions	New York State Air Pollution Control Regulations	6 NYCRR Parts 120, 200-203, 207, 211, 211, 212, 219 Air Guide-1	Establishes emissions standards for new sources of air pollutants and specific contaminants.	ARAR	Requirements would be applicable to remediation alternatives that result in emissions of air contaminants, including particulate matter.
	New York State Ambient Air Quality Standards	6 NYCRR Part 257	Establishes state ambient air quality standards and guidelines for protection of public health.	ARAR	May be applicable in evaluating air impacts during remediation activities. Establishes short-term action limits for occupational exposure.

TABLE 2-3

LITTLE VALLEY SUPERFUND SITE

LOCATION-SPECIFIC ARARs AND TBCs

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	ARAR or TBC	COMMENT
FEDERAL					
Floodplains	Executive Order 11988 - Floodplain Management	40 CFR 6, Subpart A; 40 CFR 6.302	Activities taking place within floodplains must be done to avoid adverse impacts and preserve beneficial values in floodplains.	ARAR	Activities may occur within the floodplain of the Little Valley Creek.
Wetlands/Waters of the U.S.	Dredge and Fill in Wetlands	Section 404(b)(1) Guidelines	Discharge of dredge or fill material into wetlands must be evaluated based on specified criteria.	ARAR	Would be applicable to remediation activities impacting jurisdictional wetlands.
	Executive Order 11990 - Protection of Wetlands	40 CFR Part 6 Subpart A	Activities taking place within wetlands must be done to avoid adverse impacts.	ARAR	Would be applicable to remediation activities impacting jurisdictional wetlands.
Historic/Cultural Resources	National Historic Preservation Act	16 CFR 470	Establishes requirements for the identification and preservation of historic and cultural resources.	ARAR	Would be applicable to the management of historic or archeological artifacts identified on the Site.
Critical Habitat	Endangered Species Act and Fish and Wildlife Coordination Act	16 CFR 661 and 16 U.S.C. 1531	Actions must be taken to conserve critical habitat in areas where there are endangered or threatened species.	ARAR	Requirements would be applicable if endangered or threatened species are identified on or adjacent to the Site.
Considering Wetlands at CERCLA Sites	Wetlands Protection at CERCLA sites	OSWER 9280.0-03	Guidance document to be used to evaluate impacts to wetlands at Superfund sites.	TBC	Requirements should be considered when evaluating impacts to jurisdictional wetlands.
STATE					
Water Resources	Protection of Waters	6 NYCRR 608	Regulates removal or placement of fill material within state waters.	ARAR	Removal and/or placement of soils within Little Valley Creek.
Floodplains	Floodplain Management Regulations	6 NYCRR Part 500	Establishes floodplain management requirements including limitations on projects, including placement of fill, which may result in an increase in flood levels or water surface elevations during a base flood discharge.	ARAR	Remediation activities may occur within the floodplain of Little Valley Creek.
Floodplain	TSD Facility Permitting Requirements	6 NYCRR Subpart 373-1	Facility must be designed and operated to avoid washout.	ARAR	Requirements are potentially applicable to any upland treatment, storage or disposal of hazardous wastes within the floodplain of Little Valley Creek.

TABLE 2-4

LITTLE VALLEY SUPERFUND SITE

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESS OPTIONS FOR SOILS

General Response Actions	Remedial Technology Types	Process Options
• No Action	• No Action	None
• Limited Action	• Institutional Controls • Engineering Controls	Inform local officials, hold public meetings, deed restrictions Access restrictions
• Containment	• Capping • Barriers	Soil cap, clay cap, asphalt cap, synthetic membrane, chemical sealants, and multi-layer cap. Grout curtains, sheet piling, and slurry walls.
• Removal/Treatment/Disposal	<u>Removal Technologies</u> • Excavation	Excavation of soils above action levels, hot-spot removal.
	<u>Treatment Technologies</u> • Physical Treatment	Mechanical Aeration.
	• Chemical Treatment	Soil washing, supercritical fluid extraction, solidification/stabilization.
	• Biological Treatment	Biodegradation.
	• Thermal Treatment	Incineration, thermal desorption.
	• *In-Situ* Treatment	*In-situ* soil flushing, *in-situ* vitrification, soil vapor extraction, *in-situ* solidification/stabilization, *in-situ* oxidation.
	• Vapor Phase Emission Control	Carbon adsorption, thermal oxidation, catalytic oxidation.
	<u>Disposal Technologies</u> • Disposal	On-site RCRA landfill, off-site RCRA landfill, on-site redeposition.

TABLE 2-5

LITTLE VALLEY SUPERFUND SITE

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESS OPTIONS FOR GROUNDWATER

General Response Actions	Remedial Technology Types	Process Options
• No Action	• No Action	None
• Limited Action	• Institutional Controls	Inform local officials, hold public meetings, use restrictions (*e.g.*, markings), and well permit requirements
	• Groundwater monitoring	Groundwater sampling and analysis
• Containment	• Containment	Sheet piling, slurry walls, grout curtains, bottom sealing
Removal/Treatment/Disposal	<u>Removal Technologies</u>	
	• Extraction	Suction wells, well points, deep wells, French drains
	<u>Treatment Technologies</u>	
	• Physical Treatment	Clarification, flocculation, filtration, air stripping, carbon adsorption, sludge dewatering, ion exchange.
	• Chemical Treatment	Neutralization/pH adjustment, chemical precipitation, UV-chemical oxidation
	• Biological Treatment	Aerobic biodegradation, anaerobic biodegradation
	• *In-Situ* Treatment	*In-situ* oxidation, *in-situ* air sparging, in-well stripping, PRB
	• Off-Site Treatment	POTW, TSD facility
	• Vapor Phase Emission Control	Carbon adsorption, thermal oxidation, catalytic oxidation
	<u>Discharge/Disposal Technologies</u>	
	• Discharge/Disposal	Surface water discharge, recharge, reinjection, off-site landfill.

TABLE 2-6 (Sheet 1 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR SOILS

Remedial Actions	Remedial Technology Categories and Process Options	Description	Technically Feasible	Screening Comments
1. No Action	• No Action	No action taken.	YES	Provides baseline against which other remedial technologies can be compared. Required for consideration by CERCLA as amended.
2. Limited Action	• Limited Action			
	• Institutional Controls	Negotiations are held with property owner to file a notice or similar legal document that advises of contamination and prohibits unrestricted use of property. Public awareness programs are conducted.	YES	Reduces likelihood of exposure to contaminated soil through public awareness programs and other controls.
	• Engineering Controls	Access restrictions (fencing, signage, etc.) are implemented.	YES	Reduces likelihood of exposure to soil through engineering controls.
3. Containment	• Capping			
	– Soil Cap	Installed over contaminated soil to prevent direct contact with contaminants.	NO	Susceptible to erosion, settling, ponding of liquids, burrowing animals and deep rooted vegetation. Does not limit leaching of contaminants to groundwater. Would not comply with closure requirements
	– Clay Cap	Contaminated soil is covered with low permeability clay layer	NO	A clay cap large enough to mitigate TCE migration to groundwater would not be practical at CCA.
	– Asphalt Cap	Contaminated soil is covered with asphalt layer to create a low permeability.	NO	Susceptible to cracking and settling if not properly maintained. An asphalt cap large enough to mitigate to groundwater would not be practical at CCA. Would not comply with closure requirements
	– Synthetic Membrane	Contaminated soil is covered with synthetic layer to create a low permeability layer.	NO	Not feasible for active site with space limitations.
	– Chemical Sealants	Chemical sealants or stabilizers and sealants are added to top soil to create stronger and less permeable surface seal.	NO	Not feasible for active site with space limitations.
	– Multi-layer Cap	Multi-layer cap is a combination of two or more single layer caps to cover contaminated soil.	NO	Not feasible for active site with space limitations.
	• Barriers			
	• Grout Curtains	Grouting consists of injecting fluids into a rock or soil mass, which set in place, reduce water flow, and strengthen the formation.	NO	Not feasible due to absence of confining layer at reasonable depth to key the grout curtain.
	• Sheet Piling	Sheet piling is driven into soil and can be used as a barrier to limit the spread of contaminants.	NO	Not feasible due to absence of confining layer at reasonable depth to key the sheet piling.
	• Slurry Walls	Slurry walls are constructed in a vertical trench excavated under bentonite slurry.	NO	Not feasible due to absence of confining layer at reasonable depth to key the slurry walls.

TABLE 2-6 (Sheet 2 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR SOILS

Remedial Actions	Remedial Technology Categories and Process Options	Description	Technically Feasible	Screening Comments
4. Removal	• Removal			
	– Excavation	Complete or partial physical removal of contaminated soil with the intention of subsequent treatment and/or disposal.	YES	Services, materials, and equipment are well developed and readily available.
5. Treatment	• Physical Treatment			
	– Mechanical Aeration	Mechanical aeration involves extraction of highly volatile organic contaminants by mechanically air stripping or steam stripping.	NO	Applicable for highly volatile organics but not feasible due to space limitations at the Site.
	• Chemical Treatment			
	– Soil Washing	Soil washing technology involves the extraction of inorganic and organic contaminants from the soils using solvents, surfactants, chelating agents, etc.	NO	Significant feedstock preparation is necessary and large volumes of aqueous waste are generated and would require further treatment. Limited effectiveness for low solubility contaminants. Limitations of space at the Site.
	– Supercritical Fluid Extraction	Supercritical fluid extraction is based on the use of certain gases (CO_2 or Propane), which have excellent dissolving characteristics when heated and compressed to or near their critical point, to remove organics from soil. Typical system operates at 70°F to 100°F and 200 to 1000 psi.	NO	Technically feasible for removing organics from soil. Not feasible due to space limitations.
	– Solidification/Stabilization	Solidification/stabilization is a chemical process whereby contaminated soils are converted into a stable cement type matrix in which contaminants are bound and become immobile.	NO	Not implementable due to space limitations. This technology could be used off-site as part of a treatment and disposal action.
	• Biological Treatment			
	– Biodegradation	Biological treatment involves the use of native microbes or selectively adapted bacteria to degrade variety of organic compounds.	NO	Presence of chlorinated organics would require anaerobic degradation, which is difficult to implement. In addition, space limitations make on-site or land farming treatment methods of biodegradation unimplementable.
	• Thermal Treatment			
	– Incineration	Incineration is a thermal destruction method for all forms of organic contamination involving treatment at high temperatures.	NO	Not feasible due to financial impracticality and small amount of soil requiring treatment. It may be used off-site as part of a treatment and disposal action.
	– Thermal Desorption	Thermal desorption is a thermal (400°F to 900°F) stripping process which promotes volatilization of volatile and semivolatile organics from soil to air.	NO	Not feasible due to financial impracticality and small amount of soil requiring treatment. It may be used off-site as part of a treatment and disposal action.

TABLE 2-6 (Sheet 3 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR SOILS

Remedial Actions	Remedial Technology Categories and Process Options	Description	Technically Feasible	Screening Comments
	• *In-situ* Treatment			
	– *In-situ* Soil Flushing	Soil flushing is an *in-situ* extraction of organic or inorganic compounds from the soil by passing appropriate extractant solutions to dissolve or mobilize contaminants.	NO	Difficult to implement at the Site due to possible uncontrolled migration of flushing solution.
	– *In-situ* Vitrification	*In-situ* vitrification is a process of melting wastes and soils or sludge in place at high temperature to bind the waste in a glassy, solid matrix resistant to leaching and more durable than granite or marble.	NO	Not practical due to power requirements and is over-treatment for volatile organic contaminants.
	– Soil vapor extraction	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to be removed from soil through extraction wells.	YES	Removes volatiles, effective for TCE at site. Increase potential for biodegradation.
	– *In-situ* Solidification/ Stabilization	*In-situ* solidification/stabilization is a process in which solidifying agents are injected and blended with the soil. The treated soil forms a solid vertical column.	NO	Generally used for metals, less so for volatile organic contaminants. Would interfere with site operations.
	– *In-situ* Oxidation	*In-situ* oxidation is a process in which a catalyzed hydrogen peroxide is injected into soil contaminant such as TCE is decarbonized and results in CO_2 and H_2O.	NO	Can be used with fluid flushing methods in the vadose zone to treat volatile organic compounds but could cause downward migration with the fluids in an uncontrolled manner.
	• Vapor Phase Emission Control			
	– Carbon Adsorption	Treats vapor phase emissions by transferring and concentrating volatile organics (the adsorbate) from one medium (vapor/gas) to another (adsorbent).	YES	Well established technology. Decreases contaminant mobility and volume while increasing contaminant concentration in adsorbent.
	– Thermal Oxidation	Thermally destructive methods employed to destroy hazardous wastes, particularly chlorinated hydrocarbons, PCBs, and dioxins.	NO	External energy sources are usually required. Not cost effective if soil is treated off-site.
	– Catalytic Oxidation	Destructive technology in which vapor phase contaminants are oxidized in the presence of a catalyst.	YES	Used as a final vapor phase treatment for organic vapors generated during different treatment processes. External energy source is generally required.

*EPA Presumptive Technology

TABLE 2-6 (Sheet 4 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR SOILS

Remedial Actions	Remedial Technology Categories and Process Options	Description	Technically Feasible	Screening Comments
6. Disposal	-- Disposal Technologies			
	– Construction of an on-site RCRA landfill	A new RCRA landfill facility is constructed within the Site boundary for disposal of contaminated soil.	NO	Not feasible due to restrictive site conditions.
	– Existing off-site RCRA Landfill	The contaminated soil or waste would be hauled to an existing RCRA landfill which is already permitted to accept hazardous material.	YES	Feasible for disposal of treated soils and secondary wastes resulting from soil treatment process options.
	– On-Site Redeposition	The treated soil would be redeposited on-site.	NO	No on-site treatment of soils is feasible, thereby no soils are available for re-use. Limitations of space at the Site.

* EPA Presumptive Technology

TABLE 2-7 (Sheet 1 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

Remedial Actions	Remedial Technology Categories Technically and Process Options	Description	Technically Feasible	Screening Comments
1. No Action	• No Action	No action taken.	YES	Provides baseline against which other remedial technologies can be compared. Required for consideration by NCP.
2. Limited Action	• Limited Action			
	– Institutional Controls	Public awareness programs are performed. Restrict or regulate the placement of new wells and use of existing wells at and around the Site through well permit requirements.	YES	Reduces likelihood of exposure to contaminated groundwater through public awareness programs and other controls.
	– Groundwater Monitoring	Samples are collected and analyzed for contaminants and migration of contaminants is assessed.	YES	Assist in monitoring potential public exposure to contaminated groundwater.
3. Containment	• Barriers			
	– Sheet Piling	Sheet piling is driven into soil and can be used as vertical barrier to limit the spread of contaminants.	NO	Not feasible as a remedial technology due to deep aquifer and absence of confining layer.
	– Slurry Walls	Slurry walls are constructed in vertical trench excavated under bentonite slurry to act as vertical barrier.	NO	Not feasible due to deep aquifer, and absence of confining layer.
	– Grout Curtains	Grouting consists of injecting fluids into rock or soil mass, which set in place, reduce water flow, and strengthen the formation.	NO	Not feasible due to deep aquifer, and absence of confining layer.
	– Bottom Sealing	Bottom sealing is used to place a horizontal barrier beneath the site to act as a floor to prevent downward migration of contaminants.	NO	Not feasible due to deep aquifer.
4. Extraction	• Pumping			
	– Suction Wells	Used for extraction of shallow contaminated groundwater near water table.	NO	Not feasible as a remedial technology due to deep aquifer.
	– Well Points	Used for extraction of shallow contaminated groundwater from shallow aquifers less than 20 to 25 ft below grade.	NO	Not feasible as a remedial technology due to deep aquifer.
	– Deep Wells	Used for extraction of contaminated groundwater from deeper aquifer.	YES	Potentially feasible because the water table is approximately 30 ft deep below grade. Pilot pump testing is required.
	– French Drain	French drain is constructed perpendicular to the direction of the groundwater flow. It creates a continuous zone of influence in which groundwater flow is directed toward the drain.	NO	Not practical since water table is approximately 30 ft below grade.

TABLE 2-7 (Sheet 2 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

Remedial Actions	Remedial Technology Categories Technically and Process Options	Description	Technically Feasible	Screening Comments
5. Treatment	• Physical Treatment			
	– Clarification	Clarification is a gravity settling process which allows heavier solids to collect at the bottom of a containment vessel leaving clear liquid at the top.	YES	Effective for suspended solids reduction and metal reduction to meet discharge criteria.
	– Flocculation	Flocculation is a process to promote agglomeration and settling of suspended solids	YES	Effective as treatment for suspended solids and metal removal to meet discharge criteria.
	– Filtration	Filtration is a process of separating suspended solids from a liquid by passing the liquid mixture through a porous media.	YES	Applicable as pretreatment for suspended solids removal
	– Air Stripping	Air stripping is a mass transfer process in which volatile organic contaminants in groundwater are transferred to gaseous (vapor) phase.	YES	Effective for treatment of volatile organics in site groundwater.
	– Carbon Adsorption	Carbon adsorption is a process in which organic contaminants in a water are adsorbed onto activated carbon granules.	YES	Effective for treatment of TCE in site groundwater. Can be used as polishing unit.
	– Sludge Dewatering	Physical process for separation, concentration and dewatering of solids from groundwater pretreatment process units.	YES	Required as a component for handling certain process residuals (pretreatment sludge).
	– Ion Exchange	Ion exchange is a process whereby selective ions from the waste stream process are removed from the aqueous phase and replaced by less harmful ions held by ion exchange resins.	YES	Effective as final polishing step of treatment process for metal removal if required.
	• Chemical Treatment			
	– Neutralization/pH Adjustment	Neutralization is a chemical process in which acids and alkalies are treated to eliminate or reduce their reactivity and corrosiveness. pH adjustment may also be used to optimize other treatment processes.	YES	Treatment for metal removal if necessary to meet discharge criteria.
	– Chemical Precipitation	Chemical precipitation is a pretreatment process in which acid or base is added to groundwater to adjust the pH to a point where the constituents to be removed have their lowest solubility or other precipitants such as sodium sulfide or ferric chloride are added where certain contaminants can be precipitated.	YES	Treatment for metal and suspended solids removal if necessary to meet discharge criteria.

TABLE 2-7 (Sheet 3 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

Remedial Actions	Remedial Technology Categories Technically and Process Options	Description	Technically Feasible	Screening Comments
	– UV-Chemical Oxidation	When catalyzed by ultraviolet light, a strong oxidant, such as hydrogen peroxide or ozone, forms into hydroxyl radicals (strong oxidizer) which oxidize the organic contaminants in the groundwater to CO_2 and water.	YES	Effective for treatment of organic contaminants in site groundwater.
	• Biological Treatment			
	– Aerobic Biodegradation	Organic contaminants are broken down to CO_2, water, cellular biomass, and intermediate organic compounds by micro mediate organic compounds by organisms via aerobic respiration	NO	Vapor phase emissions control may be required. Biodegradation of some contaminants of concern (e.g., metals) is not very effective, supplemental organic carbon addition would be required to support biological growth.
	– Anaerobic Biodegradation	Organics are broken down to CO_2, water, methane, cellular biomass and intermediate organic compounds via anaerobic respiration.	NO	Biodegradation of some contaminants of concern (e.g., metals) is not very effective, supplemental organic carbon addition would be required to support biological growth.
	• *In-situ* Treatment			
	– *In-situ* Oxidation	*In-situ* oxidation is a process in which a catalyzed hydrogen peroxide is injected into groundwater. Pilot testing is required. TCE is decarboxylized and results in CO_2 and H_2O.	YES	Effective for treating volatile organic contaminants in a localized plume if groundwater flow is relatively high
	– *In-situ* Air Sparging	Target contaminants are VOCs and fuels. Oxygen added to contaminated groundwater and vadose zone can enhance biodegradation. Design must be site specific	YES	Effective for treating volatile organics at different depths
	– In-Well Stripping	Groundwater is subjected to diffused air stripping in the well and the vapors are collected at the wellhead. Air injection at the bottom interior of the well and consequent lifting of water in the well causes an induced recirculation cell in the aquifer around the outside of the well. Pilot testing is required.	NO	Not effective under fairly high groundwater velocity conditions which would prevent buildup of the recirculation cell.
	– Permeable Reactive Barrier (PRB)	PRB technology has been in place for several years, and can treat chlorinated organics in groundwater by de-chlorination using a zero valent iron barrier that the groundwater flows through. The technology requires the emplacement of the barrier in the subsurface perpendicular to the direction of groundwater flow.	NO	The technology is still experimental at other than shallow depths, and deep continuous emplacement by injection methods is very difficult to verify.
	• Off-Site Treatment			

TABLE 2-7 (Sheet 4 of 4)
LITTLE VALLEY SUPERFUND SITE
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

Remedial Actions	Remedial Technology Categories Technically and Process Options	Description	Technically Feasible	Screening Comments
	– Publicly Owned Treatment Works (POTW)	Untreated or partially treated groundwater would be piped to publicly owned treatment works for treatment and disposal.	NO	Uncertainty that local POTW can accommodate the rate and contaminant load from the Site.
	– Treatment, Storage, and Disposal (TSD) Facility	Groundwater will be extracted and transported to a commercial TSD facility for treatment, storage and disposal.	NO	Not feasible for treatment/disposal of contaminated groundwater due to the large volume of groundwater to be extracted.
	• Vapor Phase Volatile Emission Control			
	– Carbon Adsorption	Carbon adsorption is a process in which contaminants present in the vapor phase will be adsorbed to the carbon granules for final destruction or disposal of contaminants.	YES	Effective as a vapor phase component of other groundwater treatment process options.
	– Thermal Oxidation	Thermal oxidation is a thermal destruction process for contaminants present in the vapor phase used in emission control.	NO	Not cost-effective unless coupled with on-site thermal treatment.
	– Catalytic Oxidation	Gaseous vapor is oxidized in the presence of a catalyst.	YES	Effective for treating the vapor phase contaminants.
6. Discharge/ Disposal	• Discharge/Disposal Technologies			
	– Surface Water Discharge	Treated groundwater would be discharged to a surface water body.	YES	Feasible as a final discharge option for treated groundwater discharged into the nearby Little Valley Creek.
	– Recharge	Treated water would be recharged to constructed fields, basins, or trenches.	NO	No recharge basins at the site.
	– Reinjection	Treated groundwater would be reinjected to the aquifer using reinjection wells or trenches.	YES	High formation conductivity and transmissivity allow for reinjection
	– Off-Site Landfill Disposal of Treatment Residues	The concentrated contaminants in the sludge from the chemical precipitation and spent granular activated carbon would be hauled to an off-site hazardous waste landfill facility for disposal.	YES	Effective as a final disposal option for all process residuals.

TABLE 2-8
LITTLE VALLEY SUPERFUND SITE
EVALUATION OF PROCESS OPTIONS FOR SOIL

Remedial Actions	Remedial Technology Categories and Process Options	Effectiveness	Implementability	Cost
1. No Action	• No Action*	– Does not meet RAOs	– Easily implemented	Very low cost
2. Limited Action	– Institutional Controls*	– Prevents exposure to site contaminants, protects workers during future activities, and monitors site conditions	– Easily implemented	Moderate cost
	– Engineering Controls*	– Prevents exposure to site contaminants, protects workers during future activities, and monitors site conditions	– Easily implemented	Moderate cost
3. Removal	– Excavation*	– Effective for contaminant removal; subsequent treatment needed	– Easily implemented at shallow depths; more complex for deeper contamination	Low to high cost, depending on required depth
4. Treatment	• *In-situ* Treatment			
	– Soil Vapor Extraction*	– Effective for volatile organic contaminants in vadose zone	– Easily difficult to implement	Moderate Cost
	– Vapor Phase Volatile Emission Control			
	– Carbon Adsorption*	– Effective removing vapor phase organic contaminants – Needs regeneration or final disposal	– Easily implemented – Regeneration or off-site disposal of spent carbon	Low cost
	– Catalytic Oxidation	– Destroys organic contaminants	– Easily implemented – Requires external energy	High costs
5. Disposal	• Disposal Technologies			
	– Existing off-site RCRA Landfill*	– Removes contaminated or treated soil and secondary waste from the Site – Reliable method to contain wastes – Protective by reducing direct contact with contaminants on site	– Limited RCRA landfills in the area – Land disposal restrictions (LDR) may make implementation difficult	Moderate costs

*Technology and process options retained for alternative development.

TABLE 2-9 (Sheet 1 of 3)
LITTLE VALLEY SUPERFUND SITE
EVALUATION OF PROCESS OPTIONS FOR GROUNDWATER

Remedial Actions	Remedial Technology Categories and Process Options	Effectiveness	Implementability	Cost
1. No Action	• No Action	– Does not meet RAOs	– Easily implemented	Very low cost
2. Limited Action	– Institutional Controls*	– Does not achieve remediation objectives – Effectiveness depends on continued future implementation – Reduce risks to humans but does not actively reduce contamination and environmental impacts	– Easily implemented	Low cost
	– Groundwater Monitoring*	– Does not achieve remediation objectives – Effectiveness depends on continued future implementation – Reduce risks to humans but does not actively reduce contamination and environmental impacts	– Easily implemented	Low cost
3. Extraction	– Deep Wells*	– Effective in extracting contaminated groundwater	– Easily implemented	Moderate cost
4. Treatment	• Physical Treatment			
	– Clarification*	– Effective in separating suspended particles from liquid phase	– Easily implemented	Low cost
	– Flocculation*	– Effective in flocculating chemical precipitants	– Easily implemented	Moderate cost
	– Filtration*	– Effective in separating less settable suspended solids from liquid phase – Removes particulate borne contaminants	– Easily implemented	Moderate cost
	– Air Stripping*	– Effective in removing volatile organics and some semivolatile organics – Needs vapor phase air pollution control	– Easily implemented – Must meet air emission regulations – Low profile and low noise air strippers that are specialty designed for residential areas are required	Moderate cost
	– Carbon Adsorption*	– Effective in removing some volatile organics and most semivolatile organics – Needs regeneration or disposal of spent carbon	– Easily implemented – Regeneration or off-site disposal of spent carbon required. – Suspended solids must be removed prior to carbon adsorption	Moderate cost
	– Sludge Dewatering*	– Effective in reducing water content in the sludge, thereby reducing the volume of sludge for disposal	– Easily implemented	Moderate cost

TABLE 2-9 (Sheet 2 of 3)
LITTLE VALLEY SUPERFUND SITE
EVALUATION OF PROCESS OPTIONS FOR GROUNDWATER

Remedial Actions	Remedial Technology Categories and Process Options	Effectiveness	Implementability	Cost
	– Ion Exchange	– Effective in removing low level metal contaminants	– Easily implemented – Needs specific resin for specific metals – Spent resin requires regeneration or disposal	High cost
	• Chemical Treatment			
	– Neutralization/pH Adjustment	– Effective in optimizing other treatment processes and also neutralizing treated groundwater	– Easily implemented	Moderate cost
	– Chemical Precipitation	– Effective in precipitating suspended solids and metals contaminants from groundwater	– Easily implemented – Sludge requires treatment and disposal	Moderate cost
	– UV-Chemical Oxidation	– Effective in oxidizing organic contaminants	– Easily implemented – Requires skilled labor – High power requirement	High cost
	• *In-situ* Treatment			
	– *In-situ* Oxidation*	– Effective for volatile organic contaminants in aquifer. Need fairly high groundwater velocity	– Easily implemented – Requires pilot testing – May require injection well installation	Moderate cost
	– *In-situ* Air Sparging*	– Effective for volatile organic contaminants in an aquifer. Effectiveness depends on the subsurface conditions	– Easily implemented by drilling methods with limited construction. Requires pilot testing. Requires capture of volatile vapor emissions by soil vapor extraction methods and requires treatment of captured vapor before release to the atmosphere.	Moderate capital, moderate O&M
	• Vapor Phase Volatile Emission Control			
	– Carbon Adsorption*	– Effective in removing vapor phase organic contaminants	– Easily implemented – Regeneration or off-site disposal of spent carbon required	Moderate cost
	– Catalytic Oxidation	– Destroys organic contaminants in the vapor phase	– Easily implemented – Requires fuel supply	High cost

TABLE 2-9 (Sheet 3 of 3)
LITTLE VALLEY SUPERFUND SITE
EVALUATION OF PROCESS OPTIONS FOR GROUNDWATER

Remedial Actions	Remedial Technology Categories and Process Options	Effectiveness	Implementability	Cost
5. Discharge/Disposal	• Discharge/Disposal Technologies			
	– Surface Water Discharge*	– Effective for disposal of treated groundwater.	– Treated water must meet applicable treatment standards	Low cost
	– Reinjection	– Effective for disposal of treated water – Restore groundwater table	– Moderately difficult to implement	Moderate cost
	– Off-site landfill for disposal of treatment residues*	– Effective for final disposal of sludge, and other process residuals	– Moderately difficult to implement – Need to locate a landfill that accepts sludge and process residuals from groundwater treatment plant – Sludge may need pretreatment before disposal	Moderate cost

* Technology and process options retained for alternative development.

TABLE 4-1 (Sheet 1 of 3)
COMPARATIVE ANALYSIS OF ALTERNATIVES FOR SOILS

CRITERIA	ALTERNATIVE S-1 NO ACTION	ALTERNATIVE S-2 INSTITUTIONAL CONTROLS	ALTERNATIVE S-3 *IN-SITU* SOIL VAPOR EXTRACTION	ALTERNATIVE S-4 EXCAVATION / OFF-SITE TREATMENT/ DISPOSAL
Key Components	No remedial action. Five-year reviews.	Institutional controls, five-year reviews, and long-term monitoring.	ISVE treatment to address TCE contamination.	Excavation and off-site treatment and disposal to address TCE contamination.
Overall Protection of Health and the Environment				
• Protection achieved over time	Protection is not achieved.	Limited protection of human health may be achieved through deed notice and public awareness measures.	RAOs are achieved in a timely manner and provide protection.	RAOs are achieved in a timely manner and provide protection.
• Site risk reduction	Site risks are not reduced.	Site risks are not reduced.	Site risks are reduced.	Site risks are reduced.
• Source management	Sources are not managed.	Sources are not managed.	Sources are managed.	Sources are managed.
Compliance with ARARs				
• Contaminant-specific ARARs	No contaminant-specific ARARs. Contaminant-specific TBCs are not achieved.	No contaminant-specific ARARs. Contaminant-specific TBCs are not achieved.	Contaminant-specific TBCs are achieved for TCE.	Contaminant-specific TBCs are achieved for TCE.
• Action-specific ARARs	Action-specific ARARs not achieved.	Action-specific ARARs are not achieved.	Action-specific ARARs are achieved.	Action-specific ARARs are achieved.
• Location-specific ARARs	No location-specific ARARs are triggered.	Location-specific ARARs are not triggered.	Location-specific ARARs are achieved.	Location-specific ARARs are achieved.
Long-Term Effectiveness and Permanence				
• Magnitude of residual risks	Risks of human exposure and contaminant migration from soil to groundwater still exist after implementation.	Risks of human exposure and contaminant migration from soil to groundwater still exist after implementation.	Residual risk would be low since TCE in excess of action levels would be removed and adverse impacts due to downward contaminant migration would be unlikely.	Residual risk would be low since TCE in excess of action levels would be removed and adverse impacts due to downward contaminant migration would be unlikely.
• Adequacy of controls	No controls are in place.	No controls are in place.	No long-term controls required.	No long-term controls required.
• Reliability of controls	No controls are in place.	No controls are in place.	No long-term controls required.	No long-term controls required.

TABLE 4-1 (Sheet 2 of 3)
COMPARATIVE ANALYSIS OF ALTERNATIVES FOR SOILS

CRITERIA	ALTERNATIVE S-1 NO ACTION	ALTERNATIVE S-2 INSTITUTIONAL CONTROLS	ALTERNATIVE S-3 *IN-SITU* SOIL VAPOR EXTRACTION	ALTERNATIVE S-4 EXCAVATION / OFF-SITE TREATMENT/ DISPOSAL
Reduction of Toxicity, Mobility and Volume through Treatment				
• Treatment process and remedy	None.	None.	Soil vapor extraction.	Excavation and off-site disposal.
• Amount of hazardous material destroyed or treated	None.	None.	Estimated 222 cubic yards of soil.	Estimated 222 cubic yards of soil.
• Reduction of toxicity, mobility and volume	No reduction in toxicity, mobility, or volume of VOC soil contaminants.	No reduction in toxicity, mobility or volume of VOC or metal soil contaminants.	Toxicity, mobility and volume of TCE are significantly reduced.	Toxicity, mobility, and volume of TCE are significantly reduced.
• Irreversibility of treatment	No treatment.	No treatment.	TCE removal by SVE is irreversible.	Soil removal from the facility is irreversible.
• Type and quantity of treatment residuals	None.	None.	Carbon vessels from SVE system for regeneration or disposal. No long-term residual stream.	Approximately 222 cubic yards of soil for disposal. No long-term residual stream.
Short-Term Effectiveness				
• Protection of community during remedial actions	No short-term adverse community impacts are expected.	No short-term adverse community impacts are expected.	Limited risk of community impacts due to site disturbance. Mitigated with engineering controls.	Limited risk due to site disturbance and truck traffic related to excavation/backfill. Mitigated with engineering controls and proper planning and implementation.
• Protection of workers during remedial action	No potential impacts to workers are expected.	Potential impacts to workers are negligible.	Potential for exposure to fugitive dust, fugitive emissions, and contaminated soil.	Potential for exposure to fugitive dust, fugitive emissions and contaminated soil.
• Environmental Impacts	No anticipated adverse environmental impacts.	No anticipated adverse environmental impacts.	No anticipated adverse environmental impacts.	No anticipated adverse environmental impacts.
• Time until remedial response objectives are achieved	RAOs are not achieved.	RAOs are not achieved.	RD time estimated at 6 months, construction time estimated at 3 months and RA time estimated at 12 months.	Excavation RD time estimated at 6 months and RA time estimated at 3 months.
Implementability				
Technical Feasibility				
• Ability to construct and operate technology	No construction.	No construction.	Conventional equipment used.	Conventional construction equipment used.
• Reliability of technology	No technology is applied.	No technology is applied.	Conventional equipment and techniques. Very reliable.	Conventional equipment and techniques. Very reliable.

TABLE 4-1 (Sheet 3 of 3)
COMPARATIVE ANALYSIS OF ALTERNATIVES FOR SOILS

CRITERIA	ALTERNATIVE S-1 NO ACTION	ALTERNATIVE S-2 INSTITUTIONAL CONTROLS	ALTERNATIVE S-3 *IN-SITU* SOIL VAPOR EXTRACTION	ALTERNATIVE S-4 EXCAVATION / OFF-SITE TREATMENT/ DISPOSAL
• Ease of undertaking additional remedial action, if necessary	Feasible (could implement treatment or removal).	Feasible (could implement treatment or removal).	Feasible (could implement additional removal), but should not be required.	None required.
• Monitoring considerations	Feasible (conventional methods).	Feasible (conventional methods).	Feasible (conventional methods).	Feasible (conventional methods).
Administrative Feasibility				
• Coordination with other agencies	Feasible (coordination with NYSDEC and CCHD).	Feasible (coordination with NYSDEC and CCHD).	Feasible (coordination with NYSDEC and CCHD).	Feasible (coordination with NYSDEC and CCHD).
Availability of Services and Materials				
• Availability of treatment, storage capacity, and disposal services	No associated treatment, storage capacity, or disposal services.	No associated treatment, storage capacity, or disposal services.	Services are well developed and readily available.	Services are well developed and readily available.
• Availability of necessary equipment, specialists, and materials	None required.	None required.	Materials and equipment are well developed and readily available.	Materials and equipment are well developed and readily available.
• Availability of technologies	No associated technologies.	No associated technologies.	Technologies are well developed and readily available.	Technologies are well developed and readily available.
Costs				
• Total Capital Cost ($)	0	$20,250	$275,265	$135,825
• Annual Operation and Maintenance (O&M) Cost ($/yr)	0	0	0	0
• Present Worth ($ based on seven percent discount rate)	0	$20,250	$275,265	$135,825

TABLE 4-2 (Sheet 1 of 4)
COMPARATIVE ANALYSIS OF ALTERNATIVES FOR GROUNDWATER

CRITERIA	ALTERNATIVE GW-1 NO ACTION	ALTERNATIVE GW-2 SITE-WIDE MONITORED NATURAL ATTENUATION/INSTITUTIONAL CONTROLS	ALTERNATIVE GW-3 SOURCE AREA EXTRACTION / TREATMENT / DISCHARGE / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-4 SOURCE AREA *IN-SITU* AIR SPARGING / VAPOR TREATMENT / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-5 SOURCE AREA *IN-SITU* CHEMICAL OXIDATION / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME
Key Components	No remedial action. Five-year reviews	Public awareness and education measures, and five-year review and long-term monitoring.	Groundwater pump and treat technology with institutional controls addresses VOC risks.	*In situ* air sparging technology with institutional controls addresses VOC risks.	*In situ* chemical oxidation technology with institutional controls addresses VOC risks.
Overall Protection of Health and the Environment					
• Protection achieved over time	Protection is not achieved.	Limited protection of human health may be achieved through water use restrictions and public awareness measures.	RAOs achieved in a timely manner and provide protection.	RAOs achieved in a timely manner and provide protection.	RAOs achieved in a timely manner and provide protection.
• Site risk reduction	Site risks are not reduced.	Site risks are not reduced.	Site risks are reduced.	Site risks are reduced.	Site risks are reduced.
• Source management	Sources are not managed.	Sources are not managed.	Sources are managed.	Sources are managed.	Sources are managed.
Compliance with ARARs					
• Contaminant-specific ARARs	Contaminant-specific ARARs are not achieved.	Contaminant-specific ARARs are not achieved.	Contaminant-specific ARARs are achieved.	Contaminant-specific ARARs are achieved.	Contaminant-specific ARARs are achieved.
• Action specific ARARs	Action-specific ARARs are not achieved.	Action-specific ARARs are not achieved.	Action-specific ARARs are achieved.	Action-specific ARARs are achieved.	Action-specific ARARs are achieved.
• Location specific ARARs	Location-specific ARARs are not achieved.	Location-specific ARARs are not achieved.	Location-specific ARARs are achieved.	Location-specific ARARs are achieved.	Location-specific ARARs are achieved.
Long-Term Effectiveness and Permanence					
• Magnitude of residual risks	Risks of human exposure and downgradient contaminant migration and mitigated. Risks would potentially be reduced over time through natural attenuation processes.	Risk of human exposure reduced through awareness measures. Risks would potentially be reduced over time through natural attenuation processes	Would effectively address the RAOs but success would depend on pilot testing and source control effectiveness.	Would achieve the RAOs but success would depend on pilot testing and source control effectiveness.	Would achieve the RAOs but success would depend on bench-scale testing, pilot testing, and source control effectiveness.
• Adequacy of controls	No controls in place.	No controls in place.	Controls are adequate.	Controls are adequate.	Controls are adequate.
• Reliability of controls	No controls in place.	No controls in place.	Controls are reliable.	Controls are reliable.	Controls are reliable.

TABLE 4-2 (Sheet 2 of 4)
COMPARATIVE ANALYSIS OF ALTERNATIVES FOR GROUNDWATER

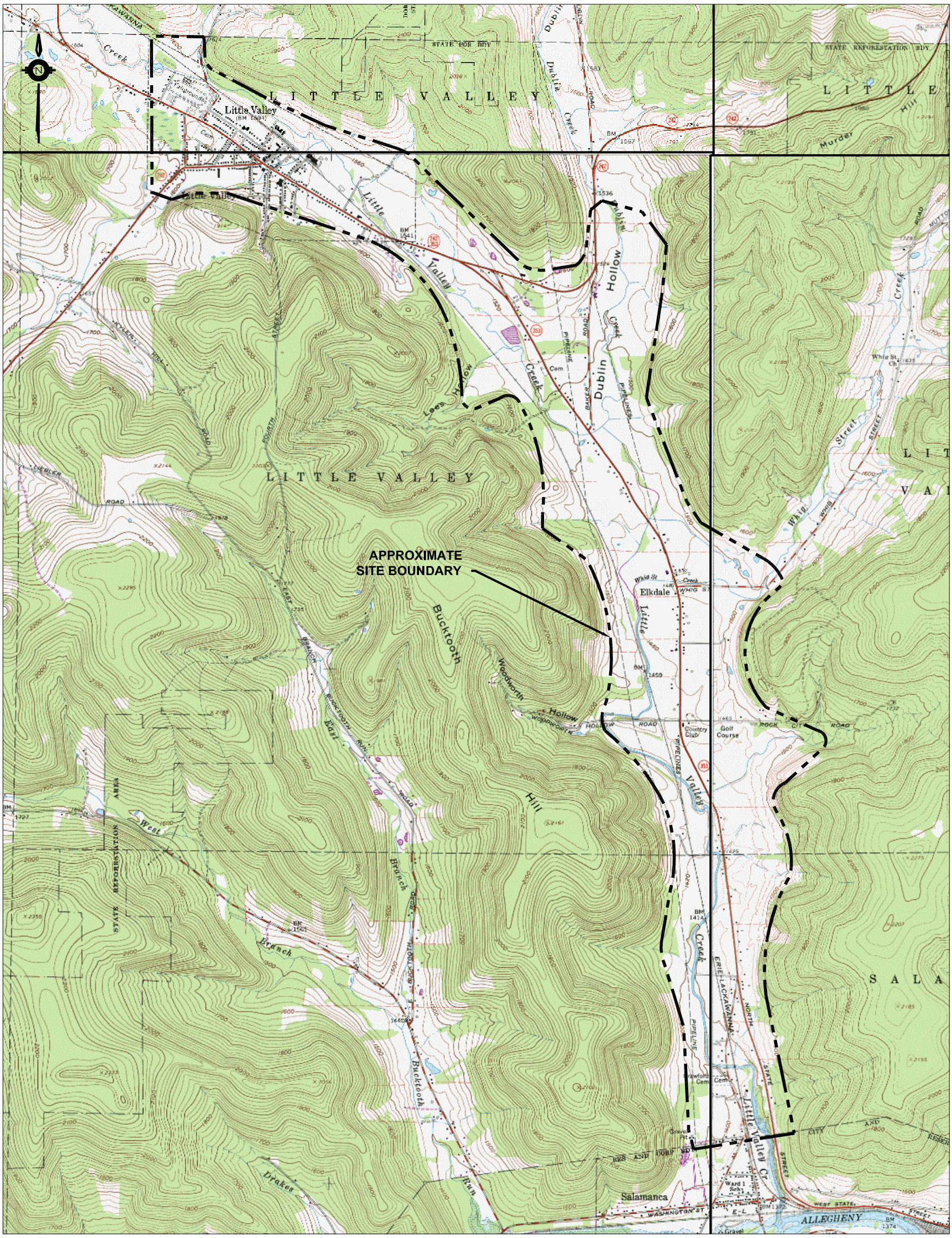
CRITERIA	ALTERNATIVE GW-1 NO ACTION	ALTERNATIVE GW-2 SITE-WIDE MONITORED NATURAL ATTENUATION/INSTITUTIONAL CONTROLS	ALTERNATIVE GW-3 SOURCE AREA EXTRACTION / TREATMENT / DISCHARGE / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-4 SOURCE AREA *IN-SITU* AIR SPARGING / VAPOR TREATMENT / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-5 SOURCE AREA *IN-SITU* CHEMICAL OXIDATION / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME
Reduction of Toxicity, Mobility, and Volume through Treatment					
• Treatment process and remedy	None.	None.	Groundwater extraction, treatment, and disposal.	VOC extraction, collection, and treatment.	*In situ* oxidation.
• Amount of hazardous material destroyed or treated	None.	None.	VOCs in approximately 90 gpm water waste stream.	VOCs in air waste stream.	Estimated VOCs in 912,000 cubic feet of water.
• Reduction of toxicity, mobility and volume	No reduction in toxicity, mobility, or volume of groundwater except by natural attenuation processes.	No reduction in toxicity, mobility, or volume of groundwater except by natural attenuation processes.	Significant reduction in toxicity, mobility, and volume of VOC groundwater contaminants in excess of action levels.	Significant reduction in toxicity, mobility, and volume of VOC groundwater contaminants in excess of action levels.	Significant reduction in toxicity, mobility, and volume of VOC groundwater contaminants in excess of action levels.
• Irreversibility of treatment	No treatment.	No treatment. Natural attenuation is irreversible.	Not reversible.	Not reversible.	Not reversible.
• Type and quantity of treatment residuals	None.	None.	Sludge volume depends on water quality. Estimated 1000#/month of carbon.	Estimated 800#/month of carbon.	None.
Short-Term Effectiveness					
• Protection of community during remedial actions	No short-term community impacts are expected.	No short-term community impacts are expected.	Limited risk due to area disturbances during installation of remedial utilities.	Limited risk due to area disturbances during installation of remedial utilities.	Limited risk due to area disturbances during installation of wells and truck traffic associated with delivery of oxidant.
• Protection of workers during remedial action	No remediation, therefore not applicable.	No remediation, therefore not applicable.	Potential for exposure to fugitive dust, fugitive emissions, and spills.	Potential for exposure to fugitive dust, fugitive emissions, and spills.	Potential for exposure to fugitive dust, fugitive emissions, and spills.
• Environmental Impacts	No anticipated adverse environmental impacts.	No anticipated adverse environmental impacts.	No anticipated adverse environmental impacts.	No anticipated adverse environmental impacts.	No anticipated adverse environmental impacts.
• Time until remedial response objectives are achieved	Estimated RAOs are achieved in 10 years.	Estimated that RAOs are achieved in 10 years, but verified by monitoring program.	Pump and treat RD time estimated at 12 months, RA construction and startup time estimated at 6 months, and RA removal time estimated at 8 years. Monitoring for 8 years.	*In situ* air sparging RD time estimated at 12 months, RA construction and startup time estimated at 6 months, and RA treatment time estimated at 2 years. Monitoring for 8 years.	*In situ* chemical oxidation RD time estimated at 12 months, and the RA treatment time is estimated at 6 months. Monitoring for 8 years.

TABLE 4-2 (Sheet 3 of 4)
COMPARATIVE ANALYSIS OF ALTERNATIVES FOR GROUNDWATER

CRITERIA	ALTERNATIVE GW-1 NO ACTION	ALTERNATIVE GW-2 SITE-WIDE MONITORED NATURAL ATTENUATION/INSTITUTIONAL CONTROLS	ALTERNATIVE GW-3 SOURCE AREA EXTRACTION / TREATMENT / DISCHARGE / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-4 SOURCE AREA *IN-SITU* AIR SPARGING / VAPOR TREATMENT / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-5 SOURCE AREA *IN-SITU* CHEMICAL OXIDATION / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME
Implementability					
Technical Feasibility					
• Ability to construct and operate technology	No construction.	No construction.	Conventional equipment used.	Conventional equipment used.	Emerging technology that has been performed successfully at numerous locations nationally.
• Reliability of technology	No technology applied.	No technology applied.	Conventional equipment and techniques. Very reliable.	Conventional equipment and techniques. Very reliable.	Conventional and modified equipment used. Reliable.
• Ease of undertaking additional remedial action, if necessary	Feasible (could extract or treat)	Feasible (could extract or treat)	Feasible (could use *in situ* methods).	Feasible (could treat or extract).	Feasible (could extract or treat).
• Monitoring considerations	No monitoring program	Requires long-term monitoring program	Requires long-term monitoring program	Requires long-term monitoring program	Requires long-term monitoring program
Administrative Feasibility					
• Coordination with other agencies	None required.	Feasible (NYSDEC and CCHD).	Feasible (NYSDEC and CCHD).	Feasible (NYSDEC and CCHD).	Feasible (NYSDEC and CCHD).
Availability of Services and Materials					
• Availability of treatment, storage capacity, and disposal services	No associated treatment, storage capacity, or disposal services.	No associated treatment, storage capacity, or disposal services.	Services are well developed and readily available.	Services are well developed and readily available.	Services are well developed and readily available.
• Availability of necessary equipment, specialists, and materials	No associated materials or specialists.	No associated materials or specialists.	Materials and equipment are well developed and readily available.	Materials and equipment are well developed and readily available.	Materials and equipment are well developed and readily available.
• Availability of technologies	No associated technologies.	Groundwater monitoring is well developed and readily available.	Technologies are well developed and readily available.	Technologies are well developed and readily available.	Technology is commercially available from multiple vendors.

TABLE 4-2 (Sheet 4 of 4)
COMPARATIVE ANALYSIS OF ALTERNATIVES FOR GROUNDWATER

CRITERIA	ALTERNATIVE GW-1 NO ACTION	ALTERNATIVE GW-2 SITE-WIDE MONITORED NATURAL ATTENUATION/INSTITUTIONAL CONTROLS	ALTERNATIVE GW-3 SOURCE AREA EXTRACTION / TREATMENT / DISCHARGE / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-4 SOURCE AREA *IN-SITU* AIR SPARGING / VAPOR TREATMENT / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME	ALTERNATIVE GW-5 SOURCE AREA *IN-SITU* CHEMICAL OXIDATION / INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME
Costs					
• Total Capital Cost ($)	0	$0	$2,563,805	$860,085	$1,506,060
• Annual Operation and Maintenance (O&M) Cost ($/yr)	0	$33,915	$553,823 (years 1-8) $33,915 (years 9-10)	$287,525 (years 1-2) $33,915 (years 3-10)	$33,915
• Present Worth ($ based on seven percent discount rate)	0	$238,205	$5,915,164	$1,556,465	$1,744,265



APPROX. QUADRANGLE LOCATIONS

SOURCE:
BASE MAP ADAPTED FROM U.S.G.S. LITTLE VALLEY, ELLICOTTVILLE, SALAMANCA, AND CATTARAUGUS NEW YORK QUADRANGLES, 7.5 MINUTE SERIES (TOPOGRAPHIC).

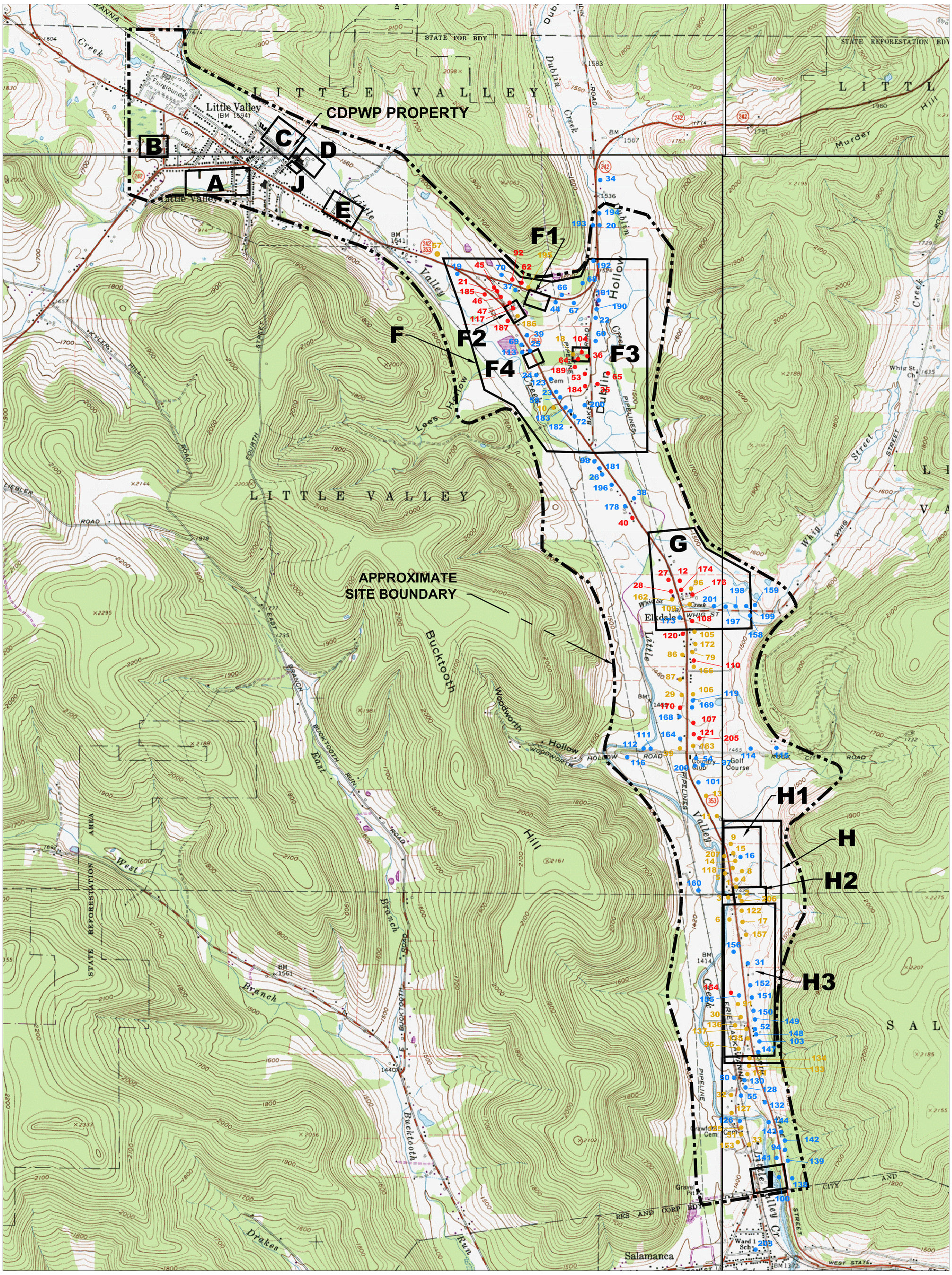
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 1-1
SITE BOUNDARY MAP

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 1-1 (SITE BOUNDARY).DWG


CDPWP PROPERTY
APPROXIMATE SITE BOUNDARY
A
B
C
D
E
F
F1
F2
F3
F4
G
H
H1
H2
H3
I
J
LITTLE VALLEY
Little Valley
Elkdale
Salamanca
Buck tooth
Woodworth Hollow
Lees Hollow
Dublin Creek
Little Valley Creek
Whig Street
Whig St
Valley Cr
Hill
Murder Hill
Branch
West Branch
Drakes Run
Golf Course
Country Club
Gravel Pit
Ward 1 Sch
Crawford Cem
Cem
Fairgrounds
BM 1567
BM 1541
BM 1414
BM 1372
BM 1561
STATE FOR BDY
STATE REFORESTATION BDY
STATE REFORESTATION AREA
RES AND CORP BDY
PIPELINES
PIPELINE
FRIENDLY AVENUE
EAST STATE STREET
WEST STATE STREET
Whig St Ch
Rock City Road
Dublin Road
Fourth Street
Bucktooth Road
Kyler Hill Road
Liebler Road
Hollow Road
Valley Road
Whig Street
Creek Street
Valley Cr Street
Bucktooth East Branch Road
Bucktooth Run Road
Bucktooth Hill Road
Bucktooth Creek
Bucktooth Run
Bucktooth East Run
Bucktooth West Branch
Bucktooth Branch
Drakes Run
Little Valley Creek
Dublin Creek
Whig Street
Valley Cr
Hollow
Creek
Hill
Street
Road
Run
Branch
Creek
Hollow
Valley
Cr

Location / Depth	CCAGEO-5 0'-1'	0'-1' Duplicate
Trichloroethene	110 D	95 J
Benzo(a)anthracene	430	430
Benzo(a)pyrene	410	
Benzo(b)fluoranthene	740	800
Chrysene	530	580
Arsenic	23	20
Beryllium	1.2	1
Cadmium	6	6.9
Chromium	53	51
Cobalt	10	10
Copper	530	590
Iron	45000	44000
Lead	130	150
Mercury	0.14	
Nickel	83	99
Selenium	4.8	
Silver	3.8	3.2
Vanadium	23	
Zinc	320	360
Depth	2'-4'	
Trichloroethene	550 D	
Benzo(a)anthracene	5700	
Benzo(a)pyrene	4300	
Benzo(b)fluoranthene	5800	
Benzo(k)fluoranthene	2300	
Carbazole	2200	
Chrysene	5400	
Indeno(1,2,3-cd)pyrene	2200	
Depth	6'-8'	
Trichloroethene	84	
Depth	20'-22'	
Trichloroethene	67 D	
Benzo(a)anthracene	610	
Benzo(a)pyrene	470	
Benzo(b)fluoranthene	650	
Chrysene	620	

Location / Depth	MWCCA-5 0'-2"
Trichloroethene	1200 D
Antimony	50.2
Arsenic	39.5
Beryllium	1.6 J
Cadmium	4.5
Calcium	21000
Chromium	1510
Cobalt	8.6 B
Copper	1680
Iron	56700
Lead	438
Mercury	0.61
Nickel	191
Vanadium	32.7
Zinc	1460
Depth	1'-5'-2'
Trichloroethene	72000 D
Arsenic	25.9
Beryllium	0.99 B
Chromium	86.3
Copper	1780
Lead	195
Mercury	0.98
Nickel	220
Selenium	1.9
Zinc	681
Depth	5'-7'
Chromium	30.7
Copper	42.3
Depth	10'-12'
Trichloroethene	91
Depth	15'-17'
Trichloroethene	120
Chromium	25.1
Copper	44.1
Depth	20'-22'
Copper	34
Depth	25'-27'
Trichloroethene	76
Copper	34.7
Depth	30'-32'
Magnesium	9890
Depth	40'-42'
Calcium	33800
Magnesium	6030

Location / Depth	10'-12' Duplicate
Trichloroethene	140

Location / Depth	CCAGEO-3 0'-1'
Aluminum	14000
Antimony	21 K
Arsenic	32
Beryllium	2.3
Cadmium	4.1
Calcium	46000 L
Chromium	95
Copper	1600
Iron	49000
Lead	620
Magnesium	9600
Manganese	1800
Nickel	220
Potassium	1300
Selenium	5.9 J
Thallium	3.6
Vanadium	32
Zinc	790
Depth	20'-22'
Trichloroethene	70
Depth	25'-27'
Trichloroethene	120

Location / Depth	CCAGEO-2 0'-1'
Arsenic	15
Beryllium	1.3
Cadmium	3.8
Calcium	38000 L
Chromium	140
Cobalt	10
Copper	780
Iron	69000
Lead	2100
Magnesium	8600
Manganese	1600
Nickel	150
Selenium	7.3
Thallium	3.5
Vanadium	72
Zinc	460
Depth	18'-20'
Trichloroethene	71

Location / Depth	CCAGEO-1 0'-1'
Benzo(a)anthracene	1100
Benzo(a)pyrene	850
Benzo(b)fluoranthene	1300
Chrysene	1300
Cadmium	3.4
Chromium	41
Cobalt	7.8
Copper	270 L
Iron	31000
Lead	130 L
Nickel	44
Silver	2.8
Zinc	720
Depth	16'-18'
Trichloroethene	46
Depth	26'-28'
Trichloroethene	110

Location / Depth	MWCCA-6 0'-2"
Arsenic	11.4
Beryllium	0.38 BJ
Calcium	35100
Chromium	35.6
Copper	328
Iron	23100
Lead	131
Magnesium	7270
Mercury	0.14 J
Nickel	53.6
Zinc	214
Depth	5'-7'
Barium	293
Chromium	87.8
Copper	55.9
Manganese	2480
Depth	10'-12'
Arsenic	45.2
Chromium	55.3
Depth	15'-17'
Trichloroethene	70
Chromium	50.4
Depth	20'-22'
Trichloroethene	220
Chromium	39.7
Depth	25'-27'
Trichloroethene	680 D
Depth	30'-32'

Location / Depth	30'-32' Duplicate
Trichloroethene	220
Copper	46.9

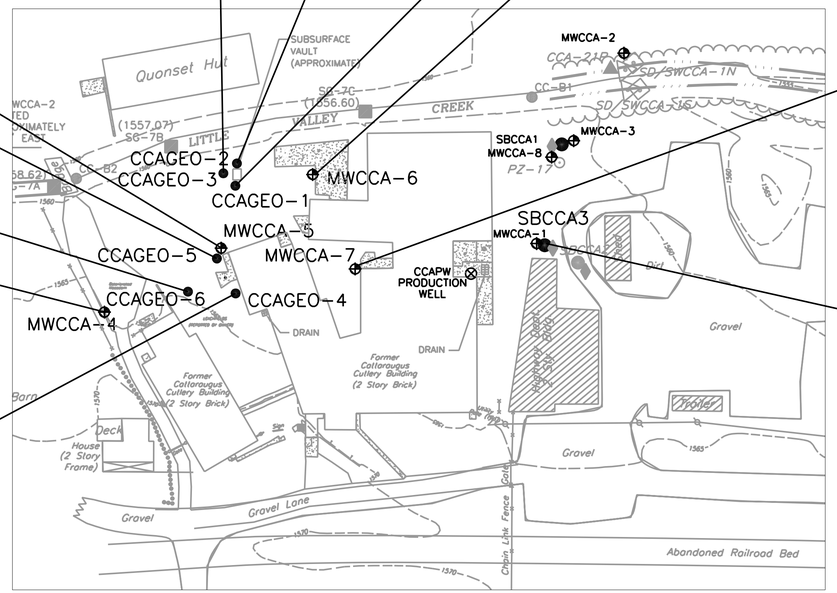
Location / Depth	MWCCA-7 0'-2"
Cadmium	2.1
Calcium	32700
Chromium	26.9
Copper	58.6
Lead	137
Magnesium	4840
Zinc	358
Depth	5'-7'
Chromium	80.1
Copper	44.2
Depth	10'-12'
Lead	34.4
Depth	15'-17'
Copper	50.5
Depth	20'-22'
Chromium	58.4
Copper	53.3
Depth	25'-27'
Trichloroethene	67
Chromium	46.1
Copper	65
Depth	30'-32'
Trichloroethene	70
Copper	34
Selenium	1.5
Depth	40'-42'
Calcium	39700
Depth	45'-47'
Calcium	64800

Location / Depth	CCAGEO-6 0'-1'
Trichloroethene	73
Chrysene	500
Beryllium	0.62
Cadmium	2
Chromium	16
Copper	650
Iron	26000
Lead	120
Nickel	110
Silver	3.6
Zinc	240
Depth	1'-2'
cis-1,2-Dichloroethene	830 J
Trichloroethene	11000 D
Benzo(a)anthracene	29000
Benzo(a)pyrene	29000
Benzo(b)fluoranthene	44000
Benzo(k)fluoranthene	18000
Carbazole	1900
Chrysene	40000
Dibenzo(a,h)anthracene	940
Indeno(1,2,3-cd)pyrene	10000
Depth	12-14'
Trichloroethene	170 D

Location / Depth	MWCCA-4 0'-2" B.J.
Beryllium	0.88
Calcium	39800
Chromium	22.9
Copper	201
Lead	83.8
Nickel	54.7
Zinc	215
Depth	10'-12'
Barium	339
Copper	37.1
Manganese	4030
Nickel	23
Depth	14'-16'
Copper	36.5
Depth	20'-22'
Copper	88.3
Magnesium	9250
Manganese	2090
Depth	24'-26'
Copper	36.2
Magnesium	7720
Depth	34'-36'
Barium	311
Copper	34.5
Selenium	1.4
Depth	44'-46'
Calcium	45000

Location / Depth	CCAGEO-4 0'-1'
Arsenic	15
Cadmium	41
Chromium	170
Cobalt	15
Copper	1500
Iron	29000
Lead	480
Mercury	2.9
Nickel	1300
Silver	13
Zinc	2000
Depth	8'-10'
Trichloroethene	180 J
Depth	16'-18'
Trichloroethene	72
Benzo(a)anthracene	1400
Benzo(a)pyrene	1200
Benzo(b)fluoranthene	1700
Chrysene	1700
Indeno(1,2,3-cd)pyrene	710
Depth	22'-24'
Trichloroethene	150

Location / Depth	SBCCA3 13'-15'
Trichloroethene	70



NOTES:

J INDICATES ESTIMATED CONCENTRATION VALUE

B INDICATES THAT FOR METALS ONLY, CONCENTRATION IS BETWEEN THE INSTRUMENT DETECTION LIMIT AND THE PRACTICAL QUANTITATION LIMIT

D CONCENTRATION PROVIDED FROM DILUTION ANALYSIS

WHERE NO VALUE IS PROVIDED, CONCENTRATION DID NOT EXCEED COMPARISON CRITERIA VALUE.

CONTAMINANT CONCENTRATIONS ARE PRESENTED IN ug/kg (ppb) FOR ORGANIC COMPOUNDS AND mg/kg (ppm) FOR INORGANIC COMPOUNDS.

Criteria exceeded are indicated by the color of the text/value: yellow exceeds human health-based values; green exceeds ecological-based values; grey exceeds State values; Blue exceeds background range values; and purple exceeds both of the above values. For comparison criteria values, see Section 4.2 and Tables 4-1 and 4-2.

For the metals, only those metals whose concentrations either [1] exceeded more than one comparison criteria (human health, ecological or state) and/or [2] were outside the range of soil background values for the analyte (i.e., blue or purple) are provided. See text for additional rationale.

LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 1-3
CATTARAUGUS CUTLERY AREA
CONTAMINANTS IN SOIL EXCEEDING
CRITERIA COMPARISON LEVELS

TETRA TECH FW, INC.

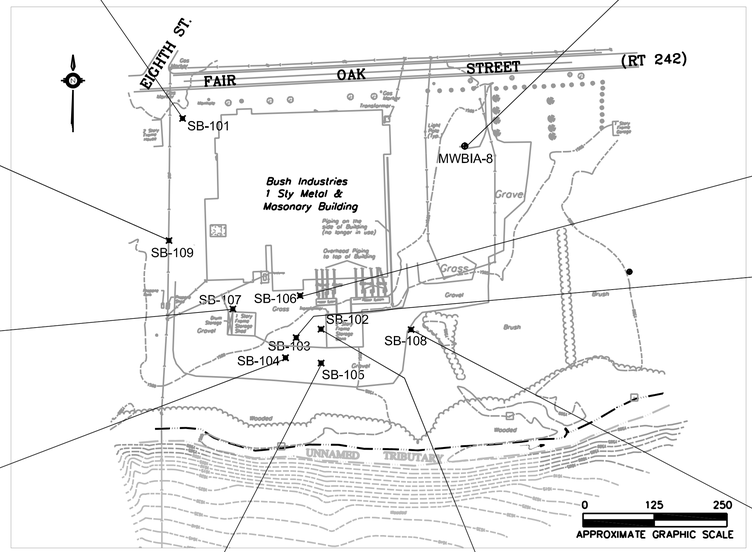
R:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 1-3 (CCA SOIL DATA).DWG

Location	SB-101
Depth	0'-2'
Aluminum	19200
Arsenic	11.4 J
Chromium	17.3
Cobalt	10.6 B
Iron	25500
Potassium	1030 B
Selenium	1.5 J
Vanadium	28.4
Depth	14'-16'
Calcium	38100
Lead	29.0

Location	SB-109	
Depth	0'-2'	
Beryllium	0.35 B	
Calcium	21800	
Chromium	27.4	
Copper	69.6	
Iron	21200	
Lead	157 J	
Thallium	12.9	
Depth	4'-6'	4'-6' Duplicate
Selenium	1.8 J	1.3 J
Thallium	13.2	16.6
Depth	8'-10'	
Copper	34.0	
Thallium	10.8	
Depth	14'-16'	
Calcium	45900	
Selenium	1.1 JB	
Thallium	9.5	
Depth	24'-26'	
Selenium	1.4 J	
Thallium	13.9	

Location	MWBIA-8	
Depth	0'-2'	
Aluminum	17200	
Beryllium	0.48 B	
Chromium	17.4	
Cobalt	10.2 B	
Iron	24600	
Potassium	1110 B	
Thallium	17.6	
Vanadium	28.7	
Zinc	127	
Depth	4'-6'	
Selenium	1.1 J	
Thallium	16	
Depth	8'-10'	8'-10' Duplicate
Copper		35.9
Thallium	15.6	14.6
Depth	18'-20'	
Thallium	10.7	
Depth	34'-36'	
Thallium	11.6	

Location	SB-106
Depth	0'-2'
Thallium	1.4 B
Depth	4'-6'
Chromium	64.8
Copper	150 J
Selenium	1.6 J
Vanadium	29.8
Zinc	207
Depth	8'-10'
Arsenic	27.8 J
Barium	303
Copper	35.5 J
Depth	14'-16'
Benzo(a)pyrene	130 J
Dibenzo(a,h)anthracene	37 J



Location	SB-103
Depth	0'-2'
Calcium	24800
Depth	14'-16'
Manganese	2050
Depth	18'-20'
Arsenic	193 J
Calcium	35800
Depth	24'-26'
Aluminum	15000
Cobalt	17.6
Iron	34200
Nickel	32.2

Location	SB-107
Depth	0'-2'
Calcium	42000
Magnesium	6240 J
Depth	4'-6'
Barium	737
Chromium	23.5
Selenium	1.2 JB
Depth	14'-16'
Benzo(a)pyrene	96 J
Selenium	1.2 J

Location	SB-104
Depth	0'-2'
Aluminum	12200
Chromium	17.2
Cobalt	11.0 B
Copper	29.5 J
Iron	22100
Potassium	1330 B
Depth	8'-10'
Trichloroethene	61

Location	SB-105
Depth	0'-2'
Thallium	1.1 B
Depth	4'-6'
Thallium	2.3
Depth	14'-16'
Aluminum	18100
Cobalt	18.1
Iron	40000
Magnesium	6430 J
Nickel	36.5
Selenium	1.3 J
Thallium	2.1 B

Location	SB-102
Depth	0'-2'
Dieldrin	1.6 J

Location	SB-108
Depth	0'-2'
Copper	27.6
Thallium	11.9
Depth	4'-6'
Selenium	1.3 J
Thallium	15.4
Depth	10'-12'
Thallium	14.9
Depth	14'-16'
Calcium	36600
Thallium	8.2

NOTES:

J INDICATES ESTIMATED CONCENTRATION VALUE

B INDICATES THAT FOR METALS ONLY, CONCENTRATION IS BETWEEN THE INSTRUMENT DETECTION LIMIT AND THE PRACTICAL QUANTITATION LIMIT

D CONCENTRATION PROVIDED FROM DILUTION ANALYSIS

WHERE NO VALUE IS PROVIDED, CONCENTRATION DID NOT EXCEED MOST CONSERVATIVE CRITERIA VALUE.

CONTAMINANT CONCENTRATIONS ARE PRESENTED IN ug/kg (ppb) FOR ORGANIC COMPOUNDS AND mg/kg (ppm) FOR INORGANIC COMPOUNDS.

Criteria exceeded are indicated by the color of the text/value: yellow exceeds human health-based values; green exceeds ecological-based values; grey exceeds State values; blue exceeds background range values; and purple exceeds both of the above values. For comparison criteria values, see Section 4.2 and Tables 4-1 and 4-2.

For the metals, only those metals whose concentrations either [1] exceeded more than one comparison criteria (human health, ecological or state) and/or [2] were outside the range of soil background values for the analyte (i.e., blue or purple) are provided. See text for additional rationale.

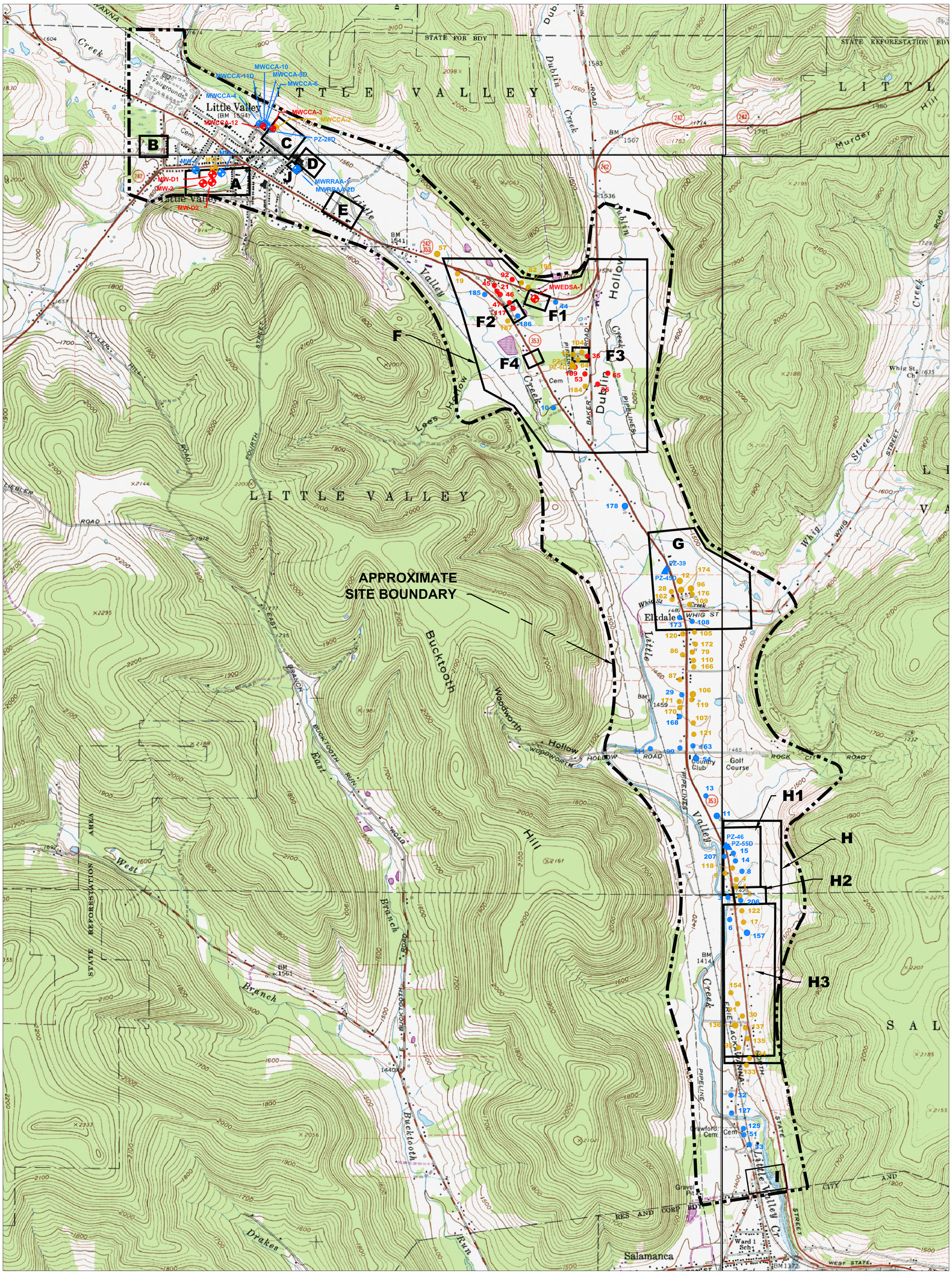
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 1-4
BUSH INDUSTRIES AREA
CONTAMINANTS IN SOIL EXCEEDING
CRITERIA COMPARISON LEVELS

TETRA TECH FW, INC.

N:\DS\DSKEY\DSPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-2A (BIA SOIL DATA).DWG



LEGEND:

NYSDEC POTENTIAL SOURCE AREAS:

- **A** BUSH INDUSTRIES AREA
- **B** NINTH STREET LANDFILL AREA
- **C** CATTARAUGUS CUTLERY AREA
- **D** KING WINDOWS (SECOND STREET) AREA
- **E** FIRST STREET AREA
- **F** GREAT TRIANGLE AREA
  - INCLUDES:
    - **F1** ENVIROTECH DRUM STORAGE
    - **F2** WESTERN BURNT HOUSE
    - **F3** WINSHIP CIRCLE/BAKER ROAD
    - **F4** TRIANGLE SOUTHWEST
- **G** WHIG STREET AREA
- **H** LUMINITE AREA
  - INCLUDES:
    - **H1** NORTH LUMINITE
    - **H2** LUMINITE PLANT AREA
    - **H3** SOUTH LUMINITE
- **I** STATE STREET AREA
- **J** RAILROAD AVENUE AREA

CDPWP CATTARAUGUS COUNTY DEPARTMENT OF PUBLIC WORKS PROPERTY

GROUNDWATER TCE RESULTS:

- NON-DETECT (ND) TO 5 UG/L
- 5 UG/L TO 10 UG/L
- 10 UG/L TO 24 UG/L

107 WELL IDENTIFICATION NUMBERS, AS SHOWN ON TABLES A-1 AND A-2 IN APPENDIX A.

TCE CONCENTRATIONS ARE FROM SAMPLING CONDUCTED IN OCTOBER 2003 (RESIDENTIAL LOCATIONS) OR NOVEMBER/DECEMBER 2003 (MONITORING WELL/PIEZOMETER LOCATIONS).

FOR THE RESIDENTIAL WELLS, SAMPLES WERE COLLECTED FROM A PORT LOCATED PRIOR TO THE TREATMENT SYSTEM TRAIN (i.e., PRE-TREATMENT).

RESIDENTIAL SAMPLING LOCATIONS ARE APPROXIMATE (NOT SURVEYED).

LOCATION LEGEND:

- RESIDENTIAL WELL LOCATION
- PIEZOMETER
- MONITORING WELL

0 1400 2800

APPROXIMATE GRAPHIC SCALE
1"=1400'



APPROX. QUADRANGLE LOCATIONS

SOURCE:
BASE MAP ADAPTED FROM U.S.G.S. LITTLE VALLEY, ELLICOTTVILLE, SALAMANCA, AND CATTARAUGUS NEW YORK QUADRANGLES, 7.5 MINUTE SERIES (TOPOGRAPHIC).

LITTLE VALLEY SUPERFUND SITE

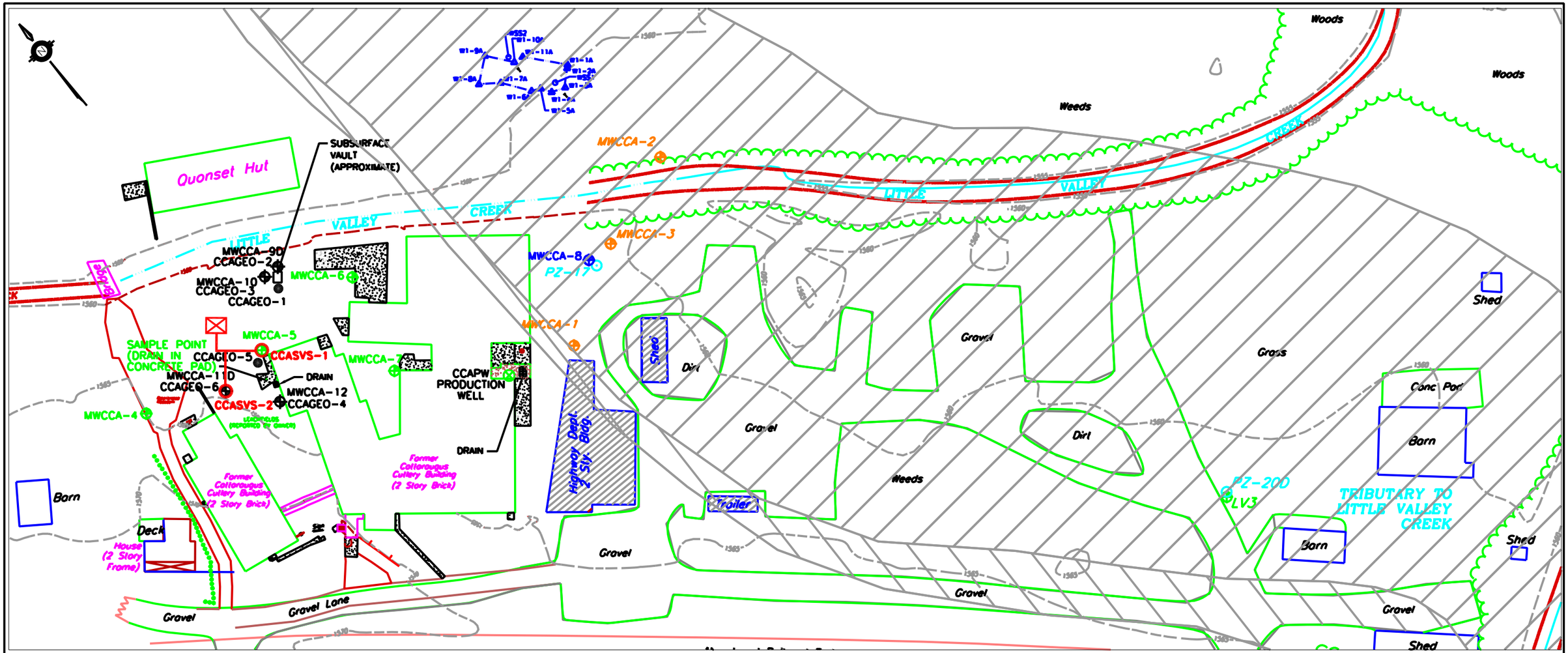
LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 1-5

TCE SAMPLING RESULTS FROM RESIDENTIAL WELLS, PIEZOMETERS AND MONITORING WELLS, 2003

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 1-5 (TCE SITE-WIDE ISOCONTOUR).DWG



LEGEND:

- MONITORING WELL – PHASE II, 1998
- MONITORING WELL – PHASE II, 1999
- MONITORING WELL – PHASE III, 2000 *
- MONITORING WELL AND DIRECT-PUSH LOCATION – PHASE IV, 2003
- PIEZOMETER – PHASE I, 1997 *
- PRODUCTION WELL *
- PHASE IV DIRECT-PUSH LOCATION
- PROPOSED SVE WELL

* LOCATIONS ARE APPROXIMATE

- SVE REMEDIATION BUILDING
- CCASVS — PROPOSED SHALLOW SVE WELL
- CONCRETE
- DEMOLISHED BUILDINGS
- WETLAND DELINEATION POINT (APPROXIMATE LOCATION)
- WETLAND SOIL SAMPLE (APPROXIMATE LOCATION)
- 100-YEAR FLOODPLAIN
- 500-YEAR FLOODPLAIN

NOTES:

1. CCASVS WELLS ARE PROPOSED 4-INCH DIAMETER SVE WELLS SCREENED FROM NEAR SURFACE TO APPROXIMATELY 10' BGS.
2. ANTICIPATED SVE RADIUS OF INFLUENCE IS 50'.

0 80 160

APPROXIMATE GRAPHIC SCALE

BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION FINAL PLAN DATED: 11/19/99 REV. 1 PLAN NUMBER R97079-F1

THERE HAVE BEEN SIGNIFICANT CHANGES IN THE 1998 SURVEY AREA THAT ARE NOT SHOWN ON THIS PLAN, CONSISTING OF BUILDING DEMOLITION AND EARTH MOVING ACTIVITIES AS THE COUNTY VACATED THE PREMISES.

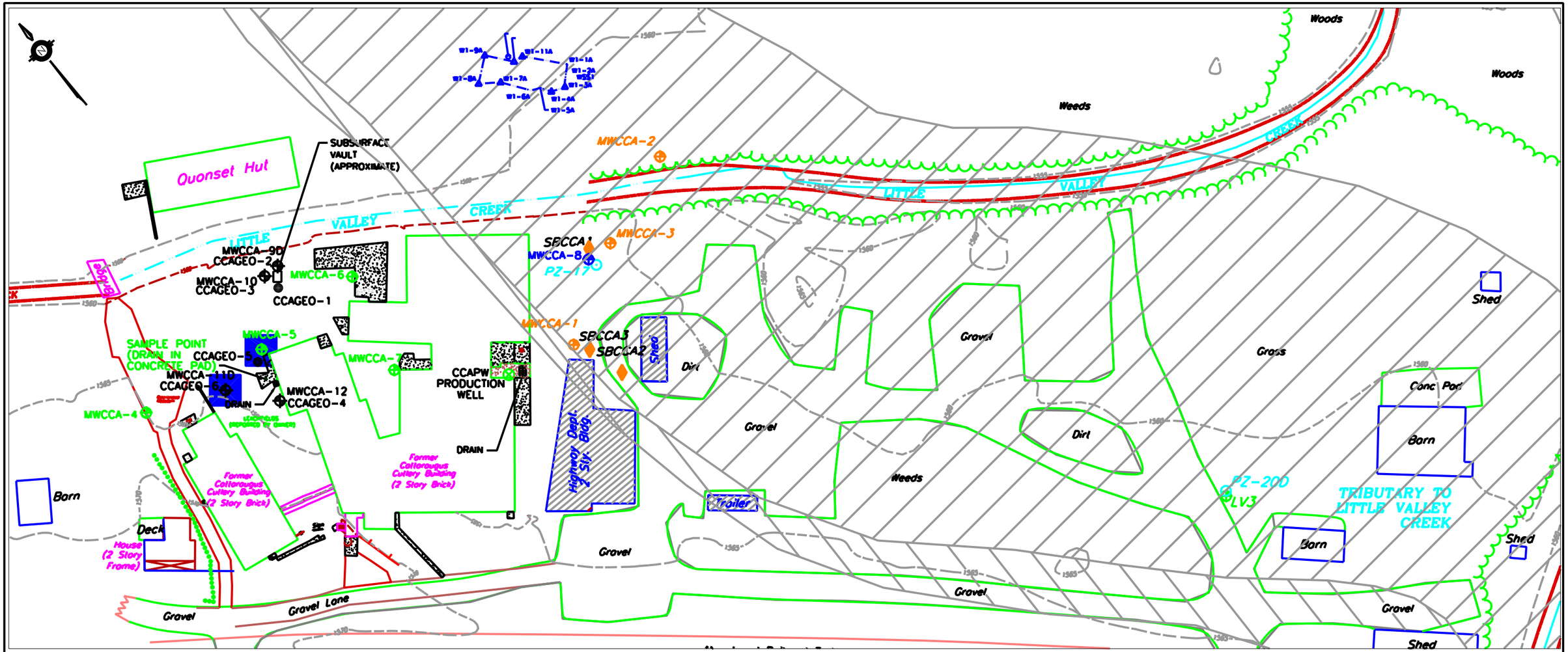
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-1
CATTARAUGUS CUTLERY AREA (CCA)
ALTERNATIVE S-3 IN SITU SOIL VAPOR EXTRACTION

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ3\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-1 (CCA ALT 4).DWG



LEGEND:

- MONITORING WELL – PHASE II, 1998
- MONITORING WELL – PHASE II, 1999
- MONITORING WELL – PHASE III, 2000 *
- MONITORING WELL AND DIRECT-PUSH LOCATION – PHASE IV, 2003
- PHASE II SOIL BORING AND SIMULPROBE LOCATION *
- PIEZOMETER – PHASE I, 1997
- PRODUCTION WELL *
- PHASE IV DIRECT-PUSH LOCATION

* LOCATIONS ARE APPROXIMATE

- ESTIMATED EXTENT OF EXCAVATION
- CONCRETE
- DEMOLISHED BUILDINGS
- 100-YEAR FLOODPLAIN
- 500-YEAR FLOODPLAIN
- WETLAND DELINEATION POINT (APPROXIMATE LOCATION)
- WETLAND SOIL SAMPLE (APPROXIMATE LOCATION)

EXCAVATION AREA	APPROXIMATE AREA* (SQ. FT.)	APPROXIMATE DEPTH * (FT.)	APPROXIMATE VOLUME (CU. YD.)
	1200	5	222

* AREA AND DEPTH TO BE VERIFIED DURING PRE-DESIGN.

NOTES:
EXCAVATE AND FILL THE SHADED AREA FOR ALTERNATIVE S-4. LEAVE STRUCTURES UNDISTURBED. RESTORE WITH TOPSOIL, SEED, AND MULCH TO ESTABLISH GRASS COVER OR REPLACE CONCRETE.

THERE HAVE BEEN SIGNIFICANT CHANGES IN THE 1998 SURVEY AREA THAT ARE NOT SHOWN ON THIS PLAN, CONSISTING OF BUILDING DEMOLITION AND EARTH MOVING ACTIVITIES AS THE COUNTY VACATED THE PREMISES.

0 80 160

APPROXIMATE GRAPHIC SCALE

BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION FINAL PLAN DATED: 11/19/99 REV. 1 PLAN NUMBER R97079-F1

LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-2
CATTARAUGUS CUTLERY AREA (CCA)
ALTERNATIVE S-4
EXCAVATION/OFF-SITE DISPOSAL

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-2 (CCA ALT 5a).DWG

MWCCA-6
MWCCA-11D
MWCCA-4
MWCCA-12
MWCCA-8
MW-3
MW-D1
MW-2
MW-5
MW-D2
MW-6
MWRRAA-1
MWRRAA-2D
PZ-48
PZ-47D
PZ-5
PZ-6D
PZ-39
PZ-45D
PZ-46
PZ-55D
PZ-59
PZ-60D

LITTLE VALLEY

REFERENCE:
"REVISED REMEDIAL INVESTIGATION REPORT" FOR LITTLE VALLEY SUPERFUND SITE, TtFW – MAY 2004.

LEGEND:

POTENTIAL SOURCE AREAS:

- BUSH INDUSTRIES AREA
- NINTH STREET LANDFILL AREA
- CATTARAUGUS CUTLERY AREA
- KING WINDOWS (SECOND STREET) AREA
- FIRST STREET AREA
- GREAT TRIANGLE AREA
  - INCLUDES:
    - ENVIROTECH DRUM STORAGE
    - WESTERN BURNT HOUSE
    - WINSHIP CIRCLE/BAKER ROAD
    - TRIANGLE SOUTHWEST
- WHIG STREET AREA
- LUMINITE AREA
  - INCLUDES:
    - NORTH LUMINITE
    - LUMINITE PLANT AREA
    - SOUTH LUMINITE
- STATE STREET AREA
- RAILROAD AVENUE AREA

MONITORING WELL

PIEZOMETER – PHASE I, 1997

INDICATES GROUNDWATER SAMPLE(S) TO BE COLLECTED FROM WELLS PROPOSED FOR MONITORED NATURAL ATTENUATION PROGRAM.

100-YEAR FLOODPLAIN

500-YEAR FLOODPLAIN

WETLAND DELINEATION POINT (APPROXIMATE LOCATION)

WETLAND SOIL SAMPLE (APPROXIMATE LOCATION)

GRAPHIC SCALE 1"=1200'

0 1200 2400 3600

APPROX. QUADRANGLE LOCATIONS

SOURCES:
1) BASE MAP ADAPTED FROM U.S.G.S. LITTLE VALLEY, ELLICOTTVILLE, SALAMANCA, AND CATTARAUGUS NEW YORK QUADRANGLES, 7.5 MINUTE SERIES (TOPOGRAPHIC).
2) LOCATION SURVEY FOR MONITORING WELLS, STREAM GAUGES AND PIEZOMETERS WAS PERFORMED BY ENVIRONMENTAL RESEARCH, INC. (OCTOBER '97 THROUGH DECEMBER '97).

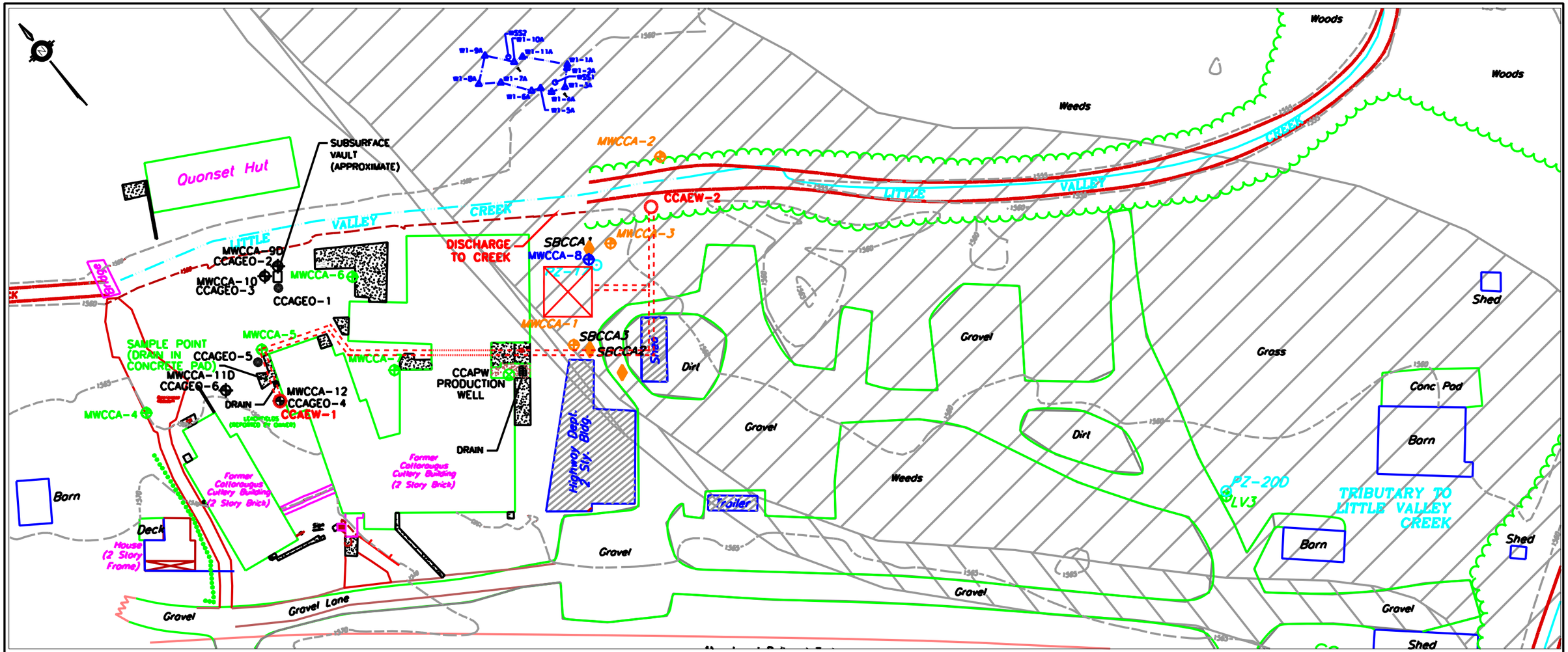
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-3
SITE-WIDE GROUNDWATER MONITORING
ALTERNATIVE GW-2
MONITORED NATURAL ATTENUATION

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-3 (GW ALT 2).DWG



LEGEND:

- MONITORING WELL – PHASE II, 1998
- MONITORING WELL – PHASE II, 1999
- MONITORING WELL – PHASE III, 2000 *
- MONITORING WELL AND DIRECT-PUSH LOCATION – PHASE IV, 2003
- PHASE II SOIL BORING AND SIMULPROBE LOCATION *
- PIEZOMETER – PHASE I, 1997
- PRODUCTION WELL *
- PHASE IV DIRECT-PUSH LOCATION

* LOCATIONS ARE APPROXIMATE

- CCAEW-1 TYP. PROPOSED EXTRACTION WELL
- TRENCH FOR EXTRACTED GROUNDWATER PIPING
- REMEDIATION COMPOUND
- CONCRETE
- DEMOLISHED BUILDINGS

NOTE:

EXTRACTED GROUNDWATER FROM BIA AND CCA TO BE TREATED AT CCA REMEDIATION COMPOUND.

- WETLAND DELINEATION POINT (APPROXIMATE LOCATION)
- WETLAND SOIL SAMPLE (APPROXIMATE LOCATION)
- 100-YEAR FLOODPLAIN
- 500-YEAR FLOODPLAIN

BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION FINAL PLAN DATED: 11/19/99 REV. 1 PLAN NUMBER R97079-F1

THERE HAVE BEEN SIGNIFICANT CHANGES IN THE 1998 SURVEY AREA THAT ARE NOT SHOWN ON THIS PLAN, CONSISTING OF BUILDING DEMOLITION AND EARTH MOVING ACTIVITIES AS THE COUNTY VACATED THE PREMISES.

0 80 160

APPROXIMATE GRAPHIC SCALE

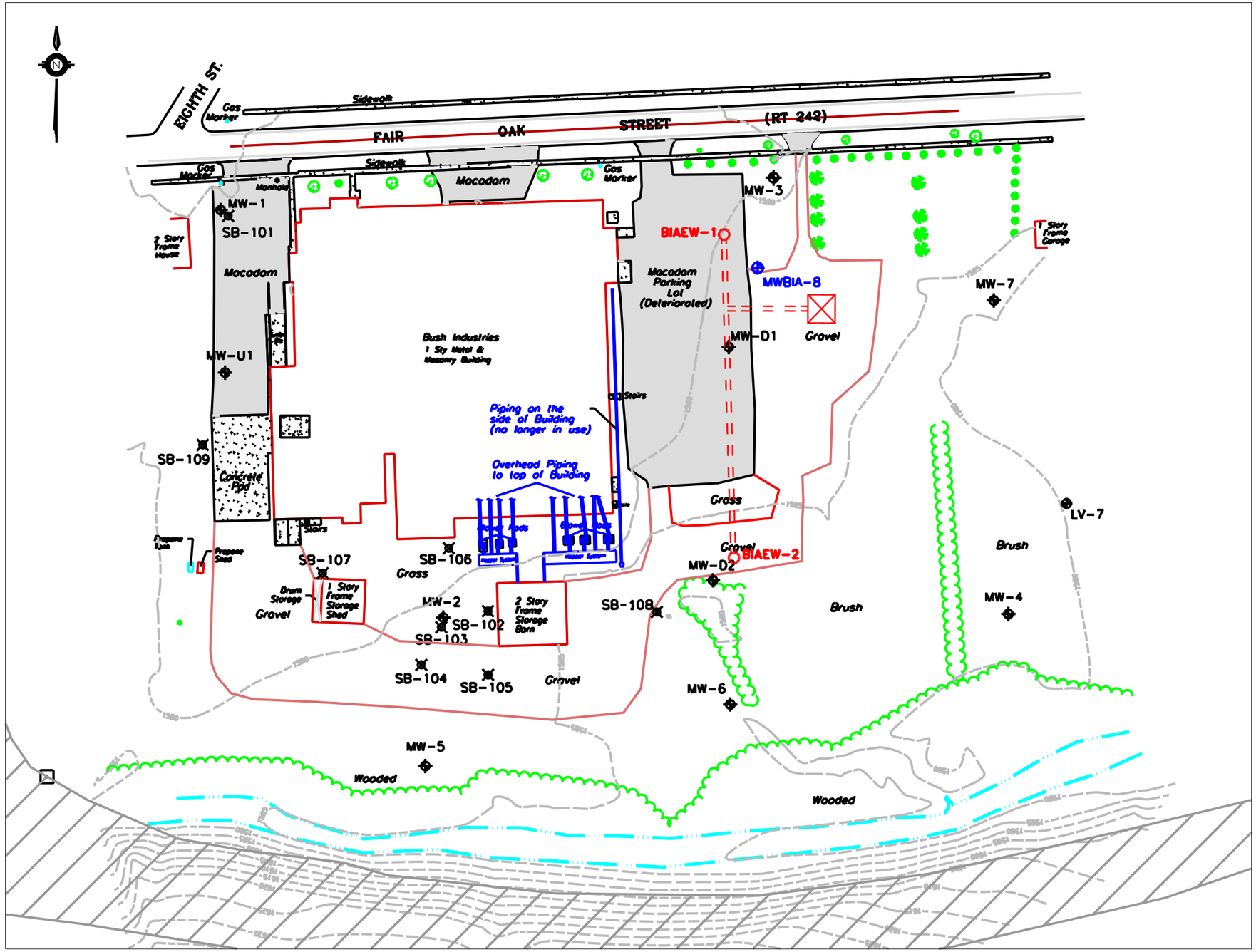
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-4a
CATTARAUGUS CUTLERY AREA (CCA)
ALTERNATIVE GW-3 EXTRACTION/TREATMENT/
DISCHARGE/INSTITUTIONAL CONTROLS WITH MONITORED
NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-4a (CCA ALT GW 3).DWG



LEGEND

- FIRE HYDRANT
- LIGHTPOLE
- UTILITY POLE
- MONITORING WELL
- MONITORING WELL – PHASE III, 2000
- SOIL BORING, PHASE III (2000/2001)
- GROUNDWATER EXTRACTION WELL–TYP.
- TRENCH FOR EXTRACTED GROUNDWATER PIPING
- PUMPING STATION FOR EXTRACTED GROUNDWATER
- TREE
- PINE TREE
- CREEK BANK
- 1500 APPROX. TOPOGRAHIC CONTOUR
- WOODS LINE
- CONCRETE
- 100–YEAR FLOODPLAIN

NOTE:

EXTRACTED GROUNDWATER TO BE PUMPED FROM BIA TO CCA FOR TREATMENT.

0 100 200

APPROXIMATE GRAPHIC SCALE

LITTLE VALLEY SUPERFUND SITE

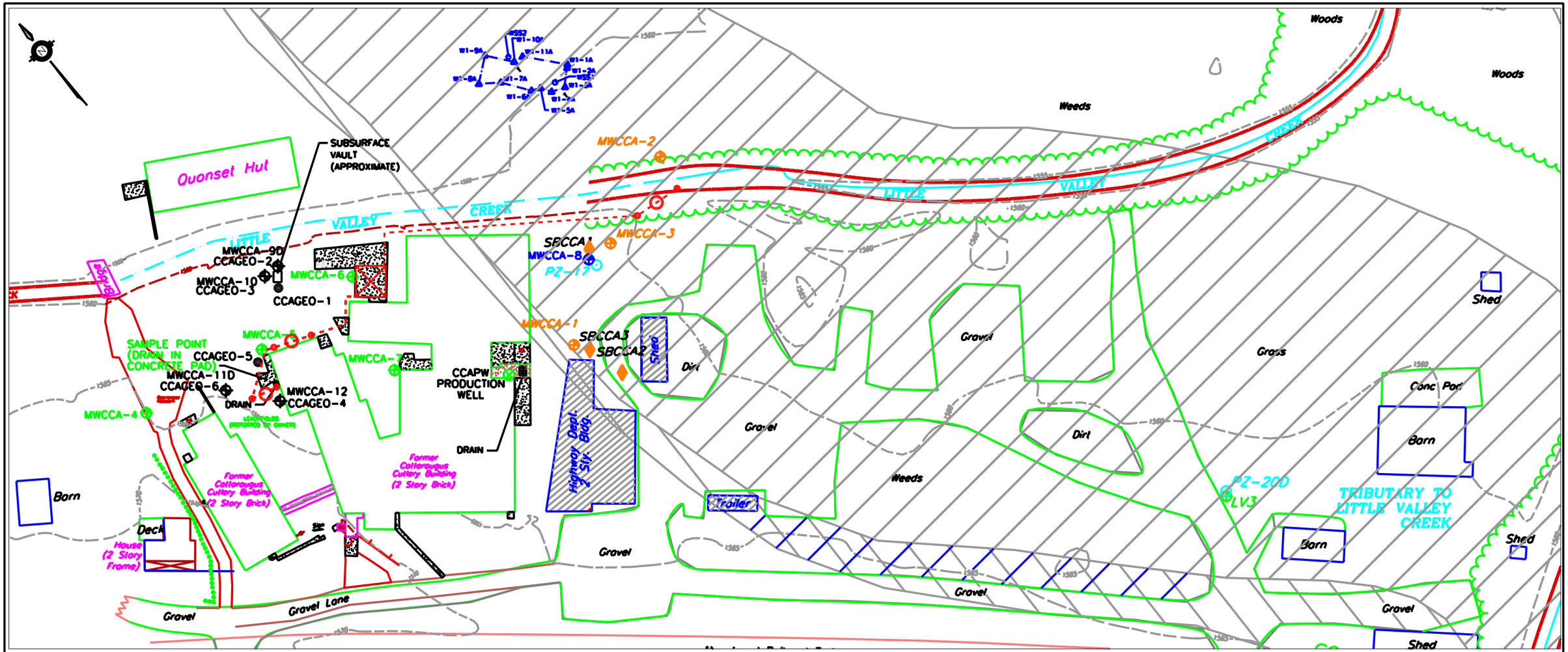
LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4–4b
BUSH INDUSTRIES AREA (BIA)
ALTERNATIVE GW–3 EXTRACTION/TREATMENT/ DISCHARGE/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

TETRA TECH FW, INC.

SOURCE:
BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION "TOPOGRAPHIC SURVEY OF BUSH INDUSTRIES SITE" DATED: 5/3/01 PLAN NUMBER E01003–F1

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4–4b (BIA ALT GW 3).DWG



LEGEND:

- MONITORING WELL – PHASE II, 1998
- MONITORING WELL – PHASE II, 1999
- MONITORING WELL – PHASE III, 2000 *
- MONITORING WELL AND DIRECT-PUSH LOCATION – PHASE IV, 2003
- PHASE II SOIL BORING AND SIMULPROBE LOCATION *
- PIEZOMETER – PHASE I, 1997
- PRODUCTION WELL *
- PHASE IV DIRECT-PUSH LOCATION

* LOCATIONS ARE APPROXIMATE

- PROPOSED ISVE WELL
- PROPOSED AIR SPARGE WELL
- TRENCH FOR SPARGE MANIFOLD AND SVE MANIFOLD
- REMEDIATION COMPOUND
- CONCRETE
- DEMOLISHED BUILDINGS
- WETLAND DELINEATION POINT (APPROXIMATE LOCATION)
- WETLAND SOIL SAMPLE (APPROXIMATE LOCATION)

- 100-YEAR FLOODPLAIN
- 500-YEAR FLOODPLAIN

NOTES:
1. SIX AIR SPARGING WELLS ARE PROPOSED IN THE PLUME SOURCE AREA.
2. THREE ISVE WELLS ARE PROPOSED FOR VAPOR COLLECTION.

BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION FINAL PLAN DATED: 11/19/99 REV. 1 PLAN NUMBER R97079-F1

THERE HAVE BEEN SIGNIFICANT CHANGES IN THE 1998 SURVEY AREA THAT ARE NOT SHOWN ON THIS PLAN, CONSISTING OF BUILDING DEMOLITION AND EARTH MOVING ACTIVITIES AS THE COUNTY VACATED THE PREMISES.

0 80 160

APPROXIMATE GRAPHIC SCALE

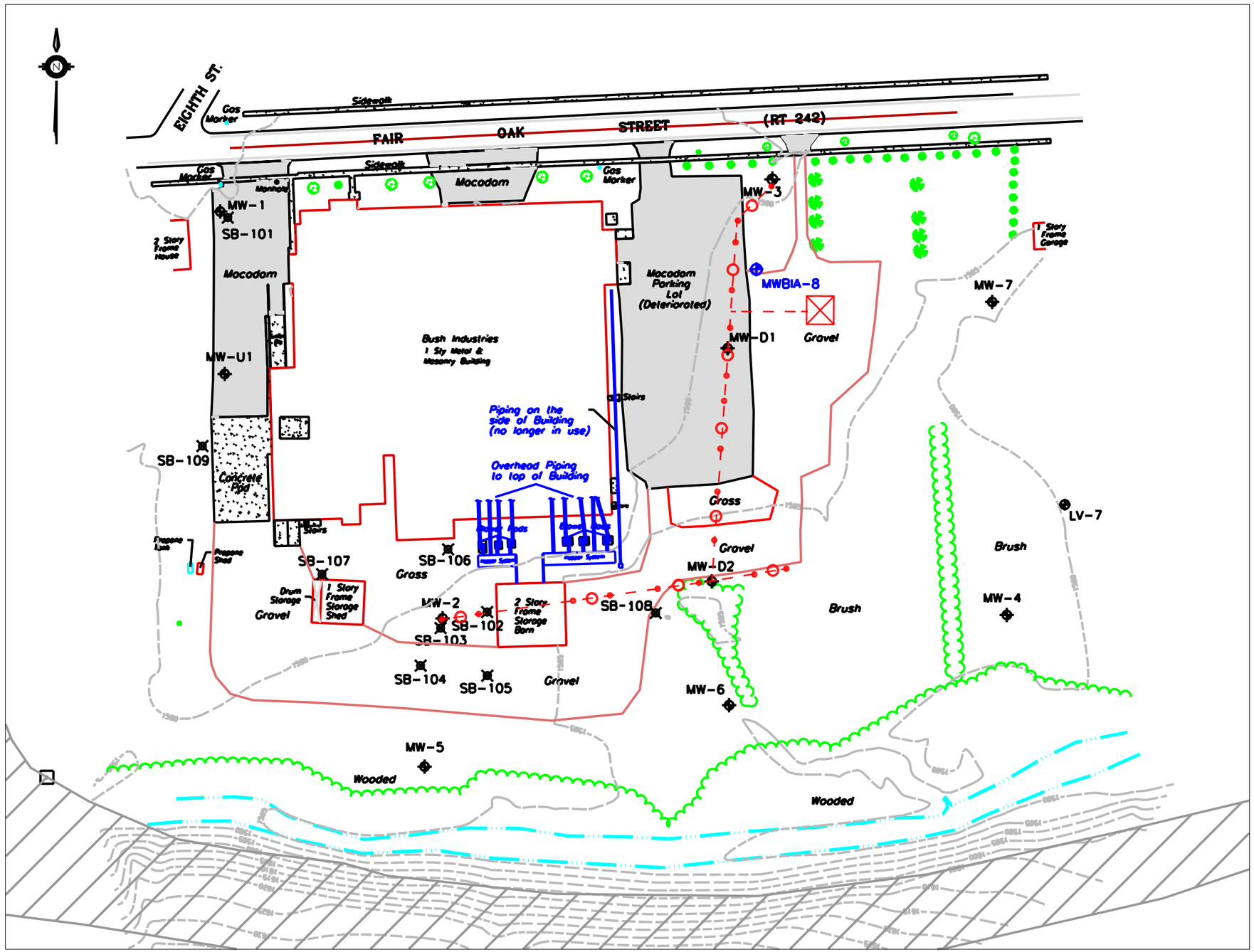
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-5a
CATTARAUGUS CUTLERY AREA (CCA)
ALTERNATIVE GW-4 IN SITU AIR SPARGING/VAPOR TREATMENT/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-5a (CCA ALT GW 4).DWG



LEGEND

- FIRE HYDRANT
- LIGHTPOLE
- UTILITY POLE
- MONITORING WELL
- MONITORING WELL – PHASE III, 2000
- SOIL BORING, PHASE III (2000/2001)
- PROPOSED ISVE WELL
- PROPOSED AIR SPARGE WELL
- TRENCH FOR SPARGE MANIFOLD AND SVE MANIFOLD
- REMEDIATION COMPOUND
- TREE
- PINE TREE
- CREEK BANK
- 1500 APPROX. TOPOGRAHIC CONTOUR
- WOODS LINE
- CONCRETE
- 100-YEAR FLOODPLAIN

NOTES:

1. EIGHTEEN AIR SPARGING WELLS ARE PROPOSED IN THE CURRENT SOURCE AREA OF THE GROUNDWATER PLUME.

2. NINE ISVE WELLS ARE PROPOSED FOR VAPOR COLLECTION.

0 100 200

APPROXIMATE GRAPHIC SCALE

SOURCE:
BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION "TOPOGRAPHIC SURVEY OF BUSH INDUSTRIES SITE" DATED: 5/3/01 PLAN NUMBER E01003-F1

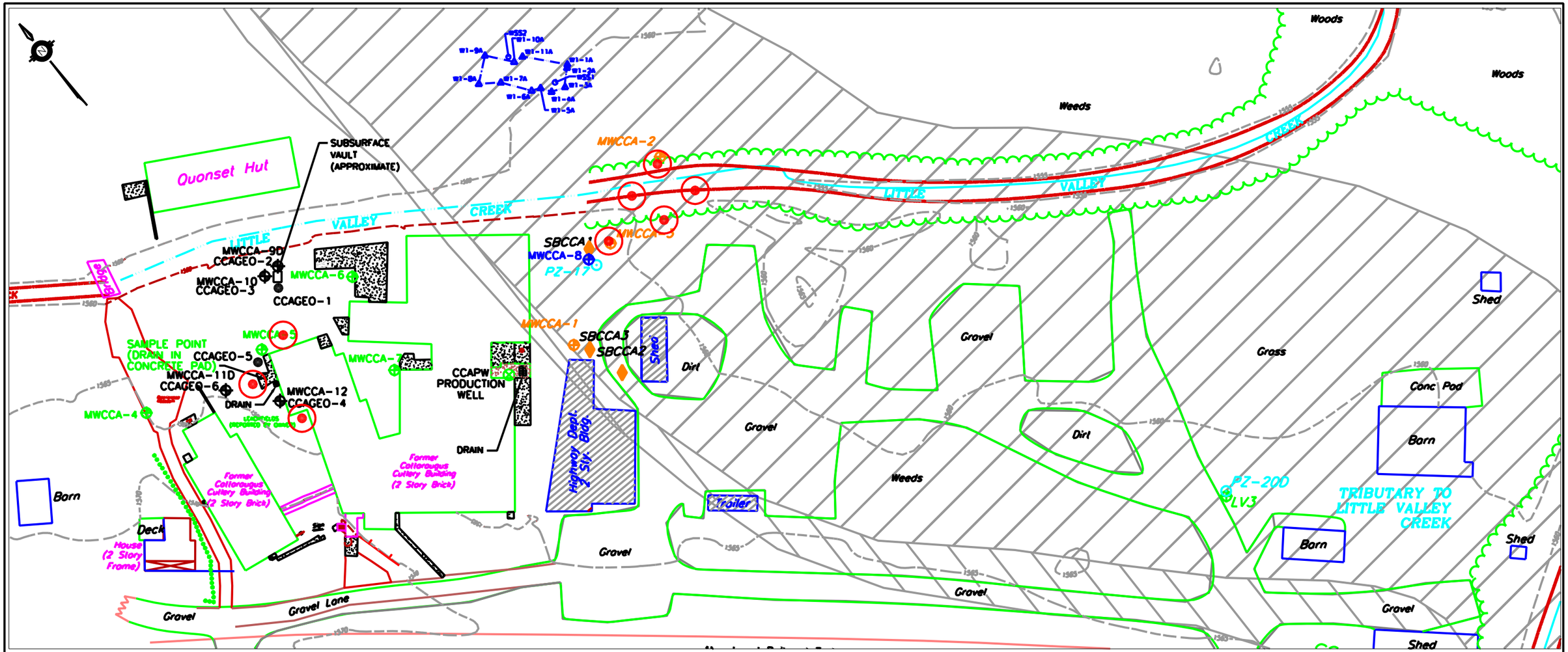
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-5b
BUSH INDUSTRIES AREA (BIA)
ALTERNATIVE GW-4 IN SITU AIR SPARGING/VAPOR TREATMENT/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

TETRA TECH FW, INC.

N:\GIS\GSKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-5b (BIA ALT GW 4).DWG



LEGEND:

- MONITORING WELL – PHASE II, 1998
- MONITORING WELL – PHASE II, 1999
- MONITORING WELL – PHASE III, 2000 *
- MONITORING WELL AND DIRECT-PUSH LOCATION – PHASE IV, 2003
- PHASE II SOIL BORING AND SIMULPROBE LOCATION *
- PIEZOMETER – PHASE I, 1997
- PRODUCTION WELL *
- PHASE IV DIRECT-PUSH LOCATION

* LOCATIONS ARE APPROXIMATE

- PROPOSED CHEMOX INJECTION WELL
- CONCRETE
- DEMOLISHED BUILDINGS

NOTE:

EIGHT WELLS ARE PROPOSED FOR THE INJECTION OF CHEMICAL OXIDANTS IN THE SOURCE AREA.

- WETLAND DELINEATION POINT (APPROXIMATE LOCATION)
- WETLAND SOIL SAMPLE (APPROXIMATE LOCATION)
- 100-YEAR FLOODPLAIN
- 500-YEAR FLOODPLAIN

BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION FINAL PLAN DATED: 11/19/99 REV. 1 PLAN NUMBER R97079-F1

THERE HAVE BEEN SIGNIFICANT CHANGES IN THE 1998 SURVEY AREA THAT ARE NOT SHOWN ON THIS PLAN, CONSISTING OF BUILDING DEMOLITION AND EARTH MOVING ACTIVITIES AS THE COUNTY VACATED THE PREMISES.

0 80 160

APPROXIMATE GRAPHIC SCALE

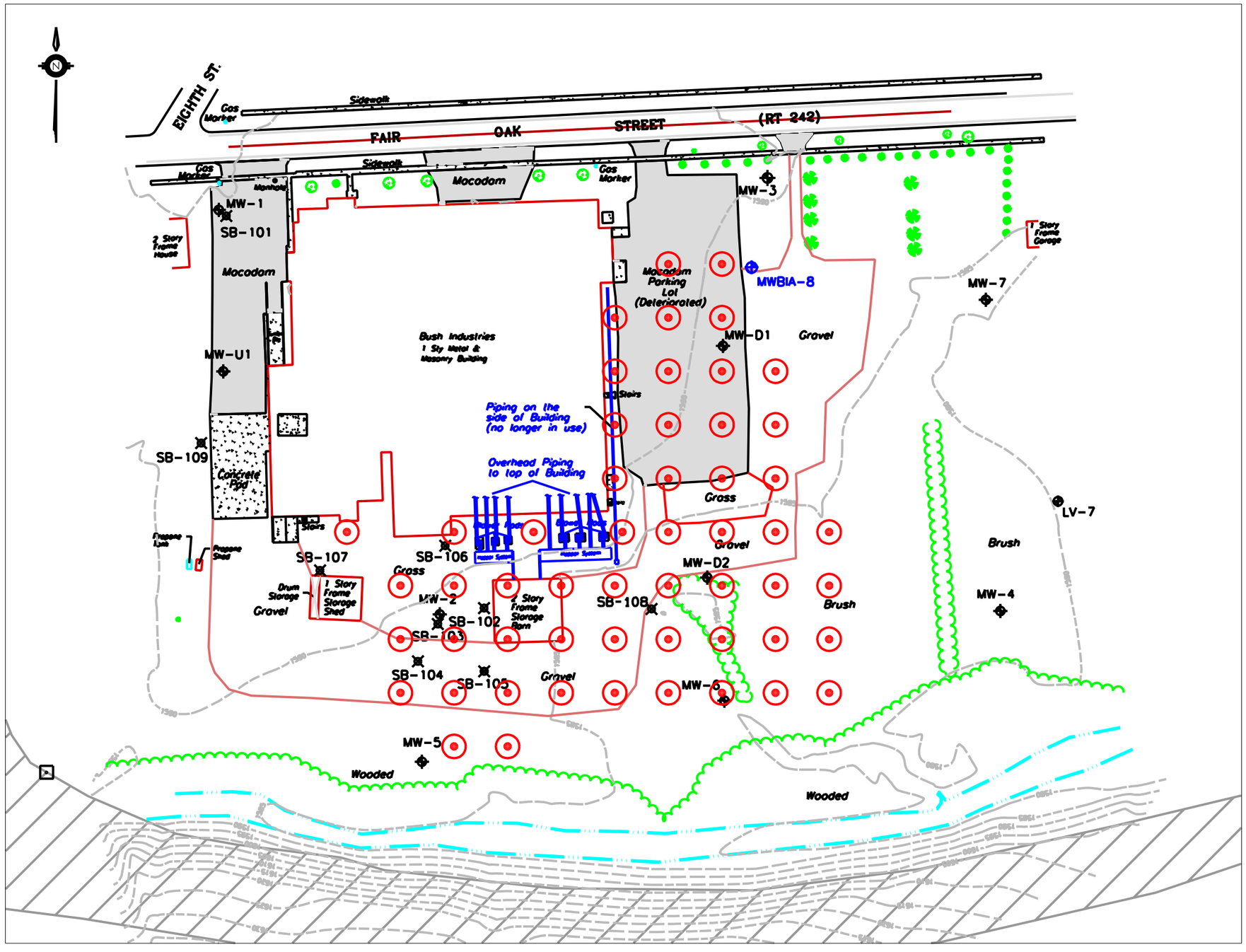
LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-6a
CATTARAUGUS CUTLERY AREA (CCA)
ALTERNATIVE GW-5 IN SITU CHEMICAL OXIDATION/ INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-6a (CCA ALT GW 5).DWG



LEGEND

- FIRE HYDRANT
- LIGHTPOLE
- UTILITY POLE
- MONITORING WELL
- MONITORING WELL – PHASE III, 2000
- SOIL BORING, PHASE III (2000/2001)
- PROPOSED CHEMOX INJECTION WELL
- TREE
- PINE TREE
- CREEK BANK
- —1500— APPROX. TOPOGRAHIC CONTOUR
- WOODS LINE
- CONCRETE
- 100-YEAR FLOODPLAIN

NOTE:

FIFTY-FOUR WELLS ARE TO BE USED FOR CHEMICAL OXIDANT INJECTION AS SHOWN IN THE SOURCE AREA.

0 100 200

APPROXIMATE GRAPHIC SCALE

SOURCE:
BASE MAP ADAPTED FROM TOPOGRAPHICAL MAP PREPARED BY VITILLO CORPORATION "TOPOGRAPHIC SURVEY OF BUSH INDUSTRIES SITE" DATED: 5/3/01 PLAN NUMBER E01003-F1

LITTLE VALLEY SUPERFUND SITE

LITTLE VALLEY
CATTARAUGUS COUNTY, NEW YORK

FIGURE 4-6b
BUSH INDUSTRIES AREA (BIA)
ALTERNATIVE GW-5 IN SITU CHEMICAL OXIDATION/ INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

TETRA TECH FW, INC.

N:\GIS\GISKEY\GISPROJ31\EPA LITTLE VALLEY\REVISED DRAFT FS 2005\FIGURE 4-6b (BIA ALT GW 5).DWG

APPENDIX A

LIST OF MAJOR FACILITIES AND CONSTRUCTION COMPONENTS FOR REMEDIAL ALTERNATIVES

TABLE A-1

ALTERNATIVE S-1: NO ACTION

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
No Remedial Action		

TABLE A-2

ALTERNATIVE S-2: INSTITUTIONAL CONTROLS

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
I. PUBLIC AWARENESS PROGRAM	LS	Hold two public meetings to describe risks from soil contamination and prepare technical handouts for residents.
II. LAND USE RESTRICTIONS	LS	EPA to assist county to establish a restrictive covenant.

TABLE A-3

ALTERNATIVE S-3: *IN-SITU* SOIL VAPOR EXTRACTION

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
I. SECURITY SYSTEM		
1. Fence	100 Lft	8 ft. high chain link fence with triple strand barbed wire top.
2. Entrance Gate	2	Two personnel entrance gates (5 feet wide).
3. Warning Signs	4	4 ft. x 3 ft. PVC signs posted on the fence.
II. SUPPORT FACILITIES		
1. Office Trailer	1	EPA, NYSDEC and Engineering Office. Lease for 12 months size (15 ft. L x 7.5 W x 7 ft. H).
2. Decontamination Trailer	1	Health and Safety Trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H).
III. TREATABILITY/PILOT STUDY		
1. *In-situ* Vapor Extraction Pilot Test	1	Pilot study for *in-situ* vapor extraction to collect design parameters data.
IV. SOIL VAPOR EXTRACTION		
1. System Installation	1	Install a remediation shed, two 4-inch shallow SVE wells, 4-inch PVC extraction piping, power drop, 1000# carbon canisters, external vent stack, and SVE blower with support accessories and appurtenances.
2. System Operation	12 mos.	Operate the SVE system for 12-months and monitor the operation with driveable/reusable monitoring points that can be relocated if necessary.
3. Confirmatory Sampling	18	Confirm completion with offgas sampling and analysis and geoprobe borings next to each SVE well with samples analyzed for TCL VOCs. There will be approximately 18 samples.
4. Demobilization	1	Remove the entire system.

TABLE A-4

ALTERNATIVE S-4: EXCAVATION/OFF-SITE/DISPOSAL

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
I. SUPPORT FACILITIES		
1. Office Trailer	1	EPA, NYSDEC and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H).
2. Decontamination Trailer	1	Health and Safety Trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H).
II. EXCAVATION		
1. Concrete Removal	15 cy	Remove the concrete slab and walks.
2. Excavation to Subgrade	222 cy	Excavate to 5-feet below ground surface in the excavation area
III. POST-EXCAVATION SAMPLING	10	After excavation, collect excavation floor samples on a 50' x 50' grid pattern. There will be about 10 samples. Analyze the samples for TCL VOCs, TCL SVOCs, and TAL metals.
IV. OFF-SITE TREATMENT AND DISPOSAL		
1. Concrete Debris	15 cy	Transportation (assume a distance of 200 miles) and disposal at a municipal landfill.
2. Non-Hazardous Soil	222 cy	Transportation (assume a distance of 200 miles) and disposal at a municipal landfill.
V. RESTORATION		
1. Subgrade Preparation	1,200 ft^2	Prepare subgrade by grading and compacting.
2. Backfill Installation	200 cy	Install clean local soil and compact to 90% maximum modified AASHO density in 1-foot lifts.
3. Topsoil, Seed, Mulch, Fertilize	1,200 square feet	Install, grade and rake a 6-inch layer of topsoil. Seed, mulch, fertilize and water.

TABLE A-5

ALTERNATIVE GW-1: NO ACTION

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
No Remedial Action.		

TABLE A-6

ALTERNATIVE GW-2: SITE-WIDE MONITORED NATURAL ATTENUATION/INSTITUTIONAL CONTROLS
SITE-WIDE GROUNDWATER

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
I. INSTITUTIONAL CONTROLS		
1. Public Awareness Program*	LS	Hold public meetings to describe risks from groundwater contamination and prepare technical handouts for residents.
2. Water Use Restrictions*	LS	Maintain land use restrictions and point-of-use treatment systems.

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

TABLE A-7 (Sheet 1 of 4)

ALTERNATIVE GW-3: SOURCE AREA EXTRACTION/TREATMENT/DISCHARGE/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
I. SUPPORT FACILITIES		
1. Office Trailer	1	EPA, NYSDEC and Engineering Office (CCA)
		Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H) (CCA)
2. Decontamination Trailer	1	Health and safety trailer with shower facility (CCA)
		Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H) (CCA)
II. GROUNDWATER EXTRACTION		
1. Pilot Pump Test	2	72 hours pump testing (CCA and BIA).
2. Extraction Well	2	Stainless steel 6" diameter, 50 ft. deep wells with 20 ft. stainless steel screen (CCA).
	2	Stainless steel 6" diameter, 60 ft. deep wells with 20 ft. stainless steel screens (BIA).
3. Pumps	2	Submersible pump, flow rate 30 gpm each, TDH 150 ft. (CCA)
	2	Submersible pump, flow rate 12 gpm each, TDH 150 ft. (BIA).
4. Piping	450 ft.	3 inch diameter, HDPE pipe buried 4.50 ft. below ground (CCA).
	220 ft.	2 inch diameter, HDPE pipe buried 4.50 ft. below ground (BIA).
III. COLLECTION/EQUALIZATION TANK		
1. Collection Tank	1	10,800 gals. (plus free board), epoxy coated carbon steel tanks (CCA).
	1	4,320 gals. (plus free board), epoxy coated carbon steel tank (BIA).
2. Pumps	2	90 gpm each centrifugal pump (one operating, one standby), 40 ft. TDH, stainless steel.
	2	24 gpm each centrifugal pump (one operating, one standby), 150 ft. TDH stainless steel (BIA).
3. Piping	50 ft.	3-inch diameter, CPVC pipe (CCA).
	2,400 ft.	2 inch diameter duct iron pipe buried in trench 4.50 ft. below ground from Bush Industries Area to Cattaraugus Cutlery treatment system (CCA).

TABLE A-7 (Sheet 2 of 4)

ALTERNATIVE GW-3: SOURCE AREA EXTRACTION/TREATMENT/DISCHARGE/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	DESCRIPTION
IV. CHEMICAL PRECIPITATION SYSTEM		
1. Rapid Mix Tank	1	300 gallon epoxy lined carbon steel tank with rapid mixer (CCA).
2. Flocculator	1	1,000 gallon epoxy lined carbon steel tank with a paddle mixer for flocculation (CCA).
3. Clarifier	1	90 gpm Lamella type clarifier with sludge collection arrangement, carbon steel construction with epoxy lining (CCA).
4. Caustic Feed Tank	1	300 gallon fiber glass reinforced tank (CCA).
5. Caustic Feed Pumps	2	1-50 ml/min each (one operating, one standby), stainless steel metering pump (CCA).
6. Ferric Chloride Feed Tank	1	300 gallon fiberglass reinforced plastic tank (CCA).
7. Ferric Chloride Feed Pumps	2	1-50 ml/min each (one operating, one standby), stainless steel metering pump (CCA).
8. Polymer Feed Tank	1	60 gallon fiberglass reinforced plastic tank (CCA).
9. Polymer Feed Pumps	2	1-30 ml/min each (one operating, one standby), stainless steel metering pump (CCA).
10. Process Piping	100 ft.	3-inch diameter CPVC pipe (CCA).
V. FILTRATION SYSTEM		
1. Filter Feed Water Sump	1	900 gallon carbon steel tank with epoxy lining (CCA).

TABLE A-7 (Sheet 3 of 4)

ALTERNATIVE GW-3: SOURCE AREA EXTRACTION/TREATMENT/DISCHARGE/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION		ESTIMATED QUANTITIES	DESCRIPTION
V.	FILTRATION SYSTEM (Cont'd)		
2.	Filter Feed Pumps	2	90 gpm each (one operating, one standby), 30 ft. TDH, carbon steel with epoxy lining construction (CCA).
3.	Process Piping	50 ft.	3-inch diameter CPVC (CCA).
4.	Dual Media Pressure Filters	2	3 ft. diameter by 8 ft. high dual media filter complete with backwash pump and automatic controls (one operating, one standby). Filters filled with 40 ft^3 of 0.99 mm anthracite and 40 ft^3 of 0.5 mm sand and internal flow distribution/collection system, carbon steel construction (CCA).
VI.	SLUDGE HANDLING SYSTEM		
1.	Sludge Pumps	2	1.5 gpm each (one operating, one standby), carbon steel diaphragm pump (CCA).
2.	Filter Press	1	1.5 gpm, suitable for intermittent operation (CCA).
3.	Filtrate Pumps	2	1.5 gpm each (one operating, one standby), carbon steel (CCA).
VII.	AIR STRIPPER SYSTEM		
1.	Air Stripper	1	Low profile air stripper, 90 gpm capacity (CCA).
2.	Air Blower	1	5 HP blower, 1,350 cfm capacity (CCA).
3.	Vapor Phase Carbon System	1	6 ft. diameter carbon adsorbers (Ventsorp units from Calcon Corp. or equivalent) with 2,000 lbs. of carbon equipped with a duct heater dehumidifier (CCA).

TABLE A-7 (Sheet 4 of 4)

ALTERNATIVE GW-3: SOURCE AREA EXTRACTION/TREATMENT/DISCHARGE/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

VIII.	DISCHARGE			
	1.	Water Sump	1	1,800 gals. sump
	2.	Treated Water Pumps	2	90 gpm each centrifugal pump (one operating, one standby, 40 ft. TDH, stainless steel (CCA).
	3.	Piping	100 L ft.	6 inch diameter PVC pipe (CCA).
	4.	Outfall Structure	1	One outfall structure at the Little Valley Creek (CCA).
IX.	ELECTRICAL		LS	For treatment facility (CCA) and pumping station (BIA).
X.	INSTRUMENTATION AND CONTROLS		LS	For treatment facility (CCA) and pumping station (BIA).
XI.	UTILITIES (Water, Phone, etc.)		LS	For treatment facility (CCA) and pumping station (BIA).
XII.	FOUNDATIONS, PAD AND PREFABRICATED BUILDINGS		LS	For treatment facility (CCA) and pumping station (BIA).
XIII.	HEALTH AND SAFETY		LS	Conformance with a Health and Safety Plan.
XIV.	MOBILIZATION/DEMOBILIZATION		LS	Provision and removal of labor, equipment, and supplies.
XV.	INSTITUTIONAL CONTROLS			
	1.	Public Awareness Program*	LS	Hold two public meetings to describe risks from groundwater contamination and prepare technical handouts for residents.
	2.	Water Use Restrictions*	LS	Maintain water use restrictions and point of use treatment utilities.

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

TABLE A-8 (Sheet 1 of 2)

ALTERNATIVE GW-4: SOURCE AREA *IN-SITU* AIR SPARGING/VAPOR TREATMENT/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION			ESTIMATED QUANTITIES	DESCRIPTION
I.	SUPPORT FACILITIES			
	1.	Office Trailer	1	EPA, NYSDEC and Engineering Office (CCA). Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H).
	2.	Decontamination Trailer	1	Health and safety trailer with shower facility (CCA).
II.	SECURITY SYSTEM			
	1.	Compound Fence	200 Lft	8 ft. high chain link fence with triple strand barbed wire top (BIA and CCA).
	2.	Entrance Gate	2	Entrance gate (10 ft. wide, 8 ft. high, double frame gate)(BIA and CCA).
	3.	Warning signs	8	4 ft. x 3 ft. PVC signs posted on the fence at 100 ft. intervals (BIA and CCA).
III.	AIR SPARGING SYSTEM			
	1.	Air Sparging Pilot Study	1	Pilot study for air sparging to collect design parameter data (BIA).
			1	Pilot study for air sparging to collect design parameter data (CCA).
	2.	Air Sparge Wells	18	2" diameter, 60 ft. deep PVC well (BIA).
			6	2" diameter, 50 ft. deep PVC well (CCA).
	3.	Compressed Air System	1	100 cfm, 12 psi, 20 hp capacity compressor with filter, silencer, etc. (BIA).
			1	160 cfm, 24 psi, 30 hp capacity compressor with filter, silencer, etc. (CCA).
	4.	Piping and Manifold	400 Lft	4-inch diameter PVC manifold buried pipe (BIA).
			720	4-inch diameter PVC manifold buried pipe (CCA).
IV.	SOIL VAPOR EXTRACTION SYSTEM			
	1.	Extraction Wells	9	4" diameter, 40 ft. deep PVC wells (BIA).
			3	4" diameter, 40 ft. deep PVC wells (CCA).
	2.	Soil Vapor Extraction System	1	250 cfm, 4-inch of mercury vacuum, 10 hp capacity blower with air filter, demister, etc. (BIA).
			1	480 cfm, 4-inch of mercury vacuum, 15 hp capacity blower with air filter, demister, etc. (CCA).
	3.	Piping and Manifold	450 Lft	6" diameter PVC manifold buried pipe (BIA).
			760 Lft.	6" diameter PVC manifold buried pipe (CCA).

TABLE A-8 (Sheet 2 of 2)

ALTERNATIVE GW-4: SOURCE AREA *IN-SITU* AIR SPARGING/VAPOR TREATMENT/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION		ESTIMATED QUANTITIES	DESCRIPTION
V.	VAPOR TREATMENT AND DISCHARGE		
1.	Vapor Phase Carbon System	16	2 ft. diameter and 3 ft. high carbon adsorbers with 200 lbs. of carbon equipped with a duct heater dehumidifier (BIA and CCA).
2.	Discharge Stack	2	20 feet high, 6 inch diameter PVC pipe (BIA and CCA).
VI.	ELECTRICALS	LS	For above treatment facility (BIA and CCA).
VII.	INSTRUMENTATION AND CONTROLS	LS	For above treatment facility (BIA and CCA).
VIII.	UTILITIES (Phone, auto dialer)	LS	For above treatment facility (BIA and CCA).
IX.	FOUNDATIONS, PAD AND PREFABRICATED BUILDING	LS	For above treatment facility (BIA and CCA).
X.	HEALTH AND SAFETY	LS	Conformance with a Health and Safety Plan (BIA and CCA).
XI.	MOBILIZATION/DEMOBILIZATION	LS	Provision and removal of labor, equipment, and supplies.
XII.	INSTITUTIONAL CONTROLS		
1.	Public Awareness Program	LS	Hold two public meetings to describe risks from groundwater contamination and prepare technical handouts for residents.
2.	Water Use Restriction	LS	Maintain water use restrictions and point of use treatment utilities.

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

TABLE A-9

ALTERNATIVE GW-5: SOURCE AREA *IN-SITU* CHEMICAL OXIDATION/INSTITUTIONAL CONTROLS WITH MONITORED NATURAL ATTENUATION OF THE DOWNGRADIENT PLUME

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION		ESTIMATED QUANTITIES	DESCRIPTION
I.	CHEMICAL OXIDATION		
1.	Pilot Study	2	Conduct a pilot study to collect design parameters data (BIA and CCA).
2.	Injection/Observation Wells (new)	54	4" diameter, 60 ft. deep PVC wells (BIA).
		8	4" diameter, 50 ft. deep PVC wells (CCA).
3.	Chemical Injection	54	Inject hydrogen peroxide and other chemical additives.
		8	Inject hydrogen peroxide and other chemical additives.
4.	Monitoring and Reporting	LS	Two rounds of groundwater sampling and evaluating the treatment effectiveness using 8 wells (BIA and CCA).
II.	INSTITUTIONAL CONTROLS		
1.	Public Awareness Program*	LS	Hold two public meetings to describe risks from groundwater contamination and prepare technical handouts for residents.
2.	Water Use Restrictions*	LS	Maintain water use restrictions and point of use treatment utilities.

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

APPENDIX B

BREAKDOWN OF CAPITAL AND OPERATION AND MAINTENANCE COST ESTIMATES FOR REMEDIAL ALTERNATIVES

TABLE B-1
ALTERNATIVE S-1: NO ACTION
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
There are no capital costs associated with this alternative.							$0

Total Direct Construction Cost (TDCC)	$0
Contingency @20% of TDCC	$0
Engineering @ 10% of TDCC	$0
Legal and Administrative @ 5% of TDCC	$0
Total Capital Cost	**$0**

TABLE B-2
ALTERNATIVE S-2: INSTITUTIONAL CONTROLS
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. Institutional Controls							
1. Public Awareness Program	1	Lump Sum		$0	$10,000	$10,000	$10,000
2. Land Use Restrictions	1	Lump Sum		$0	$5,000	$5,000	$5,000
					Total Direct Construction Cost (TDCC)		$15,000
					Contingency @20% of TDCC		$3,000
					Engineering @ 10% of TDCC		$1,500
					Legal and Administrative @ 5% of TDCC		$750
					Total Capital Cost		**$20,250**

TABLE B-3
ALTERNATIVE S-3: IN SITU SOIL VAPOR EXTRACTION
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. Security							
1. Fence	100	Linear Feet	$13.50	$1,350	$14.50	$1,450	$2,800
2. Entrance Gate	2	Each	$300	$600	$100	$200	$800
3. Warning Signs	4	Each	$100	$400	$25	$100	$500
II. Support Facility							
1. Office Trailer	1	Lump Sum		$0	$3,500	$3,500	$3,500
2. Decontamination Trailer	1	Lump Sum		$0	$13,500	$13,500	$13,500
III. Treatability Study/Pilot Test	1			$0	$50,000	$50,000	$50,000
IV. Soil Vapor Extraction							
1. System Installation	1	Lump Sum		$0	$50,000	$50,000	$50,000
2. System Operation	12	Month		$0	$5,000	$60,000	$60,000
3. Confirmatory Sampling	18	Each		$0	$600	$10,800	$10,800
4. Demobilization	1	Lump Sum		$0	$12,000	$12,000	$12,000

Total Direct Construction Cost (TDCC)	$203,900
Contingency @20% of TDCC	$40,780
Engineering @ 10% of TDCC	$20,390
Legal and Administrative @ 5% of TDCC	$10,195
Total Capital Cost	**$275,265**

TABLE B-4
ALTERNATIVE S-4: EXCAVATION/OFF-SITE DISPOSAL
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. Support Facility							
1. Office Trailer	1	Lump Sum		$0	$7,500	$7,500	$7,500
2. Decontamination Trailer	1	Lump Sum		$0	$13,500	$13,500	$13,500
II. Excavation							
3. Concrete Slab Removal	15	Cubic Yard		$0	$81	$1,215	$1,215
4. Excavation	222	Cubic Yard		$0	$150	$33,333	$33,333
III. Post-Excavation Sampling	10	Each		$0	$600	$6,000	$6,000
IV. Off-Site Treatment and Disposal							
1. Debris	15	Cubic Yard		$0	$130	$1,950	$1,950
2. Non-hazardous Soil	222	Cubic Yard		$0	$130	$28,889	$28,889
V. Restoration							
1. Subgrade Preparation	1200	Square Feet		$0	$0.48	$576	$576
2. Backfill	200	Cubic Yard		$0	$5.48	$1,096	$1,096
3. Topsoil, Seed, Mulch, Fertilizer	1200	Square Feet		$0	$5.46	$6,552	$6,552

Total Direct Construction Cost (TDCC)	$100,611
Contingency @20% of TDCC	$20,122
Engineering @ 10% of TDCC	$10,061
Legal and Administrative @ 5% of TDCC	$5,031
Total Capital Cost	**$135,825**

TABLE B-5
ALTERNATIVE GW-1: NO ACTION
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
There are no capital costs associated with this alternative.							$0
						Total Direct Construction Cost (TDCC)	$0
						Contingency @20% of TDCC	$0
						Engineering @ 10% of TDCC	$0
						Legal and Administrative @ 5% of TDCC	$0
						Total Capital Cost	**$0**

TABLE B-6
ALTERNATIVE GW-2: MONITORED NATURAL ATTENUATION/INSTITUTIONAL CONTROLS
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. Monitored Natural Attenuation							
1. Water Use Restrictions*	1	Lump Sum		$0	$0	$0	$0
2. Public Awareness Program*	1	Lump Sum		$0	$0	$0	$0
					Total Direct Construction Cost (TDCC)		$0
					Contingency @20% of TDCC		$0
					Engineering @ 10% of TDCC		$0
					Legal and Administrative @ 5% of TDCC		$0
					Total Capital Cost		**$0**

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

TABLE B-7
ALTERNATIVE GW-3: EXTRACTION/TREATMENT/DISCHARGE/INSTITUTIONAL CONTROLS
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. Support Facility							
1. Office Trailer	1	Lump Sum		$0	$7,000	$7,000	$7,000
2. Decontamination Trailer	1	Lump Sum		$0	$27,000	$27,000	$27,000
II. Groundwater Extraction							
1. Pilot Test	2	Each		$0	$50,000	$100,000	$100,000
2. Extraction Wells	4	Each	$620	$2,480	$7,600	$30,400	$32,880
3. Pumps	4	Each		$0	$19,000	$76,000	$76,000
4. Piping	670	Linear Feet	$9.50	$6,365	$56	$37,520	$43,885
III. Collection/Equalization Tank							
1. Collection Tank	2	Each	$13,000	$26,000	$3,000	$6,000	$32,000
2. Pumps	4	Each	$3,900	$15,600	$4,500	$18,000	$33,600
3. Piping	2450	Linear Feet	$9.50	$23,275	$32	$78,400	$101,675
IV. Chemical Precipitation System							
1. Rapid Mix Tank	1	Each	$3,600	$3,600	$2,400	$2,400	$6,000
2. Clarifier/Flocculator	1	Each	$65,000	$65,000		$0	$65,000
3. Caustic Feed Tank	1	Each	$3,600	$3,600	$1,100	$1,100	$4,700
4. Caustic Feed Pumps	2	Each	$900	$1,800	$3,700	$7,400	$9,200
5. Ferric Chloride Feed Tank	1	Each	$3,600	$3,600	$1,100	$1,100	$4,700
6. Ferric Chloride Feed Pumps	2	Each	$900	$1,800	$3,700	$7,400	$9,200
7. Polymer Feed Tank	1	Each	$1,500	$1,500	$1,100	$1,100	$2,600
8. Polymer Feed Pumps	2	Each	$900	$1,800	$3,700	$7,400	$9,200
9. Process Piping	100	Linear Feet	$9.50	$950	$32	$3,200	$4,150
V. Filtration System							
1. Filter Feed Water Sump	1	Each	$10,000	$10,000	$2,900	$2,900	$12,900
2. Filter Feed Pumps	2	Each	$3,900	$7,800	$4,500	$9,000	$16,800
3. Process Piping	50	Linear Feet	$9.50	$475	$32	$1,600	$2,075
4. Dual Media Pressure Filters	2	Each	$56,300	$112,600	$7,400	$14,800	$127,400
VI. Sludge Handling System							
1. Sludge Pumps	2	Each	$1,400	$2,800	$1,900	$3,800	$6,600
2. Filter Press	1	Each	$46,800	$46,800	$8,700	$8,700	$55,500
3. Filtrate Pumps	2	Each	$2,700	$5,400	$4,600	$9,200	$14,600
VII. Air Stripper System							
1. Air Stripper	1	Each	$65,500	$65,500	$14,900	$14,900	$80,400
2. Air Blower	1	Each		$0		$0	$0
3. Vapor Phase Carbon System	1	Each	$16,800	$16,800	$7,400	$7,400	$24,200
VIII. Discharge							
1. Water Sump	1	Each	$1,900	$1,900	$5,200	$5,200	$7,100
2. Treated Water Pumps	2	Each	$3,900	$7,800	$4,500	$9,000	$16,800
3. Piping	100	Linear Feet	$9.50	$950	$56	$5,600	$6,550
4. Outfall Structure	1	Lump Sum	$3,500	$3,500	$6,900	$6,900	$10,400
IX. Electrical	1	Lump Sum	$121,000	$121,000	$128,000	$128,000	$249,000
X. Instrumentation and Control	1	Lump Sum	$182,000	$182,000	$76,000	$76,000	$258,000
XI. Utilities	1	Lump Sum	$36,000	$36,000	$76,000	$76,000	$112,000
XII. Foundations, Pad, Building	1	Lump Sum	$83,000	$83,000	$107,000	$107,000	$190,000
XIII. Health and Safety	1	Lump Sum		$0	$90,000	$90,000	$90,000
XIV. Mobilization/Demobilization	1	Lump Sum		$0	$50,000	$50,000	$50,000
XV. Institutional Controls							
1. Public Awareness Program*	1	Lump Sum		$0	$0	$0	$0
2. Water Use Restrictions*	1	Lump Sum		$0	$0	$0	$0

Total Direct Construction Cost (TDCC)	$1,899,115
Contingency @20% of TDCC	$379,823
Engineering @ 10% of TDCC	$189,912
Legal and Administrative @ 5% of TDCC	$94,956
Total Capital Cost	**$2,563,805**

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

TABLE B-8
ALTERNATIVE GW-4: IN SITU AIR SPARGING/VAPOR TREATMENT/INSTITUTIONAL CONTROLS
CAPITAL COST ESTIMATE

	FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I.	Support Facility							
	1. Office Trailer	1	Lump Sum		$0	$7,000	$3,500	$3,500
	2. Decontamination Trailer	1	Lump Sum		$0	$13,500	$13,500	$13,500
II.	Security							
	1. Fence	200	Linear Feet	$13.50	$2,700	$14.50	$2,900	$5,600
	2. Entrance Gate	2	Each	$300	$600	$100	$200	$800
	3. Warning Signs	8	Each	$100	$800	$25	$200	$1,000
III.	Air Sparging System							
	1. Pilot Study	2	Each		$0	$50,000	$100,000	$100,000
	2. Air Sparge Wells	24	Each	$825	$19,800	$2,000	$48,000	$67,800
	3. Compressed Air System	2	Each		$0	$25,000	$50,000	$50,000
	4. Piping and Manifold	1120	Linear Feet	$9.50	$10,640	$36	$40,320	$50,960
IV.	Soil Vapor Extraction							
	1. Extraction Wells	12	Each	$800	$9,600	$1,800	$21,600	$31,200
	2. SVE System	2	Each		$0	$20,000	$40,000	$40,000
	3. Piping and Manifold	1210	Linear Feet	$18	$21,780	$36	$43,560	$65,340
V.	Vapor Treatment and Discharge							
	1. Vapor Phase Carbon System	16	Each	$1,000	$16,000	$200	$3,200	$19,200
	2. Discharge Stack	2	Each	$800	$1,600	$800	$1,600	$3,200
VI.	Electrical	2	Lump Sum		$0	$20,000	$40,000	$40,000
VII.	Instrumentation and Control	2	Lump Sum		$0	$20,000	$40,000	$40,000
VIII.	Utilities	2	Lump Sum		$0	$5,000	$10,000	$10,000
IX.	Foundations, Pad, Building	2	Lump Sum		$0	$30,000	$60,000	$60,000
X.	Health and Safety	2	Lump Sum		$0	$10,000	$20,000	$20,000
XI.	Mobilization/Demobilization	1	Lump Sum		$0	$15,000	$15,000	$15,000
XII.	Institutional Controls							
	1. Public Awareness Program*	1	Lump Sum		$0	$0	$0	$0
	2. Water Use Restrictions*	1	Lump Sum		$0	$0	$0	$0

Total Direct Construction Cost (TDCC)	$637,100
Contingency @20% of TDCC	$127,420
Engineering @ 10% of TDCC	$63,710
Legal and Administrative @ 5% of TDCC	$31,855
Total Capital Cost	**$860,085**

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

TABLE B-9
ALTERNATIVE GW-5: IN SITU CHEMICAL OXIDATION/INSTITUTIONAL CONTROLS
CAPITAL COST ESTIMATE

FACILITY/CONSTRUCTION	ESTIMATED QUANTITY	UNIT OF MEASURE	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. Groundwater Monitoring Wells	4		$1,100	$4,400	$3,200	$12,800	$17,200
II. Chemical Oxidation							
1. Pilot Study	2	Lump Sum		$0	$50,000	$100,000	$100,000
2. Injection Wells	62	Each	$950	$58,900	$2,250	$139,500	$198,400
3. Chemicals	62	Each	$7,500.00	$465,000	$5,000	$310,000	$775,000
4. Monitoring	1	Lump Sum		$0	$25,000	$25,000	$25,000
III. Institutional Controls							
1. Public Awareness Program*	1	Lump Sum		$0	$0	$0	$0
2. Water Use Restrictions*	1	Lump Sum		$0	$0	$0	$0

Total Direct Construction Cost (TDCC)	$1,115,600
Contingency @20% of TDCC	$223,120
Engineering @ 10% of TDCC	$111,560
Legal and Administrative @ 5% of TDCC	$55,780
Total Capital Cost	**$1,506,060**

* Due to ongoing OU-1 activities, the public has previously been notified and is periodically updated regarding the groundwater quality in the area. Point-of-use treatment systems will continue to be maintained by the State.

TABLE B-10
ALTERNATIVE GW-1: NO ACTION
ANNUAL OPERATION AND MAINTENANCE COST ESTIMATE

OPERATION AND MAINTENANCE	BASIS OF ESTIMATE	YEAR	ANNUAL O&M COST
There are no annual O&M costs associated with this alternative.		1-30	$0
		Annual O&M	$0
		NPV (@7%) of O&M	**$0**

TABLE B-11
ALTERNATIVE GW-2: MONITORED NATURAL ATTENUATION/INSTITUTIONAL CONTROLS
ANNUAL OPERATION AND MAINTENANCE COST ESTIMATE

OPERATION AND MAINTENANCE	BASIS OF ESTIMATE	YEAR	ANNUAL O&M COST
I. Monitoring			
1. Water Sampling	Labor @ $60/hr - 120 hrs/yr	1-10	$7,200
2. Laboratory Analysis	24 samples @ $600 each	1-10	$14,400
3. Reporting	Labor @ $80/hr - 80 hrs/yr	1-10	$6,400
II. Maintenance	Monitoring Well Replacement (assume 1 per year)	1-10	$4,300
III. Contingency	5% of annual O&M costs	1-10	$1,615
		Annual O&M	$33,915
		NPV (@7%) of O&M	**$238,205**

TABLE B-12
ALTERNATIVE GW-3: EXTRACTION/TREATMENT/DISCHARGE/INSTITUTIONAL CONTROLS
ANNUAL OPERATION AND MAINTENANCE COST ESTIMATE

OPERATION AND MAINTENANCE	BASIS OF ESTIMATE	YEAR	ANNUAL O&M COST
I. Effectiveness Monitoring			
1. Water Sampling	Labor @ $60/hr - 120 hrs/yr	1-10	$7,200
2. Laboratory Analysis	24 samples @ $600 each	1-10	$14,400
3. Reporting	Labor @ $80/hr - 80 hrs/yr	1-10	$6,400
II. Performance Monitoring			
1. Performance Sampling	Labor provided by plant operator	1-8	$0
2. Laboratory Analysis	6 samples/mo @ $200 each	1-8	$14,400
III. Groundwater Extraction	2.25hp (40.3 KWH/d) @ $.125/KWH	1-8	$1,839
IV. Collection	1.5 hp (26.9 KWH/d) @ $.125/KWH	1-8	$1,227
V. Chemical Precipitation			
1. Mixers/pumps	1.175hp (20.2 KWH/d) @ $.125/KWH	1-8	$922
2. Caustic	2 tons/year @ $660/ton	1-8	$1,320
3. Ferric Chloride	5 tons/year @ $375/ton	1-8	$1,875
4. Polymer	0.4 tons/year @ $5000/ton	1-8	$2,000
5. Other Chemicals	5 tons/year @ $1000/ton	1-8	$5,000
VI. Filtration	3hp (53.8 KWH/d) @ $.125/KWH	1-8	$2,455
VII. Sludge Handling System			
1. Pumps/Filter Press	2.5hp (44.9 KWH/d) @ $.125/KWH	1-8	$2,049
2. Sludge Disposal	270 tons/year @ $280/ton	1-8	$75,600
VIII. Air Stripper System			
1. Blowers	2hp (35.9 KWH/d) @ $.125/KWH	1-8	$1,638
2. Dehumidifier	6 KWH @ $.125/KWH	1-8	$6,570
3. Vapor Phase Carbon Disposal	12,000 lbs/yr @ $1.6/lb	1-8	$19,200
IX. Discharge Pump	1.5hp (26.9 KWH/d) @ $.125/KWH	1-8	$1,227
X. Miscellaneous Power for Plant	15 KWH @ $.125/KWH	1-8	$16,425
XI. Labor	Operator @ $70/hr - 8 hrs/day, 7 d/wk	1-8	$204,400
XII. Maintenance	8% of capital cost, excl. support facilities mob/demob, pilot test and ICs	1-8	$137,209
	Monitoring well replacement	1-10	$4,300
XIII. Contingency	5% of annual O&M costs	1-8	$26,168
		9-10	$1,615
		Annual O&M (year 1-8)	$553,823
		Annual O&M (year 9-10)	$33,915
		NPV (@7%) of O&M	**$3,351,359**

TABLE B-13
ALTERNATIVE GW-4: IN SITU AIR SPARGING/VAPOR TREATMENT/INSTITUTIONAL CONTROLS
ANNUAL OPERATION AND MAINTENANCE COST ESTIMATE

OPERATION AND MAINTENANCE	BASIS OF ESTIMATE	YEAR	ANNUAL O&M COST
I. Effectiveness Monitoring			
1. Water Sampling	Labor @ $60/hr - 120 hrs/yr	1-10	$7,200
2. Laboratory Analysis	24 samples @ $600 each	1-10	$14,400
3. Reporting	Labor @ $80/hr - 80 hrs/yr	1-10	$6,400
II. Performance Monitoring			
1. Performance Sampling	Labor provided by plant operator	1-2	$0
2. Laboratory Analysis	6 samples/mo @ $200 each	1-2	$14,400
III. Air Sparging System	30hp (537.8 KWH/d) @ $.125/KWH	1-2	$24,537
IV. SVE System	15hp (268.9 KWH/d) @ $.125/KWH	1-2	$12,269
V. Vapor Phase Treatment/Discharge			
1. Dehumidifier	6 KWH @ $.125/KWH	1-2	$6,570
3. Vapor Phase Carbon Disposal	$8,000/mo	1-2	$96,000
VI. Miscellaneous Power for Plant	10 KWH @ $.125/KWH	1-2	$10,950
VII. Labor	Operator @ $70/hr - 10 hrs/wk	1-2	$36,400
VIII. Maintenance	8% of capital cost, excl. support facilities, mob/demob, pilot test and ICs	1-2	$40,408
	Monitoring well replacement	1-10	$4,300
IX. Contingency	5% of annual O&M costs	1-2	$13,692
		3-10	$1,615
		Annual O&M (year 1-2)	$287,525
		Annual O&M (year 3-10)	$33,915
		NPV (@7%) of O&M	**$696,380**

TABLE B-14
ALTERNATIVE GW-5: IN SITU CHEMICAL OXIDATION/INSTITUTIONAL CONTROLS
ANNUAL OPERATION AND MAINTENANCE COST ESTIMATE

OPERATION AND MAINTENANCE	BASIS OF ESTIMATE	YEAR	ANNUAL O&M COST
I. Effectiveness Monitoring			
1. Water Sampling	Labor @ $60/hr - 120 hrs/yr	1-10	$7,200
2. Laboratory Analysis	24 samples @ $600 each	1-10	$14,400
3. Reporting	Labor @ $80/hr - 80 hrs/yr	1-10	$6,400
II. Maintenance	Monitoring well replacement (assume 1 per year)	1-10	$4,300
III. Contingency	5% of annual O&M costs	1-10	$1,615
		Annual O&M	$33,915
		NPV (@7%) of O&M	**$238,205**

APPENDIX C

MNA REPORT

LITTLE VALLEY RI/FS

WORK ASSIGNMENT NUMBER 103-RICO-02GP

EVALUATION OF MONITORED NATURAL ATTENUATION BASED ON GROUNDWATER SAMPLING FROM SELECTED WELLS IN NOVEMBER AND DECEMBER 2003

May 12, 2004

TABLE OF CONTENTS

Section	Title	Page
1.0	INTRODUCTION	1
2.0	OBJECTIVES	1
3.0	HYDROGEOLOGY	2
4.0	DATA AVAILABLE	2
5.0	INITIAL SCREENING FOR NATURAL ATTENUATION	3
6.0	DISCUSSION OF DATA	5
	6.1 Field Measurements	5
	6.2 Laboratory Measurements	6
7.0	CONCLUSIONS	8
8.0	REFERENCES	9

LIST OF TABLES

Table No.	Title	Page
1	Field Data	10
2	Interpretation of Points Awarded During Initial Screening Process	11
3	Concentrations in the Suspected Source Area at BIA	12
4	Concentrations in the Suspected Source Area at BIA	13
5	Concentrations in the Suspected Source Area at CCA	14
6	Concentrations in the Suspected Source Area at CCA	15
7	Concentrations in Well in Plume Downgradient from BIA	16
8	Concentrations in Well in Plume Downgradient from BIA	17
9	Concentrations in Well in Plume Downgradient from CCA	18
10	Concentrations in Well Immediately Downgradient of BIA Plume	19
11	Concentrations in Well Immediately Downgradient of CCA Plume	20
12	Concen. in One of theWells Farthest Downgradient of BIA and CCA Plumes	21
13	Concen. in One of theWells Farthest Downgradient of BIA and CCA Plumes	22
14	Concen. in One of theWells Farthest Downgradient of BIA and CCA Plumes	23
15	Concen. in One of theWells Farthest Downgradient of BIA and CCA Plumes	24
16	Concen. in One of theWells Farthest Downgradient of BIA and CCA Plumes	25
17	Concen. in One of theWells Farthest Downgradient of BIA and CCA Plumes	26
18	Concen. in One of theWells Farthest Downgradient of BIA and CCA Plumes	27
19	Concentrations in Upgradient Well at BIA	28
20	Concentrations in Upgradient Well at CCA	29

LIST OF APPENDICES

RESULTS OF GROUNDWATER SAMPLING FOR MNA EVALUATION. . . . . Appendix A

1.0 INTRODUCTION

Groundwater at the Little Valley Superfund Site (the Site) has been impacted by chlorinated solvents such as trichloroethylene (TCE) and associated daughter products. Although chlorinated solvents have been measured in groundwater throughout the Site, the most elevated concentrations are present in the Bush Industries Area (BIA) and the Cattaraugus Cutlery Area (CCA). For example, the maximum concentrations of TCE measured during a sampling event conducted in November 2003 were 78 ug/l (MWD-2, located in the Bush Industries Area) and 58 ug/l (MWCCA-3, located in the Cattaraugus Cutlery Area). A screening process was conducted to determine if natural bioattenuation is likely to be a viable remedial alternative for treating chlorinated solvents, such as TCE, cis-1,2-dichlroethylene (cis-1,2-DCE) and vinyl chloride (VC), encountered at the Site.

Typically, for more heavily chlorinated solvents, reductive dechlorination is the predominant degradation mechanism. This initial screening process is designed to evaluate the potential for reductive dechlorination to reduce chlorinated solvent concentrations at the Site. It is recognized, however, that other mechanisms can also reduce chlorinated solvent concentrations. For example, biodegradation of certain halogenated compounds (e.g., VC) can proceed via oxidative pathways. Additionally, dispersion and adsorption potentially can reduce chlorinated solvent concentrations downgradient from the suspected source area.

2.0 OBJECTIVES

The objectives of the monitored natural attenuation (MNA) evaluation presented in this document are to:

- Apply the initial site screening process (screening process) to assess the potential for natural attenuation; and,

- Based on the results of the screening process, make a recommendation whether to proceed to the next step of a more detailed study of natural attenuation.

As described in our recommendation to the United States Environmental Protection Agency (EPA) of 5 November 2003 concerning wells to be sampled for MNA evaluation, the screening process was to be performed in accordance with Section 2.2 of Wiedemeier et. al. (1998). Wiedemeier et. al. recommends conducting the initial screening prior to proceeding with a more detailed study of natural attenuation.

The initial screening process, which is Step 2 of EPA's Technical Protocol (Wiedemeier et. al, 1998), consists of groundwater sampling and laboratory analyses for specific parameters that are utilized to evaluate the potential for natural biodegradation of chlorinated compounds. The analytical results are then compared to values used to assess the likelihood that biodegradation is occurring (Section 5.0). The initial screening process relies on the fact that biodegradation will cause predictable changes in groundwater chemistry. If the results indicate that biodegradation is occurring, the MNA study can proceed to a more detailed study of natural attenuation, which is known as Step 3 (Wiedemeier et. al, 1998).

3.0 HYDROGEOLOGY

The vertical hydraulic gradient throughout the thickness of the valley aquifer is not highly significant. Consequently, groundwater flow in the valley aquifer is basically horizontal. The aquifer is composed of sands and gravels with a high permeability. As described in the July 2001 Revised Draft Remedial Investigation Report (Foster Wheeler Environmental Corporation), the hydraulic conductivity ranges from 308 ft/day at the north end of the valley to 655 ft/day at the south end of the valley. The hydraulic gradient purportedly ranges from 0.0023 ft/ft to 0.0056 ft/ft. The average linear groundwater velocity ranges from 2.4 ft/day at the northern end to 12.2 ft/day at the southern end of the valley. Based on an average groundwater velocity of 7.3 ft/day (average of 2.4 and 12.2 ft/day), it will take approximately 15.8 years for a complete volume of groundwater to flush through the eight-mile long valley.

4.0 DATA AVAILABLE

Groundwater samples were collected in November and December 2003 from areas inside and outside the plume. These areas included the most contaminated portion of the aquifer (suspected source areas); downgradient from the suspected source areas but still in the dissolved contaminant plume; downgradient from the dissolved contaminant plume; and upgradient and lateral locations that are not impacted by the plume.

The samples collected in potential source areas provide information concerning the predominant terminal electron-accepting processes. Samples collected in the dissolved plume downgradient from the suspected source areas provide data to help determine if the plume is degrading with distance along the flow path. These data also help determine the distribution of electron acceptors and donors, and metabolic by-products along the flow path. Samples collected downgradient from the dissolved plume aid in plume delineation and also help determine if metabolic by-products are present. The upgradient and lateral samples will allow delineation of the plume and determination of background concentrations of electron acceptors and donors.

Samples were collected from 18 piezometers and monitoring wells (wells) and analyzed. Field parameters (Table 1) and laboratory data (Appendix A) obtained from these 18 wells were used to perform the initial site screening. The wells assigned to each of the various areas are listed below and in Table 1.

Potential Source Area Wells

BIAMW-2, BIAMW-D2, MWCCA-3, and MWCCA-6.

Wells in Downgradient Plume

BIAMWD-1, BIAMW-3 and MWCCA-2.

Wells Downgradient of Plume

BIAMW-7, PZ-20D, MWEDSA-1, PZ-5, PZ-6D, PZ-39, PZ-45D, PZ-46, and PZ-55D.

Upgradient and Lateral Wells

BIAMW-1 and MWCCA-4.

Groundwater samples collected from the 18 wells were analyzed in the field for pH, temperature, specific conductivity, dissolved oxygen, turbidity and oxidation-reduction potential (ORP). The samples were analyzed in the laboratory for the following MNA parameters:

- Low Concentration Volatile Organic Compounds (VOCs);
- Hydrogen;
- Total Organic Carbon (TOC);
- Alkalinity;
- Nitrate;
- Chloride;
- Iron (II) (Fe^{+2});
- Ethane;
- Ethene; and,

Results of the field measurements are presented in Table 1 and results from laboratory analyses are presented in Appendix A.

5.0 INITIAL SCREENING FOR NATURAL ATTENUATION

The screening process was performed in accordance with Section 2.2 of Wiedemeier et. al., (1998). Wiedemeier et. al. recommend conducting the initial screening prior to proceeding with a more detailed study of natural attenuation. The initial site screening process, which is Step 2 of EPA's Technical Protocol (Wiedemeier 1998), relies on the fact that biodegradation will cause predictable changes in groundwater chemistry.

In the screening process, weights are given to the concentrations of important electron acceptors (e.g., oxygen, nitrate and sulfate) and important electron donors (e.g., dissolved hydrogen, organic carbon and petroleum hydrocarbons). In addition, weights are assigned to the concentrations of metabolic end products including methane, ferrous iron, sulfide, chloride, and alkalinity. Weights are also given to general descriptions of the oxidation reduction environment, such as electrode potential, pH and temperature. Finally, weight is given to the accumulation of metabolic daughter products such as cis-1,2-DCE, VC, ethene and ethane.

The weighted scores are then totaled, and compared to a table that interprets the scores as providing either inadequate evidence, limited evidence, adequate evidence, or strong evidence of reductive dechlorination of chlorinated organic compounds. Table 2 summarizes the ranges of scores and provides an interpretation of each score (Wiedemeier et. al., 1998).

Scores were obtained for each of the areas. These areas included the suspected source areas; downgradient from the suspected source areas but still in the dissolved contaminant plume; downgradient from the dissolved contaminant plume; and, upgradient and lateral locations that are not impacted by the plume. The area downgradient from the dissolved contaminant plume was further subdivided into an area immediately downgradient and an area farther downgradient. Additionally, within each area, where appropriate, scores were individually obtained for groundwater associated with the BIA and CCA plumes. As an example, scoring results for the BIA and CCA

suspected source areas are presented in Tables 3 through 6. Results for other areas are presented in Tables 7 through 20.

Based on the scoring results for the BIA suspected source area (see Tables 3 and 4), there is inadequate evidence for reductive dechlorination. Even though the scoring results are low, there is chemical evidence that some biodegradation is occurring as daughter products (cis-1,2-DCE and VC) of TCE were measured. The dissolved oxygen concentrations are too high (average of 2.30 mg/l) to create an environment amenable to reductive dechlorination.

Based on scoring results for the CCA suspected source area (see Tables 5 and 6), there is inadequate evidence for reductive dechlorination. Again, however, there is chemical evidence that some biodegradation is occurring as a daughter product (cis-1,2-DCE) of TCE was encountered. The high dissolved oxygen concentrations (average of 6.40 mg/l) are inimical to reductive biodegradation.

Wells in Downgradient Plumes Emanating from the BIA and CCA

The wells located in the downgradient plumes emanating from the BIA and CCA suspected source areas had scores of 1, 2 and -1, which are indications that there is inadequate evidence for reductive dechlorination (see Tables 7, 8 and 9). TCE concentrations of 6.3 ug/l and 12 ug/l were measured in the BIA plume and a concentration of 9.8 ug/l was found in the CCA plume. Cis-1,2-DCE, a daughter product, was measured above detection limits in the BIA area but not in the CCA area. The oxygen concentrations in the BIA were 6.70 mg/l and 4.83 mg/l. The oxygen concentration in the CCA area was 2.85 mg/l. These oxygen concentrations are not conducive to reductive dechlorination.

Wells Immediately Downgradient of the BIA and CCA Plumes

Wells immediately downgradient (BIAMW-7 and PZ-20D) of the BIA and CCA plumes both received scores of –1 (see Tables 10 and 11), which suggest there is inadequate evidence for reductive dechlorination. Measured TCE concentrations were below detection limits immediately downgradient of the CCA plume and 0.75 ug/l immediately downgradient of the BIA plume. No daughter products were present in either area at concentrations exceeding detection limits. The high dissolved oxygen concentrations measured in wells downgradient of the BIA plume (BIAMW-7) and CCA (PZ-20D) are not favorable to reductive dechlorination (see Tables 10 and 11).

Wells Farthest Downgradient of BIA and CCA Plumes

Results from seven wells located farthest downgradient of the BIA and CCA plumes are presented in Tables 12 through 18. These wells received scores ranging from -3 to 0, which indicates there is inadequate evidence for biodegradation. TCE was detected in some of these wells but no TCE daughter products were found. The average oxygen concentration measured in the seven wells farthest downgradient of the BIA and CCA plumes was 6.61 mg/l. Again, these oxygen concentrations are too high to promote reductive dechlorination.

Upgradient Wells

Results for wells upgradient (i.e., background) of the BIA and CCA suspected source areas are presented in Tables 19 and 20, respectively. The well upgradient of the BIA area and the well upgradient of the CCA area each had scores of –1. Consequently, the scoring system suggests there is inadequate evidence for reductive dechlorination. The dissolved oxygen concentrations for these wells were 9.8 mg/l (BIAMW-1) and 5.03 mg/l (MWCCA-4), indicating an environment hostile to reductive dechlorination.

6.0 DISCUSSION OF DATA

6.1 Field Measurements

Oxygen and Redox

When an oxidized system is reduced, the order that oxidized species disappear is O_2, NO_3^-, Mn^{2+}, Fe^{2+}, HS^-, and H_2. As the Eh of the system falls below approximately 650 mV, there are enough available electrons to reduce O_2 to H_2O. Below an Eh of approximately 300 mV, O_2 is not stable in neutral aqueous systems (EPA 1999).

Dissolved oxygen is the favored electron acceptor used by microbes for biodegradation of many forms of organic carbon. Strictly anaerobic bacteria cannot function at dissolved oxygen concentrations above 0.5 mg/l (Wiedemeier et.al., 1999). Therefore, dissolved oxygen measurements at the Site (ranging from 1.27 mg/l to 10.24 mg/l) are not conducive to reductive dechlorination.

Redox potentials in groundwater typically range between –400 mV and 800 mV. The optimum range for reductive dechlorination is below a redox potential of approximately –150 mV, where sulfate reduction and methanogenesis occur (Wiedemeier et al., 1999). The interpretation of the redox potential can be difficult as the potential measured in groundwater is a mixed or average potential that reflects the potential of many reactions, and may not reflect the actual conditions in microsites and may not agree with redox values calculated using individual redox pairs (Lindberg and Runnels, 1984). Measured redox potentials at the Site, as included within Table 1, are above -150 mV, and hence not favorable to reductive dechlorination.

pH

Bacteria typically prefer environments with neutral to slightly alkaline pH, with the optimum pH range for most microbes between 6 and 8. However, many microbes can tolerate pH values outside this range, and thus, pH is not likely to inhibit biodegradation significantly. While changes in pH are not likely to significantly affect metabolic processes directly, the availability of certain electron acceptors may be influenced significantly by pH. For example, ferric iron is soluble only at lower pH values. The pH values measured for different areas of the Site (sometimes averaged over one or more wells) ranged from 6.63 to 7.93. These pH values will not inhibit biodegradation.

Temperature

Biological activity approximately doubles with every 10 °C increase in temperature between 5° and 25 °C. Temperatures were measured in winter when temperatures are expected to be lower than in

summer. The temperatures at the Site in December were typically in the range of 8 to 10 °C, which is lower than optimum temperatures for biological activity.

6.2 Laboratory Measurements

Dissolved Hydrogen

Direct measurements of dissolved hydrogen (H_2) concentrations have been used as an alternative to standard chemistry to identify redox conditions in groundwater. EPA (2001) cited Lovley et al. (1994) who found that sulfate reduction required a minimum hydrogen concentration of 1 nanomole per liter (nmol/l), while methanogenesis required a concentration of 4 nmol/l. Reductive dechlorination occurs when groundwater is undergoing sulfate reduction or methanogenesis. EPA protocol states that reductive dechlorination will occur when hydrogen concentrations exceed 1 nmol/l. Yang and McCarty (1998) inferred from laboratory experiments that the minimum concentration of H_2 required to support organisms capable of carrying out reductive dechlorination was 2 nmol/l. Based on the above H_2 concentrations should be expected to be approximately 2 nmol/l or greater for significant reductive dechlorination to take place. Hydrogen was not detected in samples collected at the Site at a reported detection limit of 0.163 ug/l (equivalent to 80.9 nmol/l).

Nitrate/Nitrite/Ammonium

After dissolved oxygen has been depleted, nitrate may be used as an electron acceptor for the biodegradation of organic compounds via denitrification. Nitrogen is a required nutrient for microbial metabolism, and thus, cycles rapidly. The presence of nitrate in groundwater can indicate a fairly aerobic environment since it is the first electron acceptor after oxygen. Areas of depressed nitrate concentrations within a groundwater plume may indicate biodegradation via nitrate reduction. In order for reductive dechlorination to occur, nitrate concentrations in the contaminant plume should be less than 1 mg/l (EPA, 1998). Measured nitrate concentrations were > 1.0 mg/l in the plume downgradient of the BIA (see Tables 7 and 8), in the wells immediately downgradient of the plumes in the BIA and CCA (see Tables 10 and 11), in the wells (averaged) farther downgradient of the BIA and CCA plumes (see Tables 12 through 18), and in the well upgradient from the BIA (see Table 19).

Iron

Ferrous iron [Fe(II)] concentrations in groundwater can be used as an indicator that conditions are favorable to anaerobic biodegradation. All ferrous iron concentrations were below 1.0 mg/l, which indicates that either no Fe(III) iron was available for reduction or that conditions are not favorable for iron reduction. Based on the elevated oxygen concentrations, it appears that conditions are not favorable for iron reduction as oxygen would be the preferred electron acceptor.

Sulfate/Sulfide

After dissolved oxygen, nitrate and biologically available Mn(IV) and Fe(III) have been depleted, sulfate may be used as an electron acceptor for anaerobic biodegradation via sulfate reduction. As stated previously, oxygen concentrations have not been depleted and are, in fact, elevated. These conditions are not conducive to sulfate reduction as oxygen reduction will occur before sulfate reduction.

Carbonate and Bicarbonate Alkalinity

Carbonate alkalinity is a measure of the concentrations of hydroxides, carbonates, and biocarbonates in groundwater. Biologically active portions of a dissolved contaminant plume are typically identified by an increase in alkalinity, resulting from increased concentrations of carbon dioxide produced during biodegradation of organic compounds. According to Wiedemeier et. al. (1998), a two-fold increase in alkalinity values over background numbers suggests biodegradation may be occurring. Therefore, to determine if alkalinity values in downgradient wells exceeded the two-fold criterion, the alkalinity concentration in well MWCCA-4 (background well) was compared to the alkalinity concentration in wells in the suspected source area at CCA (MWCCA-6 and MWCCA-3), the well in the plume downgradient from the CCA (MWCCA-2) and the well immediately downgradient of the CCA plume (PZ-20D).

The alkalinity concentration in well BIAMW-1 (background well) was compared to the alkalinity concentrations of wells in the suspected source area at BIA (MW-2 and MW-D2), the wells in the plume downgradient from BIA (BIAMW-3 and BIAMW-1) and the well immediately downgradient from the BIA plume (BIAMW-7).

The concentrations in wells farthest downgradient (MWEDSA-1, PZ-5, PZ-6D, PZ-39, PZ-45D, PZ-46 and PZ-55D) of the BIA and CCA plumes were compared to the mean alkalinity concentration in the upgradient wells (i.e., average of wells MWCCA-4 and BIAMW-1).

Wells exceeding the two-fold criteria were found in the suspected source area at BIA (well BIAMW-2), in the plume downgradient from the BIA source (Well BIAMW-1) and in two wells farthest downgradient from the BIA and CCA source areas (PZ-45D and PZ-55D).

Chloride

Chloride is released as a breakdown product during the biodegradation of chlorinated compounds. Chloride ions do not typically enter into redox reactions, form no important solute complexes, do not form salts of low solubility, are not significantly adsorbed on mineral surfaces, and play few vital biochemical roles. As a result, significant increases in chloride concentrations relative to background may indicate the biodegradation of chlorinated solvent compounds.

The chloride concentration in well MWCCA-4 (background well) was compared to the chloride concentration in wells in the suspected source area at CCA (MWCCA-6 and MWCCA-3), the well in the plume downgradient from the CCA (MWCCA-2) and the well immediately downgradient of the CCA plume (PZ-20D).

The chloride concentration in well BIAMW-1 (background well) was compared to the chloride concentrations of wells in the suspected source area at BIA (MW-2 and MW-D2), the wells in the plume downgradient from BIA (BIAMW-3 and BIAMW-1) and the well immediately downgradient from the BIA plume (BIAMW-7).

The concentrations in wells farthest downgradient (MWEDSA-1, PZ-5, PZ-6D, PZ-39, PZ-45D, PZ-46 and PZ-55D) of the BIA and CCA plumes were compared to the mean chloride concentration in the upgradient wells (i.e., average of wells MWCCA-4 and BIAMW-1).

Wells exceeding the two-fold criteria were found in the suspected source area at BIA (well BIAMW-2), in the plume downgradient from the BIA source (Well BIAMW-1) and in two wells farthest downgradient from the BIA and CCA source areas (PZ-45D and PZ-55D).

Wiedemeier et al. (1998) consider a doubling of chloride concentrations over background values as evidence that reductive dechlorination potentially is occurring. No well met the two-fold criterion.

Total Organic Carbon

The presence of naturally occurring organic carbon can facilitate the degradation of compounds that can only be degraded under anaerobic conditions. Aerobically-degradable organic carbon will be mineralized by the resident microbes depleting the supply of more energetic electron acceptors, thus creating a reducing environment in which anaerobic degradation will dominate. Aerobically degradable organic carbon sources include petroleum hydrocarbons and naturally occurring organic carbon. Total organic carbon (TOC) is analyzed to determine if reductive dechlorination is possible throughout the plume in the absence of additional contaminant carbon sources such as petroleum hydrocarbons. The initial screening process considers TOC concentrations greater than 20 mg/l as capable of driving dechlorination. The highest TOC concentrations (2.9 mg/l average) were found in wells farthest downgradient from the suspected source area (see Tables 12 through 18). Thus, TOC concentrations are not considered to be a significant force driving dechlorination.

Chlorinated Hydrocarbons

Daughter products of TCE (cis-1,2-DCE or VC) were found in the BIA and CCA suspected source areas (see Tables 3 through 6) and in wells located in the downgradient BIA plume area (see Tables 7 and 8). TCE was encountered in the plume downgradient of the CCA but no daughter products were found.

7.0 CONCLUSIONS

The initial screening process was used to evaluate the potential for reductive dechlorination (i.e., a form of natural attenuation) to occur. The screening process was conducted in accordance with Section 2.2 of Wiedemeier et. al. (1998). The screening process was performed on various areas of the Site (see Tables 3 through 20). Results from the screening process indicated there was inadequate to limited (one well, BIAMW-2, in a potential source area) evidence of the reductive dechlorination process taking place. Additionally, elevated oxygen concentrations found throughout the Site, including in upgradient and downgradient wells, indicate that conditions are not conducive for reductive dechlorination. However, some degradation of TCE appears to be occurring as evidenced by TCE daughter products in the suspected source areas and in the BIA plume area. Other areas of the Site where TCE concentrations were measured above detection limits had no corresponding occurrences of daughter products. In conclusion, reductive dechlorination is not expected to be a dominant attenuation mechanism at the Site, though limited reductive dechlorination may be occurring in select areas, particularly the suspected source areas. Other natural attenuation mechanisms, such as dispersion and adsorption, are undoubtedly contributing to reduced downgradient concentrations of suspected solvents.

Based on the results from the initial screening process, a more detailed study of natural attenuation at the Site, as outlined in Step 3 of Wiedemeier (1998), is not justified.

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TABLE 1
FIELD DATA

Area	pH	Cond.	Turb.	D.O.	Temp	ORP
	Units	*ms/cm*	*NTU*	*mg/l*	*°C*	*mv*
Potential Source Area Wells						
BIAMW-2	8.64	0.376	92.9	1.27	9.34	228
BIAMW-D2	6.30	0.316	24.2	3.32	9.1	421
MWCCA-6	7.62	0.293	40.1	3.69	9.25	451
MWCCA-3	5.80	0.385	351	9.11	7.24	300
Wells in Downgradient Plume						
BIAMW-3	6.56	0.425	-8.4	6.70	9.69	393
MWCCA-2	6.86	0.4	198.0	2.85	9.06	188
BIAMWD-1	6.70	0.466	<10.0	4.83	10.58	390
Wells Downgradient of Plume						
BIAMW-7	7.35	0.39	111	6.14	8.6	354
PZ-20D	7.92	0.302	>999	7.45	9.83	296
MWEDSA-1	7.40	0.357	233	6.60	13.76	254
PZ-5	7.46	0.415	36.8	10.24	9.37	424
PZ-6D	8.44	0.396	260	7.75	5.03	337
PZ-39	6.46	1.56	128	6.60	10.18	453
PZ-45D	8.47	0.351	>999	2.75	8.45	369
PZ-46	5.71	0.224	-5.5	6.23	10.52	372
PZ-55D	7.48	0.438	>999	6.10	6.98	298
Upgradient and Lateral Wells (i.e., Background)						
MWCCA-4	7.57	0.349	10.1	5.03	9.99	304
BIAMW-1	6.44	0.224	6.0	9.80	9.68	391

Table 2
Interpretation of Points Awarded During Initial Screening Process

Score	Interpretation
0 to 5	Inadequate evidence for reductive dechlorination of chlorinated organics
6 to 14	Limited evidence for reductive dechlorination of chlorinated organics
15 to 20	Adequate evidence for reductive dechlorination of chlorinated organics
>20	Strong evidence for reductive dechlorination of chlorinated organics

Table 3
Concentrations in the Suspected Source Area at BIA
(Well BIAMW-2)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	1.27	mg/l	-3
Nitrate	0.050U	mg/l	2
Iron II	0.1	mg/l	0
Sulfate	16	g/l	2
Methane	0.54JD	mg/l	3
ORP	228	mV	0
pH	8.64	pH units	0
TOC	2.6	mg/l	0
Temperature	9.34	°C	0
Alkalinity	180	mg/l	1
Chloride	19	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.32J	ug/l	0
PCE	0.5U	ug/l	0
TCE	36D	ug/l	0
Cis-1,2-DCE	40D	ug/l	2
VC	4.8	ug/l	2
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**9**

Table 4
Concentrations in the Suspected Source Area at BIA
(Well BIAMW-D2)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	3.32	mg/l	-3
Nitrate	0.29	mg/l	2
Iron II	0.10U	mg/l	0
Sulfate	15	g/l	2
Methane	0.07JN	mg/l	0
ORP	421	mV	0
pH	6.30	pH units	0
TOC	2.4	mg/l	0
Temperature	9.1	°C	0
Alkalinity	130	mg/l	0
Chloride	22	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	78D	ug/l	0
Cis-1,2-DCE	18D	ug/l	2
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**3**

Table 5
Concentrations in the Suspected Source Area at CCA
(Well MWCCA-6)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	3.69	mg/l	-3
Nitrate	0.59	mg/l	2
Iron II	0.10U	mg/l	0
Sulfate	16	mg/l	2
Methane	0.05JN	mg/l	0
ORP	451	mV	0
pH	7.62	pH units	0
TOC	1.0U	mg/l	0
Temperature	9.25	°C	0
Alkalinity	130	mg/l	0
Chloride	14	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.50U	ug/l	0
PCE	0.50U	ug/l	0
TCE	0.2J	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**1**

Table 6
Concentrations in the Suspected Source Area at CCA
(Well MWCCA-3)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	9.11	mg/l	-3
Nitrate	0.51	mg/l	2
Iron II	0.10U	mg/l	0
Sulfate	19	mg/l	2
Methane	0.07JN	mg/l	0
ORP	300	mV	0
pH	5.80	pH units	0
TOC	1.0U	mg/l	0
Temperature	7.24	°C	0
Alkalinity	160	mg/l	0
Chloride	18	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.50U	ug/l	0
PCE	0.67	ug/l	0
TCE	58D	ug/l	0
Cis-1,2-DCE	3.7	ug/l	2
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**3**

Table 7
Concentrations in Well in Plume Downgradient from BIA
(Well BIAMW-3)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	6.70	mg/l	-3
Nitrate	1.2	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	12	mg/l	2
Methane	0.07JN	mg/l	0
ORP	393	mV	0
pH	6.56	pH units	0
TOC	1.0U	mg/l	0
Temperature	9.69	^{0}C	0
Alkalinity	160	mg/l	0
Chloride	44	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	6.3	ug/l	0
Cis-1,2-DCE	2.2	ug/l	2
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02JU	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**1**

Table 8
Concentrations in Well in Plume Downgradient from BIA
(Well BIAMWD-1)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	4.83	mg/l	-3
Nitrate	1.4	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	13	mg/l	2
Methane	0.06JN	mg/l	0
ORP	390	mV	0
pH	6.70	pH units	0
TOC	1.0U	mg/l	0
Temperature	10.58	^{0}C	0
Alkalinity	190	mg/l	1
Chloride	42	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	12	ug/l	0
Cis-1,2-DCE	4.8	ug/l	2
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02JU	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**2**

Table 9
Concentrations in Well in Plume Downgradient from CCA
(Well MWCCA-2)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	2.85	mg/l	-3
Nitrate	0.5	mg/l	2
Iron II	0.10U	mg/l	0
Sulfate	20	mg/l	0
Methane	0.07JN	mg/l	0
ORP	188	mV	0
pH	6.86	pH units	0
TOC	1.0U	mg/l	0
Temperature	9.06	^{0}C	0
Alkalinity	130J	mg/l	0
Chloride	12	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.2J	ug/l	0
TCE	9.8	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-1**

Table 10
Concentrations in Well Immediately Downgradient of BIA Plume
(Well BIAMW-7)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	6.14	mg/l	-3
Nitrate	1	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	12	mg/l	2
Methane	0.08JN	mg/l	0
ORP	354	mV	0
pH	7.35	pH units	0
TOC	1.0U	mg/l	0
Temperature	8.6	^{0}C	0
Alkalinity	150	mg/l	0
Chloride	44	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	0.75	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5UJ	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-1**

Table 11
Concentrations in Well Immediately Downgradient of CCA Plume
(Well PZ-20D)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	7.45	mg/l	-3
Nitrate	1.5	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	19	mg/l	2
Methane	0.07JN	mg/l	0
ORP	296	mV	0
pH	7.92	pH units	0
TOC	1.5J	g/l	0
Temperature	9.83	^{0}C	0
Alkalinity	280	mg/l	0
Chloride	51	mg/l	0
Hydrogen	0.163UJ	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	0.5U	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-1**

Table 12
Concentrations in One of the Wells Farthest Downgradient of BIA and CCA Plumes (Well MWEDSA-1)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	6.60	mg/l	-3
Nitrate	0.30	mg/l	2
Iron II	0.1U	mg/l	0
Sulfate	97	mg/l	0
Methane	0.07JN	mg/l	0
ORP	254	mV	0
pH	7.40	pH units	0
TOC	3.0	mg/l	0
Temperature	13.76	^{0}C	0
Alkalinity	110	mg/l	0
Chloride	19	mg/l	0
Hydrogen	0.163UJ	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	14	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-1**

Table 13
Concentrations in One of the Wells Farthest Downgradient of BIA and CCA Plumes
(Well PZ-5)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	10.24	mg/l	-3
Nitrate	1.6	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	39	mg/l	0
Methane	0.06JN	mg/l	0
ORP	424	mV	0
pH	7.46	pH units	0
TOC	1.0U	mg/l	0
Temperature	9.37	^{0}C	0
Alkalinity	170	mg/l	0
Chloride	14	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	6.6	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-3**

Table 14
Concentrations in One of the Wells Farthest Downgradient of BIA and CCA Plumes (Well PZ-6D)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	7.75	mg/l	-3
Nitrate	1.1	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	37	mg/l	0
Methane	0.07JN	mg/l	0
ORP	337	mV	0
pH	8.44	pH units	0
TOC	1.0U	mg/l	0
Temperature	5.03	^{0}C	0
Alkalinity	150	mg/l	0
Chloride	12	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	6.9	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-3**

Table 15
Concentrations in One of the Wells Farthest Downgradient of BIA and CCA Plumes (Well PZ-39)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	6.60	mg/l	-3
Nitrate	2.4	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	350	mg/l	0
Methane	0.07JN	mg/l	0
ORP	453	mV	0
pH	6.46	pH units	0
TOC	3.2	mg/l	0
Temperature	10.18	^{0}C	0
Alkalinity	100	mg/l	0
Chloride	19	mg/l	0
Hydrogen	0.163UJ	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	0.5U	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-3**

Table 16
Concentrations in One of the Wells Farthest Downgradient of BIA and CCA Plumes (Well PZ-45D)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	2.75	mg/l	-3
Nitrate	0.060	mg/l	2
Iron II	0.1U	mg/l	0
Sulfate	29	mg/l	0
Methane	0.06JN	mg/l	0
ORP	369	mV	0
pH	8.47	pH units	0
TOC	9.2J	mg/l	0
Temperature	8.45	°C	0
Alkalinity	6,300J	mg/l	1
Chloride	16	mg/l	0
Hydrogen	0.163UJ	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	2.1	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**0**

Table 17
Concentrations in One of the Wells Farthest Downgradient of BIA and CCA Plumes
(Well PZ-46)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	6.23	mg/l	-3
Nitrate	1.3	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	9.0	mg/l	2
Methane	0.07JN	mg/l	0
ORP	372	mV	0
pH	5.71	pH units	0
TOC	1.0U	mg/l	0
Temperature	10.52	^{0}C	0
Alkalinity	68	mg/l	0
Chloride	17	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	0.5U	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5UJ	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-1**

Table 18
Concentrations in One of the Wells Farthest Downgradient of BIA and CCA Plumes
(Well PZ-55D)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	6.10	mg/l	-3
Nitrate	1.5	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	14	mg/l	2
Methane	0.04JN	mg/l	0
ORP	298	mV	0
pH	7.48	pH units	0
TOC	1.9	mg/l	0
Temperature	6.98	^{0}C	0
Alkalinity	470J	mg/l	1
Chloride	39	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5UJ	ug/l	0
TCE	4.4J	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5UJ	ug/l	0
1,1,1-Trichloroethane	0.5UJ	ug/l	0
Carbon Tetrachloride	0.5UJ	ug/l	0
Chloroethane	0.5UJ	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5UJ	ug/l	0
Total Points Awarded			**0**

Table 19
Concentrations in Upgradient Well at BIA
(Well BIAMW-1)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	9.80	mg/l	-3
Nitrate	2	mg/l	0
Iron II	0.1U	mg/l	0
Sulfate	11.	mg/l	2
Methane	0.07JN	mg/l	0
ORP	391	mV	0
pH	6.44	pH units	0
TOC	1.0U	mg/l	0
Temperature	9.68	^{0}C	0
Alkalinity	83	mg/l	0
Chloride	46	mg/l	0
Hydrogen	0.163U	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	0.5U	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5UJ	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-1**

Table 20
Concentrations in Upgradient Well at CCA
(Well MWCCA-4)

Analyte	Concentration	Units	Points Awarded
Dissolved Oxygen	5.03	mg/l	-3
Nitrate	0.79	mg/l	2
Iron II	0.10U	mg/l	0
Sulfate	78L	mg/l	0
Methane	0.08JN	mg/l	0
ORP	304	mV	0
pH	7.57	pH units	0
TOC	1.0U	mg/l	0
Temperature	9.99	^{0}C	0
Alkalinity	150	mg/l	0
Chloride	110	mg/l	0
Hydrogen	0.163UJ	ug/l	0
BTEX	0.5U	ug/l	0
PCE	0.5U	ug/l	0
TCE	0.05U	ug/l	0
Cis-1,2-DCE	0.5U	ug/l	0
VC	0.5U	ug/l	0
1,1,1-Trichloroethane	0.5U	ug/l	0
Carbon Tetrachloride	0.5U	ug/l	0
Chloroethane	0.5U	ug/l	0
Ethene	0.03UJ	mg/l	0
Ethane	0.02UJ	mg/l	0
Chloroform	0.5U	ug/l	0
Total Points Awarded			**-1**

APPENDIX A

RESULTS OF GROUNDWATER SAMPLING

FOR MNA EVALUATION

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	BIAMW-1 LV-GW-BIA-MW1-M 12/09/2003	BIAMW-2 LV-GW-BIA-MW2- 12/11/2003	BIAMW-3 LV-GW-BIA-MW3- 12/10/2003	BIAMW-7 LV-GW-BIA-MW7- 12/09/2003	BIAMW-7 LV-GW-BIA-MW7- 12/09/2003	MWCCA-11D LV-GW-CCA11D- 11/18/2003
1,1,1-Trichloroethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
1,1,2,2-Tetrachloroethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
1,1,2-Trichloroethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
1,1-Dichloroethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
1,1-Dichloroethylene	(ug/l)	0.5 U	0.63	0.5 U	0.5 U		0.50 U
1,2,3-Trichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
1,2,4-Trichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
1,2-Dichloroethane	(ug/l)	0.5 U J	0.5 U	0.5 U J	0.5 U J		0.50 U
1,2-Dichloropropane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
2-Hexanone	(ug/l)	5 U	5 U	5 U	5 U		1.0 U
Acetone	(ug/l)	5 U	5 U	5 U	5 U		1.0 U
Alkalinity (as CaCO3)	(mg/l)	83	180	160		150	
Benzene	(ug/l)	0.5 U	0.32 J	0.5 U	0.5 U		0.50 U
Benzene,1-methylethyl-	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Bromodichloromethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Bromoform	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Carbon disulfide	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Carbon tetrachloride	(ug/l)	0.5 U J	0.5 U	0.5 U	0.5 U J		0.50 U
Chloride	(mg/l)	46	19	44		44	
Chlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Chlorobromomethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	BIAMW-1 LV-GW-BIA-MW1-M 12/09/2003	BIAMW-2 LV-GW-BIA-MW2- 12/11/2003	BIAMW-3 LV-GW-BIA-MW3- 12/10/2003	BIAMW-7 LV-GW-BIA-MW7- 12/09/2003	BIAMW-7 LV-GW-BIA-MW7- 12/09/2003	MWCCA-11D LV-GW-CCA11D- 11/18/2003
Chloroethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Chloroform	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
cis-1,2-Dichloroethylene	(ug/l)	0.5 U	40 D	2.2	0.5 U		0.50 U
cis-1,3-Dichloropropene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Cyclohexane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
DBCP	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Dibromochloromethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Dichlorodifluoromethane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
EDB	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Ethane	(mg/l)	0.02 U J	0.02 U J	0.02 U J		0.02 U J	
Ethylbenzene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Ethylene	(mg/l)	0.03 U J	0.03 U J	0.03 U J		0.03 U J	
Freon 113	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Hydrogen	(ug/l)	0.163 U	0.163 U	0.163 U		0.163 U	
m-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Methane	(mg/l)	0.07 J N	0.54 J D	0.07 J N		0.08 J N	
Methyl Acetate	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Methyl bromide	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Methyl chloride	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Methyl ethylketone	(ug/l)	5 U	5 U	5 U	5 U		1.0 U
Methyl isobutyl ketone (MIBK)	(ug/l)	5 U	5 U	5 U	5 U		1.0 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	BIAMW-1 LV-GW-BIA-MW1-M 12/09/2003	BIAMW-2 LV-GW-BIA-MW2- 12/11/2003	BIAMW-3 LV-GW-BIA-MW3- 12/10/2003	BIAMW-7 LV-GW-BIA-MW7- 12/09/2003	BIAMW-7 LV-GW-BIA-MW7- 12/09/2003	MWCCA-11D LV-GW-CCA11D- 11/18/2003
Methylcyclohexane	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Methylene chloride	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Nitrate	(mg/l)	2.0	0.050 U	1.2		1.0	
o-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
p-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Styrene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Sulfate	(mg/l)	11	16	12		12	
Tetrachloroethylene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
TOC	(mg/l)	1.0 U	2.6	1.0 U		1.0 U	
Toluene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
trans-1,2-Dichloroethene	(ug/l)	0.5 U	0.28 J	0.5 U	0.5 U		0.50 U
trans-1,3-Dichloropropene	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		0.50 U
Trichloroethylene	(ug/l)	0.5 U	36 D	6.3	0.75		0.50 U
Trichlorofluoromethane	(ug/l)	0.5 U	0.5 U J	0.5 U J	0.5 U		0.50 U
Vinyl chloride	(ug/l)	0.5 U	4.8	0.5 U	0.5 U		0.50 U
Xylene (total)	(ug/l)	0.5 U	0.5 U	0.5 U	0.5 U		

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	MWCCA-2 LV-GW-CCA2-MNA 12/03/2003	MWCCA-3 LV-GW-CCA3-MN 12/02/2003	MWCCA-4 LV-GW-CCA4-MN 11/19/2003	MWCCA-6 LV-GW-CCA6-MN 12/01/2003	MWCCA-9D LV-GW-CCA9D-0 11/18/2003	MWD-1 LV-GW-BIA-MWD 12/10/2003
1,1,1-Trichloroethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
1,1,2,2-Tetrachloroethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
1,1,2-Trichloroethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U J
1,1-Dichloroethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
1,1-Dichloroethylene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
1,2,3-Trichlorobenzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
1,2,4-Trichlorobenzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
1,2-Dichloroethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U J
1,2-Dichloropropane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
2-Hexanone	(ug/l)	5 U	5 U	1.0 U	5 U	1.0 U	5 U
Acetone	(ug/l)	5 U	5 U	1.0 U	5 U	1.1	5 U
Alkalinity (as CaCO3)	(mg/l)	130 J	160	150	130		190
Benzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Benzene,1-methylethyl-	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Bromodichloromethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Bromoform	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Carbon disulfide	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Carbon tetrachloride	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Chloride	(mg/l)	12	18	110	14		42
Chlorobenzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Chlorobromomethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	MWCCA-2 LV-GW-CCA2-MNA 12/03/2003	MWCCA-3 LV-GW-CCA3-MN 12/02/2003	MWCCA-4 LV-GW-CCA4-MN 11/19/2003	MWCCA-6 LV-GW-CCA6-MN 12/01/2003	MWCCA-9D LV-GW-CCA9D-0 11/18/2003	MWD-1 LV-GW-BIA-MWD 12/10/2003
Chloroethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Chloroform	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
cis-1,2-Dichloroethylene	(ug/l)	0.5 U	3.7	0.50 U	0.5 U	0.50 U	4.8
cis-1,3-Dichloropropene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U J
Cyclohexane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
DBCP	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Dibromochloromethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Dichlorodifluoromethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
EDB	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Ethane	(mg/l)	0.02 U J	0.02 U J	0.02 U J	0.02 U J		0.02 U J
Ethylbenzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Ethylene	(mg/l)	0.03 U J	0.03 U J	0.03 U J	0.03 U J		0.03 U J
Freon 113	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Hydrogen	(ug/l)	0.163 U	0.163 U	0.163 U J	0.163 U		0.163 U
m-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Methane	(mg/l)	0.07 J N	0.07 J N	0.08 J N	0.05 J N		0.06 J N
Methyl Acetate	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Methyl bromide	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Methyl chloride	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Methyl ethylketone	(ug/l)	5 U	5 U	1.0 U	5 U	1.0 U	5 U
Methyl isobutyl ketone (MIBK)	(ug/l)	5 U	5 U	1.0 U	5 U	1.0 U	5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	MWCCA-2 LV-GW-CCA2-MNA 12/03/2003	MWCCA-3 LV-GW-CCA3-MN 12/02/2003	MWCCA-4 LV-GW-CCA4-MN 11/19/2003	MWCCA-6 LV-GW-CCA6-MN 12/01/2003	MWCCA-9D LV-GW-CCA9D-0 11/18/2003	MWD-1 LV-GW-BIA-MWD 12/10/2003
Methylcyclohexane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Methylene chloride	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Nitrate	(mg/l)	0.50	0.51	0.79	0.59		1.4
o-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
p-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Styrene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Sulfate	(mg/l)	20	19	78 L	16		13
Tetrachloroethylene	(ug/l)	0.2 J	0.67	0.50 U	0.5 U	0.50 U	0.5 U
TOC	(mg/l)	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U
Toluene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
trans-1,2-Dichloroethene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
trans-1,3-Dichloropropene	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U J
Trichloroethylene	(ug/l)	9.8	58 D	0.50 U	0.2 J	1.4	12
Trichlorofluoromethane	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U J
Vinyl chloride	(ug/l)	0.5 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Xylene (total)	(ug/l)	0.5 U	0.5 U		0.5 U		0.5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	MWD-2 LV-GW-BIA-MWD2- 12/11/2003	MWEDSA-1 LV-GW-EDSA1-M 11/20/2003	PZ-20D LV-GW-PZ20D-M 11/19/2003	PZ-20D LV-GW-PZ20DMN 11/19/2003	PZ-39 LV-GW-PZ39-MN 12/04/2003	PZ-45D LV-GW-PZ45D-M 12/04/2003
1,1,1-Trichloroethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
1,1,2-Trichloroethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
1,1-Dichloroethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
1,1-Dichloroethylene	(ug/l)	0.81	0.50 U	0.50 U		0.5 U	0.5 U
1,2,3-Trichlorobenzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
1,2,4-Trichlorobenzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U J	0.5 U J
1,2-Dichloroethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
1,2-Dichloropropane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
2-Hexanone	(ug/l)	5 U	1.0 U	1.0 U		5 U	5 U
Acetone	(ug/l)	5 U	2.2	1.0 U		5 U	5 U
Alkallnity (as CaCO3)	(mg/l)	130	110	280		100	6300 J
Benzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Benzene,1-methylethyl-	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Bromodichloromethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Bromoform	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Carbon disulfide	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Carbon tetrachloride	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Chloride	(mg/l)	22	19	51		19	16
Chlorobenzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Chlorobromomethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	MWD-2 LV-GW-BIA-MWD2- 12/11/2003	MWEDSA-1 LV-GW-EDSA1-M 11/20/2003	PZ-20D LV-GW-PZ20D-M 11/19/2003	PZ-20D LV-GW-PZ20DMN 11/19/2003	PZ-39 LV-GW-PZ39-MN 12/04/2003	PZ-45D LV-GW-PZ45D-M 12/04/2003
Chloroethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Chloroform	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
cis-1,2-Dichloroethylene	(ug/l)	18 D	0.50 U	0.50 U		0.5 U	0.5 U
cis-1,3-Dichloropropene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Cyclohexane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
DBCP	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Dibromochloromethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Dichlorodifluoromethane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
EDB	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Ethane	(mg/l)	0.02 U J	0.02 U J		0.02 U J	0.02 U J	0.02 U J
Ethylbenzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Ethylene	(mg/l)	0.03 U J	0.03 U J		0.03 U J	0.03 U J	0.03 U J
Freon 113	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Hydrogen	(ug/l)	0.163 U	0.163 U J		0.163 U J	0.163 U J	0.163 U J
m-Dichlorobenzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Methane	(mg/l)	0.07 J N	0.07 J N		0.07 J N	0.07 J N	0.06 J N
Methyl Acetate	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U J	0.5 U J
Methyl bromide	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Methyl chloride	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Methyl ethylketone	(ug/l)	5 U	1.0 U	1.0 U		5 U	5 U
Methyl isobutyl ketone (MIBK)	(ug/l)	5 U	1.0 U	1.0 U		5 U	5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	MWD-2 LV-GW-BIA-MWD2- 12/11/2003	MWEDSA-1 LV-GW-EDSA1-M 11/20/2003	PZ-20D LV-GW-PZ20D-M 11/19/2003	PZ-20D LV-GW-PZ20DMN 11/19/2003	PZ-39 LV-GW-PZ39-MN 12/04/2003	PZ-45D LV-GW-PZ45D-M 12/04/2003
Methylcyclohexane	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Methylene chloride	(ug/l)	0.5 U	9.0 U	9.0 U		0.5 U	0.5 U
Nitrate	(mg/l)	0.29	0.30	1.5		2.4	0.060
o-Dichlorobenzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
p-Dichlorobenzene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Styrene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Sulfate	(mg/l)	15	97	19		350	29
Tetrachloroethylene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
TOC	(mg/l)	2.4	3.0	1.5 J		3.2	9.2 J
Toluene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
trans-1,2-Dichloroethene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
trans-1,3-Dichloropropene	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Trichloroethylene	(ug/l)	78 D	14	0.50 U		0.5 U	2.1
Trichlorofluoromethane	(ug/l)	0.5 U J	0.50 U	0.50 U		0.5 U	0.5 U
Vinyl chloride	(ug/l)	0.5 U	0.50 U	0.50 U		0.5 U	0.5 U
Xylene (total)	(ug/l)	0.5 U				0.5 U	0.5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	PZ-46 LV-GW-PZ46-MNA 12/08/2003	PZ-5 LV-GW-PZ5-MNA 12/01/2003	PZ-55D LV-GW-PZ55D-M 12/08/2003	PZ-6D LV-GW-PZ6D-MN 12/03/2003
1,1,1-Trichloroethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
1,1,2,2-Tetrachloroethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
1,1,2-Trichloroethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
1,1-Dichloroethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
1,1-Dichloroethylene	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
1,2,3-Trichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
1,2,4-Trichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
1,2-Dichloroethane	(ug/l)	0.5 U J	0.5 U	0.5 U J	0.5 U
1,2-Dichloropropane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
2-Hexanone	(ug/l)	5 U	5 U	5 R	5 U
Acetone	(ug/l)	5 U	5 U	5 R	5 U
Alkalinity (as CaCO3)	(mg/l)	68	170	470 J	150
Benzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
Benzene,1-methylethyl-	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
Bromodichloromethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Bromoform	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Carbon disulfide	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Carbon tetrachloride	(ug/l)	0.5 U J	0.5 U	0.5 U J	0.5 U
Chloride	(mg/l)	17	14	39	12
Chlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
Chlorobromomethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	PZ-46 LV-GW-PZ46-MNA 12/08/2003	PZ-5 LV-GW-PZ5-MNA 12/01/2003	PZ-55D LV-GW-PZ55D-M 12/08/2003	PZ-6D LV-GW-PZ6D-MN 12/03/2003
Chloroethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Chloroform	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
cis-1,2-Dichloroethylene	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
cis-1,3-Dichloropropene	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Cyclohexane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
DBCP	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Dibromochloromethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Dichlorodifluoromethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
EDB	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Ethane	(mg/l)	0.02 U J	0.02 U J	0.02 U J	0.02 U J
Ethylbenzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
Ethylene	(mg/l)	0.03 U J	0.03 U J	0.03 U J	0.03 U J
Freon 113	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Hydrogen	(ug/l)	0.163 U	0.163 U	0.163 U	0.163 U
m-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
Methane	(mg/l)	0.07 J N	0.06 J N	0.04 J N	0.07 J N
Methyl Acetate	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Methyl bromide	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Methyl chloride	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Methyl ethylketone	(ug/l)	5 U	5 U	5 R	5 U
Methyl isobutyl ketone (MIBK)	(ug/l)	5 U	5 U	5 R	5 U

Results of Groundwater Sampling
for Monitored Natural Attenuation Evaluation
Little Valley Superfund Site

PERIOD: From 11/18/2003 thru 12/11/2003 - Inclusive
SAMPLE TYPE: Water

CONSTITUENT	SITE SAMPLE ID DATE	PZ-46 LV-GW-PZ46-MNA 12/08/2003	PZ-5 LV-GW-PZ5-MNA 12/01/2003	PZ-55D LV-GW-PZ55D-M 12/08/2003	PZ-6D LV-GW-PZ6D-MN 12/03/2003
Methylcyclohexane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Methylene chloride	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Nitrate	(mg/l)	1.3	1.6	1.5	1.1
o-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
p-Dichlorobenzene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
Styrene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
Sulfate	(mg/l)	9.0	39	14	37
Tetrachloroethylene	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
TOC	(mg/l)	1.0 U	1.0 U	1.9	1.0 U
Toluene	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U
trans-1,2-Dichloroethene	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
trans-1,3-Dichloropropene	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Trichloroethylene	(ug/l)	0.5 U	6.6	4.4 J	6.9
Trichlorofluoromethane	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Vinyl chloride	(ug/l)	0.5 U	0.5 U	0.5 U J	0.5 U
Xylene (total)	(ug/l)	0.5 U	0.5 U	0.5 R	0.5 U

APPENDIX D

COMPARISON OF INDIVIDUAL WATER TREATMENT SYSTEMS AND PERMANENT WATER SUPPLY LINE ALTERNATIVES

Comparison of

Individual Water Treatment Systems

and

Permanent Water Supply Line

Alternatives

for the

Little Valley Superfund Site
Cattaraugus County, New York

July 2004

Prepared by the

U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

The remedy selected by the Environmental Protection Agency (EPA) in the 1996 Record of Decision (ROD) for the Little Valley site called for the installation of individual treatment systems on the affected private water supply wells as an interim remedy until drinking water standards are met through the identification and control of the source of contamination. The ROD also called for an evaluation within five years of the implementation of this interim remedy to determine its efficacy (*i.e.,* whether permanent alternate water supply system would be required). In an Explanation of Significant Differences, issued in April 2002, EPA determined that it would be more appropriate to evaluate the need for a permanent alternative water supply during the selection of a final remedy for the Little Valley site, which will address the source area(s) and the groundwater contamination.

This report, which is Appendix D of the *Feasibility Study Report for the Little Valley Superfund Site* (Tetra Tech FW, February 2005), presents a summary of the residential well groundwater data collected at the Little Valley site from 1989 through 2003 and compares the existing individual water treatment systems with constructing a permanent water supply. A complete evaluation of the alternatives that were considered in the selection of the interim remedy (including the alternatives discussed in this report) may be found in the *Focused Feasibility Study for Alternate Water Supply for the Little Valley Superfund Site* (EPA, July 1996).

I. INTRODUCTION

This document presents a summary of the residential well groundwater data collected at the Little Valley site from 1989 through 2003 and compares the existing individual water treatment systems with constructing a waterline. This report, which was developed by the United States Environmental Protection Agency (EPA), is included in the appendix of the *Feasibility Study Report for the Little Valley Superfund Site* (Tetra Tech FW, February 2005).

II. SITE BACKGROUND

Site Description

The site is located in the Towns of Little Valley and Salamanca in Cattaraugus County, New York. The site consists of a trichloroethene (TCE) plume extending approximately seven miles from the Village of Little Valley to the northern edge of the City of Salamanca, which is part of the Allegheny Indian Reservation. The boundaries of the site have been defined based on the locations of the monitoring and residential wells that have been sampled. The site is located in a rural, agricultural area with a number of active and inactive small industries located within one mile. There are over 200 residential properties situated in the study area along Route 353, the main transportation route between Little Valley and Salamanca (see Figure 1-1 in Attachment D-1).

Site History

In 1982, the Cattaraugus County Health Department (CCHD) and the New York State Department of Environmental Conservation (NYSDEC), while investigating TCE contamination in the vicinity of a small manufacturing facility on Route 353, detected TCE in nearby private wells. In 1989, CCHD and New York State Department of Health (NYSDOH) determined that the TCE contamination plume extended from the Village of Little Valley to the northern edge of the City of Salamanca. NYSDEC installed a number of monitoring wells in the area to investigate possible sources of the contamination. No sources were found. Although CCHD issued health advisories to the exposed residents in 1989, affected well owners were not provided with alternate water sources. About six property owners independently installed granular activated carbon filter systems and others purchased bottled water.

Following the listing of the site on the National Priorities List in June 1996, EPA prepared a focused feasibility study (FFS) to develop, screen, and evaluate alternatives for an alternative water supply system for the affected and potentially affected residences at the site. Based upon the findings of the FFS, EPA issued a Record of Decision (ROD) on September 30, 1996, providing for the installation of air stripper treatment systems on all affected and potentially affected private wells to ensure that drinking water standards were

met[1]. The ROD also called for an evaluation of the efficacy of the treatment systems within five years to determine whether or not a more permanent system (such as a water supply line) would be required. This evaluation was to consider the data collected during the source identification investigation which would indicate whether the groundwater contamination persists (and a more permanent alternate water supply system is required) or whether it is being mitigated by natural attenuation (*i.e.*, dispersion, dilution, and/or degradation). In an Explanation of Significant Differences, issued in April 2002, EPA determined that it would be more appropriate to evaluate the need for a permanent alternative water supply during the selection of a final remedy for the Little Valley site, which will address the source area(s) and the groundwater contamination.

Installation of the air stripper treatment units was performed from May 1997 through October 1997. Subsequently, granular activated carbon units were installed in addition to the air strippers to improve the overall contaminant removal efficiency.

In September 1996, EPA initiated a remedial investigation and feasibility study (RI/FS) to locate the source(s) of the contamination and to identify and evaluate measures to control or mitigate the source(s) and to address the groundwater contamination as a second operable unit (OU). The findings of the RI are documented in the *Remedial Investigation Report for OU-2, Little Valley Superfund Site* (Tetra Tech FW, January 2005).

In April 2002, it was concluded that since the air strippers were reaching the end of their useful life, the maintenance requirements associated with these units would likely increase. Because of the significant reduction in contaminant concentrations in the private wells, EPA determined that granular activated carbon units alone would be able to effectively remove the contamination. EPA also determined that the activated carbon units alone would be as protective of public health as the combined air stripper/activated carbon treatment units. For these reasons, EPA decided to remove the air stripper treatment units and use only activated carbon treatment units to address the contamination in the private wells. These findings were documented in an April 2002 Explanation of Significant Differences.

From August through September 2002, EPA removed the air stripper treatment systems and installed an additional carbon unit on each well[2]. NYSDEC subsequently assumed responsibility for the operation and maintenance (O&M) activities related to the treatment systems, which were previously performed by EPA.

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1 The Maximum Contaminant Level (MCL), or drinking water standard for TCE, the contaminant of concern, is 5 micrograms per liter (µg/l).

2 Under NYSDEC and NYSDOH standard operating procedures, two granular activated carbon treatment units in series are required for individual wells.

Routine maintenance is conducted on the carbon treatment systems on an annual basis, and repairs are performed as needed. As part of the ongoing monitoring at the site, the groundwater passing through the individual treatment systems is sampled annually to evaluate the effectiveness of the treatment systems.

III. DESCRIPTION OF ALTERNATIVES

Alternative 1: Continued Utilization of Activated Carbon Treatment Units at Individual Wells

Capital Cost: $0
Annual Operation and Maintenance Cost: $100,000
Present-Worth Cost: $950,000
Construction Time: N/A

Under this alternative, the existing activated carbon treatment systems would remain installed on the affected private wells. Annual sampling of the affected wells and routine maintenance on the treatment systems would continue to be performed to ensure their effectiveness. The treatment systems would remain in place until groundwater standards are met (estimated 10 years).

Alternative 2: Connection to the Public Water Supply of the City of Salamanca

Capital Cost: $3,152,925
Annual Operation and Maintenance Cost: $41,366
Present-Worth Cost: $3,665,863
Construction Time: 3 years

This alternative consists of constructing a waterline to the City of Salamanca and purchasing water from the Salamanca Board of Public Utilities, which supplies water to the City of Salamanca. The proposed water supply system to the affected residences would connect to the existing waterline near the intersection of Forest Avenue and Center Street at the City of Salamanca's northern corporate limit. An 8-inch diameter waterline would be installed along New York State Highway 353 (with branches to New York State Highway 242 and Baker Road) as the main transmission pipe for a total length of approximately 8 miles. Construction of the water main would entail at least three creek crossings (by submerged installation) and one railway bed crossing.

A booster pumping station would be required to provide adequate flow and pressure for domestic use conditions in the northern portion of the Little Valley site. In addition, a small storage reservoir may be required in the Whig Street/Elkdale area in order to satisfy peak flow conditions.

Approximately 20,000 feet of 2-inch diameter branch and service piping would be installed along the streets and private properties along New York State Highways 353 and 242 to supply each affected residence. At this time, it is estimated that 90 residences would be connected to the water distribution system.

Although the waterline would be permanent, a 30-year time frame was used for cost-estimating purposes.

Alternative 3: Connection to the Public Water Supply of the Village of Little Valley

Capital Cost: $3,085,250
Annual Operation and Maintenance Cost: $30,804
Present-Worth Cost: $3,467,220
Construction Time: 3 years

This alternative consists of constructing a waterline to the Village of Little Valley and purchasing water from the Public Water Supply of the Village of Little Valley, which supplies water to approximately one-quarter mile south of the Village's corporate limits along New York State Highway 353. The construction outline for the proposed water supply system to the affected residences for this alternative would be similar to the Alternative 2, but a booster pump station would not be required for servicing the affected area, due to the Village's water storage high reservoir elevation. However, the Village of Little Valley, may require redevelopment of its auxiliary well or development of a new well in order to meet the demands of an extended service area.

Although the waterline would be permanent, a 30-year time frame was used for cost-estimating purposes.

IV. DATA REVIEW

A review of the historical residential well sampling data indicates that the number of affected wells in the site area is decreasing (probably as a result of dilution and dispersion). Of the 90 private wells that have treatment units installed, 85 were included in the most recent sampling event which was conducted in October 2003[3]. Of the 85 wells sampled, results show that 28 are at or below the drinking water standard of 5 µg/l for TCE. Of the 57 wells that have contaminant levels exceeding the drinking water standard, the majority of these wells only marginally exceed 5 µg/l (44 wells have TCE levels between 6 µg/l and 10 µg/l). In addition, sampling results since 1989 indicate that there is a downward trend of contaminants in all but a few wells; the highest concentration is now 24 µg/l, as compared to an historical high of 50 µg/l, and the average concentration is now 7.2 µg/l.

[3] Five of the affected wells were inaccessible at the time sampling was conducted.

The sampling results from 1989 through 2003 for the residential wells with treatment systems are presented in Attachment D-2.

V. COST COMPARISON

Present-worth analysis is used to evaluate the combined capital and O&M costs of the alternatives on a common basis, that is, present costs or present-worth costs. This allows the costs of the alternatives to be compared on the basis of a single total cost figure representing the amount of money that if invested in the base year and expended as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. The present-worth costs are calculated using a discount rate of 7 percent. The calculations associated with the estimated capital, O&M, and present-worth costs for each of the alternatives, are summarized below.

Alternative	Capital Cost	O&M Cost	Present-Worth Cost
Retention of Activated Carbon Treatment Systems	$0	$101,250	$708,750
Connection to the City of Salamanca's Water Supply	$3,152,925	$41,366	$3,665,863
Connection to the Village of Little Valley's Water Supply	$3,085,250	$30,804	$3,467,220

While the water supply system would be permanent, for purposes of this analysis, it was assumed that the public water system would have a 30-year useful life before replacement is required. Further, the water line extensions are expected to operate throughout their entire useful life once installed, regardless of the status of the groundwater contamination. For the foregoing reasons, the present-worth cost for these alternatives is based on a 30-year time interval. Annual O&M costs for the water supply line options include the users' annual costs for the purchase of water.

Based upon preliminary modeling results, it is estimated that it will take approximately 10 years for TCE levels at the site to decrease to MCLs. Since the individual treatment systems would treat the groundwater contamination until MCLs are achieved, the present-worth costs for the individual treatment system alternative are based on a 10-year time interval.

As is indicated from the cost estimates, the present-worth costs associated with the maintenance of the existing individual treatment units are substantially less than the cost

of connecting the affected homes to the existing municipal water supply systems in the area.

VI. SUMMARY

The ROD called for an evaluation of the efficacy of the treatment systems to determine whether or not a more permanent system (such as a water supply line) would be required. This evaluation was to consider the data collected during the source identification investigation which would indicate whether the groundwater contamination persists (and a more permanent alternate water supply system is required) or whether it is being mitigated by natural attenuation (*i.e.*, dispersion, dilution, and/or degradation).

A review of the historical residential well sampling data since 1989 indicate that there is a downward trend of contaminants (probably as a result of dilution and dispersion) in all but a few wells. Of the 85 wells sampled, 28 are at or below the drinking water standard for TCE. Of the 57 wells that have contaminant levels exceeding the drinking water standard, 44 of these wells only marginally exceed the drinking water standard. The estimated cost to maintain the individual treatment systems until groundwater standards are met is $708,750. The estimated cost to install, operate, and maintain a water supply line ranges from $3.5 - $3.7 million.

ATTACHMENT D-1

FIGURES

ATTACHMENT D-2

RESIDENTIAL WELL SAMPLING RESULTS

TCE SAMPLING RESULTS FOR HOMES WITH TREATMENT SYSTEMS IN PARTS PER BILLION (ppb)
LITTLE VALLEY SUPERFUND SITE

ID #	System Location	1989 - 1996 Range	January 1997 Pre-Install.	November 1997		Oct. 98 / Feb. 99		May 1999		October 2000	March 2001		October 2002		October 2003	
				Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.
1	Maint. Shop	ND - 12	8.63	-----	-----	6.6	ND	-----	-----	-----	6.6	1.4	7	ND	6	ND
2	Boiler Room	ND - 22	8.61	-----	-----	8.5	ND	-----	-----	ND	-----	-----	7	ND	7	ND
3	Basement	4 - 9.6	9.46	10	ND	7.1	ND	-----	-----	ND	7.7	ND	7	ND	0.6	ND
4	Shed	5	9.3	-----	-----	9.5	-----	7.5	ND	ND	7.5	ND	8	ND	7	ND
5	Basement	5 - 15	8.49	9.2	ND	7.2	ND	-----	-----	ND	7.0	ND	8	ND	6	ND
6	Basement	4	5.95	4.7	ND	5.4	ND	-----	-----	ND	4.6	ND	3	ND	4	ND
8	Basement	3 - 11	6.33	6	ND	5.5	ND	-----	-----	ND	5.6	ND	6	ND	5	ND
9	Basement	7.2 - 16	10.4	8.2	ND	7.9	ND	-----	-----	ND	8.1	ND	6	ND	-----	-----
10	Wood Shop	3 - 11	1.49	-----	-----	10	-----	-----	-----	ND	-----	-----	1	ND	0.9	ND
11	Basement	6.3 - 9	6.58	5.6	ND	6.4	ND	-----	-----	ND	4.8	ND	5	ND	4	ND
12	Shed	14	12.4	8.7	ND	9.4, 12	ND	-----	-----	ND	8.7	ND	7	ND	7	ND
13	Basement	8	8.08	4.4	ND	7.1	ND	-----	-----	ND	5.8	ND	6	ND	5	ND
14	Basement	ND - 7.7	7.77	8	ND	6.3	ND	-----	-----	ND	6.2	ND	6	ND	5	ND
15	Shed	7.4 - 11	8.63	7	ND	8.9	ND	-----	-----	ND	5.6	ND	6	6	ND	ND
17	Garage	12	8.57	8.5	ND	7.1	ND	-----	-----	ND	-----	-----	7	ND	8	ND
18	Basement	7 - 20	8.6	7.8	ND	7.6	ND	-----	-----	ND	6.8	ND	7	ND	6	ND
19	Shed	3.6 - 13	4.36	4.3	ND	4.2	ND	-----	-----	ND	6.1	ND	6	ND	6	ND
21	Basement	8 - 50	22.9	-----	ND	29	ND	-----	-----	ND	18.5	ND	21	ND	24	ND
28	Basement	18	14.1	11.7	ND	12	ND	-----	-----	ND	ND	ND	8	ND	8	ND
29	Basement	9.7 - 18	7.95	6.3	ND	7.6	ND	-----	-----	ND	3.6	3.9	6	ND	ND	ND
30	Basement	8	6.52	5.9	ND	3.9	ND	-----	-----	ND	5.6	ND	5	ND	5	ND
32	Basement	3 - 8	5.52	5.6	ND	4.2	ND	-----	-----	ND	4.6	4.5	4	ND	4	ND
33	Basement	4 - 11	7.38	5.4	ND	5.9	ND	-----	-----	ND	6.2	ND	5	ND	5	ND
35	Shed	23 - 31	18.1	17.1	ND	18	ND	15	ND	ND	14.0	-----	14	ND	13	ND
36	Shed	12 - 21	14.8	13.6	ND	12	ND	-----	-----	ND	10.7	ND	10	ND	11	ND
40	Basement	19	10.7	10.5	ND	11	ND	-----	-----	ND	8.4	ND	7	ND	-----	-----
44	Basement	ND - 16	ND	ND	ND	ND	ND	-----	-----	ND	ND	ND	ND	ND	ND	ND
45	Basement	20 - 33	23.7	22.5	ND	24	ND	-----	-----	ND	-----	-----	ND	ND	23	ND
46	Basement	32	16.3	28.8	ND	30	ND	-----	-----	-----	-----	-----	20	ND	24	ND
47	Shed	19	-----	-----	-----	23, 22	ND	22	ND	6.84	17.6	ND	18	ND	19	ND
51	Basement	7	5.58	6	ND	4.7	ND	-----	-----	ND	5.0	ND	5	ND	4	ND
53	Basement	33	20	19.2	ND	28	ND	-----	-----	ND	13.2	ND	16	ND	15	ND
54	Basement	5.2 - 10	5.64	-----	-----	4	ND	-----	-----	ND	5.4	ND	5	ND	4	ND
57	Shed	7.5 - 19	6.06	7.7	ND	5.8	ND	-----	-----	ND	4.2	ND	5	ND	6	ND
62	Basement	7	9.72	11.6	ND	2.2	ND	-----	-----	ND	6.1	ND	6	ND	6	ND
64	Basement	11 - 30	12.9	9.3	ND	12	ND	-----	-----	ND	9.0	ND	8	ND	9	ND
65	Shed	33	22.7	25.2	ND	4.1	ND	-----	-----	ND	15.3	ND	17	ND	21	ND
79	Basement	9 - 18	11.2	8.5	ND	1.6	ND	-----	-----	ND	7.2	ND	7	ND	7	ND

----- Not sampled .
ND Result not detected.
* Result likely reflects a mix up of pre-treated and post-treated water samples.

TCE SAMPLING RESULTS FOR HOMES WITH TREATMENT SYSTEMS IN PARTS PER BILLION (ppb)
LITTLE VALLEY SUPERFUND SITE

ID #	System Location	1989 - 1996 Range	January 1997	November 1997		Oct. 98 / Feb. 99		May 1999		October 2000	March 2001		October 2002		October 2003	
			Pre-Install.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.
86	Basement	17	12	9.9	ND	9.6	ND	----	----	ND	7.9	ND	----	----	6	ND
87	Basement	17	10.8	9.6	ND	9.7	ND	----	----	ND	8.6	ND	8	ND	6	ND
91	Basement	9.9	9.84	9.1	ND	8	ND	----	----	2.2	7.2	2.3	6	ND	7	ND
92	Shed	17.3	17.3	16.1	ND	6.2	ND	----	----	ND	12.0	----	12	ND	13	ND
95	Basement	6.5	8.75	6.9	ND	7.7	ND	----	----	ND	7.3	ND	6	ND	6	ND
96	Shed	10.2	12	9.1	ND	9.1	ND	----	----	4.5	9.5	ND	7	ND	7	ND
99	Shed	6.4	6.49	6.1	ND	6.6	ND	----	----	ND	5.5	ND	4	ND	4	ND
104	Basement	11	13.3	10.6	ND	13	ND	----	----	----	9.5	----	8	ND	9	ND
105	Basement	9.5	9.38	8.5	ND	9.8	ND	----	----	8.5	8.8	ND	7	ND	7	ND
106	Basement	11	9.91	9.8	ND	8.8	ND	----	----	----	----	----	7	ND	8	ND
107	Basement	11 - 28.6	12	12.5	ND	9.7	ND	9.7	ND	ND	9.6	ND	8	ND	8	ND
108	Shed	12	11.9	10.5	ND	11	ND	----	----	ND	10.0	ND	8	ND	4	ND
109	Basement	12	13.8	----	----	8.9	ND	----	----	ND	----	----	9	ND	7	ND
110	Shed	11	11.5	10.4	ND	12	ND	----	----	ND	10.1	----	9	ND	10	ND
111	Basement	4.6	5.25	4	ND	4.1	ND	----	----	ND	3.7	ND	3	ND	ND *	3 *
117	Shed	19.9	20.5	23.3	ND	29	ND	----	----	----	15.6	ND	17	ND	17	ND
118	Basement	9.2	9.82	8.4	ND	1.1	ND	----	----	ND	7.9	ND	7	ND	7	ND
119	Basement	11	10.3	----	----	ND	ND	----	----	ND	8.3	ND	7	ND	6	ND
120	Shed	10	12.3	10.7	ND	10	ND	----	----	ND	9.3	ND	8	ND	7	ND
121	Basement	11	10.7	12.1	ND	12	ND	----	----	ND	7.8	ND	8	ND	7	ND
122	Basement	7.2	7.43	6.9	ND	6.4	ND	----	----	ND	----	----	5	ND	6	ND
125	Basement	----	5.5	5.2	ND	4.7	ND	----	----	ND	4.2	ND	4	ND	4	ND
127	Basement	----	7.3	7	ND	1.3	ND	----	----	ND	6.2	ND	4	ND	4	ND
133	Basement	----	6.94	7.6	ND	6.8	ND	----	----	ND	7.0	ND	6	ND	6	ND
134	Basement	----	7.9	6.7	ND	7.4	ND	----	----	ND	7.0	ND	6	ND	6	ND
135	Basement	----	8.96	8.8	ND	6.4	ND	----	----	ND	7.9	ND	6	ND	6	ND
136	Basement	----	10.4	9.9	ND	8.3	ND	----	----	ND	8.2	ND	7	ND	7	ND
137	Garage	----	10.6	9.8	ND	7.9	ND	----	----	ND	----	----	7	ND	7	ND
153	Shed	----	8.37	ND	ND	8.3	ND	----	----	----	----	----	7	ND	----	----
154	Basement	----	10.5	10.2	ND	8.2	ND	----	----	ND	7.4	ND	8	ND	6	ND
157	Basement	----	14.9	3.9	ND	5	ND	----	----	ND	3.9	ND	4	ND	3	ND
162	Shed	----	11.5	9.8	----	9.1	ND	----	----	ND	8.5	ND	8	8	7	ND
163	Basement	----	7.41	7.7	ND	7	ND	----	----	ND	5.8	ND	5	ND	5	ND
164	Basement	----	6.15	2.7	ND	4.6	ND	----	----	----	4.0	ND	----	----	----	----
166	Basement	----	11.5	8.9	ND	7.9	ND	----	----	ND	9.5	ND	9	ND	8	ND
168	Barn	----	4.64	3.5	ND	3.8	ND	----	----	ND	3.22	ND	3	ND	3	ND
170	Basement	----	12.4	10.6	ND	9.1	ND	----	----	ND	9.1	ND	8	ND	7	ND
171	Basement	----	11.1	----	----	----	----	----	----	ND	----	----	8	ND	8	ND

---- Not sampled .
ND Result not detected.
* Result likely reflects a mix up of pre-treated and post-treated water samples.

TCE SAMPLING RESULTS FOR HOMES WITH TREATMENT SYSTEMS IN PARTS PER BILLION (ppb)
LITTLE VALLEY SUPERFUND SITE

ID #	System Location	1989 - 1996 Range	January 1997	November 1997		Oct. 98 / Feb. 99		May 1999		October 2000	March 2001		October 2002		October 2003	
			Pre-Install.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.	Pre-Treat.	Post-Treat.
172	Shed	-----	9.52	7.3	ND	9.6	ND	-----	-----	ND	7.9	ND	7	ND	6	ND
173	Shed	-----	ND	-----	ND	4.5	-----	-----	-----	ND	.67	ND	3	ND	ND	ND
174	Garage	-----	12.1	10	ND	13	ND	-----	-----	ND	9.2	ND	8	ND	6	ND
176	Wood shed	-----	12.5	10.2	ND	11	ND	-----	-----	-----	-----	-----	8	ND	7	ND
178	Basement	-----	3.97	3.9	ND	6.8	ND	-----	-----	ND	2.6	ND	2	ND	2	ND
184	Wood shed	-----	13.1	10.4	ND	12	ND	-----	-----	ND	10.7	ND	9	ND	8	ND
185	Basement	-----	7.85	12.2	ND	13	ND	-----	-----	ND	ND	ND	ND	ND	0.3	ND
186	Garage	-----	7.08	7.5	ND	9.1	ND	-----	-----	ND	6.0	ND	6	ND	4	ND
187	Shed	-----	7.45	ND	ND	14	ND	-----	-----	ND	7.7	ND	8	ND	8	ND
189	Shed	-----	25.1	24.2	ND	29	ND	-----	-----	-----	-----	-----	19	ND	21	ND
195	Shed	-----	8.05	6.6	ND	8.7	ND	-----	-----	ND	6.1	ND	5	ND	6	ND
205	Shed	-----	10.7	9.1	ND	12	ND	-----	-----	-----	-----	-----	-----	-----	-----	-----
206	Shed	-----	-----	-----	-----	5.2	-----	-----	-----	0.405	-----	-----	5	ND	4	ND
207	Basement	-----	-----	-----	-----	6	-----	5.4	ND	-----	-----	-----	5	ND	5	ND
209	Basement	5.2 - 10	5.6	-----	-----	4	ND	-----	-----	ND	5.4	ND	-----	-----	-----	-----

----- Not sampled .
ND Result not detected.
* Result likely reflects a mix up of pre-treated and post-treated water samples.

TCE SAMPLING RESULTS FOR HOMES WITHOUT TREATMENT SYSTEMS IN PARTS PER BILLION (ppb)

LITTLE VALLEY SUPERFUND SITE

ID #	System Location	1989 - 1996 Historical Range	January 1997	November 1997	October 1998	Fall 1999	April 2001
16	None	ND	ND	ND	0.5	ND	-----
20	None	ND	ND	ND	-----	ND	ND
22	None	ND	ND	ND	-----	-----	ND
23	None	ND - 0.5	0.4	ND	0.5	0.5	0.3
24	None	ND	0.5	ND	-----	0.5	0.3
25	None	2.0	1.5	-----	1.5	1.0	-----
26	None	1 - 3	1.2	1.2	1.6	1.9	0.9
27	None	9.3 - 25	13.7	-----	13 (refused)	-----	-----
31	None	ND	ND	ND	0.5	ND	ND
34	None	ND	-----	-----	0.5	-----	ND
37	None	ND	ND	ND	2.7	ND	-----
38	None	3	0.7	3.0	2.7	2.7	1.8
39	None	8 - 9.4	2.4	-----	0.9	ND	0.6
50	None	ND	ND	ND	-----	ND	-----
52	None	ND	ND	ND	0.5	ND	ND
55	None	2 - 2.8	3.0	-----	0.5	3.1	2.5
56	None	ND - 0.5	0.5	-----	0.5	0.5	0.3
58	None	ND - 0.5	ND	-----	-----	ND	-----
59	None	1	1.0	-----	-----	1.0	0.8
60	None	ND	-----	ND	-----	0.4	-----
61	None	ND	ND	-----	-----	-----	-----
66	None	ND	ND	ND	0.5	-----	-----
67	None	ND	ND	ND	0.5	ND	ND
68	None	ND	ND	ND	-----	ND	ND
69	None	2	2.6	-----	1.7	1.0	1.6
70	None	ND	ND	ND	0.7	ND	ND
71	None	2	3.0	-----	-----	ND	ND
72	None	1	1.2	-----	0.9	1.0	0.9
73	None	ND	-----	-----	-----	-----	-----
93	None	ND	ND	-----	-----	ND	ND
94	None	ND	ND	ND	0.5	ND	ND
97	None	9.4	7.7	2.7	-----	-----	6.24 (non-pot.)

----- Not sampled.

ND Result not detected.

* Result likely reflects a mix up of pre-treated and post-treated water samples.

TCE SAMPLING RESULTS FOR HOMES WITHOUT TREATMENT SYSTEMS IN PARTS PER BILLION (ppb)

LITTLE VALLEY SUPERFUND SITE

ID #	System Location	1989 - 1996 Historical Range	January 1997	November 1997	October 1998	Fall 1999	April 2001
98	None	2.6	2.7	-----	1.7	2.6	1.5
100	None	ND	ND	ND	0.5	0.5	ND
101	None	1 - 2.1	2.3	2.1	-----	2.0	-----
102	None	5.8	-----	-----	-----	-----	-----
103	None	ND	ND	ND	0.5	0.5	ND
112	None	1.4	1.7	-----	1.4	3.0	2.5
113	None	2.1	2.6	-----	1.6	1.7	1.7
114	None	ND	ND	ND	0.5	ND	ND
115	None	ND	ND	ND	-----	ND	-----
116	None	ND	ND	ND	0.5	ND	ND
123	None	-----	1.2	-----	0.9	1.2	1.0
126	None	-----	1.2	-----	1.3	1.3	0.9
128	None	-----	2.3	-----	2.0	2.4	1.9
129	None	-----	5.6	-----	-----	-----	-----
130	None	-----	ND	ND	-----	0.4	ND
131	None	-----	7.5	-----	7.5 (refuse)	8.2	6.8
132	None	-----	ND	ND	0.5	ND	ND
138	None	-----	ND	ND	0.5	ND	ND
139	None	-----	ND	ND	-----	ND	-----
140	None	-----	-----	-----	-----	-----	-----
141	None	-----	ND	ND	-----	0.5	-----
142	None	-----	ND	ND	0.5	ND	-----
143	None	-----	ND	ND	0.5	ND	-----
144	None	-----	ND	ND	0.5	ND	ND
145	None	-----	-----	-----	-----	7.5	-----
146	None	-----	-----	-----	-----	0.5	ND
147	None	-----	ND	ND	0.5	-----	-----
148	None	-----	ND	ND	0.5	ND	ND
149	None	-----	ND	ND	-----	ND	ND
150	None	-----	ND	ND	0.5	ND	ND
151	None	-----	ND	ND	-----	-----	-----
152	None	-----	ND	ND	0.5	ND	ND

----- Not sampled.

ND Result not detected.

* Result likely reflects a mix up of pre-treated and post-treate ter samples.

TCE SAMPLING RESULTS FOR HOMES WITHOUT TREATMENT SYSTEMS IN PARTS PER BILLION (ppb)

LITTLE VALLEY SUPERFUND SITE

ID #	System Location	1989 - 1996 Historical Range	January 1997	November 1997	October 1998	Fall 1999	April 2001
155	None	-----	ND	ND	0.5	ND	-----
156	None	-----	ND	ND	0.5	ND	ND
158	None	-----	ND	ND	0.5	ND	ND
159	None	-----	ND	ND	-----	ND	ND
160	None	-----	ND	ND	0.5	ND	ND
161	None	-----	ND	ND	-----	ND	-----
165	None	-----	6.2	-----	-----	0.5	-----
167	None	-----	-----	-----	-----	-----	-----
169	None	-----	ND	ND	-----	0.5	-----
175	None	-----	14.9	-----	-----	-----	ND
179	None	-----	-----	-----	-----	-----	-----
180	None	-----	3.3	-----	-----	3.5	2.7
181	None	-----	1.6	-----	1.5	2.1	1.1
182	None	-----	-----	ND	0.8	1.0	0.4
183	None	-----	0.5	-----	0.5	1.1	1.0
188	None	-----	-----	-----	-----	-----	-----
190	None	-----	ND	ND	-----	ND	ND
191	None	-----	ND	ND	-----	-----	-----
192	None	-----	ND	ND	-----	-----	ND
193	None	-----	ND	ND	-----	ND	ND
194	None	-----	ND	ND	-----	-----	ND
196	None	-----	3.3	-----	3.0	3.0	2.7
197	None	-----	ND	ND	-----	ND	ND
198	None	-----	ND	ND	0.5	ND	-----
199	None	-----	ND	ND	-----	ND	ND
200	None	-----	0.7	-----	0.5	-----	-----
201	None	-----	ND	ND	-----	2.9	-----
202	None	-----	4.5	-----	-----	-----	-----
203	None	-----	2.7	-----	2.1	2.7	2.1
208	None	-----	-----	-----	-----	-----	ND
209	None	-----	-----	-----	-----	-----	ND

----- Not sampled.

ND Result not detected.

* Result likely reflects a mix up of pre-treated and post-treated water samples.

TCE SAMPLING RESULTS FROM STATE AND COUNTY AGENCY SAMPLING IN PARTS PER BILLION (ppb)
LITTLE VALLEY SUPERFUND SITE

ID #	Testing Organization	Range	Last Sample Result	Date of Last Sample Result	1997 EPA Sample Result
7	CCHD	ND-8	10/08/1998	ND	--
41	CCHD	8-20	Not Sampled		--
42	CCHD	ND	Not Sampled		--
43	CCHD	ND	Not Sampled		--
48	CCHD	3	Not Sampled		--
49	CCHD	ND	Not Sampled		--
63	CCHD	18-22	10/21/1998	22	19.2
74	CCHD	ND	03/19/1991	ND	--
75	NYSDEC	ND	12/07/1992	ND	--
76	D&M	ND	05/29/1991	ND	--
77	NYSDEC	45-186	12/07/1992	186	--
78	NYSDEC	27-280	12/07/1992	27	--
80	NYSDEC	ND	12/07/1992	ND	--
81	NYSDEC	ND	12/07/1992	ND	--
82	NYSDEC	0.7-1.4	12/07/1992	1.4	--
83	NYSDEC	ND	12/07/1992	ND	--
84	NYSDEC	ND	12/07/1992	ND	--
85	NYSDEC	ND-0.5	12/07/1992	0.5	--
89	NYSDEC	ND	12/07/1992	ND	--
90	NYSDEC	ND	12/07/1992	ND	--
204	unknown	0.8	10/07/1998	0.8	

CCHD = Cattaraugus County Health Department
NYSDEC = New York State Department of Environmental Conservation
D&M = Dames and Moore

----- Not sampled
ND Result not detected.

ATTACHMENT D-3

COSTS

ESTIMATION OF REPLACEMENT FREQUENCY FOR ACTIVATED CARBON UNITS USING AVERAGE CONCENTRATION OF 8.0 µg/l

The first step in the process is to determine the time required for saturation of the carbon. Saturation of the carbon occurs when the influent concentration equals the effluent concentration (i.e., all adsorptive capacity is used). Breakthrough will occur prior to saturation of the carbon.

Based upon information obtained from a vendor of activated carbon adsorption systems, 0.007 pounds of carbon will be used per day at each residence, assuming a water usage of 1 gallon per minute (which is equivalent to 1,440 gallons per day) and a maximum TCE influent concentration of 8.0 µg/l (the average TCE concentration observed at the site at the time carbon units were installed.)

At a carbon usage rate of 0.007 pounds/day, 1 pound of carbon will be used every 143 days. For a single 2 ft^3 vessel containing 40 pounds of carbon, the carbon will be completely used up (i.e., saturated) in 143 x 40 = 5,720 days, or approximately 15.7 years. Since breakthrough will occur before saturation, a reasonable replacement time for the carbon would be at 50% of the saturation time, or approximately 8 years.

TABLE 1: Retention of Existing Carbon Treatment Systems O&M Costs		
Cost Component	**Basis of Estimate**	**Annual O&M Cost**
Operation, Maintenance, and Sample Collection	$1000/unit x 90 systems	$90,000
Sample Analysis	$125/unit x 90 systems	$11,250
Total O&M Cost	**$101,250**	

Note: There are no capital costs associated with this alternative.

PRESENT-WORTH COST (10 YEARS):

$PW = C + 1/i - 1/i(1+i)^n \times [O\&M]$

where PW = present-worth
C= capital cost
O&M= annual O&M cost
i = discount rate (7%)
n= number of years (10 yrs)

PW = $0+ (7.0) x $101,250 = $708,750

TABLE 2: Connection to City of Salamanca Public Water Supply Capital Cost			
Description	Quantity	Unit Price	Cost
Mobilization/Demobilization		$40,000	$40,000
8-inch ID Water Main Pipe	40,000 ft	$45/ft	$1,800,000
Creek Crossing	600 ft	$75/ft	$45,000
Installation of Water Meters	65	$2,500/ meter	$162,500
Water Main Auxiliary Equipment (valves/hydrants)		$50,000	$50,000
Asphaltic Pavement (road crossings)	1,500 yd^2	$25	$37,500
Booster Pump Station with 100,000 gal. Tank			$200,000
Total Direct Construction Cost (TDCC)			$2,335,500
Contingency @ 10% of TDCC			$ 233,550
Engineering, Legal, and Administrative @ 25% of TDCC			$ 583,875
Total Construction Cost			**$3,152,925**

TABLE 3: Connection to Village of Little Valley Public Water Supply Capital Cost			
Description	Quantity	Unit Price	Cost
Mobilization/Demobilization		$40,000	$40,000
8-inch ID Water Main Pipe	40,000 ft	$45	$1,800,000
Creek Crossing	600 ft	$75	$45,000
Installation of Water Meters	65	$2,500	$162,500
Water Main Auxiliary Equipment (valves/hydrants)		$50,000	$50,000
Asphaltic Pavement (road crossings)	1,500 yd^2	$25/$yd^2$	$37,500
Storage Tank	100,000 gal.	$1.50/gal	$150,000
Total Direct Construction Cost (TDCC)			$2,285,500
Contingency @ 10% of TDCC			$ 228,550
Engineering, Legal, and Administrative @ 25% of TDCC			$ 571,250
Total Construction Cost			**$3,085,250**

TABLE 4 - Connection to City of Salamanca Public Water Supply O&M Cost		
Cost Component	Basis of Estimate	Annual O&M Cost
Purchase of Water	$15.00 + $2.00/750 gal.*	$32,616
Operator	178 man-hours/year @ $25/hr for routine maintenance and meter readings	$4,450
Supplies	[redacted]	$1,200
Billing		$1,400
Master Meter		$700
Contingencies		$1,000
Total O&M Cost	**$41,366**	

* Estimate based on 90 affected residences with an average water household water usage of 7,200 gal/month at a rate of $15.00/ 1st 1,500 gallons and $2.00/750 gallons thereafter.

PRESENT-WORTH COST (30 YEARS):

$PW = C + 1/i - 1/i(1+i)^n \times [O\&M]$

where PW = present-worth
C= capital cost
O&M= annual O&M cost
i = discount rate (7%)
n= number of years (30 yrs)

PW = $3,152,925+ (12.4) x $41,366 = $3,665,863

TABLE 5: Connection to Village of Little Valley Public Water Supply O&M Cost		
Cost Component	**Basis of Estimate**	**Annual O&M Cost**
Water	$10.10 +$1.72/1000 gal.*	$22,054
Operator	178 man-hours/year @ $25/hr for routine maintenance and meter readings	$4,450
Supplies		$1,200
Billing		$1,400
Master Meter		$700
Contingencies		$1,000
Total O&M Cost	**$30,804**	

* Estimate based on 90 affected residences with an average water household water usage of 7,200 gal/month at a rate of $10.10/ 1st 2,000 gallons and $1.72/1,000 gallons thereafter.

PRESENT-WORTH COST (30 YEARS):

$PW = C + 1/i - 1/i(1+i)^n \times [O\&M]$

where PW = present-worth
C= capital cost
O&M= annual O&M cost
i = discount rate (7%)
n= number of years (30 yrs)

PW = $3,085,250+ (12.4) x $30,804/yr = $3,467,220