FEASIBILITY STUDY REPORT

Lehigh Valley Railroad Derailment Superfund Site

LeRoy, New York

Index Number CERCLA-02-2006-2006

Prepared For:

Lehigh Valley Railroad Company

Cincinnati, Ohio 45202

Prepared By:

Unicorn Management Consultants, LLC

52 Federal Road, Suite 2C

Danbury, CT 06810

July 27, 2023

DOCUMENT AUTHORIZATION FORM

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Executive Summary

A derailment of a train operated by the Lehigh Valley Railroad Company (LVRR) resulted in a release of approximately 30,000 gallons of trichloroethene (TCE) and 1 ton of cyanide crystals at the Gulf Road railroad crossing in the Town of LeRoy, on December 6, 1970. The Spill Zone, which was estimated by the New York State Department of Environmental Conservation ("NYSDEC") in 1997 to be approximately 10 acres in size, and the resulting groundwater plume became known as the Lehigh Valley Railroad Company Derailment Superfund Site (Site). LVRR initially responded to the release, then the New York State Department of Health (NYSDOH), and NYSDEC. The United States Environmental Protection Agency (USEPA) became involved in the early 1990s in Site investigations and cleanup pursuant to Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). **Figures 1-1, 1-2**, **1.3-1, and 1.3-2** illustrate the Site.

LVRR has been undertaking the investigation and a portion of the cleanup of the Site pursuant to two USEPA orders: (1) Settlement Agreement and Order on Consent for Pre-Remedial Design Investigations, Remedial Design, and Remedial Investigation/Feasibility Study, Index. No. CERCLA-02-2006-2006, dated September 22, 2006 (hereinafter, "SA"); and, (2) Administrative Order for Remedial Action, Index No. CERCLA-02-2014-2010, dated March 21, 2014 (hereinafter, "RA Administrative Order").

For purposes of helping effectuate the investigation and cleanup, the Site was divided into two operable units, as follows:

(1) Operable Unit (OU)1: The bedrock contamination in the 10-acre Spill Zone; the area where a waterline was installed to provide drinking water; contaminated groundwater present in the bedrock (about three- and one-half square miles); and contaminated overburden in the Spill Zone (including approximately 1.5 acres of surface soil, railroad ballast, broken rock, fill, etc.); and,
(2) OU2: The 4-mile long TCE groundwater plume.

The Remedial Investigation (RI), as summarized herein, demonstrates that the extent of the TCE plume boundary is near steady-state, with some processes at work, such as matrix diffusion, that appear to have attenuated the migration of contaminants in groundwater. The TCE plume is

controlled both horizontally and vertically by natural processes such as the Oatka Creek drainage to the north, the Spring Street fault zone to the east, the influx of allogenic water from the south, as well as man-made processes such as seasonal groundwater pumping at the nearby quarry to the west. The RI has shown that:

- **Soil:**
  - The "Spill Zone Soil" consists of overburden materials composed of sand, silt and varying amounts of rock fragments and fill materials. Testing of the rock fragments indicate that contaminant mass exists within the matrices of some of these fragments.
  - Synthetic Precipitation Leaching Procedure (SPLP) and Toxicity Characteristic Leaching Procedure (TCLP) analysis of the overburden materials support that TCE concentrations in overburden materials do not act as a continuing source of contamination that threatens to contravene groundwater quality standards.
- **Non-Aqueous Phase Liquid (NAPL):**
  - Although NAPL has not been observed directly during Site investigations, TCE concentrations above the TCE solubility limit suggests that mass likely remains in a dense NAPL (DNAPL) phase in the rock matrix.
- **Bedrock Vadose Zone (BVZ):**
  - Over the 53 years since the spill, data suggest that most of the contaminant mass is now located in the bedrock matrix porosity, the small, lower transmissivity fractures (*i.e.,* microfractures) and matrix pore spaces, as dissolved and sorbed phase material, above and below the water table, and not in the larger high transmissivity fractures.
  - TCE-impacted microfractures are estimated to extend from the Spill Zone at depths to approximately 120 feet below ground surface (ft bgs) to the Spring Creek fault zone (approximately 4.0 miles from the Spill Zone) at depths of approximately 30 ft bgs.
- **Groundwater:**
  - TCE in the lower transmissivity microfractures within the bedrock matrix will act as a continuing and future source of TCE to groundwater. The 2019 "Assessment of Groundwater Restoration and Technical Impracticability Report" concludes that the remediation of over 1.5 miles of bedrock or more to restore groundwater to its most beneficial use is currently technically impracticable.

- Significant volumes of allogenic water from runoff during storm events, ranging from 3 million gallons per month (Mg/mo) to 406 Mg/mo, mix with the groundwater system in the Study Area. The plume receives the least amount of allogenic recharge in October, coinciding with the highest reported TCE groundwater concentrations.
- Water level changes of 50 feet or more, occur rapidly, in a matter of hours or days. The water level responses within each formation are similar with very little or no lag time, indicating that the geologic formations act as a single aquifer which is hydraulically interconnected through a complex fracture network.
- Large precipitation events during the summer have little effect on the groundwater levels, likely due to evapotranspiration and groundwater storage capacity in the vadose zone. A relationship between precipitation magnitude and water table rise could not be established even within the same season, except perhaps for events augmented by snowmelt events.

- **Surface Water:**
  - The highest monthly flux of 406 Mg/mo is observed along the Mud Creek drainage located immediately downgradient of the Spill Zone. TCE impacts that exceed the surface water Applicable or Relevant and Appropriate Requirements (ARAR) are limited to a section of the Mud Creek flow channel between the intersection of Gulf Road and Neid Road and the outfall of Mud Creek Pond.
  - A limited understanding of temporal variation within the Mud Creek flow channel is available for flow rates, TCE concentrations, and general flow channel chemistry. The NYSDEC and LVRR remedial investigations provided support to develop a general surface water CSM for Mud Creek; however, data gaps were identified and will require further investigation.
- **Soil Vapor Intrusion (SVI):**
  - TCE in groundwater volatilizes into the unsaturated bedrock and soil and subsequently into overlying structures in the form of SVI.
  - LVRR implemented an indoor air monitoring program (IAMP) to monitor the SVI conditions at the Site. To date, 61 locations were identified for evaluation as part of the IAMP. Of the 61 locations, 14 refused access for sample collection, 38 of the 61 have been sampled for SVI, and 9 locations were removed from the plan because of the nature of the location (*e.g.*, a seasonally-used unheated structure or

an actively-used automotive repair facility), or the absence of a structure at the location. Of the 38 locations which were sampled, active sub-slab depressurization mitigation systems (SSDS) were installed at 12 locations to mitigate SVI plus one location installed a SSDS system for radon that also acts to mitigate SVI.

- **Discrete Fracture Network (DFN) numeric modeling**:
    - DFN modeling results showed little to no impact from complete BVZ TCE mass removal on the TCE concentrations downgradient in the plume and nearer the plume front over any reasonable timeframes. The modeling thus concluded that implementation of remedial actions within the Spill Zone and BVZ will result in little to no marked improvement in downgradient groundwater quality, even if it were possible to remove all the TCE mass present within the BVZ. Based on the DFN model results, Spill Zone remedial efforts will not meet RAOs for this area, which include migration of the ongoing source of groundwater contamination, acceleration of long-term improvement to groundwater, and supporting further risk reduction in the Spill Zone or Study Area.

Investigations and monitoring over more than two decades show TCE concentrations in the plume are stable or declining throughout. The plume has maintained its shape and TCE concentrations have not expanded plume boundaries. These trends will likely continue even in the absence of aggressive remedial measures.

Upon approval of the RI Report (RIR) and in accordance with the SA, LVRR prepared a Feasibility Study (FS) Report encompassing all remaining contaminated media. This FS Report presents and evaluates remedial alternatives for the Site that will provide for the protection of human health and the environment. The FS Report incorporates historical NYSDEC Remedial Investigation/Feasibility Study (RI/FS) findings and LVRR RI findings that are used to support remedial actions historically and currently implemented; *i.e.,* waterline for current and future residential/commercial potable water and fire suppression implemented by NYSDEC in 2003, *in situ* soil vapor extraction (SVE) implemented by LVRR from 2015 through 2017, and an IAMP which includes vapor mitigation systems implemented by LVRR from 2008 through Present. In addition, the FS Report evaluates and presents additional media specific remedial alternatives for consideration, some of which were previously presented pursuant to the SA (FS Technical Memorandums); RA Administrative Order (Focused Alternatives Analysis report [FAA], dated

March 2018); and, an Assessment of Groundwater Restoration Potential and Technical Impracticability Report (AGTI), dated May 25, 2019.

The purpose of this FS Report is to evaluate potential media specific remedial options for the Site. To accomplish the FS objectives, remedial action objectives (RAOs) and preliminary remediation goals (PRGs) were evaluated and proposed for groundwater (5 micrograms per liter [µg/L]), surface water (40 µg/L), soil/indoor air vapor (current New York State and Federal SVI screening levels [VISLs] and guidance), and soil (200 parts per million [ppm]).

The process used to develop the proposed remedial alternatives consists of identifying and screening various remedial technologies, or process options, that were classified under various general response actions (GRAs) or "Methods." Certain response options that would be common to all alternatives were designated as "Common Elements." The remedial technologies and process options for each GRA were subjected to an initial evaluation and screening process that considered the technologies effectiveness, implementability, and costs. Retained remedial technologies and process options were then incorporated into media-specific remedial alternatives, consisting of one or more remedial technologies/process options, and subjected to a detailed analysis evaluating each remedial alternative against the National Oil and Hazardous Substances Contingency Plan's (NCP) nine criteria: overall protection of human health and the environment; compliance with Applicable or Relevant and Appropriate Requirements (ARARs); long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; short-term effectiveness; implementability; cost; State acceptance; and community acceptance.

A detailed analysis was performed for the following proposed media-specific remedial alternatives:

A. Common Elements

a. Remedial elements that are common to all the alternatives included in the detailed analysis section of this FS include:
    i. Institutional Controls (ICs) in the form of:
        1. Governmental controls;
        2. Proprietary controls (*e.g.*, easements on Spill Zone parcels);
        3. Informational devices relating to groundwater and the Spill Zone (*e.g.*, notices, publications);
    ii. Monitoring (groundwater, surface water, soil vapor, and indoor air);

iii. Maintenance of existing SVI mitigation systems and installation of new systems, as needed, for impacted properties constructed within, overlying, and adjacent to the groundwater plume; and,

iv. Connection of new homes constructed over the groundwater plume to the municipal water supply system.

B. **ICs and Monitoring for Portion of the Groundwater Plume Proposed for a Technical Impracticability (TI) Waiver**

a. Groundwater RAOs are as follows:

i. Prevent current and future human exposure to Site-related contaminants in groundwater that exceed Federal or State maximum contaminant levels (MCLs);

ii. Prevent further migration of Site-related contaminants in groundwater at levels exceeding MCLs beyond the delineated areal extent of the groundwater contamination Technical Impracticability (TI Zone); and,

iii. Prevent the migration of Site-related contaminants in groundwater to receiving surface water above applicable surface water quality standards.

b. Groundwater RAOs would be met through a combination of ICs and long-term response actions (common elements), active alternatives for soil and surface water, as well as consideration of additional source reduction (*e.g.*, natural attenuation). An alternative water source was implemented for the purpose of providing a long-term solution that addresses public health concerns with respect to the consumption of potable water. The waterline connections were completed in all four of the municipalities that were affected by the TCE plume (Town of Wheatland, Town of LeRoy, and the Town and Village of Caledonia).

C. ICs and Monitoring for Soil Vapor Intrusion

a. The RAO for SVI is to mitigate potential current and future unacceptable risks from subsurface SVI into indoor air.

b. This RAO will be met on-Site through a combination of ICs, monitoring, the implementation of SVI mitigation technologies, and the continued inspection and maintenance of currently installed SVI mitigation systems.

D. Bedrock Vadose Zone (BVZ) Remedial Alternatives

a. The RAOs for the BVZ alternatives are as follows:

i. Mitigate, to the extent practicable, the BVZ as an ongoing source of groundwater contamination;
ii. Accelerate long-term improvement to the groundwater in a reasonable time frame; and,
iii. Support further risk reduction for the Site as a whole.

b. The BVZ alternatives are as follows:
i. BVZ Alternative #1: No Action;
ii. BVZ Alternative #2: Monitoring and ICs (assuming TI for groundwater restoration and engineering controls for other impacted media, *e.g.*, surface water and soil);
iii. BVZ Alternative #3a: BVE in a 10-acre portion of the BVZ, Monitoring and ICs; and,
iv. BVZ Alternative #3b: BVE in a 2-acre portion of the BVZ, Monitoring and ICs.

E. Mud Creek Surface Water Remedial Alternatives

a. The RAO for surface water is to prevent unacceptable risk to human receptors from incidental ingestion and dermal contact exposure to contaminated surface and seep water in Mud Creek by reducing contaminant levels to the more stringent Federal or State standards. The Mud Creek surface water investigation was sufficient for the Conceptual Site Model (CSM) but a pre-remedial design investigation (PDI) would be performed in order to fill certain data gaps.

b. The Mud Creek Surface Water Alternatives are as follows:
i. Surface Water Alternative #1: No Action;
ii. Surface Water Alternative #2: ICs and Monitoring;
iii. Surface Water Alternative #3: Hydraulic containment of contaminated groundwater to prevent discharge/daylighting to surface water with ICs and monitoring;
iv. Surface Water Alternative #4: Streambed cover with ICs and monitoring; and,
v. Surface Water Alternative #5: *In situ* treatment of contaminated groundwater prior to discharge/daylighting to surface water with streambed cover, with ICs and monitoring.

F. Soil Remedial Alternatives

a. The soil RAOs are as follows:
    i. Prevent unacceptable risk to human health from incidental ingestion of and inhalation exposure to spill zone soil (*i.e.*, contaminated overburden fill material/debris/soil) exceeding remedial goals; and,
    ii. Prevent migration of contaminants in Spill Zone overburden fill material/debris/soil that would result in further groundwater impacts.
b. The Soil alternatives are as follows:
    i. Soil Alternative #1: No Action;
    ii. Soil Alternative #2: *Ex situ* Solidification/Stabilization (S/S) using Commercial Land-Use Based PRG with ICs;
    iii. Soil Alternative #3: Excavation/Disposal using Commercial Land-Use Based PRG and ICs; and,
    iv. Soil Alternative #4: *Ex situ* Low-Temperature Thermal Desorption (LTTD) using Commercial Land-Use Based PRG with ICs.

A comparative analysis summarizing the proposed media-specific remedial alternatives is presented within this FS Report to support the selection of an alternative remedial strategy that is technically practicable, protective of human health and the environment, and satisfies statutory and regulatory requirements of CERCLA.

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1 INTRODUCTION

Unicorn Management Consultants, LLC (UMC), prepared this Feasibility Study Report (FS Report) for the Lehigh Valley Railroad Derailment Superfund Site located in Genesee, Monroe, and Livingston Counties, New York (Site) on behalf of the Lehigh Valley Railroad Company (LVRR). LVRR is the respondent to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Settlement Agreement and Order on Consent for Pre-Remedial Design Investigations, Remedial Design, and Remedial Investigation/Feasibility Study, Index No. CERCLA-02-2006-2006, dated September 22, 2006 (hereinafter, "SA"), and Administrative Order for Remedial Action, Index No. CERCLA-02-2014-2010, dated March 21, 2014 (hereinafter, "RA Administrative Order"). The Site encompasses the area impacted by a one-time release of Trichloroethene (TCE) from a train derailment in 1970.

This FS Report takes into account the *New York State Department of Environmental Conservation, Record of Decision for the Lehigh Valley Railroad Derailment Site, Town of LeRoy, Genesee County, Site Number 8-19-014,* dated March 1997 (NYSDEC ROD). This FS Report discusses and evaluates the NYSDEC ROD-selected remedy (waterline extension, soil excavation, *ex situ* soil vapor extraction (SVE), and bedrock vapor extraction [BVE]) in context with the current Conceptual Site Model (CSM) developed through the LVRR Remedial Investigations (LVRR RI) and provides a mechanism for the development, screening, and detailed evaluation of remedial alternatives related to risks associated with TCE impacts in Site groundwater, surface water, soil, bedrock vadose zone (BVZ), and soil vapor intrusion (SVI) matrices.

1.1 Purpose and Objectives

In accordance with United States Environmental Protection Agency (USEPA) guidance, "the FS is the mechanism for the development, screening, and detailed analysis of alternative remedial actions." This FS Report provides the support to develop, screen, and perform a detailed analysis of alternatives specific to the nature and extent of risks identified by the Site's remedial investigations with the objective of supporting an informed risk management remedy selection decision for the Site. To accomplish the FS objectives, remedial action objectives (RAOs) and preliminary remediation goals (PRGs) were evaluated and proposed for groundwater, SVI, BVZ, surface water, and soil.

The groundwater technical impracticability (TI) evaluation for groundwater concludes that groundwater restoration to Maximum Contaminant Levels (MCLs) is not practicable. When restoration of groundwater to its beneficial use is not practical, the USEPA may select an alternative remedial strategy

that is technically practicable, protective of human health and the environment, and satisfies statutory and regulatory requirements of CERCLA. Consistent with the National Contingency Plan (NCP), alternative remedial strategies for sites with TI address exposure control, source control, and aqueous plume migration. Exposure control and plume migration are addressed by the groundwater RAOs and source control is addressed by the RAOs for surface water, BVZ, and soil.

1.2 Report Organization

This FS Report is organized into the following sections:

- **Section 1.0 Introduction:** Provides an introduction to the FS Report and Site. This section includes the purpose, report organization, Site background and setting, Site location, previous investigations, and physical characteristics of the Site;
- **Section 2.0 NYSDEC and LVRR RI Findings and Response Actions:** Presents the RI findings including potential remedial approaches for various media, the nature and extent of the Site's various TCE-impacted media (BVZ, groundwater, surface water, soil, soil vapor, indoor air soil vapor intrusion [SVI]), the potential risks to human health and the environment, contaminant transport modeling, Assessment of Groundwater Restoration and Technical Impracticability (AGTI), and the Site CSM.
- **Section 3.0 Remedial Alternatives Evaluation Overview:** An overview of ARARs; waivers; proposed RAOs and PRGs; evaluation and screening of General Response Actions (GRAs) and process options; and development and evaluation of alternatives.
- **Section 4.0 Media Specific Remedial Alternative Evaluations:** Contains a detailed analysis of the potentially applicable ARARs, RAOs, PRGs, GRAs, process options, and remedial alternatives per media; the assembly of alternatives per media; a comparison to the NYSDEC ROD selected remedy (as applicable); and, a detailed evaluation of the assembled alternatives per media against the USEPA's nine criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity; mobility, and volume; (5) short-term effectiveness; (6) implementability; (7) cost; (8) community acceptance; and (9) State acceptance.
- **Section 5.0 Summary and Comparative Analysis of Remedial Alternatives by Media:** A summary and brief comparative analysis of the proposed remedial alternatives per media.
- **Section 6.0 References:** References cited throughout the FS Report; and,
- **Section 7.0 Abbreviations and Acronyms:** Abbreviations and acronyms used throughout the FS Report.

The following section discusses the Site's background and setting.

1.3 Background and Setting

The following background and setting information provide a basis for the information presented in subsequent sections of this FS Report.

1.3.1 Site Location

The Site is located within parts of Genesee, Livingston, and Monroe Counties in New York State (NYS). **Figure 1-1** of this report is an index map and **Figure 1-2** of this report is a regional map depicting the approximate Site location. The Site is generally divided into two areas of interest, the Study Area and Spill Zone, as referenced by the USEPA in the Settlement Agreement (SA) and illustrated on **Figures 1.3-1** and **1.3-2** of this report.

The Spill Zone encompasses approximately 10 acres of land in the vicinity of the former LVRR crossing at Gulf Road. The Spill Zone includes a former railroad bed; a former quarry material staging area; and the foundation of a former hotel. Currently, the Spill Zone is mostly undeveloped industrial, commercial, residential, and passive recreational land largely covered with grass, brush, and wooded areas. The coordinates of the approximate center of the spill are 42 59' 32.0980"N and 77 55' 59.6295"W with an average elevation of approximately 760 ft above mean sea level (amsl) (Environmental Systems Research Institute [ESRI], 2020, ArcGIS Release 10.8.1, Redlands, CA). **Figure 1.3-2** illustrates the Spill Zone and adjacent land parcels; **Figure 1.5-1** illustrates the Study Area zoning; **Figure 1.5-2** and **Figure 1.5-3** depict the Spill Zone land parcels with reference to the individual parcel current and future land use and zoning.

The "Study Area" is roughly bounded by the Oatka Creek Valley to the north, the Dolomite Quarry and Hanson (formerly General Crushed Stone) Quarry to the west, Route 5 to the south, and Spring Creek Valley to the east. The Study Area includes a TCE-impacted groundwater plume emanating from the Spill Zone which extends eastward approximately 4.1 miles to spring-fed Spring Creek. Spring Creek flows northward and discharges into Oatka Creek, which flows eastward and is the northern boundary of the Study Area. Oatka Creek is the main surface water body in the area with local streams discharging to it.

The land between the Spill Zone and Spring Creek is mostly agricultural with a mixture of private residences and commercial establishments. Wooded land is located between the sections used for farming. Gulf Road/Flint Hill Road runs along the northern portion of the Study Area while East Main Road/Caledonia-LeRoy Road/New York State Route 5 (Route 5) is near the southern boundary of the Study

Area. Located along Gulf Road/Flint Hill Road are several sporting clubs on whose lands seasonal hunting by club members occurs. The only commercial or industrial properties located in the Study Area are along Leroy Caledonia Road (Highway 5) and the operating Hanson Quarry on Gulf Road. The Genesee Country Museum is located in the east-central section of the Study Area off of Flint Hill Road. The museum owns property on both the north and south sides of the Flint Hill Road occupied by numerous buildings exhibiting life typical of the 19th century in western New York.

Three public water supply system sources are located within or in the vicinity of the Study Area: one within the Town of Wheatland, one within the Village of Caledonia, and one within the Village of LeRoy. **Figure 1.4-2** depicts the locations of the three public water system sources in relation to the Site, the TCE plume, and existing Site waterline. The Monroe County Water Authority (MCWA) public water supply source, in the Town of LeRoy, supplies water to the Site waterline (NYSDEC, 2003). The three public water supply sources are unlikely to be impacted by the TCE plume based on the Site RI findings presented in Section 2 of this FS Report. In addition to the three public water supply sources, two domestic water supply wells are located within the TCE plume boundary (L-14 and L-33B) and, are not used as potable water sources as denoted on signage stating that the water from L-14 and L33B is not safe for drinking water purposes. Domestic well L-14 is currently used for dust control of the racetrack on Lime Rock Road; and, L-33B is located on Spring Street and used for irrigation. Efforts to obtain respective property owner approval to abandon the two existing domestic wells within the TCE plume boundary is ongoing. **Figures 1.4-1, 1.4-2 and 1.5-1, 1.5-2, 1.5-3, and 1.5-4** of this report illustrate the county boundaries, municipal boundaries, Study Area, Spill Zone, as well as the current and proposed future use and zoning of the Site.

The following section provides a summary of physical characteristics of the Site for consideration throughout this FS Report.

1.4 Physical Characteristics of the Site

1.4.1 Surface Features and Topography

1.4.1.1 Physiography

The Study Area is situated in the Allegheny Plateau Physiographic Province of western New York within the LeRoy and Caledonia 7.5-minute United States Geological Survey (USGS) topographic quadrangles. The major surface drainage feature in the Site is Oatka Creek, which flows from west to east,

generally defining the northern boundary of the Site. Mud Creek, a seasonal tributary of Oatka Creek, flows from south to north through the western portion of the Site and hydraulically downgradient of the Spill Zone. Other seasonal surface water features flow from south to north along the southern boundary of the Site, generally defined by the west to east oriented New York State (NYS) Route 5. South to north-flowing Spring Creek is also a tributary of Oatka Creek and generally defines the eastern-most distal end of the TCE plume with monitoring wells beyond that define the eastern-most portion of the Site.

East of the Spill Zone the topography slopes generally downward toward Spring Creek along an undulating surface. The ground elevation at the Spill Zone is approximately 760 to 770 ft amsl. The elevation of the upstream end of Spring Creek at NYS Route 5 is approximately 650 ft amsl while the elevation of Spring Creek at its downstream end at the confluence with Oatka Creek is approximately 600 ft amsl. North of Gulf Road/Flint Hill Road, the topography slopes downward to the north toward Oatka Creek. The confluence of Oatka Creek and Mud Creek is approximately 630 ft amsl. **Figure 1-6** of this report is a topographic contour map depicting the Study Area topography.

The area within 2 miles of LeRoy, New York is covered by cropland (54%) and artificial surfaces (40%), within 10 miles by cropland (77%) and trees (15%), and within 50 miles by trees (35%) and cropland (33%).

1.4.2 Climate

Climate represents the average weather conditions overtime. The Site receives precipitation of >0.01 inches on the ground, in the form of rain, snow, sleet, or hail, on average, 149 days per year. This amounts to approximately 34 inches of rain and 63 inches of snow, on average, per year. July is the wettest month with 3.7 inches of rain and the driest month is February with 1.7 inches of precipitation. The wettest season is Autumn with 31% of the yearly precipitation and 18% of precipitation occurs in spring (https://www.bestplaces.net/climate/zip-code/new_york/le_roy/14482).

The average temperatures at the Site range from approximately 16 degrees Fahrenheit (°F) to 81°F. With an average of 4.3 days when the high temperature is over 90 °F with an average of 137.9 days annually when the nighttime temperature is below freezing. In NYS, heating systems are generally expected to be operating routinely from November 15th to March 31st, referred to as the "heating season" (NYSDOH, 2006).

The average hourly wind speed at the Site varies seasonally. The windier part of the year lasts 4.6 months, from November 23rd to April 11th with average speeds of more than 6.4 miles per hour. The windiest

month of the year is January with an average hourly wind speed of 8.5 miles per hour. The calmer time of year lasts for 7.4 months, from April 11th to November 23rd. The calmest month of the year is August, with an average hourly wind speed of 4.1 miles per hour. The predominant average hourly wind direction at the Site is from the west throughout the year.

The growing season for the purposes of this report is the longest continuous period of non-freezing temperatures (>32 °F) in the year. The growing season at the Site typically lasts for 5.3 months (162 days), from around May 3rd to around October 12th (https://weatherspark.com/y/21211/Average-Weather-in-Le-Roy-New-York-United-States-Year-Round).

1.4.3 Site Geology

The Study Area is underlain by glacial and glacial fluvial deposits of Quaternary Age which are in turn underlain by sedimentary rocks that dip gently to the south and consist primarily of carbonates and shale of Silurian and Devonian age. A comprehensive summary of the regional geology of western New York and geology of the Site, including the Study Area and Spill Zone, can be found in the NYSDEC RI/FS and is summarized in the USEPA 2002 RI/FS WP. A summary of the geologic conditions of the Site, based on the NYSDEC RI/FS, and UMC's Site observations, and research follows.

1.4.3.1 Unconsolidated Overburden Material

Unconsolidated overburden material at the Site generally consists of sandy loam underlain by glacial till deposited as ground moraine and in pro-glacial lacustrine environments during the Pleistocene Epoch (Reddy and Kappel, 2019; Rust, 1996). During the Pleistocene Epoch, four stages of continental glacial advancement occurred, covering all of western New York. The final Wisconsin glaciation destroyed all evidence of the previous three glaciations in the western New York area. This Wisconsin event left sub-glacial deposits of till, eskers, and drumlins; terminal moraines, proglacial deposits of glacio-fluvial and glacio-deltaic material; and englacial deposits of eskers and flow-till.

The United States Department of Agriculture's (USDA) website (http://websoilsurvey.sc.egov.usda.gov/App/ HomePage.htm) shows the soil types for a given area. The website was reviewed for those portions of Genesee, Monroe, and Livingston Counties within the Study Area. This website map shows the soil between the Spill Zone and Spring Creek is mostly Benson soil with some loam soil between the Spill Zone and Lime Rock Road. East of Lime Rock Road to Spring Street cobbly loam and loam predominate with some gravely fine sand. The soil along Oatka and Spring Creek consist of loam and muck.

Large areas of rocky soils are present within the Spill Zone (**Figure 1.5-5**). The USDA Natural Resource Conservation Service Custom Soil Resource Report for Genesee County, New York (2021) includes a soil map showing the land in the Spill Zone as rubble land. Title 430 -627 (2017)– National Soil Survey Handbook, Legend Development and Data Collection, Subpart B – Exhibits, Miscellaneous Areas, define Rubble Land as "consists of areas of cobbles, flagstones, stones, and boulders in unstable deposits of sufficient thickness to significantly limit the establishment of vegetation. Rubble land is commonly at the base of mountains but in some areas consists of deposits of large rock fragments left on mountain slope by glaciation or by periglacial processes." The on-Site rubble was likely produced by quarry waste disposal (hereafter, "rocky soils") (See **Appendix B**).

Although not differentiated in the field by UMC, surficial rocky soil at the Site is documented in the NYSDEC RI/FS to be representative of the Benson Channery loam, the Farmington loam, Farmington cherty, stony loam, and the Honeoye silty loam. This rocky soil is described as dark brown to grayish brown, well drained silty soil with an average thickness of between 20 and 40 inches underlain by glacial till or weathered bedrock. The NYSDEC RI/FS indicates glacial till materials at the Site are representative of the Valley Heads drift sheet consisting of a hard, poorly sorted matrix of fine to coarse grained gravel and sand and clayey silt.

Overburden samples collected by UMC from test borings conducted in the eastern portion of the Spill Zone in wooded or grass covered areas, were observed by UMC to generally consist of between two to six inches of sandy loam with trace amounts of organic material underlain by light to reddish brown fine- to coarse-grained sand with trace amounts of silt and up to 50% fine to coarse-grained gravel. These overburden materials were in turn underlain by weathered light to medium-grey cherty limestone bedrock. UMC interprets the unconsolidated overburden material in these areas to be representative of glaciofluvial sediment while the underlying bedrock is representative of the Devonian-age Onondaga Formation as described below.

Overburden samples collected by UMC from test borings conducted in the western portion of the Spill Zone generally consists of light- to medium-grey fine- to coarse-grained sand with up to 50% fine- to coarse-grained gravel and a trace of silt. UMC interprets these materials to be fill which was likely historically generated at nearby quarries and subsequently placed in working areas around the quarries and in the former LVRR right-of-way. UMC observed trace amounts of apparent coal and/or asphaltic material in the fill material located generally along the former LVRR right-of-way both south and north of Gulf Road. The fill material generally extends downward to the weathered limestone bedrock but is occasionally underlain by between one to six inches of yellowish brown silty fine-grained sand or fine-grained sandy

silt. These sediments are interpreted by UMC to be representative of a residual soil that was partially eroded prior to overlying fill emplacement. Overburden materials were generally observed to be dry, with occasionally moist to damp conditions in the sandy silt/silty sand material immediately overlying bedrock.

Test boring split-spoon refusal was generally observed at depths of less than one foot to a maximum depth of 10.6 ft and an average depth of approximately five ft within the Spill Zone. The depth to bedrock was observed to be generally deeper in the northern portion of the Spill Zone north of Gulf Road.

Though not specifically characterized during bedrock drilling due to the air hammer drilling techniques employed, overburden in the overall Study Area east of the Spill Zone generally ranges in thickness between approximately 2 ft and 10 ft. However, along Spring Creek, weathered bedrock or bedrock was encountered at LVRR-22, LVRR-24, and LVRR-25 at depths between approximately 25 and 50 ft below the ground surface, considerably deeper than in borings advanced west of Spring Creek.

1.4.3.2 Bedrock Geology

UMC conducted a review of available literature, bedrock test boring and coring data, and test boring geophysical data to assess the Site bedrock stratigraphy.

1.4.3.2.1 Bedrock Stratigraphy

The NYSDEC RI/FS mapped the geologic units encountered in the Study Area as illustrated on Figure 4-2 of the NYSDEC RI/FS. As depicted on the figure, the rock units exposed at the ground surface in the Study Area are generally encountered in stream cuts along Oatka Creek and Mud Creek. The figure indicates that over most of the Study Area, the Late Devonian-age Onondaga Formation is the upper most rock unit, dipping gently to the south. However, in the northern and eastern portions of the Study Area, stratigraphically lower Early Devonian and Late Silurian-age formations are exposed north and east of an erosional line resulting in an erosional surface sloping north and east into the Oatka Creek and Spring Creek drainages.

The Silurian-age Syracuse Formation is defined as the base of the Study Area for this investigation due to the presence of evaporates which preclude its use as a potable water supply. None of the current or former water supply wells in the area penetrate into or below the Syracuse Formation. The Syracuse Formation is overlain in ascending order by the Silurian-age Camillus, Bertie and Akron Formations and the Devonian-age Bois Blanc and Onondaga Formations. In the Study Area, the Camillus Formation is approximately 65 ft thick and consists of a medium light gray to dark grey, fine grained, crystalline argillaceous dolomite. The Camillus Formation is present below the unconsolidated overburden and

outcrops occasionally in the Spring Creek area, and in sections along Oatka Creek. The Bertie Formation is documented to be approximately 45 ft thick and consists of argillaceous dolomites. The Akron Formation is described as a thinly bedded, medium gray to yellowish gray, fine grained crystalline dolomite, 5 to 8 ft thick in the Site area. The Bois Blanc Formation is approximately 0.30 ft to 7 ft thick in the Study Area and is described as a medium to light gray, fine- to course-grained limestone or cherty limestone with a limey sandstone base considered to have formed by reworking of the now eroded Silurian strata. The Onondaga Formation averages approximately 55 ft thick in the western and central portions of the Study Area and is entirely eroded in the eastern portion. The formation varies with depth and consists of medium-dark gray to medium-light gray, fine- to coarse-grained fossiliferous limestone containing up to 70% chert.

1.4.3.2.2 Structural Geology

The regional structural geology consists of generally flat-lying stratigraphy with the geologic formations dipping gently (0.5 to 1.0 degree) to the south. Regionally, macro-scale, low-amplitude folds with fold axes trending in a north to northeast direction are present. Folding is not a significant structural feature in the LeRoy area. The area is also crossed by small (local) to large (regional) faults. The largest fault in the region is the north-south trending Claredon-Linden Fault zone (LaChapelle, 2010), located between the towns of Claredon and Linden to the west of the Study Area. The Claredon-Linden fault may extend across Lake Ontario into Canada. Geophysical studies revealed that the fault extends to a depth of approximately 9.6 kilometers with magnetic anomalies that are due to the Precambrian basement rocks. A sharp change in the magnetic pattern across the fault line suggests the Precambrian basement controls the fault.

In 2010, Reddy and Kappel also mapped the top of bedrock in Genesee County. Their map (Plate 6, Map 2) shows a trough in the top of bedrock from south and east of LeRoy, trending to the northeast by Circular Hill Road, immediately west of the Study Area. East of Circular Hill Road, through the Spill Zone and then eastward to the county line, the top of bedrock is fairly uniform and slopes to the north. Since the formations dip to the south, this surface is an erosional surface. This trough is generally coincident with the LeRoy Fault shown by Reddy and Kappel on their Figure 2. This map also showed two other faults, although these were interpreted but not mapped, to the east of LeRoy. The motions of these faults were not identified but the eastern most one, the Retsof Fault, runs through the Study Area with a north-south trend.

During a meeting of the Northeastern Section of the Geological Society of America held in New Brunswick, New Jersey from March 13 to 15, 2000, Dr. Robert D. Jacobi and his students from the University of Buffalo reported their findings on the presence of faults in the upstate New York area. They

identified numerous faults in western New York, some dating back to the Precambrian, that extend from Buffalo to Albany.

Studies conducted by Richards, *et al.* (2010) used aerial photographs and topographic maps to identify the location of faults in the area west of Batavia to just east of Caledonia, including the Study Area, to assess groundwater flow paths and the potential impact to groundwater from fertilizer application. The results of these studies are presented in the LVRR RI Report. A review of these studies reveals that the number (or frequency) and size of the fractures increases from west to east, with the highest number in the LeRoy area. Two sets of fractures predominate; one trending in a northeast-southwest direction and the second in a northwest-southeast direction.

However, in the Study Area, between LeRoy and Caledonia, the trend of the fractures becomes more easterly. Additionally, two large fractures are mapped in the vicinity of the Spill Zone, both trend in general northeast-southwest direction. Further east in Caledonia, a fracture is identified along Spring Creek trending in a north-south direction. Furthermore, a large number of solution and patterned sinkholes, as illustrated on **Figure 1.3-1** of this report, are in the Spill Zone and the area just to the west with fractures trending in east-west directions.

The fault along Spring Creek, herein referred to as the Spring Creek Fault, extends from near the center of the Village of Caledonia northward to Oatka Creek. Oatka Creek flow direction changes as it passes by the fault. West of the fault, the flow direction is southeastward whereas east of the fault the flow direction is northeastward. Additionally, a stream valley north of Oatka Creek aligns with Spring Creek, suggesting the Spring Creek Fault crosses and extends north of Oatka Creek. Outcrops located between Spring Street and the west bank of Spring Creek dip to the west at up to approximately 20º. Other outcrops in the same area closer to Spring Creek exhibit various directions of dip. Given that the general dip of the geologic formations in the area is about 1º to the south, the changes in dip direction and magnitude suggests deformation or displacement along Spring Creek has occurred.

1.4.4 Hydrology and Hydrogeology

The NYSDEC has identified the surface water quality of the streams in the area and lists Oatka Creek (in the vicinity of the Site) as a Class B water. Class B water is for primary and secondary contact recreation and fishing and is suitable for fish and wildlife propagation and survival. The 2001 Genesee River Basin Waterbody Inventory and Priorities Waterbodies List shows that for public bathing Oatka Creek is a “threatened water body” but for recreation and aesthetics it is a “stressed water body.” The type

of pollutant is algal/weed growth, nutrients, and silt/sediment primarily from agriculture and stream bank erosion.

Mud Creek is identified as a Class C surface water. The NYSDEC Environmental Resource Mapper shows Mud Creek as a Class C stream with a water quality standard for TCE of 40 micrograms per liter (µg/L) for the consumption of fish. The term "standards" means such measures of purity or quality for any waters established pursuant to Section 17-0301 of the Environmental Conservation Law (ECL). The best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

Spring Creek is identified as a Class C, C(T), and C(TS) water; with Class C water usage the same as Mud Creek; with the T and TS notations for trout streams and trout spawning streams.

Owing to the predominantly carbonate/dolomite nature of the bedrock, the Study Area is characterized by karstic features including sinkholes, swallets, and sinking streams, as well as numerous springs/seeps along Oatka Creek, Mud Creek, and Spring Creek. Studies referenced in the LVRR RI Report conducted by Dr. Richards *et al.* included the mapping of karstic features including sinkholes, patterned ground, swallets, and sinking streams in the Study Area. Mud Creek is an example of a sinking stream that reaches Oatka Creek generally only during the spring runoff season and otherwise intermittent with segments sinking the majority of the year. During periods of flowing water, it infiltrates to the subsurface groundwater system via a sinkhole located immediately east and hydraulically downgradient of the Spill Zone. **Figure 1.3-1** of this report is a Study Area map depicting the location of karstic features documented by Dr. Richards.

The karstic nature of the Study Area bedrock has a dramatic effect on the overall hydrogeology of the area and TCE-impacted groundwater transport mechanisms, including documented groundwater elevation fluctuations of up to 50 ft or more over short time periods. These effects are discussed in detail in the LVRR RI Report (2014) and Addendum 1 to the LVRR RI Report (2014) and are summarized in the following paragraphs.

Groundwater hydrogeology in the Study Area is a dual-porosity system where the majority of groundwater flow is through the fracture network (*i.e.,* the secondary porosity), directed eastward and discharging at Spring Creek with storage capacity located within the pore spaces of the rock matrix (*i.e.,* the primary porosity).

As measured by Flexible Liner Underground Technologies (FLUTe) descent liner testing and summarized in the LVRR RI Report, the overall bulk hydraulic conductivity (K) of the fractured bedrock system ranges between about 1.4×10^{-3} centimeters per second (cm/sec) to 1.9×10^{0} cm/sec, with an average of 2.1×10^{-1} cm/sec (Apertures on **Table 1-2**). **Figure 1-7** of this FS Report presents the overall Bulk Fracture Hydraulic Conductivity (Series 1). Bulk fracture porosity estimates, obtained from the FLUTe descent liner tests, ranged from 0.025% to 0.072% with a mean of 0.046% (**Table 1-2**). **Figure 1-7** of this FS Report presents the Bulk Fracture Porosity (Series 2). The Stone Environmental Rock Core report (Table 2 of the Stone Report) presents rock matrix porosity ranging from 1% to 33% with an average of approximately 8%, orders of magnitude higher than the bulk fracture porosity, demonstrating that storage capacity is available in the pore spaces within the rock matrix. TCE penetrates into the porewater within the rock matrix by molecular diffusion. Since the rock matrix has a larger water storage capacity than the larger higher transmissive fractures, it is estimated that most of the TCE storage is also located within the pore spaces of the rock matrix. Rock matrix hydraulic conductivity (K_m) was not measured on Site samples, however based on literature reviewed for similar lithologies, it is expected to be several orders of magnitude lower than the bulk K, which is governed by the higher transmissive fractures.

The packer testing summarized in the LVRR RI Report generally indicates that transmissive zones in the bedrock are not evenly distributed vertically. The packer test intervals were selected based on the borehole geophysics and FLUTe data to evaluate specific intervals suspected of being able to transmit large volumes of water. The packers were approximately five feet long and were placed over selected fractures to determine their ability to transmit water. In general, transmissive zones are evident within approximately the top 40 feet of the saturated zone and highly transmissive zones are evident in the Camillus Formation. The packer testing demonstrated that the average transmissivities of the packer tested zones (performed over a 5-foot interval for each test) in the Onondaga, Bois Blanc, Bertie, and Camillus formations are approximately 28 square centimeters per second (cm^2/sec), 9 cm^2/sec, 45 cm^2/sec, and 21 cm^2/sec, respectively. It should be noted that the packer testing targeted fracture zones identified by the borehole geophysics over short intervals; and therefore, are limited to the fractures related to the secondary porosity (larger relative fractures and not pore matrix spaces) and produce different values than testing the entire boring. FLUTe profiling testing of the entire boring demonstrated that highest transmissivities are in the Bertie Formation, ranging up to 20 cm^2/sec and in the Camillus Formation, ranging up to 90 cm^2/sec. However, in the lower-most karstic section of the Camillus Formation, the flow exceeded the measurement range of the FLUTe equipment and the transmissivity is expected to be higher in this portion of the formation.

Down-hole geophysical flow meter testing summarized in the LVRR RI Report generally indicated that a downward groundwater gradient is evident between the Onondaga and underlying Bertie Formations and both downward and upward gradients are evident in the Camillus Formation. A generally upward gradient is evident in the Camillus and Syracuse Formations in the eastern portion of the Study Area resulting in the discharge of TCE-impacted groundwater to Spring Creek.

The Bertie Formation appears to be the primary transport pathway of groundwater through the Study Area. The Mud Creek sinkhole acts as a vertical conduit, allowing Mud Creek surface water and TCE-impacted groundwater transported from the Spill Zone through the Onondaga Formation under hydraulic gradient, to penetrate downward to the Bertie Formation. The groundwater moves eastward and encounters other karstic features including solution enlarged fractures and sinkholes allowing the groundwater to penetrate deeper into the Camillus Formation. Here the groundwater moves rapidly through the karstic section of the Camillus formation.

LVRR provided transducer and manually collected groundwater elevation data from select monitoring wells to Dr. Richards who in turn conducted Soil Water Assessment Tool (SWAT) modeling (Richards, 2016) and provided LVRR with a report quantifying the flow of allogenic surface water and groundwater originating from highlands south of the Study Area that mixes with and dilutes the TCE plume, ultimately discharging to Spring Creek. The SWAT modeling report and conclusions are discussed in detail in Addendum 1 to the LVRR RI Report and are summarized as follows:

- Groundwater elevation responses to precipitation and/or snowmelt events occurring between 2012 and 2016 were observed as high as 19.2 ft in Spill Zone monitoring well DC-01B, 34.9 ft in well LVRR-30-3 located immediately downgradient of the Spill Zone, and 34.9 ft in mid-plume well LVRR-32-1, all screened in the Bertie Formation. Groundwater elevation responses in the Camillus Formation were observed as high as 14.1 ft in Spill Zone well DC-01C. The lowest magnitude water table responses are generally observed during all seasons at the distal end of the plume at Spring Creek that is partially controlled by Big Spring, the source of Spring Creek. The dynamic water table response to meteorological events indicated by the transducer data is evidence of the diluting effect of allogenic recharge on the TCE plume. Further, the large water table responses are indicative of a well interconnected fractured bedrock system with low bulk fracture porosity.
- Although highly variable, the lowest magnitude water table responses generally occur as the result of meteorological events in the summer and early fall during the growing season when the uptake of meteoric water by vegetation and evapotranspiration effects are highest. The highest magnitude water table responses generally occur as the result of meteorological events and snow melt in the winter, spring,

and late fall, outside of the growing season, indicating that the diluting effect of allogenic recharge on the TCE plume is highest during these seasons.

- Little or no delay in hydraulic head response between the Akron, Bertie and Camillus is evident indicating that fractures between bedrock units are generally hydraulically connected.
- The highest TCE concentrations observed in Spill Zone monitoring wells generally occur during the fall season. However, the relationship between TCE concentrations and seasons appears to vary locally within the Study Area, likely influenced by local variations in storage capacity due to differences in the fracture network density and connectivity, and the resulting flow paths. The storage capacity will not change seasonally but may change depending on location within the plume because of variations in fracture spacing, width, and connectivity. As the groundwater levels decline during the summer some of these water-filled fractures may be isolated above the water table allowing TCE to accumulate in the water by back diffusion from the bedrock matrix. As water levels rise during the fall and intersect the isolated TCE-impacted fractures, the TCE-impacted water will mix with groundwater resulting in higher TCE concentrations. Further, there is generally a high degree of uncertainty in predicting the magnitude and timing of hydraulic head responses for a given precipitation event during any given season. Based on these observations, the value of conducting post-storm event groundwater sampling with the objective of assessing storm influence on TCE concentrations is questionable.
- Average monthly fluxes of allogenic water into the Study Area range between approximately 3.5 to 484 million gallons per month (Mg/mo). The highest average monthly flux of 484 Mg/mo is associated with the Mud Creek sink hole. High fluxes are also associated with watersheds that drain north into the southern boundary of the plume along NYS Route 5 ranging from 27.7 Mg/mo to 110 mg/mo. Smaller fluxes are evident in areas along the northern boundary of the plume (ranging between 3.5 Mg/mo and 13.9 Mg/mo) that are recharged primarily by precipitation and receive lower water yields from the southerly watersheds. Monthly fluxes are generally highest in spring months April and May and lowest in fall months September and October. These results generally correspond to the observed seasonally highest and lowest groundwater levels.
- Approximately 10,903.8 million gallons per year of allogenic water mixes with the Study Area groundwater system and is directed eastward, eventually discharging at the Spring Creek fault zone (Richards, 2016).
- The influx of allogenic water to the TCE plume is expected to be well oxygenated due to turbulent flow along stream channels prior to infiltration and mixing with the TCE plume. This water in turn can be expected to influence groundwater chemistry in recharge areas along the southern boundary of

the plume, changing from anaerobic to aerobic conditions during recharge periods. However, due to the variability involved, the timing and magnitude of these changes and their potential effects on attenuation rates are difficult to predict.

In summary, Site Area hydrogeologic conditions are significantly influenced by the karstic nature of the bedrock and approximately 10,903.8 million gallons per year of allogenic water entering the groundwater system. These conditions act to control the lateral and vertical extent of the TCE-impacted groundwater plume and augment non-destructive attenuation processes by natural means. The influx of fresh water along the southern boundary of the plume acts to dilute the TCE concentrations and acts to control the lateral extent of the plume to the south. Areas in the center and northern portions of the plume do not receive as much infiltrating water, but the eastward groundwater flow is most likely controlled by the geology – faults and southward dipping formations. Oatka Creek acts to control the lateral extent of the plume along its northern boundary. Upward vertical gradients at the distal end of the plume result in the discharge of groundwater to the Spring Creek fault zone. See **Figure 2-6**. These controls are evident by the generally stable TCE plume configuration observed during historical groundwater sampling events conducted between 1993 and the present.

1.4.5 Ecology

1.4.5.1 Wetlands

On September 20, 2010, URS conducted a wetland delineation survey in the Study Area, results of the survey are summarized in a report titled "Wetland Delineation Report, Lehigh Valley Railroad Derailment Superfund Site" dated October 2010 (URS Report).

The purpose of the wetland delineation was to identify the boundaries of potential jurisdictional wetlands in the vicinity of the Spill Zone. URS did not identify any wetlands within the Spill Zone. Figure 2 of the URS report (dated October 2010) shows several areas north of Gulf Road and west of Neid Road that are included in the National Wetlands Inventory. These areas appear to be located in former quarries. URS also identified wetlands listed as NYSDEC freshwater wetlands along Oatka Creek west of Mud Creek.

The NYSDEC's Environmental Resource Mapper was consulted to identify other wetlands that might be located between the Spill Zone and Spring Creek. Three areas of State-regulated fresh-water wetlands were identified; along Oatka Creek west of Mud Creek, as previously identified by URS, along Oatka Creek west of Mumford to the Genesee Country Museum, and along Spring Creek. The upstream

Oatka Creek wetlands are approximately 45 acres in size and have been identified as CH-27 and CH-28. The wetlands along Oatka Creek near Mumford are approximately 27 acres in size and have been identified as WH-8. The wetlands along Spring Creek are about 88-acres in area and they have been identified as CA-1. The NYSDEC classifies these as Class II wetlands. NYSDEC has four classes of wetlands; Class I through IV, with Class I being the highest or best quality wetland. Class II wetlands are high-quality wetlands that are an ecologically significant plant community/habitat.

No wetlands were identified between Gulf Road on the north and Route 5 on the south from the Spill Zone to Spring Creek or east of Spring Creek.

1.4.5.2 Significant Habitat and Endangered Species

The NYSDEC Environmental Resource Mapper (https://www.dec.ny.gov/animals/38801.html) was reviewed for Significant Natural Communities as well as Rare Plants and Animals within the Study Area. The website shows an area of animals listed as Endangered or Threatened; and, plants listed as Endangered, Threatened, or Rare by New York State extending from Oatka Creek southward to near Route 5 and westward from the Spill Zone to approximately Lime Rock Road. East of Lime Rock Road and south of Oatka Creek is an area identified with animals listed as Endangered or Threatened. Along Spring Creek is an area listed as a Significant Waterfowl Winer Concentration Area.

Also, the Environmental Resource Mapper website identified Significant Natural Communities (confined to plants and trees) near the Spill Zone and along Church Road including Calcareous Cliff Community, Limestone Woodland, Hemlock-Northern Hardwood Forest, and Maple-Basswood Rich Mesic Forest. Along Mud Creek, additional Significant Natural Communities were identified as Rich Sloping Fen and Floodplain Forest. The website did not list natural communities in the Lime Rock Road area or Spring Creek area.

In 2013, URS performed a Screening Level Ecological Risk Assessment (SLERA, September 2013) for the Site. As part of the SLERA, URS reviewed the NYSDEC Fish and Wildlife Impact Analysis (FWIA, 1996) and consulted the US Fish and Wildlife Service, as well as the NYSDEC to identify Rare, Threatened and Endangered Species potentially within or near the Site. Through this process four threatened and five rare plants species were identified near the Site. These species are listed below:

- The threatened species were:
    - *Trollius laxus* spp. (Spreading Globeflower);
    - *Hydrastis canadensis* (Golden-Seal);

- *Desmodium ciliare* (Tick-Trefoil); and,
- *Desmodium glabellum* (Tall Tick-Clover).

- The rare species were:
  - *Jeffersonia diphylla* (Twin-Leaf);
  - *Lathyrus ochroleucus* (Wild-Pea);
  - *Carex willdenowii* (Willdenow Sedge);
  - *Agrimonia rostellata* (Woodland Agrimony Plant); and,
  - *Triglochin palustre* (Marsh Arrow-Grass Plant).

In a letter dated February 18, 2013, URS contacted the New York Heritage Program regarding the potential for threatened or endangered species or species of concern to exist at or near the Site. On February 26, 2013, the NYSDEC, Division of Fish, Wildlife & Marine Resources, responded via letter correspondence that identified 21 rare or state-listed animals and plants and significant natural communities in the vicinity of the Study Area or Spill Zone. These species are listed in the NYSDEC letter and in Table 3-1 of the SLERA. To summarize, the following are listed as Rare, Threatened or Endangered:

NYSDEC Plants or Animals Listed as Rare, Threatened, or Endangered

Resource	Name	Listing	Heritage Conservation Status
Animal Assemblages	Waterfowl Winter Concentration Area	-	-
Wetland Aquatic Communities	Floodplain Forest	-	High Quality Occurrence/Rare Community Type
	Marl Pond Shore	-	High Quality Occurrence/Rare Community Type
	Northern White Cedar Swamp	-	High Quality Occurrence/Rare Community Type
	Rich Sloping Fen	-	High Quality Occurrence/Rare Community Type
Upland/Terrestrial Communities	Calcareous Cliff Community	-	High Quality Occurrence/Uncommon Community Type
	Hemlock-Northern Hardwood Forest	-	High Quality Occurrence
	Limestone Woodland	-	High Quality Occurrence/Rare Community Type
	Maple-Basswood Rich Mesic Forest	-	High Quality Occurrence/Uncommon Community Type
	Rocky Summit Grassland	-	High Quality Occurrence/Uncommon Community Type
Vascular Plants	Golden-Deal	Threatened	Imperiled in NYS
	Goosefoot Corn-Salad	Endangered	Critically Imperiled in NYS

NYSDEC Plants or Animals Listed as Rare, Threatened, or Endangered			
	Green Gentian	Threatened	Imperiled in NYS
	James Sedge	Threatened	Imperiled in NYS
	Little-leaf Tick-Trefoil	Threatened	Imperiled in NYS
	Marsh Arrow-Grass	Threatened	Imperiled in NYS
	Spreading Globeflower	Rare	Vulnerable in NYS/Globally Uncommon
	Twin-Leaf	Threatened	Imperiled in NYS
	Willdenow's Sedge	Rare	Imperiled in NYS
	Woodland Agrimony	Threatened	Imperiled in NYS
	Yellow Giant-Hyssop	Threatened	Imperiled in NYS

Also, URS consulted the US Fish and Wildlife Service's Information, Planning, and Conservation System for a preliminary species list and an official species list. Three threatened, endangered, or candidate species, and/or designated critical habitat were identified as follows within the vicinity of the Site:

- Houghton's Goldenrod (*Solidago houghtonii*), threatened;
- Bog Turtle (*Clemmys muhlenbergii*), northern population, threatened; and,
- Eastern Massasauga (*Sistrurus catenatus*), candidate.

The search also identified freshwater emergent wetlands, freshwater forested/shrub wetlands, and freshwater ponds intersecting the Site. As the area may be potential habitat for turtles, a bog turtle survey may be required if remedial actions are proposed in the future. The preliminary and official species lists are provided in Appendix B of the SLERA.

1.4.6 Land Use and Zoning

UMC reviewed Zoning and Land Use maps for the Town of LeRoy, Town of Caledonia, Village of Caledonia, Town of Wheatland and Hamlet of Mumford to determine current and potential future use of the land parcels within the Study Area. In LeRoy, the land north of Gulf Road and south of Gulf Road west of Church Road is zoned as Industrial (I-1) with current land use varying per parcel between industrial, residential, and recreational use. North of Route 5 eastward from Church Road to the Caledonia town line, the land is zoned as Residential, Light Industry (I-1) and Agricultural Rural (AR-2). In the Town of

Wheatland, the areas along Flint Hill Road, George Street, and Spring Street are zoned as Residential (R-12 and R-16) while the remainder of the town between the residential zoned land and the towns of LeRoy to the west and Caledonia to the south is zoned as Agricultural Rural (AR-2). In the Village of Mumford, zoning is a mix of Residential (R-12 and R-16), Village Business (R-16 VB), and Village Industrial (VI). East of North Street is zoned as Agricultural Rural (AR-2). Along Spring and Oatka Creeks, the land is zoned as Flood Hazard (F-1). Zoning in the Village of Caledonia along Spring Creek and westward to the village line with the Town of Caledonia is zoned as Residential (R-1). Land along Route 5 leading west out of the Caledonia Village center is zoned as, Light Commercial (L-C), Light Industrial (I-1) and Industrial (I) and the portion along the western Village border with the Town of Caledonia is zoned as Light Industrial (I-1).

The land between the Spill Zone and Spring Creek is mostly agricultural with a mixture of private residences. Wooded land is located between the sections used for farming. Land use north and west of the Spill Zone is for quarry operations. Northeast of the Spill Zone, north of Gulf Road and along Neid Road are residential properties. East and south of the Spill Zone is a hunting club, which extends southward to the railroad tracks and eastward to Church Road. South of the railroad tracks are commercial properties. Residential properties are located on the east side of Church Road. North of Gulf/Flint Hill Road are private residences and a hunting club. South of Gulf/Flint Hill Road, between Church and Lime Rock Roads are private residences, a hunting club and a private campground. South of the railroad tracks along Route 5 are private residences with a few commercial properties. Between Lime Rock Road and Spring Street and north of the railroad tracks is a racetrack and a hunting club. Also, along Lime Rock Road, is agricultural land and the Genesee Country Museum. Along Spring Street are residential properties. The land along Route 5 contains commercial and industrial properties. In the Village of Caledonia and Town of Caledonia east of Spring Creek the properties are residential, commercial and agricultural. Just east of the Caledonia village center is JCI Jones Chemicals, Inc. **Figures 1.4-1, 1.4-2 and 1.5-1, 2, 3, and 4** of this report illustrates the Site, county boundaries, municipal boundaries, as well as the current and proposed future use and zoning of the Site. **Table 1-1** of this report lists each land parcel within the Study Area and the associated municipality, county, zoning, current land use, and future land use.

2 NYSDEC AND LVRR REMEDIAL INVESTIGATION FINDINGS AND RESPONSE ACTIONS (1970 – 2006)

2.1 Investigations 1970 through 2006

As a result of the 1970 train derailment, approximately 30,000 gallons of TCE and 1 ton of cyanide crystals were released into the Spill Zone. Immediate cleanup of the spill included the removal of cyanide crystals and the spreading of neutralizers to counteract the effects of any remaining cyanide that could not be removed. TCE released by two ruptured tank cars could not be recovered at the time of the derailment and ultimately was discharged into the ground.

Eight days after the derailment, TCE odors were reported in the basement of the Knickerbocker Hotel, 200 ft north of the intersection of the former LVRR rail line and Gulf Road. Subsequently, residents in the surrounding areas reported TCE odors in homes and wells. LVRR sampling of private wells found that TCE had contaminated groundwater east of the Spill Zone.

In 1971, LVRR conducted remedial activities at the Site. Trenches were constructed at the Spill Zone and were subsequently flooded with water to flush TCE out of the contaminated ground. Additionally, carbon filters were installed to remove TCE from drinking water from local private wells. Railroad tracks at the Site were removed after LVRR was merged into Conrail in 1976. Portions of the Spill Zone were acquired by the town of LeRoy and a local sportsman's club.

In September 1989, TCE was detected during routine sampling of the Genesee County Campground well located more than 1.5 miles east of the Spill Zone. Additional sampling between 1990 and 1994 detected TCE in approximately 50 wells located east and southeast of the Site.

Numerous investigations and remedial activities have been performed by or on behalf of NYSDEC. In February 1992, Dunn Geoscience Engineering Co. (Dunn), on behalf of NYSDEC, performed an RI/FS at the Site. The RI/FS was accomplished in three phases. In 1992, office and field research and reconnaissance were done as part of the initial phase. During the initial RI/FS, a Hydrogeological Investigation and a Fish and Wildlife Impact Analysis (FWIA) was undertaken. The FWIA identified fish and wildlife resources that existed in the vicinity of the Site and discussed the impacts of the TCE release on fish and wildlife resources.

This was followed by sampling of various media, geophysical and soil gas surveys, and use of test pits to determine the extent of the impact from the release. As part of the final phase, monitoring was expanded with drilling and installation of monitoring wells. This action also included groundwater, surface

water, and sediment sampling. Throughout the RI/FS, analytical programs focused on TCE (and its degradation products) and cyanide. The NYSDEC's1996 RI/FS Report concluded that approximately 15,000 cubic yards (yd^3) of fill and rocky soil materials at and in the vicinity of the Spill Zone appear to be contaminated with TCE in excess of NYSDEC soil cleanup objectives (SCOs). In general, elevated concentrations of TCE were detected in overburden rocky soil, vadose-zone bedrock, surface water, and groundwater (**Figure 2-7**) in the Spill Zone and in bedrock groundwater within the downgradient plume extending approximately 3.5 miles from the Spill Zone. Following review of the initial RI/FS results, the NYSDEC separated the Site into two Operable Units for administrative purposes. The NYSDEC RI/FS focused primarily on the TCE-impacted overburden rocky soil identified in the Spill Zone. The impacted groundwater and vadose zone were to be assessed under separate NYSDEC studies.

Following a review of the findings of the RI/FS, NYSDEC prepared two feasibility studies with the selected remedial approach included in a Record of Decision (ROD) executed on March 28, 1997 (NYSDEC, 1997a). The NYSDEC prepared a Proposed Remedial Action Plan (1997c) and selected *ex situ* SVE and *in situ* BVE as source-control measures, and a water-line extension to provide a safe potable water supply to all affected residences and businesses. The State's ROD also provided for monitoring of the groundwater. The NYSDEC conducted pre-design activities (1998 to 1999) including an *ex situ* SVE pilot test, BVE pilot test, and design of a waterline extension to connect impacted residents to a potable water supply. A total of 29 wells were installed within the Spill Zone and Study Area during the pilot tests.

In 1991, the NYS Department of Health (NYSDOH) and NYSDEC listed the Site on the NYS Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 site, indicating that the Site posed a significant threat to the environment and/or public health and that remedial action was required. In December 1991, the USEPA and NYSDEC installed Point-of-Entry (POE) treatment systems at 38 drinking water supply well locations and developed an Operation and Maintenance (O&M) program for the systems. The O&M program was funded under the NYS Superfund Program.

On August 7, 1998, the NYSDEC petitioned the USEPA for the Site's inclusion on the National Priorities List (NPL) and requested that the USEPA assume responsibility for the source-control components of the remedy while the NYSDEC continued its work on the waterline component of the remedy. The USEPA placed the Site on the NPL by publication in the Federal Register on January 19, 1999. On July 27, 1999, the USEPA concurred with the waterline component of the NYSDEC ROD selected remedy. However, the USEPA withheld concurrence on the source-control components and the USEPA assumed the lead role for future groundwater studies at the Site.

On May 21, 2002, the USEPA approved the source-control measures contained in the NYSDEC ROD as supported by a USEPA memorandum dated May 15, 2002. The USEPA's approval was granted after the NYSDEC conducted Pilot Tests for the ROD selected remedies of *ex situ* SVE and *in situ* BVE (discussed in greater detail in Section 4.3 below). In July of 2003, the State completed construction of the waterline which is currently providing current and future potable water uses and fire suppression needs to approximately 70 affected residences and businesses in the area.

On September 22, 2006, USEPA and LVRR entered into the SA wherein LVRR agreed to perform certain pre-remedial design (pre-RD) investigations (PDI), remedial design of the SVE system, and a Remedial Investigation / Feasibility Study (RI/FS) for groundwater at the Site.

2.2 Spill Zone Investigation Findings and Response Actions

2.2.1 Pre-Remedial Design Bedrock Vapor Extraction Summary Report

UMC conducted bedrock investigations at the Site during 2010 as part of the PDIs. The investigations included: bedrock coring and rock core analysis to assess the bedrock matrix for TCE impacts; inspection of boreholes for the presence of nonaqueous phase liquid (NAPL); geophysical testing and FLUTe profiling to assess bedrock structure and aquifer hydraulic characteristics; packer testing and the collection of groundwater samples to assess aquifer hydraulic characteristics and groundwater quality at discrete intervals; and, bedrock vapor sampling to assess BVZ TCE vapor concentrations.

Consistent with Pre-RD requirements, UMC conducted the bedrock investigation in order to determine whether there are conditions at the Site, such as the presence of a source area of dense nonaqueous phase liquid (DNAPL) below the vadose zone, which would limit or undermine the effectiveness of BVE in the NAPL/Spill Zone.

Based on the bedrock investigation findings, UMC concluded the following:

- NAPL was not detected in bedrock fractures during FLUTe NAPL testing or when using an electronic interface probe. However, based on Spill Zone rock core sampling results, estimated bedrock porewater concentrations in the vadose zone are as much as one to two orders of magnitude higher than the solubility limit for TCE. These data suggest that NAPL is likely present in the bedrock matrix porewater and/or in microfractures in the Spill Zone that would reduce the effectiveness of BVE as a remedial alternative.

- The NYSDEC BVE Pilot Test Report recommended that high resolution seismic bedrock fracture mapping be conducted to provide a detailed assessment of the bedrock fracture network in order to maximize contaminant removal while minimizing the number of extraction wells. However, geophysical testing conducted in the Study Area indicates that the direction and dip of planar features, including potentially transmissive fractures and bedding plane partings, varies widely across the Study Area and indicates that the overall geometry of the bedrock fracture network cannot be assessed with a significant degree of confidence. Further, the effectiveness of seismic mapping would be limited due to the extreme, rapid, and relatively unpredictable fluctuations in groundwater level observed across the Study Area. Therefore, UMC concluded that seismic mapping would not significantly improve understanding of the Study Area fracture network and is not recommended at this time.

- TCE concentrations in Spill Zone fracture groundwater samples collected immediately below the static water level during packer testing are generally one to two orders of magnitude lower than the estimated rock matrix porewater concentrations in that interval. These data indicate that TCE is diffusing out of the rock matrix into fracture water.

- Bedrock matrix porewater concentrations in the Spill Zone generally decrease below the observed static water level, reaching generally non-detect concentrations at an elevation that approximately coincides with the top of the Camillus Formation.

- Estimates of the TCE mass concentrations above the observed static water level in the Spill Zone rock matrix porosity range from approximately 221 grams per square meter (g/m^2) to 3,100 g/m^2. Considerable TCE mass is also evident below the observed static water level in the Spill Zone, with estimated concentrations ranging between approximately 9.7 g/m^2 and 45 g/m^2. BVE will not address TCE mass residing below the water table. This TCE mass will act as a continuing source of TCE impacts to the vadose zone as the result of documented unpredictable, rapid, and high magnitude groundwater level fluctuations, and to groundwater as it back-diffuses into fractures from the rock matrix.

- Bedrock matrix porewater TCE concentrations in the vicinity of Lime Rock Road (approximately 1.5 miles downgradient of the Spill Zone) are estimated to range between approximately 10 µg/L and 100 µg/L above the observed static water level and generally increase below the static water level to as high as approximately 1,000 µg/L at the top of the Camillus Formation. The bedrock

matrix porewater concentrations are higher than observed packer test groundwater sample concentrations in corresponding intervals, indicating TCE is diffusing out of the rock matrix into fracture water in that area. BVE will not address the TCE mass residing below the water table which will act as a continuing source of TCE impacts to the vadose zone and to groundwater. In addition, these data indicate that NAPL and TCE mass is present in the bedrock matrix porosity in an area far larger than the 10-acre area considered in the 1998 NYSDEC BVE pilot test.

- Due to the karstic nature of Study Area bedrock, including sinkholes and solution enlarged fractures, infiltrating precipitation and meltwater recharge groundwater very rapidly and with large volumes of water leading to rapid changes in hydraulic head and rapid and high magnitude water level fluctuations. These conditions would necessitate the use of cut-off switches during BVE system operation and act to limit the overall efficiency of the BVE system.

- Analysis of bedrock vapor samples collected in the Spill Zone and immediate vicinity detected TCE concentrations ranging from 430 micrograms per cubic meter (µg/m^3) to 10,000,000 µg/m^3 with an average concentration of 1,732,277 µg/m^3. Approximately 12 gallons of TCE remains in the vapor phase in the Spill Zone bedrock fracture network based on an estimate of the total volume of the vadose zone within the bedrock vapor sampling area, and an assumed average fracture spacing and aperture within the area based on FLUTe profiling data.

- Based on groundwater and rock core data collected to date, the amount of TCE mass estimated in the rock matrix is approximately 141,700 kilograms (kg) in the Spill Zone and 2,200 kg downgradient of the Spill Zone to the vicinity of Lime Rock Road. This equates to approximately 25,566 gallons of TCE mass in the rock matrix located within the Spill Zone, and 397 gallons of TCE mass in the rock matrix within the area located downgradient of the Spill Zone to Lime Rock Road, representing approximately 85.2% and 1.3%, respectively of the original TCE release volume of 30,000 gallons[1]. The remaining TCE mass (approximately 4,037 gallons or 13.5% of the original release volume of 30,000 gallons) resides within the bedrock matrix downgradient of Lime Rock Road, has volatilized into the vapor phase, remains in the soil above the bedrock in the Spill Zone, or has partitioned into the dissolved phase.

[1] Estimated mass of TCE determined by Stone Environmental from rock core data analysis (2010). Estimated volume of TCE based on a TCE mass density of 1.4642 g/cm^3 at 20ºC (reference: https://www.aqua-calc.com/page/density-table/substance/trichloroethylene).

- FLUTe profiling and geophysical testing generally indicate that discrete fractures in the bedrock transmit the majority of the groundwater while the remainder of the bedrock transmits little or no water. Most features identified during geophysical testing are characterized by relatively shallow dip angles with the direction of the dip varying widely. The fractures are not evenly distributed either vertically or in terms of frequency indicating that an accurate assessment of the overall Study Area bedrock fracture network and application of a BVE system as an effective remedial alternative is problematic.

- FLUTe profiling and geophysical testing indicate transmissive zones are generally evident just below the observed static water level, followed by less transmissive zones at intermediate levels of the aquifer and a highly transmissive zone at the base of the Camillus Formation. These conditions result in limiting the downward vertical movement of groundwater from the upper bedrock section to the lower bedrock section and allow for the rapid horizontal transmission of groundwater in the Camillus Formation.

- Based on packer test data, multilevel well data, and borehole geophysical data a downward vertical component of the hydraulic gradient predominates in the Spill Zone that becomes less pronounced in the central portion of the Study Area and is generally upward in the vicinity of Spring Creek. Groundwater at least seasonally discharges via seeps and springs to the Spring Creek drainage which is interpreted to be the surface expression of a fault with a displacement of approximately 55 ft on the eastern downthrown side.

2.2.2 Pre-Remedial Desgin Soil Data Summary Report

LVRR submitted to the USEPA a Pre-RD Soil Data Summary Report and an addendum to that report dated December 14, 2010, and January 27, 2011, respectively. The Pre-RD Soil Data Summary Report and Addendum confirmed the presence of elevated TCE in the overburden material at the Site requiring remedial action. On September 27, 2013, the USEPA approved the final Soil Remedial Design Report for the SVE system (*in situ*).

On March 21, 2014, the USEPA issued to LVRR an RA Administrative Order for the implementation of the SVE component of the remedy.

A Remedial Action Work Plan Compendium for SVE consisting of an SVE pilot test work plan, permitting plan, and SVE construction operations was drafted by Benchmark Environmental Engineering

& Science, PLLC, and Turnkey Environmental Restoration, LLC (Benchmark), and subsequently submitted to and approved by the USEPA on October 1, 2014. In January of 2015, LVRR submitted the SVE Pilot Test Report to the USEPA (Benchmark, 2015) which determined that SVE is an effective technology for remediating the Spill Zone rocky soil. The USEPA approved the SVE Pilot Test and associated remedial design modifications on March 4, 2015. SVE construction was initiated in April 2015 with full scale SVE systems placed in operation in July 2015. The SVE system was installed per Appendix A, Sheet C-4 of the referenced Remedial Action Work Plan Compendium, which provided for a maximum SVE extraction trench excavation depth of 6 ft bgs, with 6 inches of bedding stone placed in the trench to support the horizontal slotted extraction pipe. This yielded a maximum extraction pipe depth of 5.5 ft bgs.

The U.S. Army Corp of Engineers, on behalf of the USEPA, oversaw the technical and operational aspects of both the SVE pilot test and the as-built SVE system and noted the system's satisfactory performance.

In September and November 2016, post-SVE sampling efforts identified TCE concentrations in the overburden above concentration-based performance objectives; therefore, the SVE system remained operational. The SVE system was later shut down on July 21, 2017, after having removed over 284 pounds of volatile organic compounds (VOCs) and reaching an asymptotic state. In June of 2017, a Remedial Evaluation Work Plan (REWP) (Benchmark, 2017) was implemented from August 22-24, 2017, to determine the effectiveness of the SVE system.

The REWP activities are summarized in a Focused Alternatives Analysis Report (FAA) (Benchmark, 2018) which concluded that TCE concentrations in the overburden rocky soil remain above concentration-based performance objectives and that additional *in situ* cleanup to achieve RAOs via SVE does not appear feasible.

2.2.3 Spill Zone Risk Assessments

2.2.3.1 Spill Zone Focused Human Health Risk Assessment (HHRA) (2002)

In January 2002, USEPA Region 2 completed a focused risk assessment to evaluate the hazards and risks from exposure to soil at the Spill Zone.

Results of the focused risk assessment evaluation for soil were compared to USEPA's acceptable risk range of one in ten thousand (1×10^{-4}) to one in one million (1×10^{-6}) cumulative excess cancer risk, and a hazard index (HI) of 1 for groups of toxicants that affect the same target organ (USEPA, 1989).

Noncancer hazards were above USEPA's target noncancer effects level of 1. The highest total HIs are 5.4 for the child noncancer ingestion hazard and 6.4 for total ingestion and dermal hazard. Likewise, the highest cumulative cancer risk estimate (1.1 x 10-4) was above the acceptable risk range (1x 10^{-6} to 1 x 10^{-4}). As a result, USEPA recommended remedial action for the Site soil.

2.2.3.2 Supplemental Human Health Risk Evaluation for Spill Zone Soil (2021)

USEPA prepared a Supplemental Human Health Risk Evaluation (2021) to estimate risks to current and future on-Site commercial and construction workers from exposure to Spill Zone soil. The purpose of the evaluation was to supplement prior baseline human health risk assessment (BHHRA) soil evaluations and ensure that previously reached risk conclusions remain valid for current Site conditions (*i.e.*, for residual soil contamination in the Spill Zone soil post-SVE treatment).

Analytical data used in the Supplemental Risk Evaluation included TCE concentrations measured in post-SVE soil boring samples collected in August 2017. USEPA calculated two exposure point concentrations (EPCs) for the risk evaluation: surface soil defined as 0.5 – 2.5-ft below ground surface (ft bgs) and subsurface soil defined as 0.5 -10.5 ft bgs. The surface soil EPC was estimated to be 460.2 milligrams per kilogram (mg/kg) and the subsurface soil EPC was estimated to be 384.3 mg/kg. Both EPCs were based on the 95% upper confidence limit of the mean concentration (UCL_{95}) calculated using USEPA's ProUCL software. The resulting EPCs were compared to USEPA Regional Screening Levels (RSLs) derived for commercial workers and construction workers. As both RSLs were exceeded, the EPCs were then used in USEPA's on-line RSL calculator to estimate potential cancer risks and non-cancer hazards for a commercial worker exposed to surface soil and a construction worker exposed to the soil column (surface and subsurface soil). Exposure pathways quantitatively evaluated for each receptor were incidental ingestion of soil and inhalation of soil-derived vapors. Dermal contact exposure pathways were not included in the evaluation consistent with USEPA guidance (USEPA, 2004a). USEPA default exposure assumptions were used in the RSL calculator.

Estimated cancer risks for on-Site commercial workers exposed to surface soil and on-Site construction workers exposed to the soil column were within USEPA's acceptable cancer risk range (1x10^{-6} to 1x10^{-4}). Cumulative cancer risks were 8x10^{-5} and 1x10^{-5} for on-Site commercial workers and on-Site construction workers, respectively. However, non-cancer hazards exceeded the target non-cancer effects level of 1. HIs were 25 and 91 for on-Site commercial workers and on-Site construction workers, respectively. The inhalation pathway was the exposure pathway of concern. USEPA concluded that

residual TCE in Site soil poses an unacceptable non-cancer risk to human health and the need to take remedial action remains valid (USEPA, 2021a).

However, it should be noted that USEPA identified potential receptors as both current and future. Under current Site conditions and land use, no potentially complete soil exposure pathways for potential on-Site receptors have been identified. CSCO exceedances for commercial workers are located beneath a synthetic impermeable liner, topped with imported topsoil (see **Appendix E**) and gravel cover. The existing SVE cover (see **Figure 1.5-3a**) prevents current exposure to Site soil through direct human contact.

2.2.3.3 Supplemental Ecological Risk Evaluation for Soil (2021)

USEPA prepared a Supplemental Ecological Risk Evaluation for Soil (USEPA, 2021b) in October 2021, to support the risk calculation from exposure to residual TCE contamination in the Spill Zone soil post-SVE treatment. This streamlined ecological risk assessment evaluation estimates the potential for adverse effects to ecological receptors exposed to contaminated soil on the Site (USEPA, 2021b).

Similar to the human health risk evaluation discussed in Sections 2.2.3.1 to 2.2.3.2, analytical data used in the Supplemental Risk Evaluation included TCE concentrations measured in post-SVE soil boring samples collected in August 2017. The risk was evaluated for surface soil (0.5-2.5 ft) because exposure pathways to terrestrial ecological receptors are only complete in surface soil. EPCs calculated by USEPA were compared to the 2 mg/kg value for protection of ecological receptors established by the NYSDEC. USEPA calculated a hazard quotient (HQ[2]) for the Site of 230 based on an EPC of 460.2 mg/kg.

LVRR contracted EHS Support (former URS staff) to review the Supplemental Ecological Risk Evaluation (EHS-Support, 2022a). The purpose of the technical review was to: 1) evaluate the technical approach used by USEPA; and 2) to assess the applicability of the conclusions for potential remedial decision-making in the Spill Zone.

As noted earlier, USEPA compared their calculated EPC to the NYSDEC value of 2 mg/kg for the protection of ecological receptors. The NYSDEC value for the protection of ecological receptors for TCE assumes that the soil-to-earthworm-to-small mammal exposure pathway is the most sensitive wildlife ingestion pathway. In calculating the 2 mg/kg TCE concentration in soil for the protection of the soil-to-earthworm-to-small mammal exposure pathway, NYSDEC assumed that an exposure scenario where short-

[2] A hazard quotient (HQ) is calculated as the exposure point concentration divided by the benchmark concentration for the protection of ecological receptors.

tailed shrew (*Blarina brevicauda*) consumes 100% of their diet in earthworms and the TCE bioaccumulation from soil to earthworm tissue is based on general bioaccumulation models for organic compounds based on octanol-water partitioning coefficients. The placement of a stone cover as part of the SVE system prevents the establishment of habitat to support a forage base (*e.g.*, earthworms, vegetation, etc.) for ecological receptors and minimizes incidental soil ingestion in the current timeframe. In addition, the soil samples used by USEPA in their EPC calculations are within the area that is being evaluated for remedial alternatives, which will mitigate future ecological exposure.

On November 10, 2021, the Supplemental Ecological Risk Evaluation and subsequent review by EHS Support was discussed between USEPA and LVRR, with LVRR presenting the position that there is minimal ecological risk based on the lack of complete exposure pathways under current scenarios, as established in the EHS Support review. USEPA agreed that current conditions (*i.e.*, gravel cover) would not provide sufficient habitat for small carnivorous ecological receptors. However, if the gravel cover is removed, there is a potential for future habitat to be present for small carnivorous mammals.

2.3 Groundwater Investigation Findings

On September 22, 2006, USEPA and LVRR entered into the SA for the Site. Included as appendices to the SA is a 1997 NYSDEC ROD and two USEPA Memoranda that supplement the NYSDEC ROD (Memoranda) (Appendix A of the SA). Specifically, through the Memoranda, EPA reserved concurrence on the groundwater components of the NYSDEC ROD and stated that additional groundwater investigations will be undertaken to evaluate the feasibility of aquifer restoration to its most beneficial use as required in the NCP. The SA also included a statement of work (SOW) (Appendix B of the SA) and a work plan and Addendum (USEPA 2002 RI/FS WP) (Appendix C of the SA) to focus the investigations.

LVRR subsequently implemented the SOW and RI/FS WP, as well as prepared and implemented Addendums 2 through 7 to the RI/FS WP; a Work Plan to investigate groundwater impacts from an industrial fire within the Site Study Area dated November 4, 2014; and, a Monitored Natural Attenuation (MNA) Work Plan dated November 8, 2015 (LVRR, 2015b).

Pursuant to the SA, LVRR conducted RI activities from 2008 through 2015 and submitted a report summarizing the findings of the investigations to the USEPA titled “Remedial Investigation Report, USEPA Operable Unit 2, Groundwater Plume” dated December 10, 2014 (LVRR RI Report) approved by the USEPA on December 16, 2014. The objective of the LVRR RI Report was to further investigate the groundwater and define the nature and extent TCE groundwater contamination at the Site.

Addendum 1 to the LVRR RI Report submitted to the USEPA on September 28, 2016, summarized the findings of RI activities proposed in work plans prior to the issuance of the LVRR RI Report and completed after the issuance of the LVRR RI Report. Addendum 1 summarizes RI activities conducted consistent with three work plans including: (1) the Addendum 7 Work Plan submitted to the USEPA on October 30, 2014 (LVRR, 2014c); (2) the November 4, 2014 Work Plan; and, (3) the September 8, 2015 Final MNA Work Plan (LVRR, 2015b).

Upon USEPA acceptance of the LVRR RI Report and Addendum 1, the USEPA requested an AGTI Report to evaluate the potential and technical feasibility for restoring the groundwater at the Site to beneficial use as defined by CERCLA groundwater restoration cleanup levels which are established by chemical-specific ARARs.

The AGTI proposed six remedial alternatives and concluded that the restoration of groundwater to its most beneficial use is not technically practical within a reasonable timeframe. The NCP states that "EPA expects to return usable groundwaters to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site." At most sites expectations of remedial effectiveness would be a decade or two or perhaps three, at most. However, at the LVRR Site, restoration to MCLs would be expected to take centuries, even with the removal of all TCE from the Spill Zone, as discussed in further detail within Sections 2.4.4 and 4.3.4 of this FS Report and illustrated on **Figure 4.3-3**. These are not reasonable time frames in the context of the NCP and thus a TI evaluation was conducted. The proposed spatial extent of a proposed TI waiver zone was presented in the AGTI report and is illustrated on **Figures 2-1, 2-2, and 2-3** of this report. UMC incorporated all USEPA comments into the revised AGTI dated February 8, 2019, which was subsequently acknowledged by the USEPA on May 30, 2019.

The TI evaluation for groundwater acknowledges that groundwater restoration to the MCL is not practicable. When restoration of groundwater to its beneficial use is not practicable, the USEPA selects an alternative remedial strategy that is technically practicable, protective of human health and the environment, and satisfies statutory and regulatory requirements of CERCLA. Consistent with the NCP, alternative remedial strategies for sites with TI address exposure control, source control, and aqueous plume migration.

2.3.1 Groundwater, Surface Water, and Sediment Risk Assessments

2.3.1.1 Screening-Level Risk Assessment (2015)

URS Corporation, on behalf of UMC, prepared a SLERA (URS, 2015) in accordance with USEPA 2002 RI/FS WP addendum. The objectives of the SLERA were to determine whether potential adverse

ecological effects are occurring or may occur based on contaminant of potential ecological concern (COPEC) concentrations in the impacted media evaluated. Impacted media considered in the SLERA included sediment and surface water.

Ecological exposure was first evaluated using an exposure evaluation approach that quantified potential risk based on the most conservative exposure scenarios. The results indicated that maximum concentrations of some constituents in surface water and sediment exceeded conservative screening criteria. However, the potential for impacts to populations from exposure to those constituents is low when evaluated using refined benchmarks. The findings of the exposure estimate and risk characterization supported the following conclusions for the exposure area:

- The low detected concentration of cyanide in surface water at one location in Mud Creek does not pose unacceptable risks for fish communities because the pathway for exposure in Mud Creek is incomplete since Mud Creek upstream of Mud Pond and Gorge Pond runs dry a majority of the year and therefore is unable to support fish communities.

- Acetone is not related to the train derailment and hence is not considered a Site-related constituent of concern. It is unlikely to adsorb to sediment and was found in similar concentrations within and outside the historical plume. The lack of sediment quality criteria and ecotoxicity data suggest that this analyte is unlikely to adversely impact macroinvertebrates. Therefore, the presence of this constituent in sediment samples is not considered Site-related and does not pose a significant risk to benthic invertebrate populations.

In summary, there is adequate information to conclude that ecological risks from exposure to sediment and surface water are negligible; therefore, no further action is warranted in these media based on ecological risk (URS, 2015).

2.3.1.2 Baseline Human Health Risk Assessment (2016)

A BHHRA for groundwater, and associated surface water and sediments, was conducted in 2016 in accordance with Section 13D of USEPA 2002 RI/FS WP addendum and guidance provided by USEPA Region 2 (2014a, 2014b).

The BHHRA evaluated the significance of current and potential future exposures of human receptors to constituents detected in Sitewide groundwater and associated surface water and sediments. The objectives of the risk assessment were to determine whether releases of chemical constituents in environmental media (groundwater, surface water and sediment) pose unacceptable risks to human health

under baseline exposure conditions (in the absence of remedial action); and, to provide risk information sufficient for remedial decision-making, based upon current and reasonably anticipated future land uses.

The BHHRA provided cumulative cancer risk estimates and non-cancer hazard indices for potential receptors under current and reasonably anticipated future land uses, namely current/future construction/excavation workers and current/future recreational users of Mud Creek, Spring Creek and Oatka Creek. In addition, a future residential scenario and future commercial/industrial scenario was evaluated for hypothetical groundwater use as a potable source to provide an upper-bound estimate of potential risk to assist in remedial decisions.

Risk results were compared to USEPA's acceptable risk range of (1×10^{-6} to 1×10^{-4}) cumulative excess cancer risk, and a HI of 1 for groups of toxicants that affect the same target organ (USEPA, 1989).

The BHHRA concluded the following (AECOM, 2016):

- For potable use exposure pathways evaluated for future commercial/industrial workers and future residents, total HIs range from 19 (worker) to 12,000 (child resident); target organ HIs were also above 1. Potential Reasonable Maximum Exposure (RME) cancer risk estimates were between 2×10^{-4} and 4×10^{-2}, above USEPA's acceptable risk range. TCE was the primary contaminant of concern (COC) that contributed to overall risk exceedances. Ingestion of and dermal contact with TCE in tap water and inhalation of TCE volatilized into bathroom air were the exposure pathways of concern for future residents. Ingestion of tap water was the exposure pathway of concern for future commercial/industrial workers.
- Due to the shallow depth of groundwater downgradient of the Spill Zone exposure may occur during construction/excavation activities. The total HI for current/future construction/excavation workers was 3 and the target organ HI was also 3. Potential RME cancer risk estimates were within the acceptable risk range (the RME risk estimate was 1×10^{-6}).
- In the Mud Creek exposure area, total HIs ranged between 6 (adult recreational user) and 16 (child recreational user), and the total HI by target organ ranged between 3 and 6. Potential total RME cumulative cancer risk estimates were within the acceptable risk range. The primary Spill Zone-related COC was TCE, and ingestion of and dermal contact with surface water (spring water) while swimming were the exposure pathways of concern. Cumulative central tendency (CT) cancer risk estimates and noncancer hazards, based on wading rather than swimming, were within acceptable risk levels. Sediment was not identified as a medium of concern for exposure to Spill Zone-related COCs.
- In the Spring Creek/Oatka Creek exposure area, cancer risk estimates and noncancer hazards were within the acceptable risk levels for Spill Zone-related constituents in surface water and sediment.

2.3.1.3 Soil Vapor Intrusion Evaluation

In April 2008, an Indoor Air Monitoring Program (IAMP) was implemented to determine if subsurface SVI into the indoor air of overlying structures was occurring at the Site. More specifically, the IAMP investigated if vapors of TCE and/or its degradation products: cis-1,2-dichloroethene (cDCE), trans-1,2-dichloroethene (tDCE), and vinyl chloride (VC), were impacting indoor air quality in structures overlying the groundwater plume. The IAMP evaluated a total of 61 locations, of the 61 locations: 14 refused access for sample collection; 38 of the 61 were sampled for SVI; and, 9 locations were removed from the plan because of the nature of the location (*e.g.*, a seasonally-used unheated structure or an actively-used automotive repair facility) or the absence of a structure at the location. **Figures 2-17** through **2-20** depict all air monitoring locations and current status as of February 2023. LVRR has contacted property owners who denied access multiple times by mail and in person; the latest attempt was met with a verbal approval for one of the properties in 2022.

The next section discusses the CSM to assist in the identification of appropriate remedial technologies, if necessary.

2.4 Conceptual Site Model

The use of a CSM provides a means of documenting and periodically updating general information and data regarding potential releases to the environment (USEPA, 2008). The CSM also provides a framework for problem definition; aids in the identification of data gaps, which can then be addressed in the investigation; and assists in the identification of appropriate remedial technologies, if necessary.

The CSM is based on an integrated analysis of potential receptors, potential exposure routes, Site-related constituent concentrations in environmental media, and environmental fate and transport mechanisms. The CSM includes the following four primary elements:

- Identification and characterization of known and potential source areas;
- Identification of COCs;
- Definition of primary transport mechanisms; and
- Identification of potential receptors and exposure points.

In support of the CSM, an accurate understanding of the physical characteristics of the Site, including geology and hydrogeology, must also be known. A description of the physical characteristics of the Site was previously presented in Section 1.4 of this FS Report.

Information provided within this Section was obtained and summarized from remedial investigations and actions conducted by LVRR, NYSDOH, NYSDEC, and the USEPA between 1970 - Present.

2.4.1 Sources

A derailment of a train operated by the LVRR resulted in a release of approximately 30,000 gallons of TCE and 1 ton of cyanide crystals at the Gulf Road railroad crossing in the Town of LeRoy, on December 6, 1970. The sudden spill of 30,000 gallons of TCE likely produced extensive pools of DNAPL with sufficient fluid head to invade very small aperture microfractures in addition to larger openings. The DNAPL likely reached a stable position within a relatively short period after the release occurred, and then began to dissolve into groundwater flowing in fractures (secondary porosity) and diffusion into the pore spaces within the rock matrix (primary porosity) which provides substantial contaminant storage capacity as dissolved and sorbed phase. The transmission of groundwater occurs almost exclusively through the secondary porosity (fractures, joints and solution-enlarged channels). Remnant DNAPL in the BVZ also contributes contaminant mass to the plume through volatilization, diffusion, and dissolution in recharging water. The TCE mass in the matrix pore spaces is essentially immobile relative to the flow of groundwater in the fractures, and back diffusion of contamination from the matrix pore spaces back to fractures, in response to reversals in concentration gradients, provides a long-term source of contamination to the groundwater in the fractures.

The relatively high TCE concentrations detected in spring/surface water samples collected at the intermittently flowing Mud Creek waterfall and intermittently flowing areas of Mud Creek downstream of the waterfall to the influent end of Mud Creek Pond (*i.e.,* concentrations exceeding the NYSDEC Class C surface water quality standard of 40 µg/L) likely indicates that TCE-impacted groundwater originating from the Spill Zone discharges via springs to this portion of the Mud Creek drainage. In addition, the rapid rise in the water table displaces TCE-impacted vapor in the void spaces in the BVZ and overburden thereby pushing it upward. This phenomenon results in periodic TCE-impacted SVI into residences in down-plume areas.

Figures 2-4, 2-5, and 2-6 of this report provide schematic diagrams of the LVRR CSM. **Figure 2-4** of this report shows the groundwater flow throughout the area (blue arrows), as well as, the TCE impact at the Spill Zone (red plume). The TCE plume migration horizontally downgradient and vertically is then illustrated as well as SVI into structures in the area. The SVI pathway is illustrated and depicts typical groundwater elevation as a blue dashed line and vapors migrating vertically as red arrows. **Figure 2-5** of this report illustrates plume evolution and **Figure 2-6** of this report illustrates an aerial view of the CSM.

2.4.2 Constituents of Potential Concern

TCE and its degradation products are the primary COCs resulting from the train derailment. COCs for protection of human health are defined by USEPA as constituents of potential concern (COPCs) that significantly contribute to a pathway in a use scenario for a receptor that either exceeds a cumulative cancer risk of 1 x 10^{-6} or a HQ of 1 (USEPA, 1991). Chemicals are not considered as significant contributors to risk and therefore are not included as COCs if their individual carcinogenic risk contribution is less than $1x10^{-6}$ and their non-carcinogenic HQ is less than 0.1. Chemical-specific cancer risk estimates and HQs were tabulated in the Risk Assessment Guidance for Superfund (RAGS) Part D tables provided in the BHHRA (see RAGS Table 7 series in AECOM, 2016). Consequently, the following Spill Zone-related COCs for potential human receptors were identified for soil, groundwater, and surface water.

Spill Zone-Related COC's for Potential Human Receptors		
Media	**Pathway**	**Analyte**
Soil	Potential human receptors	TCE and cDCE
Groundwater	Future Drinking Water	1,1-DCE, cDCE, tDCE, TCE, VC
Groundwater	Direct contact with shallow groundwater in an excavation	TCE
Groundwater	Future SVI	1,1-DCE, cDCE, tDCE, TCE, VC
Surface Water	Swimming in Mud Creek Exposure Area	TCE

2.4.2.1 Physical and Chemical Properties of TCE

TCE and its degradation products are the primary COPCs resulting from the train derailment and related to the Site. The physical and chemical properties of TCE and the nature of the media through which the TCE is migrating control the environmental fate and transport of TCE throughout the Study Area. The physical and chemical properties of TCE were obtained from the Agency for Toxic Substances & Disease Registry's (ATSDR's), Toxicological Profile for Trichloroethylene (dated September 1997), available at www.atsdr.cdc.gov/toxprofiles/tp19-c3.pdf. TCE is a clear, colorless or bluish liquid having a sweet chloroform-like odor and the following properties:

Melting Point	-87.1 Degrees Centigrade (°C)
Boiling Point	86.7 °C

Molecular Weight	131.4
Density/Specific Gravity	1.465 at 20 °C
Vapor Pressure	74 millimeters of mercury (mmHg) at 25 °C
Aqueous Solubility	1.070 grams per liter (g/L) at 20°C
Henry's Law Constant	0.011 atm- m^3/mole at 25 °C

TCE will dissolve into water in small amounts depending on the water temperature. Most studies have been performed at water temperatures of 20°C to 25°C. The lowest TCE solubility occurs at approximately 40°C with increasing solubility at higher and lower temperatures. The average groundwater temperature observed during MNA sampling conducted by LVRR was approximately10°C. There is very little change for aqueous solubility in the 10°C to 20°C range. The difference is not considered significant and will not change the interpretations or conclusions of the dissolved-phase TCE transport or receptor impacts. The following sections discuss transport and fate processes throughout the Study Area.

2.4.3 Contaminant Transport and Fate

The environmental fate and transport of a contaminant is controlled by the compound's physical and chemical properties and the nature of the subsurface media through which the compound is migrating. The following subsections address the transport and fate of TCE within the various impacted media throughout the Study Area.

2.4.3.1 Contaminant Migration

2.4.3.1.1 Overburden

The sudden spill of 30,000 gallons of TCE likely produced extensive pools of DNAPL that penetrated into the overburden. Interim remedial measures via water infiltration trenches implemented shortly after the release would have enhanced spreading of the DNAPL. Infiltrating precipitation and snow melt would dissolve some of the TCE and carried it downward to the saturated zone.

Relatively little DNAPL TCE was retained in the unconsolidated porous media (overburden) due to the thin mantle of unconsolidated material over rock. TCE impacted overburden in the Spill Zone is thin, no more than 12 ft thick, and has been subject to volatilization since 1970. However, the TCE impacted overburden within the Spill Zone is above regulatory criteria and, per the RA Administrative Order, remediation via SVE was implemented but unsuccessful to reduce Spill Zone overburden rocky soil/fill

TCE concentrations to below concentration-based performance standards. The character of the impacted overburden and analytical data do not support employment of partitioning theory to determine a soil concentration protective of groundwater quality. Partitioning theory assumes a soil matrix; however, the overburden materials in the Spill Zone contain significant quantities of rock fragments into which the TCE has diffused. This rocky soil matrix does not liberate TCE as readily as soil as evidenced by the Synthetic Precipitation Leaching Procedure (SPLP) data, which represent actual leachate concentrations generated from Site-specific samples subjected to simulated precipitation. Total TCE concentrations at three locations within the Spill Zone were reported at 280, 190, and 64.5 mg/kg, with corresponding SPLP levels reported at 221, 424, and 134 µg/L (Benchmark, 2018). In all cases, dividing these leachate concentrations by a Dilution Attenuation Factor (DAF) of 100 results in conformance with groundwater quality standards. In other words, the SPLP results indicate that samples with TCE concentrations significantly higher than those typically encountered on-Site do not act as a continuing source of contamination that threatens to contravene groundwater quality standards. In addition, overburden downgradient of the Spill Zone is not a significant contributor of TCE to the groundwater system.

2.4.3.1.2 Bedrock Vadose Zone

The sudden spill of 30,000 gallons of TCE likely volatilized a portion of the TCE into the atmosphere and produced extensive pools of DNAPL with sufficient fluid head to invade very small aperture microfractures in addition to larger openings within the BVZ. TCE DNAPL dissolved into water present in the fractures and diffused into the matrix porewater under a concentration gradient. The dissolution of the DNAPL resulted in a concentration gradient with high concentrations in the fractures adjacent to the DNAPL and concentrations of zero (initially) in the pore spaces within the rock matrix. The BVZ was also potentially affected by emergency response remedial actions, that included the injection of water via remediation trenches, shortly after the release occurred during efforts to suppress vapors from the spill, which presumably caused additional DNAPL spreading.

The DNAPL likely reached a stable position within a relatively short period after the release occurred, and then began to dissolve into groundwater flowing in fractures (secondary porosity) and diffused into pore spaces within the rock matrix (primary porosity), which provides contaminant storage capacity as dissolved and sorbed phase. The transmission of groundwater occurs almost exclusively through the secondary porosity (fractures, joints and solution-enlarged channels). Contaminant migration rates in fractures are expected to be substantially slower than the groundwater flow rates because of contaminant retardation. This is a process where the contaminant is diffused into the pore spaces and sorbed onto the

overburden/bedrock resulting in a slower transport velocity, allowing for longer residence times for the TCE to be in contact with the rock surfaces. Sorption to the rock surfaces in the matrix results in retardation and retention of TCE mass. Remnant DNAPL in the BVZ also contributes contaminant mass to the plume through volatilization, diffusion, and dissolution in recharging water.

Over more than five decades (53 years) since the spill, most or all of the DNAPL has disappeared from the fractures due to dissolution and diffusion into the rock matrix pore spaces, and through advective/dispersive solute transport downgradient in the fracture network below the water table (see **Figure 2-5**, "Intermediate Time" illustrations). DNAPL likely persists in microfractures and/or imbibed in the rock matrix porewater in the unsaturated BVZ, but DNAPL has not been observed directly in the Study Area. Very little of the TCE mass is present in the fractures.

The TCE mass in the matrix pore spaces is initially immobile relative to the flow of groundwater in the fractures until back diffusion of contamination from the matrix pore spaces back to fractures occurs in response to reversals in concentration gradients. This can provide a long-term source of contamination to the groundwater in the fractures (see **Figure 2-5** of this report, "Late Time" illustrations).

The current source for the dissolved phase TCE is residual DNAPL located in microfractures and/or diffused into the rock matrix pore spaces in the BVZ in the Spill Zone and downgradient Study Area. The highest TCE concentrations were observed in the rock matrix above the water table in LVRR-36 (within the Spill Zone) with some TCE concentrations indicative of continued DNAPL presence, and lesser concentrations in the rock matrix below the water table suggesting most or all of the DNAPL that penetrated below the water table has disappeared. The rock core profile and groundwater concentration data from LVRR-33, located approximately two miles from the Spill Zone, shows that back diffusion of TCE mass is occurring from the higher TCE concentration BVZ rock matrix pore spaces to the lower TCE concentration groundwater in the fractures (see **Figures 2-10, 2-11, 2-12, 2-13, and 4.3-2** of this report).

2.4.3.1.3 Groundwater

TCE in a non-wetting phase is denser than air and water; therefore, it moves downward along preferential pathways until reaching a resistive layer (*e.g.,* bedding plane if moving laterally). At LVRR DNAPL penetrated well below the water table in the Spill Zone causing the plume to rapidly advance. Once TCE dissolved in the groundwater, it moved eastward with the regional groundwater by advective flow and into and out of the pore spaces within the rock matrix. The groundwater flow also has a vertical component where deeper geologic formations are impacted by TCE, likely through sinkhole features, bedrock joints, and fractures penetrating multiple formations. As groundwater moves eastward it discharges into springs

located at the base of an escarpment along the south side of Oatka Creek and at Spring Creek. The springs at the base of the escarpment manifest themselves as ponds or wetlands south of the Oatka Creek channel.

At the time of the train derailment the dissolution of the TCE and subsequent transport by groundwater flow in the interconnected fracture network resulted in TCE odors detected at the former Knickerbocker Hotel, located approximately 500 ft north and slightly east of the derailment site. On December 21, 1970, 15 days after the derailment, TCE was detected at a concentration of 33,000 µg/L, in domestic water supply well DW-7 located along Gulf Road approximately 1,000 ft east of the derailment Site. By January 20, 1971, TCE was detected in domestic well G-2 at a concentration of 70,000 µg/L, located along Gulf Road approximately 500 ft east of the derailment Site. TCE concentrations approaching 2,000 µg/L were detected in domestic wells G-8, G-9, and G-11 located along Church Road between approximately 2,000 ft and 4,000 ft southeast of the derailment Site. The NYSDEC RI Report summarized the findings of further domestic water supply well sampling and the installation and sampling of a monitoring well network extending from the derailment Site eastward approximately 4 miles to Spring Creek.

Currently, the TCE plume extends approximately 4.1 miles to the east where groundwater discharges in the vicinity of the Spring Creek fault zone. The plume is approximately 1.5 miles wide, at its widest. The aquifer affected by the spill occurs primarily in carbonate sedimentary rocks of the Camillus, Bertie, Akron, Bois Blanc, and Onondaga Formations. These limestones and dolostones have dual porosity with significant primary matrix porosity (pore spaces in the rock matrix). The extent of migration is due to the secondary porosity; specifically, the apertures of fractures, joints, solution openings, connectedness of fractures, as well as the length and orientation of these features. It is these features that govern the overall transmissivity of the flow system, and, coupled with the hydraulic gradients, determine transport velocity.

Groundwater flow within the Study Area occurs through a combination of laminar (or Darcian) flow in the smaller fractures and turbulent flow in the larger fractures and karstic solution channels. The geophysical logging of exploratory borings identified large solution channels in the Camillus Formation and fractures in the Onondaga and Bertie Formations through which water is transmitted. The large water level fluctuations and rapid response observed in the spring in response to snow melt and heavy precipitation events demonstrates limited storage in the bedrock fractures. This is indicative of fracture flow. Very large water level fluctuations were identified by the NYSDEC RI/FS and confirmed by the LVRR RI.

The turbulent flow observed in the solution channels and possibly some fractures along with the large quantity of infiltrating water from the surface runoff results in dilution, dispersion, and mechanical mixing of TCE concentrations in the groundwater plume. The fracture flow also reduces the residence time the TCE stays in the fracture system. However, the overall residence time of the TCE in the flow system is increased due to the diffusive flux of TCE into and eventually back out of the primary rock matrix pore space.

In relatively high secondary porosity environments such as LVRR, large groundwater flow velocities occur, which can cause rapid rates of plume transport in the absence of processes that move mass away from these features. However, mass transfer by diffusion from these secondary features with rapid groundwater flow velocities into the primary porosity where groundwater flow is generally minor or negligible, serves to retard the advance of the solute plume and to decrease the contaminant mass discharge rates. Within the primary porosity the rates of mass transfer and mass storage is also enhanced due to sorption processes.

TCE impacted groundwater in the Onondaga and Bertie Formations in the immediate vicinity of the Spill Zone is directed under hydraulic gradient to the south-southeast, likely influenced by the mounding effect of the large volumes of allogenic water that infiltrate the bedrock through the Mud Creek sinkhole, located approximately 250 ft east of the Spill Zone. This water includes State Pollutant Discharge Elimination System (SPDES) water generated during active dewatering of the Dolomite Quarry, located immediately southwest of the Spill Zone (**Figure 4.4-1b).** The Dolomite Quarry operates seasonally and, when in operation, extracts as much as 800,000 gallons per day (gpd) as part of efforts to keep the quarry dewatered. Pumping at the quarry locally influences the hydraulic gradients and captures the upgradient fringe of the Spill Zone in an episodic and transient manner. Monitoring of: 1) hydraulic heads at the Site; 2) records of volumetric pumping rates; and, 3) concentrations of pumping influent and effluent in accordance with the quarry discharge permit effectively provide a check on the effects of the dewatering flow patterns and transport at the Site. The quarry dewatering effluent is treated and discharged to Mud Creek. The Dolomite Quarry's effluent TCE concentrations from 2015 through March 2023, as illustrated in **Figure 4.4-1b**, are consistently below 8 µg/L, which is below the NYSDEC Class C surface water quality standard of 40 µg/L and indicates minimal impact to this portion of the Mud Creek drainage.

A comparison of recent LVRR investigations (2008-2018) with the initial NYSDEC remedial investigations (1996) shows that the TCE plume has not changed significantly in terms of aerial extent since at least 1996 and has achieved a steady state plume configuration condition (**Figures 2-7, 2-8,** and **2-9**). Depletion of TCE concentrations within the plume is primarily due to: 1) the mechanical dispersion inherent

in this type of fractured and solution-weathered aquifer; 2) the influx of large volumes of fresh water (uncontaminated with TCE) from sinkholes; and, 3) the sequestration (*i.e.*, diffusion) of a portion of the total initial contaminant mass from secondary porosity features into the primary porosity of the pore spaces within the rock matrix. Mass transfer back out of the primary porosity into the secondary porosity (back-diffusion) is what sustains the plume now and into the future.

2.4.3.1.4 Surface Water

The residence time of TCE in surface water is generally short lived due to volatilization. Groundwater contaminated with dissolved-phase TCE will mix with the surface water, dilute the TCE concentrations, with a portion of the TCE volatilizing into the atmosphere. The Henry's Law constant for TCE is 9.85×10^{-3} atmospheres-cubic unit per mole at 25ºC (atm-cu/mole at 25ºC); therefore, TCE is expected to rapidly partition from the dissolved-phase to the vapor phase, sometimes with a half-life of minutes to hours. If the dissolved TCE is not near the surface where volatilization can readily occur, breakdown of the TCE can take days to weeks (Warneck 2007).

TCE may be more persistent in sediment because of the presence of potentially high amounts of organic carbon from vegetative matter in the stream bed. Once in the sediment, adsorbed TCE can be a continuing source of dissolved TCE to the surface water. The risks associated with TCE in sediment were evaluated and found acceptable in the LVRR SLERA and were further discussed within the LVRR RI Report (2014b).

Site remedial investigations identified a large sinkhole located near the Spill Zone through which Mud Creek flows and loses much of its water to the bedrock. Downgradient of the sinkhole, relatively high TCE concentrations are detected in spring/surface water samples collected at the intermittently flowing Mud Creek waterfall and intermittently flowing areas of Mud Creek downstream of the waterfall to the influent end of Mud Creek Pond (*i.e.,* concentrations exceeding the NYSDEC Class C surface water quality standard of 40 µg/L) likely indicating that TCE-impacted groundwater originating from the Spill Zone discharges via springs to this portion of the Mud Creek drainage. It should be noted that the TCE concentrations decrease with distance downstream from the Mud Creek waterfall (closest to the Spill Zone) to the Mud Pond inlet (downgradient from the Spill Zone).

In addition, TCE impacted water in the vicinity of the Spill Zone sinkhole (Mud Creek sinkhole) is directed eastward through a narrow area beneath Church Road. East of Church Road, the TCE plume in the Bertie Formation spreads out to the north and south as it migrates eastward to Spring Creek. **Figures 4.4-**

1a, c, and **d** depict Sitewide surface water sample concentrations in the Mud Creek, Oatka Creek and Spring Creek areas.

Data obtained from transducers within select Site wells show that the geologic formations essentially act as a single hydrologic unit with little to no lag time between responses to the different precipitation/snow melt events. However, the responses vary widely between seasons and specific precipitation/snow events within the same season. The transducer data support that the late summer and early fall (prior to end of growing season) appears to have the lowest frequency of water table response from meteorologic events. This would imply less dilution of the plume from surface water inputs. Warm snowmelt periods in the winter and spring introduce significant quantities of meteoric water into the plume. Periods of high temperatures that occur after significant snowfall accumulation are the key meteorologic factors that triggers these surface water inputs. This is much different than the convention that large precipitation events are required to trigger large water table fluctuations. The study, *Recharge into the LVRR Plume Estimated by the Soil Water Assessment Tool* (Richards 2016) (SWAT Model Report), did not identify any relationship between precipitation magnitude and water table rise, except perhaps for events augmented by snowmelt events. For example, the SWAT model compared two events within the plume in the same season. A 100-year storm event of 5.74-inches of precipitation in 24-hours had virtually no impact with only a 1 to 3-foot water table rise throughout the plume while a commonly occurring 0.85-inch event, six weeks later, had a much larger impact with an approximately 16-foot water table rise near the Spill Zone and mid-plume near Lime Rock Road, 17-foot water table rise near Church Road, and less than a 2-foot water table rise at the plume end near Spring Creek. To illustrate this example, refer to the following Figure 5 from the SWAT Model Report, Comparison of Growing and Nongrowing Season Well Response in the Fall.

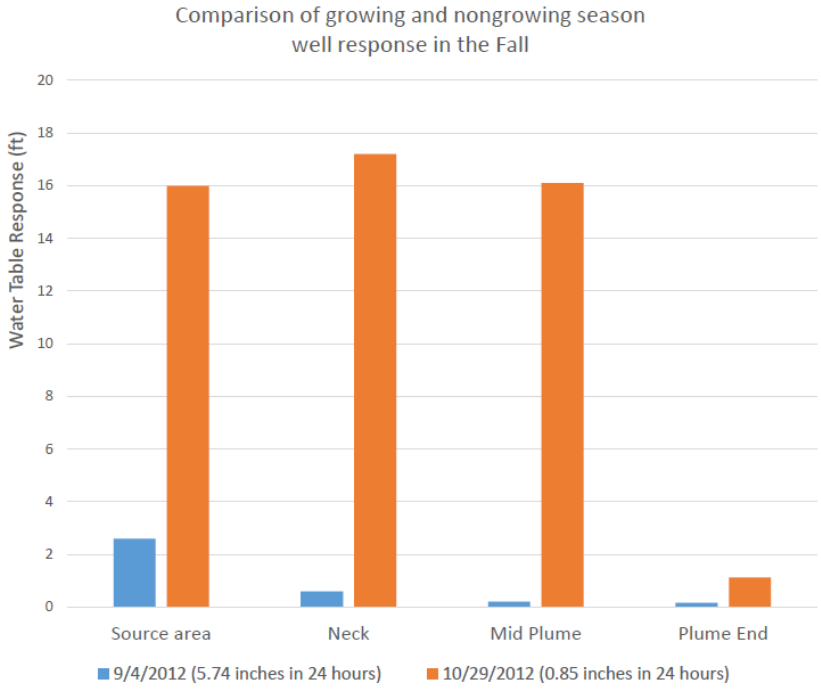


Figure 5 Comparison of two events within the plume in the same season. Note how a 100 year storm event had virtually no impact on the water table while a commonly occurring 0.85 inch event had a much larger impact a mere 6 weeks later in the season. The difference was the smaller event occurred after the end of the growing season. This implies that despite the thin soils associated with the study area, water uptake by vegetation during the growing season is capable of absorbing much of the precipitation that falls in the Summer and early Fall. There are events that trigger water table response in the growing season, however these are much rarer then in other seasons, and produce a smaller water table response.

In downgradient parts of the plume (*e.g.*, Lime Rock Road and areas to the east), the potentiometric surface is closer to the ground surface than it is in the Spill Zone. The rapid rises in the potentiometric surface in response to recharge events result in the water table reaching the surface or near-surface. Groundwater can rise above the top of bedrock in the Spring Street/Spring Creek area. Groundwater can rise above the top of bedrock in the Mackay Park spring at the south end of Spring Street and in a wetlands area at the north end of Spring Street. Other areas where groundwater can potentially rise above top of bedrock are in wetlands, seeps, and springs along Mud and Oatka Creeks. In some cases, this results in groundwater entering residences (basements, sumps, etc.) near the discharge zone (Spring Street/Spring Creek Area).

Groundwater quality data and vertical gradients observed in Spring Creek well clusters indicate that Study Area groundwater discharges to Spring Creek via seeps and springs along its course. Spring Creek is interpreted to be a surface expression of a fault (Spring Creek fault) with a displacement of up to

approximately 55 ft with the east side of the fault downthrown. As groundwater moves eastward it encounters the fault zone and moves upward to the surface and discharges as springs forming Spring Creek. Based on groundwater quality data collected from three domestic wells and well clusters installed east of Spring Creek, TCE impacted groundwater does not extend significantly east of Spring Creek. The vertical gradients observed in well clusters installed east of Spring Creek indicate an upward vertical gradient from the lower to upper Camillus Formation predominates in this area. Based on these data, TCE-impacted groundwater either discharges to Spring Creek or is effectively diluted and dispersed by groundwater moving through the Spring Creek Fault. These mechanisms work to prevent TCE-impacted groundwater from extending significantly east of Spring Creek.

2.4.3.1.5 Soil Vapor Intrusion (SVI)

The rapid rise in the water table displaces TCE-impacted vapor in the void spaces in BVZ and overburden thereby pushing it upward. This phenomenon results in periodic TCE-impacted SVI into residences in down-plume areas

LVRR conducted indoor air sampling and oversaw the installation and maintenance of indoor sub-slab depressurization systems (SSDS) (SVI mitigation systems) in 13 affected residences. The details of the IAMP work implemented by LVRR between April 2008 and January 2013 are included in the Revised Draft Indoor Air Monitoring Report (LVRR, 2013). Since submitting the IAMP Report to the USEPA, LVRR has issued nine addendums that document the continuing IAMP work between 2013 and 2023. The work conducted in relation to each addendum occurred during the NYS Heating Season, defined by the NYSDOH SVI Guidance as November 15th to March 31st between two given years, though the start and end dates may vary depending on the conditions of a location or year.

To date, 61 locations were identified for evaluation as part of the IAMP. Of the 61 locations: 14 refused access for sample collection; 38 of the 61 have been sampled for SVI; and, 9 locations were removed from the plan because of the nature of the location (*e.g.*, a seasonally-used unheated structure or an actively-used automotive repair facility) or the absence of a structure at the location. LVRR has contacted property owners who denied access multiple times by mail and in person; the latest attempt was met with a verbal approval for one of the properties in 2022.

The SVI sampling conducted during the IAMP has demonstrated that TCE vapors were entering structures in the Study Area. Of the 38 locations sampled, 33 properties yielded TCE detections. Among these 33 properties: 28 had indoor detections; 28 had sub-slab detections; and, 14 had outdoor detections.

These counts are based on the entire monitoring history of each location, but do not reflect repeated detections at any given location. The locations with the highest concentrations are generally along the axis of the dissolved-phase TCE plume core; however, two mitigation systems are located along Route 5 just west of the center of the Village of Caledonia. LVRR installed 12 SVI mitigation systems at sampled properties. A thirteenth property requiring TCE mitigation, has a property owner installed radon mitigation system which, is regularly inspected by LVRR, as part of the IAMP for effectiveness in mitigating SVI from TCE. Additionally, a fourteenth location was sampled in 2022, that resulted in detections of TCE. Communications between the UMC, USEPA, and the property owner are ongoing for the management of the TCE detections at the fourteenth property.

Overall, the IAMP work performed by LVRR between 2008 and 2023 has been successful in addressing concerns of TCE exposure via SVI in both residential and commercial structures in the Study Area.

2.4.3.2 Contaminant Persistence

According to the USEPA, several processes are known to cause a reduction in the concentration and/or mass of a contaminant dissolved in groundwater. Those processes that result only in the reduction of a contaminant's concentration, but not of the total contaminant mass in the system, are termed "nondestructive." Those processes that result in degradation of contaminants are referred to as "destructive." Nondestructive processes include advection, hydrodynamic dispersion (mechanical dispersion and diffusion), sorption, dilution, and volatilization. Destructive processes include biodegradation and abiotic degradation mechanisms. Biodegradation may be the dominant destructive attenuation mechanism acting on a contaminant, depending upon the type of contaminant and the availability of electron donors or carbon sources. Abiotic degradation processes are also known to degrade chlorinated solvents; where biodegradation is not occurring, these may be the only destructive processes operating. However, the rates of abiotic processes are generally slow relative to biodegradation rates. Natural attenuation processes affect the fate and transport of chlorinated solvents in all hydrologic systems. Natural attenuation in groundwater systems results from the integration of several subsurface attenuation mechanisms.

LVRR evaluated the attenuation mechanisms (both nondestructive and destructive) at the Site. The NYSDEC's and LVRR's RI Reports provide evidence that supports both destructive and nondestructive attenuation mechanisms are integrated to attenuate TCE within the Study Area. However, destructive processes, although present, will not restore groundwater to its most beneficial use in a reasonable

timeframe due to physical processes including: dispersion of TCE in the fracture network groundwater; significant dilution from recharge; and, diffusion of TCE into and out of the rock matrix pore spaces.

2.4.3.2.1 Destructive Processes

Biodegradation can be accomplished by several methods including iron reduction, sulfate reduction, nitrate reduction, methanogenesis and reductive dechlorination. Site groundwater samples were analyzed for a number of parameters to determine if biodegradation of TCE is occurring. Based on the groundwater geochemical conditions observed during MNA sampling, there is inadequate or limited evidence that anaerobic reductive dechlorination is occurring in the Study Area. This condition is evident both in wells most heavily impacted with TCE and in wells exhibiting little or no impact. However, the rock core analytical results support that attenuation is occurring. Rock core samples from the Spill Zone contain concentrations of TCE, cDCE, tDCE, and 1,1-Dichloroethene (1,1DCE). These concentrations are highest above the water table and decrease significantly at the water table.

Considered individually, most MNA parameter results are not favorable to anaerobic reductive dechlorination processes. These include: overall ferrous iron concentrations that are generally less than 1.0 milligrams per liter (mg/L); carbon dioxide (CO_2), alkalinity, and chloride concentrations that are generally less than two times background concentrations; sulfate and sulfide concentrations that are generally greater than 20 mg/l and less than 1.0 mg/L, respectively; total organic carbon (TOC) concentrations that are generally less than 20 mg/L; and, ethane, ethylene, and methane concentrations that are generally less than 0.1 mg/L, 0.01 mg/L, and 0.5 mg/L, respectively. In addition, stabilized low-flow parameter measurements are generally not favorable to reductive dechlorination processes including; Dissolved Oxygen (DO) generally observed at concentrations greater than 0.5 mg/L; groundwater temperature generally less than 20ºC; Oxidation-Reduction Potential (ORP) values generally less than 50 millivolts (mV); and, pH measurements generally outside the optimal range. Although benzene, toluene, ethylbenzene and xylene (BTEX) compounds have been historically detected in Site groundwater samples (not Site related COPCs), including benzene and toluene in concentrations exceeding SCGs, in no instances have total BTEX concentrations exceeded 1.0 mg/L which, could potentially promote reductive dechlorination.

Conversely, overall nitrate concentrations are generally less than 1.0 mg/L which is favorable for anaerobic reductive dechlorination processes since higher concentrations could potentially compete with dechlorination pathways. In addition, cDCE has historically been detected in concentrations or estimated concentrations in groundwater samples collected from Spill Zone well clusters DC-01, DC-05, DC-15 and DC-16 and well clusters immediately downgradient of the Spill Zone including DC-03, DC-06, and DC-

7R. These concentrations are generally greater than 80% of the total DCE (isomers of 1,2-DCE) concentrations. Assuming only virgin TCE was released, this suggests that limited reductive dechlorination is likely occurring in the Spill Zone or in downgradient areas. Rapid groundwater flux resulting in rapid TCE dispersion, displacement, and dilution likely prevents larger scale and more effective biodegradation from occurring.

Analysis of groundwater samples historically collected from Site monitoring wells detected TCE and occasionally concentrations or estimated concentrations of the chlorinated compounds DCE, VC, and chloroethane. TCE cannot be oxidized but the other compounds can be oxidized into CO_2, water, chlorine, and electrons, in conjunction with the reduction of oxygen to water. However, given the infrequent detection and low-level concentrations, direct aerobic oxidation of these compounds does not appear to be a significant degradation process at the Site.

Ammonia and the dissolved gasses ethane, ethylene, propane, and methane were non-detect at laboratory reporting limits or relatively low concentrations in Site MNA samples. In addition, analysis of Site groundwater samples has historically detected toluene (not a Site-related COPC) at relatively low or estimated concentrations. However, given the infrequent detection and low-level concentrations of these compounds, cometabolic aerobic oxidation of TCE does not appear to be a significant degradation process at the Site.

Evidence of cometabolic anaerobic reductive dechlorination is scant and suggests that the process is not nearly as important a degradation mechanism for chlorinated solvents in the saturated zone as direct anaerobic reductive dechlorination. Therefore, if cometabolic anaerobic reductive dechlorination is occurring at the Site, the rate of the reaction is likely slower than can be detected on a field scale.

As discussed above, the highest methane concentration observed during MNA sampling was 240 µg/L and overall concentrations generally do not exceed single digit or estimated concentrations. In no instance did methane approach the 500 µg/L (0.5 mg/L) concentration level indicative of on-going methanogenic anaerobic reductive dechlorination (USEPA, 1999b). These data indicate that methanogenic anaerobic reductive dechlorination is not a significant degradation process at the Site.

Chlorinated compounds dissolved in groundwater may be degraded by abiotic processes involving reactions not associated with biological activity. Abiotic reductive dechlorination reactions include hydrogenolysis and dihaloelimination. Hydrogenolysis involves the replacement of chlorine or another halogen atom by a hydrogen atom, while dihaloelimination is the removal of two chlorine or other halogen atoms accompanied by the formation of a double carbon-carbon bond. Research suggests these reactions

often do not take place in the absence of biological activity, even if such activity is only indirectly responsible for the reaction. Therefore, discerning the relative contribution of biotic versus abiotic reductive dechlorination processes on a field scale is difficult.

The MNA sampling between 2010 and 2015 revealed trends for a number of parameters. The trends for TOC, DO, ORP, Nitrate, Sulfate and CO_2 in the Spill Zone and just downgradient reveal no relation between subsequent sampling events for each constituent. In the mid-plume and discharge areas, the constituent trends are less variable than in the Spill Zone. Additionally, in the mid-plume area (LVRR-33) the constituent concentrations are generally different than those from the Spill Zone or the discharge area.

The LVRR RI Report concluded that a large influx of fresh water into the aquifer occurs near the Spill Zone along Mud Creek which provides a continuing source of surface water with potentially different chemistry than the aquifer water into which it is infiltrating. This infiltrating surface water has a potential significant effect on the chemistry of the aquifer water preventing the aquifer water chemistry from becoming anoxic due to constantly changing cation, anion, and dissolved gas levels. This prevents or limits the aquifer from establishing a substantial microbial population to allow for consistent anaerobic degradation of TCE. Although limited anaerobic degradation has been observed and documented during Site remedial investigations in the Spill Zone wells down to Church Road.

The LVRR RI Report concludes that large influxes of surface water are present along the southern boundary of the plume from Church Road eastward to Caledonia. The infiltrating surface water then flows through the aquifer eastward to discharge at Spring Creek. As with the Spill Zone, this influx of fresh water prevents the chemistry of the aquifer from establishing a substantial microbial population to allow for the consistent degradation of the TCE.

However, surface water infiltration in the mid-plume area is significantly less than in the Spill Zone or along the plume's southern boundary. Consequently, the aquifer chemistry is more amenable to anaerobic degradation in this area as can be seen in the differences in the chemistry between the Spill Zone wells and LVRR-33 that is not as affected by surface water infiltration.

In summary, the infiltration of large volumes of surface water have affected the aquifer in several locations to the degree that prevents or limits formation of the anaerobic conditions required for anaerobic degradation of TCE. The trends of the constituents monitored during UMC's various sampling events identified the areas where surface water was infiltrating and altering the chemistry. Infiltration of surface water prevents degradation of TCE along common degradation pathways resulting in "Inadequate" to

"Limited" MNA scores (USEPA, 1999b). However, the occasional detection of TCE daughter products including cDCE and VC in Study Area groundwater samples collected during historical events, suggest that anaerobic degradation of TCE is occurring in portions of the Site from the Spill Zone to the distal portion of the TCE plume at Spring Creek.

UMC retained PACE Analytical to conduct compound-specific isotope analysis (CSIA) on select samples collected throughout the LVRR Study Area. The CSIA analysis concluded that the degradation of TCE is occurring along the plume flow path and is preferentially consuming the carbon 12 (^{12}C) in the TCE. The CSIA analysis supports that ^{12}C is greater in areas of the groundwater plume where the TCE concentration is highest. Abiotic degradation by Iron Sulfide (FeS) resulted in more negative bulk enrichment values than those produced by microbial degradation alone. The LVRR CSIA analysis resulted in a bulk enrichment factor that is more negative than what is expected from anaerobic degradation, suggesting that abiotic TCE degradation is occurring at the LVRR Site.

Further, UMC conducted magnetic susceptibility testing on rock core samples collected from LVRR-33, 35, and 36. UMC concluded that limited ferromagnetic minerals including magnetite may be present in the Study Area matrix exceeding values typically reported for carbonate rocks and may be contributing to the abiotic degradation processes. The presence of cDCE, tDCE, and VC in the rock core samples also suggests abiotic degradation.

The overall RI findings indicate that the primary mechanisms for the TCE concentration reductions historically observed both in the Spill Zone and downgradient of the Spill Zone are matrix diffusion and the diluting and dispersing effects of the rapid and high-volume infiltration of allogenic water.

In the 2016 LVRR DFN model report, simulations were conducted for scenarios both without degradation and with degradation applying a low (20-year) half-life, which showed that even a low degradation rate such as this influences long-term plume transport, causing even stronger attenuation versus the no-degradation scenario. A paper by Pierce *et al*. 2018, provides a more general overview of degradation effects in fractured sedimentary rock, with insights transferable to LVRR conditions. Therefore, DFN simulations and sensitivity analysis suggest that even slow rates of degradation can play an important role in long-term plume attenuation when combined with matrix diffusion processes.

2.4.3.2.2 Non-Destructive Processes

Non-destructive processes include advection, hydrodynamic dispersion (mechanical dispersion during flow through the fracture network and diffusion), matrix diffusion, sorption, mechanical mixing, dilution, and volatilization (USEPA, 1999b). The following subsections discuss the non-destructive attenuation process identified at the Site.

2.4.3.2.2.1 Sorption

The retardation of organic solutes caused by sorption is an important consideration when simulating the effects of natural attenuation over time. Sorption of a contaminant to the aquifer matrix results in an apparent decrease in contaminant mass because dissolved contamination is retarded compared to the groundwater flow. The high vapor pressure and low adsorption coefficient for TCE shows that it has a low potential to adsorb onto soil or sediment. The USEPA (2014e), indicates that 4% to 6% of TCE concentrations will adsorb onto silty clay loams, with no sorption onto calcium-saturated montmorillonite clay. Although the conditions stated by Shapiro 2002 are not Site conditions, sorption is the process by which TCE attaches to organic carbon contained in the rock fractures or solution channels (secondary porosity) or onto organic carbon and mineral grains containing oxides of aluminum or iron in the rock matrix (primary porosity). TCE adsorption at the LVRR Site is expected to be less in the relatively thin sandy loam and glacial till overburden materials present.

Flow velocity in the Site bedrock secondary porosity is quite fast and in some cases the surface area of the fractures or solution channels is small relative to the volume of flow through it. There is little organic matter on the fracture/channel walls relative to the volume of groundwater; therefore, TCE sorption in the secondary porosity is relatively minor and results in no discernible retardation.

Site bedrock does not contain significant amounts of aluminum or iron so little sorption onto mineral grains in the rock matrix is expected by this means. However, the average porosity of 8% and the average TOC content of 0.16% in the rock matrix primary porosity results in both sorbed mass and dissolved mass being stored in the primary porosity. This large storage capacity results in retardation of the plume due to diffusive transfer of mass into and out of the fractures and rock matrix pore spaces.

2.4.3.2.2.2 Dispersion

The dispersion of organic solutes in an aquifer is another important consideration when simulating natural attenuation. The dispersion of a contaminant into relatively pristine portions of the aquifer allows the solute plume to mix with uncontaminated groundwater containing higher concentrations of electron

acceptors. Dispersion occurs vertically as well as parallel and perpendicular to the direction of groundwater flow. Advective dispersion describes mass transport simply due to the bulk flow of water in which the mass is dissolved, or movement of solute as a consequence of groundwater flow. Advection is the primary process by which solutes move in the groundwater. There are two types of dispersion mechanical and molecular a summary of each is discussed below.

2.4.3.2.2.2.1 Mechanical Dispersion

As defined by the USEPA, mechanical dispersion is mixing that occurs as a result of local variations in velocity around some mean velocity of flow. With time, a given volume of solute will gradually become more dispersed as different portions of the mass are transported at the differing velocities and along different flow paths. In general, the main cause of variations of both rate and direction of transport velocities is the heterogeneity and anisotropy of the porous aquifer medium. These heterogeneities are present at scales ranging from microscopic (*e.g.*, pore to pore) to macroscopic (*e.g.*, well to well) to megascopic (*e.g.*, a regional aquifer system). Three processes are responsible for mechanical dispersion on the microscopic scale. The first process is the variation in flow velocity through pores of various sizes. As groundwater flows through a porous medium, it flows more slowly through small pores than through larger pores. The second cause of mechanical dispersion is tortuosity, or flow path length. As groundwater flows through a porous medium, some of the groundwater follows less tortuous (shorter) paths, while some of the groundwater takes more tortuous (longer) paths. The longer the flow path, the slower the average linear velocity of the groundwater and the dissolved contaminant. The final process causing mechanical dispersion is variable friction within an individual pore. Groundwater traveling close to the center of a pore experiences less friction than groundwater traveling next to a mineral grain, and therefore moves faster. These processes cause some of the contaminated groundwater to move faster than the average linear velocity of the groundwater and some to move slower. This variation in average velocity of the solute causes dispersion of the contaminant.

Heterogeneity at the macroscopic and megascopic scales also creates variability in groundwater and solute velocities, therefore producing dispersion on a larger scale. Geologic features that contribute to dispersion at the macroscopic scale include: stratification characteristics such as changing unit geometry, discontinuous units, contrasting lithologies; and, permeability characteristics such as non-uniform permeability, directional permeability, and trending permeability. Even in aquifer material that appears to be homogeneous, relatively small changes in the fraction of fine sediment can change hydraulic conductivity characteristics enough to produce significant variations in fluid and solute velocities and thus

introduce dispersion. Larger geological features will introduce dispersion at the megascopic scale. At this scale, structural features such as faults, dipping strata, folds, or contacts will create inhomogeneity, as will stratigraphic features such as bedding or other depositional structures. As a result of dispersion, the solute front travels at a rate that is faster than would be predicted based solely on the average linear velocity of the groundwater. The overall result of dispersion is spreading and mixing of the contaminant plume with uncontaminated groundwater.

The bedrock underlying LVRR is a dual porosity system with most of the groundwater flow through the fractures and with most of the TCE mass storage in the rock matrix pore spaces. The geologic and hydrogeologic conditions of the Site introduce microscopic dispersion in the rock matrix pore spaces, with macroscopic and megascopic (fracture) scales of dispersion resulting in the spreading and mixing of the TCE contaminated plume with uncontaminated groundwater.

2.4.3.2.2.2.2 Molecular Diffusion

Molecular diffusion occurs when concentration gradients cause solutes to migrate from zones of higher concentration to zones of lower concentration, even in the absence of groundwater flow. This process is important for the movement of TCE from the bedrock fractures to the matrix porewater (and back out again) but not for migration through the aquifer since the distance scales are so long and the flow velocities in the secondary porosity are so high.

TCE has penetrated into the rock matrix through molecular diffusion. Within the Spill Zone BVZ, the TCE concentrations in the porewater are elevated above the TCE solubility limit concentration, implying the presence of DNAPL that may have diffused into the rock matrix above the water table. In the saturated zone, TCE migrates from fractures into the rock matrix pore spaces via diffusion processes in response to concentration gradients in both the Spill Zone and downgradient plume, and the substantial surface area provides potential for significant mass to be stored in the rock matrix. Over time, as source inputs decline, the TCE concentrations in the fractures are expected to decline below the TCE concentrations in the rock matrix porewater reversing the concentration gradient, after which TCE mass will begin to diffuse back out from the rock matrix pore spaces into the fractures. In the Lime Rock Road area (LVRR-33), TCE has also penetrated the rock matrix pore spaces but here the TCE concentration in the fractures is lower, indicating that the TCE is now generally diffusing out of the rock matrix and back into the fracture water, although this process can vary on a localized scale.

2.4.3.2.2.3 Dilution from Recharge

Recharge of a water table aquifer has two effects on the natural attenuation of a dissolved contaminant plume. Additional water entering the system due to infiltration of precipitation or from surface water will contribute to dilution of the plume; and the influx of relatively fresh, electron-acceptor-charged water, can alter geochemical processes and, in some cases, facilitate additional biodegradation. Recharge from infiltrating precipitation is the result of a complex series of processes in the unsaturated zone.

Dilution results in a reduction in contaminant concentrations due to the introduction of additional water to the system. The two most common causes of dilution (real or apparent) are infiltration and sampling from monitoring wells screened over large vertical intervals. Richards *et. al.* (2012b) and Richards (2016) determined that a large volume of allogenic water (billions of gallons annually) mixes with the Study Area groundwater system and is directed eastward, eventually discharging at the Spring Creek fault zone. The large influx of allogenic water to the TCE plume is expected to be well oxygenated due to turbulent flow along stream channels prior to infiltration and mixing with the TCE plume. This water in turn can be expected to influence groundwater chemistry in recharge areas along the southern boundary of the plume, changing from anaerobic to aerobic conditions during recharge periods. However, due to the variability involved, the timing and magnitude of these changes and their potential effect on attenuation rates is difficult to predict. In summary, Study Area hydrogeologic conditions are significantly influenced by the karstic nature of the bedrock and extremely large influx of allogenic water entering the groundwater system. These conditions act to augment non-destructive attenuation processes by natural means.

Monitoring wells screened over large vertical distances may dilute groundwater samples by mixing water from clean aquifer zones with contaminated water during sampling. The NYSDEC and LVRR monitoring wells were installed to depth discrete intervals in an attempt to minimize mixing. However, some of the NYSDEC wells are open bore holes or have screened intervals of 20 ft or more.

2.4.3.2.2.4 Volatilization

While not a destructive attenuation mechanism, volatilization does remove contaminants from the groundwater system. In general, factors affecting the volatilization of contaminants from groundwater into the vapor phase include: the contaminant concentration; the change in contaminant concentration with depth; the Henry's Law constant; diffusion coefficient of the compound; mass transport coefficients for the contaminant in both water and soil gas; sorption; and, the temperature of the water.

The Henry's Law constant indicates that TCE will readily evaporate from the dissolved-phase in water in a short time. The USEPA (2014e) states, that the half-life could be on the order to several minutes to hours but it may take several days to weeks to break down in surface water. Volatilization from the groundwater to the vadose zone follows Henry's Law, which is the relationship of the concentration of TCE in groundwater and the concentration of TCE in vadose zone above the contaminated groundwater. This is a linear relationship which shows that volatilization will be greatest near the Spill Zone where the groundwater concentrations are highest. The effects of volatilization will decrease away from the Spill Zone as the dissolved-phase TCE concentrations decrease. Furthermore, the partitioning of TCE from groundwater to the vadose zone generally happens only near the saturated/unsaturated interface. However, in a karstic environment such as that present at the Site, there may be solution channels, solution enlarged fractures, and sink holes that are seasonally not completely water filled. When air space is present in these channels, volatilization will occur and TCE mass may exit the system to the atmosphere. Sinkholes may act as natural "air strippers" in some cases, when water cascades down a sink hole from a fracture or flow channel. TCE will not volatilize from deep groundwater. Volatilization is important only for the shallow groundwater and where partially filled flow channels exist in karst.

TCE vapors have been detected above laboratory reporting limits in 33 structures, 13 of which required vapor mitigation systems, extending downgradient from the Spill Zone approximately 3.5 miles. The presence of the TCE vapors demonstrates that volatilization of TCE from impacted groundwater is occurring and TCE is being partitioned from the groundwater to the vadose zone.

In an effort to understand the CSM in relation to the potential restoration of groundwater to its most beneficial use, Site-specific parameters were used to develop a DFN model to illustrate the degree of plume attenuation due to matrix diffusion, attenuation, and other processes, as well as the magnitude and longevity of back diffusion effects from the rock matrix and timeframes to meet the MCLs. The DFN model is discussed in detail in the following section as well as in the LVRR RI (2016b), Parker and Chapman (2016) and LVRR (2019).

2.4.4 Discrete Fracture Network Modeling

On October 2, 2014, UMC on behalf of LVRR, proposed the modeling of TCE mass transfer from the bedrock matrix porewater to the groundwater in the rock fractures as a component of Addendum 7 to the RI/FS work plan dated October 30, 2014. The proposed modeling effort was approved by the USEPA via letter correspondence dated February 10, 2015.

A DFN model was prepared by G360 Centre for Applied Groundwater Research, University of Guelph, Guelph (DFN Report) to estimate the degree of TCE plume attenuation from matrix diffusion and other processes, as well as the magnitude and longevity of back diffusion effects from the rock matrix porewater and timeframes to meet the MCLs. The model is not a contaminant transport model and does not predict contaminant migration pathways or velocities. Rather, the modeling consists of screening-level or 'stylistic' DFN flow and transport model incorporating Site parameters and data to the extent possible, using a 2-dimensional steady state flow and transient contaminant transport DFN (FRACTRAN), based on Sudicky and McLaren (1992), that incorporates matrix diffusion and other relevant processes, but requires simplifications of the fracture network and flow system.

2.4.4.1 Model Approach

The model simulations are process-based in that the matrix diffusion and other key processes are included; however, it is recognized that this screening level modeling with steady state flow cannot incorporate the full complexity of the Site flow system. The simulations were informed by Site measured parameters and incorporate the key processes that control contaminant transport in a dual porosity system. This includes rapid groundwater flow in a system of interconnected fractures, with diffusion between fractures and the rock matrix, which has higher porosity than the bulk fracture porosity and can provide a significant reservoir for contaminant mass storage as dissolved and sorbed phase.

Therefore, simulations required several assumptions and simplifications given the complexity of the actual flow system conditions. Some of the uncertainties in the model simulations and potential ranges of behavior are addressed through sensitivity analyses. Simulations were also conducted to evaluate remedial scenarios. The DFN scenarios include, but are not limited to, the following:

- Current conditions, no further remedial action;
- Complete removal of mass from the unsaturated source zone in the Spill Zone; and,
- Complete source removal from both the vadose and saturated zones in the Spill Zone.

It is important to note that the latter two modeling scenarios represent hypothetical scenarios, in that such actions/conditions may not be a realistic possibility (*i.e.,* complete source removal) given the Site conditions and practical limitations to remedial technologies in fractured bedrock systems.

2.4.4.2 Model Results

To evaluate the effectiveness of potential remedial alternatives, several scenarios were added to the DFN and simulations performed. The scenarios considered were:

- No remedial actions;
- Aggressive source zone removal from the vadose zone;
- Aggressive source zone removal from both the vadose zone and saturated zone; and,
- Downgradient plume control along Church Road.

Each was evaluated using complete remediation of TCE and comparing the simulations to the base case.

2.4.4.2.1 No Remedial Actions

The no remedial action scenario simulations are the same as the base case simulation. The simulations show TCE concentrations within the plume declining into the future, as the source zone is depleted of TCE mass and inputs from the vadose zone continue to decline. The simulation also shows that the plume will reach steady-state conditions with internal plume concentrations and mass discharge levels lower than present day, depending on the ongoing nature of source inputs from the vadose zone. If slow degradation within the plume is included, conditions within the plume will continue to improve in the future.

Hypothetical simulations including degradation were evaluated. With a simulation including finite or declining TCE source and slow degradation within the plume, the long-term plume concentrations and mass discharge will continue to decline with the possibility of the plume front eventually retreating.

2.4.4.2.2 Aggressive Source Zone Removal from the Vadose Zone

The aggressive source removal in the vadose zone scenario was evaluated with time set to zero (time after remediation completion), 50 years after the spill. Simulations were run for 10, 20 and 50 years after remediation and compared to the base case. The simulations show only minor differences in TCE concentrations when compared to the base case, indicating little benefit to aggressive vadose zone remediation.

2.4.4.2.3 Aggressive Source Zone Removal from Both the Vadose Zone and Saturated Zone

The aggressive source removal for both vadose and saturated zones scenario was evaluated, again with time set to zero for the completion of remediation. Simulations were run for 10, 20, and 50 years after completion of remediation. When compared to the base case, the simulations show little difference other than some minor changes near the source zone. Minimal changes were noted further downgradient, indicating only minor benefits to aggressive source vadose and saturated zone removal.

2.4.4.2.4 Downgradient Plume Control Along Church Road

Evaluation of the downgradient plume control scenario using a two-dimensional (2D) model such as FRACTRAN is not feasible, since such simulations cannot incorporate the more complex three-dimensional (3D) flow system effects including hydraulic capture. However, this scenario is similar to the aggressive source zone removal scenarios given that the plume would be essentially cut off at some control plane, yet significant mass remains downgradient mostly in the dissolved and sorbed phase in the rock matrix porewater, and, like those scenarios, would provide only minor improvements in groundwater quality and mass discharge over time downgradient of the control area.

2.4.4.2.5 Conclusions

The DFN report concludes that the simulations presented required many assumptions and simplifications owing to the complexity of the field conditions at the LVRR Site, including a complex 3D flow system in the fractured dolostone aquifer with karst conditions including: sinkholes and dissolution channels; very transient conditions including rapidly varying water table/hydraulic head and inputs of water to the plume; complex source inputs that were exacerbated by water floods shortly after releases occurred; etc. Therefore, simulation results should be considered ‘stylistic’ in nature, but incorporate key processes controlling contaminant transport in dual porosity systems and tailored to Site conditions to the extent feasible. The flow system was constrained by hydraulic information on bulk K and plume scale hydraulic gradients and matrix parameters by lab measurements on core samples (Parker *et. al.,* 1994 Appendix E and Appendix F for graphs). Overall, the simulations show that matrix diffusion is expected to have strongly attenuated plume transport at the LVRR Site, consistent with field monitoring data showing strong declines in contaminant concentrations with distance from the source area along the plume longsect. Simulation results indicate the majority of contaminant mass is now present in the rock matrix, which is consistent with results from detailed rock matrix sampling at key locations along the plume flow path

(LVRR-36, LVRR-35 and LVRR-33). Under these conditions, it is expected that mass discharge within the downgradient portions of the plume in fractures, which carry nearly all groundwater flow, should be relatively low. With declining contaminant inputs to the plume, due to depletion of DNAPL mass that penetrated below the water table likely occurring within a few years after releases occurred, and inputs from the larger mass persisting in the vadose zone also declining, model results suggest conditions within the plume should slowly improve over time with declining mass discharge to downgradient receptors. As discussed elsewhere in this report, such trends are consistent with Site groundwater monitoring data collected between 1993-1995 by NYSDEC, and in the more recent investigations by LVRR between 2010-2015, showing concentrations generally stable or declining throughout the plume.

FRACTRAN model simulations suggest that aggressive remedial efforts to further reduce mass inputs to the plume, including complete removal of ongoing vadose zone source inputs, remediation of hotspot mass present in the groundwater zone near and below the source area, and/or cut off plume mass discharge downgradient of the source area would have only minor influence on improving water quality downgradient within the plume and only after extended periods of time, and negligible impact on conditions nearer the plume front within any reasonable timeframe. Inclusion of slow degradation in simulations, based on field evidence suggesting degradation may be playing a minor role at the Site, would lead to greater impacts on the downgradient plume following source depletion or cutoff; however, the extent to which degradation is occurring and influencing the plume is unclear and appears to only be a minor process, so such evaluations are likely not justified based on Site data collected to date.

The following section incorporates the above Site history and CSM to evaluate Groundwater Restoration and TI.

2.4.5 Evaluation of Groundwater Restoration and Technical Impracticability

Upon USEPA acceptance of the LVRR RI Report and Addendum 1, the USEPA requested an evaluation of the potential and technical feasibility for restoring the groundwater at the Site to beneficial use as defined by CERCLA groundwater restoration cleanup levels which are established by chemical-specific ARARs. On February 8, 2019, UMC submitted a draft AGTI Report to USEPA Region 2 and USEPA headquarters for consideration during the FS, Proposed Plan, and Record of Decision (ROD) phases of the Site project. On May 30, 2019, the USEPA issued a letter correspondence stating, “The rational presented in the TI evaluation documents are acceptable and the TI consultation requirements have now been successfully met. It should be noted that this acknowledgement does not equate to a TI waiver since that can only be achieved in the finalized decision document.”

The AGTI, with USEPA guidance (USEPA 2013), defined two technical impracticability waiver zones (TI Zones) developed on the basis of the maximum historical extents of dissolved phase TCE and TCE breakdown products at or above laboratory method reporting limits. The horizontal and vertical spatial extent of the proposed TI Zones are illustrated on Figures 2-1, 2-2, 2-3 and are defined as follows:

1. **Zone 1**: Figure 2-1 depicts a red colored area encompassing the approximately 3.1 million square foot Spill Zone and extending vertically to the upper Camillus Formation (a depth corresponding to approximately 120 feet below the ground surface), resulting in a volume of approximately 213 million cubic feet where groundwater TCE concentrations generally exceed 1,000 µg/L; and,
2. **Zone 2:** Figure 2-1 depicts a yellow colored area encompassing approximately 102 million square feet outside of the Spill Zone area extending vertically to the base of the Camillus Formation (ranging from approximately 120 feet below ground surface in the western extent of the Study Area to outcrops occasionally near Spring Creek, and Oatka Creek), resulting in a volume of approximately 7,821 million cubic feet where groundwater TCE concentrations generally range from 5 µg/L to 1,000 µg/L. The TI boundary at the distal end of the TCE plume was established to include the entire Spring Creek Fault Zone (illustrated on Figure 2-6) that extends just east of Spring Creek.
3. **Monitoring Zone:** Figure 2-1 depicts a gray colored area that encompasses an approximately 39 million square foot area extending vertically to the base of the Camillus Formation (ranging from approximately 120 feet below ground surface in the western extent of the Study Area to outcrops occasionally near Spring Creek, and Oatka Creek) resulting in a volume of approximately 2,990 million cubic feet where groundwater where groundwater TCE concentrations generally range from non-detect to 5 µg/L.

The AGTI concludes that the restoration of groundwater to its most beneficial use is not technically practical within a reasonable timeframe. The NCP states that "EPA expects to return usable ground waters to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site." However, at the LVRR Site, restoration to MCLs would be expected to take centuries with or without active remediation. These are not reasonable time frames in the context of the NCP. The proposed spatial extent of the TI zone was presented in the AGTI report and is illustrated on **Figures 2-1, 2-2, and 2-3** of this report.

The following sections present an overview of the potential COPC exposure pathways and receptors.

2.4.6 Exposure Pathways and Potential Receptors

The USEPA's Guidance (1997), states, an exposure pathway is the pathway by which a stressor (any physical, chemical, or biological entity that can induce an adverse response) travels from a source to receptor(s). The NYSDEC and LVRR remedial investigations, CSMs, and interim remedial actions identified how, when, and where exposure occurs or has occurred. In evaluating potential exposure pathways for human receptors inhalation, ingestion, and/or dermal contact exposure routes were considered. In evaluating potential exposure pathways for ecological receptors, Spill Zone soil, Sitewide groundwater, Mud Creek surface water, sediment, BVZ, and SVI were considered.

An exposure pathway consists of the following:

- Source of constituents;
- Mechanism of constituent release to the environment;
- Transport or exposure medium containing the constituents;
- Exposure point where human receptors can contact the exposure medium; and,
- Exposure route (*e.g.*, inhalation, ingestion, or dermal contact).

All these elements must be present for an exposure to occur. The human health conceptual exposure model in **Figure 2-14** of this report shows both potentially complete and incomplete pathways for each of the potential receptors described below.

Potential receptors are defined as human populations or individuals and environmental systems that are susceptible to contaminant exposure from Spill Zone soil and Sitewide groundwater and associated surface water, sediments, BVZ, and SVI. Both current and future land use conditions were considered when determining exposure scenarios.

Currently, with the exception of remediation activities, Spill Zone soil is not used for any activities or uses. The northern portion of the Spill Zone is sparsely vegetated and contains the remains of a concrete foundation for the former Knickerbocker Hotel. Approximately 375 ft north of the former Knickerbocker Hotel is an approximate 50-foot-deep abandoned limestone quarry. The active General Crushed Stone Company limestone quarry is located west of the Spill Zone and has been excavated to a depth of approximately 100 ft. A portion of the quarry property comprises the west portion of the Spill Zone. This area consists of sparse vegetation, little or no soil cover and stockpiled limestone gravel. Residential land within the eastern portion of the Spill Zone appears to be associated with farmland (where TCE concentrations are less than Unrestricted Use SCOs). Areas within the southern portion of the Spill Zone

and to the south and east of the Spill Zone are generally wooded properties owned by the Town of Leroy and the Northwoods Sportsman's Club. The Site layout is detailed in **Figure 1.3-2** of this report.

The Spill Zone is generally unsecured with the exception of two fenced areas accessible through locked entry gates: an area which formerly contained trailers that house the SVE mechanical systems; and, the support zone area which contains an office trailer, equipment storage, and investigation derived wastes storage.

Future land use in and surrounding the Spill Zone is expected to remain predominantly agricultural and forested lands, but residential areas may increase. Utilizing ICs, such as environmental easements, could prevent residential exposure to any remaining contamination in and around the Spill Zone.

Therefore, the following potential receptors were identified given the Site setting and land uses at and downgradient of Spill Zone soil and Sitewide groundwater:

Spill Zone Soil:

- Future Industrial Worker;
- Future Utility/Excavation Worker;
- Future Construction Worker;
- Future Trespasser; and,
- Future Recreational User (Hunter, ATV/Dirt Bike User).

Groundwater, Surface Water and Sediment:

- Current/Future Resident (Adult/Child);
- Current/Future Commercial/Industrial Worker;
- Current/Future Construction Worker; and,
- Current/Future Recreational User (Adult/Adolescent/Child) in Mud Creek.

Potentially complete human exposure pathways of concern for Spill Zone soil and Sitewide groundwater, surface water, and sediment are as follows:

Potentially Complete Human Exposure Pathways of Concern	
Spill Zone Soil	
Future Industrial Worker	Incidental ingestion of and dermal contact with surface soil; and, inhalation of surface soil-derived particulates and vapors

Potentially Complete Human Exposure Pathways of Concern	
Future Trespasser	Incidental ingestion of and dermal contact with surface soil; and, inhalation of surface soil-derived particulates and vapors
Future Recreational User (Adult/Child)	Incidental ingestion of and dermal contact with surface soil; and, inhalation of surface soil-derived particulates and vapors
Future Utility/Excavation Worker	Incidental ingestion of and dermal contact with subsurface soil; and, inhalation of soil-derived particulates and vapors
Future Construction Worker	Incidental ingestion of and dermal contact with subsurface soil; and, inhalation of soil-derived particulates and vapors
Groundwater, Surface Water and Sediments	
Current/Future Resident (Adult/Child)	Inhalation of vapor-phase chemicals released from the subsurface (groundwater and soil) to indoor air
Future Resident (Adult/Child)	Ingestion of and dermal contact with COCs in tap water and inhalation of COCs volatilized into bathroom air
Current/Future Commercial/Industrial Worker	Inhalation of vapor-phase chemicals released from the subsurface (groundwater and soil) to indoor air
Future Commercial/Industrial Worker	Ingestion of and dermal contact with tap water
Current/Future Construction Worker	Ingestion of and dermal contact with trench water and inhalation of trench air
Current/Future Recreational User (Adult/Adolescent/Child) in Mud Creek, Oatka Creek and Spring Creek	Ingestion of and dermal contact with surface water (including spring water) and sediments while swimming

Since the less conservative on-Site receptors (*i.e.*, industrial worker and construction worker) for soil were evaluated in the 2021 Supplemental Human Health Risk Evaluation and showed unacceptable risks, the more conservative receptor populations such as residents, that were not evaluated in the 2021 Supplemental Human Health Risk Evaluation, would also exceed risk thresholds.

The extent of Site-related constituents in Spill Zone soil has been defined and does not extend beyond the Spill Zone above NYSDEC Unrestricted Use SCOs. In addition, under current conditions, the SVE cover prevents the overland runoff or airborne transport of Site-related constituents to off-Site

locations. However, off-Site receptors (such as residents, workers or recreational users) were also considered potential receptors of Spill Zone soil under future land use conditions (in the absence of cover).

Ecological receptors include both terrestrial and aquatic communities. The terrestrial communities include the invertebrate community, plant community, along with avian and mammalian wildlife. Aquatic communities include the benthic community, along with avian and mammalian piscivorous receptors. The existing SVE cover prevents current exposure of potential ecological receptors to Spill Zone soil. It also does not provide sufficient habitat for small carnivorous ecological receptors. However, if the existing cover is removed, there is a potential for future habitat to be present for ecological receptors including small carnivorous mammals, at the Spill Zone. Impacts to the wildlife community from exposure to surface water and sediment at the Site are not expected.

The following sections summarize proposed RAOs and media specific remedial action alternatives to address the human and ecological exposure pathways and potential receptors.

3 REMEDIAL ALTERNATIVES EVALUATION OVERVIEW

This section provides a general overview for the development, screening, and detailed evaluation of alternative remedial actions. The Site and media specific remedial alternatives evaluation is provided in Section 4 of this FS Report. The initial step in the development of remedial alternatives is to develop RAOs for protecting human health and the environment. The development of these RAOs involves consideration of ARARs, "To Be Considered" (TBC) advisories, criteria, or guidance, and other guidance, as well as the results of the SLERA and BHHRA. For purposes of this FS Report, ARARs is used to refer to all of these elements. An overview of ARARs is presented, followed by identification of Site-specific ARARs, TBCs or other guidance. PRGs are then selected that conform to the ARARs and TBCs (see **Appendix A**). Then, GRAs and Process Options are evaluated for implementability, effectiveness, and general cost as well as their ability to meet the RAOs and PRGs. The GRAs that could meet the RAOs and PRGs are further evaluated against the NCP's nine criteria for consideration as a remedial alternative for the Site. A general overview of each of these steps is discussed below.

3.1 Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

The USEPA defines applicable requirements as "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State

environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site." An applicable requirement must directly and fully address the situation at the Site.

The USEPA defines relevant and appropriate requirements as "those cleanup standards, standards of control, or other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws 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."

Actions must comply with State ARARs that are more stringent than Federal ARARs. State ARARs are also used in the absence of a Federal ARAR, or where a State ARAR is broader in scope than the Federal ARAR.

ARARs are not currently available for every chemical, location, or action that may be encountered. When ARARs are not available, remediation goals may be based upon TBCs, other guidance, local ordinances, or other site-specific health-based levels.

Remedial actions performed under Superfund authority must comply with ARARs except in the following circumstances: (1) the remedial action is an interim measure or a portion of the total remedy which will attain the standard upon completion; (2) compliance with the requirement could result in greater risk to human health and the environment than alternative options; (3) compliance is technically impractical from an engineering perspective; (4) the remedial action will attain an equivalent standard of performance; (5) the requirement has been promulgated by the State, but has not been consistently applied in similar circumstances; or (6) the remedial action would disrupt fund balancing.

ARARs are generally classified as chemical-specific, action-specific, or location-specific. Chemical-specific and are usually health- or risk-based concentrations in environmental media (*e.g.*, air, soil, water), or methodologies that when applied to site-specific conditions, result in the establishment of concentrations of a chemical that may be found in, or discharged to, the ambient environment. The determination of potential chemical-specific ARARs for a site is based on the nature and extent of contamination; potential migration pathways and release mechanisms for site contaminants; reasonably anticipated future site use; and likelihood that exposure to site contaminants will occur.

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location. Some examples of these unique

locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. The location of the site is a fundamental determinant of its impact on human health and the environment.

Action-specific ARARs are restrictions placed on particular treatment or disposal technologies. Examples of action-specific ARARs are effluent discharge limits and hazardous waste manifest requirements. ARARs for impacted media identified within the Spill Zone and Study Area are presented in Section 4.

3.2 Remedial Action Objectives and Preliminary Remediation Goals

3.2.1 Remedial Action Objectives

According to USEPA RI/FS Guidance, RAOs consist of media-specific or operable unit-specific goals for protecting human health and the environment. The objectives should be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited. RAOs should specify the contaminant of concern, exposure routes and receptors; and an acceptable contaminant level or range of levels for each exposure route (*i.e.*, a PRG). The USEPA RI/FS Guidance further states that RAOs for protecting human health should express both a contaminant level and an exposure route, rather than contaminant levels alone, because protectiveness may be achieved by reducing exposure (such as capping an area, limiting access, or providing and alternate water supply) as well as by reducing contaminant levels. RAOs for protecting environmental receptors typically seek to preserve or restore a resource, environmental objective(s) should be expressed in terms of the medium of interest and target cleanup levels, whenever possible.

The establishment of RAOs and criteria are used to evaluate the expected performance of remedial technologies to be applied at the site. These factors are then used to determine areas on-Site where specific media need to be remediated. RAOs are Site- and medium-specific objectives established to help meet the PRGs to ensure that the remedial action will be protective of human health and the environment. RAOs for impacted media identified within the Spill Zone and Study Area are presented for each media in Section 4.

3.2.2 Preliminary Remediation Goals

PRGs are media- and contaminant-specific numerical or qualitative standards that can be compared directly to the results or predicted results of remedial actions to verify compliance with RAOs. Consistent with USEPA guidance, PRGs should be clear and reasonable, be protective of human health and the environment, and take into consideration Site-specific conditions and foreseeable future land-use.

To evaluate remedial alternatives and support the RAOs, PRGs for the Site were developed for soil, groundwater, surface water and vapor intrusion as detailed in Section 4.

3.3 Development, Evaluation, and Screening of General Response Actions and Process Options

3.3.1 General Response Actions

GRAs describe those actions that will satisfy the RAOs. GRAs may include treatment, containment, excavation, extraction, disposal, ICs, or a combination of these. Like RAOs, GRAs are media-specific. Combinations of GRAs may be utilized in the development of remedial alternatives. GRAs that might be used at a site are initially defined during the RI/FS process as a better understanding of site conditions is gained and ARARs are identified.

The specific GRAs that will be evaluated in this FS Report include the following:

1. No Action;
2. ICs and Monitoring;
3. Containment; and,
4. Physical Removal/Treatment.

The Common Elements GRA is discussed in further detail in Section 3.3.1.1.

3.3.1.1 Common Elements of Feasability Study Alternatives General Response Actions

The Common Elements GRA is applicable to the Site as a whole and includes actions such as ICs and long-term response actions. The other three GRAs listed are discussed within the media-specific remedial alternatives evaluations (Sections 4.1 through 4.5) and are applicable for the media under which they are listed.

Green remediation techniques, as detailed in NYSDEC's Green Remediation Program Policy-DER-31[3], and USEPA Region 2's Clean and Green Policy[4], will be further considered during the remedial design phase of the selected remedy and implemented during the remedial action phase of the project.

3.3.1.1.1 Institutional Controls

ICs are non-engineered instruments, such as administrative and legal controls that help to minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. ICs play an important role in site remedies because they reduce exposure to contamination by limiting land or resource use and guide human behavior where hazardous substances prevent unlimited use and unrestricted exposure. The USEPA requires the identification and evaluation of ICs during the FS stage. The USEPA identifies four general categories of ICs: (1) governmental controls (*e.g.,* zoning, state or local ordinances); (2) proprietary controls (*e.g.,* easements, restrictive covenants); (3) enforcement and permit tools (*e.g.*, consent decrees, administrative orders); and, (4) informational devices (*e.g.*, notices filed with the land records, advisories). The NCP states that ICs are meant to supplement active remediation and engineering controls (ECs) and that they will rarely be the sole remedy at a site.

LVRR has reviewed zoning, current and potential future land uses and existing governmental controls in the relevant jurisdictions in order to assist in the identification and implementation of various ICs. ICs will, in some capacity, be a component of any remedy for the Site with different ICs utilized for different areas/media. Below is a table identifying the contemplated ICs for each media at the Site.

Contemplated ICs for Each Media			
Environmental Media	**Governmental Controls**	**Proprietary Controls**	**Informational Devices**
Groundwater	X		X
Soil	X	X	X
Surface Water		X	X
Bedrock		X	X

[3] See http://www.dec.ny.gov/docs/remediation_hudson_pdf/der31.pdf

[4] See http://epa.gov/region2/superfund/green_remediation

Contemplated ICs for Each Media			
Soil Vapor Intrusion	X		X

A further discussion of the ICs is provided below.

3.3.1.1.1.1 Governmental Controls

Governmental controls, in the form of State/County/Local laws to the extent that they exist, were evaluated for inclusion, if necessary, in remedies for the various media at the Site.

3.3.1.1.1.1.1 Governmental Controls Specific to Groundwater

LVRR reviewed existing governmental controls that serve to limit groundwater usage at the Site. An evaluation of these governmental controls is provided in more detail in **Appendix C**[5]. The evaluation identified several existing governmental controls including the New York State Sanitary Code and the Uniform Fire Prevention and Building Code, county level sanitary and building codes enacted by Genesee County, Monroe County and Livingston County, and municipal ordinances enacted by Town of LeRoy (Genesee Co.), Town of Wheatland (Monroe Co.), Village of Caledonia (Livingston Co.), and Town of Caledonia (Livingston Co.).

3.3.1.1.1.2 Governmental Controls Specific to Soil

A review of State and Local laws and regulations was conducted for governmental controls that would limit exposure to soil. The Spill Zone is located within the Town of Leroy and is designated on the Town's Zoning Map as I-1 Industrial District. See **Figures 1.4-1 and 1.5-1, 2, 3**. The I-1 Industrial District does not permit residential development. See Town of Leroy Code, Part II: General Legislation, Article IV, District Use and Bulk Requirements, § 165-20.

3.3.1.1.2 Proprietary Controls

Proprietary controls, such as a Declaration of Covenants, Restrictions and Environmental Easement ("Environmental Easement"), may be used to limit exposure to soil and bedrock in the Spill Zone, and

[5] **Appendix C**, revised by Blank Rome, and presented to USEPA via email correspondence dated April 24, 2023.

potentially restrict future land uses in the Spill Zone, and potentially restrict the uses of surface water at Mud Creek.

3.3.1.1.1.2.1 Proprietary Controls Specific to Groundwater

A review of existing governmental controls identified a sufficient regulatory system that serves to limit groundwater usage at the Site. See **Appendix C.** Accordingly, proprietary controls specific to groundwater are not contemplated at this time.

3.3.1.1.1.2.2 Proprietary Controls Specific to Soil, Surface Water, Bedrock, and Soil Vapor

Proprietary controls, in the form of Environmental Easements, could be utilized within the Spill Zone and potentially for surface water areas of Mud Creek. See **Figures 1.4-1, 1.5-1, 2, 3, 4, and 2-17, 18, 19, 20.** Proprietary controls could limit the use of parcels in the Spill Zone to non-residential, require further testing of soil vapor, and require compliance with the Site O&M Plan (sometimes referred to as a Site Management Plan [SMP[6]] in NYS) to, among other things, avoid direct contact with soil during construction activities, and conduct inspections that would include identifying new homes in the plume area, new connections to the public water line, new soil vapor intrusion mitigations sub-slab depressurization systems (SSDS), and any other soil vapor intrusion investigations. The NYSDEC/DOH recommends these inspections be conducted on an annual basis, with and accompanying annual report. Costs related to potential SVI inspections are included within **Table 4.2-1**.

3.3.1.1.1.3 Informational Devices

Informational devices such as advisories or notices published in newspapers and periodic letters sent to local government authorities on need to limit water withdrawal or new construction unless appropriate SVI investigations are conducted and/or mitigation measures are taken, could be utilized as part of the remedy. Additionally, a "Notice to Successors-in-Title" ("Deed Notice") may be utilized in the Spill Zone to notify current and future owners of contamination remaining at the Site.

[6] A Site-wide O&M Plan/SMP for all media will be drafted and implemented after remedy selection. The cost associated with SMP preparation is included on **Table 4.1-1** Institutional Controls and Monitoring for Portion of Groundwater Plume Proposed for a Technical Impracticability Waiver.

3.3.1.1.1.3.1 Informational Devices Specific to Groundwater

In addition to the governmental controls for groundwater discussed above, additional ICs in the form of informational devices could be employed. These may include advisories published in newspapers, periodic letters sent to State and local authorities informing them of the need to prevent well installation, and inspection of State and local land use and health department records to ensure that no wells are installed that could impact the groundwater plume or result in exposure to contaminated groundwater.

3.3.1.1.1.3.2 Informational Devices Specific to Bedrock

A Deed Notice is contemplated to identify the boundaries of the contaminated bedrock existing at the Site. A Deed Notice would provide notice to current and future property owners of contaminated bedrock under their parcels, and notice to the local governments on the extent of the bedrock contamination area in their jurisdiction, and notify these parties on the requirements of the O&M Plan. Advisories, similar to the notices discussed above, would be published in the newspapers and periodic letters could be sent to local government authorities on the need to limit certain construction activities in/near the bedrock in accordance with the O&M Plan.

3.3.1.1.1.3.3 Informational Devices Specific to Surface Water

Informational devices, similar to the notices and advisories discussed above, would be published in the local newspapers and periodic letters could be sent to affected property owners and local government authorities on limiting certain activities in the surface water at the Site in accordance with the O&M Plan. Additionally, a Deed Notice is contemplated to identify the boundaries of the contaminated surface water existing at the Site. A Deed Notice would provide notice to the current and future property owners and local governments on the boundaries of contaminated surface water and provide reference to the requirements of the O&M Plan.

3.3.1.1.1.3.4 Informational Devices Specific to Soil Vapor Intrusion

In addition to a Deed Notice used to identify the extent of the groundwater plume contamination area as discussed above, a Deed Notice is also contemplated to identify the potential for SVI in the groundwater plume area. This Deed Notice would alert local governments to the boundaries of contaminated groundwater plume and the potential for SVI in those areas. Advisories published in newspapers and periodic letters sent to local government authorities on need to limit new construction in the Spill Zone unless appropriate SVI investigations are conducted and/or mitigation measures (including

periodic monitoring, as necessary) are implemented would be utilized. These notices would inform future property owners of the potential for SVI at their property and provide contact information should an affected property owner wish to seek SVI sampling or installation of SVI mitigation systems to meet applicable NYSDOH/NYSDEC SVI thresholds. A review of State and local laws and regulations was conducted for informational devices specific to SVI. New York's Environmental Conservation Law, ECL § 27-2405, is applicable Statewide, and requires property owners to notify tenants or occupants of any property affected by SVI and any vapor testing results.

3.3.1.1.2 Long – Term Monitoring

Monitoring of ICs, groundwater, surface water, EC, soil vapor, vapor mitigation systems, etc., is discussed within each proposed media specific alternative (Section 4.0) and will likely be a component of any proposed remedy.

3.3.1.1.3 Maintenance

O&M of a selected remedy ensures that the remedy continues to perform as intended and remains protective of human health and the environment. O&M activities may include remedy operation, maintenance and monitoring, as well as monitoring of impacted media and the implemented ICs. For example, maintenance is anticipated at the Site for existing vapor mitigation systems and potential installation of new systems, as needed, for impacted properties constructed within, overlying, and adjacent to the groundwater plume.

3.3.1.1.4 Connection to Waterline

The potential connection of newly constructed structures within or overlying the groundwater plume to the municipal water supply system is anticipated and considered within this FS Report.

3.3.2 Identification and Screening of Technologies and Process Options

According to USEPA RI/FS Guidance, in this step the universe of potentially applicable technology classes and process options is reduced by evaluating the options with respect to technical implementability. The term "technology classes" refers to general categories of technologies, such as, chemical treatment, thermal destruction, immobilization, capping, or dewatering. The term "technology process options" refers to specific processes within each technology type. Several broad technology classes may be identified for each GRA, and numerous technology process options may exist within each technology class. During this

screening step, process options and entire technology classes are eliminated from further consideration on the basis of technical implementability based on the RI site characterization and on-Site characteristics.

The technology processes considered to be implementable are evaluated in greater detail before selecting one or more processes to represent each technology class to simplify the subsequent development and evaluation of alternatives. Process options are evaluated using three of the USEPA's nine criteria: effectiveness, implementability, and cost related only to each technology and GRA and not the site as a whole. The evaluation process provides a basis for developing performance specifications during preliminary design; however, the specific process actually used to implement the remedial action at a site may not be selected until the remedial design phase. These process options are screened for their applicability to the LVRR Site as described below. As indicated above, each process option is briefly described, and evaluated for the following three criteria:

a) ***Effectiveness:*** Specific technology processes that have been retained will be evaluated further on their effectiveness relative to other processes within the same technology class. This evaluation will focus on: (1) the potential effectiveness of process options in handling the estimated areas or volumes of media and meeting the remediation goals identified in the RAOs; (2) the potential impacts to human health and the environment during the construction and implementation phase (if required); and (3) how proven and reliable the process is with respect to the contaminants and conditions at the Site.

b) ***Implementability:*** Evaluation of implementability will encompass both the technical and administrative feasibility of implementing each specific technology process. Technical implementability is used as an initial screen of technology classes and process options to eliminate those that are clearly ineffective or unworkable at the site. Therefore, this subsequent, more detailed evaluation of process options will place a greater emphasis on the institutional aspects of implementability, such as the ability to obtain necessary permits for off-site actions, the availability of treatment, storage, and disposal services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology.

c) ***Cost:*** This evaluation will utilize general capital and/or O&M costs rather than detailed estimates. At this stage in the process, the cost analysis is made on the basis of engineering judgment, and each process is evaluated as to whether costs are high, low, or average relative to other process options in the same technology class. Using different process options within a technology class usually has a less significant effect on cost than does the use of different technology classes.

3.4 Development and Detailed Analysis of Alternatives

Once the evaluation and selection of representative technologies is complete, alternatives selected for detailed analysis against the NCP's nine criteria are developed. The detailed evaluation follows the process specified in the "*Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*" (USEPA, 1988). Per the guidance, nine evaluation criteria are to be applied against each of the remedial alternatives. A brief description of each of these criteria is provided below:

Overall Protection of Human Health and the Environment **-** This criterion provides a final check to assess whether each alternative meets the requirement that it is protective of human health and the environment. The overall assessment of protection is based on a combination of factors assessed under the evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs **-** This criterion is used to determine how each alternative complies with Federal and State ARARs, as defined in CERCLA Section 121, or justifies a waiver.

Long Term Effectiveness **-** This criterion addresses the results of a remedial action in terms of the risk remaining at the Site after the response objectives have been met. The primary focus of this evaluation is to determine the extent and effectiveness of the controls that may be required to manage the risk posed by residual contamination. The factors to be evaluated include the magnitude of remaining risk (measured by standards such as reduction in off-site contaminant loadings and associated risk reduction), and the adequacy, suitability, and long-term reliability of management controls for providing continued exposure protection from residuals (*i.e.*, assessment of potential failure of the technical components).

Reduction of Toxicity, Mobility, or Volume **-** This criterion addresses the statutory preference for selecting remedial actions that permanently and significantly reduce toxicity, mobility, or volume of the contaminants. The factors to be evaluated include the remediation process employed, the amount of hazardous material destroyed or treated, the degree of reduction expected in toxicity, mobility or volume, and the type and quantity of residuals.

Short-Term Effectiveness **-** This criterion addresses the effects of the alternative during the construction and implementation phase until the remedial actions have been completed and the selected level of protection has been achieved. Each alternative is evaluated with respect to its effects on the community and on-Site workers during the remedial action, environmental impacts resulting from implementation, and the amount of time until protection is achieved.

Implementability - This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Technical feasibility considers construction and operational difficulties, reliability, ease of undertaking additional remedial action (if required), and the ability to monitor its effectiveness. Administrative feasibility considers activities needed to coordinate with other agencies (*e.g.*, State and Local) in regard to obtaining permits or approvals for implementing remedial actions.

Cost - This criterion addresses the capital costs, annual O&M costs, and present worth analysis. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor, and material necessary to perform remedial actions. Indirect costs include expenditures for engineering, financial and other services that are not part of actual installation activities but are required to complete the installation of remedial alternatives. Annual O&M costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action.

All costs will be targeted toward an estimated accuracy of +50/- 30% in 2023 dollars. Construction costs do not include legal, accounting, insurance, or interest and financing charges that may be incurred in connection with the construction unless otherwise specified.

A present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to the current base year. This allows the cost of remedial action alternatives to be compared on a common basis representing the amount of money that would be sufficient to cover all costs associated with the remedial action over its planned life. Unless otherwise stated, a discount rate of 7% before taxes and after inflation is assumed, with a maximum period of performance of 30 years.

State Acceptance - This criterion evaluates the technical and administrative issues and concerns the State of New York may have regarding each of the alternatives. The NYSDEC and NYSDOH are the two primary State agencies expected to provide input to remedy acceptability. This criterion will be assessed following submittal of the FS Report based on input from these agencies during the regulatory review period.

Community Acceptance - This criterion incorporates public concerns into the evaluation of the remedial alternatives. Typically, community (and also State) acceptance cannot be determined during development of the RI/FS. Accordingly, evaluation of these criteria is postponed until the FS Report has been released for State and public review. These criteria are then addressed in the ROD and the responsiveness summary.

The USEPA letter correspondence to LVRR dated August 26, 2021, requests the evaluation of remedial alternatives on a media-specific basis; therefore, Section 4 below summarizes the media-specific remedial alternative evaluations for groundwater, SVI, the BVZ, surface water, and soil.

4 MEDIA SPECIFIC REMEDIAL ALTERNATIVE EVALUATIONS

4.1 Groundwater Media Remedial Alternative Evaluations

4.1.1 Groundwater Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

All groundwater in NYS is classified as GA, groundwater suitable as a source of drinking water. Site groundwater is not currently used as a source of drinking water. However, NYS Groundwater Quality Standards are applicable requirements and the Federal and NYS primary drinking water standards are considered to be relevant and appropriate.

- National Primary Drinking Water Standards (40 CFR Section 141): drinking water standards (MCLs) for COCs are provided in **Appendix A** (Table A-1). Note that these MCLs are considered relevant and appropriate requirements for groundwater which is classified as suitable for drinking water (40 CFR Section 300.430[e][2][i][b]).
- NYS Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6 NYCRR Part 703): used as the primary basis (applicable ARAR) for setting numerical criteria for groundwater and surface water cleanups. The standards for the Sitewide groundwater plume COCs are included in **Appendix A** (Table A-1).
- NYSDOH Drinking Water Standards (10 NYCRR Part 5): sets MCLs for public drinking water supplies. This is an ARAR for cleanup of the groundwater at the Site. The standards for COCs are included in **Appendix A** (Table A-1).
- It should be noted that select ARARs related to Sitewide groundwater were proposed for TI waiver consideration within the AGTI report. Specifically, the USEPA MCLs for the COCs TCE and its degradation products DCE and VC.

4.1.1.1 Groundwater Restoration and Technical Impracticability Waiver

TI is a regulatory determination that remedial actions at the Site, or a portion of the Site, cannot achieve remediation goals (*e.g.*, chemical-specific ARARs) using available technologies due to several possible factors. These factors may include technology limitations, contaminant phase (*i.e.*, aqueous versus

NAPL), contaminant depth, complexity of geological setting, and hydraulic regime (*e.g.*, low hydraulic conductivity). When a TI waiver is granted, the remedial action will not be required to meet the ARAR or ARARs that have been waived, but may be required to meet an alternative level or achieve an alternative remedial goal. Furthermore, a TI decision applies only to the TI Zone (the spatial 3D area TI Zone) in which ARARs or other cleanup standards practically cannot be met. Outside of the TI Zone, the ARARs will remain as the final cleanup goal. Sites incorporating TI waivers into final decision documents must nonetheless provide for protection of human health and the environment.

USEPA Guidance documents acknowledge that restoration of groundwater to drinking water quality (or more stringent levels where required) may not always be achievable due to Site-specific factors and limitation of available remediation technologies. In cases where there is a high degree of certainty that cleanup levels cannot be achieved, a final ROD that invokes a Technical Impracticability ARAR waiver (TI Waiver) and establishes an alternative remedial strategy may be the most appropriate option.

As discussed above in Section 2.4.5, the AGTI concludes that the restoration of groundwater, within the LVRR Study Area, to its most beneficial use is not technically practicable within a reasonable timeframe. On May 30, 2019, the USEPA sent a letter to LVRR stating, "The rational presented in the TI evaluation documents are acceptable and the TI consultation requirements have now been successfully met. It should be noted that this acknowledgement does not equate to a TI waiver since that can only be achieved in the finalized decision document."

4.1.2 Groundwater Remedial Action Objectives and Preliminary Remediation Goals

In consideration of the conclusions of the ATGI, the RAOs recognize that the restoration of the groundwater to MCLs is not practicable. When restoration of groundwater to its beneficial use is not practicable, the USEPA selects an alternative remedial strategy that is technically practicable, protective of human health and the environment, and satisfies statutory and regulatory requirements of CERCLA. Consistent with the NCP, alternative remedial strategies for sites with TI Waivers address exposure control, source control, and aqueous plume migration. In the RAOs below, exposure control and plume migration are addressed by the groundwater and SVI RAOs and source control is addressed by the RAOs for the BVZ, surface water, and soil.

The following groundwater RAOs would be met through a combination of common elements such as, ICs, monitoring, and the consideration of active alternatives for surface water and soil described in

Sections 4.4 and 4.5 below, as well as a consideration of additional source reduction (*i.e.*, natural attenuation).

The RAOs for groundwater are as follows:

a) Prevent current and future human exposure to Site-related contaminants in groundwater that exceed Federal or State MCLs;

b) Prevent further migration of Site-related contaminants in groundwater at levels exceeding MCLs beyond the delineated areal extent of the groundwater contamination (TI Zone); and,

c) Prevent the migration of Site-related contaminants in groundwater to receiving surface water above applicable surface water quality standards.

Compliance with State standards for the restoration of State waters to such quality that allows for their most "Beneficial Use" is not technically practicable at the Site based on the groundwater TI evaluation. Restoration of groundwater to the most "Beneficial Use" shall be considered restoration of groundwater to conditions suitable for public water supply use for human consumption in accordance with State standards. PRGs were developed for groundwater based on the ARARs. The most stringent of the National Primary Drinking Water Standards MCLs, NYS Groundwater Quality Standards and NYSDOH Drinking Water Quality Standards were selected as the remediation goal for the COCs (see **Appendix A,** Table A-1). Consistent with the RAOs and the groundwater TI evaluation, these numerical goals will be used for developing use restrictions and other actions to prevent exposure, and for assessing the extent of the aqueous plume, but not for achieving restoration of groundwater to the numerical goals/criteria.

4.1.3 Institutional Controls and Monitoring for Portion of Groundwater Plume Proposed for a Technical Impracticability Waiver

Groundwater RAOs would be met through a combination of ICs and long-term response actions (common elements), active alternatives for soil and surface water, as well as consideration of additional source reduction (*e.g.*, natural attenuation). ICs in the form of Governmental Controls specific to groundwater and the long-term monitoring of the proposed TI Zone utilizing the USEPA Region 2 and NYSDEC green remediation techniques is discussed above in Section 3.3.1.1 and **Appendix C**. For purposes of providing a cost estimate in this FS, it is anticipated that the long-term monitoring of the proposed TI Zone would include:

- **Year 1 Event 1:** An initial baseline sampling of all available wells within the LVRR monitoring well network (approximately 150 wells) for CVOCs;
- **Year 1 Event 2 – Year 5:** Twice-a-year sampling, for 5 years, for CVOCs for a subset of monitoring locations:
  - 13 locations consisting of 50 wells for TI Zone boundary monitoring;
  - 9 locations consisting of 35 wells for CVOC concentration monitoring throughout the Spill Zone and Study Area;
- **Year 6 – Year 30:** Annual Sampling for CVOCs for a subset of monitoring locations:
  - 13 locations consisting of 50 wells for TI Zone boundary monitoring; and,
  - 9 locations consisting of 35 wells for CVOC concentration monitoring throughout the Spill Zone and Study Area.

Note, modifications of the long-term monitoring plan may be necessary based on the data results. Cost estimates for long-term monitoring of the TI Zone are included in **Table 4.1-1**.

In addition, an alternate water source was previously implemented for the purpose of providing a long-term solution that addressed public health concerns with respect to the consumption of potable water. This entailed the construction of a municipal water line that was designed by Stearns and Wheler, LLC in 1998. Construction of the water line ran from December 2001 through July 2003, and included 15 miles of 8-inch & 12-inch diameter water mains, with a total of 70 individual service connections. Once it was put into service, the waterline provided affected users with a clean source of potable water. The waterline connections were completed in all four of the municipalities that were affected by the TCE plume (Town of Wheatland, Town of LeRoy, and the Town and Village of Caledonia). Details of the installation are provided in the "Final Remediation Report, Water Distribution System, Lehigh Valley Railroad Derailment Site" prepared by Stearns and Wheler, LLC in August 2003 (NYSDEC, 2003). Additionally, decommissioning of all impacted private/domestic water supply wells that were located within the extents of the TCE groundwater plume was conducted with the exception of the following:

a. L-14: This well is used for non-potable utility purposes only (dust control of a racing track), and the property owner (The Lime Rock Speedway Club) does not wish to abandon the well. Additionally, there are signs posted on the property indicating that the water from the domestic well is for non-potable use only; and,

b. L-33B: This well is used during the summer for garden irrigation only, and the property owner does not wish to abandon the well. The property owner permitted

LVRR to post a "non-potable" sign next to the well. On May 20, 2020, UMC on behalf of LVRR posted the agreed upon sign next to the domestic well.

As discussed previously in Section 2.4.3 of the FS Report, the evaluation of potentially applicable remedial technologies for the restoration of groundwater to its most beneficial use was presented in the AGTI which concluded that the restoration of groundwater is technically impracticable.

4.1.4 Costs

The range of OM&M and present worth costs for the ICs and Monitoring for the Portion of the Groundwater Plume Proposed for TI are presented on **Table 4.1-1**. There are no current capital costs associated with the ICs and Monitoring proposed for Groundwater. Groundwater Sampling OM&M costs are estimated to be approximately $2.25 million (assuming a 30-year O&M time frame). $524,000 of additional costs are estimated for the implementation of ICs and the SMP. Therefore, the total costs for Groundwater ICs, SMP, and Monitoring are estimated at $2.78 million.

4.2 Soil Vapor Intrusion Media Remedial Action Evaluations

4.2.1 Soil Vapor Intrusion Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

There are no promulgated chemical-specific ARARs for SVI (soil gas or indoor air). However, applicable TBC criteria includes USEPA SVI Screening Levels (VISLs) and NYSDOH *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH, 2006).

4.2.2 Soil Vapor Intrusion Remedial Action Outcomes and Prelimiinary Remediation Goals

The RAO for SVI is for human health protection: mitigate potential current and future unacceptable risks from subsurface SVI into indoor air.

The most current USEPA VISLs and NYSDOH criteria will be used to establish PRGs for SVI and will continue to be used in the evaluation of the SVI pathway at the Site.

4.2.3 Institutional Controls and Monitoring for Soil Vapor Intrusion

As discussed in Section 2.4.3.1.5 of this report, the RAO for SVI is currently being met on Site. The RAO for SVI will continue to be met through a combination of ICs (see Section 3.3.1.1), SVI investigations, SVI monitoring, the implementation of various applicable SVI mitigation technologies, and the continued inspection (annual and 5-year review) of currently installed SVI mitigation systems. The USEPA Region 2 and NYSDEC green remedial techniques, as discussed in Section 3.3.1.1, will be considered during the development of an SVI O&M Plan.

4.2.4 Cost

The range of O&M and present worth costs for the SVI Alternative are presented on **Table 4.2-1**. There are no current capital costs associated with the SVI Alternative; however, if new mitigation systems are designed and constructed in the future, capital costs may be relevant. Present worth costs for O&M are estimated to be approximately $659,704 (assuming a 30-year O&M time frame). Present worth costs are calculated based on a 7% discount rate for each year of system O&M.

4.3 Bedrock Vadose Zone Media Remedial Alternative Evaluations

4.3.1 Bedrock Vadose Zone Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

Currently, there are no published ARARs, TBCs, or other Guidance specific to the BVZ. The bedrock will continue to be a source of dissolved TCE in groundwater for the foreseeable future (over 150 years per the DFN Report).

4.3.2 Bedrock Vadose Zone Remedial Action Objectives and Preliminary Remediation Goals

The RAOs for bedrock are:

a) Mitigate, to the extent practicable the BVZ as an ongoing source of groundwater contamination;

b) Accelerate long-term improvement to the groundwater in a reasonable time frame; and,

c) Support further risk reduction for the Site as a whole.

The LVRR RI Report supports that a substantial quantity of TCE released from the original spill diffused into the rock matrix. Remediation of the bedrock matrix was shown to be technically impracticable (UMC, 2016). Therefore, PRGs have not been identified specifically for the BVZ. PRGs identified for groundwater are considered applicable. However, as discussed above in Section 2.4.5, the AGTI concludes that the restoration of groundwater, within the LVRR Study Area, to its most beneficial use is not technically practical within a reasonable timeframe. On May 30, 2019, the USEPA issued a letter correspondence stating, "The rational presented in the TI evaluation documents are acceptable and the TI consultation requirements have now been successfully met. It should be noted that this acknowledgement does not equate to a TI waiver since that can only be achieved in the finalized decision document."

Therefore, given the consideration of the proposed TI waiver for the restoration of groundwater, BVZ RAOs are based on source reduction and exposure control.

4.3.3 Bedrock Vadose Zone Evaluation and Screening of General Response Actions and Process Options

The BVZ, or the contaminated bedrock above the water table, is a component of the Spill Zone where BVE was one of the selected remedies outlined in NYSDEC's ROD, published in March 1997. It was noted in the ROD that "*Present site characterization data indicates that the majority of the DNAPL contamination in the bedrock is above the water table for most of the year. Therefore, it appears cost effective to install a bedrock system which would target this unsaturated zone. However, this assumption needs to be clarified in the design phase and additional work is proposed in the Detailed Pilot Study*". Furthermore, it was also stated in the NYSDEC ROD that "*If the RAOs for groundwater are met at the source area the bedrock remediation would end. If the RAOs are not achieved, the bedrock and soil vapor extractions systems will continue to be operated until TCE removal rates become insignificant."* The DNAPL referenced in the 1997 ROD likely represents aqueous and dissolved phase TCE mass that has not changed over 26 years since the 1997 ROD. Fifty-three years later, however, data suggests that DNAPL may still be present at the Site (*i.e.*, bedrock core location LVRR-36 suggests a persistent DNAPL phase).

It is important to note that the NYSDEC ROD RAOs were proposed as numerical goals that targeted the groundwater media, with the assumption being that if the bedrock media is remediated, the groundwater quality would be improved such that it would satisfy the proposed RAO. However, as discussed above in Section 2.4.5, the AGTI concludes that the restoration of groundwater, within the LVRR Study Area, to its most beneficial use is not technically practical within a reasonable timeframe. On May 30, 2019, the USEPA issued a letter correspondence stating, "The rational presented in the TI evaluation documents are

acceptable and the TI consultation requirements have now been successfully met. It should be noted that this acknowledgement does not equate to a TI waiver since that can only be achieved in the finalized decision document." Therefore, given the TI of the restoration of groundwater, BVZ RAOs related to the restoration of groundwater and groundwater PRGs were not developed for the BVZ in this FS Report. BVZ alternatives are instead based on source reduction.

The 1997 NYSDEC ROD selected source control remedy of BVE is further evaluated in the following section.

4.3.4 Bedrock Vadose Zone Remedial Alternative Evaluations

The BVZ is defined as the portion of subsurface bedrock media that is the zone above the water table which fluctuates up to 40 ft seasonally and may be influenced by pumping from the adjacent quarry typically from approximately May 1 through Jan 1 each year; and, that is generally located within the immediate vicinity of the Spill Zone. Typically, a portion of the BVZ that is unsaturated exists from 0-25 ft bgs with a portion of the BVZ that is seasonally saturated between 25 – 70 ft bgs. A significant portion of the TCE mass that was released at the time of the train derailment resides within the BVZ, as demonstrated from the historical rock coring data discussed in the Pre-RD BVE Summary Report and LVRR RI Report.

The alternatives proposed for the addressing the TCE impacts within the BVZ include the following:

- Alternative #1: No Action;
- Alternative #2: ICs and Monitoring (assuming TI for groundwater restoration and engineering controls for other impacted media, *e.g.*, surface water and soil);
- Alternative #3a: BVE in a 10-Acre portion of the BVZ with Monitoring and ICs; and,
- Alternative #3b: BVE in a 2-Acre portion of the BVZ with Monitoring and ICs.

Alternatives 3a and 3b propose active remediation of the TCE-impacts within the BVZ. Note that it is not possible for either one of these active remedial alternatives to address TCE impacts that are present within the saturated bedrock zone below the water table. An evaluation of each alternative is presented below.

4.3.4.1 Bedrock Vadose Zone Alternative #1: No Action

In this alternative, no remedial action, monitoring, and/or ICs would be implemented within the BVZ. An evaluation of the NCP's nine criteria for this alternative is presented below.

4.3.4.1.1 Overall Protection of Human Health and the Environment

This alternative would have no effect with respect to protection of human health and the environment. There would be no means in place to control potential exposure to the impacted BVZ or to monitor potential improvements over time.

4.3.4.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

UMC is unaware of any current Federal and/or State ARARs that would be applicable for bedrock media. However, the NYSDEC ROD discusses the achievement of groundwater standards immediately downgradient of the Spill Zone as part of the BVE component of the remedy.

4.3.4.1.3 Long-Term Effectiveness and Permanence

The long-term effectiveness of this alternative would be unknown since there would be no monitoring in place in order to determine this metric.

4.3.4.1.4 Reduction of Toxicity, Mobility, and Volume

As there is no active remediation being proposed under this alternative, any reduction of toxicity, mobility, and volume of contaminants would occur through natural processes only. While it is expected that these processes will occur, it would be difficult to determine the extent of these reductions without a long-term monitoring program in place.

4.3.4.1.5 Short-Term Effectiveness

By its nature, the no action alternative would not result in any risks to on-Site workers or the local community. There would be no additional environmental impacts associated with this alternative.

4.3.4.1.6 Implementability

Since no action would be taken, implementability would not be a factor under this alternative.

4.3.4.1.7 Cost

There are no costs associated with this alternative.

4.3.4.1.8 State Acceptance

As part of the overall evaluation to determine whether the no action alternative should be selected and implemented for the BVZ, feedback and concerns from the NYSDEC would need to be considered.

4.3.4.1.9 Community Acceptance

As part of the overall evaluation to determine whether the no action alternative should be selected and implemented for the BVZ, feedback and concerns from the local communities that are impacted by this decision would need to be considered.

4.3.4.2 Bedrock Vadose Zone Alternative #2: Institutional Controls and Monitoring (assuming Technical Impracticability for groundwater restoration and engineering controls for other impacted media, *e.g.*, surface water and soil)

Similar to Alternative #1 presented above, no active remedial actions would be implemented within the BVZ as part of this alternative. However, ICs and monitoring would be in place to control the potential use of and prevent exposure to impacted bedrock media and to monitor potential improvements in groundwater quality (that may be impacted by TCE within the BVZ) over time. An O&M Plan would be prepared in order to document the measures that would be necessary to protect human health and the environment within the proposed 10-acre and 2-acre areas within the Spill Zone, as defined in Section 4.3.4.3, below. Any activities that would potentially expose on-Site workers to TCE within these areas (*e.g.*, construction and/or excavation activities) would require implementation in a manner that is consistent with the methods and procedures outlined in the proposed O&M Plan. The USEPA Region 2 and NYSDEC green remediation techniques, as discussed above in Section 3.3.1.1 would be considered as part of this remedial alternative.

4.3.4.2.1 Overall Protection of Human Health and the Environment

Direct exposure to TCE impacted bedrock media is unlikely, unless major construction activities or a future quarrying operation were to occur within the Spill Zone. This alternative would act to protect human health and the environment under such a scenario through the implementation of ICs and

Monitoring. These controls would work to prevent potential human exposure to the TCE-impacted bedrock media, and/or the groundwater that may itself be impacted by the TCE contamination in the bedrock media.

4.3.4.2.2 Compliance with Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

UMC is unaware of any current Federal and/or State ARARs that would be applicable for bedrock media. However, the NYSDEC ROD discusses the achievement of groundwater standards immediately downgradient of the Spill Zone as part of the BVE component of the remedy.

4.3.4.2.3 Long-Term Effectiveness and Permanence

Details regarding the long-term effectiveness and permanence of the proposed ICs are discussed in Section 3.3.1.1.

4.3.4.2.4 Reduction of Toxicity, Mobility, and Volume

As there is no active remediation being proposed under this alternative, any reduction of toxicity, mobility, and volume of contaminants would occur through natural processes only. While it is expected that these processes will occur, the extent of these reductions could only be evaluated with a long-term monitoring program in place.

4.3.4.2.5 Short-Term Effectiveness

By its nature, this alternative would pose minimal risks associated with ICs and Monitoring to on-Site workers and the local community. Common element controls such as ICs would help inform and protect on-Site workers, property owners, and the local community of the impacted bedrock media exposure risks. Further details regarding these ICs are discussed in Section 3.3.1.1.

4.3.4.2.6 Implementability

Details regarding the implementability of the proposed ICs are discussed in Section 3.3.1.1.

4.3.4.2.7 Cost

Costs associated with the ICs and Monitoring specific to bedrock are estimated to be approximately $137,250 as presented on **Table 4.3-1**. Note that costs associated with ICs and Monitoring are also included as part of Alternatives #3a and #3b (please refer to **Tables 4.3-2** and **4.3-3** for a summary of these costs).

4.3.4.2.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented for the BVZ, feedback and concerns from the NYSDEC will be considered.

4.3.4.2.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented for the BVZ, feedback and concerns from the local communities that are impacted by this decision will be considered.

4.3.4.3 Bedrock Vadose Zone Alternative #3: Bedrock Vapor Extraction in a 10-Acre (3a) or a 2-Acre (3b) Portion of the Bedrock Vadose Zone, with Monitoring and Institutional Controls

The two alternatives described below (Alternatives #3a and #3b) would both include installation of a BVE system within the Spill Zone in order to address the residual TCE mass that is present within the unsaturated BVZ. As discussed above, TCE within the seasonally saturated BVZ with unpredictable groundwater elevation fluctuations (25-40 ft of elevation change) is not addressed by either one of these active remedial alternatives. The primary components of the BVE system would consist of: i) a network of vapor extraction wells to be installed within the impacted BVZ; ii) a vacuum extraction pump(s) which would be connected to each of these extraction wells via a network of above ground piping; and, iii) a treatment system to mitigate the extracted vapors prior to discharge to the atmosphere (*e.g.,* via adsorption onto activated carbon or thermal/catalytic oxidization). A process schematic diagram is provided as **Figure 4.3-1** of this report, indicating the general layout of this equipment. The USEPA Region 2 and NYSDEC green remediation techniques, as discussed above in Section 3.3.1.1 would be considered as part of these remedial alternatives. These alternatives will be evaluated for two BVE application areas as described below:

Alternative #3a – Bedrock Vapor Extraction application in a 10-acre area with Monitoring and Institutional Controls

Alternative #3a will be evaluated for an approximate 10-acre area. The proposed 10-acre area is based on the results of bedrock TCE vapor data that was obtained by UMC in 2013, and as summarized in **Figure 2-16** of this report. Bedrock TCE vapor data is indicated on **Figure 2-16** of this report in units of

µg/m^3; isocontours indicate the extent of bedrock TCE vapor concentrations within the Spill Zone. The outer-most contour, representing a TCE concentrations of 10,000 µg/m^3, depicts the extent of the approximate 10-acre area targeted for the application of Alternative #3a.

Alternative #3b – Bedrock Vapor Extraction application in a 2-acre area with Monitoring and Institutional Controls

Alternative #3b will be evaluated for a smaller, approximate 2-acre area. The proposed 2-acre area is also based on the results of bedrock TCE vapor data that was obtained by UMC (2013d) (**Figure 2-16** of this report**).** The contour representing a TCE concentration of 1,000,000 µg/m^3 depicts the extent of the approximate 2-acre area targeted for the application of Alternative #3b. Note that although the size of this area is significantly smaller than the area targeted by Alternative #3a, the majority of the TCE mass in the BVZ (*i.e.*, > 65%) is anticipated to be present within this smaller area. This is highlighted in **Figures 2-10 and 2-16** of this report by the large difference in estimated vadose zone mass at LVRR-36 (located within both the 2-acre and 10-acre areas) versus LVRR-35 (located within the 10-acre area only).

The potential BVE applications in the BVZ (*i.e.,* Alternatives #3a and #3b) were evaluated to determine if the alternatives could meet the BVZ RAOs defined in Section 4.3.2. The evaluation concluded that BVE is not a viable remedial alternative to meet the BVZ RAOs based on the following considerations:

- TCE Mass Transfer Mechanisms within the BVZ: The TCE at the Site has been in the rock for many years or decades, diffusion-driven chemical mass transfer typically results in much or nearly all of the contaminant mass to be relocated from fractures, where nearly all groundwater and DNAPL flow would occur, into the low permeability rock matrix block pore spaces between the fractures, where groundwater is essentially immobile (Parker, *et al.*, 2012). TCE mass estimates within the BVZ indicate that a large proportion of the original released TCE resides in the BVZ matrix pore spaces (Pre-RD Bedrock Data Summary Report, 2013). The high remnant TCE mass, decades after the original TCE spill occurred, clearly illustrates the mass transfer limitations within the BVZ. Mass remains as DNAPL phase in the bedrock matrix as well as dissolved and sorbed phase, with the latter expected to be substantial given the relatively high organic carbon content of the matrix (ranges from 0.05% to 0.45% in the upper Onondaga Formation). Removal of the TCE mass from the BVZ would be exceedingly slow given the high moisture content in the BVZ and the very slow rates of matrix diffusion. It is not possible to impart a vacuum low enough with enough residence time to extract TCE from the bedrock matrix pore spaces via diffusion out of the bedrock matrix pore spaces into the higher transmissive fracture wall where the TCE would become

available for extraction. In order to extract the TCE that is bound up within the primary matrix porosity, a significant input of energy would need to be applied over a very long period of time. The immobile TCE mass within the moisture impacted matrix pore spaces in the BVZ is not accessible to BVE. Therefore, BVE cannot meet the RAOs intended to mitigate the BVZ as an ongoing source of groundwater contamination, nor can BVE accelerate long-term improvement to groundwater, or support further risk reduction within the Spill Zone or Study Area.

- Complexity of Fracture Network in the BVZ: The success of BVE is reliant on identifying and understanding the fracture network, including bedrock matrix pore space orientations, for the appropriate placement of extraction wells. The geometry of the bedrock fracture network determines how much air and entrained TCE vapors can be removed by a BVE system. The fracture network is inherently complex (anisotropic) with regards to fracture apertures, length, and spacing; general fracture geometry, and connectivity; all of which reduces the extraction efficiency resulting in the effective vacuum radius being asymmetrical from the extraction wells. The anisotropy of the bedrock fractures is such that it is not possible to predict the aerial extent of the fractures or their connectivity. NYSDEC and LVRR remedial investigations attempted, without success, to map the specific fracture network within the Study Area and Spill Zone using the following methods: ground penetrating radar (GPR), very low frequency electromagnetic survey (VLF EM), down-hole geophysical testing, FLUTe profiling, and fracture trace analysis (2D mapping). The LVRR RI Report concluded that currently available bedrock fracture mapping techniques do not have the sensitivity to identify the micro pore spaces within the BVZ, where the majority of the TCE mass is located. Therefore, BVE will have negligible effect on removing TCE mass from the BVZ and is not a viable technology for meeting the BVZ RAOs.
- Groundwater Elevation Fluctuations: The TCE mass is located within the lower transmissivity zones (micro pore spaces) above and below the water table which act as a continuing source of TCE to groundwater throughout the entire groundwater plume due, in part, to unpredictable and significant (25-40 ft of elevation change) groundwater elevation fluctuations. These unpredictable groundwater elevation fluctuations result in the BVZ having a high moisture content and significantly reduce the available BVZ for BVE application. The TCE mass within the temporarily saturated BVZ is diffusion controlled with the TCE mass diffusing into and out of the matrix pore spaces with the concentration gradient. The high dissolved TCE concentrations in groundwater re-impact the BVZ as the groundwater elevations fluctuate; thereby, limiting the ability of BVE meet the RAOs intended to mitigate the BVZ as an ongoing source of groundwater contamination, accelerate long-term improvement to groundwater, and support further risk reduction to the Study Area and Spill Zone.

- TCE Mass in Saturated Zone: TCE mass is located in the saturated zone as dissolved-phase and sorbed-phase in the rock matrix porewater from the Spill Zone to the downgradient Spring Creek Fault Zone discharge area. This mass would not be affected by BVE and would act as a continuing source of TCE to the BVZ and groundwater for many decades preventing BVE from achieving the BVZ RAOs.
- NYSDEC BVE Pilot Test Conclusions (1999): The NYSDEC 1999 BVE Pilot Test was designed to evaluate the effectiveness of BVE as a potential remedial option by measuring the TCE mass removed during extraction, determining the radial extraction area created by the applied vacuum, and identifying the number of extraction wells necessary for Spill Zone remediation. The cumulative total mass removal was approximately 2.2 pounds per hour, with an average removal rate of 0.24 pounds per hour per extraction well. The observation wells registered widely varying vacuum influence suggesting that there are very few intersecting fractures in the vicinity of the selected wells. The pilot study concluded that "detailed mapping of the fracture network should be performed" as a guide to the placement of extraction wells. Also, the tests proved to be of insufficient duration (the longest was 18.5 hours) to support definitive conclusions on the effectiveness of BVE as a long-term remedy. Further, the NYSDEC pilot test did not consider that the majority of the TCE mass resides within the bedrock pore spaces (primary porosity) which are technically impracticable to map, the unpredictable fluctuations in groundwater elevations, or the potential for asymptotic mass removal over time. BVE may temporarily remove some TCE mass from the high transmissive fractures but is not technically practical to address the majority of the TCE mass stored within the low transmissive bedrock matrix pore spaces that act as a continuing source of TCE to the Study Area. Therefore, the BVE pilot test is insufficient to conclude that BVE is a viable technology to meet the BVZ RAOs.
- DFN Model Conclusions: The DFN Report (Parker and Chapman, 2016) details the development of a DFN model to evaluate the potential effectiveness of the remediation of TCE in the BVZ source area via a source hotspot removal method (such as BVE). This was accomplished through a simulation where it was assumed that the BVZ TCE source above the water table is completely removed, which is the ideal but very unrealistic situation representing the best-case scenario, and then evaluating the impacts of this source zone removal on the downgradient plume. The DFN Report presents a series of simulated TCE concentration distributions which can be compared to the base case situation, each projected for 10, 20, and 50 years after the proposed remediation activities have been completed (see **Figure 4.3-3** in this FS Report). As demonstrated by these TCE concentration distributions, the complete removal of the TCE source area above the water table would not have a significant impact on the overall TCE distribution within the majority of the groundwater plume, even 50 years after completion of remediation activities,

with only modest improvements nearer the Spill Zone. These simulations show that removal of the Spill Zone BVZ source inputs has little effect on the downgradient plume even after long periods of time.

Improvements in groundwater quality through BVE could only be accomplished if the BVZ was the sole source of TCE groundwater contamination. However, rock core samples demonstrate that bedrock within the saturated zone has also been impacted by TCE, with large mass storage in the rock matrix porewater throughout the entire Study Area as dissolved and sorbed phase mass. Back-diffusion out of the rock matrix porewater and into the groundwater in the fractures, with the stored mass in the matrix as dissolved and sorbed phase essentially acting as a secondary source zone, will sustain the plume for long time periods even if (hypothetically) source inputs from the BVZ could be terminated. Therefore, implementation of BVE will result in little to no marked improvement in downgradient groundwater quality, even if it were possible to remove the TCE mass that is present within the BVZ. Based on the DFN model results, BVE is not a viable remedial technology to meet RAOs intended to mitigate the BVZ as an ongoing source of groundwater contamination, accelerate long-term improvement to groundwater, and support further risk reduction in the Spill Zone or Study Area.

- SVE Application in Overburden Conclusions: An *in situ* SVE application had been previously implemented at the LVRR Site in order to address impacted overburden materials within the Spill Zone (Benchmark, 2017, 2018). It was estimated that approximately 1,753 pounds of TCE is present in the overburden (Benchmark, 2015) of which only approximately 300 pounds or 17% was recovered via the SVE process. These results suggest that *in situ* SVE does not provide an effective strategy for recovery and treatment of TCE impacts in overburden material at the Site. The challenge is anticipated to be much more pronounced when attempting to address TCE impacts via BVE in the underlying BVZ, as there is less surface area and fewer pathways available for TCE to transfer into the vapor phase, and subsequently be recovered, along with the mass transfer limitations between fractures acting as the primary conduits and the rock matrix pore spaces where nearly all of the TCE mass is now stored. The challenges anticipated with the implementation of BVE, within the BVZ, based on the results of the *in situ* SVE remedial technology support that BVE is not a viable remedial technology to meet RAOs intended to mitigate the BVZ as an ongoing source of groundwater contamination, accelerate long-term improvement to groundwater, or support further risk reduction within the Study Area or Spill Zone.

The considerations outlined above are key to bear in mind when evaluating the application of Alternatives #3a and #3b. These considerations are referenced as part of the evaluation of these alternatives against the NCP's nine criteria, and as presented below.

4.3.4.3.1 Overall Protection of Human Health and the Environment

Direct exposure to BVZ is unlikely unless major construction activities or a future quarrying operation were to occur within the Spill Zone. Under such a scenario, the bedrock media is still likely to have a substantial amount of TCE contamination that will need to be considered as part of any potential Site work that is conducted. The implementation of BVE (whether it is conducted as part of Alternative #3a or #3b), would be expected to recover only a very small fraction of the TCE mass that is present within the BVZ (as outlined in Section 4.3.4.3). Therefore, the majority of the TCE mass would still be present within the BVZ, and could pose a risk to on-Site workers under the scenarios described.

However, this alternative could act to protect human health and the environment through the implementation of ICs and Monitoring, which would include ICs under a situation where future excavation, construction, and/or quarrying activities may occur. These controls would work to prevent potential human exposure to the TCE-impacted bedrock media, and/or the groundwater that may itself be impacted by the TCE contamination in the bedrock media.

With the implementation of BVE, potential human exposure to impacted groundwater, surface water, sediments and indoor vapors would not play a role, since the ICs described previously will be utilized to achieve these goals. In comparison to the use of ICs alone, the addition of BVE will have very little incremental benefit with regards to human health and environmental protection, as demonstrated by Site data and by the results presented in the DFN Report.

4.3.4.3.2 Compliance with Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

UMC is unaware of any current Federal and/or State ARARs that would be applicable for bedrock media. Therefore, in the absence of specific Federal/State ARARs, RAOs that were previously outlined for bedrock in Section 4.3.1 will be used to evaluate this criterion. Note that RAOs #1 and #2 (and to a certain extent RAO #3) are presented as remedial goals that would prioritize source reduction as improvements to groundwater quality versus the BVZ itself.

RAO #1: Mitigate, to the extent practicable, the BVZ as an ongoing source of groundwater contamination:

Based on the results of the DFN, there will be little to no impact to groundwater quality throughout the entire Site, regardless of the degree to which the TCE present in the BVZ can be remediated by either

Alternative #3a or #3b. Even if it were possible to remove the entire source of TCE in the BVZ by either one of these alternatives, the DFN model demonstrates that this will result in only a minor improvement to downgradient groundwater quality even 50 years after the scenario of complete source remediation has been achieved (**Figure 4.3-3** of this report) as previously detailed in this section. Therefore, it is not possible to achieve the goal that is outlined by this RAO to any practicable extent.

RAO#2: Accelerate long-term improvement to the groundwater in a reasonable time frame

Since RAO#2 also proposes improvements to groundwater quality through the removal of TCE impacts within the BVZ, it is similarly not possible to achieve this RAO in a practicable or reasonable timeframe, for the same reasons described for RAO#1, and as further demonstrated in Section 2.4.5.

RAO #3: Support further risk reduction for the Site as a whole

In order to further evaluate RAO#3, further risk assessment may be applicable to identify additional exposure pathways, if any, from the potential migration of the BVZ TCE impacts. The groundwater exposure pathway will not be considered as part of this risk assessment, since the DFN and AGTI have indicated that the groundwater TCE impacts cannot be mitigated to any reasonable extent through the proposed remediation of the BVZ.

4.3.4.3.3 Long-Term Effectiveness and Permanence

Based on the discussions already presented in Section 4.3 and elsewhere, the long-term effectiveness of both Alternatives #3a and #3b would not be expected to provide any benefit with respect to i) reducing TCE mass to any practical extent within the BVZ, and ii) reducing TCE concentrations (and associated exposure risk) within the TCE-impacted groundwater media.

With respect to the effectiveness associated with TCE mass recovery within the BVZ, an analysis of the data from the NYSDEC pilot study suggests that TCE extraction rates would be high initially (as the system would be able to recover TCE vapors that are present in the larger, more transmissive network of fractures), but would decline asymptotically over time. This rapid decline in TCE recovery rates is due to extractions the inaccessible TCE trapped within smaller, lower permeability pores, and microfractures, as dissolved and sorbed phase TCE and remnant DNAPL, where transport is diffusion controlled. In comparison to extracting TCE from a soil matrix or within the larger bedrock fractures. TCE that has diffused into the rock matrix pore spaces is unlikely to experience the same effect from an applied vacuum as TCE that is present within the interconnected fractures. Extraction rates for TCE that has diffused into

the rock matrix pore spaces would be expected to be very minimal, as the TCE must first diffuse back out of the rock matrix pore spaces, and into the fractures where extraction can occur. BVE system performance will also be significantly impacted from water table fluctuations during periods of heavy rain and snowmelt. During these times, air flow and TCE recovery rates may be significantly reduced as the groundwater rises and infiltrates into the pore space of the bedrock matrix. The challenges associated with these groundwater fluctuations is further discussed in Section 2.4.3.1.4 above and the Implementability Section 4.3.4.3.6 below. The effectiveness of the BVE application will also be greatly limited by the factors that were previously summarized in Sections 4.3.4.3. As it has previously been discussed (and as demonstrated by the DFN model), TCE concentrations in groundwater would be minimally influenced by any remedial activities that may be implemented within the BVZ, no matter how successful they may be.

Based on these challenges, and the generally limited application of this technology in fractured bedrock media, it is very unlikely that any significant amount of the residual TCE mass that occurs in the bedrock matrix as dissolved, sorbed and remnant DNAPL phases above the water table, could be recovered through BVE.

4.3.4.3.4 Reduction of Toxicity, Mobility, and Volume

Based on the discussions presented in Section 4.3.4.3 above, implementation of BVE (whether it is conducted as part of Alternative #3a or #3b), would be expected to recover only a very small fraction of the TCE mass within the BVZ. Consequently, a minimal reduction of toxicity, mobility and volume would also be expected within the BVZ.

As noted previously, when considering TCE impacts to groundwater over time, the results of the DFN Report (Parker and Chapman, 2016, Figure 20) indicate negligible reduction in TCE groundwater concentrations throughout the entirety of the groundwater plume; this is the case even if all of the TCE mass that is present in the BVZ could be removed via application of BVE. This is a result of TCE being trapped within the rock matrix porewater throughout the entire Study Area, which now acts as an ongoing persistent source of TCE to the groundwater plume. As a result, the toxicity, mobility and volume of TCE within groundwater media will likewise be minimally affected by the application of BVE through either Alternative #3a or #3b.

4.3.4.3.5 Short-Term Effectiveness

Field activities associated with the installation of the BVE system for both Alternatives #3a and #3b would include installation/drilling of many bedrock extraction wells, disposal of drill cuttings,

installation of conveyance piping to be connected to each of the extraction wells, procurement and installation of remediation, installation of electrical service required to operate the treatment system, system sampling activities, and system O&M. The activities conducted during the system installation phase of the project would present a moderate to high degree of risk to on-Site workers. Once the system is operational, routine sampling and O&M activities would present a moderate degree of risk to on-Site workers. O&M activities would potentially include maintenance of vapor extraction pumps/motors, handling of condensate, carbon change-outs, and sample collection and monitoring to assess system performance. The risks associated with the system installation and sampling/O&M activities described above can be mitigated by utilizing properly trained personnel and implementing rigorous safety protocols for each phase or task of the project.

It is expected that there would be minimal risk to the community and the environment associated with these activities. All equipment would be staged within a secure area which would be accessible to Site personnel only. A routine sampling/monitoring program would need to be implemented in order to assess the treatment efficiency of extracted TCE vapors in order to prevent air emissions exceedances that could affect local residents and other receptors in the immediate area. System condensate that may potentially be impacted by TCE would undergo proper disposal and/or treatment procedures.

4.3.4.3.6 Implementability

The potential implementation of Alternative #3a or #3b within the Spill Zone would introduce a significant degree of complexity and difficulty. The conclusions of the NYSDEC Pilot Test acknowledged that the most challenging task associated with the design of the BVE system would be to determine the placement of the extraction wells, such that they would be located at the intersection of major bedrock fractures. They recommended using 3D seismic technique to map the fracture network in order to facilitate placement of the extraction wells. However, due to the extensive area of the BVZ, and the complexity associated with determining locations for both the vertically and horizontally oriented fractures, this technique will not work. Other methods such as electrical resistivity also have limited usefulness for the LVRR Site. As previously discussed above, locating the lower transmissivity fractures and diffusion-controlled zones is difficult, if not impossible, using currently available technology. Even if the lower transmissive diffusion-controlled zones could be located, the approach of installing a large number of borings will have a limited effect on accessing the remaining mass due to mass retention in the lower transmissivity and diffusion-controlled zones.

A network of approximately 190 extraction wells were proposed from the results of NYSDEC pilot study. Under this remedial scenario, two separate BVE systems may be required, one on either side of Gulf Road. A vapor extraction system capable of meeting the applied vacuum and flow requirements for the extraction well network would need to be designed, procured and installed. Installation of above grade conveyance piping, which would be connected to each of the extraction wells, would also be required. Extraction wells would need to be installed to the approximate depth of the water table, up to 50 ft below grade. The network of 190 extraction wells proposed in the NYSDEC pilot study would cover an approximately 10-acre area, which may be applicable when considering Alternative #3a **(**which targets a similarly sized area). Since Alternative #3b addresses an area that is only 20% of the area targeted by Alternative #3a, it is estimated that approximately 38 wells would be required for its implementation. However, the exact number and location of wells that would be required under each alternative would be challenging to determine without an understanding of the local bedrock fracture network and lower transmissivity and diffusion-controlled zones, as highlighted previously. This would introduce a level of uncertainty at the system design stage, which will likely lead to operational inefficiencies once the BVE system is activated. It is estimated that the system installation would require at least 4 months (Alternative #3b) to 8 months (Alternative #3a) to complete, primarily due to the substantial number of bedrock extraction wells that would need to be installed.

An additional consideration regarding the implementability of the proposed BVE application is the seasonal fluctuation in the groundwater elevation within the BVZ. **Figures 4.3-4** through **4.3-10** of this report indicate the seasonal variation in the depth to groundwater at monitoring well DC-01B, from 2015 through 2020. This well is located in the vicinity of the highest TCE concentrations within the Spill Zone, and where the proposed BVE efforts would be primarily focused. Groundwater elevation measurements were logged on a continuous basis over this period, using a down-well transducer. The transducer data indicates that in most years, depth to groundwater ranges between 25 to 35 ft bgs for almost half the year. These shallow groundwater conditions typically occur in the fall through the winter seasons. In the spring and summer, depth to groundwater drops significantly, sometimes up to 30 ft or more. The variation in the high and low groundwater conditions within the BVZ can be better visualized by looking at a cross-section of the BVZ (**Figure 4.3-10** of this report). This significant seasonal variation in the water table elevation within the BVZ will introduce a significant challenge with regards to recovering TCE vapors from the bedrock fractures. When the groundwater elevation is high during the fall and winter season, the depth of the BVZ is significantly diminished, and TCE that is present below the water table is inaccessible and cannot be recovered. However, when the water table drops in the spring and summer, high residual moisture

is expected to be retained within the fracture network, especially in the smaller fractures where strong capillary forces would be exerted, and where most of the TCE mass is present, as well as high saturation of the low permeability bedrock matrix. This will further limit the amount of TCE mass that can be recovered by the proposed BVE application.

Based on the limitations previously discussed with the effectiveness of the BVE application, subsequent system performance evaluations may indicate that additional extraction wells would be required in order to address areas where the system vacuum influence may not be present. Additional time and labor would be necessary to install additional extraction wells, connect them to the existing extraction piping infrastructure, and monitor and assess performance of the revised system configuration.

4.3.4.3.7 Cost

The range of capital, O&M, and present worth costs for each of the BVE remedial alternatives (Alternatives #3a and #3b) are presented on **Tables 4.3-2** and **4.3-3**, respectively. Alternatives #3a and #3b have capital worth costs of approximately $8.36 and $2.73 million, and present worth costs for O&M of $1.01 million and $0.85 million, respectively (assuming a 3-year system operation time frame). Present worth costs are calculated based on a 7% discount rate for each year of system O&M. $137,250 of additional costs are estimated for Alternatives #3a and #3b for the implementation of ICs. Therefore, the total costs for Alternatives #3a and #3b are estimated at $9.50 million and $3.72 million, respectively.

4.3.4.3.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for the BVZ media, feedback, and concerns from the NYSDEC will be considered.

4.3.4.3.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for the BVZ media, feedback and concerns from the local communities impacted by the activities proposed in the remedy will be considered.

4.4 Mud Creek Surface Water Media Remedial Alternative Evaluations

The following sections provide: i) a summary of the applicable surface water ARARs, RAOs and PRGs; ii) identification and initial screening of GRAs, Technology Classes, and Process Options for surface

water; and iii) a detailed evaluation of several alternatives for addressing TCE-impacted surface water at the Site.

Note that TCE impacts that exceed the surface water ARAR of 40 µg/L (discussed in further detail in Section 4.4.1 below) are currently limited to a segment of the Mud Creek flow channel located northeast of the intersection of Gulf Road and Neid Road between the Mud Creek waterfall and the inlet of Mud Creek Pond (see **Figures 1.3-2, 4.4-1** and **4.4-1a** of this FS report). Please note that this area of Mud Creek, which will be referenced as the *Mud Creek Area of Interest* in the discussions that follow, is located on private land. Based on the surface water ARAR, remedial alternatives to address surface water impacted by TCE will be focused exclusively within this area.

4.4.1 Surface Water Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

According to the NYSDEC Environmental Resource Mapper, the section of Mud Creek and Mud Creek Pond that is within the Mud Creek Area of Interest is designated as a Class "C" fresh surface waterway. As per NYS's Codes, Rules and Regulations (NYCRR) under Title 6, Chapter X, Part 701.8, a Class "C" fresh surface waterway is described as follows:

> "The best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes."

Based on NYCRR under Title 6, Chapter X, Part 703.5 (Water quality standards for taste-, color- and odor-producing, toxic and other deleterious substances), a Class "C" fresh surface waterway has single standard for TCE of 40 µg/L. This standard has a type code of "H(FC)" and a basis code of "A" which combined make reference to oncogenic effects to human health associated with fish consumption.

Based on the designation of Mud Creek as a NYS Class "C" fresh surface waterway the PRG of 40 µg/L will be utilized for the purposes of evaluating surface water alternatives.

4.4.2 Surface Water Remedial Action Objective and Preliminary Remediation Goal

The proposed RAO for surface water shall be as follows:

- Prevent unacceptable risk to human receptors from incidental ingestion and dermal contact exposure to contaminated surface and seep water in Mud Creek by reducing contaminant levels to the more stringent Federal or State standards.

Risk-based screening levels for the swimming scenario were calculated for the Site along with health-based ARARs and TBC values to identify a PRG to support the surface water RAO and evaluate remedial alternatives. Compiled ARARs, TBC values and risk-based PRGs are provided in **Appendix A,** Table A-2.

For the purposes of evaluating surface water alternatives within this FS Report, the ARAR of 40 µg/L will be used as the PRG for surface water throughout the entire Mud Creek Area of Interest, and for Mud Creek Pond. In comparison to Site-specific exposure scenarios, this ARAR is less than the risk-based screening value for swimming calculated for the Site based on non-cancer hazards (67 µg/L, based on a HQ of 1) and is at the low end of the risk-based value which represent USEPA's acceptable cancer risk range of $1x10^{-6}$ to $1x10^{-4}$ (10 µg/L to 1,000 µg/L) representing a 4×10^{-6} risk level. Therefore, the ARAR would be considered sufficiently protective of both non-cancer hazards and cancer risks meeting the intent of the NCP point of departure.

4.4.3 Surface Water Evaluation and Screening of General Response Actions and Process Options

GRAs describe those actions that will satisfy the previously established PRGs for the Mud Creek Area of Interest. GRAs may include containment, treatment, disposal, or institutional actions. Each of these GRAs will include one or more Technology Classes, which further classify potential remedial strategies that may be implemented within the Mud Creek Area of Interest. The term Technology Class refers to general categories of technologies such as chemical treatment, thermal destruction, immobilization, etc. Each Technology Class will also have one or more Process Options that refers to specific processes within that particular Technology Class.

Process Options will undergo an initial screening by evaluating their effectiveness, implementability and cost. During this screening step, Process Options (and possibly entire Technology Classes) may be eliminated from further consideration on the basis of their technical implementability. For surface water impacted by TCE within the Mud Creek Area of Interest, the following GRAs, Technology Classes, and Process Options have been identified for initial screening:

- GRA #1: Containment
  - Technology Class #1.1: Groundwater Pumping
    i. Process Option #1.1.1: Groundwater Pump and Treat
    ii. Process Option #1.1.2: Interceptor Trench
  - Technology Class #1.2: Subsurface Barriers
    i. Process Option #1.2.1: Slurry Wall
    ii. Process Option #1.2.2: Grout Curtain
  - Technology Class #1.3: Surficial Flow Barriers
    i. Process Option #1.3.1: Stone Cover
    ii. Process Option #1.3.2: Gabion Baskets
- GRA #2: Physical Removal (Treatment)
  - Technology Class #2.1: Chemical/Biological Treatment
    i. Process Option #2.1.1: Permeable Treatment Barriers (PTBs)
  - Technology Class #2.2: Extraction
    i. Process Option #2.2.1: *In situ* Air Sparging
    ii. Process Option #2.2.2: PTBs (using extraction methods)
  - Technology Class #2.3: *In situ* Thermal Treatment
    i. Process Option #2.3.1: Thermal Conduction Heating
    ii. Process Option #2.3.2: Electrical Resistance Heating (ERH)
    iii. Process Option #2.3.3: Injection of Hot Air
    iv. Process Option #2.3.4: Radio Frequency Heating (RFH)

The GRAs, Technology Classes, and Process Options listed above are summarized and described in **Table 4.4-1** of this report. An initial screening for each of the Process Options is presented below.

4.4.3.1 General Response Action#1: Containment

4.4.3.1.1 Technology Class #1.1: Groundwater Pumping

The Process Options listed and evaluated below provide for means that could prevent TCE-impacted groundwater from daylighting within the Mud Creek Area of Interest. If successful implementation of one or more of these Process Options is possible, this could potentially result in the elimination of a surface water exposure route to TCE-impacted groundwater that would otherwise make its way to the surface within the Mud Creek Area of Interest.

4.4.3.1.1.1 Process Option #1.1.1: Groundwater Pump and Treat

This option involves hydraulic control of the groundwater contaminant plume via the installation of a series of groundwater extraction wells near the TCE-impacted seeps, and to provide hydraulic control of TCE-contaminated groundwater and prevent it from daylighting. The extraction wells pump contaminated groundwater to the surface where it may be treated using various unit processes which can include air stripping and carbon adsorption to remove chlorinated VOCs. Treated groundwater is typically discharged to either a receiving surface water body or back into the aquifer.

a) *Effectiveness*

Groundwater pumping would not be expected to be effective in terms of recovering a significant amount of contaminant mass. However, groundwater pumping could provide a means for preventing daylighting of TCE-impacted surface water within the Mud Creek channel. A long-term groundwater pumping test would be required in order to determine well placement, so the effectiveness of this method cannot be determined until this test is conducted.

b) *Implementability*

In order to prevent potential surface water exposure to TCE-impacted water, the groundwater pumping system would need to pump groundwater out of the fracture network that contributes to the active TCE-impacted seeps within the Mud Creek Area of Interest; pumping rates would need be sufficiently high to prevent daylighting of groundwater in this section of Mud Creek. The location, orientation, and hydraulic connectivity of fractures, and other subsurface flow pathways, contributing to the seeps and flows within the Mud Creek Area of Interest would need to be identified and intercepted. Snowmelt and meteoric events in the Mud Creek Watershed recharge an estimated 5,813.8

million gallons of surface water and groundwater per year (approximately 484.47 million gallons per month) (Richards, 2016). This influx of water results in rapid, unpredictable, groundwater elevation fluxes (>30 ft within hours) in monitoring wells near the Mud Creek Area of Interest. The impact of this water, its impact on groundwater elevations, and potential contribution to the flow conditions need to be considered in the design of this system. In addition, an understanding of variations in groundwater seep flow rates, seep water quality, and surface water quality need to be considered in the design of the system. It is possible that contaminated groundwater could bypass the groundwater pump and treat system, and daylight in different locations within Mud Creek. A Mud Creek Area of Interest PDI including the installation of monitoring wells, surface water/seep sampling, flow rate monitoring, etc., would need to be conducted in order to confirm that this process option could be effectively implemented.

c) *Cost*

Costs for groundwater pumping and treatment could be very high given the expected variability in surface water flow conditions in Mud Creek, and the amount of groundwater that would require pumping in order to provide adequate containment of TCE impacted groundwater prior to daylighting in Mud Creek flow channel.

Based on this evaluation, Groundwater Pump and Treat will be retained for further evaluation as part of a remedial alternative for the Site.

4.4.3.1.1.2 Process Option #1.1.2: Interceptor Trench

Interceptor trenches are installed to provide a barrier to further migration of contaminants in a groundwater or surface water plume. Interceptor trenches are typically constructed downgradient of the source area, and are filled with gravel to promote collection of contaminated groundwater and/or surface water as it flows into the trenches. The contaminated water that is collected within each interceptor trench would then be pumped to a treatment system and discharged as in the groundwater pump and treat method discussed above.

a) *Effectiveness*

Assuming that interceptor trenches are properly designed and placed, they could potentially be effective at preventing surface water impacts from migrating further downstream.

b) *Implementability*

Implementation of interceptor trenches would be extremely difficult within the Mud Creek channel, and would require extensive construction operations. It may not be possible or practical to install interceptor trenches deep enough within the bedrock such that all flow channels that TCE-impacted groundwater travels through can be intercepted, prior to potentially surfacing further downstream.

c) *Cost*

Interceptor extraction trenches are significantly more expensive in comparison to groundwater extraction wells, especially in fractured rock environments, and thus would be unlikely to provide a significant cost-benefit over extractions wells.

Based on this evaluation, interceptor trenches will not be retained for further evaluation as part of a remedial alternative for the Site.

4.4.3.1.2 Technology Class #1.2: Subsurface Barriers

The process options listed and evaluated below would incorporate the installation of subsurface structures upgradient of the Mud Creek Area of Interest. If the successful implementation of one or more of these process options is possible, this could potentially result in no further downgradient migration of TCE-impacted groundwater; consequently, this could eliminate the surface water exposure route to TCE-impacted groundwater that would otherwise make its way to the surface within the Mud Creek Area of Interest.

4.4.3.1.2.1 Process Option #1.2.1: Slurry Wall

A slurry wall consisting of a low-permeability soil-bentonite mixture could be installed upgradient of the Mud Creek seep areas in order to prevent TCE-impacted groundwater from daylighting as TCE-impacted surface water. The slurry wall could be installed using modified deep soil mixing equipment and injecting a soil/bentonite mixture or by quarrying a deep rock trench and backfilling with soil-bentonite.

a) *Effectiveness*

A slurry wall could potentially be effective with respect to containing TCE and preventing its migration downgradient towards the seeps and flows within the Mud Creek Area of Interest.

However, this would require installation of a sizable barrier that would need to extend to a significant depth in order to effectively contain TCE-impacted groundwater.

b) *Implementability*

The construction of a slurry wall in limestone/dolomite rock to the necessary depths of greater than 50 ft bgs would require highly specialized and relatively rare construction equipment. Construction of the slurry wall near the steep slopes of Mud Creek would be challenging. It is likely that TCE-impacted groundwater would flow around, or even under the slurry wall and possibly daylight in new or different locations near Mud Creek. Additionally, slurry walls are most effective when combined with a hydraulic control pump and treat system to reduce the potential for flow around the slurry wall.

c) *Cost*

Costs associated with the installation of one or more slurry walls are expected to be very high given the depth and width of the TCE-impacted groundwater plume requiring containment.

4.4.3.1.2.2 Process Option #1.2.2: Grout Curtain

Similar to a slurry wall, a grout curtain provides a barrier to groundwater flow. The grouting material is installed via high pressure injection using special fluids such as epoxy and sodium silicate, or particulate grouts such as Portland cement and sodium bentonite. Grout injection points are typically spaced 5 to 10 ft apart to ensure adequate coverage and overlapping of the grout mixture.

a) *Effectiveness*

A grout curtain could potentially be effective with respect to containing TCE and preventing its migration downgradient towards the seeps and flows within the Mud Creek Area of Interest. However, this would require installation of a sizable barrier that would need to extend to a significant depth in order to effectively contain TCE-impacted groundwater.

b) *Implementability*

Implementation of a grout curtain application would be challenging for the LVRR Site. Installation may be possible via jet grouting methods; however, it is not apparent how effective the grout mixture could be dispersed in this type of fractured and karst bedrock environment, and at the depths required to contain the TCE-impacted groundwater plume. Additionally, controlling the grout

injections and providing construction quality assurance regarding which fractures are grouted would be difficult. It is likely that extensive pre-design fracture mapping would be required and that several mobilizations would be necessary. It is likely that even several iterations of grouting would result in new seep locations in Mud Creek.

c) *Cost*

Costs associated with the installation of one or more grout curtains are expected to be very high given the depth and width of the TCE-impacted groundwater plume requiring containment.

In order to provide adequate containment, the two process options listed under the *Subsurface Barriers* technology class would require installation of large subsurface structures within the bedrock media, and at significant depths. Therefore, process options under this entire technology class are impractical for application within the Mud Creek Area of Interest and will not be retained for further evaluation.

4.4.3.1.3 Technology Class #1.3: Surficial Flow Barriers

The process options listed and evaluated below would incorporate the installation of surficial structures within the Mud Creek flow channel. If the successful implementation of one or more of these process options is possible, this could potentially result in surface water flows and seeps in the Mud Creek Area of Interest to be confined within the surficial flow barrier; consequently, this could eliminate the potential exposure to TCE-impacted surface water that would otherwise be present in the absence of a surficial flow barrier.

4.4.3.1.3.1 Process Option #1.3.1: Stone Cover

This option would involve filling in the active stream segments and seep areas with a stone cover to prevent potential exposure to TCE-impacted surface water. Stone, which can be sourced from nearby quarries to match the existing rocks in the creek bed, would be placed and arranged in a configuration which encompass the entire area where active surface water flow and seeps are present. The stone cover would be placed to a height above the streambed that would result in TCE-impacted surface water always being several feet below the modified ground surface, thus preventing direct contact, and daylighting of contaminated groundwater to the surface.

a) *Effectiveness*

This option would be an effective means of preventing direct human contact with TCE-impacted surface water within the Mud Creek Area of Interest. This is because the use of a stone cover would effectively increase the elevation of the streambed and would mimic the natural losing conditions observed within Mud Creek. Losing stream conditions have been observed along Mud Creek (within the Mud Creek Area of Interest) when the water table elevation is below the bottom of the stream channel, causing Mud Creek surface water to infiltrate into the ground recharging the local groundwater.

b) *Implementability*

The implementation of this alternative would be relatively straightforward and would involve little to no excavation activity. The surface of the stone cover could be further landscaped to provide a land bridge that would facilitate movement of wildlife through this area. Mud Creek is classified as a Class "C" stream in NYS. According to the NYSDEC, a Protection of Waters Permit is required for disturbing the bed or banks of a stream with a classification of "AA", "A" or "B", or with a classification of "C" with a standard of (T) or (TS) (disturbance may be either temporary or permanent in nature). An understanding of seasonal seep and Mud Creek flow and contaminant variations within the Mud Creek Area of Interest will need to be considered in the design of the stone cover.

c) *Cost*

Costs associated with the installation of a stone cover within the Mud Creek stream channel are expected to be high, but significantly less that other remedial options presented, in which extensive drilling, excavation, and/or O&M activities are required.

Based on this evaluation, a stone cover will be retained for further evaluation as part of a remedial alternative for the Site.

4.4.3.1.3.2 Process Option #1.3.2: Gabion Baskets

Gabion baskets are rectangular wire-mesh cages that are filled with rocks, concrete, and sometimes sand and/or soil, that are routinely used for erosion control. In this application, Gabion Baskets would be placed within the Mud Creek channel up to a sufficient height above the streambed that would result in TCE-impacted surface water always being several feet below the modified ground surface, and thus preventing direct contact, and daylighting of contaminated groundwater to the surface.

a) *Effectiveness*

Similar to the stone cover option, the use of gabion baskets within the Mud Creek channel would be an effective means of preventing direct human contact with TCE- impacted surface water within the Mud Creek Area of Interest.

b) *Implementability*

This option would also be relatively straightforward to implement within the Mud Creek Area of Interest. Since this option also involves the modification/disturbance of an existing streambed, a Protection of Waters Permit would also be required prior to its implementation.

c) *Cost*

Costs associated with the installation of gabion baskets within the Mud Creek stream channel are expected to be high, but significantly less that other remedial options presented, in which extensive drilling, excavation, and/or O&M activities are required.

Although gabion baskets would provide an effective means of preventing human exposure to TCE-impacted surface water and implementation would be relatively straightforward, they would not blend in with the existing natural environment in the same way as a stone cover. Additionally, because of their steel mesh construction, gabion baskets will likely require periodic maintenance and/or replacement. Therefore, gabion baskets will not be retained for further evaluation as part of a remedial alternative for the Site.

4.4.3.2 General Response Action #2: Physical Removal (Treatment)

4.4.3.2.1 Technology Class # 2.1: Chemical/Biological Treatment

The process option listed and evaluated below would incorporate the installation of an active treatment system that would include either a chemical or biological treatment process. If an adequate treatment process can be identified, this could result in the destruction and/or degradation of TCE in portions of Mud Creek where surface water TCE concentrations exceed the PRG of 40 µg/L. If the successful implementation of this process option is possible, surface water TCE concentrations could potentially be reduced to meet the PRG value.

4.4.3.2.1.1 Process Option #2.1.1: Permeable Treatment Barriers

PTBs can be configured as physical barriers or a series of borings that are filled with either a reactive reagent or a media that can provide active treatment of contaminants in the groundwater plume. PTBs can therefore act as both a barrier to the migration of TCE, and as an *in situ* treatment method to reduce TCE concentrations in surface water, or groundwater that may daylight as surface water. PTBs can use a variety of different media that may act upon the dissolved phase TCE through various mechanisms such as aerobic biodegradation, anaerobic biodegradation, chemical oxidation, or chemical reduction pathways.

a) *Effectiveness*

The effectiveness of a PTB is a function of both its method of installation, and the material or reagent that is installed within the barrier. For chlorinated contaminants such as TCE, reagents which promote either anaerobic biodegradation or chemical reduction would be most ideal. An adequate residence would be a key factor in the performance of an effective barrier, as the TCE-impacted water that flows through the barrier would have to have sufficient time to allow for contact and subsequent chemical transformation of aqueous-phase TCE with the reactive media that is placed within the barrier. Since potential exposure to TCE impacted surface water would still be a possibility, some form of restricted access may still be necessary.

b) *Implementability*

PTBs could be configured to be either vertical, or horizontal as an *in situ* reactive cap in areas where surface flow is present. Seasonal seep and flow conditions, water quality (including geochemical composition), and the location, orientation, and hydraulic conductivity of fractures and other subsurface flow pathways that may be contributing to the flows and seeps in the Mud Creek Area of Interest need to be considered in the design of the system. A PDI and pilot test(s) would be conducted in order to confirm PTBs can be effectively implemented.

c) *Cost*

Costs associated with the installation and implementation of one or more PTBs are expected to be very high, given the extensive construction and O&M activities that would be associated with their implementation and use.

Based on this evaluation, PTBs will be retained for further evaluation as part of a remedial alternative for the Site.

4.4.3.2.2 Technology Class # 2.2: Extraction

The process options listed and evaluated below would incorporate the installation of an active treatment system that would include a process to recover TCE in portions of Mud Creek where surface water TCE concentrations exceed the PRG of 40 µg/L. Rather than being destroyed, in this scenario TCE mass present in the aqueous phase would be transferred to some other media (such as volatilization into air, or adsorption onto carbon media). If the successful implementation of this process option is possible, surface water TCE concentrations could potentially be reduced to meet the PRG value.

4.4.3.2.2.1 Process Option #2.2.1: *In Situ* Air Sparging

This process option involves the generation and injection of pressurized air into the subsurface via a series of injection nozzles. This process generates air bubbles in the groundwater which allows for the mass transfer of VOCs from the dissolved phase to the vapor phase. The air bubbles will travel up the water column and within the fractured bedrock media to the ground surface, where they are ultimately discharged to the atmosphere (sparged vapor capture via SVE would not be feasible at this site). Volatilized TCE would be discharged to the air, where dilution would quickly reduce concentrations to below any action levels. TCE in air would be degraded by photo-oxidation, with a half-life of approximately 7 days (ATSDR 2019).

Vertical, horizontal, or angled air sparge wells could be installed near the seep so that injected air would target contaminated groundwater before it daylights. Small diameter sparge wells (less than 1-inch in diameter) could be installed via portable rock drills near the waterfall seep. A small air sparge system building housing the air compressor and manifold could be installed near Gulf Road. Piping or tubing would be used to convey the compressed air to the sparge wells.

a) *Effectiveness*

It is unlikely that pressurized air can be effectively dispersed within the fractured bedrock media underneath Mud Creek, which would make it challenging to meet the PRG of 40 µg/L. Additionally, precipitate fouling of the air sparge points and associated fractures could require periodic maintenance. Typical sparge well rehabilitation uses acidic solutions to dissolve the precipitate; applying these acidic solutions near the seep area is likely to result in daylighting of acidic solution to

surface water, which would be problematic. Air sparging would create aerobic conditions in groundwater near the seep areas, which would counter the anaerobic biodegradation that appears to be slowly occurring in Site groundwater.

b) *Implementability*

Installing sparge wells so that the injected air targets and treats contaminated groundwater before daylighting would require extensive knowledge of the fracture networks and connectivity of the seep area. Additionally, air sparging can create changes in hydraulic head which could alter groundwater flow patterns and inadvertently cause new contaminated seeps. Even with extensive fracture network knowledge, successful implementation of air sparging may not be possible, or at best may require several rounds of trial-and-error sparge well installations, until a potential network of sparge wells successfully contacts and treats TCE-contaminated groundwater before daylighting into Mud Creek.

c) *Cost*

Costs for *in situ* air sparging are expected to be high given the challenges associated with the precision that would be required for installation of the sparge wells into the bedrock zone, and the long-term O&M and equipment costs.

Based on this evaluation, *in situ* air sparging will not be retained for further evaluation as part of a remedial alternative for the Site.

4.4.3.2.2.2 Process Option #2.2.2: Permeable Treatment Barriers (using extraction methods)

PTBs can alternately be configured to incorporate non-destructive treatment processes such as *in situ* aeration (via compressed air delivery to air diffusers placed within natural or constructed depressions within the Mud Creek channel) or filled with an adsorptive media that binds TCE to its surface. In the case of *in situ* aeration, this would result in the extraction of TCE from the impacted surface water, and ultimate discharge to the atmosphere. An adsorptive media (such as activated carbon) would also result in the extraction of TCE from the impacted surface water, but the extracted TCE would remain on the media itself and would need to be properly disposed of once the media has been fully loaded.

a) *Effectiveness*

Natural aeration and dilution processes are likely responsible for an observed decrease in TCE concentrations in the Mud Creek Area of Interest from approximately 400 µg/L (upstream by the Mud Creek Waterfall) to 27 µg/L (downstream inlet to Mud Creek Pond). It is anticipated that aeration would enhance this process and result in a further reduction in TCE concentration along sections of Mud Creek impacted with TCE. It may be more challenging to achieve the PRGs via adoption if the water flow is too high to allow for appropriate contact time with the media. Since potential exposure to TCE impacted surface water would still be a possibility, some form of restricted access may still be necessary.

b) *Implementability*

PTBs (using extraction methods) could be configured to be either vertical, or horizontal as an *in situ* cap in areas where surface flow is present. Seasonal seep and flow conditions, water quality (including geochemical composition), and the location, orientation, and hydraulic conductivity of fractures and other subsurface flow pathways that may be contributing to the flows and seeps in the Mud Creek Area of Interest need to be considered in the design of the system. A PDI and pilot test(s) would be conducted in order to confirm that PTBs can be effectively implemented.

c) *Cost*

Costs associated with the installation and implementation of one or more PTBs (using extraction methods) are expected to be very high, given the extensive construction and O&M activities that would be associated with their implementation and use.

Based on this evaluation, PTBs (using extraction methods, specifically via aeration) will be retained for further evaluation as part of a remedial alternative for the Site.

4.4.3.2.3 Technology Class # 2.3: *In Situ* Thermal Treatment

The process options listed and evaluated below would incorporate the installation of various thermal remediation technologies that would be utilized for the purposes of elevating subsurface and surface water temperatures, and result in either the destruction or recovery of TCE mass. If the successful implementation of these process options is possible, surface water TCE concentrations could potentially be reduced to meet the targeted PRG value.

4.4.3.2.3.1 Process Option #2.3.1: Thermal Conduction Heating (TCH)

Thermal conduction heating (TCH) is also known as *in situ* thermal desorption (ISTD), this process involves the application of heat to the subsurface in order to promote volatilization of TCE. Heat is applied via the installation of electrical-powered heaters throughout the application area. Application within the Mud Creek Area of Interest would require the installation of a number of TCH wells within the shallow saturated bedrock upstream of, and along Mud Creek (and potentially at other locations where seeps are suspected to be occurring). A means for recovering the TCE vapors may also need to be implemented in order to prevent excessive emissions of TCE to the atmosphere. Successful application of this technology would address TCE impacts within both the bedrock and the TCE-impacted groundwater, and thus prevent TCE-impacted surface water flows and seeps from making their way into Mud Creek.

a) *Effectiveness*

While most remediation approaches that target contaminant mass removal have been very challenging to implement in a fractured bedrock environment, application of ISTD at other fractured bedrock sites has proven to be successful. This technology can be particularly effective with regards to contaminant mass removal due to the combination of high application temperatures, and COCs with high volatility characteristics such as TCE. The effectiveness of this approach with regards to Mud Creek would be more limited since the saturated bedrock would need to be targeted in order to effectively remove TCE from impacted groundwater prior to surfacing within Mud Creek and the surrounding seeps.

b) *Implementability*

Implementation of this alternative would require the installation of several thermal and vapor extraction wells throughout the Mud Creek Area of Interest. However, the application of this technology is expected to be challenging due to the significant quantity of energy that would be required to heat the saturated bedrock matrix.

c) *Cost*

Given that a significant quantity of saturated bedrock media and groundwater would need to be targeted for remediation, costs for the implementation of TCH are expected to be very significant. This would directly affect the amount of infrastructure that would need to be installed (heating wells, extraction wells, and associated conveyance piping), the size of the extraction and treatment equipment

that would be necessary, and the amount of utility resources (*e.g.*, gas and electric) that would be consumed during operation.

4.4.3.2.3.2 Process Option #2.3.2: Electrical Resistance Heating

ERH involves the installation of electrodes in the subsurface, which when energized, results in the production of an electrical current. The passage of electrical current between the electrodes generates elevated temperatures which results in the volatilization of TCE. Similar to the TCH application, TCE vapors can then be recovered via vacuum extraction. Application within the Mud Creek Area of Interest would require the installation of a number of ERH wells within the shallow saturated bedrock upstream of, and along Mud Creek (and potentially at other locations were seeps are suspected to be occurring). Successful application of this technology would address TCE impacts within both the bedrock and the TCE-impacted groundwater, and thus prevent TCE-impacted surface water flows and seeps from making their way into Mud Creek.

a) *Effectiveness*

ERH uses heat generated by the resistance of the rock material to the flow of electrical current to raise subsurface temperatures up to the boiling point of water (100°C). ERH electrodes do not get any hotter than the surrounding rock; the electrodes merely direct electrical current into the targeted depth intervals. ERH is limited by the electrical resistivity of the rock. Rock with low porosity, and thus low water content, has higher electrical resistance. During ERH application, volatile compounds are transferred to the vapor phase and are subsequently recovered by a vapor extraction system. Because ERH is limited to temperatures of 100 °C; therefore, it would be achievable since *in situ* temperatures far exceed the boiling points of TCE (approximately 80°C); therefore, it is theoretically possible to mobilize CVOCs, such as TCE, that have adsorbed to and/or diffused into the rock matrix and achieve some treatment of the rock matrix. It is possible to extract fluids from ERH heating boreholes. This keeps fluids moving inward towards the heated zone during operations and reduces risk of spreading contaminants. The effectiveness of this approach with regards to Mud Creek would be more limited since the saturated bedrock would need to be targeted in order to effectively remove TCE from impacted groundwater prior to surfacing within Mud Creek and the surrounding seeps.

b) *Implementability*

ERH has been applied at many different sites as either a pilot-scale and/or full-scale application. ERH electrodes are constructed using readily available materials such as galvanized steel pipe, and have been used to treat contamination to depths of 100 ft bgs. However, because the treatment depths at LVRR extend up to approximately 120 ft bgs, several stacked electrodes would be required. In order to accommodate this configuration of electrodes, boreholes that are 10 to 12 inches in diameter may be required. A pilot test would need to be completed in order to determine the appropriate electrode spacing. The local electrical utility system would also need to be evaluated in order to determine if it can provide sufficient capacity to provide power for a potential full-scale ERH system. A significant footprint would likely be required to stage the ERH components and controls, as wells as the vapor and water treatment processes.

c) *Cost*

Capital costs include installation of boreholes for placement of the electrodes, temperature monitoring points, and vapor extraction wells, as well as the groundwater and vapor treatment system processes. These costs are relatively high compared to capital costs of other process options. O&M costs include utilities, monitoring, and groundwater/vapor treatment; these costs are also anticipated to be very high.

4.4.3.2.3.3 Process Option #2.3.3: Injection of Hot Air

This method is similar to air sparging, except that the air stream is heated prior to injection. The elevated air temperatures, promote enhanced volatilization of TCE and recovery through vacuum extraction. Application within the Mud Creek Area of Interest would require the installation of a number of injection wells within the shallow saturated bedrock upstream of, and along Mud Creek (and potentially at other locations where seeps are suspected to be occurring). Successful application of this technology would address TCE impacts within both the bedrock and the TCE-impacted groundwater, and thus prevent TCE-impacted surface water flows and seeps from making their way into Mud Creek.

a) *Effectiveness*

The injection of hot air would be expected to have a very limited effectiveness in fractured bedrock media, especially in the case where the majority of the TCE contaminant is diffused within the bedrock matrix. Heat transfer from the fractures to the rock matrix would be insufficient to promote

any significant amount of back diffusion of TCE into the fractures where it could be recovered through vacuum extraction or other methods.

b) *Implementability*

Due to the extent of TCE impacts within the Mud Creek Area of Interest, a large number of air injection and vacuum extraction wells would be required to fully implement this process. This equipment would be expected to take up a significant footprint, and precautions would need to be taken in order to implement this process safely.

c) *Cost*

Costs associated with the remediation strategy are expected to be very high given the amount of infrastructure and sizing of equipment that would be required to fully implement within the Mud Creek Area of Interest.

4.4.3.2.3.4 Process Option #2.3.4: Radio Frequency Heating

The RFH process is used to generate radio waves (in the 30 to 300 megahertz [MHz] range), which are propagated through the subsurface matrix in order to generate heat and thereby volatilize the contaminants. The radio frequency (RF) energy created will preferentially heat the groundwater and organic constituents over the bedrock matrix. Radio waves are created by an RF generator at the surface and directed into the ground using an array of antennas installed within wells.

a) *Effectiveness*

RFH can be effective with respect to addressing impacted groundwater. However, since most of the TCE mass is present within the bedrock matrix, the effectiveness of this technology would be limited to addressing only the dissolved phase TCE mass located within the saturated zone. Therefore, RFH would not address the TCE mass still present in the bedrock matrix pore spaces which acts as a source of contamination to groundwater and surface water.

b) *Implementability*

The implementation of RFH would be relatively complex, given the size of the Mud Creek Area of Interest. Installation of several hundred boreholes would be required in order to address the entire area.

c) *Cost*

Costs associated with the remediation strategy are expected to be very high given the amount of infrastructure and sizing of equipment that would be required to fully implement within the Mud Creek Area of Interest.

The four process options under the i*n situ* thermal treatment technology class would all require a significant input of heat energy in order to effectively heat the TCE-impacted groundwater (prior to surfacing within Mud Creek) to the extent where TCE can be reduced to below the proposed PRG. This would become even more challenging to achieve when flow conditions within Mud Creek are high. Additionally, the elevated surface water temperatures that would result from the implementation of these process options would likely have a detrimental effect on the local ecology in the Mud Creek Are of Interest (*e.g.*, algae blooms). Therefore, process options under this entire technology class are impractical, and will not be retained for further evaluation.

4.4.4 Surface Water Remedial Alternative Evaluations

As previously described in the CSM, historical investigations conducted within the Study Area have identified TCE impacts in surface water at several locations along the Mud Creek and Spring Creek flow channels. As demonstrated in the 2016 HHRA (AECOM, 2016), unacceptable non-cancer risks from exposure to TCE in surface water and seeps exist for a recreational user visiting Mud Creek. These TCE concentrations are greatest in a short section of stream that flows out of the Mud Creek bed approximately 300 ft downstream of Mud Creek Falls (**Figure 4.4-1a** of this FS Report), which was previously identified as active stream segment #1. TCE concentrations in this portion of Mud Creek exceed the 40 µg/L ARAR for a Class C stream. Samples collected from Mud Creek upstream of Gulf Road were found to have low TCE concentrations (typically below 10 µg/L) despite the fact that they were collected within 200 ft of the Spill Zone. Previous field surveys, as well as, observations of upland plants growing in the creek bed indicate that Mud Creek is dry portions of the year. However, Mud Creek appears to be actively flowing in the early spring, during snowmelt, and rain events. These events coincide with karst-related flooding within the region and are associated with high water tables. Thus, it appears water table variation will impart significant control on the timing and magnitude of flow within Mud Creek.

Figure 2-15 of this report presents TCE data from surface water samples that have been collected at various locations within Mud Creek. This data shows a 50% decrease in TCE concentration (see samples Mudcreek-03 to Mudcreek-02) within Active Stream Segment #1 (**Figure 4.4-1a**), after only flowing 200

feet along the creek bed. These data and observations suggest that the very shallow surface water flowing along the streambed of the Mud Creek active stream segment is subjected to natural degradation processes that may include aeration, volatilization, and/or dilution. Turbulent flow along the streambed has been observed due to the presence of rocks in the streambed that create obstacles to the natural flow of surface water. This turbulent flow can promote volatilization of TCE which may account for the significant reduction of TCE surface water concentration that is observed in the downstream surface water sample, Mudcreek-03. Turbulent flow has been shown to promote volatilization of organic compounds which have a Henry's Law constant greater than 10^{-3} atm•m^3/mol (Peng J., et al, "Effect of turbulence on volatilization of selected organic compounds from water", Water Environment Research, Jan/Feb 1995). Although TCE was not evaluated as part of this study, TCE by comparison has a Henry's Law constant of 1.03 x 10^{-2} atm•m^3/mol, which is a full order of magnitude higher, and would therefore be expected to volatilize more readily.

A stratigraphic analysis of Mud Creek suggests the cliff of Mud Creek Falls represents the lowest member of the Onondaga Formation. The base of the falls is therefore within the Akron or Bertie Formations. Due to the narrow thickness of the Akron Formation in the Study Area, much of the active stream segment and Mud Creek Pond are located on either the Bertie Formation or the Camillus Formation. **Figure 4.4-2** of this report shows boxplots of groundwater TCE from wells screened in the three stratigraphic units. Note that the Camillus Formation TCE concentration is quite low (non-detect levels were assumed to be 0.1 µg/L in this plot). Groundwater baseflow from this formation will likely dilute the TCE in the active segment and Mud Creek Pond. The fact that the TCE concentration drops so quickly within the active segment suggests that Camillus Formation groundwater inputs are high, the flux of TCE from the seeps are low, or both. This is also supported in **Figure 4.4-1a** of this report by the continuous drop of TCE concentration from Mud Creek Falls to levels below 40 µg/L at the southern inlet of Mud Creek Pond.

The implementation of any alternative for surface water will consider the USEPA Region 2 and NYSDEC green remediation techniques, and include a PDI to further assess at minimum, the following questions:

- What are the seasonal flow conditions in all portions of the creek including the active segment? The PDI would assess the flow conditions via a series of transducer measurements, monitoring wells, visual observations, and other data collection and analysis techniques used to inform the Mud Creek surface water CSM and to determine whether or not a remedial alternative can be a successful remedy.

- What is the relationship between the discharge in Mud Creek and groundwater elevation? The PDI would evaluate the relationship between Mud Creek surface water and groundwater through data collection and analysis from monitoring wells, transducers, thermal variation, and other techniques used to inform the Mud Creek surface water CSM and to determine whether or not a remedial alternative can be a successful remedy.
- What is the relationship between the flow of Mud Creek above and below Mud Creek Falls and precipitation/snow melt events? The PDI would evaluate meteorologic events and their potential relationship to the flow within the Mud Creek Area of Interest to inform the Mud Creek surface water CSM and to determine whether or not a remedial alternative can be a successful remedy.
- What is the TCE concentration in Mud Creek; and how does it change seasonally and vary along the creek bed? The PDI would include the collection of surface water, seep, and groundwater samples for TCE to evaluate potential temporal variations in TCE concentrations within the Mud Creek Area of Interest to inform the Mud Creek surface water CSM and to determine whether or not a remedial alternative can be a successful remedy.
- To what extent does dilution by groundwater, surface water, and volatilization impact the TCE concentration of the active stream segment? The PDI would evaluate the relationship between Mud Creek surface water and groundwater through data collection and analysis from monitoring wells, transducers, thermal variation, and other techniques. Also, the PDI would include the collection of surface water, seep, and groundwater samples for TCE to evaluate potential temporal variations in TCE concentrations within the Mud Creek Area of Interest to inform the Mud Creek surface water CSM and to determine whether or not a remedial alternative can be a successful remedy.
- How does the length, area, and depth of the active stream segment vary seasonally? The PDI would include the collection of physical measurements such as bathymetric surveys, topographic surveys, visual observations to evaluate potential physical variations within the Mud Creek Area of Interest to inform the Mud Creek surface water CSM and to determine whether or not a remedial alternative can be a successful remedy.

This baseline data is also essential for developing a post-implementation monitoring program to ensure that the alternative is meeting remediation goals.

All of the TCE-impacted portion of Mud Creek is located on private land. This land is forested, steep and undeveloped. Access to the property would be needed for any surface water alternative in order to: i) remove a portion of the trees and vegetation on the property; ii) build access roads required for transport of materials and equipment to various location on-Site; iii) install the appropriate number of extraction wells and associated subsurface conveyance piping; iv) allow for temporary on-Site storage of equipment necessary for the proposed installation; and, v) allow the necessary personnel to have access to the property during the construction and O&M phases of the project.

A review of the available remedial technologies and process options for surface water that were retained for further analysis in Section 4.4.3 above were considered in building several alternatives that would undergo a detailed analysis against the NCP's nine specific criteria, as presented in the USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA [Interim Final version, published October 1988]. The five alternatives selected for detailed analysis are listed below:

Alternative #1: No Action;

Alternative #2: ICs and Monitoring;

Alternative #3: Hydraulic containment of contaminated groundwater to prevent discharge/daylighting to surface water with ICs and Monitoring;

Alternative #4: Streambed cover with ICs and Monitoring; and,

Alternative #5: *In situ* treatment of contaminated groundwater prior to discharge/daylighting to surface water with streambed cover, with ICs and Monitoring.

A detailed analysis of each of these five alternatives against the nine criteria is presented below.

4.4.4.1 Surface Water Alternative #1: No Action

In this alternative, no surface water remedial action, monitoring, and ICs would be implemented. Improvement in surface water quality, if any, would be through natural attenuation of TCE by dispersion, dilution, biodegradation, abiotic processes. An evaluation of the NCP's nine criteria for this alternative is presented below.

4.4.4.1.1 Overall Protection of Human Health and the Environment

This alternative would have no effect with respect to protection of human health and the environment. There would be no means in place to control the potential use of or exposure to impacted surface water or to monitor potential improvements in surface water quality over time.

4.4.4.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Since no monitoring activities would be conducted under this alternative, there would be no means of determining if and when ARARs would be achieved.

4.4.4.1.3 Long-Term Effectiveness and Permanence

The long-term effectiveness of this alternative would be unknown since there would be no surface water monitoring in place in order to determine this metric.

4.4.4.1.4 Reduction of Toxicity, Mobility, and Volume

As there is no active remediation being proposed under this alternative, any reduction of toxicity, mobility, and volume of contaminants would occur through natural processes only. While it is expected that these processes would occur, it would be difficult to determine the extent of these reductions without a long-term monitoring program in place.

4.4.4.1.5 Short-Term Effectiveness

By its nature, the no action alternative would not result in any risks to on-Site workers or the local community. There would be no additional environmental impacts associated with this alternative.

4.4.4.1.6 Implementability

Since no action would be taken, implementability would not be a factor under this alternative.

4.4.4.1.7 Cost

There are no costs associated with this alternative.

4.4.4.1.8 State Acceptance

As part of the overall evaluation to determine whether the no action alternative should be selected and implemented for surface water, feedback and concerns from the NYSDEC will be considered.

4.4.4.1.9 Community Acceptance

As part of the overall evaluation to determine whether the no action alternative should be selected and implemented for surface water, feedback and concerns from the local communities that are impacted by this decision will be considered.

4.4.4.2 Surface Water Alternative #2: Institutional Controls and Monitoring

Similar to Alternative #1 presented above, no active surface water remedial actions would be implemented as part of this alternative. Improvement in surface water quality would be through natural degradation of TCE by dispersion, dilution, volatilization, biodegradation, and abiotic processes. However, ICs (governmental, proprietary, informational, etc.), long-term monitoring of surface water quality, and maintenance (established through the PDI) would be in place to: i) control the potential use of surface water; ii) limit human exposure to impacted surface and seep water; and, iii) to monitor potential improvements in surface water quality over time. The PDI, in addition to supporting a long-term monitoring and maintenance program, would include potential pilot testing to determine the technical practicability of a remedial alternative and determine whether or not a remedial alternative can be a successful remedy. An evaluation of the NCP's nine criteria for this alternative is presented below.

4.4.4.2.1 Overall Protection of Human Health and the Environment

This alternative would not fully protect human health and the environment. Although the human exposure pathway would still exist, ICs and monitoring would be used to provide some protection in preventing human use or consumption of the impacted surface water.

4.4.4.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

The ARARs relating to surface water would not be achieved within a reasonable timeframe. As such, ICs and monitoring are not considered a stand-alone alternative.

4.4.4.2.3 Long-Term Effectiveness and Permanence

The long-term effectiveness of this alternative would be limited but ICs and monitoring could assist in limiting exposure to impacted surface water over time.

4.4.4.2.4 Reduction of Toxicity, Mobility, and Volume

As there is no active remediation being proposed under this alternative, any reduction of toxicity, mobility, and volume of contaminants would occur through natural processes only. While it is expected that these processes would occur, the extent of these reductions would need to be evaluated through long-term monitoring.

4.4.4.2.5 Short-Term Effectiveness

By its nature, this alternative would pose minimal risks to on-Site workers. ICs would help to inform and protect on-Site workers, property owners, and the local community of the impacted surface water exposure risks.

4.4.4.2.6 Implementability

The implementability of this alternative would be relatively straight forward as the Mud Creek Area of Interest is located within one private parcel of land.

4.4.4.2.7 Cost

The range of costs for ICs and Monitoring and capital costs for Alternative #2 are presented on **Table 4.4-2** as $1.57 million to $1.76 million. Costs associated with the ICs and Monitoring specific to Surface Water are estimated to be approximately $81,750. These include costs for ICs, monitoring and maintenance as previously discussed. Note that costs associated with ICs and Monitoring are also included as part of Alternatives #3, #4 and #5 (please refer to **Tables 4.4-3, 4.4-4 and 4.4-5** for a summary of these costs). Capital worth costs associated with implementation of the proposed PDI (Section 4.4.4) are $2.12 million. Total costs for Alternative #2 range from $1.65 million to $1.84 million.

4.4.4.2.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented for surface water, feedback and concerns from the NYSDEC will be considered.

4.4.4.2.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented for surface water, feedback and concerns from the local communities that are impacted by this decision will be considered.

4.4.4.3 Surface Water Alternative #3: Hydraulic Containment of Contaminated Groundwater with Institutional Controls and Monitoring

This alternative would involve the installation and operation of several groundwater extraction wells (and associated treatment and discharge of extracted groundwater) to prevent contaminated groundwater discharges to surface water and active seeps and flows within the Mud Creek Area of Interest. Factors that may play a role in the potential design and implementation of Surface Water Alternative #3 would be evaluated in a PDI and include, but are not limited to, the following:

- Seasonal flow conditions of Mud Creek within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Seasonal and precipitation event-related groundwater elevations within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Seasonal data for surface water quality samples within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Identification of fractured rock or karst subsurface flow pathways that may be contributing to the flows and seeps in the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Installation of groundwater monitoring wells, quantity and specific locations of monitoring wells to be determined based on the findings of the PDI, within the Mud Creek Area of Interest to improve understanding of groundwater level fluctuations, groundwater flow directions, seep flow rates, and changes in COC concentrations;
- Installation of groundwater extraction well(s), observation piezometers & performance of pumping tests within the Mud Creek Area of Interest will be based on the findings

of the PDI. An extensive pump testing and observation well network will likely be necessary to evaluate hydraulic connectivity between various fractures and seeps. The pump test investigation derived waste (which may be substantial) will require an appropriate method of treatment and disposal, which may also be determined at this stage; and,

As discussed above and in Section 4.4.4, further information would be collected as part of the proposed PDI. For the purposes of evaluation of costs associated with this alternative, several assumptions will need to be made with respect to its implementation (such as number of extraction wells, pumping rate, discharge locations, etc.).

A conceptual design for hydraulic control in the Mud Creek Area of Interest is presented in **Figure 4.4-3** of this report. This figure shows the Mud Creek Channel as a section view from the Mud Creek Waterfall (left) to Mud Creek Pond (right), with hydraulic control implemented. Historical sampling locations along the channel are indicated by dark blue and light blue circles, which indicate those locations where TCE concentrations exceed the PRG of 40 µg/L, and those locations where TCE concentrations are below this PRG, respectively. Note that although **Figure 4.4-3** of this report indicates a single well located upgradient of the Mud Creek Waterfall, this is a simplified depiction for conceptual purposes only. In reality, multiple groundwater extraction wells would likely need to be installed along the Mud Creek Channel in a configuration and spacing that would prevent the daylighting of TCE-impacted groundwater throughout the full length of the Mud Creek Channel. Data obtained during the proposed PDI would be evaluated to identify the design parameters that would be required for effective implementation of this alternative (*e.g.*, well placement, number of extraction wells, pumping rates, etc.).

Note that the majority of the activities proposed as part of this alternative would be conducted on a land parcel which is privately owned. Therefore, property access agreements and/or a governmental order may need to be issued before proceeding with the activities described.

ICs and monitoring which have been described in Section 3.3.1.1 (Common Elements of FS Alternatives GRA), would be implemented as part of this alternative. An evaluation of the NCP's nine criteria for this alternative is presented in Sections 4.4.4.3.1 through 4.4.4.3.9, below.

4.4.4.3.1 Overall Protection of Human Health and the Environment

The property where the Mud Creek Area of Interest is currently located is under private ownership, and public access is restricted; however, the potential for human exposure to surface water TCE impacts is possible and could be mitigated via implementation of hydraulic containment. If it can be effectively

implemented, the proposed groundwater pumping system could lower the groundwater table in the vicinity of Mud Creek to the extent that the TCE-impacted groundwater would remain below the surface of the Mud Creek streambed; this would effectively control the seeps within this section of the Mud Creek channel and eliminate a potential exposure pathway via surface water to both human and wildlife receptors.

4.4.4.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

The proposed extraction well network would be installed to prevent, to the extent practicable, TCE impacted groundwater (>40 µg/L) from discharging to surface water. The groundwater extracted from the well network will undergo treatment prior to discharge, the method of which will be determined during the proposed PDI (described in Sections 4.4.4 and 4.4.4.2). Potential methods for treatment of extracted groundwater may include air stripping, and/or treatment via activated carbon adsorption. It is anticipated that these methods of treatment would be designed to meet the PRG for surface water (40 µg/L). This would allow for the treated water to be discharged to a nearby downgradient surface water body (such as Mud Creek Pond). However, given the challenges associated with mapping the complex fractures responsible for solute transport orientation of the extraction well network would prove difficult and may not capture all flow paths discharging to the Mud Creek Area of Interest. Also, the flow rate necessary to intercept groundwater flowing into the entire Mud Creek seep area could be very high depending on the season, and require treatment equipment that could be substantial in size. This is discussed further in the Implementability Section 4.4.4.3.6, below. It should be noted that although it may be possible to treat the extracted groundwater such that the RAO is met, the groundwater that remains underneath the Mud Creek channel will likely continue to be impacted by TCE through diffusive mechanisms that occur between the rock matrix porewater and the groundwater media, as described previously.

4.4.4.3.3 Long-Term Effectiveness and Permanence

If the proposed PDI (described in Sections 4.4.4 and 4.4.4.2) indicates that an effective groundwater pump and treat system can be designed and installed within the Mud Creek Area of Interest, this alternative could potentially provide for an effective means of hydraulic containment to prevent potential human exposure to TCE-impacted surface water.

In practice, the long-term effectiveness of this alternative would be dependent on a number of factors, including, but not limited to the following:

- The routine and thorough maintenance of all system components;

- The proper placement of groundwater extraction wells, as determined by the PDI, which should be installed in such a manner that they transect those specific fracture zones that discharge into the active seeps and flow within the Mud Creek Area of Interest;
- An adequately designed backup power generating system that would keep the system operational during short and long-term power outages; and,
- The frequency and intensity of precipitation and/or flooding events that occur both in the vicinity, and upgradient/upstream of the Mud Creek Area of Interest, as evaluated during the PDI. These weather-related events could result in significantly increased daylighting of groundwater to surface water within the Mud Creek Area of Interest that may overwhelm the design capacity of the groundwater pumping system and impact its ability to prevent groundwater from surfacing into the Mud Creek channel. These events may also increase or decrease TCE concentrations through piston flow (a scenario where meteoric water from a rainfall or snow melt event [recharge] pushes a slug of contaminated water via fractures out of the seep) of contaminated water, or dilution by runoff.

It is essential that a thorough PDI be conducted in order to properly assess the long-term effectiveness of the proposed groundwater pump and treat system and to ensure the proper design and placement of the system components. The success of this alternative is dependent on the factors outlined above, and on an effective long-term O&M strategy that allows for the system to run continuously, without interruption. Because of the slow back diffusion of TCE between the rock matrix and groundwater, TCE contaminated groundwater will continue to impact surface water within Mud Creek (for at least 50 years based on the DFN), therefore, the system would have to be operated for an indefinite period of time until groundwater quality improves to the extent where the surface water PRG can be met.

4.4.4.3.4 Reduction of Toxicity, Mobility, and Volume

This alternative is primarily designed as a mechanism for hydraulic containment of groundwater to prevent daylighting of TCE-impacted groundwater to the Mud Creek Area of Interest, and therefore does not directly address the extensive source of TCE associated with the bedrock matrix pore spaces that is a continuous source of contamination to the groundwater matrix (a portion of which discharges into the seeps and flows that have been identified in the Mud Creek Area of Interest). If the proposed PDI indicates favorable results, this alternative may result in an adequate reduction of toxicity, mobility and volume of TCE within the surface water media; additionally, TCE may be removed permanently from the groundwater media through treatment of groundwater that is extracted by this process.

4.4.4.3.5 Short-Term Effectiveness

Field activities associated with the installation of the groundwater pumping system include clearing of vegetation and trees, construction of access roads, installation/drilling of bedrock extraction and monitoring wells, installation of subsurface trenches and conveyance piping to be connected to each of the groundwater extraction wells, procurement and installation of remediation equipment, installation of a building to house the necessary remediation equipment and controls, installation of electrical service required to operate the system, and system performance assessment through sampling activities.

Since the majority of the construction activities would occur on wooded land with uneven terrain, this would present a moderate to high degree of risk to on-Site workers during the system installation phase. Routine O&M activities once the system is operational would also present a moderate degree of risk to workers. These would include maintenance of pumps and motors, particulate filter changes, carbon change-outs and disposal of spent carbon, air stripper maintenance, and sample collection and monitoring to assess system performance. The risks associated with the various activities described can be mitigated by utilizing properly trained personnel, development of task-specific safety procedures, and use of appropriate equipment during each phase or task of the project.

It is expected that there would be minimal risk to the community and the environment associated with these activities. All equipment would be staged within a secure area which would be accessible only to Site personnel.

4.4.4.3.6 Implementability

This alternative would be challenging to implement at the Site and would require a significant amount of construction activity. Once the PDI has been completed, the proposed construction activities associated with this alternative would be expected to last a year or more, due to the multiple construction phases of the project that would be necessary for implementation. Since groundwater flow likely occurs in multiple fracture networks which are located at different depth intervals (which may not necessarily have vertical or horizontal communication with each other), the spacing between pumping wells would be a primary consideration in order to ensure capture of groundwater exceeding the PRG along all potential flow paths that connect to the flows and seeps in Mud Creek. Therefore, a significant network of pumping wells may be required. As mentioned previously in Section 4.4.4.2, an analysis of the bedrock fracture network and a pumping test would need to be performed as part of a PDI in order to estimate the placement of the network of extraction wells within the Mud Creek Area of Interest. The pumping test may need to be

conducted both under "normal" groundwater flow conditions, and "peak" groundwater flow conditions in order to properly design a system which can maintain groundwater capture along the entire length of the stream channel and seeps that are impacted with TCE.

The terrain in Mud Creek is mostly wooded and steeply sloped, due to the presence of the Mud Creek channel which has formed a substantially deep gorge along its flow path. Trees and brush will therefore need to be removed in order to construct access roads that can be utilized by drill rigs and other heavy equipment to access the proposed groundwater extraction well installation locations. Since this portion of Mud Creek is located on private land, an access agreement with the property owner would need to be negotiated in order to i) remove a portion of the trees and vegetation on the property, ii) build access roads required for transport of materials and equipment to various locations on-Site; iii) install the appropriate number of extraction wells and associated subsurface conveyance piping; iv) allow for temporary on-Site storage of equipment necessary for the proposed installation; and, v) allow the necessary personnel to have access to the property during the construction and O&M phases of the project.

A groundwater treatment system capable of handling these high groundwater extraction rates would require an area with a significant footprint for staging all the necessary process treatment equipment (*e.g.*, low profile air stripper and/or carbon adsorbers for polishing). This equipment would need to be contained within an insulated and heated building. Additionally, in case there is a short or long-term power outage in the area, an appropriately sized backup power generator would also need to be included as part of the system. The terrain within the Mud Creek Area of Interest is not suitable for the installation of such a large building which will be required to house the necessary system equipment. Therefore, it may be necessary to install this building on an off-Site property, where the terrain is more amenable for such an installation. Additional access agreements may need to be negotiated with the corresponding property owner(s). The distance between the treatment building and the extraction wells would need to be considered during the design phase, as an increased head loss within the conveyance piping would be anticipated the further away the building is located from the extraction well network. This could be a factor in the sizing of the various system components.

Once the system has been installed and is under full-scale operation, routine maintenance and sampling activities to assess system performance will need to be conducted. The presence of minerals in the extracted groundwater stream are anticipated to create fouling issues in the process equipment and associated piping. The use of chemical reagents to address these mineral deposits may need to be considered as part of the system design and O&M plan. A dedicated location will be required for the storage of these reagents, as wells as for the wastes that are generated through their use. Maintenance personnel

should understand the proper use and safe handling procedures of these chemicals, and the associated waste stream. The backup generation system will also require routine inspection and maintenance.

Because of the potential scale of the system, it is estimated that it would take at least one year to complete the installation of the groundwater pump and treat system. These long-term construction activities would also impact the residents who live in the vicinity of the proposed system installation.

4.4.4.3.7 Cost

The range of capital, O&M, and present worth costs for Alternative #3 are presented on **Table 4.4-3**. Capital worth costs (which include the implementation of the proposed PDI) are estimated to be approximately $5.43 million, and present worth costs for O&M are estimated to be approximately $5.09 million (assuming a 30-year system operation time frame). Present worth costs are calculated based on a 7% discount rate for each year of system O&M. Approximately $81,750 of additional costs are estimated for the implementation of ICs and monitoring. Therefore, the total costs for Alternative #3 are estimated to be approximately $10.60 million.

4.4.4.3.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for surface water, feedback and concerns from the NYSDEC will be considered.

4.4.4.3.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for surface water, feedback and concerns from the local communities impacted by the activities proposed in the remedy will be considered.

4.4.4.4 Surface Water Alternative #4: Streambed Cover with Institutional Controls and Monitoring

This alternative would involve covering the Mud Creek active stream segments and seeps impacted by TCE, as determined through the PDI, with a streambed cover to prevent potential human exposure to TCE impacted media. Stone, which can be sourced from nearby quarries to match the existing rocks in the creek bed, would be placed and arranged in a configuration which encompasses the entire area where active stream flows and seeps are present within the Mud Creek Area of Interest. The top of the streambed cover would be configured to be high enough above the streambed such that the contaminated water would flow

through the interstices in the stones, and well below the top of the streambed cover; thus, direct human contact with TCE-impacted surface water within the Mud Creek Area of Interest would be mitigated.

However, it should also be noted that the presence of the streambed cover can also provide a mechanism for the reduction of TCE concentrations in surface water within the Mud Creek Area of Interest. Existing seep and surface water sampling data from the Mud Creek Area of Interest indicates that seep water TCE concentrations decrease by more than 90% to below the PRG of 40 µg/L as the water flows west to east, starting from the vicinity of the Mud Creek Waterfall, along the Mud Creek channel, and towards Mud Creek Pond to the east. The mechanism of this reduction is likely aeration/volatilization and dilution. With the streambed cover emplaced, it is likely that a similar continued reduction of contaminant concentration will occur between the seep areas and Mud Creek Pond. This will be further evaluated in the PDI. Factors which may impact the placement, thickness, and horizontal extent of the streambed cover may include the following:

- Seasonal flow conditions of Mud Creek within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Seasonal and precipitation event-related groundwater elevations within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Seasonal high flow level of the Mud Creek Channel. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Seasonal data for surface water quality samples within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion); and,

A conceptual design for the streambed cover within the Mud Creek Area of Interest is presented in **Figure 4.4-4** of this report**.** This figure shows the Mud Creek Channel as a section view from the Mud Creek Waterfall (left) to Mud Creek Pond (right), with implementation of the proposed streambed cover. Historical sampling locations along the channel are indicated by dark blue and light blue circles, which indicate those locations where TCE concentrations exceed the 40 µg/L PRG, and those locations where TCE concentrations are below this PRG, respectively. Please note that the depiction of the streambed cover

in this figure is for conceptual purposes only, and that its location, thickness, and horizontal extent will be dependent on the results of a PDI.

Note that the majority of the activities proposed as part of this alternative would be conducted on a land parcel which is privately owned. Therefore, property access agreements and/or a governmental order may need to be issued before proceeding with the activities described.

This alternative is a feasible approach, as the NYSDEC could issue a permit for LVRR for such work. See: "Disturbance of The Bed or Banks of a Protected Stream or Other Watercourse" permits (https://www.dec.ny.gov/permits/6554.html). ICs and monitoring, which have been described in Section 3.3.1.1 (Common Elements of FS Alternatives GRA), as well as a consideration of the NYSDEC and USEPA green remediation techniques, would be implemented as part of this alternative An evaluation of the NCP's nine criteria for this alternative are presented in Sections 4.4.4.4.1 through 4.4.4.4.9, below.

4.4.4.4.1 Overall Protection of Human Health and the Environment

The property where the Mud Creek Area of Interest is currently located is under private ownership, and public access is restricted; however, potential human exposure to surface water TCE would be mitigated via implementation of the streambed cover. The cover would primarily act as a physical barrier between the streambed, where active seeps and flows of TCE-impacted surface water occur, and the top surface of the streambed cover. Therefore, human exposure to the TCE impacted surface water would be mitigated, since all seeps and surface water impacts would be confined within the streambed cover.

4.4.4.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

The primary objective of this alternative is to eliminate the human and wildlife exposure to contaminated surface water through the implementation of the streambed cover. This can be effectively implemented through the proper design and installation of the streambed cover and would not require implementation of any active treatment processes in order to be realized. The cover would be placed over the entire area exceeding the PRG. When considering surface water samples Mudcreek-03 and Mudcreek-02 (both collected in 2018 within the first active flow segment [see **Figure 4.4-1a** of this report]), an approximate 50% reduction in surface water TCE concentration was observed in the downstream sample (Mudcreek-02, 380 µg/L), compared to the upstream sample (Mudcreek-03, 200 µg/L). Surface water flow in this active stream segment has been observed to be very shallow (*i.e.*, less than six inches in total depth).

These data and observations suggest that the shallow surface water flowing along the streambed of the Mud Creek active stream segment is subjected to natural degradation processes that may include aeration, volatilization and/or dilution. Turbulent flow along the streambed has been observed due to the presence of rocks in the streambed that create obstacles to the natural flow of surface water. This turbulent flow can promote volatilization of TCE which may account for the significant reduction of TCE surface water concentration that is observed in the downstream surface water sample, Mudcreek-03. Turbulent flow has been shown to promote volatilization of organic compounds which have a Henry's Law constant greater than 10^{-3} atm•m^3/mol (Peng J., et al, "Effect of turbulence on volatilization of selected organic compounds from water", Water Environment Research, Jan/Feb 1995). Although TCE was not evaluated as part of this study, TCE by comparison has a Henry's Law constant of 1.03×10^{-2} atm•m^3/mol, which is a full order of magnitude higher, and would therefore be expected to volatilize more readily. Although PRGs may not be achieved in the immediate area of the seeps, the streambed cover would provide additional stone material that could potentially increase the turbulent flow along the bottom of the stream channel, and further reductions in surface water TCE concentrations may be realized downstream. Volatilization of TCE would also be expected to increase in proportion to the ambient air and water temperatures. Therefore, the rate of volatilization of TCE would be expected to be highest during the summer months. Data collected during the proposed PDI will be utilized to confirm the mechanism of reduction related to the observed TCE concentrations within the active stream segment, and to determine the degree of reduction in surface water TCE concentrations that may be realized with implementation of the proposed streambed cover.

4.4.4.4.3 Long-Term Effectiveness and Permanence

If the proposed PDI (described in Section 4.4.4) indicates that an effective streambed cover system can be designed and placed within the Mud Creek Area of Interest, this alternative would provide for an effective means of preventing potential human exposure to TCE-impacted surface water.

In practice, the long-term effectiveness of this alternative would be dependent on the results of the PDI and a number of factors, including, but not limited to the following:

- The routine maintenance and repair of the streambed cover;
- The specific mechanisms of TCE degradation in surface water (*i.e.*, volatilization, aeration, and/or dilution) and the degree to which they may occur; and,
- The frequency and intensity of precipitation and/or flooding events that occur both in the vicinity, and upgradient/upstream of the Mud Creek Area of Interest. These weather-related

events could result in significantly increased daylighting of groundwater to surface water within the Mud Creek Area of Interest.

It is essential that a thorough PDI be conducted in order to properly assess the long-term effectiveness of the proposed streambed cover, and to ensure its proper design and placement. Since this alternative does not address the extensive source of TCE that is associated with the bedrock matrix pore spaces that continually impacts the groundwater plume (a portion of which discharges into the seeps and flows that have been identified in the Mud Creek Area of Interest), the success of this alternative will be dependent on the factors outlined above, and on an effective long-term sampling and maintenance program within the Mud Creek Area of Interest.

4.4.4.4.4 Reduction of Toxicity, Mobility, and Volume

This alternative is primarily designed as a mechanism for addressing the surface water seeps and flows within the Mud Creek Area of Interest. If the proposed PDI indicates favorable results this alternative may result in an adequate reduction of toxicity, mobility and volume of TCE within the surface water media.

4.4.4.4.5 Short-Term Effectiveness

Field activities associated with the installation of the streambed cover include clearing of vegetation and trees, construction of access roads, installation of materials (primarily stone) within the streambed, maintenance of the streambed cover, and system performance assessment through sampling activities.

Since the majority of the construction activities would occur on wooded land with uneven terrain, this would present a moderate to high degree of risk to on-Site workers during the system installation phase. Routine operation, maintenance and sampling activities once the system is operational would present a low degree of risk to workers. The risks associated with the various activities described can be mitigated by utilizing properly trained personnel, development of task-specific safety procedures, and use of appropriate equipment during each phase or task of the project.

It is expected that there would be minimal risk to the community and the environment associated with these activities. All equipment would be staged within a secure area which would be accessible only to Site personnel.

4.4.4.4.6 Implementability

Once the proposed PDI has been completed, this alternative could be implemented in a fairly short time frame (within a three-month period). The terrain in the Mud Creek Area of Interest is mostly wooded

and sloped, due to the presence of the Mud Creek channel which has formed a substantially deep gorge along its flow path. Trees and brush will need to be removed in order to construct access roads that can be utilized by trucks and other heavy equipment to access the various locations of the Mud Creek channel and seep locations where the streambed cover would be installed. Since this portion of Mud Creek is located on private land, an access agreement with the property owner would need to be negotiated in order to i) remove a portion of the trees and vegetation on the property, ii) build access roads required for transport of materials and equipment to various location on-Site; iii) allow for temporary on-Site storage of equipment necessary for the proposed installation; and iv) allow the necessary personnel to have access to the property during the construction and O&M phases of the project.

Once the streambed cover has been installed, routine maintenance and sampling activities to assess its effectiveness will need to be conducted. These activities are expected to be straightforward, and result in minimal disruption to the property owner and surrounding community.

4.4.4.4.7 Cost

The range of capital, O&M, and present worth costs for Alternative #4 are presented on **Table 4.4-4**. Capital worth costs (which include the implementation of the proposed PDI) are estimated to be approximately $2.07 million, and present worth costs for O&M are estimated to be approximately $533,587 (assuming a 30-year system operation time frame). Present worth costs are calculated based on a 7% discount rate for each year of system O&M. Approximately, $81,750 of additional costs are estimated for the implementation of ICs and monitoring. Therefore, the total costs for Alternative #4 are estimated to be approximately $2.69 million.

4.4.4.4.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for surface water, feedback and concerns from the NYSDEC will be considered.

4.4.4.4.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for surface water, feedback and concerns from the local communities impacted by the activities proposed in the remedy will be considered.

4.4.4.5 Surface Water Alternative #5: *In situ* Treatment of Contaminated Groundwater Prior to Discharge/Daylighting to Surface Water with Streambed Cover, with Institutional Controls and Monitoring

This alternative also involves the placement of a streambed cover within the Mud Creek stream bed (similar to Surface Water Alternative #4), with the addition of one or more PTBs, which would create one or more treatment zones (TZs) as an engineered *in situ* treatment process. Multiple contaminated seep locations are likely present throughout the Mud Creek Channel; therefore, it may not be feasible or desirable to install a TZ at every seep location. Instead, the TZs may be installed downstream from seeps where they will treat the contaminated seep water, prior to the treated water daylighting to the surface. In this way, the streambed cover would prevent direct contact with the contaminated seeps and contaminated surface water upstream of the TZs.

In addition to providing an effective means of preventing human contact with any potential TCE-impacted surface water within the Mud Creek Area of Interest, Surface Water Alternative #5 also has the benefit of providing active treatment to the TCE-impacted surface water within this area.

Please note that the number of TZs, their specific location, configuration, and the process or media to be used within the TZs will be determined only after a PDI has been completed within the Mud Creek Area of Interest. Treatment technologies which may be evaluated for use within the proposed TZs may include reactive media such as zero-valent iron (ZVI) which promotes chemical reduction, sorptive media such as granular activated carbon (GAC), GAC impregnated with ZVI (such as BOS-100), and *in situ* aeration.

Factors that may play a role in the potential design and implementation of Surface Water Alternative #5 may include the following:

- Seasonal flow conditions of Mud Creek within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Seasonal and precipitation event-related groundwater elevations within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);

- Seasonal data for surface water quality samples within the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Additional geochemical sampling for specific parameters that may influence the performance and maintenance requirements of the proposed TZs. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Identification of fractured rock or karst subsurface flow pathways that may be contributing to the flows and seeps in the Mud Creek Area of Interest. Information can be obtained through a PDI to inform the Mud Creek Area of Interest CSM (see Section 4.4.4 for additional PDI discussion);
- Pilot scale installation of one or more PTBs within the selected TZs and associated performance monitoring within the Mud Creek Area of Interest to evaluate effectiveness, media longevity, and potential biological, particulate, and precipitate fouling issues; and,

Most of this information is currently unknown and would need be obtained during the proposed PDI. For the purpose of evaluating costs associated with this alternative, several assumptions will need to be made with respect to its implementation (such as the number of TZs, their specific configuration, the media to be used within the TZs, etc.).

A conceptual design for a TZ with streambed cover within the Mud Creek Area of Interest is presented in **Figure 4.4-5** of this report**.** This figure shows the Mud Creek Channel as a section view from the Mud Creek Waterfall (left) to Mud Creek Pond (right), with implementation of the proposed TZ with streambed cover. Historical sampling locations along the channel are indicated by dark blue and light blue circles, which indicate those locations where TCE concentrations exceed the proposed 40 µg/L PRG, and those locations where TCE concentrations are below this PRG, respectively.

Figure 4.4-6 of this report indicates a detailed section view of this remedial alternative with two possible configurations. The first option (left figure) illustrates a TZ with air diffusers placed along its bottom. The process of aeration within the TZ would strip TCE out of the aqueous media as it flows through the TZ, and thereby potentially reduce TCE concentrations in surface water downgradient of the TZ. The second option (**Figure 4.4-6**, image on right) illustrates a TZ which contains media that is either reactive in nature (*e.g.*, ZVI), sorptive (*e.g.*, GAC), or a combination of the two (*e.g.*, GAC impregnated with ZVI).

Similar to the aeration option, TCE-impacted water that flows through the TZ would undergo treatment, and thereby potentially reduce TCE concentrations in surface water downgradient of the TZ.

Please note that the depiction of the TZ and streambed cover in **Figure 4.4-6** of this report is for preliminary conceptual purposes only, and that the location and configuration of each component will be dependent on the results of the proposed PDI.

Note that the majority of the activities proposed as part of this alternative would be conducted on a land parcel which is privately owned. Therefore, property access agreements and/or a governmental order may need to be issued before proceeding with the activities described.

ICs and monitoring, which have been described in Section 3.3.1.1 (Common Elements of FS Alternatives GRA), as well as the consideration of NYSDEC and USEPA green remediation techniques, would be implemented as part of this alternative. An evaluation of the NCP's nine criteria for this alternative is presented in Sections 4.4.4.5.1 through 4.4.4.5.9, below.

4.4.4.5.1 Overall Protection of Human Health and the Environment

The property where the Mud Creek Area of Interest is currently located is under private ownership, and public access is restricted; however, potential human exposure to surface water TCE impacts could be mitigated via implementation of a streambed cover and *in situ* treatment. The streambed cover would primarily act as a physical barrier between the streambed, where active seeps and flows of TCE-impacted surface water occur, and the top surface of the streambed cover. Therefore, human exposure to the TCE impacted surface water would be mitigated, since all seeps and surface water impacts would be confined within the streambed cover.

4.4.4.5.2 Compliance with Applicable or Relevant and Appropriate Requirements

This alternative provides for two potential pathways for the treatment of surface water, one of which includes physical processes, such as volatilization of TCE through the presence of the streambed cover (as described in Section 4.4.4.4.2). The second treatment pathway is the implementation of one or more TZs which will further reduce surface water TCE concentrations through an engineered *in situ* treatment process, the effectiveness of which will be highly dependent on the specific type of treatment that is utilized within each TZ (*i.e.*, aeration, sorptive media and/or reactive media as previously described).

One of the objectives of this alternative is to eliminate the human exposure route to contaminated surface water. This can be effectively implemented through the installation of the streambed cover and would not require implementation of any active treatment processes in order to be realized. However, the installation of one or more TZs would result in additional treatment, that may further assist in achieving this PRG. Data collected during the proposed PDI will be utilized to determine the degree of reduction in surface water TCE concentrations that may be realized with the implementation of both *in situ* treatment and the streambed cover. An *in situ* aeration cell may volatilize VOCs to the atmosphere, which may require obtaining an additional permit.

4.4.4.5.3 Long-Term Effectiveness and Permanence

If the proposed PDI (described in Section 4.4.4.5) indicates that an effective streambed cover and *in situ* treatment system can be designed and placed within the Mud Creek Area of Interest, this alternative could provide for an effective means of: i) preventing potential human exposure to TCE-impacted surface water, and ii) reducing surface water TCE impacts to meet the PRG of 40 µg/L.

In practice, the long-term effectiveness of this alternative would be dependent on a number of factors, including, but not limited to the following:

- The routine maintenance and repair of the streambed cover and components associated with each TZ;
- Adequate residence time for the treatment of surface water flowing within each TZ;
- The specific mechanisms of TCE removal/treatment in surface water (*i.e.*, volatilization, aeration, dilution, sorption, and/or active treatment), and the degree to which they may occur; and,
- The frequency and intensity of precipitation and/or flooding events that occur both in the vicinity, and upgradient/upstream of the Mud Creek Area of Interest. These weather-related events could result in significantly increased daylighting of groundwater to surface water within the Mud Creek Area of Interest.

It is essential that a thorough PDI be conducted in order to properly assess the long-term effectiveness of the proposed *in situ* treatment system and streambed cover, and to ensure the proper design and placement of these components.

4.4.4.5.4 Reduction of Toxicity, Mobility, and Volume

This alternative is primarily designed as a mechanism for addressing the surface water seeps and flows within the Mud Creek Area of Interest.

4.4.4.5.5 Short-Term Effectiveness

Field activities associated with the installation of the streambed cover and TZs include clearing of vegetation and trees, construction of access roads, installation of materials (primarily stone) within the streambed, excavation activities associated with the installation of the TZ(s), maintenance of the streambed cover and TZs, and system performance assessment through sampling activities.

Since the majority of the construction activities would occur on wooded land with uneven terrain, this would present a moderate to high degree of risk to on-Site workers during the system installation phase. Routine operation, maintenance and sampling activities once the system is operational would present a low degree of risk to workers. The risks associated with the various activities described can be mitigated by utilizing properly trained personnel, development of task-specific safety procedures, and use of appropriate equipment during each phase or task of the project.

It is expected that there would be minimal risk to the community and the environment associated with these activities. All equipment would be staged within a secure area which would be accessible only to Site personnel.

4.4.4.5.6 Implementability

Once the proposed PDI has been completed, this alternative could be implemented within a 6-to-12-month time frame. As mentioned previously in Section 4.4.4.5, an analysis of the bedrock fracture network and a pilot scale installation and evaluation of one or more TZs would need to be conducted as part of a PDI in order to determine the effectiveness of this alternative. The pilot study may need to be conducted both under "normal" flow conditions, and as close to peak flow conditions as possible in order to design an *in situ* treatment system which can properly deal with seasonal fluctuations in surface water flow. For example, if one were to consider installation of a TZ within the first active stream segment of Mud Creek (**Figure 4.4-1a** of this FS report), and that the surface water flow in that stream segment is approximately 3-4 cubic ft per second (cfs) under peak flow conditions, the minimum estimated volumetric flow that the TZ components should be designed for is approximately 1,500 to 2,000 gallons per minute

(gpm). A similar evaluation would need to be conducted for other portions of the Mud Creek Area of Interest where installation of a TZ may be a consideration.

The terrain in the Mud Creek Area of Interest is mostly wooded and sloped, due to the presence of the Mud Creek channel which has formed a substantially deep gorge along its flow path. Trees and brush will therefore need to be removed in order to construct access roads that can be utilized by trucks and other heavy equipment to access the various locations of the Mud Creek channel and seep locations where the streambed cover would be installed. Since this portion of Mud Creek is located on private land, an access agreement with the property owner would need to be negotiated in order to: i) remove a portion of the trees and vegetation on the property, ii) build access roads required for transport of materials and equipment to various location on-Site; iii) allow for temporary on-Site storage of equipment necessary for the proposed installation; iv) conduct excavation activities at one or more locations within the Mud Creek Channel in order to install the components associated with each TZ, and v) allow the necessary personnel to have access to the property during the construction and O&M phases of the project.

Given the seasonal fluctuations in surface water flow, TZs that use sorptive- and/or reactive-type media may require a significant footprint in order to achieve an appropriate amount of residence time for adequate treatment. In this scenario, TZs would require larger excavations to install the PTBs, and consequently the use of larger quantities of media would be necessary. When considering an aeration cell, the aeration rate can simply be increased (rather than significantly increasing the size of the aeration cell) in order to meet the required treatment objectives. The use of aeration cells within the TZs would require additional equipment to be installed on the property in order to provide compressed air to the aeration cell(s), as well as a backup power source. This equipment would require installation of an electrical service and periodic maintenance. Additional access agreements may need to be negotiated with the property owner, depending on how the TZs are configured.

Once the streambed cover and TZs have been installed, routine maintenance and sampling activities to assess their effectiveness will need to be conducted. These activities are expected to be straightforward, and result in minimal disruption to the property owner and surrounding community.

4.4.4.5.7 Cost

The range of capital, O&M, and present worth costs for Alternative #5 are presented on **Table 4.4-5**. Capital worth costs (which include the implementation of the proposed PDI) are estimated to be approximately $4.12 million, and present worth costs for O&M are estimated to be approximately $3.10 million (assuming a 30-year system operation time frame). Present worth costs are calculated based on a

7% discount rate for each year of system O&M. Approximately, $81,750 of additional costs are estimated for the implementation of ICs and Monitoring. Therefore, the total costs for Alternative #5 are estimated to be approximately $7.31 million.

4.4.4.5.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for surface water, feedback and concerns from the NYSDEC will be considered.

4.4.4.5.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for surface water, feedback and concerns from the local communities impacted by the activities proposed in the remedy will be considered.

4.5 Soil Media Remedial Alternative Evaluations

The following sections provide i) a summary of the applicable soil ARARs, RAOs and PRGs ii) identification and initial screening of GRAs, Technology Classes, and Process Options for soil, and iii) a detailed evaluation of several alternatives for addressing TCE-impacted soil at the Site.

Note that TCE impacts that exceed the soil ARARs (discussed in further detail in Section 4.5.2 below) are currently limited to an area within the Spill Zone, located in the northwestern portion of the Site west of the intersection of Gulf Road and Neid Road (see **Figure 1.5-3 and 1.5-3a** of this FS report). Please note that this area of the Spill Zone is located on private land and includes the soil beneath a limited stretch of Gulf Road as depicted on **Figure 1.5-3 and 1.5-3a**. Based on the LVRR remedial investigations and the soil ARARs, remedial alternatives to address soil impacted by TCE will be focused exclusively within this area.

4.5.1 Soil Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

4.5.1.1 Identification of Applicable or Relevant and Appropriate Requirements, To Be Considered, and Other Guidance

Soil guidance criteria include the CERCLA ARARs and the USEPA's TBCs category of non-enforceable criteria or guidance. ARARs, TBCs and related guidance are generally classified as chemical,

action, or location-specific. Discussions concerning specific chemical, action, and location-specific ARARs are presented below.

- **Chemical-Specific ARARs and TBCs** – Chemical-specific ARARs and TBCs for soil are usually health- or risk-based concentrations or methodologies that when applied to site-specific conditions, result in the establishment of concentrations of a chemical that may be found in, or remain in, the soil column. The determination of potential chemical-specific ARARs and TBCs for this Site is based on the nature and extent of contamination; potential migration pathways and release mechanisms for Site contaminants; reasonably anticipated future Site use; and likelihood that exposure to Site contaminants will occur. Potential chemical-specific ARARs for the Spill Zone soil are presented on **Table 4.5-1a**.

- **Location-Specific ARARs and TBCs** – Location-specific ARARs and TBCs for soil are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location. Some examples of these unique locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. The location of the Site is a fundamental determinant of its impact on human health and the environment. Potential location-specific ARARs and TBCs for the Spill Zone soil are presented in **Table 4.5-1b**.

- **Action-Specific ARARs and TBCs** – Action-specific ARARs and TBCs are restrictions placed on particular treatment or disposal technologies. Examples of action-specific ARARs are effluent discharge limits and hazardous waste manifest requirements. Potential action-specific ARARs and TBCs for the Spill Zone soil are presented in **Table 4.5-1c**.

4.5.2 Soil Remedial Action Objectives and Preliminary Remediation Goals

RAOs were established for the Site per correspondence with the USEPA on August 26, 2021. RAOs are Site-specific statements that convey the goals for minimizing substantial risks to public health and the environment. The appropriate RAOs for the Site have been identified as:

- Prevent unacceptable risk to human health from incidental ingestion of and inhalation exposure to Spill Zone soil (*i.e.*, contaminated overburden fill material/debris/rocky soil) exceeding remedial goals; and,

- Prevent migration of contaminants in Spill Zone overburden fill material/debris/ rocky soil that would result in further groundwater impacts.

PRGs for Spill Zone soil which address the RAOs have been developed using applicable chemical-specific ARARs, TBCs and other criteria as further discussed below.

Protection of Human Health

Consistent with 6 NYCRR 375-1.8 (f) and DER-10 4.2: (i) the current, intended and reasonably anticipated future uses of the Site are considered when selecting PRGs. Currently, the Spill Zone contains portions of parcels zoned industrial, recreational, or residential. Future land use is zoned industrial and recreational (see **Figure 1.5-3)**. The Spill Zone is designated industrial land and mining/quarrying on the Genesee County Web Mapping website (Benchmark, 2018). The majority of the Spill Zone is not currently used. The surrounding land in the Spill Zone is predominantly vacant with some adjacent and nearby industrial, residential, and recreational properties. Residential land within the eastern portion of the Spill Zone appears to be associated with farmland (where TCE soil concentrations are less than Unrestricted Use SCOs). Recreational land within the southern portion of the Spill Zone is currently only used for secondary access to the nearby Northwoods Sportsman's Association at 8402 Gulf Road. Outdoor grounds use at the Northwoods Sportsman's Association are primarily for firearms practice (*i.e.*, a passive recreational use).

NYSDEC regulations at 6NYCRR Part 375 allow for passive recreational uses under the definition of commercial use. Passive recreational uses are public uses with limited potential for soil contact (*i.e.*, Site access). As a result, the NYSDEC Industrial SCO (ISCO) ARAR for TCE of 400 mg/kg is a potential PRG for properties zoned industrial and the NYSDEC Commercial SCO (CSCO) ARAR for TCE of 200 mg/kg is a potential PRG for properties zoned recreational. Note that the Part 375 Residential SCO (RSCO) of 10 mg/kg) has not been considered as a potentially relevant PRG as soil concentrations in the Spill Zone that fall within the area zoned residential are less than Part 375 Unrestricted SCOs of 0.47 mg/kg; however, if the zoning changes (*e.g.*, residential area increases) than future remediation may be necessary. The zoning within the Study Area will be evaluated during the USEPA 5-year review.

In addition to these ARARs, proposed NYSDEC revisions to commercial/industrial SCOs for TCE (NYSDEC, 2020) to 54 mg/kg each is a TBC and potential PRG, as are USEPA RSLs for the composite commercial/industrial worker (USEPA, November 2022). For TCE these RSLs are set at 6 mg/kg and 19 mg/kg for the allowable excess cancer risk of $1x10^{-6}$ and HQ of 1, respectively. Risk based PRGs derived for subsurface soil that may be encountered by construction workers[7] are also TBC criteria as PRGs. These

[7] Because there are no promulgated standards (ARARs) that are available for future construction workers, risk-based preliminary remediation goal (PRGs) for this scenario were developed by EHS Support as identified in **Appendix A** of this report.

values were established as 4.2 mg/kg and 34 mg/kg for the allowable excess cancer risk of $1x10^{-6}$ and HQ of 1, respectively.

Protection of Groundwater

Potentially applicable PRGs for TCE in soil deemed protective of groundwater (*i.e.*, from leaching) include: the 6NYCRR Part 375 Protection of Groundwater Soil Cleanup Objective (PGWSCO) ARAR of 0.47 mg/kg, and the PRG identified in the March 1997 and May 2002 ROD of 7 mg/kg, which was derived based on similar methodology as the current NYSDEC PGWSCO but with use of Site-specific organic carbon content data.

Ecological Considerations

While the Spill Zone soil RAOs do not specifically address ecological concerns, an inherent requirement of the remedy is that it be protective of ecological receptors. As such, the Part 375 Protection of Ecological Resources SCO (ERSCO) ARAR of 2 mg/kg is a potentially applicable PRG.

4.5.3 Soil Evaluation and Screening of General Response Actions and Process Options

As presented in **Table 4.5-2 through 4.5-4**, GRAs for Spill Zone soil include containment and physical removal, as well as the "no action" GRA common to all site media. Candidate technologies comprising specific remedial methods that could potentially, alone or in combination with other technologies, comprise a GRA for Spill Zone soil are also identified in **Tables 4.5-2 through 4.5-4**, and screened in this section, as are associated process options demonstrated to be potentially capable of addressing the Spill Zone soil RAOs.

Tables 4.5-2 through 4.5-4 evaluate the process options relative to the preliminary screening factors of effectiveness, implementability, and cost, with each of the evaluations carried through for various potentially applicable PRGs. Because there are numerous candidate PRGs, a representative cross section of potential PRGs including 0.47 mg/kg, 2 mg/kg, 7 mg/kg, 19 mg/kg, 200 mg/kg, and 400 mg/kg were employed to estimate costs for several cleanup levels. **Table 4.5-5** provides additional detail concerning the estimated costs. Note, however, that costs are limited to capital costs necessary to affect the technology; they do not include post-remedial operation, maintenance and monitoring costs or ancillary costs that may be required to complete full remediation. In addition, in all instances involving excavation for disposal or treatment purposes, the cost estimates do not discount potential savings from screening of larger materials.

While screening of larger materials may be required to render the technology effective (*e.g.*, in the case of solidification), it is not known whether screened materials would meet the PRGs. Thus, the benefit of screening to reduce treatment/disposal volumes is unknown without completion of pre-design pilot testing. In the case of the asphalt/concrete cover, costs assume the use of asphalt as it represents a lower capital investment and is more conducive to placement across uneven grade.

In identifying and screening the candidate technologies and process options, it is important to note that while the terms "Spill Zone Soil" and "rocky soil" have been used to describe the overburden materials within the historic derailment/Spill Zone area, up to 50% fine to coarse-grained gravel or rock fragments were observed within the overburden in parts of the Spill Zone.

4.5.3.1 No Action General Response Action for Soil

The no-action alternative for overburden is defined as taking no further action to address the concentrations of TCE identified in the overburden materials at the Site. The no action alternative provides a baseline for comparing other remedial alternatives.

Effectiveness - The no action alternative provides no control of exposure to contaminated overburden materials and provides no long-term effectiveness toward achieving the RAOs.

Implementability - No technical or administrative implementation issues are associated with the no action alternative.

Cost - No remediation costs are associated with the no action alternative.

4.5.3.2 Containment General Response Action for Soil

Containment of contaminated soil is accomplished through immobilization or covering techniques, as discussed in the following sections. Containment process options discussed in this section include immobilization via solidification/stabilization (S/S) and covering via placement of a soil or hardscape (asphalt or concrete) cover system.

4.5.3.2.1 Immobilization

Immobilization reduces the mobility of hazardous substances and contaminants. This is accomplished by binding the contaminants within the contaminated media, thereby reducing the potential for off-Site migration via wind or surface water erosion and the potential for particulate inhalation or incidental ingestion. Reduced leaching potential may also occur dependent on the contaminant class and type of immobilizing agent employed.

4.5.3.2.1.1 Solidification/Stabilization (S/S)

S/S is accomplished by mechanically mixing Portland cement, concrete, or other materials into the contaminated matrix. The S/S process may be accomplished *in situ*, typically using large diameter (3 to 12 ft) augers with mixing paddles and grout ports for deeper applications or an excavator bucket for shallow applications, or *ex situ* following excavation. In the case of the Spill Zone rocky soil, the heterogeneous nature of the overburden and the presence of gravel and large diameter cobbles, is expected to preclude conventional *in situ* S/S. In addition, stabilization techniques to reduce contaminant leachability are generally applicable to inorganic contaminants and non-volatile organics such as polyaromatic hydrocarbons and PCBs. Accordingly, the benefits of S/S for TCE-impacted overburden would be limited to those realized through solidification processes that would reduce particulate mobility and inhibit ingestion/inhalation exposure pathways. Thus, *ex situ* solidification would be employed for the Spill Zone.

The identified contaminated overburden material would be excavated and stockpiled on-Site. As particles greater than 2 inches in diameter may not be treated effectively, a screening process would be required to physically segregate larger materials prior to treatment. Pre-design pilot testing would be needed to determine whether these larger particles require crushing or would meet PRGs without the need for treatment (larger gravel/cobbles may not exhibit TCE mass above PRGs even in instances where it is present within an area characterized by elevated TCE concentrations due to the lower surface area to mass ratio). Pre-design pilot testing would also evaluate whether volatilization would be a concern for workers or the community (per exclusion zone and downwind perimeter air monitoring, respectively) during segregation and/or crushing of larger gravel/cobbles. Periodic testing would be required during full scale construction to confirm pre-design testing if larger particles were to be replaced in the excavation without crushing and treatment. An amendment such as Portland cement, concrete, or other materials and water (as needed) would then be added to the smaller-grained contaminated matrix and mechanically mixed. Once the mixture is homogenized, the material would be poured back into the excavation where it would be allowed to cure into a stable, monolithic, or semi-monolithic solid matrix. However, on-Site treatment of TCE-impacted

overburden *ex situ* in a temporary treatment unit and placing the solidified material in the excavation area would need to comply with the Resource Conservation and Recovery Act (RCRA) corrective action management units (CAMU) performance standards. Since solidification treatment would not achieve 90% reduction of TCE or reach 10 times the universal treatment standard (60 mg/kg), the CAMU would have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring.

In addition to the pre-design testing to evaluate TCE content of larger particles and potential volatilization during segregation/crushing of these larger particles, this process option would require completion of a small pilot-scale treatability study prior to implementation to determine which solidification material to use (Portland cement, concrete, etc.), and the percentage of that material needed to effectively solidify the overburden at the Site. Implementation of this process option also includes acquisition of the binding agent and equipment needed to excavate and mechanically mix the soil, and installation of temporary and permanent sediment and erosion controls to prevent stockpile erosion during storm events. Other general controls that would be applied during excavation and mixing activities include community air monitoring and dust control to prevent unacceptable particulate and vapor emissions, extraction, and above grade treatment/discharge of perched groundwater if encountered. In general, any water removed from the excavation area would be stored/settled in a portable storage tank and pumped through a bag or cartridge filter prior to treatment using GAC.

Effectiveness – This option reduces the mobility of TCE-impacted unconsolidated material within the Spill Zone by thoroughly blending impacted materials with cement in a mechanical mixing device, such as a pug mill. The treated soil would be placed into the lined CAMU, which would be constructed within the excavation area, and capped. It does not reduce the toxicity or volume of the TCE or other constituents. A pilot test would be required to identify the appropriate blend of cement to unconsolidated material by weight. Dust controls would be required during removal work in dry weather. This alternative satisfies the RAOs for Spill Zone soil.

Implementability – Technical implementability issues with this option include design and construction of the CAMU to accommodate an increase in overburden volume due to the addition of cement and the varying size of the rock materials in the overburden, which are expected to require screening and segregation of larger size debris or crushing of larger debris due to poor mixing of such materials and high variability in the density of the unconsolidated material if not removed or size-reduced prior to blending. Administrative implementability may be expected due to aesthetic concerns following treatment and the need for agency approval of the CAMU design.

Cost – The volume of unconsolidated material requiring treatment to achieve PRGs is estimated to range from 356 to 19,257 yd^3. The estimated capital cost ranges from $320,000 to $9,286,000. The cost to design and construct the CAMU has not been included in this process option screening estimate.

4.5.3.2.2 Cover System

Installation of a cover system typically includes site clearing and possibly grading to facilitate drainage, followed by placement of "clean" material to prevent direct human and wildlife contact with contaminated rocky soil/fill and erosion and off-Site transport of contaminated soil particles. A cover system may also reduce infiltration and contaminant leaching if it is constructed of low-permeability material. The cover system process options considered potentially applicable to this Site include a soil cover and hardscape (asphalt or concrete) cover.

4.5.3.2.2.1 Soil Cover

A soil cover would involve placement of one foot of clean, imported soil over a visually identifiable demarcation layer, including 4-6 inches of topsoil capable of supporting vegetation, and seeding and fertilization of the completed cover to promote vegetative growth for erosion control. Soil cover systems prevent human and wildlife exposure to contaminated overburden and reduce wind and surface water erosion and may reduce but not prevent infiltration. The amount of infiltration reduction would be dependent on grading and evapotranspiration losses through the vegetative layer.

Soil cover systems typically require periodic maintenance, including repair of damage from erosion or burrowing and removal of larger vegetation to ensure the integrity of the cover.

Effectiveness – This option reduces the mobility of TCE-impacted unconsolidated material within the Spill Zone by adding supplemental clean soil to provide for no less than a foot of clean, vegetated barrier soil between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE or other constituents. This alternative satisfies the RAOs for Spill Zone soil.

Implementability – No significant technical or action-specific administrative implementability issues are associated with this option.

Cost – The area requiring cover to achieve PRGs is estimated to range from 4,719 to 114,025 square ft (ft^2). The estimated capital cost ranges from $88,162 to $277,221.

4.5.3.2.2.2 Asphalt Cover/Concrete Cover

A hardscape cover involves placement of a layer of asphalt and/or concrete over a layer of clean, imported stone. The thickness of the stone layer and asphalt or concrete would be dependent on intended end use; if the cover were not intended to support routine or heavy vehicular traffic, a 6-8" layer of compacted stone and 4" asphalt or concrete cover would be sufficient. This process option prevents human and wildlife exposure to contaminated overburden; reduces wind and surface water erosion; and would limit infiltration and potential leaching. This option requires periodic maintenance and potential replacement due to weathering and cracking over time.

Effectiveness – This option reduces the mobility of TCE-impacted unconsolidated material within the Spill Zone by placing an approximate 3-4" layer of asphalt over aggregate to provide for a hardscape barrier between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE. This option satisfies the RAOs for Spill Zone soil.

Implementability – No significant technical implementability issues are associated with this option; however, periodic significant maintenance will be required to repair or replace damage from weathering and freeze-thaw cracking. In addition, storm water controls will be needed to manage the large quantity of precipitation runoff. Administrative implementability issues may be expected due to aesthetic concerns and increased potential for trespassing.

Cost – The area requiring cover to achieve PRGs is estimated to range from 4,719 to 114,025 ft^2. The estimated capital cost ranges from $153,033 to $918,175.

4.5.3.3 Physical Removal General Response Action for Overburden

The primary method for physical soil removal at the Site is excavation. Various process options associated with excavation including off-Site landfill disposal, low-temperature thermal desorption (LTTD), and *ex situ* SVE are discussed in the following sections.

4.5.3.3.1 Excavation

Excavation is a commonly used method to remove contaminated material from the subsurface. The extent of excavation is determined based on the selected PRG for each process option; all soil with concentrations above the selected PRG is excavated while all soil with concentrations below the selected PRG is left in-place. Excavated soil is either disposed off-Site or treated on-Site and returned to the excavation. If soil below PRGs is removed to allow access to deeper soils exhibiting impacts above PRGs,

the non-impacted soil would be returned to the excavation. In addition, as discussed for the *ex situ* solidification process option, it may be possible to screen and physically segregate larger materials prior to treatment or disposal, as larger rock fragments may not exhibit TCE mass above PRGs even in instances where it is present within an area characterized by elevated TCE concentrations due to the lower surface area to mass ratio of those larger materials. If so, a screening plant would be used to separate the excavated material based on grain size. Pre-design testing would be required to establish the expected size of the particles that meet PRGs as necessary to determine the target screen size. Periodic testing would be required during full-scale construction to confirm pre-design testing. Coarse-grained materials that are screened from the excavation pile would then be used to backfill the excavation, which would reduce the quantity of imported backfill material needed and reduce the amount of material requiring off-Site disposal or treatment.

General controls that would be applied during all excavation activities would include:

- Community air monitoring and dust control to prevent unacceptable particulate and vapor emissions;
- Extraction and above grade treatment/discharge of perched groundwater if encountered. In general, any water removed from the excavation area would be stored/settled in a portable storage tank, and pumped through a bag or cartridge filter prior to treatment using GAC; and,
- Temporary sediment and erosion controls to prevent erosion of stockpiles or sediment runoff during storm events.

4.5.3.3.1.1 Off-Site Disposal of Excavated Overburden

This process option would involve transport of the excavated materials to a permitted, off-Site disposal facility. While nearly all the excavated materials are expected to exhibit hazardous waste characteristics for TCE per the toxicity characteristic leaching procedure (TCLP) determination, they will likely be subject to State and Federal Land Disposal Restrictions above 60 mg/kg[8]. If the unconsolidated material exceeds 60 mg/kg and/or is characteristically hazardous, it would need to be treated at an off-Site Treatment, Storage and Disposal Facility (TSDF) and meet TCLP criteria prior to disposal.

[8] The EPA's Alternative Soil Treatment Standards for soils allows land disposal of TCE-impacted soils up to 10 times the Universal Treatment Standard (UTS) of 6 mg/kg. NYSDEC allows such materials to be disposed as non-hazardous wastes in a permitted sanitary landfill if meeting the 60 mg/kg total TCE threshold and passing TCLP criteria, provided a "contained-in" determination is issued by the Department.

If this process option is selected, a contained-in request will be submitted to the NYSDEC outlining the TCLP results of samples collected from locations previously exhibiting elevated TCE concentrations, which indicated that the overburden is not characteristically hazardous at levels well above 60 mg/kg. Once the NYSDEC issues the contained-in determination for the Site, soil with concentrations less than 60 mg/kg may be disposed as non-hazardous waste at a local Subtitle D sanitary waste landfill, whereas soil with concentrations greater than 60 mg/kg must be disposed of as hazardous waste at an out-of-State TSDF.

Effectiveness – Once the unconsolidated material is placed in an off-Site disposal facility, the mobility of the TCE would be reduced; however, the overall volume and toxicity of the materials would remain unchanged unless treatment were required by the TSDF. This option would meet the RAOs for the Spill Zone soil.

Implementability – Technical implementability issues would include coordination of truck traffic resulting from this approach. The number of trucks leaving the Site is dependent on the volume of unconsolidated material to be removed, and an equal number of truckloads of clean backfill will need to be brought in. Selection of a lower PRG would result in a larger volume of unconsolidated material being removed and therefore more truck traffic and a longer construction period. Locating disposal locations for hazardous and, depending on the selected PRG, non-hazardous material will be necessary. This may be problematic if a large volume of material is slated for disposal under this option. Local traffic control and identification of import sources for clean soil/stone meeting applicable import standards would also be required.

Cost – The capital costs associated with this alternative are estimated to range from $688,000 to $6,961,000. These costs assume that off-Site treatment would not be required prior to disposal.

4.5.3.3.1.2 Low-Temperature Thermal Desorption of Excavated Overburden

This process option includes excavation, stockpiling, and treatment of impacted overburden using LTTD. LTTD volatilizes contaminants by heating the impacted material to temperatures ranging between 93ºC and 315ºC within a reactor, such as a rotary dryer or thermal screw, at a rate of approximately 10 to 50 tons per hour. The low temperature effectively removes VOCs, such as TCE, from the feed stream while allowing the overburden to retain its physical properties and organic material. Once this process is completed, samples are collected for laboratory analysis to ensure that the treated media meets required criteria, and the treated soil is returned to the excavation as backfill. On-Site treatment of TCE-impacted overburden *ex situ* in a temporary treatment unit and placing the treated material in the excavation area

would need to comply with the RCRA CAMU performance standards. If LTTD treatment achieves 90% reduction of TCE or reaches 10 times the universal treatment standard (60 mg/kg), the CAMU would not have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring.

Implementation of this process option includes acquiring the equipment required to complete excavation, LTTD, and backfilling activities, as well as capture and treatment of air emissions, and completion of post-excavation sample analysis for TCE. Residual products include particulates, treated gas emissions, filters, and fuel emissions. Wet scrubbers or fabric are typically used to reduce particulates and condensation or adsorption to GAC are used to treat TCE emissions due to volatilization. GAC filters must be properly characterized and disposed after use. As this site is not located within an area supplied by natural gas, the reactor will need to be run on propane or heating oil.

Effectiveness – This option may be effective in reducing TCE to below PRGs; however, pilot testing would be necessary to confirm the ability of this option to remove VOCs from rock fragments. The volume of TCE in the treated overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Zone soil.

Implementability – Technical implementability issues include potential challenges in removing VOCs from larger particles, limited availability of LTTD equipment, and lack of a readily available natural gas source or sufficient electrical power supply, necessitating use of a unit capable of running on propane or fuel oil.

Cost – The capital costs associated with this alternative are estimated to range from $509,574 to $16,554,766.

4.5.3.3.1.3 *Ex Situ* SVE of Excavated Overburden

SVE technology removes VOCs by inducing air flow through impacted media, thereby enhancing volatilization from VOC-contaminated overburden into the vapor phase. *Ex si*tu SVE is completed by excavating and placing impacted materials on a predetermined treatment area, typically in windrow form, where a network of horizontal extraction wells would be installed within the overburden pile. Vacuum is applied to the extraction wells via a blower. A poly cover may be used to preclude short circuiting and saturation of the piles by precipitation. Sample ports are positioned on the influent and effluent lines to enable collection of representative vapor samples during treatment. Visual observations and photoionization detector (PID) screening are completed during remediation to monitor the progress. Once

this process is complete, samples are collected for laboratory analysis. If the soil meets required import criteria, the treated soil is returned to the excavation as backfill. Vapor-phase GAC is typically used to absorb TCE in vapors extracted from the overburden. If *ex situ* SVE achieves 90% reduction of TCE or reaches 10 times the universal treatment standard (60 mg/kg), the CAMU would not have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring.

Effectiveness – *Ex situ* SVE may be minimally effective in reducing TCE to below the PRGs, as prior *ex situ* pilot testing and full-scale *in situ* SVE were not successful at reducing TCE concentrations to below remedial objectives. An additional pilot testing program would be necessary to confirm the ability of this option to remove VOCs from the rock fragments. The results of the pilot testing would likely require crushing the rock fragments prior to treatment. A pilot test to assess the impact of volatilization on downwind perimeter monitoring during crushing would also be required. The volume of TCE in the treated overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Zone soil.

Implementability – Technical implementability issues would include the requirement to crush rock fragments prior to any attempted treatment due to the potential for short circuiting within the heterogeneous overburden matrix. If treatment goals are not met, the CAMU would have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring.

Cost – The capital costs associated with this alternative are estimated to range from $303,994 to $1,224,879.

4.5.3.4 Summary

All process options discussed above are expected to be effective in achieving GRAs except for *ex situ* SVE. A previous *ex situ* SVE test conducted at the Site in 1998 (NYSDEC, 1998) indicated that minimal influence (approximately 2-foot radius) could be achieved via vacuum extraction, even when the soil pile was covered with an impermeable cover to minimize short-circuiting. Additionally, full-scale *in situ* SVE was applied from 2015 to 2017 with adequate radius of influence to effectively treat the impacted overburden; however, concentrations remained well above PRGs after two years of treatment including focused pulsing of the system in areas of highest TCE impact. Based on these findings, *ex situ* SVE is not expected to provide significantly improved results. Therefore, *ex situ* SVE has been removed from consideration in the soil remedial alternatives.

All process options discussed above are implementable, although some options are likely more challenging to accomplish with little additional benefit. For example, a hardscape cover system greater than an acre in size would require the installation of permanent storm water controls, such as a retention pond, to account for the loss of infiltration at the Site. This would require additional excavation activities, potentially off-Site, as well as potential permission from a non-related entity to install and maintain a retention pond on their property. In addition, a hardscape cover would require more costly maintenance and potential periodic replacement. Therefore, a hardscape cover has been removed from consideration in the overburden remedial alternative evaluation.

4.5.4 Soil Remedial Alternative Evaluations

The available remedial technologies and process options for Spill Zone rocky soil/overburden materials that were retained for further analysis in Section 4.5.3 above were considered in the development of several remedial alternatives that would undergo detailed analysis.

In developing the remedial alternatives, it is appropriate to first evaluate the candidate PRGs, which are comprised of values deemed protective of human health, ecology, and/or groundwater.

Groundwater at and downgradient from the Spill Zone is already impacted by the presence of TCE. The soil cleanup level for TCE in the ROD (7 mg/kg) was developed to provide protection of the groundwater resource. This value was derived consistent with the procedures employed in NYSDEC's Division of Environmental Remediation, Technical and Administrative Guidance Memorandum (TAGM) 4046[9] "Determination of Soil Cleanup Objectives and Cleanup Levels." The guidance employed partitioning theory and allowed substitution of the default organic carbon value with the known level. The equations predict the concentration of the leachate that will be produced due to percolation of water through the impacted soil column, and then divide that concentration by a DAF[10] of 100 to determine whether groundwater quality standards would be contravened at the point at which the leachate reaches the water table.

This is the same approach that was employed to derive the Part 375 PGWSCO (0.47 mg/kg). As indicated in the prior ROD, the TCE cleanup level of 7 mg/kg was calculated using an actual Sitewide

[9] Replaced by NYSDEC Policy CP-51/Soil Cleanup Guidance, issued October 21, 2020.

[10] Employment of a DAF of 100 is the same approach used to identify theoretical PGWSCOs per the September 2006 Technical Support Document developed by the New York State Department of Environmental Conservation and New York State Department of Health

average organic carbon content of 9.6% and therefore reflects a lower theoretical leachate concentration and, as such, a higher allowable soil concentration than the Part 375 PGWSCO, which was determined using the default organic carbon content (1%). However, both values assume that the impacted media is in fact soil, and that standard partitioning theory will apply. The character of the impacted overburden and analytical data do not support employment of partitioning theory to determine a soil concentration protective of groundwater quality. Partitioning theory assumes a soil matrix; however, the overburden materials in the Spill Zone contain significant quantities of rock fragments into which the TCE has diffused. This rocky soil matrix does not liberate TCE as readily as soil as evidenced by the SPLP data, which represent actual leachate concentrations generated from Site-specific samples subjected to simulated precipitation. Total TCE concentrations at three locations within the Spill Zone were reported at 280, 190, and 64.5 mg/kg, with corresponding SPLP levels reported at 221, 424, and 134 µg/L (Benchmark, 2018). In all cases, dividing these leachate concentrations by a DAF of 100 results in conformance with groundwater quality standard. In other words, the SPLP results indicate that samples with TCE concentrations significantly higher than those typically encountered on-Site do not act as a continuing source of contamination that threatens to contravene groundwater quality standards.

As discussed in Section 2.4.4, the DFN model (Parker and Chapman, 2016) was used to evaluate the potential effectiveness of remediation of TCE in the vadose zone source area via a source hotspot removal method, such as those contemplated by the Spill Zone overburden process options retained for further analysis. This was accomplished through a simulation where it was assumed that the vadose zone TCE source above the water table is completely removed and then evaluating the impacts of this source zone removal on the downgradient plume. The DFN Report (Parker and Chapman, 2016) presents a series of simulated TCE concentration distributions which can be compared to the base case situation, each projected for 10, 20 and 50 years after the proposed remediation activities under consideration have been completed (see **Figure 4.3-3** of this FS Report). As demonstrated by these TCE concentration distributions, the complete removal of the TCE source area above the water table (including TCE in the unsaturated bedrock, which will not be addressed by the Spill Zone overburden process options) would not have a significant impact on the overall TCE distribution within the majority of the groundwater plume, even 50 years after completion of remediation activities, with only modest improvements nearer the Spill Zone.

These simulations show that removal of the vadose zone source inputs has little effect on the downgradient plume. Improvements in groundwater quality through source removal might be accomplished if the Spill Zone matrix was in fact comprised of soil and was the sole source of TCE groundwater contamination, but that is not the case. As stated above, the overburden materials contain

significant rock fragments that significantly inhibits leaching due to percolation effects. In addition, rock core samples demonstrate that bedrock within the saturated zone has also been impacted by TCE, with large mass storage in the rock matrix pore spaces throughout the entire groundwater plume zone as dissolved and sorbed phase mass. Back-diffusion out of the rock matrix pore spaces and into the groundwater in the fractures, with the stored mass in the matrix as dissolved and sorbed phase essentially acting as a secondary source zone, will sustain the plume for long time periods even if (hypothetically) source inputs from the unsaturated overburden could be eliminated. Therefore, implementation of the Spill Zone overburden process options will result in little to no marked improvement in downgradient groundwater quality, even if such measures were successful in achieving PRGs deemed protective of groundwater quality.

Lastly as it relates to protection of groundwater, the RAO for Spill Zone soil is to: "Prevent migration of contaminants in Spill Zone overburden fill material/debris/rocky soil that would result in further groundwater impacts." Considering again the Site-specific data, the maximum reported TCE concentration in the overburden leachate generated through the synthetic precipitation testing, which conservatively models the effects of acid rain percolating through the overburden materials, was 424 µg/L with a corresponding total TCE concentration of 190 mg/kg. Thus, the ratio of TCE in the SPLP leachate, expressed in µg/L, to total TCE, expressed in mg/kg, was approximately 2.23. The highest use-based PRGs contemplated for the Spill Zone overburden are 200 mg/kg (commercial use SCO) and 400 mg/kg (industrial use SCO). Assuming an equivalent leaching ratio, the leachable TCE at these concentrations would be approximately 446 and 893 µg/L, respectively. Employing a DAF of 100 indicates the concentrations at the point of groundwater contact would be approximately 4.5 µg/L (commercial SCO) and 8.9 µg/L (industrial SCO). By comparison, concentrations in groundwater within the Spill Zone have historically been in the range of hundreds to thousands of parts per billion. Thus, there would be no further groundwater impact from alternatives that meet the use-based PRGs of 200 mg/kg or 400 mg/kg; lower use-based PRGs would yield even lesser potential impact. SPLP data and calculations are included in **Appendix D**. Based upon this information, PRGs based upon groundwater protection were eliminated from consideration in the development of remedial alternatives for the Spill Zone soil.

The remaining PRGs are health-based SCOs for sites used or slated to be used in a commercial capacity, including a passive recreational capacity, or sites used or slated to be used in an industrial capacity, as well as the protection of ecological risk SCO of 2 mg/kg. Of these, the CSCO of 200 mg/kg, when combined with ICs, such as proprietary controls, is considered the applicable PRG based on zoning, historic use of the property, and anticipated future use of the Site (see **Figures 1.4-1, and 1.5-1 to 1.5-4** of this report, which show the current Site zoning and current and anticipated future use per the Town of LeRoy

Master Plan, 2017). As previously discussed, a portion of the Spill Zone falls within an area where current land use is deemed "recreational" as it services the nearby Northwoods Sportsman's Association at 8402 Gulf Road in LeRoy. Outdoor grounds use at the Northwoods Sportsman's Association are primarily for firearms practice (*i.e.*, a passive recreational/commercial use). However, this area of the Northwoods Sportsman's Association is not used in a recreational manner; it is only used for secondary access to their property, due to the proximity to Gulf Road. Therefore, this area is used in a capacity no different than land used for commercial purposes. Additionally, ICs, such as an environmental easement, will be put in place for the Northwood Sportsman's Association portion of the Spill Zone to assure it will not be used for any active recreational purposes in the future. Accordingly, the CSCO is considered applicable to this portion of the Northwoods Sportsman's Association property under both the current and future use scenarios.

Further evaluation of the 200 mg/kg CSCO was performed by EHS Support (2022b) to determine whether it would be protective of all Site receptors under a post-remedial use scenario. Specifically, EHS Support evaluated a cancer risk range of $1x10^{-6}$ to $1x10^{-4}$ and a non-cancer risk with an HQ of 1. The evaluation considered the future Site worker, including the more sensitive outdoor worker, the recreational user/trespasser, and the construction worker/utility worker. Under the CSCO scenario there are no unacceptable risks or hazards to the future Site worker/user, with the exception of the future construction worker. An O&M Plan would be implemented to address the construction worker exposure pathways involving direct contact with subsurface soil or inhalation of soil-derived particulates or vapor during post-remedial excavation activities through implementation of the associated Excavation Work Plan (EWP) and by mandating the use of personal protective equipment (PPE).

Therefore, the CSCO was identified as protective of public health, without the implementation of a cover system. The CSCO scenario would however necessitate the implementation of an O&M Plan, including appropriate ICs, a Site-specific Health and Safety Plan (HASP), and an Excavation Work Plan (EWP) to be protective of the future construction worker. Additionally, the CSCO scenario would necessitate the implementation of three Environmental Easements, including an easement established for the Site to restrict land uses to commercial, an easement established with the Northwoods Sportsman's Association to restrict the portion of their Site within the Spill Zone to passive recreational use, and an easement established with Genesee County that requires any future intrusive work addressing impacts beneath Gulf Road when the roadway undergoes significant repair or replacement to be completed in accordance with the O&M Plan.

Concerning ecological risks, the applicability of the Part 375 ERSCO is discussed in the EHS Support Memorandum "Preliminary Review of the Supplemental Ecological Risk Evaluation for the Lehigh

Valley Railroad Derailment Site, LeRoy, New York" (2021). This memo discusses the Supplemental Ecological Risk Evaluation completed by the USEPA for the Spill Zone soils. The USEPA used post-SVE TCE concentrations in surface soil samples (0.5 to 2.5 ft bgs) collected in a 0.15-acre area to estimate the exposure point concentration (EPC). The estimated EPC for the Site (460.2 mg TCE/kg) was then compared to the ERSCO (2 mg/kg), which was derived using potential exposure to the short-tailed shrew. The USEPA concluded that there was a potential for "adverse impact to ecological receptors under current Site conditions."

The EPC calculated by the USEPA only represents a 0.15-acre area, 0.05 acres of which is identified as a portion of Gulf Road. This limited area only represents approximately 10% of the typical 0.96-acre foraging range of the short-tailed shrew. Additionally, the existing stone cover over the Site constructed during installation of the SVE system minimizes direct or indirect soil exposure and is not likely to provide an acceptable habitat to support a sufficient forage base of earthworms, which were assumed to be the primary food source for the short-tailed shrew, the wildlife receptor that is the basis of the NYSDEC ESCO, and likely prevents burrowing of small mammals, which would also be at risk of exposure.

Under a future exposure scenario, following the potential removal of the stone cover and implementation of remedial measures in the Spill Zone to meet the CSCO, as well as site restoration activities, potential ecological exposure is not likely to adversely affect ecological receptor populations based on the limited spatial extent of remaining soil concentrations exceeding the NYSDEC ESCO for TCE. As discussed in **Appendix A** (EHS Appendix A.3), population-level effects are not likely based on the findings of an evaluation of future exposure scenarios. Pertaining to the Spill Zone as a whole, the extent of residual TCE that may remain in surface soil under a future scenario would be less than or equal to the typical foraging range of a short-tailed shrew (0.96 acres; Sample and Suter, 1994). South of Gulf Road, it is estimated that an individual shrew foraging entirely within the maximum extent of the area exceeding the ESCO (approximately 0.4 acres) following the potential removal of the stone cover and implementation of remedial measures would obtain less than half of the TCE dose equivalent to the dose used to establish the ESCO. Based on an area use factor (AUF) of 0.42, which is the ratio of the exposure area to the typical foraging range of a short-tailed shrew (AUF=0.4 acres/0.96 acres=0.42), a short-tailed shrew exposed to an average soil TCE concentration of 2 mg/kg in areas outside of the extent of remedial excavation limits south of Gulf Road would obtain approximately 42% of the lowest observed adverse effect level (LOAEL) dose used in the ESCO derivation. North of Gulf Road, it is estimated that an individual shrew foraging entirely within the maximum extent of the area exceeding the ESCO (AUF ~ 1) following the potential removal of

the stone cover and implementation of remedial measures would obtain a TCE dose equivalent to the dose used to establish the ESCO; however, given that the typical density of shrews ranges from 2-10 individuals per acre (Saunders, 1988), the limited number of individuals that may be adversely affected would not be sufficient to impact overall populations. Ecological exposure in these areas would be further mitigated by restoration of the area currently covered by stone, if removed, through the placement of topsoil and revegetation following the removal of stone cover. As stated in Section 4.5.5.2, one foot of clean topsoil and seed will be placed over areas outside of the remedial excavation limits that are currently covered by polyethylene sheeting and stone ballast and will extend to areas of the Spill Zone where surface soils were identified at TCE concentrations exceeding 2 mg/kg (see **Figure 1.5-3a**). The placement of one foot of topsoil and seed will promote the restoration of the Site and mitigate ecological exposure pathways to soils with TCE concentrations exceeding 2 mg/kg. Therefore, EHS Support concluded that when current and future Site exposure scenarios are considered, the contamination does not present a significant impact to ecological receptors at the Site. Thus, employment of the CSCO as the PRG precludes unacceptable ecological risks.

Based upon the process option screening and the further evaluation of risks to future Site receptors, the following remedial alternatives were developed:

- Soil Alternative #1: No Action;
- Soil Alternative #2: *Ex Situ* Solidification/Stabilization (S/S) using Commercial Land-Use Based PRG with ICs;
- Soil Alternative #3: Excavation/Disposal using Commercial Land-Use Based PRG with ICs; and,
- Soil Alternative #4: *Ex Situ* Low-Temperature Thermal Desorption (LTTD) using Commercial Land-Use Based PRG with ICs.

Each alternative (except for Soil Alternative #1: No Action) will include ECs and ICs to further protect human health and the environment, as well as consideration of NYSDEC and USEPA green remediation techniques (see Section 3.3.1.1 above). An O&M Plan will be implemented and will include an EC/IC Plan, an Excavation Work Plan (EWP) to address procedures for post-remedial excavation activities, Site use limitations, Site signage requirements, and groundwater use restrictions. An environmental easement will be filed with Genesee County to restrict land use and prevent future exposure to contamination remaining in the Spill Zone. In addition, each of the alternatives assumes that the environmental easement filed with the County will require any future extrusive work addressing impacts

beneath Gulf Road when the roadway undergoes significant repair or replacement will be completed in accordance with the O&M Plan.

4.5.4.1 Soil Alternative #1: No Action

The no-action alternative for overburden is defined as taking no further action to address the concentrations of TCE identified in the overburden materials at the Site. The no action alternative provides a baseline for comparing other remedial alternatives.

4.5.4.1.1 Overall Protection of Human Health and the Environment

The no action alternative has no effect on the protection of human health and the environment from contamination remaining in the Spill Zone overburden. There would be no controls to prevent more restrictive forms of future Site use (*e.g.*, unrestricted or residential uses). This alternative would not be protective of human health.

4.5.4.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Under the current and reasonably anticipated future use scenario (commercial and industrial), the TCE contamination detected in on-Site overburden soil does not comply with ARARs.

4.5.4.1.3 Long-Term Effectiveness and Permanence

The no action alternative provides no control of exposure to contaminated overburden materials and provides no long-term effectiveness toward achieving the RAOs.

4.5.4.1.4 Reduction of Toxicity, Mobility, or Volume

The no action alternative provides no further reduction in toxicity, mobility, or volume of contamination in the overburden soil. Any reduction of toxicity, mobility, and volume of contaminants would occur through natural processes only.

4.5.4.1.5 Short-Term Effectiveness

There would be no additional risks posed to the community, Site workers, or the environment attributable to implementation of this alternative.

4.5.4.1.6 Implementability

No technical or administrative implementation issues are associated with the no action alternative.

4.5.4.1.7 Cost

No remediation costs are associated with the no action alternative.

4.5.4.1.8 State Acceptance

As part of the overall evaluation to determine whether the no action alternative should be selected and implemented for overburden material, feedback and concerns from the NYSDEC will be considered.

4.5.4.1.9 Community Acceptance

As part of the overall evaluation to determine whether the no action alternative should be selected and implemented for overburden material, feedback and concerns from the local communities that are impacted by this decision will be considered.

4.5.4.2 Soil Alternative #2: *Ex Situ* Solidification/Stabilization (S/S) using Commercial Land-Use Based Preliminary Remediation Goals with Institutional Controls

Under Alternative #2, the Spill Zone overburden soils would be remediated using *ex situ* solidification. Overburden materials exceeding the CSCO for TCE (200 mg/kg) would be excavated, mixed with Portland cement (or other material) to immobilize the contamination, and returned to the excavation area where a CAMU has been constructed. The CSCO was identified as protective of public health without the implementation of a cover system, therefore placement of a soil or asphalt cover as described in Section 4.5.3.2.2 is not included in this alternative. However, a cap will be installed over the solidified soil mixture per 40CFR 264.552 CAMU requirements.

Immobilization of overburden materials exceeding the CSCO for TCE through solidification would consist of the following construction activities:

- Completion of a PDI incorporating a small pilot scale treatability test to determine the type and percentage of material (*e.g.*, cement) to be mixed with the contaminated overburden for solidification. The PDI would also be implemented to determine whether larger overburden materials could be screened, removed and returned to the excavation without further treatment, as particles 2 inches in diameter may not

be conducive to mixing and solidification. If not, such materials would require crushing. While community air monitoring will include vapor monitoring, it is not expected that significant vapors will be generated based on field screening completed within the Spill Zone soil area following the completion of SVE. However, the proposed pilot testing will also evaluate whether volatilization is a concern, and if criteria are not met, all screening and/or crushing work will be performed within a temporary structure with appropriate ventilation and emission controls.

- Excavation of all overburden materials exceeding 200 mg/kg to depths ranging up to 10.5 ft bgs. An estimated total of 1,150 yd^3 (1,840 tons) of overburden containing an estimated 1,500 pounds of TCE will be removed and stockpiled on-Site. Community air monitoring will be performed to verify volatilization of VOCs in the air is not an issue. Such issues were not encountered during previous Site work and are therefore not expected to be encountered during future Site activities. It is assumed that material underlying Gulf Road will not be excavated due to implementability issues associated with accessing the material, as discussed below.
- Cleaning and disposal of all solid waste resulting from the excavation of piping and poly cover associated with the former SVE process;
- Post-excavation overburden samples will be completed to ensure all impacted overburden material exceeding the CSCO for TCE have been removed;
- Mixing of cement (or other material) with stockpiled overburden. Mixing will be completed until the material is homogenized and no elevated VOCs are detected. Appropriate controls will be applied to ensure community air monitoring thresholds are met;
- Installation of a geocomposite liner (60-mil geomembrane, geocushion net) and a leachate collection system per 40CFR 264.552 CAMU requirements;
- Pouring of the mixture back into the excavation. As the Portland cement (or other material) will add volume, the backfill is expected to extend above grade;
- Installation of a cap per CAMU requirements including a gas venting layer, 6-inches of bedding material, a 60-mil HDPE liner, 12-inches of barrier protection, and 6-inches of seeded topsoil;
- Managing groundwater if encountered during remedial activities through on-Site pumping, settling, treatment, and discharge;
- Managing stormwater as needed using temporary and/or permanent sediment and erosion controls; and,
- Completion of site restoration in areas outside of the CAMU. Following installation of the former subgrade SVE system and prior to placement of a poly vapor barrier liner and stone ballast, a 6-inch

layer of clean topsoil was placed over the treatment area to mitigate puncture and provide a better surface seal for the liner. Original site restoration plans included cutting former SVE piping risers below the topsoil and backfilling with the stone ballast, removing the remaining ballast and poly sheeting, and raking and seeding the topsoil. Restoration will be undertaken as originally planned and an additional 6-inches of topsoil will be placed and seeded to promote site restoration. In addition, placement of topsoil and seed to provide for one foot of clean soil cover will extend to any areas of the Spill Zone where surface soils were identified at levels exceeding 2 mg/kg (see **Figure 1.5-3a**).

An evaluation of this alternative against the NCP's nine criteria is presented below.

4.5.4.2.1 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. As discussed in Section 4.5.4, data collected following the completion of *in situ* SVE at the Site demonstrate that the Spill Zone overburden materials do not appreciably leach to the subsurface. Binding of the overburden into larger sized materials either in a monolithic or semi-monolithic state would mitigate wind and surface water erosion, as well as incidental ingestion or inhalation. The RAOs for the Site would be satisfied through immobilization of TCE and the use of ICs and monitoring to prevent potential future exposure and limit the future Site use to industrial.

4.5.4.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

The planned remedial activities would need to be performed in accordance with ARARs. Post-excavation samples would be collected to verify conformance with CSCOs. Since solidification would not achieve 90% reduction in TCE concentrations, the CAMU would need to comply with the requirements for a liner, leachate collection, cap, and groundwater monitoring.

4.5.4.2.3 Long-Term Effectiveness and Permanence

Immobilization of TCE-impacted overburden exceeding CSCOs with placement in a lined/capped CAMU would prevent direct contact with residual impacts.

4.5.4.2.4 Reduction of Toxicity, Mobility, or Volume

While the solidification remedial measure will not reduce the volume or toxicity of TCE in the overburden, it will reduce the mobility of the TCE-impacted particles that might otherwise occur through

wind and/or surface water erosion. Further reduction in mobility would be achieved through placement of the solidified material in a lined and capped CAMU.

4.5.4.2.5 Short-Term Effectiveness

The short-term adverse impacts and risks to the community, workers, and environment during implementation of this alternative would include noise, dust, and vapors from excavation, screening, mixing and potentially crushing equipment and noise and dust from truck traffic delivering cement or other binding materials. These risks are considered minimal and controllable. While community air monitoring will include vapor monitoring, it is not expected that significant vapors will be generated based on field screening completed within the Spill Zone soil following the completion of SVE. However, if criteria are not met, all blending work will be performed within a temporary structure with appropriate ventilation and emission controls. Site workers would be required to wear PPE to prevent direct contact with TCE-impacted overburden during excavation, solidification, and backfilling activities. Typical construction equipment will be used during remedial activities. Construction of a CAMU would require an open excavation for a significant period to install the liner and leachate collection system. Excavations will be backfilled once solidification is completed to minimize the time excavations are left open but will generally be shallow.

4.5.4.2.6 Implementability

This alternative has significant technical and administrative implementability issues surrounding construction of a CAMU in the Spill Zone. Since *ex situ* solidification does not result in a TCE concentration reduction, the CAMU would have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring. Administrative issues include needing agency approval of the CAMU design. The impacted soil media would need to be excavated and stockpiled or placed in roll off containers, pending CAMU construction, and covered to prevent erosion. Technical implementation issues associated with solidification include identifying the appropriate type and amount of binding agent to complete overburden immobilization and securing appropriate screening and blending equipment as well as potentially crushing equipment. In addition, it may be necessary to expand the placement of solidified materials across areas outside of the footprint of the excavation to manage grade change due to volume increases through the addition of the solidification agent. Excavation and solidification of material under Gulf Road would not be implementable as this would create a significant expense and traffic burden. Therefore, the area under Gulf Road would be addressed through the implementation of an environmental easement and O&M Plan, as needed. If future intrusive activities were planned under Gulf Road (*e.g.*, road construction, utility work, etc.), established O&M requirements would be followed for the duration of the

work to ensure continued protection of human health and the environment. Once a PDI and remedial design is completed and approved it is expected that this alternative could be substantially implemented within 19-20 months.

4.5.4.2.7 Cost

The capital cost of implementing this alternative is estimated to be approximately $1.37 million including the cost of one foot of clean soil cover to areas of the Spill Zone where surface soil exceeds the 2 mg/kg value for the protection of ecological receptors, construction of the CAMU, and a 35% engineering contingency. Total O&M costs for minor cover system repairs and leachate treatment are estimated at $52,000 per year. Therefore, with annual certification, the 30-year present worth to implement Alternative #2 is estimated to be approximately $2.20 million using a 7% discount rate. **Table 4.5-6** provides a breakdown of the capital and O&M costs.

4.5.4.2.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for overburden material in the Spill Zone, feedback and concerns from the NYSDEC will be considered.

4.5.4.2.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for overburden material in the Spill Zone, feedback and concerns from the local communities impacted by the activities proposed in the remedy will be considered.

4.5.4.3 Soil Alternative #3: Excavation/Disposal Using Commercial Land-Use Based Preliminary Remediation Goals with Institutional Controls

Under Alternative #3, the Spill Zone overburden would be remediated to the commercial land use PRG (CSCO) for TCE (200 mg/kg) by excavating all overburden exceeding the CSCO and disposing the overburden off-Site at a RCRA-permitted TSDF. The area would then be backfilled with clean imported material meeting CSCOs. The CSCO was identified as protective of public health without the implementation of a cover system, therefore placement of a soil or asphalt cover as described in Section 4.5.3.2.2 is not included in this alternative.

Excavation and disposal of all overburden materials exceeding the CSCO for TCE would consist of the following construction activities:

- Completion of pre-design testing to assess whether larger rubble at the Site exhibit TCE mass above its CSCO and to establish the expected size of particles that meet CSCOs. A screening plant will be used to separate out the particles expected to meet CSCOs, and periodic testing will be completed to confirm pre-design testing results. The screened materials meeting CSCOs will be used to backfill the excavation, reducing quantities of import and export materials. These quantities cannot be estimated until the pre-design testing is completed. While community air monitoring will include vapor monitoring, it is not expected that significant vapors will be generated based on field screening completed within the Spill Zone soil area following the completion of SVE. However, pilot testing will be completed to evaluate whether volatilization is a concern, and if criteria are not met, all screening work will be performed within a temporary structure with appropriate ventilation and emission controls.
- Excavation of all overburden materials exceeding 200 mg/kg to depths up to 10.5 ft bgs. An estimated total of 1,150 yd^3 (1,840 tons) of overburden containing an estimated 1,500 pounds of TCE would be removed and disposed off-Site. Community air monitoring will be performed to verify volatilization of VOCs in the air is not an issue. Such issues were not encountered during previous Site work and are therefore not expected to be encountered during future Site activities. It is assumed that material underlying Gulf Road will not be excavated due to implementability issues associated with accessing the material, as discussed below.
- Cleaning and disposal of all solid waste resulting from the excavation of piping and poly cover associated with the former SVE process;
- Post-excavation samples will be completed to ensure all impacted overburden material exceeding the CSCO for TCE have been removed;
- Disposal of overburden at an out-of-State TSDF;
- Backfilling using clean, imported soil and/or stone and a minimum of 6-inches of seeded topsoil meeting CSCOs;
- Managing groundwater if encountered during remedial activities through on-Site pumping, settling, treatment, and discharge;
- Managing stormwater as needed using temporary sediment and erosion controls; and,
- Completion of site restoration in areas outside of the excavation area. Following installation of the former subgrade SVE system and prior to placement of a poly vapor barrier liner and stone ballast, a 6-inch layer of clean topsoil was placed over the treatment area to mitigate puncture and

provide a better surface seal for the liner. Original site restoration plans included cutting former SVE piping risers below the topsoil and backfilling with the stone ballast, removing the remaining ballast and poly sheeting, and raking and seeding the topsoil. Restoration will be undertaken as originally planned and an additional 6-inches of topsoil will be placed and seeded to promote site restoration. In addition, placement of topsoil and seed to provide for one foot of clean soil cover will extend to any areas of the Spill Zone where surface soils were identified at levels exceeding 2 mg/kg (see **Figure 1.5-3a**).

An evaluation of this alternative against the NCP's nine criteria is presented below.

4.5.4.3.1 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. Overburden material with TCE concentrations greater than 200 mg/kg would be removed from the Site and disposed at a permitted TSDF, therefore reducing TCE concentrations at the Site. The RAOs for the Site would be satisfied through excavation and off-Site disposal of TCE-impacted material and the use of an environmental easement and O&M Plan to control potential future exposure and limit the future Site use to commercial or industrial uses. This includes the portion of the Spill Zone deemed recreational, which would need to be limited to recreational uses consistent with commercial use (*i.e.*, passive recreational use).

4.5.4.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

The planned remedial activities would need to be performed in accordance with ARARs. Post-excavation samples would be collected to verify conformance with CSCOs.

4.5.4.3.3 Long-Term Effectiveness and Permanence

Excavation and off-Site disposal of TCE-impacted overburden exceeding CSCOs and backfilling with clean, imported soil or stone would reduce the TCE concentrations in the overburden at the Site and prevent direct contact with residual impacts.

4.5.4.3.4 Reduction of Toxicity, Mobility, or Volume

The materials will be removed from the Site and transported to a permitted TSDF where the toxicity and/or volume of TCE may be reduced depending upon the form of treatment and/or disposal employed.

4.5.4.3.5 Short-Term Effectiveness

The short-term adverse impacts and risks to the community, workers, and environment during implementation of this alternative would include noise, dust, and vapors from excavation equipment, and noise and dust from truck traffic transporting TCE-impacted materials off-Site and delivering stone and/or soil for backfill. These risks are considered minimal and controllable. Site workers would be required to wear PPE to prevent direct contact with TCE-impacted overburden during excavation and backfilling activities. Typical construction equipment will be used during remedial activities. Excavations will be backfilled once confirmatory samples indicate TCE concentrations below 200 mg/kg along the sidewalls and the bottom of the excavation to minimize the time excavations are left open but will generally be shallow.

4.5.4.3.6 Implementability

Technical implementation issues associated with excavation and off-Site disposal include the need for pre-design testing to determine whether larger gravel/cobbles require disposal and traffic coordination for trucks entering and exiting the Site. Administrative implementation issues include the need to coordinate and secure a disposal contract with an out-of-State TSDF and locating local borrow sources for the required backfill. Excavation of material under Gulf Road would not be implementable as this would create a significant expense and traffic burden. Therefore, the area under Gulf Road would be addressed through the implementation of an environmental easement and O&M Plan. If future intrusive activities were planned under Gulf Road (*e.g.*, road construction, utility work, etc.), established ICs, ECs, and monitoring would be followed for the duration of the work to ensure continued protection of human health and the environment. It is expected that this alternative could be substantially implemented within 5-6 months.

4.5.4.3.7 Cost

The capital cost of implementing this alternative is estimated to be approximately $3.02 million including the cost of one foot of clean soil cover to areas of the Spill Zone where surface soil exceeds the 2 mg/kg value for the protection of ecological receptors and a 35% engineering contingency. With the annual certification, the 30-year present worth to implement Alternative #3 is estimated to be approximately $3.20 million using a 7% discount rate. **Table 4.5-7** provides a breakdown of the capital and O&M costs.

4.5.4.3.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for overburden material in the Spill Zone, feedback and concerns from the NYSDEC will be considered.

4.5.4.3.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for overburden material in the Spill Zone, feedback and concerns from the local communities impacted by the activities proposed in the remedy will be considered.

4.5.4.4 Soil Alternative #4: *Ex Situ* Low-Temperature Thermal Desorption (LTTD) Using Commercial Land-Use Based PRG with ICs

Under Alternative #4, the Spill Zone overburden would be remediated to the commercial land use PRG (CSCO) for TCE (200 mg/kg) using LTTD. The overburden material exceeding the CSCO for TCE would be excavated, treated via LTTD, and returned to the excavation as backfill. On-Site treatment of TCE-impacted overburden *ex situ* in a temporary treatment unit and placing the treated material in the excavation area would need to comply with the RCRA CAMU performance standards. The CSCO was identified as protective of public health without the implementation of a cover system, therefore placement of a soil or asphalt cover as described in Section 4.5.3.2.2 is not included in this alternative. However, if LTTD treatment achieves 90% reduction of TCE or reaches 10 times the universal treatment standard (60 mg/kg), the CAMU would not have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring.

Excavation and LTTD of overburden exceeding the CSCO for TCE would consist of the following activities:

- Completion of pre-design testing to assess whether larger rock fragments at the Site exhibit TCE mass above its CSCO and to establish the expected size of particles that meet CSCOs. A screening plant will be used to separate out the particles expected to meet CSCOs, and periodic testing will be completed to confirm pre-design testing results. The screened materials meeting CSCOs will be used to backfill the excavation without being treated, reducing quantity of materials needing treatment via LTTD. The quantity of material to be backfilled without treatment cannot be estimated until the pre-design testing is completed. While community air monitoring will include vapor monitoring, it is not expected that

significant vapors will be generated based on field screening completed within the Spill Zone soil area following the completion of SVE. However, pilot testing will be completed to evaluate whether volatilization is a concern, and if criteria are not met, all screening work will be performed within a temporary structure with appropriate ventilation and emission controls.

- Completion of a PDI incorporating a pilot-scale treatability test to determine the feasibility of LTTD in achieving CSCOs, including whether larger materials exceeding CSCOs could be treated or would require segregation via screening and potentially crushing for treatment. The pilot test would also serve to determine whether crushing would liberate unacceptable levels of VOCs at the Site perimeter.
- Excavation of overburden exceeding 200 mg/kg to depths up to 10.5 ft bgs. An estimated total of 1,150 yd^3 (1,840 tons) of overburden containing an estimated 1,500 pounds of TCE will be removed and stockpiled on-Site to be treated by LTTD. Community air monitoring will be performed to verify volatilization of VOCs in the air is not an issue. Such issues were not encountered during previous Site work and are therefore not expected to be encountered during future Site activities. It is assumed that material underlying Gulf Road will not be excavated due to implementability issues associated with accessing the material, as discussed below.
- Cleaning and disposal of all solid waste resulting from the excavation of piping and poly cover associated with the former SVE process;
- Post-excavation samples will be completed to ensure all impacted overburden material exceeding the CSCO for TCE has been removed;
- Treatment of overburden materials using LTTD. Analytical testing will be completed to ensure that the treated overburden meets commercial backfill criteria and emissions controls are functioning as intended;
- Backfilling using treated overburden and 6-inches of seeded topsoil;
- Managing groundwater if encountered during remedial activities through on-Site pumping, settling, treatment, and discharge;
- Managing stormwater as needed using temporary sediment and erosion controls; and,
- Completion of site restoration in areas outside of the excavated area. Following installation of the former subgrade SVE system and prior to placement of a poly vapor barrier liner and stone ballast, a 6-inch layer of clean topsoil was placed over the treatment area to mitigate puncture and provide a better surface seal for the liner. Original site restoration plans included cutting former SVE piping risers below the topsoil and backfilling with the stone ballast, removing the remaining ballast and poly sheeting, and raking and seeding the topsoil. Restoration will be undertaken as originally planned and an additional 6-

inches of topsoil will be placed and seeded to promote site restoration. In addition, placement of topsoil and seed to provide for one foot of clean soil cover will extend to any areas of the Spill Zone where surface soils were identified at levels exceeding 2 mg/kg (see **Figure 1.5-3a**).

An evaluation of this alternative against the NCP's nine criteria is presented below.

4.5.4.4.1 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. Excavation and treatment of overburden materials exceeding CSCOs using LTTD would reduce TCE concentrations at the Site. The RAOs for the Site would be satisfied through excavation and treatment via LTTD of TCE-impacted material and the use of an environmental easement and O&M Plan to control potential future exposure and limit the future Site use to commercial or industrial uses. This includes the portion of the Spill Zone deemed recreational, which would need to be limited to recreational uses consistent with commercial use (*i.e.*, passive recreational use).

4.5.4.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

The planned remedial activities would need to be performed in accordance with ARARs, including those for control of air emissions from the treatment process. Post-excavation samples would be collected to verify conformance with CSCOs.

4.5.4.4.3 Long-Term Effectiveness and Permanence

Excavation and treatment of TCE-impacted overburden material exceeding CSCOs using LTTD, if proven effective by pilot testing, would reduce the TCE concentrations in the overburden at the Site and prevent direct contact with residual impacts.

4.5.4.4.4 Reduction of Toxicity, Mobility, or Volume

Treatment of impacted overburden using LTTD would reduce the volume of TCE in the overburden. The overall reduction in the volume and toxicity of TCE will be dependent on the form of emissions controls employed. Assuming vapor-phase GAC, the TCE will be transferred to the GAC, but the TCE volume and toxicity may be reduced if that material is sent to a TSDF.

4.5.4.4.5 Short-Term Effectiveness

The short-term adverse impacts and risks to the community, workers, and environment during implementation of this alternative would include noise, dust, and vapor from excavation, and potentially screening and crushing equipment and noise and substantial fuel usage of the LTTD reactor. As this site is not located within an area supplied by natural gas, the reactor would need to run on propane or heating oil These risks are not considered minimal and controllable. Site workers would be required to wear PPE to prevent direct contact with TCE-impacted overburden during excavation and treatment activities. Excavations will be backfilled once the treatment process is completed to minimize the time excavations are left open but will generally be shallow.

4.5.4.4.6 Implementability

Technical implementation issues associated with excavation and treatment via LTTD include the need for pre-design testing to determine whether larger gravel/cobbles require treatment, the need for a pilot study in advance of construction to determine the efficacy of the process in achieving CSCOs, excavation, and LTTD equipment, including fuel for the LTTD reactor, as well as emissions control equipment or media. Excavation of material under Gulf Road would not be implementable as this would create a significant expense and traffic burden. Therefore, the area under Gulf Road would be addressed through the implementation of an environmental easement and O&M Plan, as needed. If future intrusive activities were planned under Gulf Road (*e.g.*, road construction, utility work, etc.), established O&M procedures would be followed for the duration of the work to ensure continued protection of human health and the environment. It is expected that this alternative could be substantially implemented within 14-16 months.

4.5.4.4.7 Cost

The capital cost of implementing this alternative is estimated to be approximately $1.81 million including the cost of one foot of clean soil cover to areas of the Spill Zone where surface soil exceeds the 2 mg/kg value for the protection of ecological receptors and a 35% engineering contingency. With the annual certification, the 30-year present worth to implement Alternative #4 is estimated to be approximately $2.00 million using a 7% discount rate. **Table 4.5-8** provides a breakdown of the capital and O&M costs.

4.5.4.4.8 State Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for overburden material in the Spill Zone, feedback and concerns from the NYSDEC will be considered.

4.5.4.4.9 Community Acceptance

As part of the overall evaluation to determine whether this alternative should be selected and implemented as the remedy for overburden material in the Spill Zone, feedback and concerns from the local communities impacted by the activities proposed in the remedy will be considered.

The following sections present a summary and comparative analysis of remedial alternatives per media discussed in Section 4 of this FS Report.

5 SUMMARY AND COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES BY MEDIA

In this section, the alternatives per media presented in **Section 4** above are compared to one another against each of the NCP's nine evaluation criteria. The purpose of this comparison is to identify the relative advantages and disadvantages of each of the alternatives.

5.1 Comparative Analysis for the Portion of the Groundwater Plume Proposed for Technical Impracticablitiy

Based on the investigations and analysis conducted during the RI/FS and the TI evaluation, the RAOs developed for this Site recognize that the restoration of the groundwater to MCLs is not practicable. When restoration of groundwater to its beneficial use is not practicable, the USEPA selects an alternative remedial strategy that is technically practicable, protective of human health and the environment, and satisfies statutory and regulatory requirements of CERCLA. Consistent with the NCP, alternative remedial strategies for sites with TI waivers address exposure control, source control, and aqueous plume migration. Exposure control and plume migration are addressed by the groundwater and SVI RAOs and source control is addressed by the RAOs for the BVZ, surface water and soil, as well as a combination of ICs, ECs, monitoring, the consideration of active alternatives for surface water and soil described in Sections 4.4 and 4.5, and a consideration of additional source reduction (*e.g.*, natural attenuation).

An alternate water source was implemented for the purpose of providing a long-term solution that addressed public health concerns with respect to the consumption of potable water and fire suppression.

The waterline includes 15 miles of 8-inch & 12-inch diameter water mains, with a total of 70 individual service connections. The waterline connections were completed in all four of the municipalities that were affected by the TCE spill (the Towns of Wheatland, Caledonia, LeRoy, as well as the Village of Caledonia). Details of the installation are provided in the "Final Remediation Report, Water Distribution System, Lehigh Valley Railroad Derailment Site" prepared by Stearns and Wheler, LLC in August 2003 (NYSDEC, 2003). Additionally, decommissioning of all impacted private/domestic water supply wells that were located within the extents of the TCE groundwater plume was conducted with the exception L-14 (Lime Rock Speedway) and L-33B (landscaping and irrigation only). The evaluation of potentially applicable remedial technologies for the restoration of groundwater to its most beneficial use was presented in the AGTI which concluded that the restoration of groundwater is technically impracticable.

5.2 Comparative Analysis Institutional Controls and Monitoring for Soil Vapor Intrusion

The Sitewide remedy selected by the USEPA would include ICs and monitoring. As discussed in Section 2.4.3.1.5 and 4.2.3 of this FS Report, the RAO for SVI is currently being met on Site. The RAO for SVI will continue to be met through a combination of ICs, ongoing SVI investigations, the implementation of various applicable SVI mitigation technologies, and the continued inspection of currently installed SVI mitigation systems. The range of O&M and present worth costs for the SVI Alternative are presented on **Table 4.2-1**.

5.3 Comparative Analysis of Bedrock Vadose Zone Media Remedial Alternatives

5.3.1 Overall Protection of Human Health and the Environment

The potential for direct exposure to impacted bedrock media would only occur in instances where future construction activities or quarrying operations may be implemented within the immediate vicinity of the Spill Zone. The No Action alternative (Alternative #1) would not provide for any means of risk mitigation with respect to these potential future activities. In contrast, Alternatives #2, #3a and #3b would address risk mitigation through the ICs described in Section 3.3.1.1 (Common Elements of FS Alternatives GRA). Although the active remedial alternatives (#3a and #3b) would provide for a marginal reduction in TCE mass within the BVZ, the beneficial impact with respect to protection of human health would be negligible given that the majority of the TCE mass would be retained within the bedrock matrix micro pore spaces. None of the alternatives presented would have a beneficial impact to groundwater quality due to the matrix

diffusion mechanisms that occur between the bedrock matrix porewater and the groundwater media, which would be expected to continue for a significant period of time into the future (as demonstrated by the DFN modeling report).

5.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

There are no current Federal and/or State ARARs that would be applicable for bedrock media. Therefore, a comparative analysis of the alternatives presented is not possible for this criterion with respect to specific remedial targets for the BVZ. When considering the groundwater ARAR of 5 µg/L, the DFN model demonstrates that none of the alternatives presented would be sufficient to meet this target across the entirety of the TCE-impacted groundwater plume, or to reduce risk in general with regards to exposure to TCE impacted groundwater media.

5.3.3 Long-Term Effectiveness and Permanence

Analysis of the Site data collected through various investigations and modeling efforts indicates that the long-term effectiveness of active remediation through BVE (Alternative #3a and #3b) would not be expected to provide any benefit with respect to: i) reducing TCE mass to any practical extent within the BVZ, and ii) reducing TCE concentrations (and associated exposure risk) within the TCE-impacted groundwater media. However, as described in Section 3.3.1.1 (Common Elements of FS Alternatives GRA), the implementation of ICs would provide for a permanent and effective means of mitigating potential exposure to TCE-impacted bedrock media, and to Site groundwater that is impacted by the TCE that is present within the bedrock media.

5.3.4 Reduction of Toxicity, Mobility and Volume

Due to the limitations associated with the matrix diffusion processes within bedrock media, the unpredictable nature associated with the application of soil vapor extraction in a fractured bedrock media and the generally inconclusive results of the 1998 BVE Pilot Study, any implementation of active remediation through BVE (Alternative #3a and #3b), would be expected to recover a very small fraction of the TCE mass that lies within the BVZ. Consequently, only a marginal reduction of toxicity, mobility and volume would be expected within the bedrock media when compared to Alternative #1 and #2.

5.3.5 Short-Term Effectiveness

The activities associated with the BVE system installation phase for Alternatives #3a and #3b would present a moderate to high degree of risk to on-Site workers, and little to no risk to the community. The elevated risk associated with the installation of the BVE system could be mitigated through the appropriate training of on-Site personnel, and implementation of rigorous safety protocols. Once a BVE system is operational, routine sampling and O&M activities would present a moderate degree of risk to on-Site workers, and little to no risk to the community. In contrast, implementation of either Alternative #1 or #2 would not present any increased risk to on-Site workers or the public in general.

5.3.6 Implementability

The implementability of the BVE remedial alternatives (#3a and #3b) would be challenging due the large number of extraction wells that would be required, uncertainties with regards to their placement, and system operational challenges associated with: i) a highly variable water table; and, ii) matrix diffusion processes within the bedrock media (both of which would limit that amount of TCE mass that could be recovered by the BVE process). Additionally, the application of BVE would not address the TCE-impacted bedrock that is present below the water table, thus further impacting its implementability and effectiveness. In contrast, there are no technical or administrative implementability issues associated with the Alternatives #1 and #2.

5.3.7 Cost

There are no costs associated with the No Action alternative (Alternative #1), while costs associated with the ICs and Monitoring alternative (Alternative #2), are estimated to be approximately $137,250 (**Table 4.3-1**). The range of capital, O&M and present worth costs for each of the BVE remedial alternatives (Alternatives #3a and #3b) are presented on **Tables 4.3-2 and 4.3-3**, respectively. Alternatives #3a and #3b have capital worth costs of approximately $8.36 and $2.67 million, and present worth costs for O&M of $1.01 million and $0.85 million, respectively (assuming a 3-year system operation time frame). These costs are significant in comparison to the costs associated with the alternative which contains only ICs and Monitoring (Alternative #2), with little to no benefit achieved through implementation of the active treatment alternatives.

5.3.8 State Acceptance

Feedback and concerns from the NYSDEC will be considered as part of the evaluation and selection of an appropriate alternative.

5.3.9 Community Acceptance

Feedback and concerns from the local communities impacted by the activities proposed in each of the four alternatives presented will be considered as part of the evaluation and selection of an appropriate alternative.

5.4 Comparative Analysis of Surface Water Media Remedial Alternatives

It should be noted that the comparative analysis for the surface water alternatives discussed below are presented with the assumption that the results of the proposed PDI within the Mud Creek Area of Interest indicate that the three active remediation alternatives (*i.e.*, Alternatives #3, #4 and #5) can be implemented successfully. Therefore, the analyses presented below may need to be revised should the data from the PDI indicate otherwise for one or more of the three active remedial alternatives presented for surface water.

According to the NYSDEC Environmental Resource Mapper, the section of Mud Creek and Mud Creek Pond that is within the Mud Creek Area of Interest is designated as a Class "C" fresh surface waterway. However, seasonal observations of the section of Mud Creek which extends from the southwestern property boundary (*i.e.*, at the corner of Guld Road and Neid Road) to the inlet of Mud Creek Pond have demonstrated that surface water is absent for a portion of the year (PDI to determine frequency), except for an approximately 200-foot-long flowing segment, located approximately 200 ft downstream of the Mud Creek Waterfall. For the purposes of the evaluating the proposed alternatives, the PRG for surface water TCE concentration is 40 µg/L; this is based on NYCRR Title 6, Chapter X, Part 703.5 for a Class "C" fresh surface waterway. This standard has a type code of "H(FC)" and a basis code of "A" which combined make reference to oncogenic effects to human health associated with fish consumption.

5.4.1 Overall Protection of Human Health and the Environment

The No Action alternative (Alternative #1) would not provide any means for the protection of human health or the environment with regards to the TCE-impacted surface water within the Mud Creek Area of Interest. The ICs and Monitoring alternative (Alternative #2) could provide for some degree of protection of human health through proprietary controls as described in Section 3.3.1.1 (Common Elements of FS Alternatives GRA). Lastly, if the results of the PDI investigations are favorable, Alternatives #3, #4, and #5 could

potentially be implemented to the extent that they would provide for the protection of human health from TCE-impacted surface water. The Hydraulic Containment (Alternative #3) and Streambed Cover (Alternative #4) alternatives would provide protection through the containment of the TCE impacted surface water, whereas the *In Situ* Treatment with Streambed Cover alternative (Alternative #5) would provide protection through both a containment mechanism, and an active treatment process. Although Alternative #3 includes a treatment component, the media that it addresses via treatment is groundwater rather than surface water. In reality, Alternative #3 would be capturing groundwater prior to daylighting as surface water in Mud Creek and treating for subsequent discharge. As previously discussed, a thorough PDI would need to be conducted in order to obtain Site data such as seasonal surface water flows, TCE concentrations, and pilot scale data to assist in the implementation of key design elements for each remedial alternative.

5.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

The No Action and ICs and Monitoring alternatives (Alternative #1 and #2) would not provide for compliance with the established NYS Standard for surface water TCE concentration within a "Class C" stream (*i.e.*, 40 µg/L), which is also the PRG proposed for surface water within this FS Report. Implementation of Hydraulic Containment (Alternative #3) or the Streambed Cover (Alternative #4) would not provide for a reduction in TCE concentrations that would meet the this PRG; rather, surface water flows for portions of Mud Creek where TCE concentrations exceed the PRG target value (40 µg/L) would either be removed through pumping a sufficient volume of groundwater (Alternative #3), or covered by a sufficient quantity of stone (Alternative #4) in order to eliminate these surface water flows. Therefore, depending on the results obtained from the PDI, both alternatives could be designed such that surface water flows that exceed the PRG could be contained to the extent where the exposure route to receptors such as humans and wildlife would be eliminated. Similar to Alternative #4, the *In Situ* Treatment with Streambed Cover (Alternative #5) would also provide a containment mechanism; however, it would also provide for a reduction of TCE concentrations potentially to a level where the PRG is satisfied. Again, this would require an extensive PDI that in this case would include a pilot study to evaluate one or more methods of treatment for TCE-impacted surface water.

5.4.3 Long Term Effectiveness and Permanence

The long-term effectiveness of the No Action and the ICs and Monitoring alternatives (Alternative #1 and #2) are not applicable, as these two alternatives do not provide for a method to address surface water TCE

concentrations that exceed the proposed PRG. If the proposed PDI indicates favorable results, Alternatives #3, #4, and #5, could all provide for an effective long-term solution with regards to surface water TCE-impacts in the Mud Creek Area of Interest. In addition to favorable results from the PDI, the implementation of routine O&M procedures would be another key component with regards to the long-term effectiveness of Alternatives #3, #4, and #5.

5.4.4 Reduction of Toxicity, Mobility and Volume

The No Action and the ICs and Monitoring alternatives (Alternatives #1 and #2) do not provide for any reduction of toxicity, mobility or volume of TCE impacts. Since Alternatives #3, #4 and #5 all provide for a method of containment, all three alternatives would provide for a reduction in the toxicity, mobility and volume of TCE with regards to the surface water pathway. Alternative #5 also provides for an additional mechanism that may result in the reduction of toxicity, mobility and volume of TCE in surface water through an active treatment process.

5.4.5 Short-Term Effectiveness

The system installation activities associated with Alternatives #3, #4 and #5 would present a moderate to high degree of risk to on-Site workers, and little to no risk to the community. A significant component of this risk is due to the construction activities that would need to be conducted in largely wooded, and uneven terrain. The elevated risk associated with the installation of these remedial systems could be mitigated through the appropriate training of on-Site personnel, use of proper construction equipment, and implementation of rigorous safety protocols. Routine sampling and O&M activities associated with the proposed remedial systems would present a moderate degree of risk to on-Site workers, and little to no risk to the community. In contrast, implementation of either the No Action, or the ICs and Monitoring alternatives (Alternative #1 and #2) would not present any increased risk to on-Site workers or the public in general.

5.4.6 Implementability

No technical implementability issues are associated the No Action and ICs and Monitoring alternatives (Alternatives #1 and #2). Alternatives #3, #4 and #5 would all require a PDI to be conducted initially in order to determine the design parameters associated with their implementation. Depending on the results of the PDI, each of these three alternatives would require a significant amount of construction activities to be conducted within a heavily wooded area, and the Mud Creek streambed itself. Access roads would need

to be constructed in order for construction equipment and on-Site workers to access the various locations where system infrastructure needs to be installed. Alternatives #3 and #5 in particular would require an installation phase that may take half a year or more to complete. Additionally, Alternative #3 would require a significant footprint to house all the necessary equipment necessary for its implementation.

Alternatives #3 and #5 would require the establishment of a reliable source of electricity and extensive routine O&M activities associated with their long-term operation. This could include servicing of pumps, motors and treatment equipment, replacement of treatment media, and/or waste disposal. In contrast, the long-term O&M activities associated with Alternative #4 would be simple and straightforward, and significantly easier to manage over the long-term.

5.4.7 Cost

There are no costs associated with the No Action alternative (Alternative #1), while costs associated with the ICs and Monitoring alternative (Alternative #2) are estimated to be approximately $81,750. These include costs for ICs and monitoring, as previously discussed. Capital worth costs associated with implementation of the proposed PDI are $2.12 million.

Capital worth costs for Hydraulic Control with ICs and Monitoring (Alternatives #3), Streambed Cover with ICs and Monitoring (Alternative #4), and *In situ* Treatment, Streambed Cover with ICs and Monitoring (Alternative #5) are estimated to be approximately $5.43 million, $2.07 million and $4.12 million, respectively. Note that these costs include the implementation of the proposed PDI. Present worth costs for O&M for these three alternatives are estimated to be approximately $5.09 million, $534,000 and $3.10 million, respectively (which assumes a 30-year period of O&M). Present worth costs are calculated based on a 7% discount rate for each year of system O&M. The corresponding total costs for these three alternatives are estimated to be approximately $10.6 million, $2.69 million and $7.31 million, respectively. The costs for Alternatives #3 and #5 are significant in comparison to the other alternatives presented, as they will incur more upfront capital expenditures and higher O&M costs over the course of their operation.

5.4.8 State Acceptance

Feedback and concerns from the NYSDEC will be considered as part of the evaluation and selection of an appropriate alternative.

5.4.9 Community Acceptance

Feedback and concerns from the local communities impacted by the activities proposed in each of the five alternatives presented will be considered as part of the evaluation and selection of an appropriate alternative.

5.5 Comparative Analysis of Soil Media Remedial Alternatives

The following sections compare soil remedial Alternatives #1 through #4 for each of the NCP's nine evaluation criteria. **Table 5.3-1** of this report summarizes the comparative analysis of soil alternatives.

For the alternatives involving excavation and on-Site treatment (*i.e.*, thermal desorption and solidification), the evaluations below assume that generated overburden materials handled on-Site within the limits of the Spill Zone, are subject to RCRA CAMU requirements. If thermal desorption treatment achieves 90% reduction of TCE or reaches 10 times the universal treatment standard (60 mg/kg) and the materials meet TCLP criteria, the CAMU would not have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring. Since solidification would not reduce the TCE concentration, the CAMU for these alternatives would have to comply will all requirements.

As previously discussed, off-Site disposal alternatives will require a "contained-in" determination to allow for overburden materials below 60 mg/kg TCE to be deemed non-listed waste and disposed at a permitted solid waste landfill facility if meeting the 60 mg/kg criteria and falling below TCLP limits.

5.5.1 Overall Protection of Human Health and the Environment

Except for the No Action Alternative, all alternatives are protective of human health and the environment. The physical removal Alternatives #3 and #4 reduce TCE concentrations on-Site. Although Alternative #2 does not reduce TCE concentrations, solidification would mitigate wind/surface water erosion and incidental ingestion/inhalation and placement within a lined/capped CAMU would make these alternatives equally as protective.

5.5.2 Compliance with Applicable or Relevant and Appropriate Requirements

The No Action Alternative does not comply with the ARARs. Since all alternatives involve excavation of the Spill Zone soil, post-excavation soil samples would verify conformance with the PRGs. Imported soil for backfill under Alternative #3 would be tested to verify conformance with the allowable constituent levels for imported fill soil. Since Alternative #2 (solidification) would not achieve 90%

reduction in soil TCE concentrations, the CAMU would need to comply with the requirements for a liner, leachate collection, cap, and groundwater monitoring.

5.5.3 Long-Term Effectiveness and Permanence

The No Action Alternative provides no long-term effectiveness toward achieving the RAOs. All alternatives prevent direct contact with residual impacts. Alternative #3 provides the greatest long-term effectiveness and permanence since the TCE-impacted soil media is removed from the Site. If proven effective through pilot testing, Alternative #4 (LTTD) will permanently reduce TCE concentrations on-Site.

5.5.4 Reduction of Toxicity, Mobility, and Volume

The No Action Alternative provides no further reduction in toxicity, mobility, or volume of contamination in the overburden soil. Alternative #2 (solidification) would reduce the mobility but not the toxicity or volume of TCE impacted soil media. Alternative #3 (off-Site disposal) would reduce the toxicity, mobility, and volume on-Site; however, the off-Site reduction in toxicity and/or volume depends on the form of treatment/disposal at the TSDF. Alternative #4 (LTTD), would reduce the volume of TCE in the soil media but the overall reduction in volume and toxicity depends on the form of emissions control employed.

5.5.5 Short-Term Effectiveness

The No Action Alternative would not pose additional risks to the community, Site workers, or the environment. All other soil alternatives would result in noise, dust, and vapor impacts; however, these are considered minimal and controllable through proper construction techniques. Evaluation of additional emissions controls for crushing that might be required under Alternative #2 would be considered during pilot-testing. Except for Alternative #2 (solidification), the work would be sequenced to minimize the time the excavation will remain open and safety measures would be in place. Construction of a CAMU for Alternative #2 would require an open excavation for a significant period to install the liner and leachate collection system. Alternative #4 would require significant fuel for the LTTD reactor and, since natural gas is not available near the Site, propane or heating oil tanks would need to be kept on-Site resulting in short-term risk to both human health and the environment.

5.5.6 Implementability

No technical or administrative implementability issues are associated with the No Action Alternative. Alternative #2 (solidification) would have significant technical and administrative implementability issues surrounding construction of a CAMU in the Spill Zone. Since *ex situ* S/S of the soil media does not result in a TCE concentration reduction, the CAMU would have to comply with the requirements for a liner, leachate collection system, cap, and groundwater monitoring. Administrative issues include needing agency approval of the CAMU design. The impacted soil media would need to be excavated and stockpiled or placed in roll off containers pending CAMU construction. The impacted material would need to be covered to prevent erosion. Design and construction of a CAMU would extend these remedial alternatives by approximately 12 months. Other implementability issues include determining the type and amount of binding agent that will effectively solidify the impacted soil media, and securing the appropriate equipment. The footprint of the CAMU would need to be larger than the excavation area to manage the grade change due to volume increases through the addition of the solidification agent.

Alternative #3 would require traffic coordination for off-Site transport to the TSDF, securing a disposal contract with out-of-State TSDF, and locating a borrow source for backfill material. Alternative #4 requires a pilot test to verify effectiveness, securing specialized equipment for LTTD, and emissions control. Alternative #4 is estimated to take up to 18 months to implement.

5.5.7 Cost

There are no remediation costs associated with the No Action Alternative. Comparing Alternatives #2 through #4, Alternative #3 (off-Site disposal) is significantly more expensive than Alternatives #2 (solidification) and #4 (LTTD), however the potential savings from screening of larger materials (which cannot presently be determined) has a greater impact for cost savings under Alternative #3 than Alternatives #2 and #4.

5.5.8 State Acceptance

Feedback and concerns from the NYSDEC will be considered as part of the evaluation and selection of an appropriate alternative.

5.5.9 Community Acceptance

Feedback and concerns from the local communities impacted by the activities proposed in each of the four alternatives presented will be considered as part of the evaluation and selection of an appropriate alternative.

5.6 Summary

This FS Report provides the support to develop, screen, and perform a detailed analysis of remedial alternatives specific to the nature and extent of risks identified by the Site's remedial investigations with the objective of supporting an informed risk management remedy selection decision for the Site. This FS Report is intended to support the USEPA with the development of a USEPA drafted Proposed Plan that will recommend a remedial alternative strategy that is technically practicable, protective of human health and the environment, and satisfies statutory and regulatory requirements of CERCLA for inclusion in an ROD for the Site.

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7 ABBREVIATIONS AND ACRONYMS

°C	Degrees Centigrade
°F	Degrees Fahrenheit
µg/L	Micrograms Per Liter
µg/m^3	Micrograms Per Cubic Meter
µm	Micrometers
1,1-DCE	1,1-Dichloroethene (CAS# 75-35-4)
2D	Two-dimensional
3D	Three-dimensional
AGTI	Assessment of Groundwater Restoration Potential and Technical Impracticability
amsl	Above Mean Sea Level
ARAR	Applicable or Relevant and Appropriate Requirements
atm-m^3/mole	Atmospheres-cubic unit per mole at 25ºC
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	Area Use Factor
bgs	Below Ground Surface
BHHRA	Baseline Human Health Risk Assessment
BTEX	Benzene, Toluene, Ethyl Benzene, Xylenes
BVE	Bedrock Vapor Extraction
BVZ	Bedrock Vadose Zone
CAMU	Corrective Action Management Units
cDCE	cis-1,2-Dichloroethene (CAS#156-59-2)

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic Feet Per Second
cm/sec	Centimeters Per Second
cm^2/sec	Square Centimeters Per Second
CO_2	Carbon Dioxide
COCs	Contaminants of Concern
COPCs	Constituents of Potential Concern
COPECs	Contaminants of Potential Ecological Concern
CSCOs	Commercial Soil Cleanup Objectives
CSIA	Compound-specific isotope analysis
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
CVOC	Chlorinated Volatile Organic Compounds
yd^3	Cubic Yards
DAF	Dilution Attenuation Factor
DCE	Isomers of 1,2-dichloroethene
DER-10	NYSDEC Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation
DFN	Discrete Fracture Network
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
EC	Engineering Controls
EM	Electromagnetic
EPC	Exposure Point Concentrations
ERH	Electrical Resistance Heating
ERSCO	Protection of Ecological Resources Soil Cleanup Objective
ESRI	Environmental Systems Research Institute

FAA	Focused Alternatives Analysis Report
FeS	Iron Sulfide
FLUTe	Flexible Liner Underground Technologies
FS	Feasibility Study
ft	Feet
ft^2	Square Feet
FWIA	Fish and Wildlife Impact Analysis
GAC	Granular Activated Carbon
g/L	Gram per Liter
g/m^2	Grams per square meter
gpd	Gallons Per Day
gpm	Gallons Per Minute
GPR	Ground Penetrating Radar
GRA	General Response Actions
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IAMP	Indoor Air Monitoring Program
IC	Institutional Control
ISCOs	Industrial Soil Cleanup Objectives
ISTD	*In situ* thermal desorption
K	Hydraulic Conductivity
kg	Kilogram
K_m	Rock Matrix Hydraulic Conductivity
LOAEL	Lowest Observed Adverse Effect Level
LTTD	Low-Temperature Thermal Desorption
LVRR	Lehigh Valley Railroad Company
MCL	Maximum Contaminant Level
MCWA	Monroe County Water Authority
mg/L	Milligrams Per Liter
mg/kg	Milligram per Kilogram

MHz	Megahertz
Mg/mo	Million gallons per month
mmHg	Millimeters of mercury
MNA	Monitored Natural Attenuation
mV	Millivolts
NAPL	Non-Aqueous Phase Liquid
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NPL	National Priorities List
NYS	New York State
NYCRR	New York State Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	Operation and Maintenance
OM&M	Operation, Maintenance, and Monitoring
ORP	Oxidation-Reduction Potential
OU	Operable Unit
PCBs	Polychlorinated biphenyls
PDI	Pre-Remedial Design Investigation
PGWSCO	Protection of Groundwater Soil Cleanup Objective
POE	Point-of-Entry
PPE	Personal protective equipment
ppm	Parts Per Million
Pre-RD	Pre-Remedial Design
PRG	Preliminary Remediation Goal
PTB	Permeable Treatment Barriers
RA Administrative Order	Administrative Order for Remedial Action, Index No. CERCLA-02-2014-2010, dated March 21, 2014
RAGS	Risk Assessment Guidance for Superfund
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan

RCRA	Resource Conservation and Recovery Act
REWP	Remedial Evaluation Work Plan
RF	Radio Frequency
RFH	Radio Frequency Heating
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RIR	Remedial Investigation Report
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RSCO	Residential Soil Cleanup Objective
RSL	Regional Screening Levels
SA	Settlement Agreement (CERCLA-02-2006-2006)
SCGs	New York State Standards, Criteria, and Guidelines
SCO	Soil Cleanup Objectives
ft^2	Square Feet
SLERA	Screening Level Ecological Risk Assessment
SMP	Site Management Plan
SOW	Statement of Work
SPDES	State Pollutant Discharge Elimination System
Spill Zone	10-acre area where a waterline was installed to provide drinking water; includes contaminated groundwater present in the bedrock (about 3- and one-half square miles); and contaminated overburden in the Spill Zone (including approximately 1.5 acres of surface soil, railroad ballast, broken rock, fill, etc.)
SPLP	Synthetic Precipitation Leaching Procedure
S/S	Solidification/Stabilization
SSDS	Sub-Slab Depressurization system also known as SVI mitigation systems
Stone	Stone Environmental, Inc.
SVE	Soil Vapor Extraction
SVI	Soil Vapor Intrusion

SVOC	Semi-Volatile Organic Compounds
SW	Surface Water
SWAT	Soil Water Assessment Tool
TAGM	NYSDEC's Division of Environmental Remediation, Technical and Administrative Guidance Memorandum
TBC	To Be Considered
TCE	Trichloroethene (CAS# 79-01-6)
TCH	Thermal Conductive Heating
TCLP	Toxicity Characteristic Leaching Procedure
tDCE	trans-1,2-Dichloroethene (CAS#156-60-5)
TI	Technical Impracticability
TOC	Total Organic Carbon
TSDF	Treatment, Storage, and Disposal Facility
TZ	Treatment Zone
UCL_{95}	95% Upper Confidence Limit of the Mean Concentration
UMC	Unicorn Management Consultants, LLC
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VC	Vinyl Chloride (CAS#75-01-4)
VI	Village Industrial
VISL	USEPA Vapor Intrusion Screening Level
VLF	Very Low Frequency
VOC	Volatile Organic Compounds
ZVI	Zero-Valent Iron

Tables

Table 1-1
Study Area Parcel Information
Feasibility Study
Lehigh Valley Railroad Derailment Superfund Site
LeRoy, NY

Unicorn Management Consultants, LLC

County of Parcel	Town of Parcel	Zoning Code	PIN/Parcel	Street Number	Street Name	Zoning Description	Property Type	Comments
Genesee	*Le Roy*	I-1	26.-1-77.1		Gulf Road	Industrial	340- Vacant Industrial Land	
			26.-1-2.1	8259	Gulf Road	Industrial	720- Mining and Quarrying	
			26.-1-80	8319	Gulf Road	Industrial	330- Vacant Commerical Land	
			26.-1-78.2	8339	Gulf Road	Industrial	242- Rural Residential & Recreation	
			26.-1-3		Neid Road	Industrial	852- Landfills and Dumps	
			26.-1-78.1	8389	Gulf Road	Industrial	312- Residential Land Including a Small Improvement	
			26.-1-79	8634	Neid Road	Industrial	210- One Family Residential	
			26.-1-8.1	8643	Neid Road	Industrial	242 Rural Residential & Recreation	
			26.-1-68	8250	Gulf Road	Industrial	720- Mining and Quarrying	
			26.-1-69	8259	Gulf Road	Industrial	720- Mining and Quarrying	
			26.-1-70	8402	Gulf Road	Industrial	920- Private Hunting and Fishing Clubs	
		R-1	26.-1-15.2	8859	Church Road	General Residential	242- Rural Residential & Recreation	
			26.-1-15.111		Church Road	General Residential	322- Residential Vacant Land over 10 Acres	
			26.-1-72	8871	Church Road	General Residential	210- One Family Residential	
			26.-1-73	8875	Church Road	General Residential	210- One Family Residential	
			26.-1-15.12	8877	Church Road	General Residential	210- One Family Residential	
			26.-1-15.112		Church Road	General Residential	314- Rural Vacant Lots of 10 Acres or Less	
			26.-1-71.21	8879	Church Road	General Residential	210- One Family Residential	
			26.-1-71.12		Church Road (Rear)	General Residential	322- Residential Vacant Land over 10 Acres	
			26.-1-71.111	8903	Church Road	General Residential	117- Horse Farm	
			26.-1-87		Church Road (Rear)	General Residential	321- Abandoned Agricultural Land	
			26.-1-14.113		East Main Road	General Residential	321- Abandoned Agricultural Land	
			26.-1-11.11		Gulf Road	General Residential	340- Vacant Industrial Land	
			26.-1-13	8667	Gulf Road	General Residential	920- Private Hunting and Fishing Clubs	
Livingston	*Caledonia*	I-1	2.-1-7.22	125	Spring Street	Light Industrial	314- Rural Vacant Lots of 10 Acres or Less	
			2.-1-7.211	18	Spring Street	Light Industrial	210- One Family Residential	Seems Residential and not Industrial
			7.7-1-59.1		Main Street	Light Industrial	443- Grain and Feed Elevators, Mixers, Sales Outlets	
			2.-1-11.11	2773	LeRoy Caledonia Road	Light Industrial	443- Grain and Feed Elevators, Mixers, Sales Outlets	
			2.-1-11.13		LeRoy Caledonia Road	Light Industrial	340- Vacant Industrial Land	
			2.1-11.12		LeRoy Caledonia Road	Light Industrial	340- Vacant Industrial Land	
			2.-1-7.1		Spring Street	Light Industrial	105- Farm Vacant Land	
			2.-1-6		Spring Street	Light Industrial	105- Farm Vacant Land	
			2.-1-5		Spring Street	Light Industrial	323- Other Rural Vacant Land	
			2.-1-4		Spring Street	Light Industrial	105- Farm Vacant Land	
			2.19-1-3		Main Street	Light Industrial	105- Farm Vacant Land	
			2.-1-15.1		LeRoy Caledonia Road	Light Industrial	105- Farm Vacant Land	
			2.-1-3.1		LeRoy Caledonia Road	Light Industrial	105- Farm Vacant Land	
			2.-1-12		LeRoy Caledonia Road	Light Industrial	842- Ceiling Railroad	
			1.-1-23.1		LeRoy Caledonia Road	Light Industrial	842- Ceiling Railroad	
			1.-1-23.2		LeRoy Caledonia Road	Light Industrial	842- Ceiling Railroad	
			7.-1-60.1		Graney Road	Light Industrial	105- Farm Vacant Land	
			1.-1-5.11	2577	LeRoy Caledonia Road	Light Industrial	421- Restaurant	
			2.-1-2		LeRoy Caledonia Road	Light Industrial	105- Farm Vacant Land	
			2.-1-1		LeRoy Caledonia Road	Light Industrial	105- Farm Vacant Land	
			1.-1-4		Flint Hill Road	Light Industrial	105- Farm Vacant Land	
			1.-1-3.2		Flint Hill Road	Light Industrial	920- Private Hunting and Fishing Clubs	
			1.-1-3.1		Flint Hill Road	Light Industrial	522- Racetracks	
			1.-1-21	21	Flint Hill Road	Light Industrial	522- Racetracks	
			1.-1-1.12	40	Flint Hill Road	Light Industrial	582- Camping Facilities	
			1.-1-1.11		Flint Hill Road	Light Industrial	340- Vacant Industrial Land	
		L-C	2.16-1-10	14 & 16	North Street	Land Conservation	694- Animal Welfare	
			2.-1-16		Spring Street	Land Conservation	314- Rural Vacant Lots of 10 Acres or Less	Seems Vacant and not Conservation
			2.-1-9.1	17	Spring Street	Land Conservation	220- Two Family Residence	Seems Residential and not Conservation
			2.-1-14		Spring Street	Land Conservation	314- Rural Vacant Lots of 10 Acres or Less	Seems Vacant and not Conservation
			2.15-1-1		Spring Street	Land Conservation	932- State Owned Forest Land Sec. 532B-G	
			2.15-1-3.1	61	Spring Street	Land Conservation	210- One Family Residential	Seems Residential and not Conservation
			2.20-1-5.1	96	Brook Road	Land Conservation	210- One Family Residential	Seems Residential and not Conservation
		R-1	2.-1-8	27	Spring Street	Residence	210- One Family Residential	Seems Residential and not Conservation
			2.-1-7.212	28	Spring Street	Residence	210- One Family Residential	Seems Residential and not Industrial
			2.19-1-2		Main Street	Residence	842- Ceiling Railroad	Seems like a railroad track and not residential (maybe industrial?)
			2.16-1-2	74	North Street	Residence	210- One Family Residential	Could be part Conservation land
			2.16-1-39	80	North Street	Residence	210- One Family Residential	Could be part Conservation land
		R-2	2.16-1-10	14 & 16	North Street	General Residence	694- Animal Welfare	
			2.16-1-3.11	66	North Street	General Residence	210- One Family Residential	Could be part Conservation land
		R-R	2.19-1-1.11	153 & 160	Spring Street	Agricultural Rural	120- Farm- Field Crops	
			2.20-1-67	141	Spring Street	Agricultural Rural	210- One Family Residential	
			2.20-1-66R	135	Spring Street	Agricultural Rural	210- One Family Residential	
			2.20-1-65	129	Spring Street	Agricultural Rural	210- One Family Residential	
			2.20-1-64	123	Spring Street	Agricultural Rural	210- One Family Residential	
			7.-1-60.1		Graney Road	Agricultural Rural	105- Farm Vacant Land	Copied to include Agricultural Rural land
			7.-1-56.11		McIntyre Road	Agricultural Rural	311- Residential Vacant Land	

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Study Area Parcel Information
Feasibility Study
Lehigh Valley Railroad Derailment Superfund Site
LeRoy, NY

Unicorn Management Consultants, LLC

County of Parcel	Town of Parcel	Zoning Code	PIN/Parcel	Street Number	Street Name	Zoning Description	Property Type	Comments
Monroe	*Le Roy*	AR-2	207.04-1-2.11	1897	Flint Hill Road	Agricultural Rural	210- One Family Residential	
			207.04-1-2.12	1899	Flint Hill Road	Agricultural Rural	210- One Family Residential	
			207.04-1-2.2		Flint Hill Road	Agricultural Rural	314- Rural Vacant Lots of 10 Acres or Less	
			207.04-1-18		Lime Rock Road	Agricultural Rural	105- Vacant Farmland	
			207.04-1-17.1		Lime Rock Road	Agricultural Rural	320- Rural Vacant	
			207.04-1-8.131	1845	Flint Hill Road	Agricultural Rural	210- One Family Residential	
			207.04-1-13.1	139	Lime Rock Road	Agricultural Rural	240- Rural Residential	
			207.04-1-13.2	135	Lime Rock Road	Agricultural Rural	210- One Family Residential	
			207.04-1-12.1	103	Lime Rock Road	Agricultural Rural	210- One Family Residential	
			208.03-1-1.1		Lime Rock Road	Agricultural Rural	320- Rural Vacant	
			207.04-1-16	369	Lime Rock Road	Agricultural Rural	920- Private Hunting and Fishing Clubs	
			208.03-1-9		Lime Rock Road	Agricultural Rural	320- Rural Vacant	
			208.03-1-8		Lime Rock Road	Agricultural Rural	323- Vacant Rural	
	Mumford	AR-2	208.03-1-2		Flint Hill Road	Agricultural Rural	323- Vacant Rural	
			208.03-1-3	1410	Flint Hill Road	Agricultural Rural	681- Cultural Building	
			208.03-1-4	1410	Flint Hill Road	Agricultural Rural	681- Cultural Building	
			208.03-1-5.1		Flint Hill Road	Agricultural Rural	320- Rural Vacant	
			208.04-1-32.1		Flint Hill Road	Agricultural Rural	320- Rural Vacant	
			208.03-1-7		Flint Hill Road	Agricultural Rural	105- Vacant Farmland	
		F-1	208.03-1-4	1410	Flint Hill Road	Flood Hazard	681- Cultural Building	Copied to include flood hazard zone
			208.03-1-5.1		Flint Hill Road	Flood Hazard	320- Rural Vacant	
			208.04-1-32.1		Flint Hill Road	Flood Hazard	320- Rural Vacant	Copied to include flood hazard zone
			208.04-1-25	100	Spring Street	Flood Hazard	260- Seasonal Residential	Copied to include flood hazard zone
			208.04-1-24		Main Street	Flood Hazard	320- Rural Vacant	Copied to include flood hazard zone
		R-16	208.04-1-27	125	Spring Street	Residence	210- One Family Residential	
			208.04-1-28	105	Spring Street	Residence	210- One Family Residential	
			208.04-1-29	89	Spring Street	Residence	210- One Family Residential	
			208.04-1-25	100	Spring Street	Residence	260- Seasonal Residential	
			208.04-1-24		Main Street	Residence	320- Rural Vacant	

Table 1-2
Summary of Aperture Ranges Bulk Fracture Hydraulic Conductivity and Fracture Porosity

Unicorn Management Consultants, LLC

Well	Well Data			Aperture Data[3]						Bulk Fracture Hydraulic	Bulk Fracture
Number	Test Length (feet)[1]	Number of Fractures[2]	Number of Fractures per foot of borehole	Minimum (microns)	Maximum (microns)	Mean (microns)	Geometric mean (microns)	Std. Deviation (microns)	Total Aperture (microns)	Conductivity (K_{bf}) (cm/sec)	Porosity[4] (-)
LVRR-18	72.72	78	1.07	22	339	78	70	40	6,082	4.3E-03	0.03%
LVRR-20	97.04	158	1.63	17	223	68	63	29	10,741	3.2E-03	0.04%
LVRR-21	64.75	184	2.84	15	228	77	68	41	14,183	7.5E-03	0.07%
LVRR-26	147.47	123	0.83	18	678	232	205	105	28,540	4.6E-02	0.06%
LVRR-27	59.74	7	0.12	718	1,178	1,060	1,048	160	7,420	1.9E+00	0.04%
LVRR-28	58.02	13	0.22	140	702	346	319	147	4,492	5.1E-02	0.03%
LVRR-30	85.46	44	0.51	75	75	238	218	105	10,480	5.2E-02	0.04%
LVRR-31	122.83	58	0.47	0.001	1,323	383	256	263	22,215	3.5E-01	0.06%
LVRR-32	74.09	46	0.62	0.001	507	211	144	112	9,685	5.1E-02	0.04%
LVRR-33	65.21	87	1.33	0.001	257	120	92	57	10,449	9.6E-03	0.05%
LVRR-34	82.57	290	3.51	6	170	44	41	20	12,883	1.4E-03	0.05%
LVRR-35	83.27	46	0.55	56	608	252	227	117	11,578	6.7E-02	0.05%
Average			1.14	89	524		229	100	12,395	2.1E-01	0.05%
Min			0.12	0.001	75		41	20	4,492	1.4E-03	0.03%
Max			3.51	718	1,323		1,048	263	28,540	1.9E+00	0.07%

Notes:

1) This table lists the overall frequency and range of hydraulically transmissive fracture aperatures, the bulk fracture hydraulic conductivity (K_{bf}), and the bulk fracture porosity observed in individual test borings based on FLUTe profiling data.

1 - Indicates the total length of FLUTe profile testing conducted in each test boring.

2 - Indicates the total number of hydraulically transmissive fractures observed in each test boring based on FLUTe profiling data.

3 - Indicates the range and statistical variation of hydraulically transmissive fracture aperatures estimated using the cubic law and assuming sequntial tranmisivity values at one foot intervals as listed in individual test boring FLUTe profile datasets.

4 - Bulk fracture porosity is estimated by summing all aperatures in the test boring and dividing by the profile test length.

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TABLE 4.1-1

INSTITUTIONAL CONTROLS AND MONITORING FOR PORTION OF GROUNDWATER PLUME PROPOSED FOR A TECHNICAL IMPRACTICABILITY WAIVER
FEASIBILITY STUDY REPORT
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
INDEX NUMBER: CERCLA-02-2006-2006
LEROY, NEW YORK

Item	Quantity	Units	Unit Cost	Total Cost
Groundwater Sampling[(1)]				
Groundwater Sampling OM&M - Year 1				
Field Labor	2	events	$ 36,000	$ 72,000
Equipment Rentals and Consumables	2	events	$ 14,600	$ 29,200
Hotel, Vehicle, and Per Diem Costs	2	events	$ 11,000	$ 22,000
Laboratory Analytical	2	events	$ 27,900	$ 55,800
Data Validation	2	events	$ 10,000	$ 20,000
Project Management, Notificaitons, Sheduling, and Reporting	1	unit	$ 50,400	$ 50,400
Subtotal Annual Groundwater Sampling OM&M Cost - Year 1				**$ 249,400**
Groundwater Sampling OM&M (Years 2 to 5)				
Field Labor	2	events	$ 24,000	$ 48,000
Equipment Rentals and Consumables	2	events	$ 9,700	$ 19,400
Hotel, Vehicle, and Per Diem Costs	2	events	$ 7,400	$ 14,800
Laboratory Analytical	2	events	$ 16,500	$ 33,000
Data Validation	2	events	$ 10,000	$ 20,000
Project Management, Notificaitons, Sheduling, and Reporting	1	unit	$ 50,400	$ 50,400
Total Annual Groundwater Sampling OM&M Cost (Years 2 to 5)				$ 185,600
Annual Groundwater Sampling OM&M Costs (Years 2 to 5):				
Number of Years (*n*):				4
Discount Rate (*i*):				7%
p/A value:				3.387
Subtotal Groundwater Sampling OM&M Present Worth (Years 2 to 5):				**$ 628,627**
Groundwater Sampling OM&M (Years 6 to 30)				
Field Labor	1	event	$ 24,000	$ 24,000
Equipment Rentals and Consumables	1	event	$ 9,700	$ 9,700
Hotel, Vehicle, and Per Diem Costs	1	event	$ 7,400	$ 7,400
Laboratory Analytical	1	event	$ 16,500	$ 16,500
Data Validation	1	event	$ 10,000	$ 10,000
Project Management, Notificaitons, Sheduling, and Reporting	1	unit	$ 50,400	$ 50,400
Total Annual Groundwater Sampling OM&M Cost (Years 6 to 30)				$ 118,000
Annual Groundwater Sampling OM&M Costs (Years 6 to 30):				
Number of Years (*n*):				25
Discount Rate (*i*):				7%
p/A value:				11.654
Subtotal Groundwater Sampling OM&M Present Worth (Years 6 to 30):				**$ 1,375,172**
Total Groundwater Sampling OM&M Present Worth (Years 1 to 30):				**$ 2,253,199**

(continued on next page)

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TABLE 4.1-1

INSTITUTIONAL CONTROLS AND MONITORING FOR PORTION OF GROUNDWATER PLUME PROPOSED FOR A TECHNICAL IMPRACTICABILITY WAIVER FEASIBILITY STUDY REPORT LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE INDEX NUMBER: CERCLA-02-2006-2006 LEROY, NEW YORK

Item	Quantity	Units	Unit Cost	Total Cost
Institutional Controls (ICs) and Maintenance Costs [2]				
Informational Devices				
Environmental Easements				
Legal Fees	124	parcels	$ 2,000	$ 248,000
Recording Fees	124	parcels	$ 250	$ 31,000
Publications (1 per county/year)	30	years	$ 1,500	$ 45,000
Site Operation And Maintenance [3]	30	years	$ 5,000	$ 150,000
Site Management Plan	1	unit	$ 50,000	$ 50,000
Subtotal				**$ 524,000**
Total Cost				**$ 2,778,000**

Notes and Assumptions:

(1) The groundwater sampling program will be conducted as described below

- The first groundwater monitoring event will include all well/cluster locations (estimated 150 samples in total)
- All subsequent groundwater monitoring events include 22 well/cluster locations (estimated 90 samples in total) as follows:
  - 13 perimeter wells
  - 4 source area wells
  - 5 wells located downgradient of the source area
- Costs assume a semi-annual sampling schedule for Years 1-5, and annual sampling thereafter.
- Modifications to the proposed the long-term monitoring plan may be necessary based on the results of the sampling data

(2) ICs for groundwater media include Governmetal Controls (refer to Appendix C) & Informational Devices (Deed Notices and Publications). Each property within the groundwater plume would require an associated deed notice. Additionally, publication of a notice in the local newspaper of each of the three counties affected by the groundwater plume would be required annually. Note that Informational Devices would also apply to Indoor Air; however costs for these ICs are not included in the cost summary table for Indoor Air in order to avoid duplication of costs. Please note that there are no costs associated with implementation of Governmental Controls.

(3) This includes estimated costs associated with maintenance of the well network, and annual inspections that would include identifying any new homes built within the plume area, any new connections to the public water line, any new SSD system installations, and any soil vapor intrusion investigations that may have been conducted. Findings would be documented in an accompanying annual report.

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TABLE 4.2-1

VAPOR INTRUSION ALTERNATIVE COST ESTIMATE
FEASIBILITY STUDY REPORT
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
INDEX NUMBER: CERCLA-02-2006-2006
LEROY, NEW YORK

Item	Quantity	Units	Unit Cost	Total Cost
Indoor Air OM&M				
Field Labor (Annualized)	1	EST	$ 8,320	$ 8,320
Equipment Rentals and Consumables (Annualized)	1	EST	$ 307	$ 307
Hotel, Vehicle, and Per Diem Costs (Annualized)	1	EST	$ 2,290	$ 2,290
Laboratory Analytical (Annualized)	1	EST	$ 4,845	$ 4,845
Data Validation (Annualized)	1	EST	$ 2,167	$ 2,167
Annual Soil Vapor Intrusion (SVI) Mitigation System Inspections	1	EST	$ 2,535	$ 2,535
Annual Cost of System Operation	1	EST	$ 2,000	$ 2,000
Project Management, Notificaitons, Sheduling, and Reporting	1	EST	$ 5,500	$ 5,500
Annual Reporting	1	EST	$ 25,200	$ 25,200
Total Annual Indoor Air OM&M Cost (Accounts for Annualized Costs)				**$ 53,163**
Annual Indoor Air Monitoring OM&M Costs:				
Number of Years (*n*):				30
Discount Rate (*i*):				7%
p/A value:				12.409
Total Indoor Air OM&M Present Worth (PW):				**$ 659,704**
Total Cost				**$ 659,704**

Notes and Assumptions:

Long-Term Monitoring Scope for Indoor Air:

- Air Samples will be collected every 3 years and analyzed for VOCs by TO-15 analysis.
- In general 3 samples will be collected at 13 locations. Additional samples will be collected as necessary.
- Duplicate samples will be collected at a rate of 1 per 20 samples.
- Analytical cost for TO-15 + Tentatively Identified Compounds (TICs) cost ~ $275 per sample.
- Sampling events may require up to 2 mobilizations based on property owner and subcontractor availability.
- SVI Mitigation System Inspections will be conducted annually.
- Assumes 2 personnel required for sampling events and 1 personnel required for oversight.
- Note that costs associated with new SVI system installations are not included here
- Additional Institutional Controls for VI include Environmental Easements for all 124 parcels within the plume boundary. (See Table 4.1-1; not included here to avoid duplication of costs)

TABLE 4.3-1

BEDROCK VADOSE ZONE ALTERNATIVE #2
INSTITUTIONAL CONTROLS
COST SUMMARY

Item	Quantity	Units	Unit Cost	Total Cost
Institutional Controls [(1)]				
Informational Devices				
Environmental Easements				
Legal Fees	9	parcels	$ 15,000	$ 135,000
Recording Fees	9	parcels	$ 250	$ 2,250
Subtotal:				**$ 137,250**
Total Cost				**$ 137,250**

Notes:

(1) Insitutional Controls for Bedrock media include Informational Devices only, which consist of Environmental Easements for nine (9) affected parcels

TABLE 4.3-2

BEDROCK VADOSE ZONE ALTERNATIVE #3a
BEDROCK VAPOR EXTRACTION IN A 10-ACRE AREA
COST SUMMARY

Item	Quantity	Units	Unit Cost	Total Cost
Remedial System Design	1	unit	$ 35,000	**$ 35,000**
Remedial System Installation				
Well Installation				
Survey/Location of wells	1	unit	$ 20,000	$ 20,000
Bedrock Well Installation (Contractor)	190	well	$ 10,000	$ 1,900,000
Observation Well Installation (Contractor)	80	well	$ 7,500	$ 600,000
Drill Cuttings Disposal (Assume Hazardous)	270	well	$ 3,000	$ 810,000
Consultant Oversight	230	worker-day	$ 4,000	$ 920,000
Subtotal: Well Installation				**$ 4,250,000**
Piping and Equipment Pad Installation				
Piping Materials and Labor (Contractor)	3000	linear feet	$ 200	$ 600,000
Concrete Equipment Pad Installation	1	unit	$ 35,000	$ 35,000
Consultant Oversight	30	day	$ 4,000	$ 120,000
Subtotal: Piping and Equipment Pad Installation				**$ 755,000**
Equipment Purchase & Installation				
Remedial System Purchase	1	unit	$ 750,000	$ 750,000
System Installation, Startup & Testing (Contractor)	1	unit	$ 30,000	$ 30,000
Electrical Power Drop & Service Installation	1	unit	$ 20,000	$ 20,000
Consultant Oversight	10	worker-day	$ 2,000	$ 20,000
Subtotal: Equipment Purchase & Installation				**$ 820,000**
Operation & Maintenance/Long-term Monitoring Workplan				**$ 25,000**
Subtotal Capital Cost				**$ 5,885,000**
Contractor Mobilization/Demobilization (5%)				$ 294,250
Health and Safety (2%)				$ 117,700
Engineering/Contingency (35%)				$ 2,059,750
Total Capital Cost				**$ 8,356,700**
Institutional Controls [1]				
Informational Devices				
Environmental Easements				
Legal Fees	9	parcels	$ 15,000	$ 135,000
Recording Fees	9	parcels	$ 250	$ 2,250
Subtotal:				**$ 137,250**
Alternative 3A: Annual Operation Maintenance & Monitoring (OM&M)				
Labor/Materials & Rentals	12	month	$ 5,000	$ 60,000
Electrical Costs	4	quarter	$ 40,000	$ 160,000
Carbon Changeout Costs	4	quarter	$ 30,000	$ 120,000
Spare Parts & Miscellaneous Materials	4	quarter	$ 500	$ 2,000
System Analytical Sampling	4	quarter	$ 500	$ 2,000
Quarterly Reporting, Data Review & Project Management	4	quarter	$ 10,000	$ 40,000
Total Annual OM&M Cost				**$ 384,000**
Annual OM&M Present Worth (PW):				
Number of Years (n):				3
Discount Rate (I):				7%
p/A value:				2.62
Annual OM&M Present Worth (PW):				**$ 1,007,616**
Total Cost				**$ 9,502,000**

Notes:

(1) Insitutional Controls for Bedrock media include Informational Devices only, which consist of Environmental Easements for nine (9) affected parcels

TABLE 4.3-3

BEDROCK VADOSE ZONE ALTERNATIVE #3b
BEDROCK VAPOR EXTRACTION IN A 2-ACRE AREA
COST SUMMARY

Item	Quantity	Units	Unit Cost	Total Cost
Remedial System Design	1	unit	$ 35,000	**$ 35,000**
Remedial System Installation				
Well Installation				
Survey/Location of wells	1	unit	$ 7,500	$ 7,500
Bedrock Well Installation (Contractor)	40	well	$ 10,000	$ 400,000
Observation Well Installation (Contractor)	20	well	$ 7,500	$ 150,000
Drill Cuttings Disposal (Assume Hazardous)	80	well	$ 3,000	$ 240,000
Consultant Oversight	50	worker-day	$ 4,000	$ 200,000
Subtotal: Well Installation				**$ 997,500**
Piping and Equipment Pad Installation				
Piping Materials and Labor (Contractor)	1000	linear feet	$ 200	$ 200,000
Concrete Equipment Pad Installation	1	lump sum	$ 35,000	$ 35,000
Consultant Oversight	15	day	$ 4,000	$ 60,000
Subtotal: Piping and Equipment Pad Installation				**$ 295,000**
Equipment Purchase & Installation				
Remedial System Purchase	1	unit	$ 500,000	$ 500,000
System Installation, Startup & Testing (Contractor)	1	unit	$ 30,000	$ 30,000
Electrical Power Drop & Service Installation	1	unit	$ 20,000	$ 20,000
Consultant Oversight	10	worker-day	$ 2,000	$ 20,000
Subtotal: Equipment Purchase & Installation				**$ 570,000**
Operation & Maintenance/Long-term Monitoring Workplan				**$ 25,000**
Subtotal Capital Cost				**$ 1,922,500**
Contractor Mobilization/Demobilization (5%)				$ 96,125
Health and Safety (2%)				$ 38,450
Engineering/Contingency (35%)				$ 672,875
Total Capital Cost				**$ 2,729,950**
Institutional Controls [1]				
Informational Devices				
Environmental Easements				
Legal Fees	9	parcels	$ 15,000	$ 135,000
Recording Fees	9	parcels	$ 250	$ 2,250
Subtotal:				**$ 137,250**
Annual Operation Maintenance & Monitoring (OM&M):				
Labor/Materials & Rentals	12	month	$ 5,000	$ 60,000
Electrical Costs	4	quarter	$ 25,000	$ 100,000
Carbon Changeout Costs	4	quarter	$ 30,000	$ 120,000
Spare Parts & Miscellaneous Materials	4	quarter	$ 500	$ 2,000
System Analytical Sampling	4	quarter	$ 500	$ 2,000
Quarterly Reporting, Data Review & Project Management	4	quarter	$ 10,000	$ 40,000
Total Annual OM&M Cost				**$ 324,000**
Annual OM&M Present Worth (PW):				
Number of Years (n):				3
Discount Rate (I):				7%
p/A value:				2.62
Annual OM&M Present Worth (PW):				**$ 850,176**
Total Cost				**$ 3,718,000**

Notes:

(1) Insitutional Controls for Bedrock media include Informational Devices only, which consist of Environmental Easements for nine (9) affected parcels

Table 4.4-1: Process Option Screening For Surface Water

General Response Actions	Technology Class	Process Options	Description	Technology retained for further evaluation as part of an alternative?	Comments
No Action	-	-	Perform no actions to limit, reduce or prevent exposure to the contaminants.	Y	
Containment	*Groundwater Pumping*	Groundwater Pump and Treat (GWP&T)	This method involves hydraulic control of the groundwater contaminant plume via the installation of a series of groundwater extraction wells near the seeps, to provide hydraulic control of TCE-contaminated groundwater and prevent it from daylighting. The extraction wells pump contaminated groundwater to the surface where it may be treated using various unit processes which can include air stripping and carbon adsorption to remove chlorinated VOCs. Treated groundwater is typically discharged to either a receiving surface water body or back into the aquifer.	Y	In order to prevent potential surface water exposure to TCE-impacted water, the groundwater pumping system would need to pump groundwater out of the fracture network that contributes to the active TCE-impacted seeps within the Mud Creek Area of Interest (MCAI); pumping rates would need be sufficiently high to prevent daylighting of groundwater in the section of Mud Creek. The location, orientation, and hydraulic connectivity of fractures, and other subsurface flow pathways, contributing to the MCAI would need to be identified and intercepted. Snowmelt and meteoric events in the Mud Creek Watershed recharge the MCAI with an estimated 5,813.8 million gallons of surface water and groundwater per year (approx. 484.47 million gallons per month). This influx of water results in rapid, unpredictable, groundwater elevation fluxes (>30 ft within hours) in monitoring wells near the MCAI. The impact of this water, its impact on groundwater elevations, and potential contribution to the MCAI flow conditions need to be considered in the design of this system. In addition, an understanding of variations in groundwater seep flow rates, seep water quality, and surface water quality need to be considered in the design of the system. It is possible that contaminated groundwater could bypass the GWP&T system and daylight in different locations within Mud Creek. A pre-remedial design investigation would be needed to determine if GWP&T can be effectively implemented and if applicable, the design parameters required for implementation.
		Interceptor Trench	Interceptor trenches are installed to provide a barrier to further migration of contaminants in a groundwater or surface water plume. Trenches are typically constructed downgradient of the source area, and are filled with gravel to promote collection of contaminated groundwater as it flows into the trenches. Groundwater would then be pumped to a treatment system and discharged as in the GWP&T method discussed above.	N	Interceptor extraction trenches are significantly more expensive in comparison to extraction wells, especially in fractured rock. In addition to the comments presented above for GWP&T the installation of extraction trenches to the target depths would pose significant constructability issues. Interceptor trenches are unlikely to provide significant cost-benefit over extractions wells. It is possible that contaminated water could bypass the trench and possibly daylight in different locations within Mud Creek.
	Subsurface Barriers	Slurry Wall	A slurry wall consisting of a low-permeability soil-bentonite mixture could be installed around the seep area to prevent TCE-impacted groundwater from daylighting in the MCAI. The slurry wall could be installed using modified deep soil mixing equipment and injecting a soil/bentonite mixture or by quarrying a deep rock trench and backfilling with soil-bentonite.	N	In addition to the comments presented above for GWP&T the construction of a slurry wall in limestone/dolomite rock to the necessary depths of greater than 50 feet bgs would require highly specialized and relatively rare construction equipment. Construction of the slurry wall near the steep slopes of Mud Creek would be challenging. It is likely that contaminated groundwater would flow around or under the slurry wall and possibly daylight in new or different locations near Mud Creek. Additionally, slurry walls are most effective when combined with a hydraulic control pump and treat system to reduce the potential for flow around the slurry wall.
		Grout Curtain	Similar to a slurry wall, a grout curtain provides a barrier to groundwater flow. The grouting material is installed via high pressure injection using special fluids such as epoxy and sodium silicate, or particulate grouts such as Portland cement and sodium bentonite. Grout injection points are typically spaced 5 to 10 feet apart to ensure adequate coverage and overlapping of the grout mixture.	N	In addition to the comments presented above for GWP&T, controlling the grout injections and providing construction quality assurance regarding which fractures are grouted would be difficult. It is likely that extensive pre-design fracture mapping would be required and that several mobilizations would be necessary. It is likely that even several iterations of grouting would result in new seep locations in Mud Creek.
	Surficial Flow Barriers	Stone Cover	This option would involve filling in the active stream segment with a stone cover to prevent potential exposure to TCE-impacted surface water. Stone, which can be sourced from nearby quarries to match the existing rocks in the creek bed, would be placed and arranged in a configuration which encompass the entire area where active flow and seeps are present. The stone cover would be placed to a thickness such that contaminated groundwater is always several feet below the modified ground surface, thus preventing direct contact, and daylighting of contaminated groundwater to the ground surface.	Y	Losing stream conditions are observed along Mud Creek (within the MCAI) when the water table elevation is below the bottom of the stream channel causing Mud Creek surface water to infiltrate into the ground recharging the local groundwater. This alternative would mimic the natural losing conditions within Mud Creek by using local stone to increase the ground elevation to prevent direct human contact with the impacted surface water. The surface of the stone cover could be further landscaped to provide a land bridge that would facilitate movement of wildlife through this area. Mud Creek is classified as a Class "C" stream in New York State. According to the NYSDEC, a Protection of Waters Permit is required for disturbing the bed or banks of a stream with a classification of "AA", "A" or "B", or with a classification of "C" with a standard of (T) or (TS) (disturbance may be either temporary or permanent in nature). An understanding of seasonal seep and Mud Creek flow and contaminant variations within the MCAI will need to be considered in the design of the Stone Cover.
		Gabion Baskets	Gabion baskets are rectangular wire-mesh cages that are filled with rocks, concrete, and sometimes sand and/or soil that are routinely used for erosion control.	N	Gabion baskets may be installed within portions of the Mud Creek stream bed in order to provide a physical barrier to potential exposure of impacted surface water in a similar fashion to the stone cover described above. However, Gabion baskets would not blend in with the natural environment in the way that a stone cover would, and may also require additional maintenance.

Table 4.4-1: Process Option Screening For Surface Water

General Response Actions	Technology Class	Process Options	Description	Technology retained for further evaluation as part of an alternative?	Comments
Physical Removal (Treatment)	*Chemical/ Biological Treatment*	Permeable Treatment Barriers (PTBs)	PTBs can be configured as physical barriers or a series of borings that are filled with either a reactive reagent, material with adsorption capabilities, or an aeration cell that can treat the contaminants in the groundwater plume. PTBs therefore can act as both a barrier to the migration of TCE, and as an in-situ treatment method to reduce TCE concentrations in surface water, or groundwater that may daylight as surface water. PTBs can use a variety of different media that may act upon the dissolved phase TCE through various destructive mechanisms such as aerobic biodegradation, anaerobic biodegradation, chemical oxidation, or chemical reduction pathways.	Y	PTBs would be installed in the vicinity of the Mud Creek. The PTBs may be installed with various types of media to address the TCE impacted water at this location. Since potential exposure to TCE-impacted surface water would still be a possibility, some form of restricted access may also need to be implemented in the MCAI. PTBs could require periodic maintenance and/or media replacement which may impact their long-term effectiveness and practicality. PTBs could be configured either vertically, or horizontally as an in-situ reactive cap in areas where surface flow is present. Seasonal seep and MCAI flow conditions, water quality including geochemical composition, and the location, orientation, and hydraulic conductivity of fractures and other subsurface flow pathways that may be contributing to the flows and seeps in the MCAI need to be considered in the design of the system. A pre-remedial design investigation would be needed to determine if PTBs can be effectively implemented and if applicable, the design parameters required for implementation.
	Extraction	In-Situ Air Sparging	Pressurized air is generated and injected into the subsurface via a series of injection nozzles. This process generates air bubbles in the groundwater which allows for the mass transfer of volatile organic compounds from the dissolved phase to the vapor phase. The air bubbles will travel up the water column and within the fractured bedrock media to the ground surface, where they are ultimately discharged to the atmosphere (sparged vapor capture via SVE would not be feasible at this site). Volatilized TCE would be discharged to the air, where dilution would quickly reduce concentrations to below any action levels. TCE in air would be degraded by photo-oxidation, with a half-life of approximately 7 days (ATSDR 2019). Vertical, horizontal, or angled air sparge wells would be installed near the seep so that injected air would target contaminated groundwater before it daylights. Small diameter sparge wells (less than 1-inch in diameter) could be installed via portable rock drills near the waterfall seep. A small air sparge system building housing the air compressor and manifold would be installed near Gulf Road. Piping or tubing would convey the compressed air to the sparge wells.	N	Installing sparge wells so that the injected air targets and treats contaminated groundwater before daylighting would require extensive knowledge of the fracture networks and connectivity of the seep area. Additionally, air sparging can create changes in hydraulic head which could alter groundwater flow patterns and inadvertently cause new contaminated seeps. Even with extensive fracture network knowledge, successful implementation of air sparging would likely require several rounds of trial-and-error sparge well installation until a successful network of sparge wells successfully contacts and treats contaminated groundwater before daylighting. Continuous injection of compressed air would need to operate indefinitely to meet RAOs. Precipitate fouling of the air sparge points and associated fractures could require periodic maintenance. Typical sparge well rehabilitation uses acidic solutions to dissolve the precipitate; applying these acidic solutions near the seep area is likely to result in daylighting of acidic solution to surface water. Air sparging would create aerobic conditions in groundwater near the seep area, retarding the anaerobic biodegradation that appears to be slowly occurring in site groundwater.
		PTBs using extraction methods	PTBs can alternately be configured to incorporate non-destructive treatment processes such in-situ aeration, or filled with an adsorptive media. In the case of in-situ aeration, this would result in the extraction of TCE from the impacted surface water, and ultimate discharge to the atmosphere. An adsorptive media (such as activated carbon) would also result in the extraction of TCE from the impacted surface water, but the extracted TCE would remain on the media itself, and could be properly disposed of once the media has been fully loaded.	Y	Natural aeration processes are likely responsible for an observed decrease in TCE concentrations in the MCAI from approximately 400 ug/L (upstream by the waterfall) to 27 ug/L (downstream inlet of Mud Creek Pond). It is anticipated that aeration would enhance this process and result in a further reduction in TCE concentration along sections of Mud Creek impacted with TCE. Since potential exposure to TCE impacted surface water would still be a possibility, some form of restricted access may also need to be implemented. Alternatively, ex-situ aeration could also be applied as part of a PTB (see above) and/or in conjunction with a stone cover.
	In-Situ Thermal Treatment	Thermal Conduction Heating (TCH)	Also known as in-situ thermal desorption (ISTD), this process involves the application of heat to the subsurface in order to promote volatilization of TCE. Heat is applied via the installation of electrical-powered heaters throughout the source area. Vacuum extraction is typically conducted in parallel with TCH in order to facilitate recovery and treatment of TCE vapors.	N	Note that all of the thermal technologies listed here would need to be applied to saturated bedrock media in order to permanently address groundwater impacts that could make their way to the surface at Mud Creek (as described in the site conceptual model). As such, it would be anticipated that a large input of heat energy would be required to elevate groundwater temperatures to a sufficient level that would allow for these remedial technologies to be effectively implemented. The energy requirements to achieve this goal may be impractical.
		Electrical Resistance Heating (ERH)	This thermal treatment method involves the installation of electrodes in the subsurface, which when energized, results in the production of an electrical current. The passage of electrical current between the electrodes generates elevated temperatures which results in the volatilization of TCE. Similar to the TCH application, TCE vapors can then be recovered via vacuum extraction.	N	
		Injection of Hot Air	This thermal treatment method is similar to air sparging, except that the air stream is heated prior to injection. The elevated air temperatures, promote enhanced volatilization of TCE and recovery through vacuum extraction.	N	
		Radio Frequency Heating (RFH)	This thermal treatment process is used to generate radio waves (in the 30 to 300 MHz range), which are propagated through the subsurface matrix in order to generate heat and thereby volatilize the contaminants. The RF energy created will preferentially heat the groundwater and organic constituents over the bedrock matrix. Radio waves are created by an RF generator at the surface and directed into the ground using an array of antennas installed within wells.	N	

Reference: ATSDR. 2019. Toxicological Profile for Trichloroethylene (TCE) Toxicity. June

TABLE 4.4-2

SURFACE WATER ALTERNATIVE #2
INSTITUTIONAL CONTROLS AND MONITORING
COST SUMMARY

Item	Quantity	Units	Unit Cost	Total Cost
Pre-Remedial Design Investigation				
Test Well Installation/Sampling				
Workplan Preparation	1	unit	$ 30,000	$ 30,000
Installation of Testing Wells (contractor)	40	wells	$ 10,000	$ 400,000
Field Oversight & sample colllection	100	worker-days	$ 2,000	$ 200,000
Periodic/Seasonal data collection & analysis	80	worker-days	$ 2,000	$ 160,000
Laboratory Analysis	400	samples	$ 250	$ 100,000
Data Validation	400	samples	$ 125	$ 50,000
Subtotal:				**$ 940,000**
Pilot Testing (1)				
Pilot Testing Implementation (low range)	1	unit	$ 30,000	$ 232,500
Pilot Testing Implementation (high range)	1	unit	$ 20,000	$ 422,500
Subtotal Capital Cost (low range)				**$ 1,172,500**
Subtotal Capital Cost (high range)				**$ 1,362,500**
Contractor Mobilization/Demobilization (5%)				$ 47,000
Health and Safety (2%)				$ 18,800
Engineering/Contingency (35%)				$ 329,000
Total Capital Cost (low range)				**$ 1,567,300**
Total Capital Cost (high range)				**$ 1,757,300**
Institutional Controls (2)				
Informational Devices				
Environmental Easements				
Legal Fees	1	parcel	$ 15,000	$ 15,000
Recording Fees	1	parcel	$ 250	$ 250
Signage (3)	1	parcel	$ 5,000	$ 5,000
Monitoring (4)	30	years	$ 1,050	$ 31,500
Site Operation And Maintenance	30	years	$ 1,000	$ 30,000
Subtotal:				**$ 81,750**
Total Cost (low range) (5)				**$ 1,650,000**
Total Cost (high range) (5)				**$ 1,840,000**

Notes:

(1) Cost sassociated with pilot testing will be dependant on the type of pilot testing conducted. Low range and high range costs presented in this table are associated with pilot testing for hydraulic containment (see table 4.4-3), and In-situ treatment with streambed cover (see table 4.4-5), respectively.

(2) Institutional Controls for surface water media include Informational Devices (Environmental Easement & Signage), Monitoring and Maintenance

(3) Signage to be posted along property boundary to indicate that surface water on the property is not suitable for recreational use

(4) Costs presented include annual sampling for up to seven (7) surface water samples per year for TCE analysis

(5) Costs do not include Remedial Design & System Installation Activities. If Pilot Testing indicates favorable results for any remedial technology presented here, additional costs will be incurred through potential full-scale system installation and associated operation and maintenance with regards to the remedial strategy that may be selected for implementation.

TABLE 4.4-3

SURFACE WATER ALTERNATIVE #3
HYDRAULIC CONTAINMENT
COST SUMMARY

Item	Quantity	Units	Unit Cost	Total Cost
Pre-Remedial Design Investigation				
Test Well Installation/Sampling				
Workplan Preparation	1	unit	$ 30,000	$ 30,000
Installation of Testing Wells (contractor)	40	wells	$ 10,000	$ 400,000
Field Oversight & sample colllection	100	worker-days	$ 2,000	$ 200,000
Periodic/Seasonal data collection & analysis	80	worker-days	$ 2,000	$ 160,000
Laboratory Analysis	400	samples	$ 250	$ 100,000
Data Validation	400	samples	$ 125	$ 50,000
Subtotal:				**$ 940,000**
Pilot Testing				
Workplan Preparation	1	unit	$ 30,000	$ 30,000
Installation of Testing Pump Wells (contractor)	1	wells	$ 25,000	$ 25,000
Installation of Testing Observation Wells (contractor)	5	wells	$ 10,000	$ 50,000
Contractor/Equipment Rentals	1	rental	$ 30,000	$ 30,000
Field Oversight & sample colllection	10	worker-days	$ 2,000	$ 20,000
Laboratory Analysis	20	samples	$ 250	$ 5,000
Data Validation	20	samples	$ 125	$ 2,500
Remedial System Design	1	unit	$ 70,000	$ 70,000
Subtotal:				**$ 232,500**
Remedial System Installation				
Extraction Well Installation				
Construction of Access Roads on Property	1	unit	$ 50,000	$ 50,000
Survey/Location of wells	1	unit	$ 20,000	$ 20,000
System Well Installation (Contractor)	10	wells	$ 25,000	$ 250,000
Drill Cuttings Disposal (Assume Hazardous)	10	wells	$ 10,000	$ 100,000
Consultant Oversight	60	worker-days	$ 2,000	$ 120,000
Subtotal:				**$ 540,000**
Piping and Equipment Pad Installation				
Piping Materials and Labor (Contractor)	500	linear feet	$ 200	$ 100,000
Concrete Equipment Pad Installation	1	unit	$ 35,000	$ 35,000
Consultant Oversight	30	worker-days	$ 2,000	$ 60,000
Subtotal:				**$ 195,000**
Equipment Purchase & Installation				
Remedial System Purchase	1	unit	$ 750,000	$ 750,000
Building Construction	1	unit	$ 1,000,000	$ 1,000,000
System Installation, Startup & Testing (Contractor)	1	unit	$ 30,000	$ 30,000
Electrical Power Drop & Service Installation	1	unit	$ 50,000	$ 50,000
Consultant Oversight	30	worker-days	$ 2,000	$ 60,000
Subtotal:				**$ 1,890,000**
Operation & Maintenance/Long-term Monitoring Workplan				**$ 25,000**
Subtotal Capital Cost				**$ 3,822,500**
Contractor Mobilization/Demobilization (5%)				$ 191,125
Health and Safety (2%)				$ 76,450
Engineering/Contingency (35%)				$ 1,337,875
Total Capital Cost				**$ 5,427,950**
Institutional Controls (1)				
Informational Devices				
Environmental Easements				
Legal Fees	1	parcel	$ 15,000	$ 15,000
Recording Fees	1	parcel	$ 250	$ 250
Signage (2)	1	parcel	$ 5,000	$ 5,000
Monitoring (3)	30	years	$ 1,050	$ 31,500
Site Operation And Maintenance	30	years	$ 1,000	$ 30,000
Subtotal:				**$ 81,750**
Annual Operation Maintenance & Monitoring (OM&M)				
Labor/Materials & Rentals	1	unit	$ 120,000	$ 120,000
Electrical Costs	1	unit	$ 100,000	$ 100,000
Carbon Changeout Costs	1	unit	$ 100,000	$ 100,000
Waste Disposal	1	unit	$ 10,000	$ 10,000
Spare Parts & Miscellaneous Materials	1	unit	$ 25,000	$ 25,000
System Analytical Sampling	10	/quarter	$ 250	$ 10,000
Data Validation	1	unit	$ 5,000	$ 5,000
Quarterly Reporting, Data Review & Project Management	1	unit	$ 40,000	$ 40,000
Total Annual OM&M Cost				**$ 410,000**
Annual OM&M Present Worth (PW):				
Number of Years (n):				30
Discount Rate (I):				7%
p/A value:				12.41
Annual OM&M Present Worth (PW):				**$ 5,087,690**
Total Cost (4)				**$ 10,598,000**

Notes:

(1) Institutional Controls for surface water media include Informational Devices (Environmental Easement & Signage), Monitoring and Maintenance
(2) Signage to be posted along property boundary to indicate that surface water on the property is not suitable for recreational use
(3) Costs presented include annual sampling for up to seven (7) surface water samples per year for TCE analysis
(4) All costs are estimated based on favorable results from the Pre-Remedial Design Investigation (PDI), and are subject to change based on the actual data obtained from the the PDI

TABLE 4.4-4

SURFACE WATER ALTERNATIVE #4
STREAMBED COVER
COST SUMMARY

Item	Quantity	Units	Unit Cost	Total Cost
Pre-Remedial Design Investigation				
Test Well Installation/Sampling				
Workplan Preparation	1	unit	$ 30,000	$ 30,000
Installation of Testing Wells (contractor)	40	wells	$ 10,000	$ 400,000
Field Oversight & sample collection	100	worker-days	$ 2,000	$ 200,000
Periodic/Seaonal data collection & analysis	80	worker-days	$ 2,000	$ 160,000
Laboratory Analysis	400	samples	$ 250	$ 100,000
Data Validation	400	samples	$ 125	$ 50,000
Remedial System Design	1	unit	$ 35,000	$ 35,000
Subtotal:				**$ 975,000**
Remedial System Installation				
Streambed Cover Installation				
Construction of Access Roads on Property	1	unit	$ 50,000	$ 50,000
Materials for Stone Cover	1800	cu. Yards	$ 50	$ 90,000
Installation (Contractor)	1	unit	$ 200,000	$ 200,000
Consultant Oversight	60	worker-days	$ 2,000	$ 120,000
Subtotal:				**$ 460,000**
Operation & Maintenance/Long-term Monitoring Workplan				**$ 25,000**
Subtotal Capital Cost				**$ 1,460,000**
Contractor Mobilization/Demobilization (5%)				$ 73,000
Health and Safety (2%)				$ 29,200
Engineering/Contingency (35%)				$ 511,000
Total Capital Cost				**$ 2,073,200**
Institutional Controls [1]				
Informational Devices				
Environmental Easements				
Legal Fees	1	parcel	$ 15,000	$ 15,000
Recording Fees	1	parcel	$ 250	$ 250
Signage [2]	1	parcel	$ 5,000	$ 5,000
Monitoring [3]	30	years	$ 1,050	$ 31,500
Site Operation And Maintenance	30	years	$ 1,000	$ 30,000
Subtotal:				**$ 81,750**
Annual Operation Maintenance & Monitoring (OM&M)				
Labor/Materials & Rentals	4	quarters	$ 2,000	$ 8,000
Misc Materials	1	unit	$ 7,500	$ 7,500
System Analytical Sampling	20	samples	$ 250	$ 5,000
Data Validation	20	samples	$ 125	$ 2,500
Quarterly Reporting, Data Review & Project Management	1	unit	$ 20,000	$ 20,000
Total Annual OM&M Cost				**$ 43,000**
Annual OM&M Present Worth (PW):				
Number of Years (n):				30
Discount Rate (I):				7%
p/A value:				12.41
Total OM&M Present Worth (PW):				**$ 533,587**
Total Cost [4]				**$ 2,689,000**

Notes:

(1) Institutional Controls for surface water media include Informational Devices (Environmental Easement & Signage), Monitoring and Maintenance
(2) Signage to be posted along property boundary to indicate that surface water on the property is not suitable for recreational use
(3) Costs presented include annual sampling for up to seven (7) surface water samples per year for TCE analysis
(4) All costs are estimated based on favorable results from the Pre-Remedial Design Investigation (PDI), and are subject to change based on the actual data obtained from the the PDI

TABLE 4.4-5

SURFACE WATER ALTERNATIVE #5
IN-SITU TREATMENT WITH STREAMBED COVER
COST SUMMARY

Item	Quantity	Units	Unit Cost	Total Cost
Pre-Remedial Design Investigation				
Test Well Installation/Sampling				
Workplan Preparation	1	unit	$ 30,000	$ 30,000
Installation of Testing Wells (contractor)	40	wells	$ 10,000	$ 400,000
Field Oversight & sample colllection	100	worker-days	$ 2,000	$ 200,000
Periodic/Seaonal data collection & analysis	80	worker-days	$ 2,000	$ 160,000
Laboratory Analysis	400	samples	$ 250	$ 100,000
Data Validation	400	samples	$ 125	$ 50,000
Subtotal:				**$ 940,000**
Pilot Testing - In-Situ Treatment Barrier				
Workplan Preparation	1	unit	$ 30,000	$ 30,000
Installation of Pilot Scale Treatment Barrier	1	unit	$ 200,000	$ 200,000
Reagent/Equipment to be used in Barrier	1	unit	$ 50,000	$ 50,000
Contractor/Equipment Rentals	1	rental	$ 25,000	$ 25,000
Field Oversight & sample colllection	20	worker-days	$ 2,000	$ 40,000
Laboratory Analysis	20	samples	$ 250	$ 5,000
Data Validation	20	samples	$ 125	$ 2,500
Remedial System Design	1	unit	$ 70,000	$ 70,000
Subtotal:				**$ 422,500**
Remedial System Installation				
Treatment Barrier Installation				
Construction of Access Roads on Property	1	EST	$ 50,000	$ 50,000
Installation of Treatment Barriers	2	barriers	$ 200,000	$ 400,000
Reagent/Equipment to be used in Barrier	1	unit	$ 100,000	$ 100,000
Consultant Oversight	20	worker-days	$ 2,000	$ 40,000
Subtotal:				**$ 590,000**
Streambed Cover Installation				
Construction of Access Roads on Property	1	unit	$ 50,000	$ 50,000
Materials for Stone Cover	1800	cu. Yards	$ 50	$ 90,000
Installation (Contractor)	1	unit	$ 200,000	$ 200,000
Consultant Oversight	60	worker-days	$ 2,000	$ 120,000
Subtotal:				**$ 460,000**
Piping and Equipment Pad Installation				
Piping Materials and Labor (Contractor)	600	linear feet	$ 200	$ 120,000
Concrete Equipment Pad Installation	1	unit	$ 30,000	$ 30,000
Consultant Oversight	25	worker-days	$ 2,000	$ 50,000
Subtotal:				**$ 200,000**
Equipment Purchase & Installation				
Remedial System Purchase	1	unit	$ 100,000	$ 100,000
Shed/Building Construction for equipment	1	unit	$ 75,000	$ 75,000
System Installation, Startup & Testing (Contractor)	1	unit	$ 30,000	$ 30,000
Electrical Power Drop & Service Installation	1	unit	$ 20,000	$ 20,000
Consultant Oversight	20	worker-days	$ 2,000	$ 40,000
Subtotal:				**$ 265,000**
Operation & Maintenance/Long-term Monitoring Workplan				**$ 25,000**
Subtotal Capital Cost				**$ 2,902,500**
Contractor Mobilization/Demobilization (5%)				$ 145,125
Health and Safety (2%)				$ 58,050
Engineering/Contingency (35%)				$ 1,015,875
Total Capital Cost				**$ 4,121,550**
Institutional Controls [1]				
Informational Devices				
Environmental Easements				
Legal Fees	1	parcel	$ 15,000	$ 15,000
Recording Fees	1	parcel	$ 250	$ 250
Signage [2]	1	parcel	$ 5,000	$ 5,000
Monitoring [3]	30	years	$ 1,050	$ 31,500
Site Operation And Maintenance	30	years	$ 1,000	$ 30,000
Subtotal:				**$ 81,750**
Annual Operation Maintenance & Monitoring (OM&M)				
Labor/Materials & Rentals	1	EST	$ 120,000	$ 120,000
Electrical Costs	1	EST	$ 15,000	$ 15,000
Waste Disposal	1	EST	$ 25,000	$ 25,000
Spare Parts & Miscellaneous Materials	1	EST	$ 30,000	$ 30,000
System Analytical Sampling	1	EST	$ 10,000	$ 10,000
Data Validation	1	EST	$ 10,000	$ 10,000
Quarterly Reporting, Data Review & Project Management	1	EST	$ 40,000	$ 40,000
Total Annual OM&M Cost				**$ 250,000**
Annual OM&M Present Worth (PW):				
Number of Years (n):				$ 30
Discount Rate (I):				$ 0
p/A value:				$ 12
Annual OM&M Present Worth (PW):				**$ 3,102,250**
Total Cost [4]				**$ 7,306,000**

Notes:

(1) Institutional Controls for surface water media include Informational Devices (Environmental Easement & Signage), Monitoring and Maintenance
(2) Signage to be posted along property boundary to indicate that surface water on the property is not suitable for recreational use
(3) Costs presented include annual sampling for up to seven (7) surface water samples per year for TCE analysis
(4) All costs are estimated based on favorable results from the Pre-Remedial Design Investigation (PDI), and are subject to change based on the actual data obtained from the the PDI

TABLE 4.5-1a
POTENTIAL CHEMICAL-SPECIFIC ARARs, TBCs, and Other Guidance
FEASIBILITY STUDY
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
LEROY, NEW YORK

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
Air:		
New York State Air Quality Classifications and Standards	6 NYCRR Parts 256 and 257	Establishes air quality standards protective of public health. Applicable to point source emissions from treatment technologies. Potentially applicable to disruptive activities.
National Primary and Secondary Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Establishes primary and secondary ambient air quality standards to protect public health and welfare. Applicable to point source emissions from treatment technologies. Potentially applicable to disruptive activities.
Soil:		
Environmental Remediation Programs	6 NYCRR Part 375-6 Remedial Program SCOs	Applies to the development and implementation of the remedial programs for soil and other media. Includes the SCO tables at 375-6.8.
Soil Cleanup Guidance	DEC Commissioner Policy CP-51 Soil Cleanup Guidance, October 2010	Guidance for NYSDEC and remedial parties to provide a uniform and consistent process in determining soil cleanup levels for SSF, BCP, VCP, ERP, Spill Response Program (SRP), and RCRA Corrective Action Program Sites.
USEPA Superfund Soil Screening Guidance (SSG)	Technical Background Document and Users Guide, 1996 revisions	Presents a framework for developing risk-based, soil screening levels (SSL) for protection of human health. Provides a flexible, tiered approach to site evaluation and screening level development.
USEPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	2002 Companion Guide to the 1996 SSG	Builds upon the soil screening framework in the original 1996 guidance focusing specific elements of soil screening evaluation that differ for residential, non-residential, and construction scenarios.
USEPA Preliminary Remediation Goals (PRGs)	USEPA Region 9, PRG Table, October 2004	Presents contaminant toxicity values, PRGs, and SSL for residential and non-residential scenarios based on human health criteria and groundwater protection.
USEPA Risk Assessment Guidance for Superfund (RAGS) Part C	Publication 9285.7-01C, October 1991	Provides guidance on the human health risk evaluations of remedial alternatives that are conducted during the feasibility study, during selection and documentation of a remedy, and during and after remedy implementation.
USEPA Regional Screening Levels (RSLs) Composite Worker Soil Table	November 2022	Establishes RSLs for the composite worker. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
Surface Water:		
Federal Water Pollution Control Act (CWA)	CWA §304 40 CFR Part 131	Establishes criteria for setting water quality standards for surface water bodies based on the latest scientific data on impacts that a constituent concentration has on a particular aquatic species and/or human health; criteria used as guidance by states in setting water quality standards.

National Recommended Water Quality Criteria	63 Federal Register 68354	Established national recommended water quality criteria for a range of contaminants including PCBs in freshwater.
NYSDEC Water Quality Standards and Classifications	6 NYCRR Parts 700-701.14, 701.19-702.17, 702.22-703.5, 703.7-706	Establishes surface water quality standards and effluent limitations.
New York State Division of Water TOGS Ambient Water Quality Standards and Guidance Values	TOGS 1.1.1	Provides screening criteria for surface water.
New York State Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations	6 NYCRR Part 703	Establishes numerical standards for groundwater and surface water cleanups.

TABLE 4.5-1b
POTENTIAL LOCATION-SPECIFIC ARARs, TBCs, AND OTHER GUIDANCE
FEASIBILITY STUDY
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
LEROY, NEW YORK

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
General Requirements for Site Remediation:		
USEPA Corrective Action Management Units (CAMUs)	40 CFR 264.552	Outlines the conditions under which USEPA can designate an area as a CAMU to be used for managing CAMU-eligible wastes for implementing corrective action or facility cleanup. Outlines minimum treatment
The National Historic Preservation Act (NHPA)	16 U.S.C. § 470	A review of the Site's descriptive data suggests the potential for the discovery of both historic and prehistoric resources within the project area. A Stage IA Cultural Resource Survey (CRS) has been carried out for the project area where the waterline was constructed. An additional Stage IA CRS will be conducted within the Spill Zone. These areas will be subject to a subsequent Stage IB CRS field survey where construction-related impacts are scheduled to occur.
The Endangered Species Act	16 U.S.C. § 1531	The U.S. Fish and Wildlife Service will be consulted to determine whether endangered or threatened species and/or their habitats exist on or in the vicinity of the Site during the remedial design phase of the project.
The Fish and Wildlife Coordination Act (FWCA)	16 U.S.C. § 661	In accordance with the FWCA, state and federal wildlife agencies will be consulted when wetlands and water resources may be or are being impacted.
New York State Endangered and Threatened Species of Fish and Wildlife; Species of Concern; Incidental Take Permits Regulations	6 NYCRR Part 182	Establishes lists of endangered, threatened, and special concern species; recovery and restoration plans, experimental population designation; permit requirements; special rules; penalties, and enforcement.
Floodplains and Wetlands:		
Floodplain Management, Executive Order No. 11988		Portions of the project area adjacent to Mud Creek and Spring Creek are located within the 100-year and 500-year floodplain. As remedial activities are proposed for the 100-year or 500-year floodplain, a floodplain assessment will be performed during remedial design to minimize or avoid the adverse effects of a 500-year event, and to protect against the spread of contaminants and the long-term disabling of remedial treatment systems. This assessment will include a delineation of the floodplain on a Site map in relation to areas of contamination and remedial activities, a discussion of the effects of the proposed remedial action on the floodplain, and measures to minimize potentially adverse floodplain impacts.
The Federal Water Pollution Control Act	33 U.S.C. § 1344	A Wetlands Delineation Work Plan will be developed and any requisite mitigative measures resulting from the delineation work will be addressed during remedial design and construction.
Protection of Wetlands, Executive Order No.11990	40 CFR Part 6, Appendix A	

USEPA Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR Part 6, Appendix A, Sections 3 and 4	Establishes requirements associated with actions that have impacts on wetlands or floodplains.
New York State Freshwater Wetlands Regulations	6 NYCRR Parts 662-665	Establishes permit requirement regulations, wetland maps and classifications. On-site CERCLA response actions are exempt from permit requirements pursuant to CERCLA Section 121(e), although such activities must comply with substantive requirements of these regulations.
New York State Floodplain Development Permits	6 NYCRR Part 500	Describes permitting requirements for development in floodplains. On-site CERCLA response actions are exempt from permit requirements pursuant to CERCLA Section 121 (e), although such activities must comply with substantive requirements of these regulations.
Clean Water Act Section 404	40 CFR Part 230 and 33 CFR Parts 320-330	Prohibits discharge into wetlands.
Waterways:		
New York State – Use and Protection of Waters	6 NYCRR Part 608	Establishes requirements with excavation or placement of fill in navigable waters.

TABLE 4.5-1c
POTENTIAL ACTION-SPECIFIC ARARs, TBCs, and Other Guidance
FEASIBILITY STUDY
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
LEROY, NEW YORK

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
Air:		
NYSDEC Guidance for Fugitive Dust and Particulate Monitoring	NYSDEC Program Policy DER-10, Appendix 1B	Establishes guidance for community air monitoring and controls to monitor and mitigate fugitive dusts during intrusive activities at NYS SSF, ERP, BCP, and VCP Sites. Potentially applicable for disruptive activities.
National Ambient Air Quality Standards for Hazardous Air Pollutants	40 CRF Part 61	
Excavation and Fugitive Dust Emissions	40 CFR Part 254.25	
Ambient Air Quality Standards	6 New York Code of Rules and Regulations (NYCRR) Part 200.6	
NYSDEC Control of Toxic Ambient Air Contaminants, Air Guide I		
NYSDOH Guidelines for TCE in Air		
ATSDR Environmental Media Evaluation Guides for Indoor Air-Screening Levels		
Solid and Hazardous Waste:		
NYSDEC Solid Waste Management Facilities	6 NYCRR Part 360	Describes procedures for transferring, processing, recovering, storing, reclaiming, or disposing non-hazardous solid waste.
NYSDEC Solid Waste Transporters	6 NYCRR Part 364	Establishes procedures to protect the environment from mishandling and mismanagement of all regulated waste transported from a site of generation to the site of ultimate treatment, storage, or disposal. Potentially applicable for alternatives involving off-site disposal.
NYSDEC Hazardous Waste Manifest System and Related Standards for Generators	6 NYCRR Part 372	Establish standards for generators and transporters of hazardous waste and standards for generators, transporters, and treatment, storage or disposal facilities relating to the use of the manifest system and its recordkeeping requirements.
NYSDEC and USEPA Land Disposal Restrictions	6 NYCRR Part 376 40 CFR 268.40	Identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise prohibited waste may be land disposed. Describes chemical-specific treatment requirements for land disposal of hazardous waste. Potentially relevant to off-site waste disposal alternatives.
USEPA Corrective Action Management Units (CAMUs)	40 CFR 264.552	Outlines the conditions under which USEPA can designate an area as a CAMU to be used for managing CAMU-eligible wastes for implementing corrective action or facility cleanup. Outlines min. design requirements.
DOT Hazardous Materials Regulations	49 CFR Parts 107 and 171	Establishes requirements for shipping of hazardous materials. Potentially applicable for alternatives involving off-site disposal.

Occupational Safety and Health Act	29 CFR Part 1910.120	Hazardous waste operations and emergency response.
Occupational Safety and Health Act	29 CFR Part 1926	Describes procedures for safety and health related to construction activities.
Surface Water:		
CWA- USEPA Administered Permit Programs: National Pollutant Discharge Elimination System (NPDES) and Criteria and Standards for the NPDES	40 CFR Part 401 40 CFR Parts 122 and 125	Provides NPDES permit requirements for point source discharges, including the NPDES Best Management Practice Program. These regulations include, but are not limited to, requirements for compliance with water quality standards, discharge monitoring systems, and records maintenance. On-site CERCLA response actions are exempt from permit requirements pursuant to CERCLA Section 121(e), although such activities must comply with substantiative requirements of these regulations.
Federal Water Pollution Control Act (CWA)	40 CFR Part 401 40 CFR Parts 121.2, 122-125	Requires federal license or permit applicants to provide a certification that any discharges (e.g., dredged material, dewatering effluent, placement of fill, discharges of decants water) will comply with the CWA, including water quality standard requirements (water quality certification). On-site CERCLA response actions are exempt from permit requirements pursuant to CERCLA Section 121(e), although such activities must comply with substantiative requirements of these regulations.
New York State Freshwater Wetlands Permit Requirements	6 NYCRR Part 663	Establishes freshwater wetlands permit requirements to protect and conserve freshwater wetlands and the benefits derived therefrom, to prevent the despoliation and destruction of freshwater wetlands, and to regulate the use and development of such wetlands to secure the natural benefits of wetlands , consistent with the general welfare and beneficial economic, social, and agricultural development of the State.
Fish and Wildlife Management Practices Cooperative Program	NYS ECL §11-0513	Establishes that no deleterious or poisonous substances shall be thrown or allowed to run into any public or private waters in quantities injurious to fish life, protected wildlife, or waterfowl inhabiting those waters, or injurious to the propagation of fish, protected wildlife, or waterfowl therein.
Environmental Conservation Water Resources Permits	ECL Article 15, Title 5	Lists the permit requirements for working in or modifying protected creeks and streams. On-site CERCLA response actions are exempt from permit requirements pursuant to CERCLA Section 121(e), although such activities must comply with substantive requirements of these regulations.

Table 4.5-2: General Response Action (GRA): Containment
Technology Class: Immobilization

Process Options		Preliminary Remediation Goals (PRGs)					
		0.47 mg/kg	**2 mg/kg**	**7 mg/kg**	**19 mg/kg**	**200 mg/kg**	**400 mg/kg**
Ex-Situ Solidification/ Stabilization	Effectiveness	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by thoroughly blending impacted materials with cement in a mechanical mixing device, such as a pug mill. The treated soil is then placed back into the ground from where it was removed. It does not reduce the toxicity or volume of the TCE. A pilot test would be required to identify the appropriate blend of cement to soil/rubble by weight. Dust controls would be required during removal work in dry weather. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by thoroughly blending impacted materials with cement in a mechanical mixing device, such as a pug mill. The treated soil is then placed back into the ground from where it was removed. It does not reduce the toxicity or volume of the TCE. A pilot test would be required to identify the appropriate blend of cement to soil/rubble by weight. Dust controls would be required during removal work in dry weather. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by thoroughly blending impacted materials with cement in a mechanical mixing device, such as a pug mill. The treated soil is then placed back into the ground from where it was removed. It does not reduce the toxicity or volume of the TCE. A pilot test would be required to identify the appropriate blend of cement to soil/rubble by weight. Dust controls would be required during removal work in dry weather. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by thoroughly blending impacted materials with cement in a mechanical mixing device, such as a pug mill. The treated soil is then placed back into the ground from where it was removed. It does not reduce the toxicity or volume of the TCE. A pilot test would be required to identify the appropriate blend of cement to soil/rubble by weight. Dust controls would be required during removal work in dry weather. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by thoroughly blending impacted materials with cement in a mechanical mixing device, such as a pug mill. The treated soil is then placed back into the ground from where it was removed. It does not reduce the toxicity or volume of the TCE. A pilot test would be required to identify the appropriate blend of cement to soil/rubble by weight. Dust controls would be required during removal work in dry weather. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by thoroughly blending impacted materials with cement in a mechanical mixing device, such as a pug mill. The treated soil is then placed back into the ground from where it was removed. It does not reduce the toxicity or volume of the TCE. A pilot test would be required to identify the appropriate blend of cement to soil/rubble by weight. Dust controls would be required during removal work in dry weather. This alternative satisfies the Remedial Action Objectives for Spill Area soils.
	Implementability	Technical implementability issues with this option include a potentially significant increase in Spill Area overburden volume due to the addition of cement and the varying size of the rubble materials in the overburden, which are expected to require screening and segregation of larger size debris or crushing of larger debris due to poor mixing of such materials and high variability in the density of the soil/rubble if not removed or size-reduced prior to blending. Administrative implementability may be expected due to aesthetic concerns following treatment.	Technical implementability issues with this option include a potentially significant increase in Spill Area overburden volume due to the addition of cement and the varying size of the rubble materials in the overburden, which are expected to require screening and segregation of larger size debris or crushing of larger debris due to poor mixing of such materials and high variability in the density of the soil/rubble if not removed or size-reduced prior to blending. Administrative implementability may be expected due to aesthetic concerns following treatment.	Technical implementability issues with this option include a potentially significant increase in Spill Area overburden volume due to the addition of cement and the varying size of the rubble materials in the overburden, which are expected to require screening and segregation of larger size debris or crushing of larger debris due to poor mixing of such materials and high variability in the density of the soil/rubble if not removed or size-reduced prior to blending. Administrative implementability may be expected due to aesthetic concerns following treatment.	Technical implementability issues with this option include a potentially significant increase in Spill Area overburden volume due to the addition of cement and the varying size of the rubble materials in the overburden, which are expected to require screening and segregation of larger size debris or crushing of larger debris due to poor mixing of such materials and high variability in the density of the soil/rubble if not removed or size-reduced prior to blending. Administrative implementability may be expected due to aesthetic concerns following treatment.	Technical implementability issues with this option include a moderate increase in Spill Area overburden volume due to the addition of cement and the varying size of the rubble materials in the overburden, which are expected to require screening and segregation of larger size debris or crushing of larger debris due to poor mixing of such materials and high variability in the density of the soil/rubble if not removed or size-reduced prior to blending. Administrative implementability may be expected due to aesthetic concerns following treatment.	Technical implementability issues with this option include a slight increase in Spill Area overburden volume due to the addition of cement and the varying size of the rubble materials in the overburden, which are expected to require screening and segregation of larger size debris or crushing of larger debris due to poor mixing of such materials and high variability in the density of the soil/rubble if not removed or size-reduced prior to blending. Administrative implementability may be expected due to aesthetic concerns following treatment.
	Cost	The volume of soil/rubble requiring treatment to achieve the 0.47 mg/kg PRG is estimated to be approximately 19,257 cubic yards. The estimated capital cost for this option is $9,286,000.	The volume of soil/rubble requiring treatment to achieve the 2 mg/kg PRG is estimated to be approximately 12,197 cubic yards. The estimated capital cost for this option is $5,937,000.	The volume of soil/rubble requiring treatment to achieve the 7 mg/kg PRG is estimated to be approximately 7,992 cubic yards. The estimated capital cost for this option is $3,942,000.	The volume of soil/rubble requiring treatment to achieve the 15 mg/kg PRG is estimated to be approximately 5,463 cubic yards. The estimated capital cost for this option is $2,742,000.	The volume of soil/rubble requiring treatment to achieve the 200 mg/kg PRG is estimated to be approximately 1,148 cubic yards. The estimated capital cost for this option is $696,000.	The volume of soil/rubble requiring treatment to achieve the 400 mg/kg PRG is estimated to be approximately 356 cubic yards. The estimated capital cost for this option is $320,000.

Table 4.5-3: General Response Action (GRA): Containment
Technology Class: Cover System

Process Options		Preliminary Remediation Goals (PRGs)					
		0.47 mg/kg	**2 mg/kg**	**7 mg/kg**	**19 mg/kg**	**200 mg/kg**	**400 mg/kg**
Soil Cover	Effectiveness	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by adding supplemental clean soil to provide for no less than a foot of clean, vegetated barrier soil between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by adding supplemental clean soil to provide for no less than a foot of clean, vegetated barrier soil between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by adding supplemental clean soil to provide for no less than a foot of clean, vegetated barrier soil between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by adding supplemental clean soil to provide for no less than a foot of clean, vegetated barrier soil between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by adding supplemental clean soil to provide for no less than a foot of clean, vegetated barrier soil between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE. This alternative satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by adding supplemental clean soil to provide for no less than a foot of clean, vegetated barrier soil between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE. This alternative satisfies the Remedial Action Objectives for Spill Area soils.
	Implementability	No significant technical or action-specific administrative Implementability issues are associated with this option.	No significant technical or action-specific administrative Implementability issues are associated with this option.	No significant technical or action-specific administrative Implementability issues are associated with this option.	No significant technical or action-specific administrative Implementability issues are associated with this option.	No significant technical or action-specific administrative Implementability issues are associated with this option.	No significant technical or action-specific administrative Implementability issues are associated with this option.
	Cost	The area requiring cover to achieve the 0.47 mg/kg PRG is estimated to be approximately 114,025 square feet. The estimated capital cost for this alternative is $277,221.	The area requiring cover to achieve the 2 mg/kg PRG is estimated to be approximately 75,719 square feet. The estimated capital cost for this alternative is $210,966.	The area requiring cover to achieve the 7 mg/kg PRG is estimated to be approximately 53,925 square feet. The estimated capital cost for this alternative is $173,270.	The area requiring cover to achieve the 15 mg/kg PRG is estimated to be approximately 39,538 square feet. The estimated capital cost for this alternative is $148,386.	The area requiring cover to achieve the 200 mg/kg PRG is estimated to be approximately 9,950 square feet. The estimated capital cost for this alternative is $97,210.	The area requiring cover to achieve the 400 mg/kg PRG is estimated to be approximately 4,719 square feet. The estimated capital cost for this alternative is $88,162.
Concrete/ Asphalt Cover	Effectiveness	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by placing an approximate 3-4” layer of asphalt over aggregate to provide for a hardscape barrier between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE or other constituents. This option satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by placing an approximate 3-4” layer of asphalt over aggregate to provide for a hardscape barrier between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE or other constituents. This option satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by placing an approximate 3-4” layer of asphalt over aggregate to provide for a hardscape barrier between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE or other constituents. This option satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by placing an approximate 3-4” layer of asphalt over aggregate to provide for a hardscape barrier between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE or other constituents. This option satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by placing an approximate 3-4” layer of asphalt over aggregate to provide for a hardscape barrier between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE or other constituents. This option satisfies the Remedial Action Objectives for Spill Area soils.	This option reduces the mobility of TCE-impacted soil/rubble within the Spill Area by placing an approximate 3-4” layer of asphalt over aggregate to provide for a hardscape barrier between the underlying overburden and ground surface. It does not reduce the toxicity or volume of the TCE or other constituents. This option satisfies the Remedial Action Objectives for Spill Area soils.
	Implementability	No significant technical Implementability issues are associated with this option, however periodic significant maintenance will be required to repair or replace damage from weathering and freeze-thaw cracking. In addition, storm water controls, potentially located offsite, will be needed to control a large amount of precipitation run-off. Administrative Implementability issues may be expected due to aesthetic concerns and increased potential for trespassing.	No significant technical Implementability issues are associated with this option, however periodic significant maintenance will be required to repair or replace damage from weathering and freeze-thaw cracking. In addition, storm water controls, potentially located offsite, will be needed to control a large amount of precipitation run-off. Administrative Implementability issues may be expected due to aesthetic concerns and increased potential for trespassing.	No significant technical Implementability issues are associated with this option, however periodic significant maintenance will be required to repair or replace damage from weathering and freeze-thaw cracking. In addition, storm water controls, potentially located offsite, will be needed to control a large amount of precipitation run-off. Administrative Implementability issues may be expected due to aesthetic concerns and increased potential for trespassing.	No significant technical Implementability issues are associated with this option, however periodic significant maintenance will be required to repair or replace damage from weathering and freeze-thaw cracking. Storm water controls may be employed to control precipitation run-off but based upon the area of cover (less than 1-acre) would not be mandatory. Administrative Implementability issues may be expected due to aesthetic concerns and increased potential for trespassing.	No significant technical Implementability issues are associated with this option, however periodic significant maintenance will be required to repair or replace damage from weathering and freeze-thaw cracking. Storm water controls may be employed to control precipitation run-off but based upon the area of cover (less than 1-acre) would not be mandatory. Administrative Implementability issues may be expected due to aesthetic concerns and increased potential for trespassing.	No significant technical Implementability issues are associated with this option, however periodic significant maintenance will be required to repair or replace damage from weathering and freeze-thaw cracking. Storm water controls may be employed to control precipitation run-off but based upon the area of cover (less than 1-acre) would not be mandatory. Administrative Implementability issues may be expected due to aesthetic concerns and increased potential for trespassing.
	Cost	The area requiring cover to achieve the 0.47 mg/kg PRG is estimated to be approximately 114,025 square feet. The estimated capital cost for this alternative is $918,175.	The area requiring cover to achieve the 2 mg/kg PRG is estimated to be approximately 75,719 square feet. The estimated capital cost for this alternative is $650,033.	The area requiring cover to achieve the 7 mg/kg PRG is estimated to be approximately 53,925 square feet. The estimated capital cost for this alternative is $497,475.	The area requiring cover to achieve the 15 mg/kg PRG is estimated to be approximately 39,538 square feet. The estimated capital cost for this alternative is $396,766.	The area requiring cover to achieve the 200 mg/kg PRG is estimated to be approximately 9,950 square feet. The estimated capital cost for this alternative is $189,650.	The area requiring cover to achieve the 400 mg/kg PRG is estimated to be approximately 4,719 square feet. The estimated capital cost for this alternative is $153,033.

Table 4.5-4: General Response Action (GRA): Physical Removal
Technology Class: Excavation

Process Options			Preliminary Remediation Goals (PRGs)				
		0.47 mg/kg	2 mg/kg	7 mg/kg	19 mg/kg	200 mg/kg	400 mg/kg
Off-Site Disposal	Effectiveness	Once the soil/rubble is placed in an off-site disposal facility, the mobility of the TCE would be reduced, however the overall volume and toxicity of the materials would remain unchanged unless treatment was required by the TSDF. This option would meet the Remedial Action Objectives for the Spill Area soils.	Once the soil/rubble is placed in an off-site disposal facility, the mobility of the TCE would be reduced, however the overall volume and toxicity of the materials would remain unchanged unless treatment was required by the TSDF. This option would meet the Remedial Action Objectives for the Spill Area soils.	Once the soil/rubble is placed in an off-site disposal facility, the mobility of the TCE would be reduced, however the overall volume and toxicity of the materials would remain unchanged unless treatment was required by the TSDF. This option would meet the Remedial Action Objectives for the Spill Area soils.	Once the soil/rubble is placed in an off-site disposal facility, the mobility of the TCE would be reduced, however the overall volume and toxicity of the materials would remain unchanged unless treatment was required by the TSDF. This option would meet the Remedial Action Objectives for the Spill Area soils.	Once the soil/rubble is placed in an off-site disposal facility, the mobility of the TCE would be reduced, however the overall volume and toxicity of the materials would remain unchanged unless treatment was required by the TSDF. This option would meet the Remedial Action Objectives for the Spill Area soils.	Once the soil/rubble is placed in an off-site disposal facility, the mobility of the TCE would be reduced, however the overall volume and toxicity of the materials would remain unchanged unless treatment was required by the TSDF. This option would meet the Remedial Action Objectives for the Spill Area soils.
	Implementability	Technical Implementability issues would include coordination of large amounts of truck traffic resulting from this approach. Based on the conservative estimate of 19,257 cubic yards of TCE-impacted overburden, approximately 1,481 truckloads of material would need to leave the Site, with an equal number of truckloads of clean backfill brought in. This work would likely necessitate a 2-3 month construction period. Locating disposal locations for hazardous and non-hazardous material may be problematic based upon the large volume of material slated for disposal under this option. Local traffic control and identification of import sources for clean soil/stone meeting applicable import standards would also be required.	Technical Implementability issues would include coordination of large amounts of truck traffic resulting from this approach. Based on the conservative estimate of 12,197 cubic yards of TCE-impacted overburden, approximately 938 truckloads of material would need to leave the Site, with an equal number of truckloads of clean backfill brought in. This work would likely necessitate a 2-month construction period. Locating disposal locations for hazardous and non-hazardous material may be challenging based upon the large volume of material slated for disposal under this option. Local traffic control and identification of import sources for clean soil/stone meeting applicable import standards would also be required.	Technical Implementability issues would include coordination of large amounts of truck traffic resulting from this approach. Based on the conservative estimate of 7,992 cubic yards of TCE-impacted overburden, approximately 615 truckloads of material would need to leave the Site, with an equal number of truckloads of clean backfill brought in. This work would likely necessitate a 1-2-month construction period. Locating disposal locations for hazardous and non-hazardous material may be challenging based upon the large volume of material slated for disposal under this option. Local traffic control and identification of import sources for clean soil/stone meeting applicable import standards would also be required.	Technical Implementability issues would include coordination of large amounts of truck traffic resulting from this approach. Based on the conservative estimate of 5,463 cubic yards of TCE-impacted overburden, approximately 420 truckloads of material would need to leave the Site, with an equal number of truckloads of clean backfill brought in. This work would likely necessitate a 1-month construction period. Locating disposal locations for hazardous and non-hazardous material may be challenging based upon the large volume of material slated for disposal under this option. Local traffic control and identification of import sources for clean soil/stone meeting applicable import standards would also be required.	Technical Implementability issues may include coordination of truck traffic resulting from this approach. Based on the conservative estimate of 1,148 cubic yards of TCE-impacted overburden, approximately 88 truckloads of material would need to leave the Site, with an equal number of truckloads of clean backfill brought in. This work would likely be completed in a month or less. Locating disposal locations for hazardous material should be manageable based upon the volume of material slated for disposal under this option. Local traffic control and identification of import sources for clean soil/stone meeting applicable import standards would also be required.	Technical Implementability issues may include coordination of truck traffic resulting from this approach. Based on the conservative estimate of 356 cubic yards of TCE-impacted overburden, approximately 28 truckloads of material would need to leave the Site, with an equal number of truckloads of clean backfill brought in. This work would likely be completed in less than one month. Locating disposal locations for hazardous material should be very manageable based upon the volume of material slated for disposal under this option. Local traffic control and identification of import sources for clean soil/stone meeting applicable import standards would also be required.
	Cost	The capital costs associated with this alternative are estimated at $6,961,000, assuming off-site treatment would not be required prior to disposal.	The capital costs associated with this alternative are estimated at $5,971,000, assuming off-site treatment would not be required prior to disposal.	The capital costs associated with this alternative are estimated at $5,381,000, assuming off-site treatment would not be required prior to disposal.	The capital costs associated with this alternative are estimated at $5,027,000, assuming off-site treatment would not be required prior to disposal.	The capital costs associated with this alternative are estimated at $2,041,000, assuming off-site treatment would not be required prior to disposal.	The capital costs associated with this alternative are estimated at $688,000, assuming off-site treatment would not be required prior to disposal.
Low-Temperature Thermal Desorption	Effectiveness	May be effective in reducing TCE to below PRG, however pilot testing would be necessary to confirm the ability of this option to remove VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be effective in reducing TCE to below PRG, however pilot testing would be necessary to confirm the ability of this option to remove VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be effective in reducing TCE to below PRG, however pilot testing would be necessary to confirm the ability of this option to remove VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be effective in reducing TCE to below PRG, however pilot testing would be necessary to confirm the ability of this option to remove VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be effective in reducing TCE to below PRG, however pilot testing would be necessary to confirm the ability of this option to remove VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be effective in reducing TCE to below PRG, however pilot testing would be necessary to confirm the ability of this option to remove VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.

Table 4.5-4: General Response Action (GRA): Physical Removal
Technology Class: Excavation

Process Options			Preliminary Remediation Goals (PRGs)				
		0.47 mg/kg	2 mg/kg	7 mg/kg	19 mg/kg	200 mg/kg	400 mg/kg
Low-Temperature Thermal Desorption	Implementability	Technical Implementability issues would include potential challenges in removing VOCs from larger particles, limited availability of LTTD equipment, and lack of a readily available natural gas source or sufficient electrical power supply, necessitating use of a unit capable of running on propane fuel oil.	Technical Implementability issues would include potential challenges in removing VOCs from larger particles, limited availability of LTTD equipment, and lack of a readily available natural gas source or sufficient electrical power supply, necessitating use of a unit capable of running on propane fuel oil.	Technical Implementability issues would include potential challenges in removing VOCs from larger particles, limited availability of LTTD equipment, and lack of a readily available natural gas source or sufficient electrical power supply, necessitating use of a unit capable of running on propane fuel oil.	Technical Implementability issues would include potential challenges in removing VOCs from larger particles, limited availability of LTTD equipment, and lack of a readily available natural gas source or sufficient electrical power supply, necessitating use of a unit capable of running on propane fuel oil.	Technical Implementability issues would include potential challenges in removing VOCs from larger particles, limited availability of LTTD equipment, and lack of a readily available natural gas source or sufficient electrical power supply, necessitating use of a unit capable of running on propane fuel oil.	Technical Implementability issues would include potential challenges in removing VOCs from larger particles, limited availability of LTTD equipment, and lack of a readily available natural gas source or sufficient electrical power supply, necessitating use of a unit capable of running on propane fuel oil.
	Cost	The capital costs associated with this alternative are estimated at $16,554,766.	The capital costs associated with this alternative are estimated at $10,613,776.	The capital costs associated with this alternative are estimated at $7,025,268.	The capital costs associated with this alternative are estimated at $4,866,630.	The capital costs associated with this alternative are estimated at $1,191,042.	The capital costs associated with this alternative are estimated at $509,574.
Ex-Situ Soil Vapor Extraction	Effectiveness	May be minimally effective in reducing TCE to below the PRG, as prior ex-situ pilot testing and full-scale in-situ SVE were not successful. An additional pilot testing program would be necessary to confirm the ability of this option to removed VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be minimally effective in reducing TCE to below the PRG, as prior ex-situ pilot testing and full-scale in-situ SVE were not successful. An additional pilot testing program would be necessary to confirm the ability of this option to removed VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be minimally effective in reducing TCE to below the PRG, as prior ex-situ pilot testing and full-scale in-situ SVE were not successful. An additional pilot testing program would be necessary to confirm the ability of this option to removed VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be minimally effective in reducing TCE to below the PRG, as prior ex-situ pilot testing and full-scale in-situ SVE were not successful. An additional pilot testing program would be necessary to confirm the ability of this option to removed VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be minimally effective in reducing TCE to below the PRG, as prior ex-situ pilot testing and full-scale in-situ SVE were not successful. An additional pilot testing program would be necessary to confirm the ability of this option to removed VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.	May be minimally effective in reducing TCE to below the PRG, as prior ex-situ pilot testing and full-scale in-situ SVE were not successful. An additional pilot testing program would be necessary to confirm the ability of this option to removed VOCs from the rubble matrix. Volume of TCE in the overburden would be reduced but transferred to the emission control media. If successful, this option would satisfy the RAOs for Spill Area soils.
	Implementability	Technical Implementability issues would include potential challenges in removing VOCs diffused into the overburden rock materials and potential for short circuiting within the heterogeneous rubble matrix.	Technical Implementability issues would include potential challenges in removing VOCs diffused into the overburden rock materials and potential for short circuiting within the heterogeneous rubble matrix.	Technical Implementability issues would include potential challenges in removing VOCs diffused into the overburden rock materials and potential for short circuiting within the heterogeneous rubble matrix.	Technical Implementability issues would include potential challenges in removing VOCs diffused into the overburden rock materials and potential for short circuiting within the heterogeneous rubble matrix.	Technical Implementability issues would include potential challenges in removing VOCs diffused into the overburden rock materials and potential for short circuiting within the heterogeneous rubble matrix.	Technical Implementability issues would include potential challenges in removing VOCs diffused into the overburden rock materials and potential for short circuiting within the heterogeneous rubble matrix.
	Cost	The capital costs associated with this alternative are estimated at $1,224,879.	The capital costs associated with this alternative are estimated at $1,061,778.	The capital costs associated with this alternative are estimated at $964,633.	The capital costs associated with this alternative are estimated at $748,146.	The capital costs associated with this alternative are estimated at $324,954.	The capital costs associated with this alternative are estimated at $303,994.

BENCHMARK

TABLE 4.5-5
SUMMARY OF PROCESS OPTIONS AND COSTS FOR POTENTIALLY APPLICABLE PRGs

Lehigh Valley Railroad Derailment Superfund Site
LeRoy, NY

Preliminary Remediation Goal (PRG)	0.47 MG/KG	2 MG/KG	7 MG/KG	19 MG/KG	200 MG/KG	400 MG/KG
Weight of TCE-Impacted Soil ≥ PRG (Tons)[1]	31,774	20,125	13,187	9,013	1,894	587
Area of Impact ≥ PRG (SF)[1]	114,025	75,719	53,925	39,538	9,950	4,719

Process Option	Quantity	Unit	Unit Price	Estimated Capital Cost					
				0.47 MG/KG	2 MG/KG	7 MG/KG	19 MG/KG	200 MG/KG	400 MG/KG
SOLIDIFICATION/STABILIZATION									
Pre-remedial Costs (RA Work Plan, Mobilization/Demobilization, Clearing, Pilot Test Erosion Control, Survey, etc.)	1	EST	$150,000	$150,000					
Excavation and Screening of TCE-Impacted Soils/Admix Amendment/Backfill	Per Above	Ton	$175	$5,561,000	$3,522,000	$2,308,000	$1,578,000	$332,000	$103,000
Purchase Amendment (Assume Cement @25%)	Per Above	Ton	$450	$3,575,000	$2,265,000	$1,484,000	$1,014,000	$214,000	$67,000
Screening Level Cost Estimate				**$9,286,000**	**$5,937,000**	**$3,942,000**	**$2,742,000**	**$696,000**	**$320,000**
SOIL COVER									
Pre-remedial Costs (RA Work Plan, Mobilization/Demobilization, Clearing, Erosion Control, Survey, etc.)	1	EST	$80,000	$80,000					
Soil Cover (Test, Import, Place, Seed)	Per Above	CY	$40	$185,819	$123,394	$87,878	$64,432	$16,215	$7,690
Demarcation Layer	Per Above	SF	$0.10	$11,403	$7,572	$5,393	$3,954	$995	$472
Screening Level Cost Estimate				**$277,221**	**$210,966**	**$173,270**	**$148,386**	**$97,210**	**$88,162**
ASPHALT/CONCRETE COVER									
Pre-remedial Costs (RA Work Plan, Mobilization/Demobilization, Clearing, Erosion Control, Survey, etc.)	1	EST	$80,000	$80,000					
Asphalt Cover (Sub-base 8" and 4" asphalt)	Per Above	SF	$7	$798,175	$530,033	$377,475	$276,766	$69,650	$33,033
Permanent Storm Water Controls for >1 Acre	1	EST	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
Screening Level Cost Estimate				**$918,175**	**$650,033**	**$497,475**	**$396,766**	**$189,650**	**$153,033**
OFFSITE DISPOSAL OF EXCAVATED SOIL									
Pre-remedial Costs (Mobilization/Demobilization, Clearing, Erosion Control, Survey, etc.)	1	EST	$80,000	$80,000					
Excavation of TCE-Impacted Soils	Per Above	Ton	$10	$317,741	$201,251	$131,868	$90,130	$18,942	$5,874
Offsite Disposal (Assume all overburden > 60 mg/kg goes as hazadous waste, 4,400 tons)	Per Above	Ton	$1,000	$4,400,000	$4,400,000	$4,400,000	$4,400,000	$1,894,200	$587,400
Non-Hazardous Waste	Per Above	Ton	$50	$1,368,703	$786,253	$439,340	$230,650		
Backfill	Per Above	Ton	$25	$794,351	$503,126	$329,670	$225,325	$47,355	$14,685
Screening Level Cost Estimate				**$6,961,000**	**$5,971,000**	**$5,381,000**	**$5,027,000**	**$2,041,000**	**$688,000**

TABLE 4.5-5
SUMMARY OF PROCESS OPTIONS AND COSTS FOR POTENTIALLY APPLICABLE PRGs

Lehigh Valley Railroad Derailment Superfund Site
LeRoy, NY

Preliminary Remediation Goal (PRG)				0.47 MG/KG	2 MG/KG	7 MG/KG	19 MG/KG	200 MG/KG	400 MG/KG
Weight of TCE-Impacted Soil ≥ PRG (Tons)[1]				**31,774**	**20,125**	**13,187**	**9,013**	**1,894**	**587**
Area of Impact ≥ PRG (SF)[1]				**114,025**	**75,719**	**53,925**	**39,538**	**9,950**	**4,719**
LOW-TEMP THERMAL DESORPTION OF EXCAVATED SOIL									
Pre-remedial Costs (Mobilization/Demobilization, Clearing, Erosion Control, Pilot Test, Survey, etc.) [3,4]	1	EST	$150,000	$150,000					
Excavation of TCE-Impacted Soils	Per Above	Ton	$10	$317,741	$201,251	$131,868	$90,130	$18,942	$5,874
Onsite Treatment	Per Above	Tons	$500	$15,887,025	$10,062,525	$6,593,400	$4,506,500	$947,100	$293,700
Vapor Phase Carbon Furnish, Regenerate	Per Above	lb	$4	$200,000	$200,000	$150,000	$120,000	$75,000	$60,000
Screening Level Cost Estimate				**$16,554,766**	**$10,613,776**	**$7,025,268**	**$4,866,630**	**$1,191,042**	**$509,574**
EX-SITU SOIL VAPOR EXTRACTION OF EXCAVATED SOIL									
Pre-remedial Costs (Mobilization/Demobilization, Clearing, Erosion Control, Survey, etc.)	1	EST	$100,000	$100,000					
Excavation of TCE-Impacted Soils	Per Above	Ton	$10	$317,741	$201,251	$131,868	$90,130	$18,942	$5,874
Construct Treatment Pad (Perimeter Bermed Soils, Synthetic Liner, Perforated Pipe, Leachate Collection, Wood Chips) Assume each pad can hold 1,500 tons of TCE-impacted soil 3' thick, 3-4 pads for larger soil weights, 1 pad for the others	10,000	SF	$10	$400,000	$400,000	$400,000	$300,000	$100,000	$100,000
Blower for Ex-situ Extraction (assume stack for discharge of vapors. If required, vapor phase carbon would be used to treat the blower exhaust. Assume one blower per pad.) [4]	1	EST	$70,000	$280,000	$280,000	$280,000	$210,000	$70,000	$70,000
Treatment Time weeks				42	27	18	16	12	8
OMM including mixing of the soils on the pad (Assume 8 weeks to treat 1,500 tons per pad)	Per Above	Week	$3,000	$127,096	$80,500	$52,747	$48,000	$36,000	$24,000
Relocate Treated Soils to Excavation	Per Above	Ton	$7	$222,418	$140,875	$92,308	$63,091	$13,259	$4,112
Screening Level Cost Estimate				**$1,224,879**	**$1,061,778**	**$964,633**	**$748,146**	**$324,954**	**$303,994**

Notes:
1. Area and volume of impact at various PRGs determined through 3D Modelling of availabe soil data by Rockware, Inc. and assumed soil/rubble density of 1.65 Tons/CubicYard
2. Pricing information from Zoladz Construction personal communique 8/19/22.
3. Added $100,000 to Pre-Remedial Line Item for mobilization of LTTD equipment
4. Estimate does not include energy/fule costs to operate the equipment

Declarations/Limitations

Benchmark's opinion of cost is made on the basis of the available data and Benchmark's experience with similar projects. Benchmark has no control over the cost of labor, materials, equipment or services furnished by others, or over contractor methods of determining prices, or over competitive bidding or market conditions. Benchmark does not guarantee that proposals, bids or actual Project cost will not vary from Benchmark's opinions of probable cost.

BENCHMARK

TABLE 4.5-6

SOIL ALTERNATIVE #2: SOLIDIFICATION/STABILIZATION USING COMMERCIAL LAND-USE BASED PRG
CLEANUP LEVEL 200 MG/KG
FEASIBILITY STUDY REPORT
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
INDEX NUMBER CERCLA-02-2006-2006
LEROY, NEW YORK

Item	Quantity	Units	Unit [1] Cost	Total Cost
Pre-Remediation Work				
Treatability Study	1	EST	$ 25,000	$ 25,000
Survey Limits of Excavation	1	EST	$ 10,000	$ 10,000
Erosion Control	1	EST	$ 10,000	$ 10,000
Temporary Construction Fencing	800	LF	$ 10.00	$ 8,000
Remedial Action Work Plan	1	EST	$ 40,000	$ 40,000
Subtotal:				**$ 93,000**
Impacted Soil Removal and Treatment				
Excavate Soils for Admixing	1900	Ton	$ 10	$ 19,000
Screening and Crushing Equip Rental [2]	1.0	Month	$ 40,000	$ 40,000
Screening and Crushing Labor and Anciliary Equip	1.0	Month	$ 40,000	$ 40,000
Admix Amendment	1900	Ton	$ 20	$ 38,000
Amendment (Assume Cement) [3]	475	Ton	$ 450	$ 213,750
Corrective Action Management Unit				
Geocomposite Liner (60-mil geomembrane, geocushion net	12500	SF	$ 5	$ 62,500
Leachate Collection System	12500	SF	$ 4	$ 50,000
Leachate Treatment System (building, carbon treatment, filters, etc)	1	EST	$ 200,000	$ 200,000
Fill CAMU w S/S Treated Soil	2375	Ton	$ 5	$ 11,875
Cap Installation	12500	SF	$ 10	$ 125,000
Drainage Swales	450	LF	$ 25	$ 11,250
Detention Pond	1	LS	$ 15,000	$ 15,000
Post-Excavation Confirmatory Sampling				
Bottom Samples (1/900 sf)	11	EA	$ 100.00	$ 1,106
Sidewall (1/30LF)	35	EA	$ 100.00	$ 3,533
Subtotal:				**$ 831,014**
Site Restoration				
Removal of stone ballast and vapor barrier liner; placement of additional 6-inches of clean, imported topsoil	1	LS	$ 40,000.00	**$ 40,000**
Subtotal:				**$ 40,000**
Subtotal Capital Cost				**$ 964,014**
Contractor Mobilization/Demobilization (5%)				$ 48,201
Health and Safety (2%)				$ 19,280
Engineering/Contingency (35%)				$ 337,405
Total Capital Cost				**$ 1,368,900**
Institutional Controls				
Environmental Easements [4]	1	LS	$ 106,750.00	$ 106,750
O&M Plan	1	LS	$ 15,000.00	$ 15,000
Total Institutional Controls				**$ 121,750**
Leachate Treatment (OMM, Carbon Changeout)	1	LS	$ 50,000.00	$ 50,000
CAMU Cap Repairs	1	LS	$ 2,000.00	$ 2,000
			Sub-total	$ 52,000
Engineering Controls (Cap Repairs/Leachate Treatment) OM&M Present Worth (PW):				
Number of Years (n):				30
Interest Rate (I):				7%
p/A value:				12.40
EC OM&M Present Worth (PW):				**$ 644,800**
Annual Performance Report	1	LS	$ 5,000.00	$ 5,000
Annual Certification OM&M Present Worth (PW):				
Number of Years (n):				30
Interest Rate (I):				7%
p/A value:				12.40
Annual Certification OM&M Present Worth (PW):				**$ 62,000**
Total Institutional Controls and OM&M Present Worth (PW):				**$ 828,550**
Total Cost				**$ 2,198,000**

Notes

1) Unit costs developed based on Benchmark's experience with remedial projects except where noted.

2) Monthly rental costs based on personal communication with Zoladz Consruction

3) Quote from Mitkem Resources July 2022

4) Estimated cost for environmental easements on 7 parcels within Spill Zone having exceedances above Residential use. In addition, deed notices will be required to prevent groundwater use, these costs are included in Table 4.1-1 "Groundwater Cost Table".

BENCHMARK

TABLE 4.5-7

SOIL ALTERNATIVE #3: EXCAVATION/DISPOSAL USING COMMERCIAL LAND-USE BASED PRG
CLEANUP LEVEL 200 MG/KG
FEASIBILITY STUDY REPORT
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
INDEX NUMBER CERCLA-02-2006-2006
LEROY, NEW YORK

Item	Quantity	Units	Unit [1] Cost	Total Cost
Pre-Remediation Work				
Screening Pilot Study	1	EST	$ 50,000	$ 50,000
Survey Limits of Excavation and Soil Cover System	1	EST	$ 10,000	$ 10,000
Erosion Control	1	EST	$ 10,000	$ 10,000
Temporary Construction Fencing	800	LF	$ 10	$ 8,000
Remedial Action Work Plan	1	EST	$ 40,000	$ 40,000
Subtotal:				**$ 118,000**
Impacted Soil Removal and Treatment				
Excavate Soils for Screening	1900	Ton	$ 7	$ 13,300
Load/Haul/Dispose as Hazardous Waste [2]	1900	Ton	$ 1,000	$ 1,900,000
Backfill and Compaction (Imported Soil) Replace all Less tops	1777	Ton	$ 25	$ 44,432
Topsoil 4" on top of excavation	123	Ton	$ 40	$ 4,909
Post-Excavation Confirmatory Sampling				
Bottom Samples (1/900 sf)	11	EA	$ 100	$ 1,106
Sidewall (1/30LF)	35	EA	$ 100	$ 3,533
Subtotal:				**$ 1,967,280**
Site Restoration				
Removal of stone ballast and vapor barrier liner; placement of additional 6-inches of clean, imported topsoil	1	LS	$ 40,000.00	**$ 40,000**
Subtotal:				**$ 40,000**
Subtotal Capital Cost				**$ 2,125,280**
Contractor Mobilization/Demobilization (5%)				$ 106,264
Health and Safety (2%)				$ 42,506
Engineering/Contingency (35%)				$ 743,848
Total Capital Cost				**$ 3,017,897**
Institutional Controls				
Environmental Easements [3]	1	LS	$ 106,750.00	$ 106,750
O&M Plan	1	LS	$ 15,000.00	$ 15,000
Subtotal:				**$ 121,750**
Total Institutional Controls				**$ 121,750**
Annual Performance Report	1	LS	$ 5,000.00	$ 5,000
Annual Certification OM&M Present Worth (PW):				
Number of Years (n):				30
Interest Rate (I):				7%
p/A value:				12.40
Annual Certification OM&M Present Worth (PW):				**$ 62,000**
Total Institutional Controls and OM&M Present Worth (PW):				**$ 183,750**
Total Cost				**$ 3,202,000**

Notes

1) Unit costs developed based on Benchmark's experience with remedial projects except where noted.

2) Verbal Quote from Waste Management (PQ Canada).Quote from Mitkem Resources July 2022

3) Estimated cost for environmental easements on 7 parcels within Spill Zone having exceedances above Residential use. In addition, deed notices will be required to prevent groundwater use, these costs are included in Table 4.1-1 "Groundwater Cost Table".

BENCHMARK

TABLE 4.5-8

SOIL ALTERNATIVE #4: LOW-TEMPERATURE THERMAL DESORPTION USING COMMERCIAL LAND-USE BASED PRG CLEANUP LEVEL 200 MG/KG
FEASIBILITY STUDY REPORT
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
INDEX NUMBER CERCLA-02-2006-2006
LEROY, NEW YORK

Item	Quantity	Units	Unit [1] Cost	Total Cost
Pre-Remediation Work				
LTTD and Screening Pilot Study	1	EST	$ 100,000	$ 100,000
Survey Limits of Excavation and Soil Cover System	1	EST	$ 10,000	$ 10,000
Erosion Control	1	EST	$ 10,000	$ 10,000
Temporary Construction Fencing	800	LF	$ 10.00	$ 8,000
Remedial Action Work Plan	1	EST	$ 40,000	$ 40,000
Subtotal:				**$ 168,000**
Impacted Soil Removal and Treatment				
Excavate Soils for Screening	1900	Ton	$ 10	$ 19,000
LTTD Onsite [2]	1900	Ton	$ 500	$ 950,000
1000 lb Carbon Units (Initial spot and GAC charge)	2	Ea	$ 5,000	$ 10,000
GAC Vessel Rental	10	Months	$ 850	$ 8,500
GAC Lead Vessel Changeouts (1000 lb)	12	Ea	$ 4,500	$ 54,000
Backfill and Compaction of Treated Soils	1777	Ton	$ 10	$ 17,772
Topsoil 4" on top of excavation	123	Ton	$ 40	$ 4,914
Post-Excavation Confirmatory Sampling				
Bottom Samples (1/900 sf)	11	EA	$ 100	$ 1,106
Sidewall (1/30LF)	35	EA	$ 100	$ 3,533
Subtotal:				**$ 1,068,824**
Site Restoration				
Removal of stone ballast and vapor barrier liner; placement of additional 6-inches of clean, imported topsoil	1	LS	$ 40,000.00	**$ 40,000**
Subtotal:				**$ 40,000**
Subtotal Capital Cost				**$ 1,276,824**
Contractor Mobilization/Demobilization (5%)				$ 63,841
Health and Safety (2%)				$ 25,536
Engineering/Contingency (35%)				$ 446,888
Total Capital Cost				**$ 1,813,090**
Institutional Controls				
Environmental Easements [3]	1	LS	$ 106,750.00	$ 106,750
O&M Plan	1	LS	$ 15,000.00	$ 15,000
Subtotal:				**$ 121,750**
Total Institutional Controls				**$ 121,750**
Annual Performance Report	1	LS	$ 5,000.00	$ 5,000
Annual Certification OM&M Present Worth (PW):				
Number of Years (n):				30
Interest Rate (I):				7%
p/A value:				12.40
Annual Certification OM&M Present Worth (PW):				**$ 62,000**
Total Institutional Controls and OM&M Present Worth (PW):				**$ 183,750**
Total Cost				**$ 1,997,000**

Notes

1) Unit costs developed based on Benchmark's experience with remedial projects except where noted.

2) Quote from TDX Associates LP. Comparable to EPA Federal Remediation Technologies Roundtable cost of $232/CY = 390/Ton. $500/Ton reflects current fuel prices.

3) Estimated cost for environmental easements on 7 parcels within Spill Zone having exceedances above Residential use. In addition, deed notices will be required to prevent groundwater use, these costs are included in Table 4.1-1 "Groundwater Cost Table".

BENCHMARK

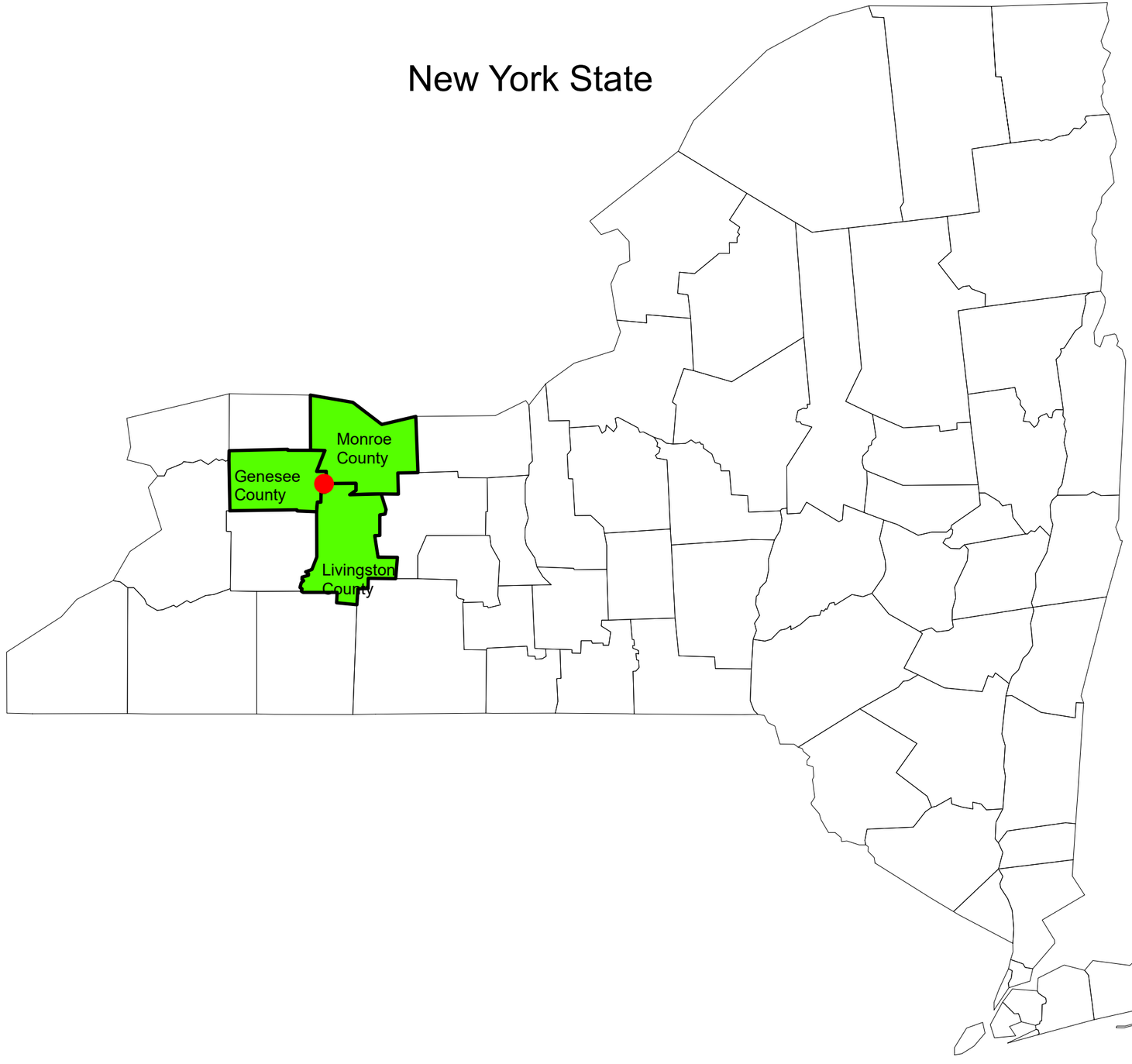
TABLE 5.3-1
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SOIL MEDIA
FEASIBLITY STUDY
LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
LEROY, NEW YORK

Alternative #	General Response Actions	Technology Class	Description	Preliminary Remediation Goal	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobiity, and Volume	Short-Term Effectiveness	Implementability	Cost (30-Yr Present Worth)	State and Community Acceptance
Soil Alternative #1	No Action	None	No further action to address the concentrations of TCE identified in the overburden materials	N/A	Not protective	Does not comply	No long-term protection	No further reduction	No additional risks	No implementability issues	$0	To be assessed following regulatory agency and public review. These criteria will be addressed in the ROD and responsiveness summary.
Soil Alternative #2	Containment	Immobilization	Ex-situ solidification/stabilization	>CSCO for TCE	Mitigates wind/surface water erosion, incidental ingestion/inhalation through solidification and placement in a lined/capped CAMU.	Post-excavation samples would verify conformance	Prevents direct contact with residual impacts.	Reduces mobility not toxicity or volume	Noise, dust, vapors impacts considered minimal and controllable. Excavation open for significant time during CAMU construction.	Selecting type and amount of binding agent. Securing appropriate equipment and approval of CAMU design. Stabilized area would expand to manage grade changes.Estimated 12 months to design and construct the CAMU plus 7-8 months to implement.	$2,198,000	
Soil Alternative #3	Physical Removal	Excavation	Off-site disposal of excavated soil	>CSCO for TCE	Reduces TCE concentrations on-site	Post-excavation samples would verify conformance	Reduces TCE concentrations on-site and prevents direct contact with residual impacts.	Reduces toxicity, mobility, and volume on-site. Off-site reduction of toxicity and/or volume depends on form of treatment/disposal at TSDF.	Noise, dust, vapors impacts considered minimal and controllable. Time excavation left open will be minimized.	Pre-design testing to determine if larger rubble requires disposal. Traffic coorination required. Need to secure disposal contract with out-of-state TSDF and located borrow source for backfill. Estimated 5-6 months to implement.	$3,202,000	
Soil Alternative #4	Physical Removal	Excavation	LTTD of excavated soil	>CSCO for TCE	Reduces TCE concentrations on-site	Post-excavation samples would verify conformance	If proven effective by pilot testing, will reduces TCE concentrations on-site and prevents direct contact with residual impacts.	Reduces volume of TCE in overburden. Overall reduction in volume/toxicity form of emissions control.	Noise, dust, vapors impacts considered minimal and controllable. Time excavation left open will be minimized. Substantial fuel usage for LTTD reactor; propane or heating oil needed as NG not available.	Pre-design testing to determine if larger rubble requires treatment. Pilot testing required. Need to secure appropriate screening, excavation, and LTTD equipment (reactor and emissions control). Estimated 14-16 months to implement.	$1,997,000	

Definitions:

ARARs = Applicable or relevant and appropriate requirements
LTTD = Low temperature thermal desorption
CSCO = Commercial SCO (200 mg/kg)
SCO = Soil Cleanup Objective, per 6 NYCRR Part 375
ROD = Record of Decision
TSDF = Treatment, storage, and disposal facility.
mg/kg = millgrams per kilograms
N/A = Not Applicable

FIGURES



0 25 50 100 150 200 Miles

Index Map

M/N

Unicorn Management Consultants, LLC

52 Federal Road
Suite 2C
Danbury, CT
06810

(203) 205 9000

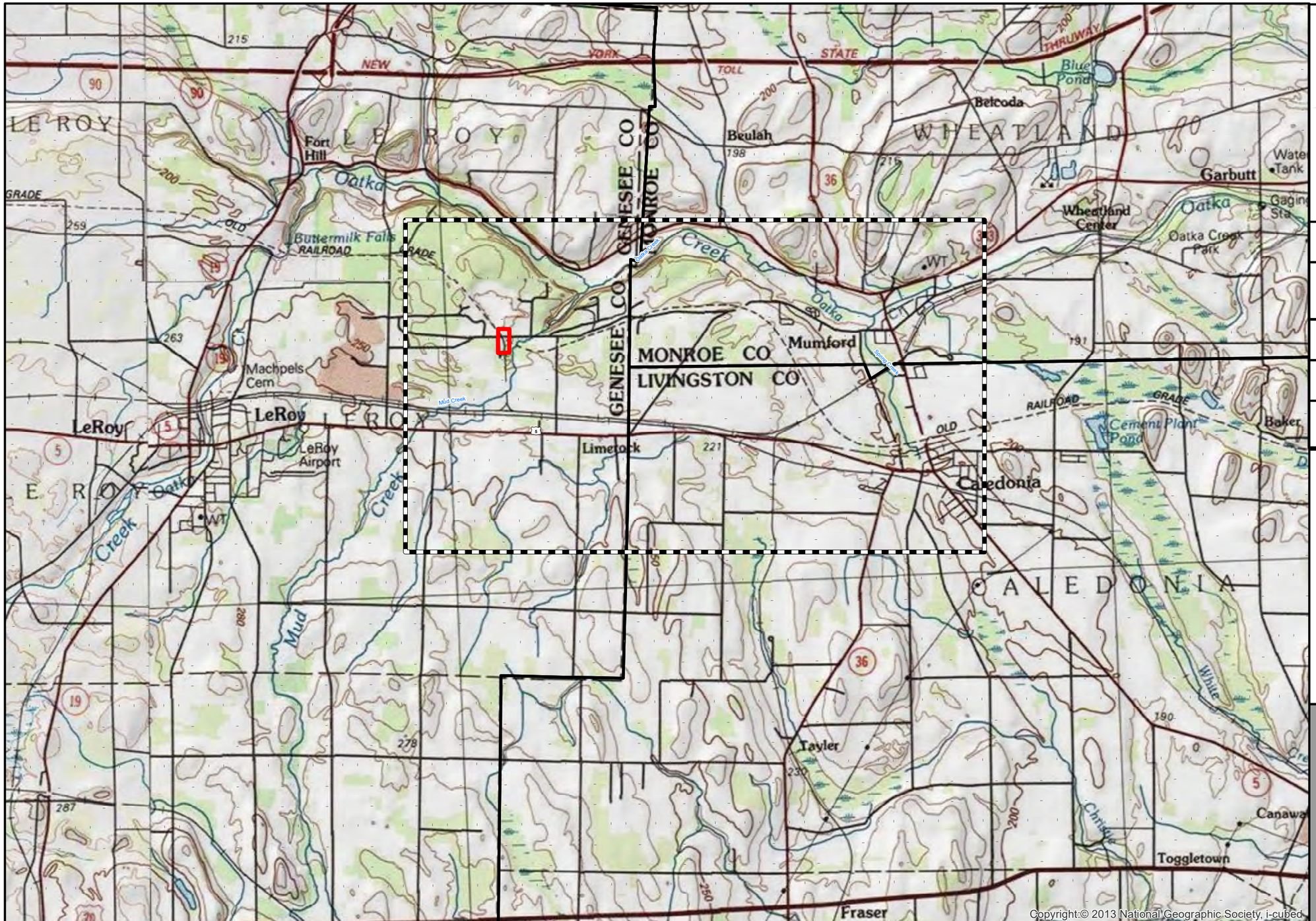
Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1-1
Feasibility Study Report

Author: RTM	**Checked By:** NRH/ZDD
Project #: 2032	**Created:** 10/27/09 **Revised:** 8/11/20
Scale: 1 in:250,000 ft	**File:** Fig1-1_Index

Legend

- Approximate Study Area



Unicorn Management Consultants, LLC

52 Federal Road
Suite 2C
Danbury, CT
06810

(203) 205-9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1-2
Feasibility Study Report

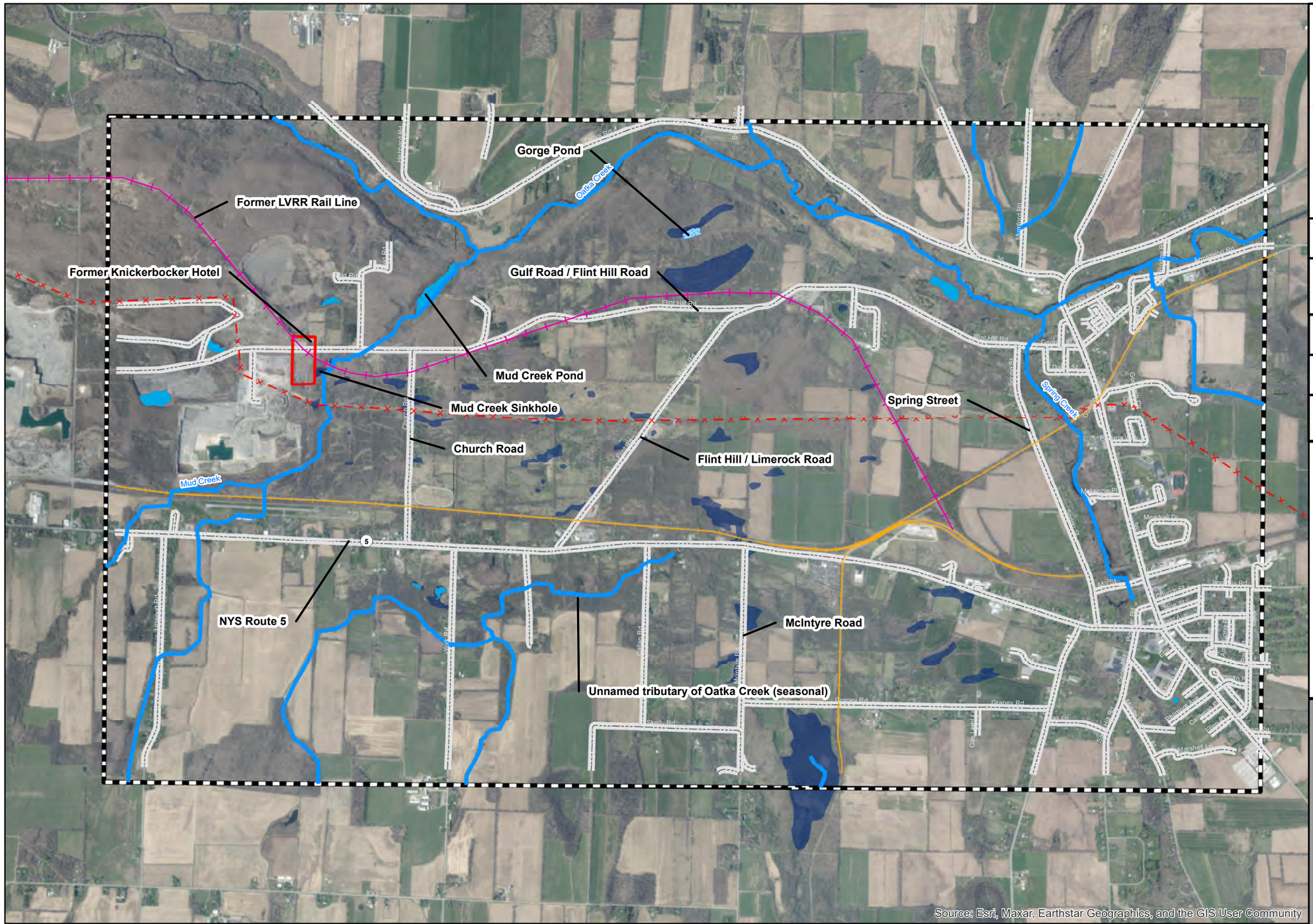
Author: RTM	**Checked By:**
Project #: 2032	**Created:** 10/27/09
	Revised: 8/11/20
Scale: 1 in:5,000 ft	**File:** Fig1-2_Regional

New York State

●= Approximate Study Area

Legend

- Approximate Spill Zone
- Approximate Study Area
- County Boundary



0 2,500 5,000 10,000 15,000 Feet

Study Area Map

M/N

Unicorn Management Consultants, LLC

52 Federal Road
Suite 2C
Danbury, CT
06810

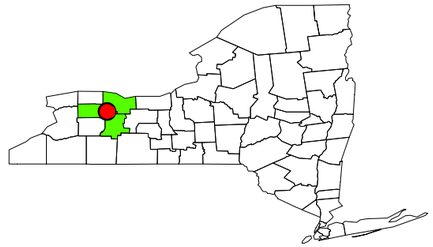
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.3-1

Author: NRH	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 12/16/22
Scale: 1 in:3,426 ft	**File:** Fig1-3-1_StudyArea

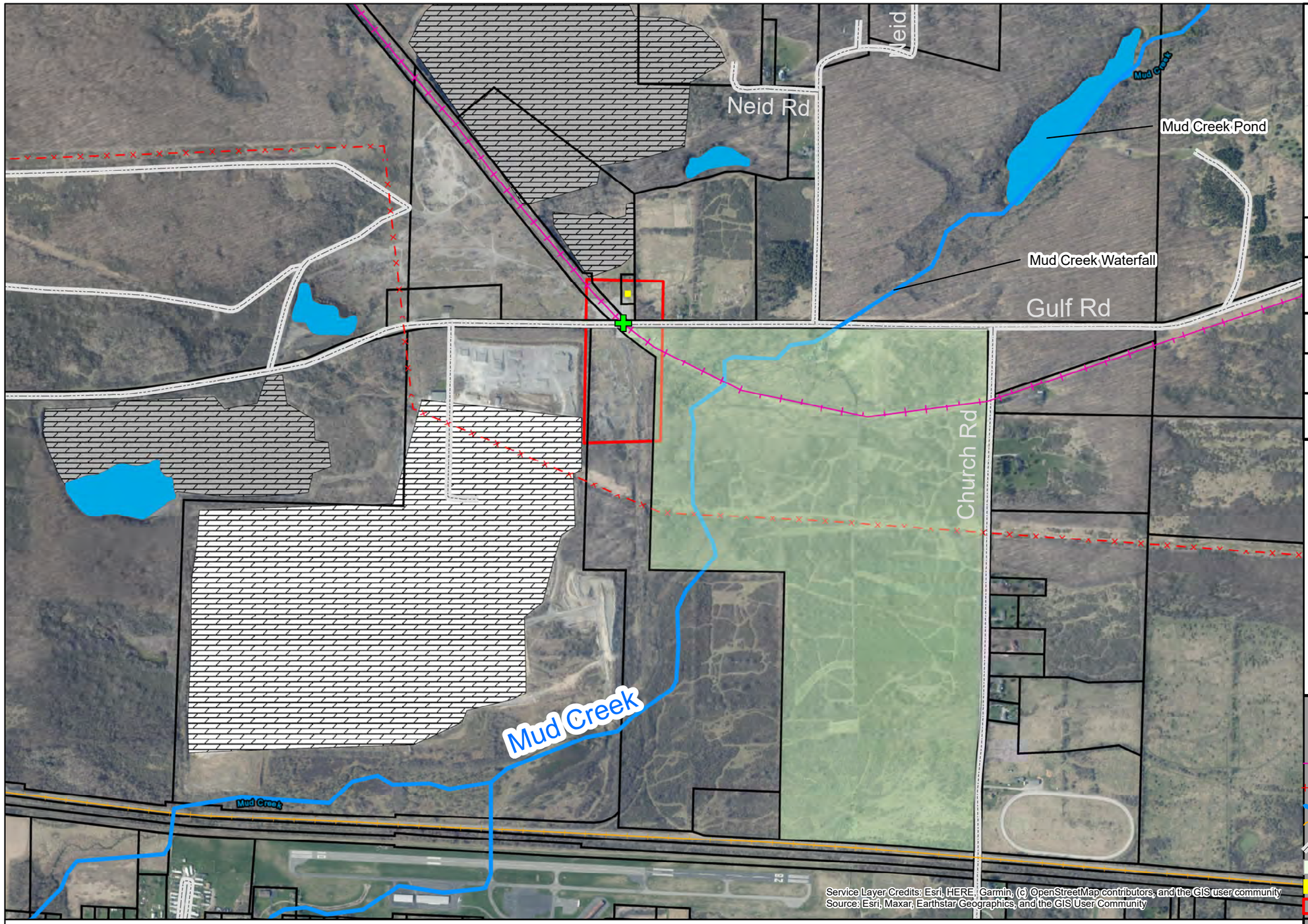
New York State



● = Approximate Study Area

Legend

- Former LVRR Railroad
- Gorge Pond
- Approximate Spill Zone
- Major Transmission Line
- Streams
- Railroad
- Roads
- Approximate Study Area
- Sinkholes



0 750 1,500 3,000 Feet

Spill Zone Map

M/N

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52 Federal Road
Suite 2C
Danbury, CT
06810

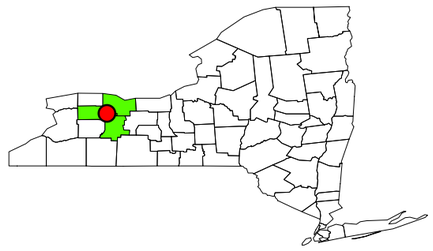
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.3-2

Author: NRH	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 01/30/23
Scale: 1 in:1,005 ft	**File:** Fig1-3-2_SpillZone

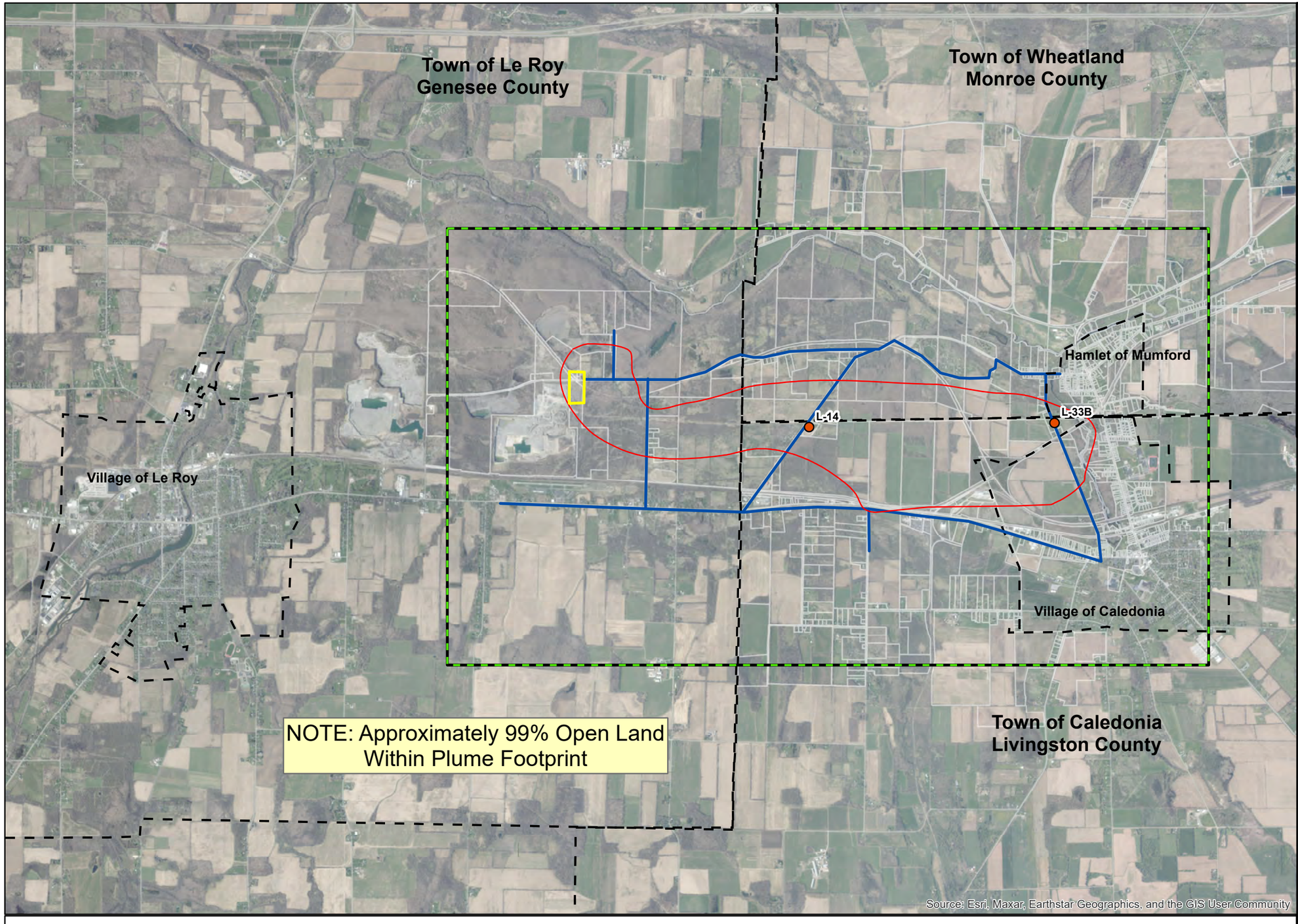
New York State



● = Approximate Study Area

Legend

- Location of LVRR Derailment
- Former LVRR Railroad
- Major Transmission Line
- Streams
- Railroad
- Roads
- Northwoods Sportsman Association Property
- Approximate Foundation of Former Knickerbocker Hotel
- Approximate Spill Zone
- Parcels
- Active Quarry
- Abandoned Quarry



0 2,500 5,000 10,000 Feet

LVRR Institutional Controls
Reference Map

M/N

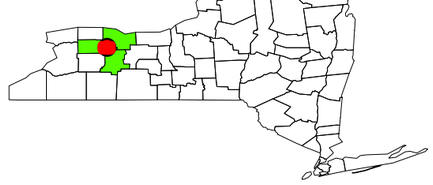
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52 Federal Road
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.4-1

Author: RTM	**Checked By:** NRH/ZDD
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/6/23
Scale: 1 in:3,780 ft	**File:** Fig1-4-1_IC_Basemap2021

New York State



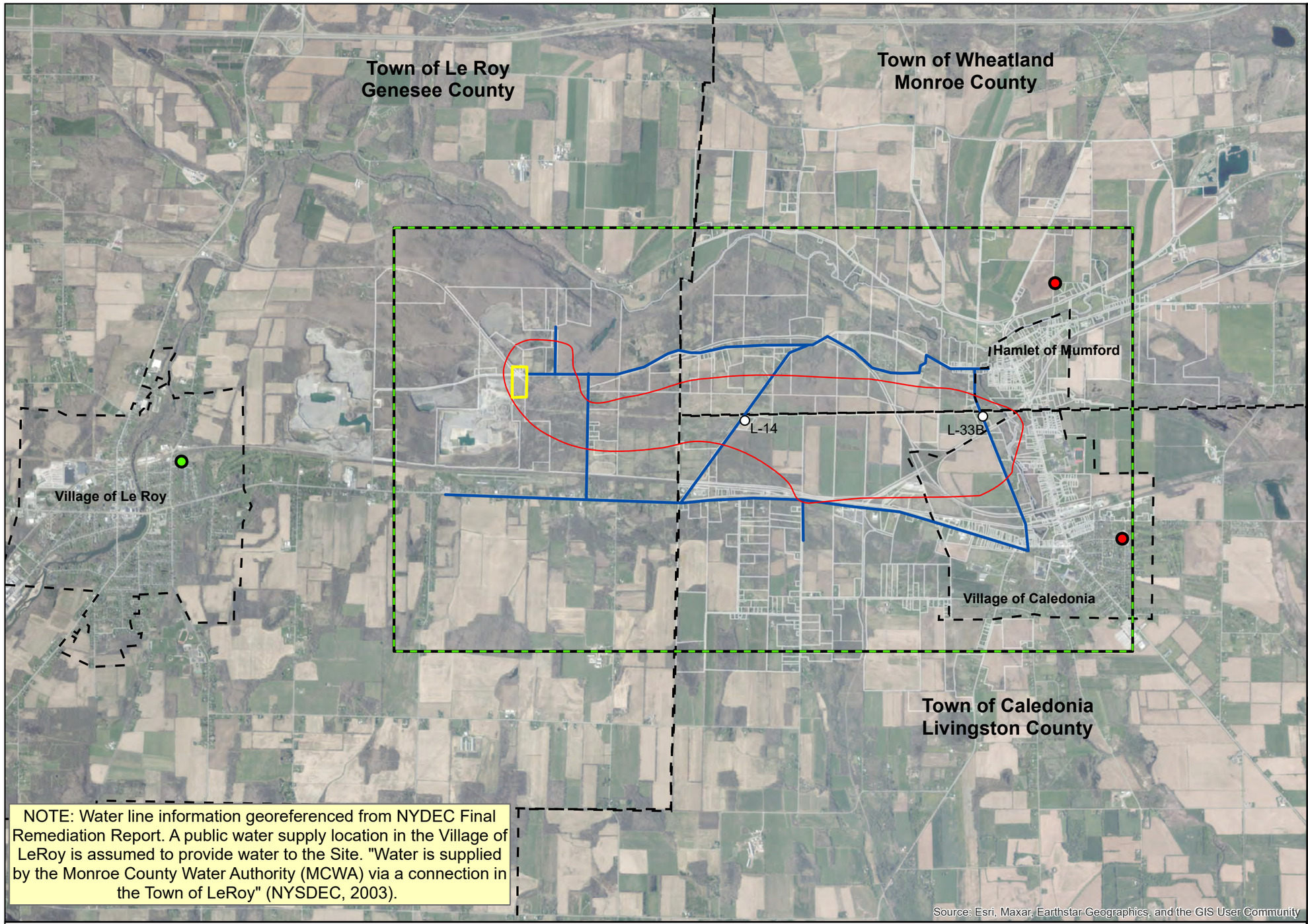
●= Approximate Study Area

Legend

- Approximate Spill Zone
- Approximate Study Area
- Remaining Domestic Well
- TCE Plume- May 2017
- Existing Water Line- 8 to 12 inch diameter
- Town/ Village Boundary
- Tax Parcel within proximity of Groundwater Plume

Hamlet of Mumford Boundary was approximately located from a Wikipedia public domain figure

TCE Plume- May 2017 shows the 5 µg/L groundwater boundary



NOTE: Water line information georeferenced from NYDEC Final Remediation Report. A public water supply location in the Village of LeRoy is assumed to provide water to the Site. "Water is supplied by the Monroe County Water Authority (MCWA) via a connection in the Town of LeRoy" (NYSDEC, 2003).

0 2,250 4,500 9,000 13,500 18,000 Feet

Public Water Supply Locations Near Site Reference Map

M/N

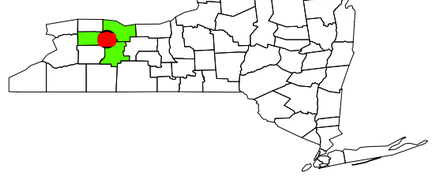
Unicorn Management Consultants, LLC
52 Federal Road
Suite 2C
Danbury, CT
06810
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.4-2

Author: NRH	**Checked By:**
Project #: 2032	**Created:** 10/27/09
	Revised: 01/27/23
Scale: 1 in:3,925 ft	**File:** Water_Supply

New York State



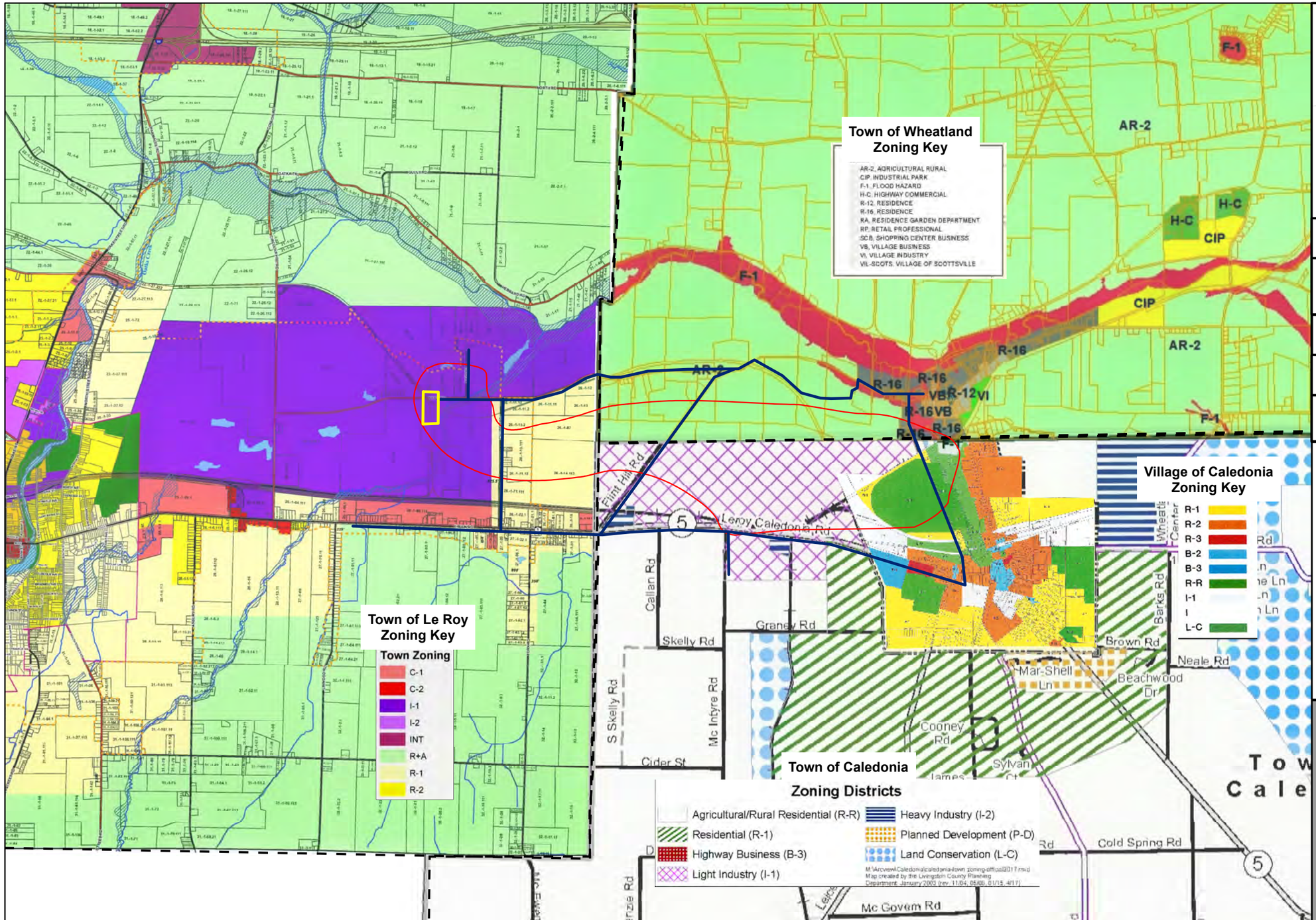
●= Approximate Study Area

Legend

- Water Supply Location: Does Not Connect to Site
- Water Supply Location: Connects to Site
- Remaining Domestic Well
- Approximate Spill Zone
- Approximate Study Area
- TCE Plume- May 2017
- Existing Water Line- 8 to 12 inch diameter
- Town/ Village Boundary
- Tax Parcel within proximity of Groundwater Plume

Hamlet of Mumford Boundary was approximately located from a Wikipedia public domain figure

TCE Plume- May 2017 shows the 5 ug/L groundwater boundary



0 2,500 5,000 10,000 Feet

LVRR Zoning Maps Around Plume Footprint Reference Map

M/N

All Zoning Maps were approximately georeferenced onto the map. For Reference Only

TCE Plume- May 2017 shows the 5 µg/L groundwater boundary

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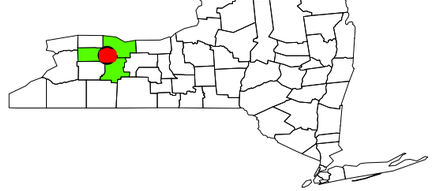
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.5-1

Author: RTM	**Checked By:** NRH/ZDD
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/6/23
Scale: 1 in:3,750 ft	**File:** Fig1.5-1_IC_ZoningMapLeRoy_2021

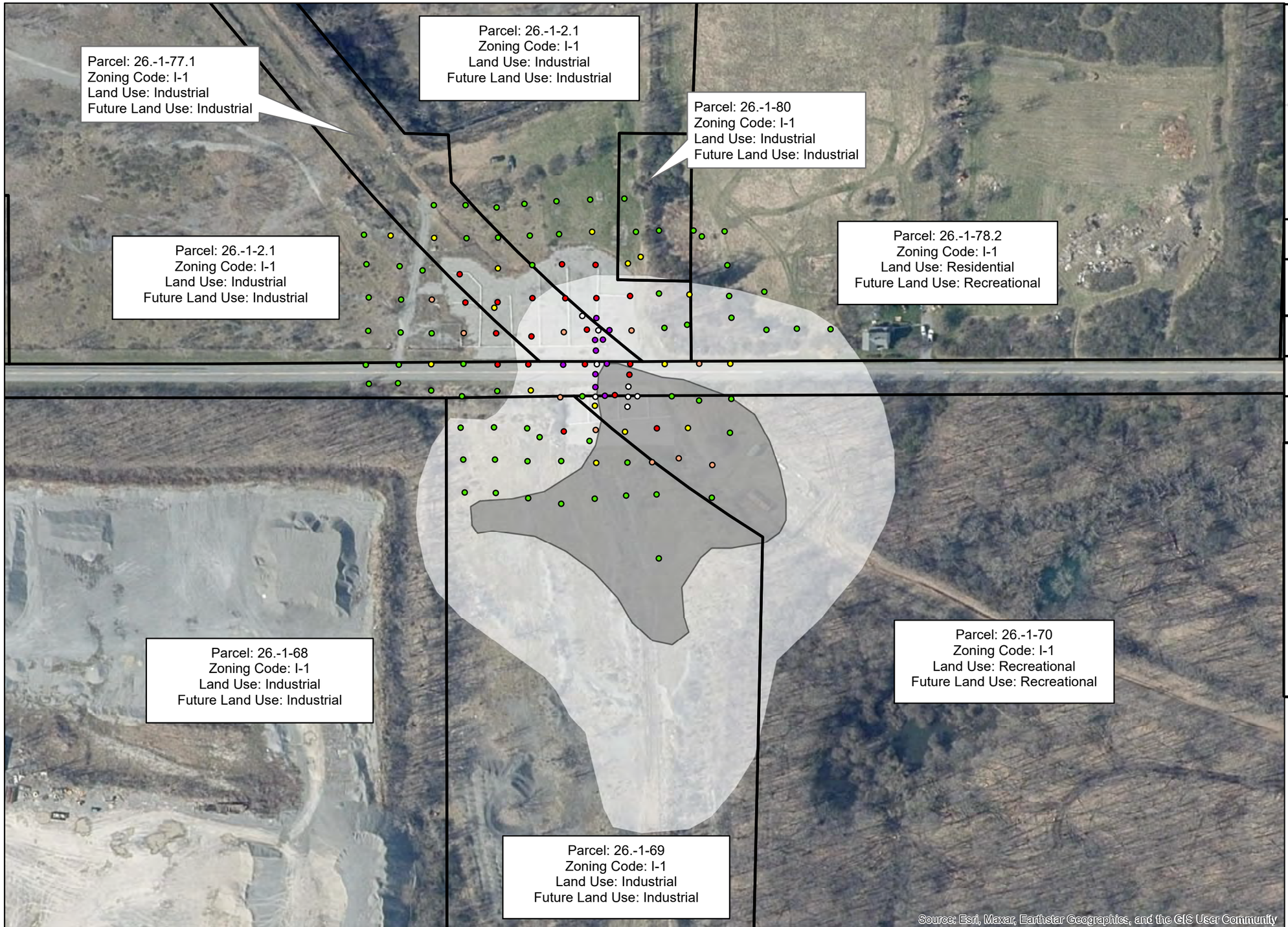
New York State



●= Approximate Study Area

Legend

- Approximate Spill Zone
- Existing Water Line- 8 to 12 inch diameter
- TCE Plume- May 2017



0 125 250 500 Feet

Bedrock Vadose Zone Alternative
Area of Interest

M/N

N W E S

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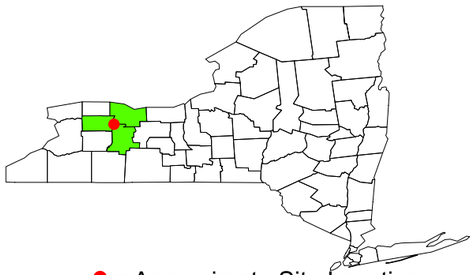
(203) 205-9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.5-2

Author: NRH	**Checked By:** AL
Project #: 2032	**Created:** 10/27/09 **Revised:** 08/04/2022
Scale: 1 in:149 ft	**File:** Fig1-5-2_Soil_Bedrock_reference

New York State

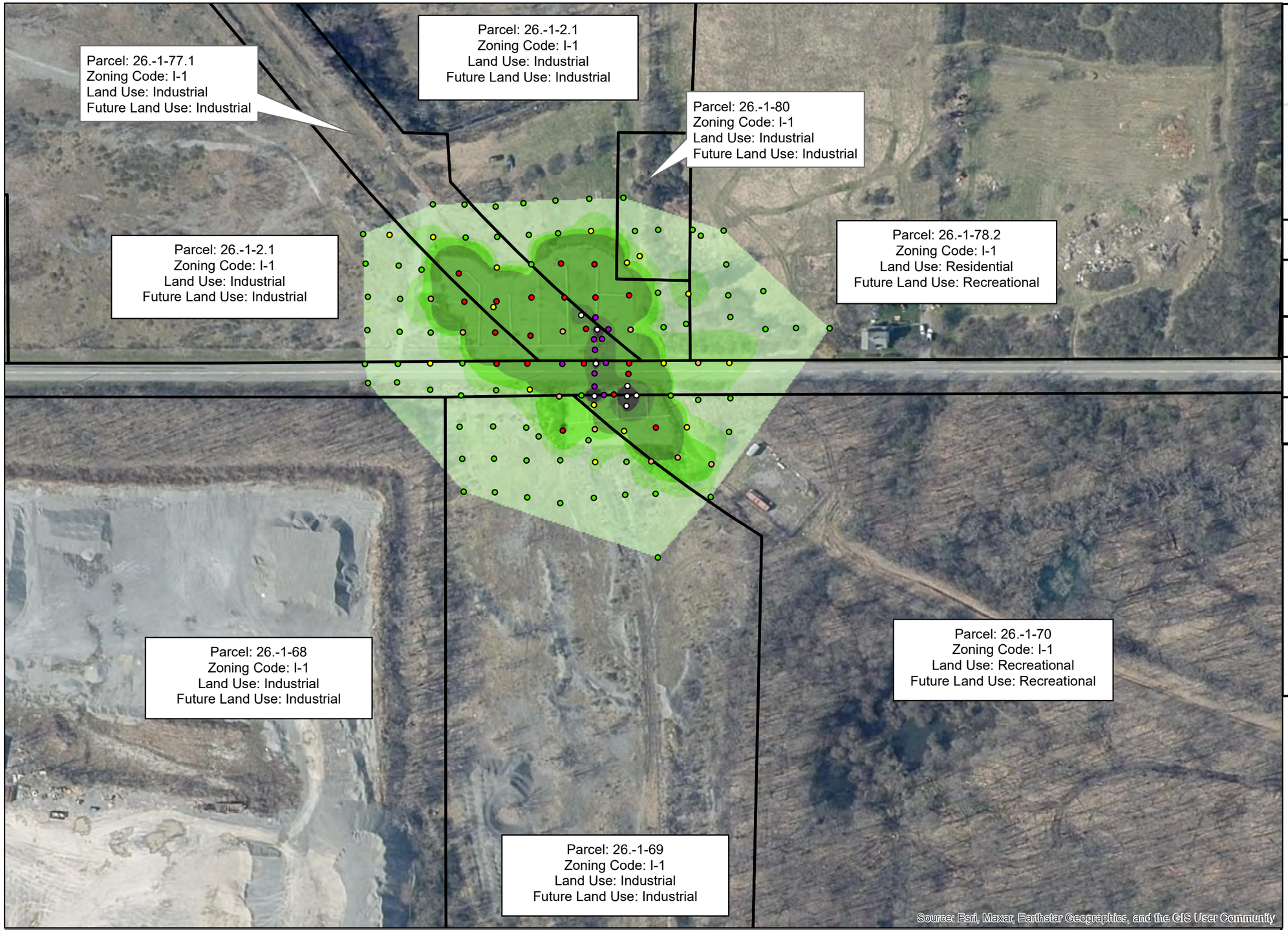


● = Approximate Site Location

Legend

Soil Samples

- TCE Below NYS Unrestricted use of 0.47 ppm
- TCE between 0.47 ppm- 1.99 ppm
- TCE between 2- 6.99 ppm
- TCE between 7- 199.99 ppm
- TCE above CSCO of 200 ppm
- TCE above ISCO of 400 ppm
- Le Roy Tax Parcels- Genesee County
- Proposed 2 Acre Study Area
- Proposed 10 Acre Study Area



0 125 250 500 Feet

Soil Alternative
Area of Interest

M/N

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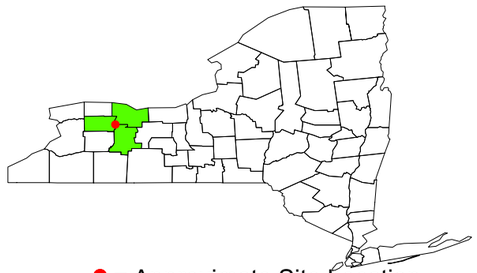
(203) 205-9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.5-3

Author: NRH	**Checked By:** AL
Project #: 2032	**Created:** 10/27/09 **Revised:** 08/04/2022
Scale: 1 in:148 ft	**File:** Fig1-5-3_Soil_TCE

New York State



● = Approximate Site Location

Legend

Soil Samples

- TCE Below NYS Unrestricted use of 0.47 ppm
- TCE between 0.47 ppm- 1.99 ppm
- TCE between 2- 6.99 ppm
- TCE between 7- 199.99 ppm
- TCE above CSCO of 200 ppm
- TCE above ISCO of 400 ppm

Le Roy Tax Parcels- Genesee County

TCE Concentration (ppm)

- 0-.469
- 0.470 - 1.99
- 2.00-6.99
- 7.00-199.9
- 200.0-399.9
- >400



0 50 100 200 Feet

Soil Remediation and Restoration Area

M/N

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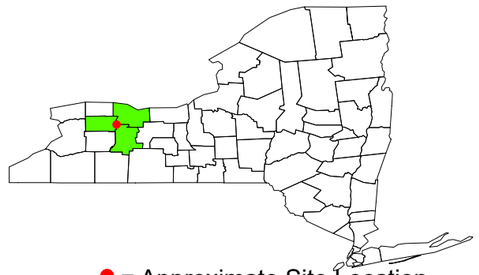
(203) 205-9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.5-3a

Author: NRH	**Checked By:** AL
Project #: 2032	**Created:** 4/5/23 **Revised:**
Scale: 1 in:62 ft	**File:** Fig1-5-3a_GravelArea

New York State



● = Approximate Site Location

Legend

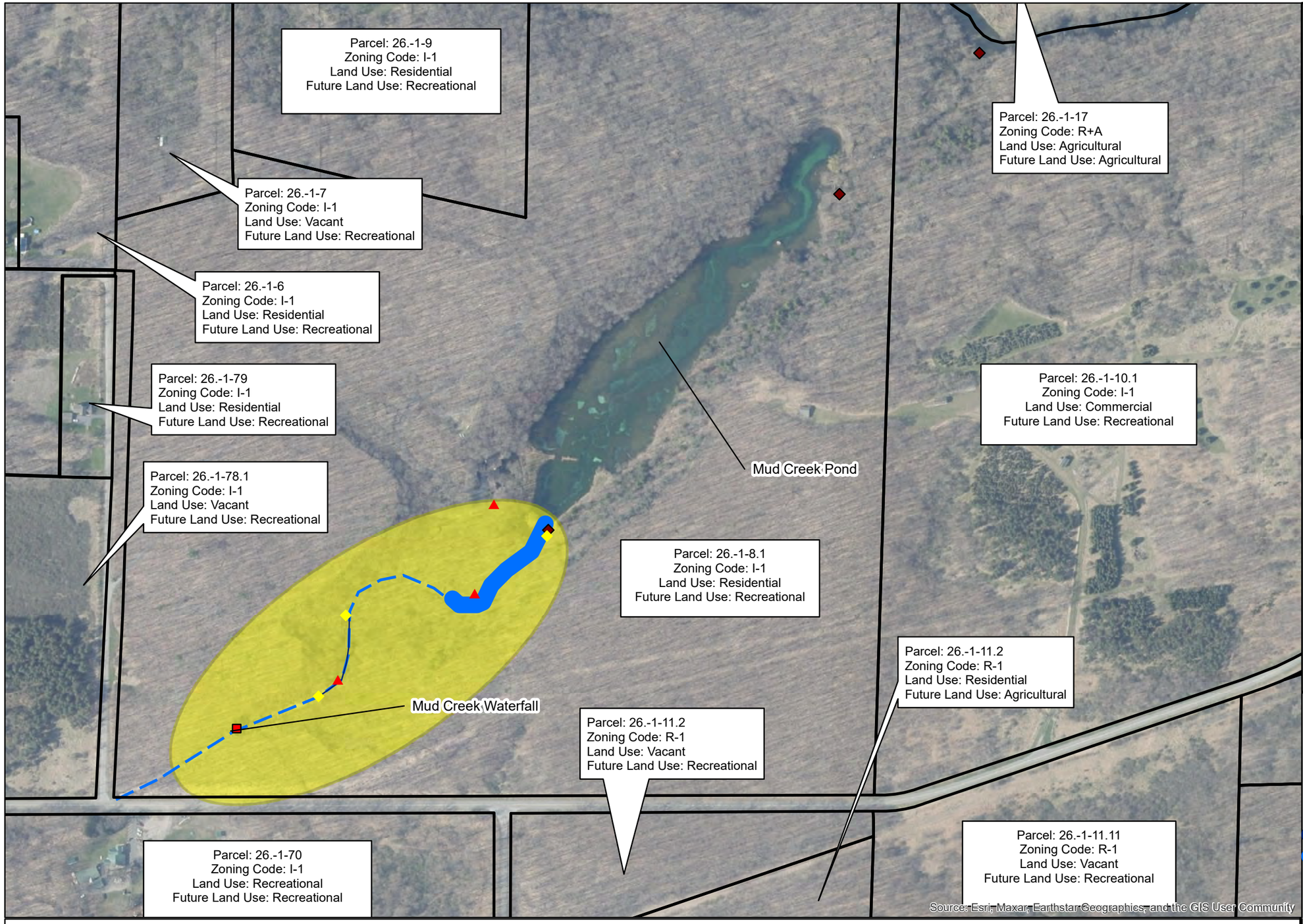
Gravel Area

Soil Samples

- TCE Below NYS Unrestricted use of 0.47 ppm
- TCE between 0.47 ppm- 1.99 ppm
- TCE between 2- 6.99 ppm
- TCE between 7- 199.99 ppm
- TCE above CSCO of 200 ppm
- TCE above ISCO of 400 ppm

TCE Concentration (ppm)

- 0 - 1.99
- 2.00-199.99
- >200.00



0 125 250 500 750 1,000 Feet

Surface Water Alternative Area of Interest

M/N

N W E S

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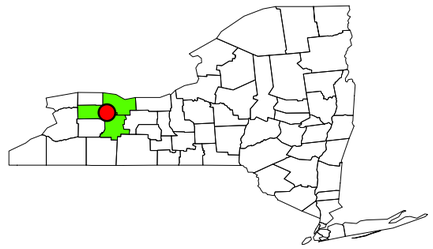
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.5-4

Author: NRH	**Checked By:** AL
Project #: 2032	**Created:** 10/27/09 **Revised:** 08/05/2022
Scale: 1 in:324 ft	**File:** Fig1-5-4_SurfaceWater_reference

New York State

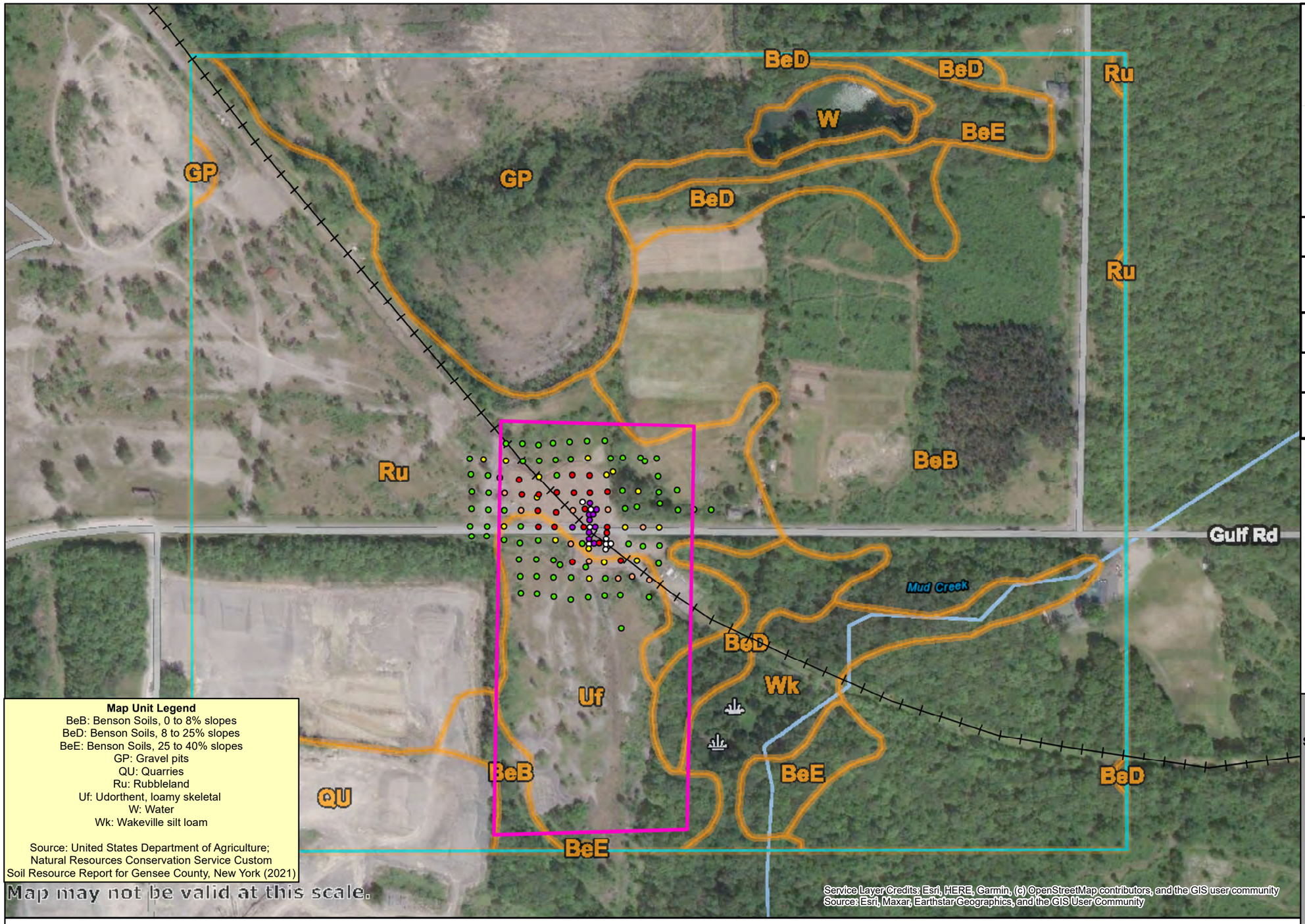


●= Approximate Study Area

Legend

- Le Roy Tax Parcels- Genesee County
- Mud Creek Sample Location- 2018
- Mud Creek Drainage Sample- 2009/2010
- Mud Creek Spring Sample- 2017
- Mud Creek Surface Water Sample- 2017
- Active Stream Segment #1 (Typically Flowing)
- Active Stream Segment #2 (Typically Flowing)
- Mud Creek StreamChannel (Typically dry/ Subsurface Flow)
- Approximate Mud Creek Area of Interest

Note: Approximate Mud Creek Area of Interest is subject to change based on the results of proposed pre-remedial design investigation



Map Unit Legend
BeB: Benson Soils, 0 to 8% slopes
BeD: Benson Soils, 8 to 25% slopes
BeE: Benson Soils, 25 to 40% slopes
GP: Gravel pits
QU: Quarries
Ru: Rubbleland
Uf: Udorthent, loamy skeletal
W: Water
Wk: Wakeville silt loam

Source: United States Department of Agriculture; Natural Resources Conservation Service Custom Soil Resource Report for Gensee County, New York (2021)

0 250 500 1,000 Feet

Spill Zone Soil Reference Map

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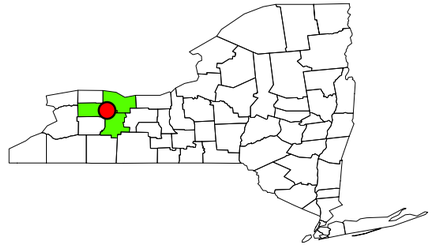
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.5-5

Author: NRH	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/6/23
Scale: 1 in:397 ft	**File:** Soil_Map

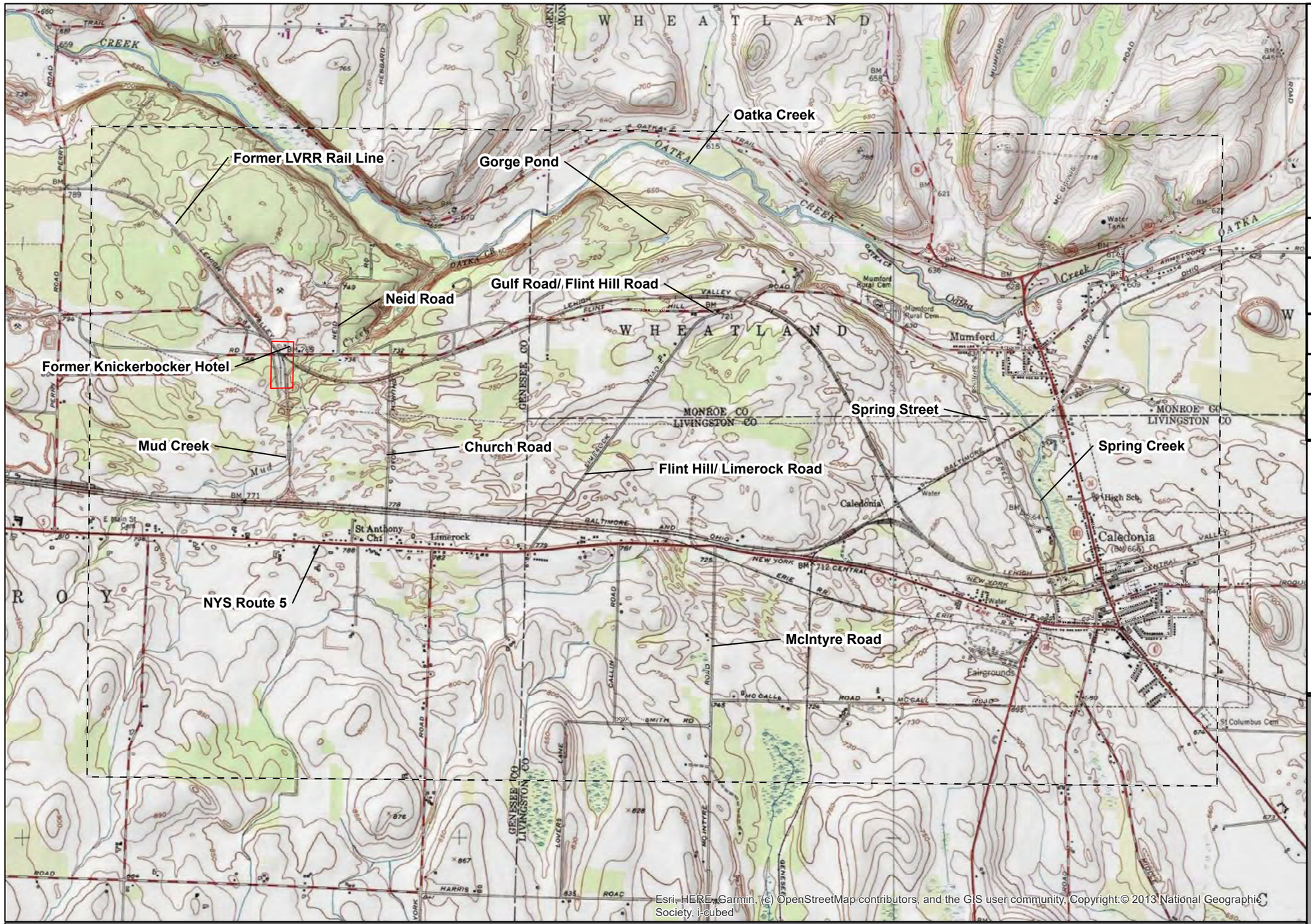
New York State



● = Approximate Study Area

Legend

Soil Samples
- TCE Below NYS Unrestricted use of 0.47 ppm
- TCE between 0.47 ppm- 1.99 ppm
- TCE between 2- 6.99 ppm
- TCE between 7- 199.99 ppm
- TCE above CSCO of 200 ppm
- TCE above ISCO of 400 ppm
- Former LVRR Railroad
- Approximate Spill Zone
- Soil Unit
- Area of Interest From USDA Soil Resource Report



0 1,875 3,750 7,500 11,250 15,000 Feet

Study Area Topographical Map

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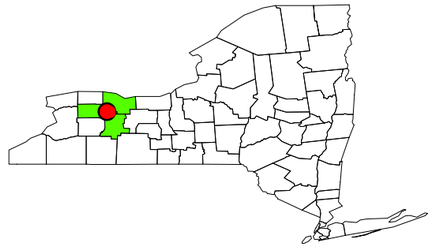
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1-6

Author: RTM	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/6/23
Scale: 1 in:3,500 ft	**File:** Fig1-6_Topo

New York State



= Approximate Study Area

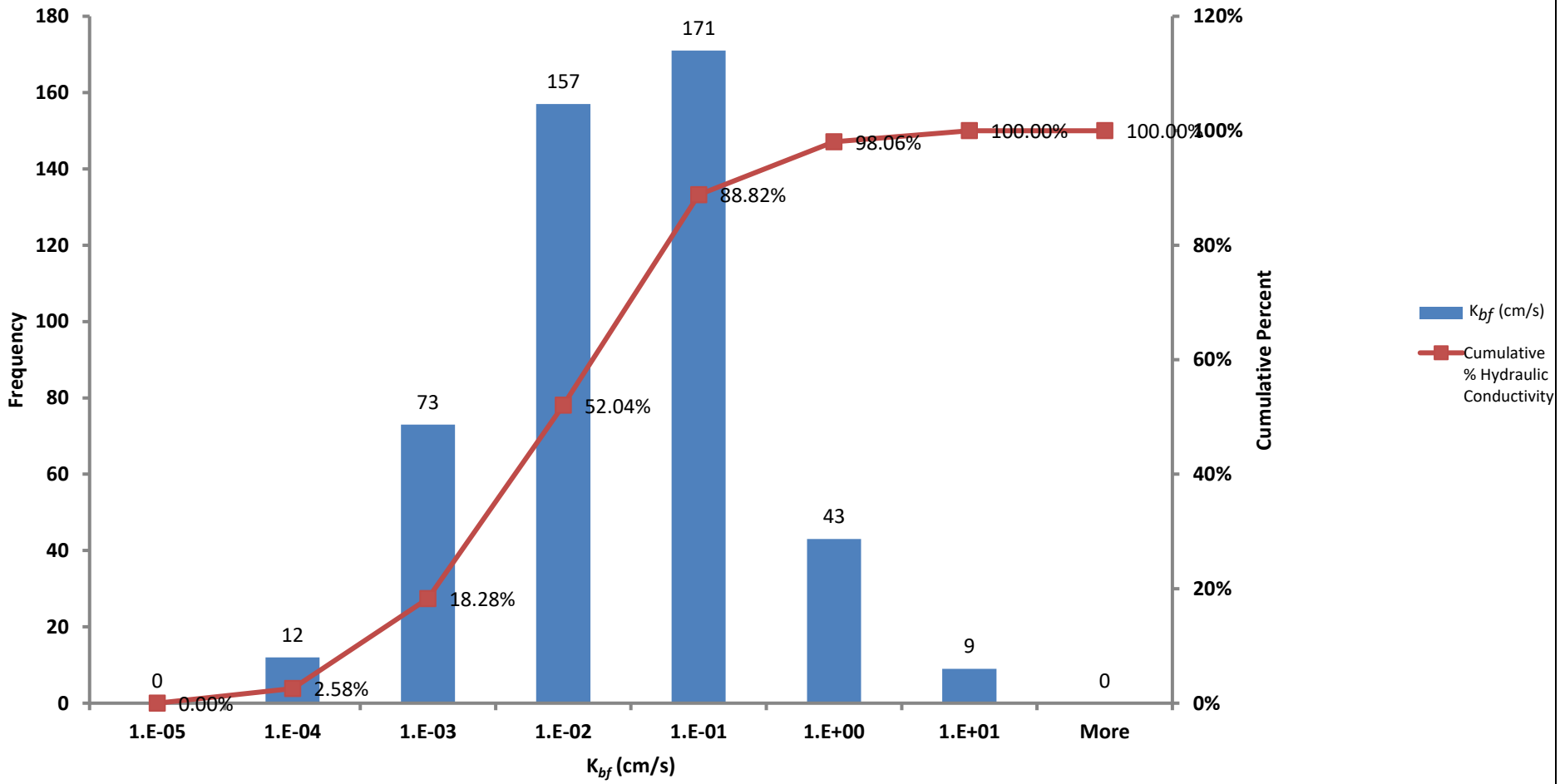
Legend

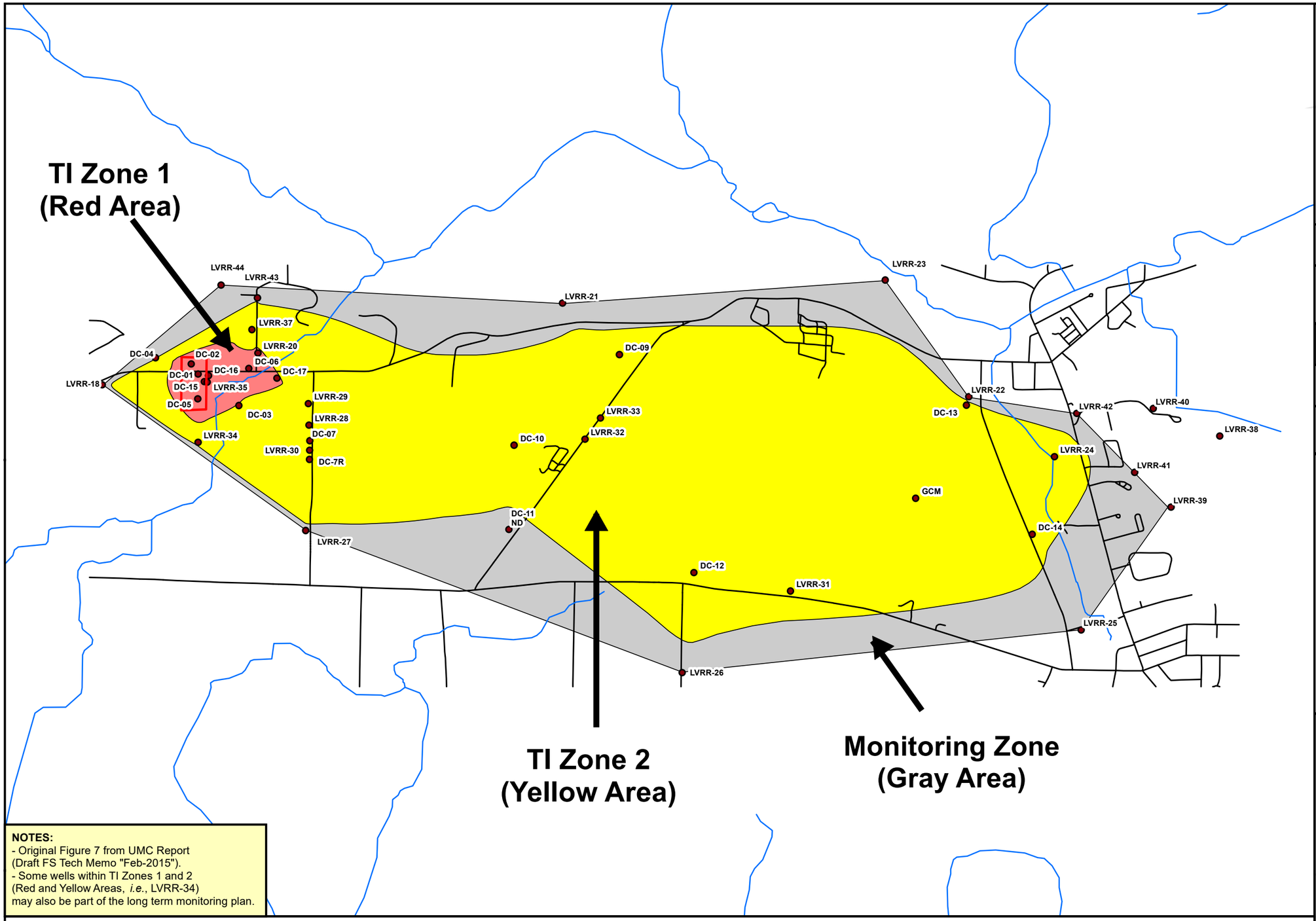
- Approximate Spill Zone
- Approximate Study Area

Topo- 2011 National Geographic Society

Figure 1-7
Overall Bulk Fracture Hydraulic Conductivity (K_{bf})
based on
FLUTe Profiling Data

Unicorn Management Consultants, LLC





NOTES:
- Original Figure 7 from UMC Report (Draft FS Tech Memo "Feb-2015").
- Some wells within TI Zones 1 and 2 (Red and Yellow Areas, *i.e.*, LVRR-34) may also be part of the long term monitoring plan.

0 1,500 3,000 6,000 9,000 12,000 Feet

LVRR TCE Groundwater Concentration Zones

MN

N W E S

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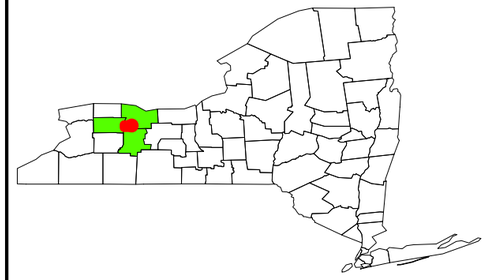
(203) 205-9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-1
Feasibility Study Report

Author: CRW/RTM	**Checked By:**
Project #: 2032	**Created:** 2/18/15 **Revised:** 8/1/23
Scale: 1 in:2,250 ft	**File:** Fig2-1_TCE_Zones

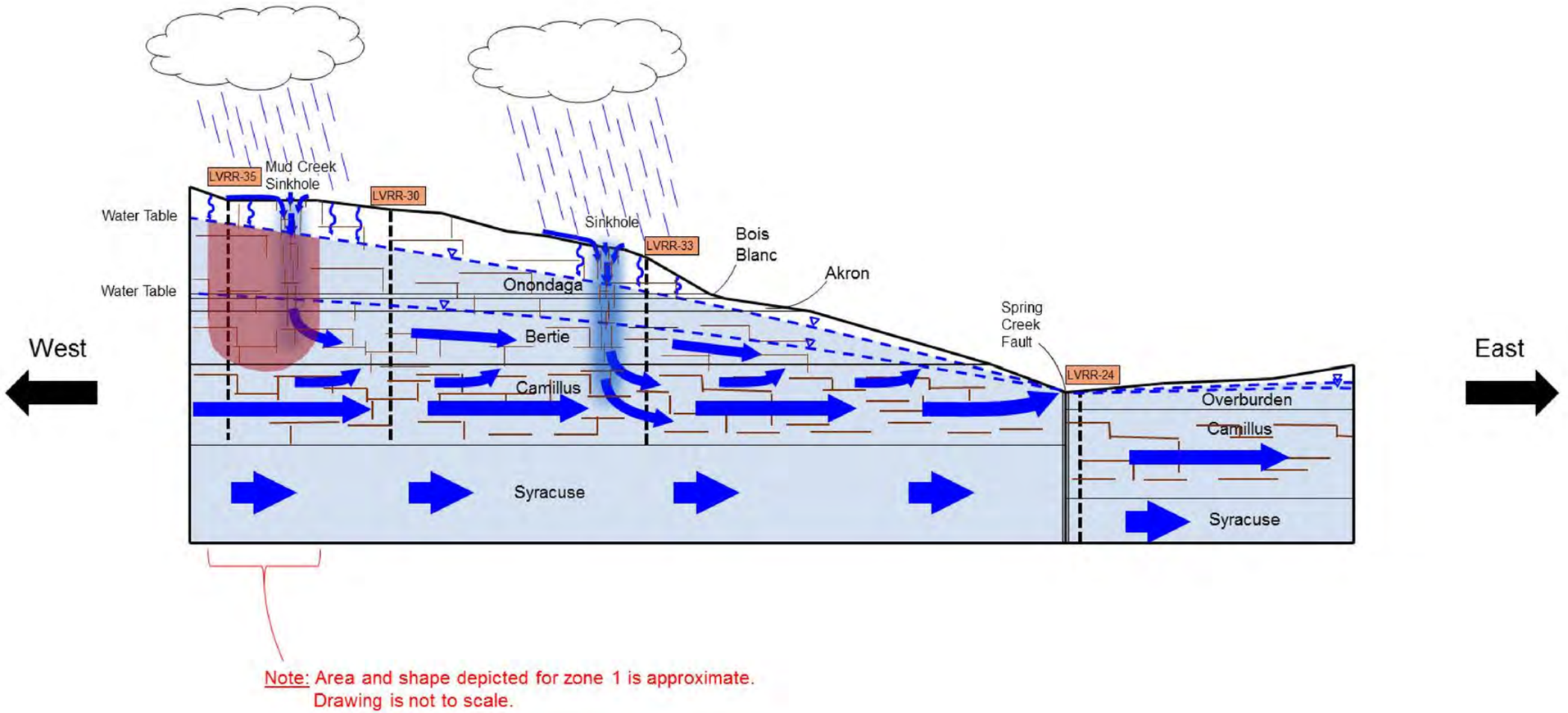
New York State



● = Approximate Site Location

Legend

- Approximate Spill Zone
- Monitoring Well Cluster
- Stream
- Road
- Groundwater Zone 1: TCE Concentration >1000 ppb
- Groundwater Zone 2: TCE Concentration >5 ppb
- Groundwater Zone 2: TCE Concentration >1 ppb



Note: Area and shape depicted for zone 1 is approximate.
Drawing is not to scale.

LVRR TCE Concentrations - Zone 1 Cross Section

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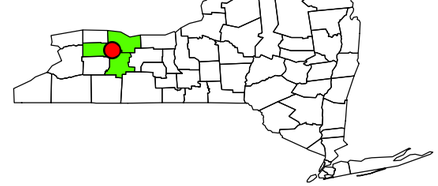
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-2
Feasibility Study Report

Author: CRW	**Checked By:** MG
Project #: 2032	**Created:** 2/18/15 **Revised:** 8/12/20
Scale: Not to scale	**File:** Fig2-2_TCE_Plume_Cross_1000

New York State



● = Approximate Study Area

Legend

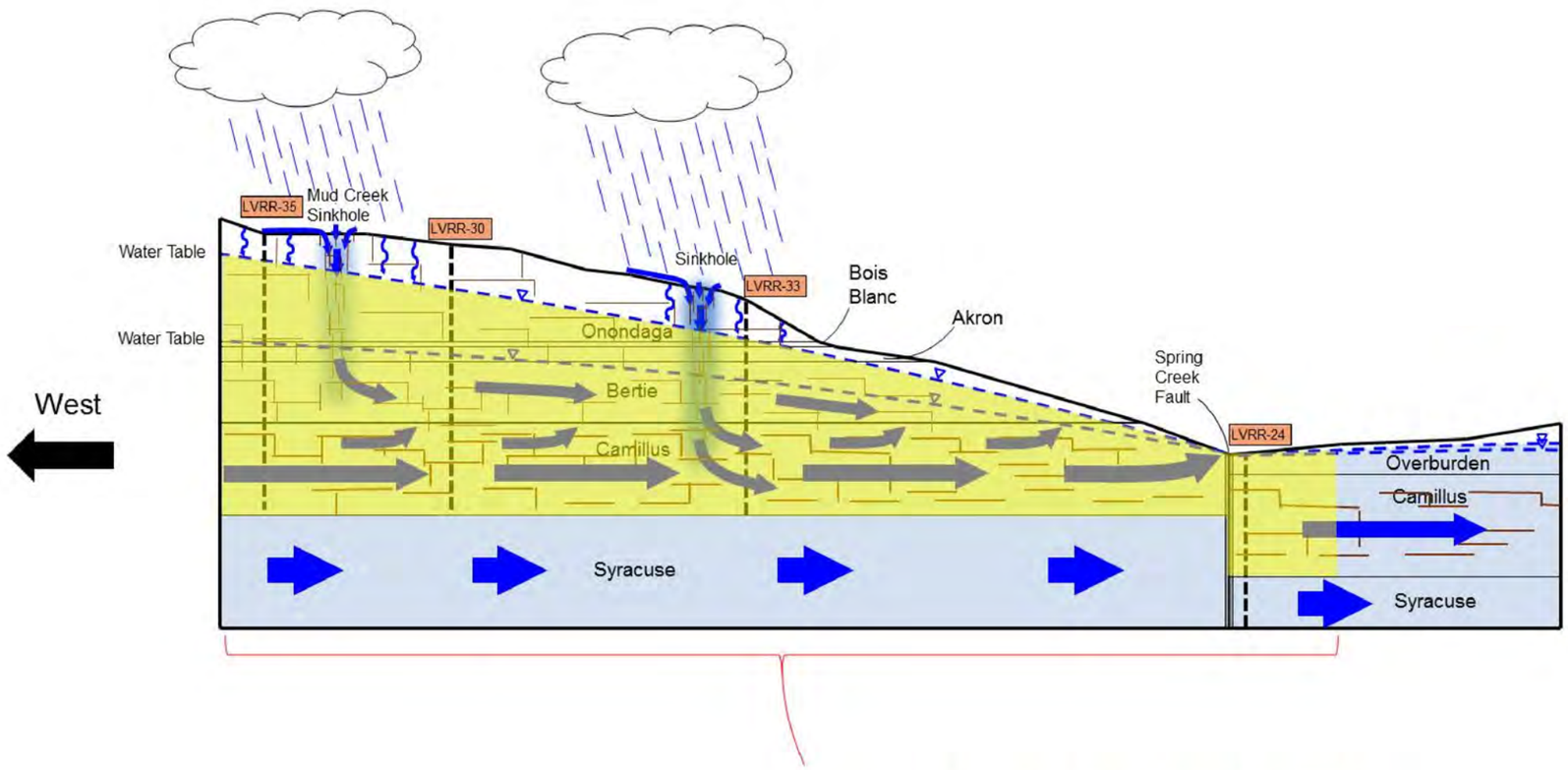
LVRR-24 — GW Monitoring Well

Bedrock Fractures

Water Flow Direction

Zone 1: Extent of TCE plume (>1,000 µg/L)

Original Figure 8 from UMC Report (Draft FS Tech Memo "Feb-2015")



Note: Area and shape depicted for zone 2 is approximate.
Drawing is not to scale.

LVRR TCE Concentrations - Zone 2 Cross Section

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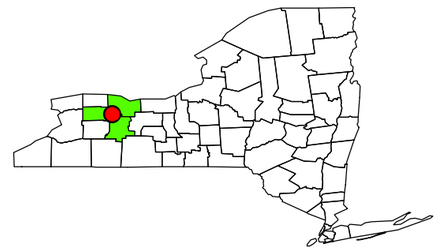
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-3
Feasibility Study Report

Author: CRW	**Checked By:** MG
Project #: 2032	**Created:** 2/18/15
	Revised: 8/12/20
Scale: Not to scale	**File:** Fig2-3_TCE_Plume_Cross_5

New York State

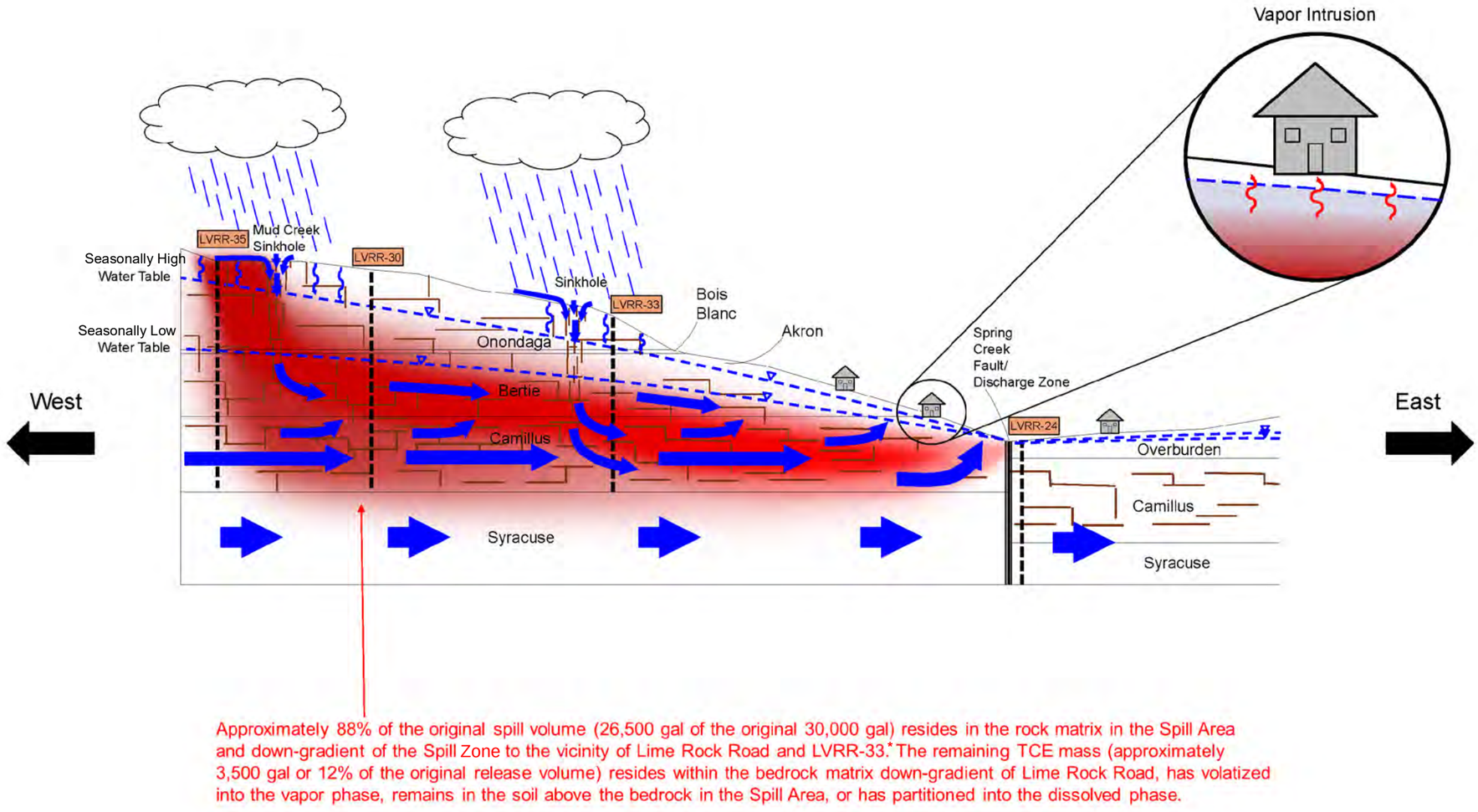


● = Approximate Study Area

Legend

- LVRR-24 — GW Monitoring Well
- Bedrock Fractures
- Water Flow Direction
- Zone 2: Extent of TCE plume (>5 ug/L)

Original Figure 9 from UMC Report (Draft FS Tech Memo"Feb-2015")



*UMC's December 2014 RIR provides a discussion of the process employed to estimate the distribution of TCE mass in the Study Area. The estimate was provided by Stone Environmental, Inc. (Stone) whose sampling procedures and analytical findings are summarized in the Stone report in Appendix I of UMC's December 2014 RIR.

Conceptual Site Model Schematic

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Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-4
Feasibility Study Report

Author:	CRW	**Checked By:**	RTM
Project #:	2032	**Created:**	7/23/14
		Revised:	8/11/20
Scale:		**File:**	Fig2-4_ConceptualSiteModel

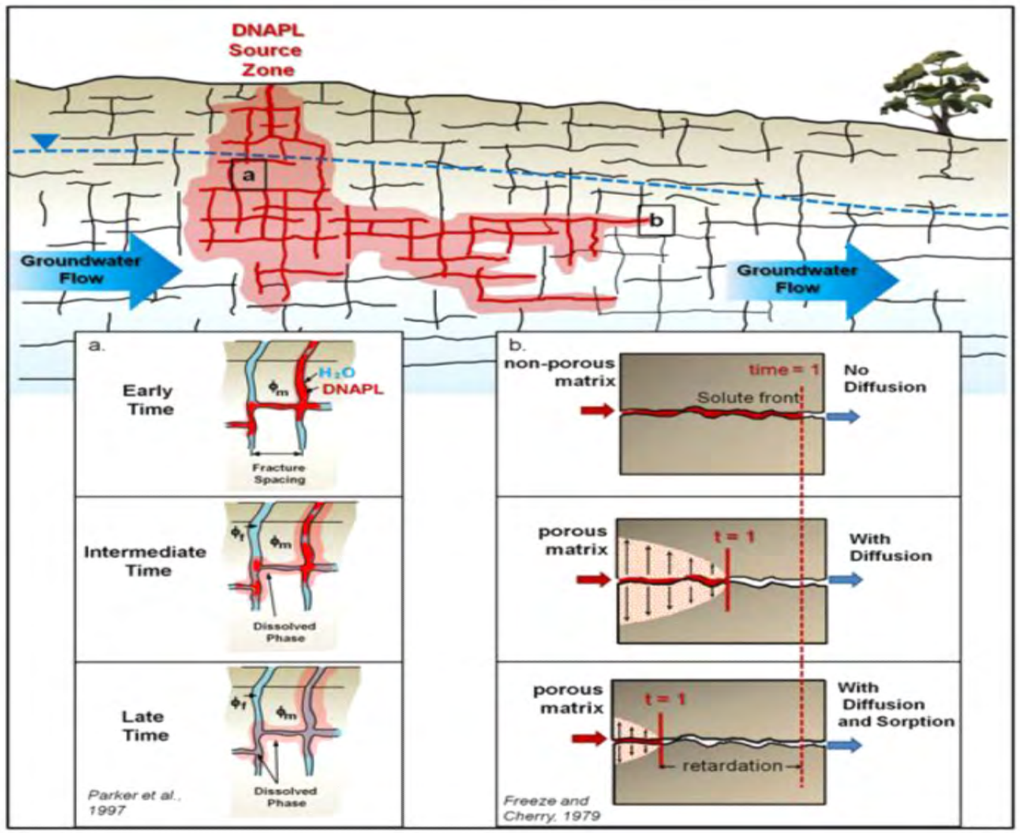
New York State

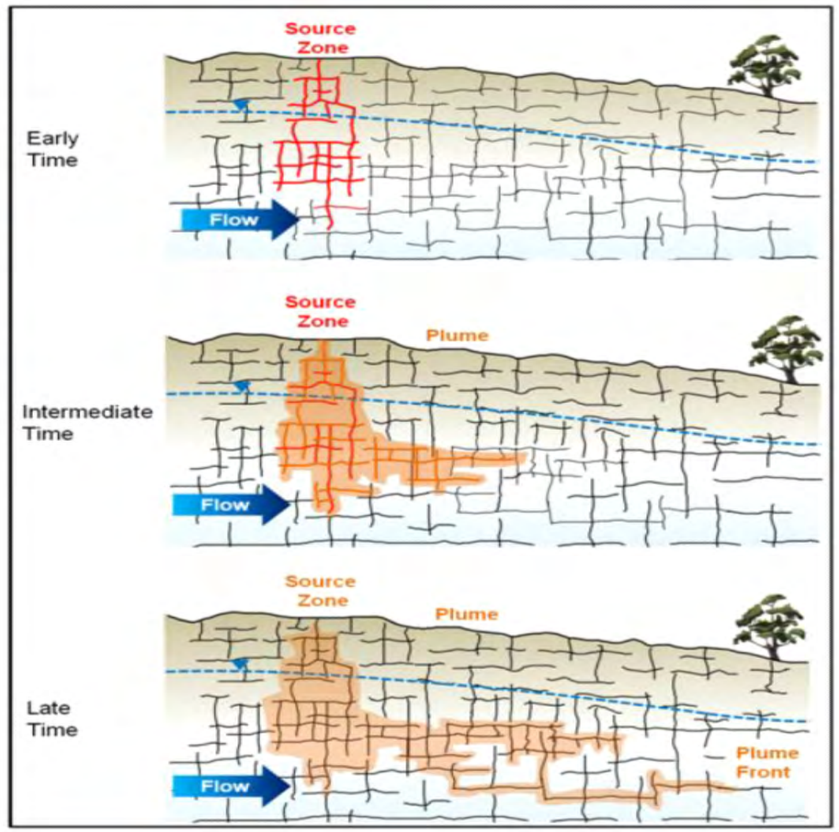


● = Approximate Study Area

Legend

- LVRR-24 — GW Monitoring Well
- Bedrock Fractures
- Water Flow Direction
- Indicates generalized TCE plume through the central portion of the Study Area where the NYS Standards, Criteria, and Guidance for TCE of 5ug/L is exceeded.





Parker et al., 2012

Conceptual Site Model Schematic
Source Zone/ Plume Evolution

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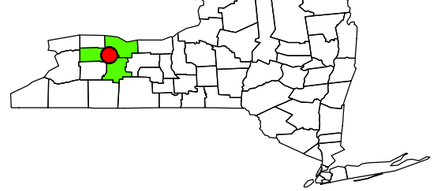
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

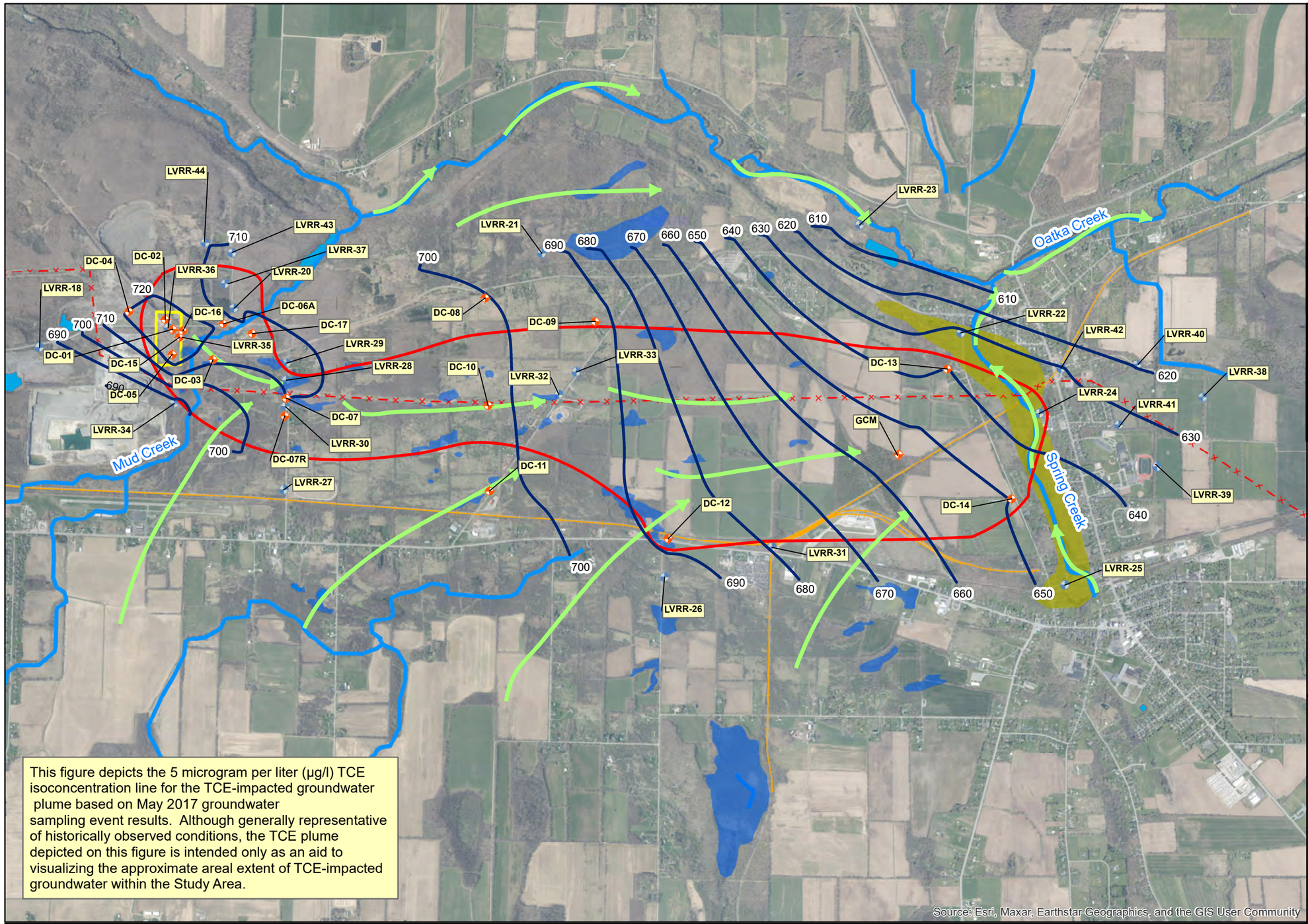
Figure 2-5
Feasibility Study Report

Author:	CRW	**Checked By:**	RTM
Project #:	2032	**Created:**	7/23/14
		Revised:	8/11/20
Scale:		**File:**	Fig2-5_ConceptualSiteModel

New York State



● = Approximate Study Area



0 1,500 3,000 6,000 9,000 12,000 Feet

Conceptual Site Model
Areal View

M/N

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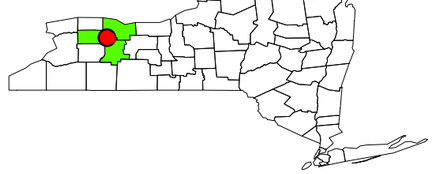
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-6
Feasiblity Study Report

Author: RTM	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/6/23
Scale: 1 in:2,250 ft	**File:** Fig2-6_ArealCSM

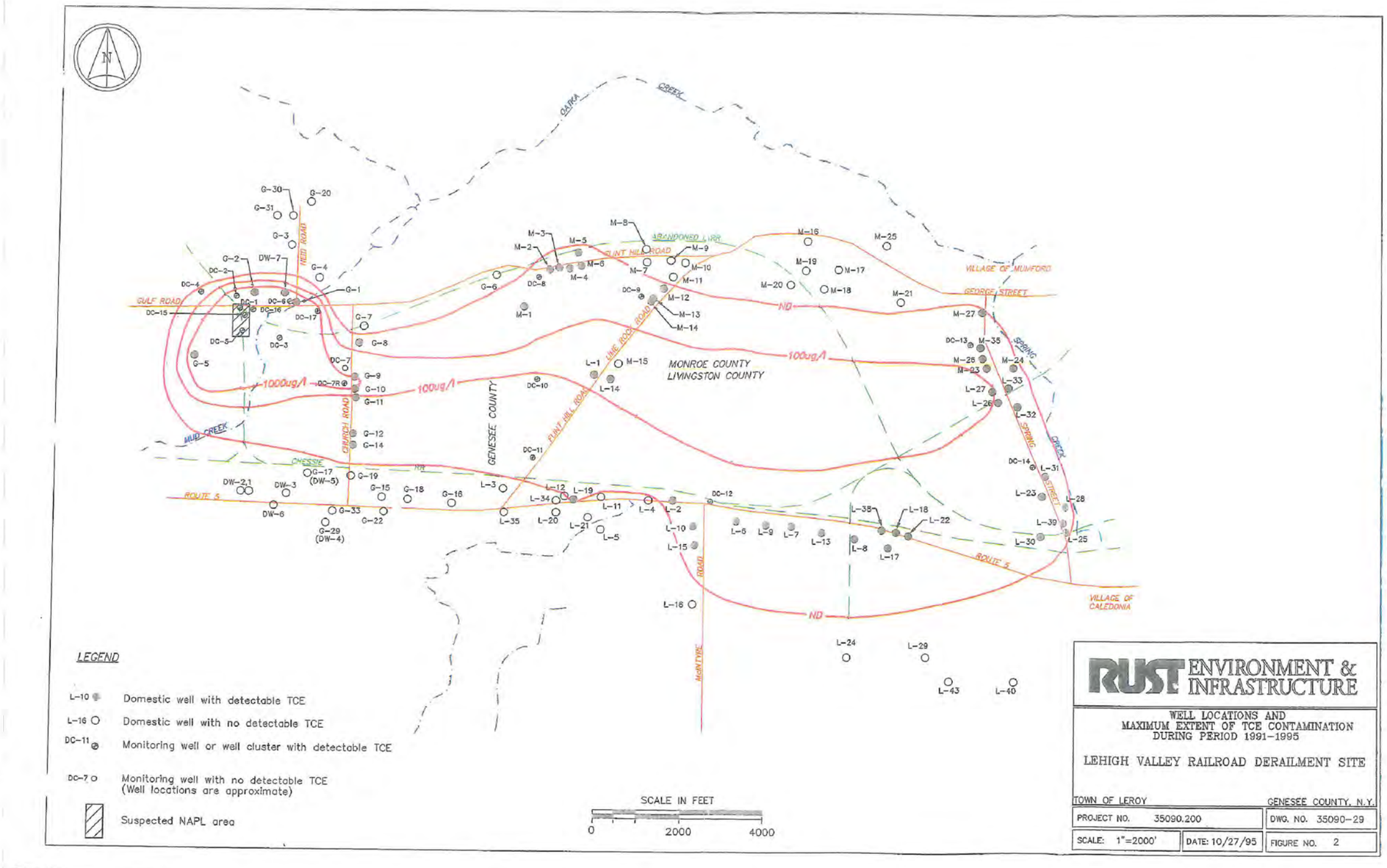
New York State



= Approximate Study Area

Legend

- NYSDEC Monitoring Well Cluster
- May 2017 GW Contour- 10 ft Interval
- Water Flow Direction
- 5 µg/l Isoconcentration Line
- Sinkholes
- Approximate Spill Zone
- LVRR Monitoring Well Cluster
- Dolomite Quarry
- Major Transmission Line
- Streams
- Spring Creek Fault Zone
- Railroad



Maximum Extent of TCE Contamination
During Period 1991-1995 from RUST Report 1996

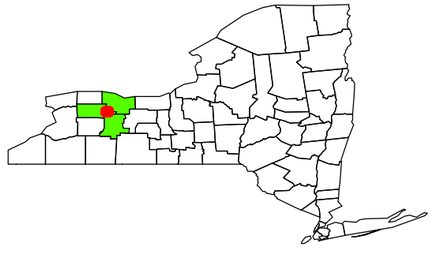
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

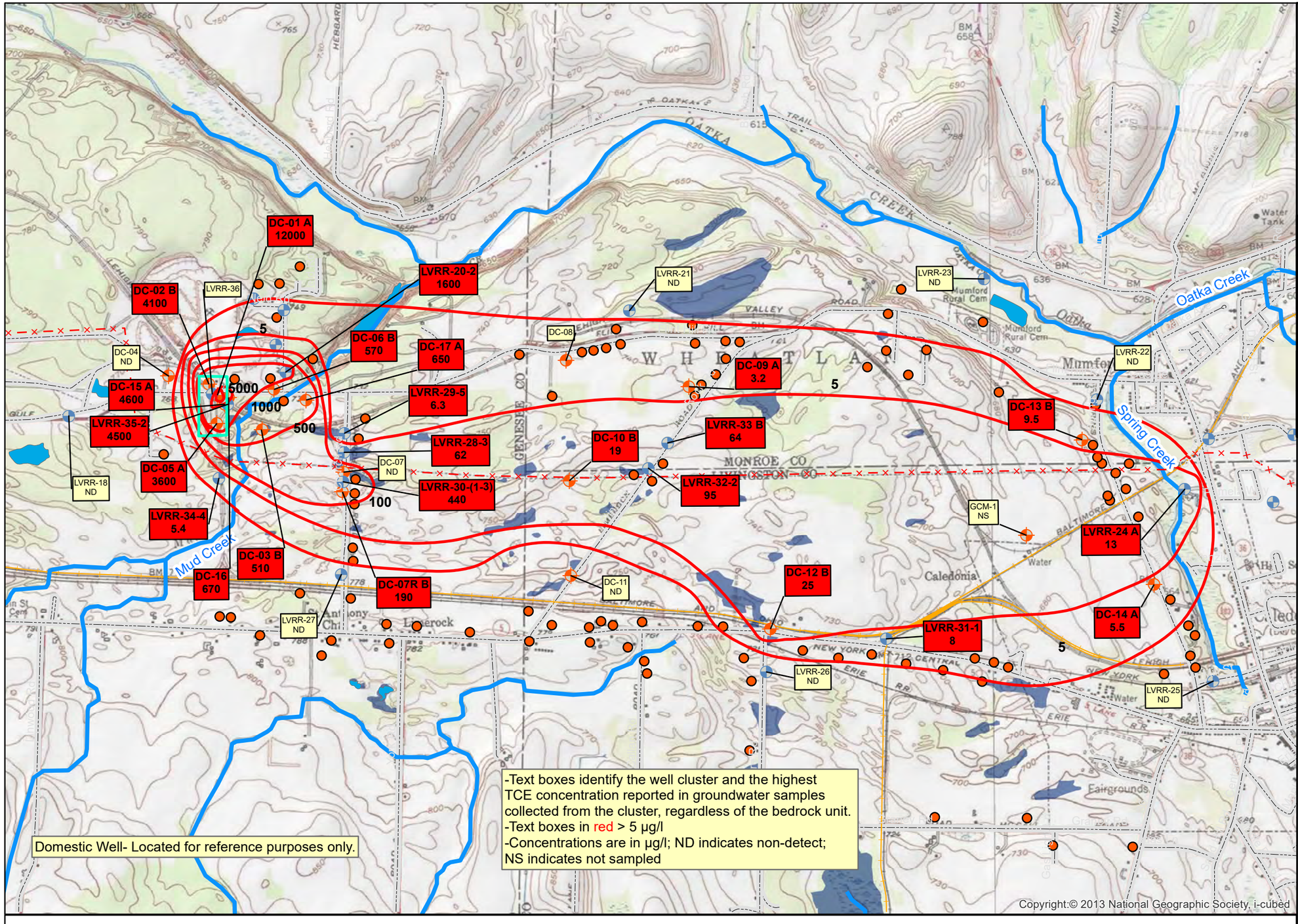
Figure 2-7
Feasibility Study Report

Author: RTM	**Checked By:** NRH/ZDD
Project #: 2032	**Created:** 10/27/09 **Revised:** 8/11/20
Scale: 1 in:2,000 ft	**File:** Fig2-7_95DEC

New York State



● = Approximate Study Area



Nature and Extent of TCE Contamination- December 2010

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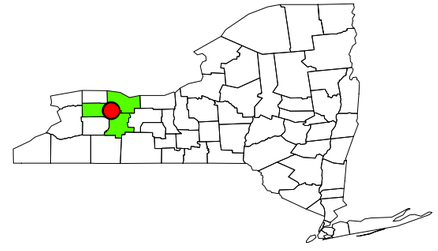
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-8
Feasibility Study Report

Author: RTM	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/6/23
Scale: 1 in:2,000 ft	**File:** Fig2-9_TCE_Dec10

New York State

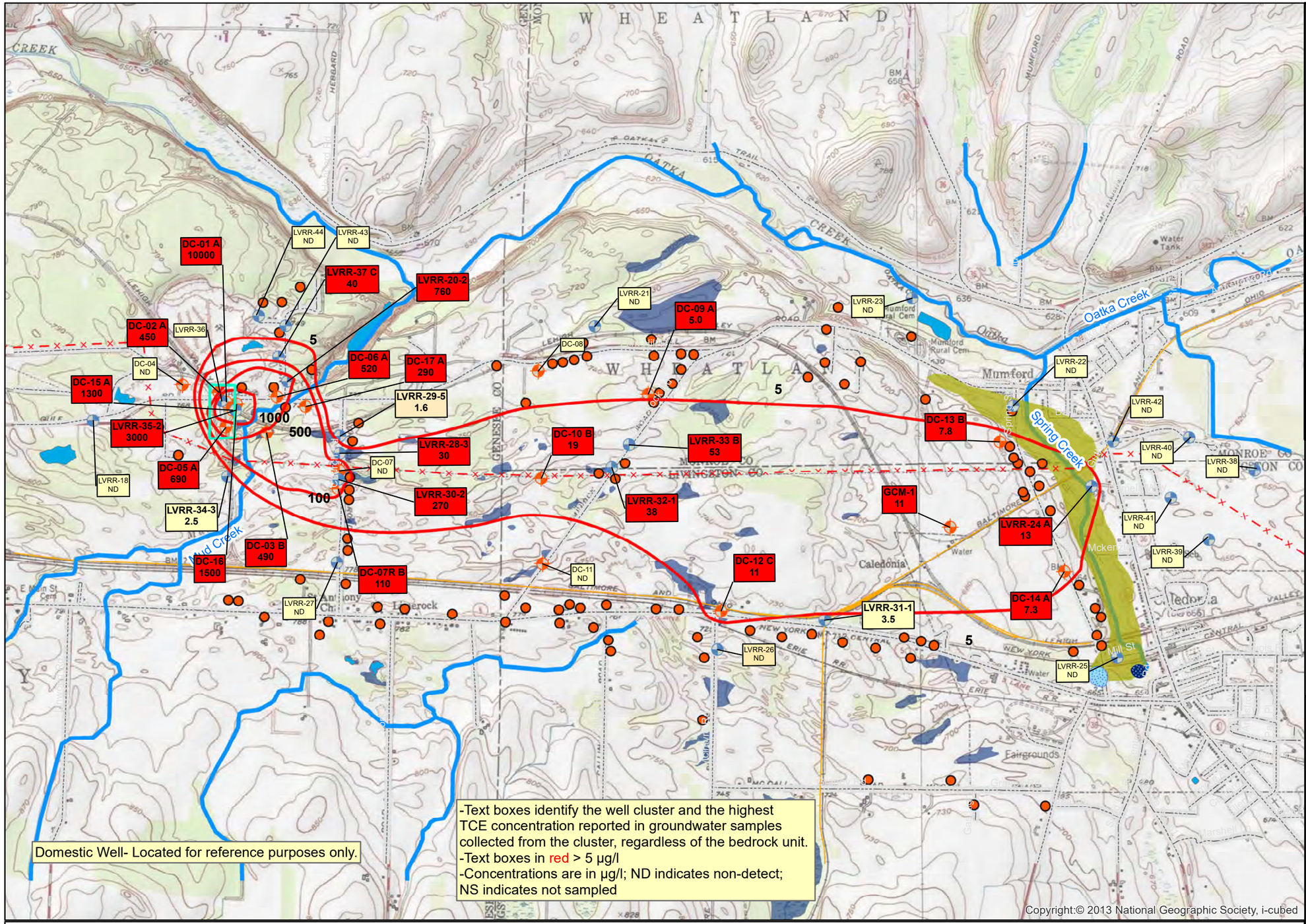


● = Approximate Study Area

Legend

- Approximate Spill Zone
- TCE Plume- December 2010
- LVRR Wells
- Existing DEC Well Clusters
- Domestic Wells
- Major Transmission Line
- Streams
- Railroad
- Roads
- Sinkholes

Original Figure 17A from UMC Report (LVRR RIR "Dec-2014")



0 1,250 2,500 5,000 7,500 10,000 Feet

Maximum TCE Concentrations May 2017

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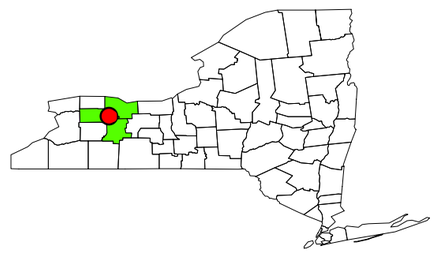
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-9
Feasibility Study Report

Author: RTM	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/6/23
Scale: 1 in:2,250 ft	**File:** Fig2-9_TCE_May2017

New York State



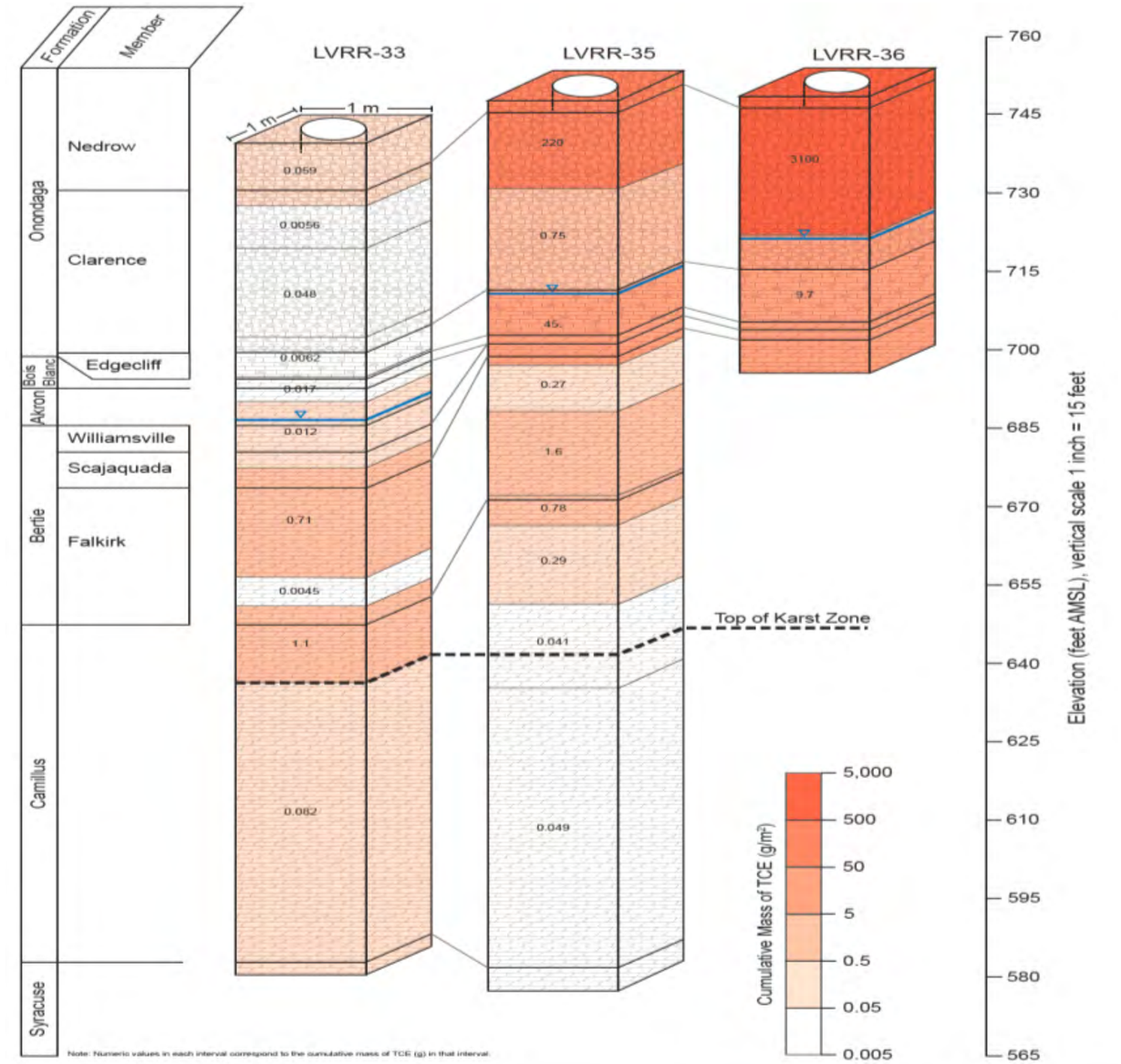
●= Approximate Study Area

Legend

- Big Spring
- Mackay Spring
- Approximate Spill Zone
- TCE Plume- May 2017
- LVRR Monitoring Well Cluster
- NYSDEC Monitoring Well Cluster
- Domestic Wells
- Major Transmission Line
- Spring Creek Fault Zone
- Streams
- Railroad
- Roads
- Sinkholes

Original Figure 9 from UMC Report (Addendum 1 to RIR "Feb-2018")

Plume ⟵ Source



From Stone Environmental Report

Mass Distribution in Rock Matrix

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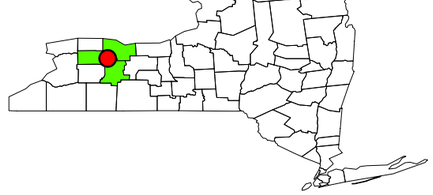
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

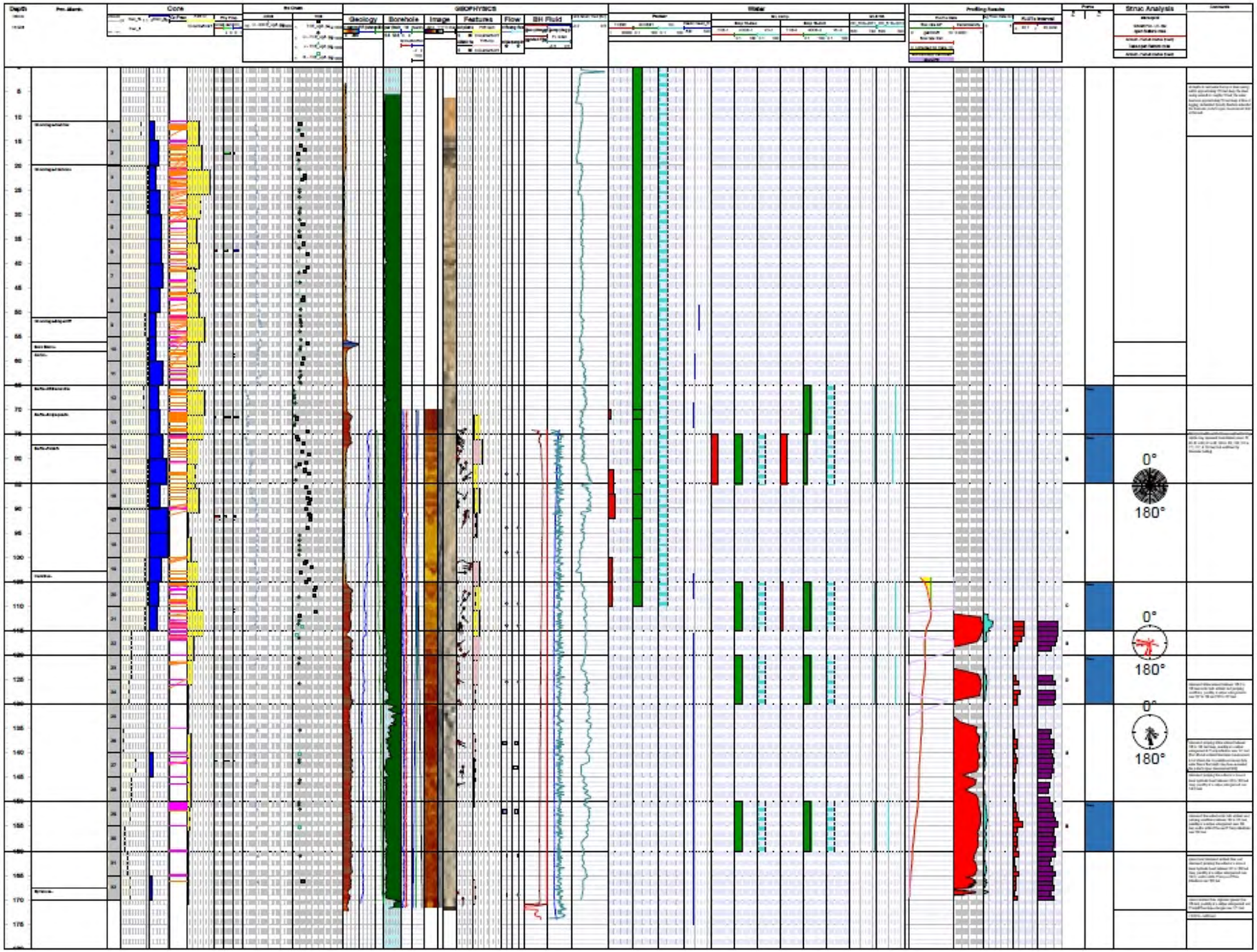
Figure 2-10
Feasibility Study Report

Author: CRW	**Checked By:** RTM
Project #: 2032	**Created:** 7/23/14
	Revised: 8/11/20
Scale:	**File:** Fig2-10_MassDis

New York State



● = Approximate Study Area



LVRR-33 Montage

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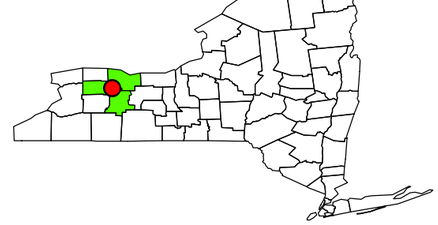
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

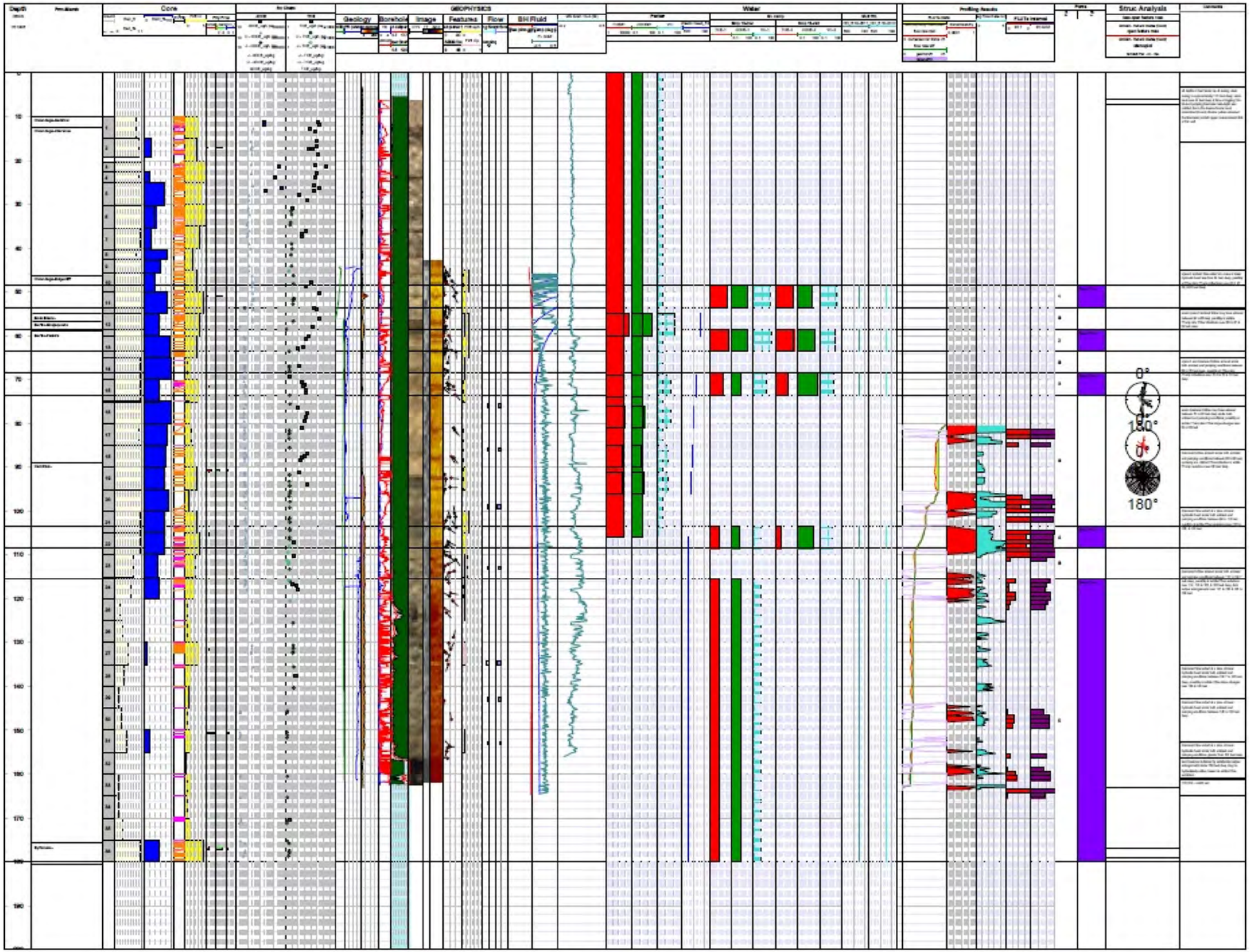
Figure 2-11
Feasibility Study Report

Author:	CRW	**Checked By:**	RTM
Project #:	2032	**Created:**	7/23/14
		Revised:	8/11/20
Scale:		**File:**	Fig2-11_LVRR33

New York State



● = Approximate Study Area



LVRR-35 Montage

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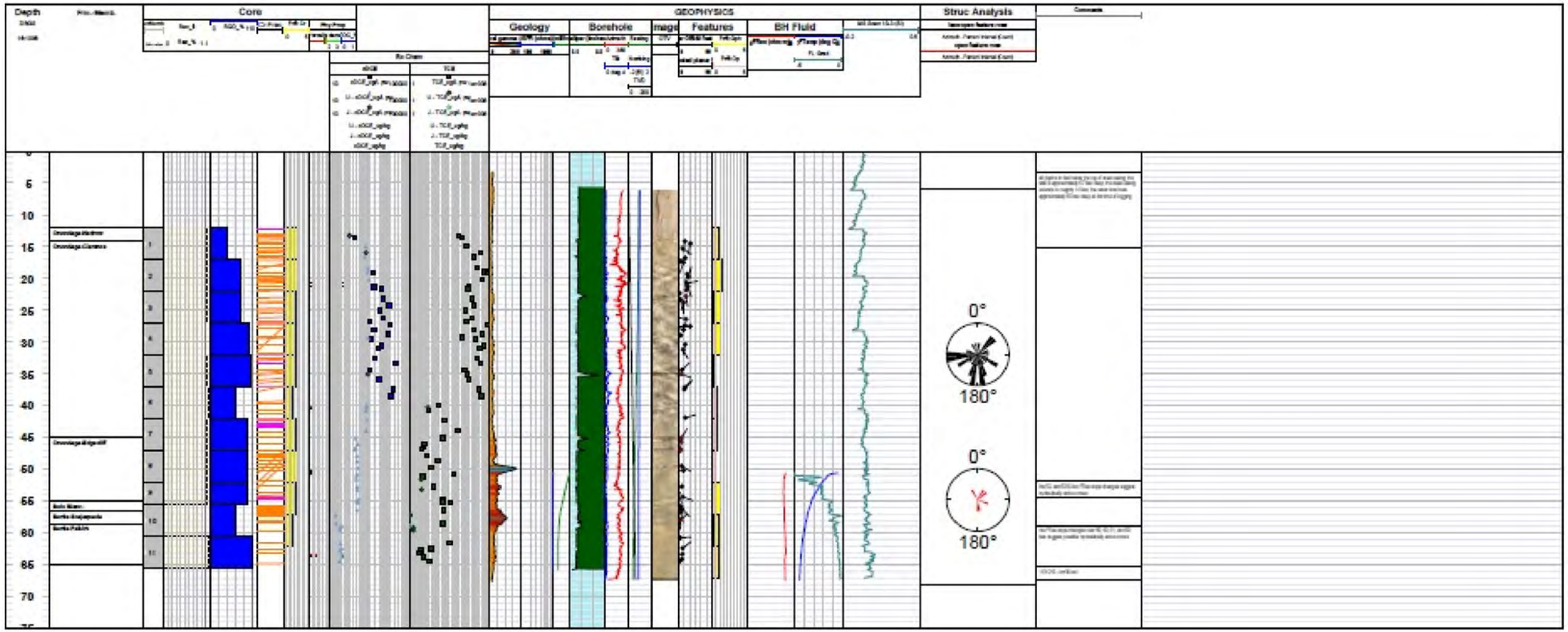
Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-12
Feasibility Study Report

Author:	CRW	**Checked By:**	RTM
Project #:	2032	**Created:**	7/23/14
		Revised:	8/11/20
Scale:		**File:**	Fig2-12_LVRR35

New York State

● = Approximate Study Area



LVRR-36 Montage

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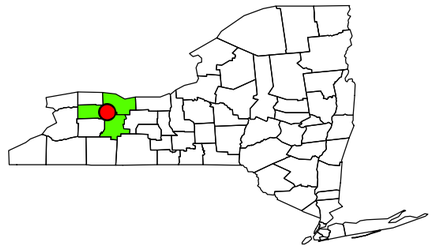
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

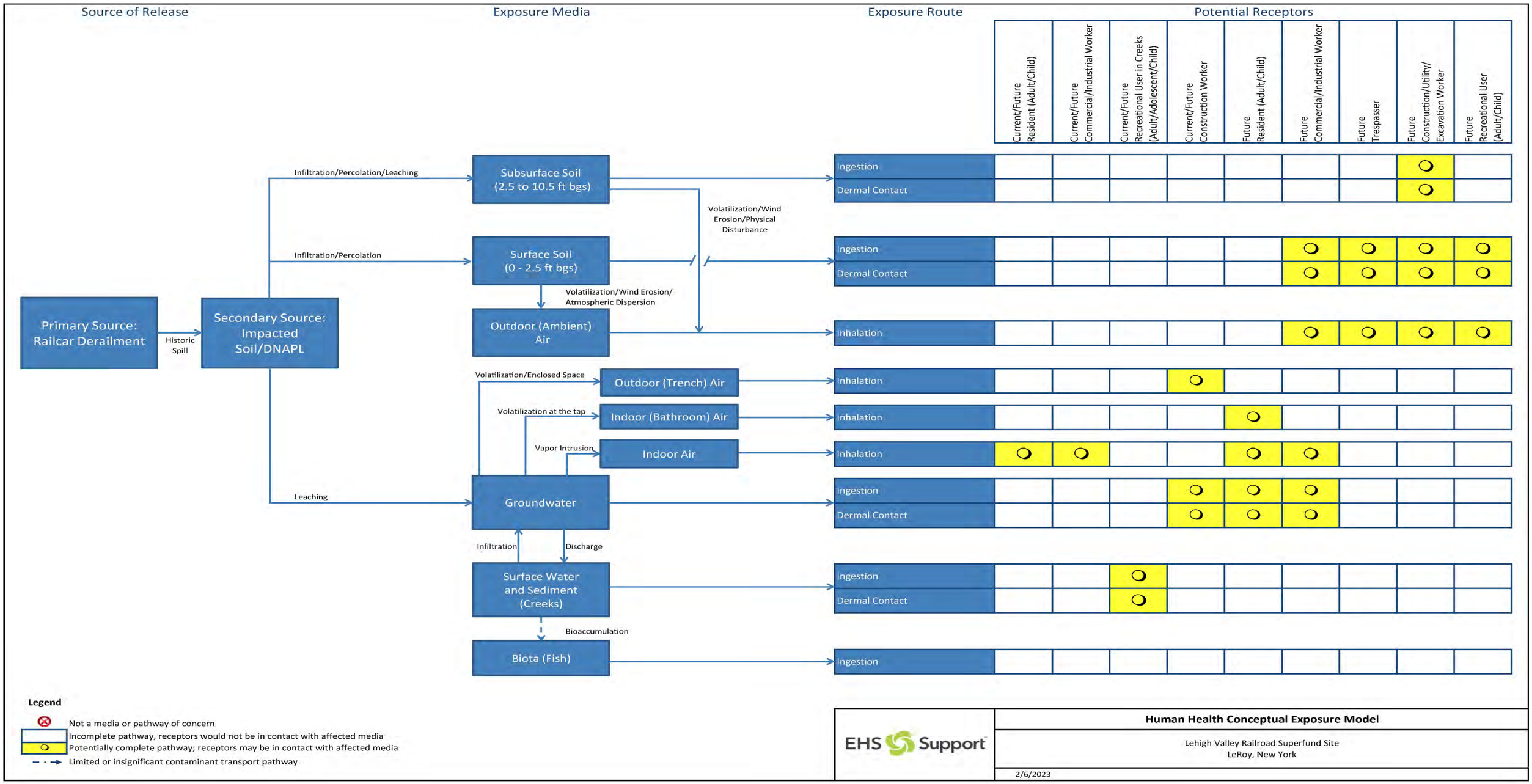
Figure 2-13
Feasibility Study Report

Author:	CRW	**Checked By:**	RTM
Project #:	2032	**Created:**	7/23/14
		Revised:	8/11/20
Scale:		**File:**	Fig2-13_LVRR36

New York State



● = Approximate Study Area



EHS Support

Human Health Conceptual Exposure Model

Lehigh Valley Railroad Superfund Site
LeRoy, New York

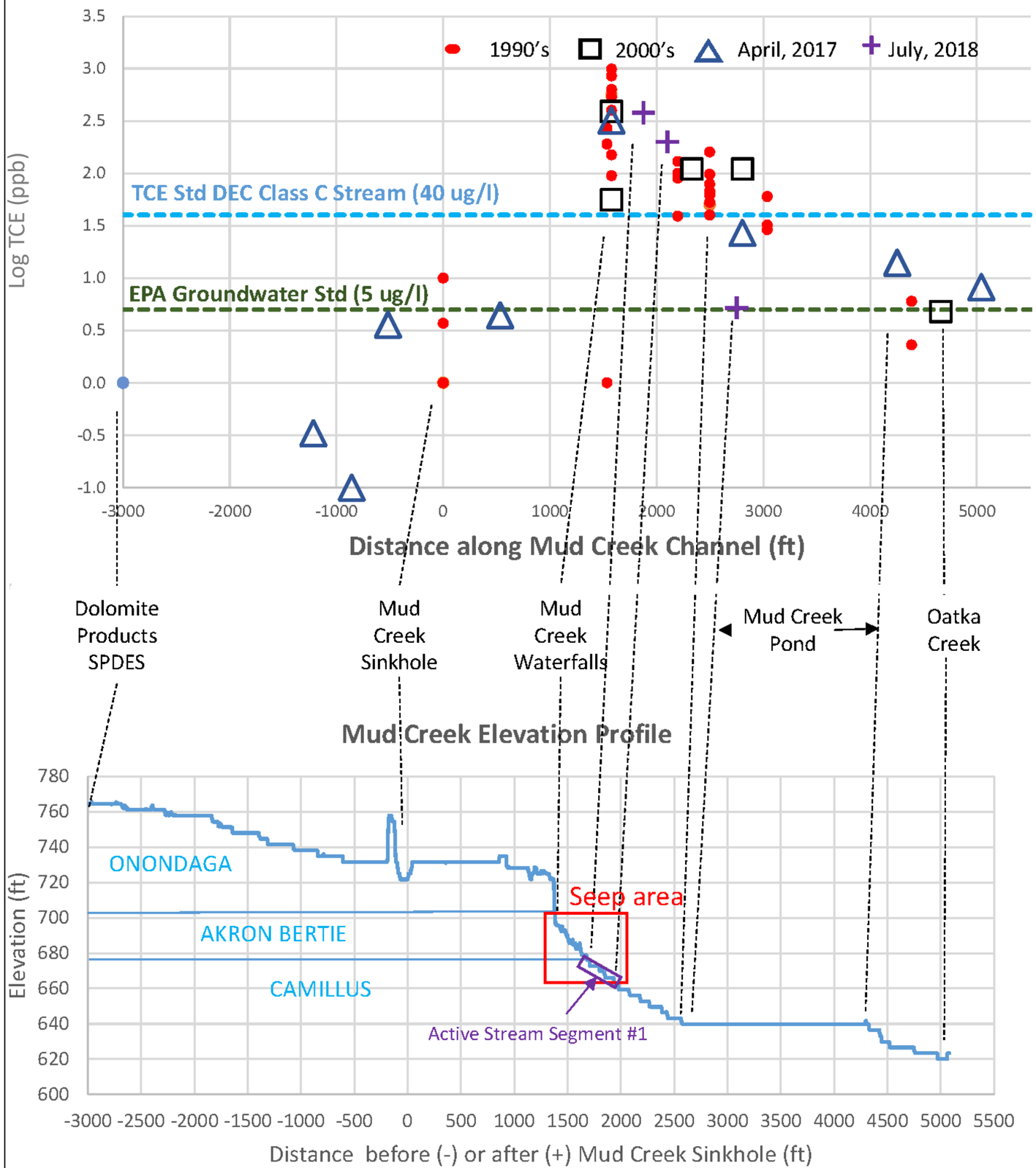
2/6/2023

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Figure 2-14	
Author: MEH	Project # 2032
Checked By: AL	Created: 06/02/2022
Revised: 02/07/2023	Source: EHS Support
File: Figure2-14 Human Health Conceptual Exposure Model Feb23	





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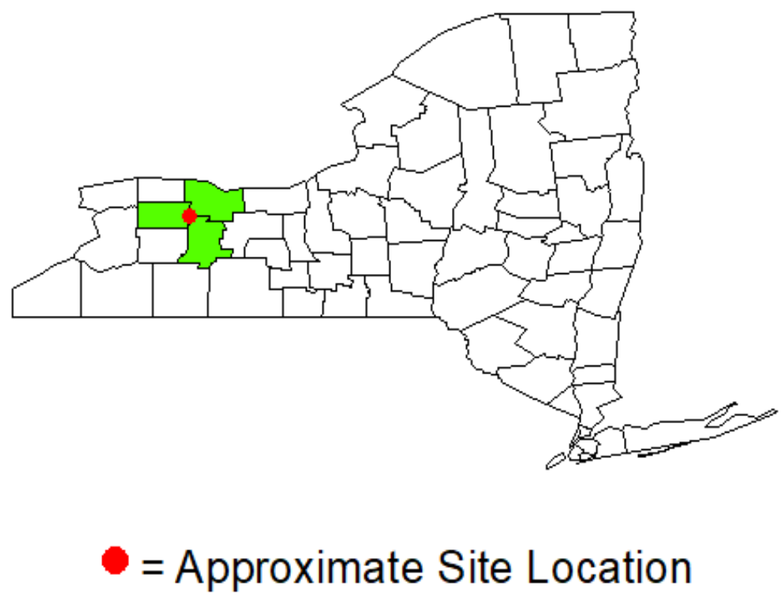
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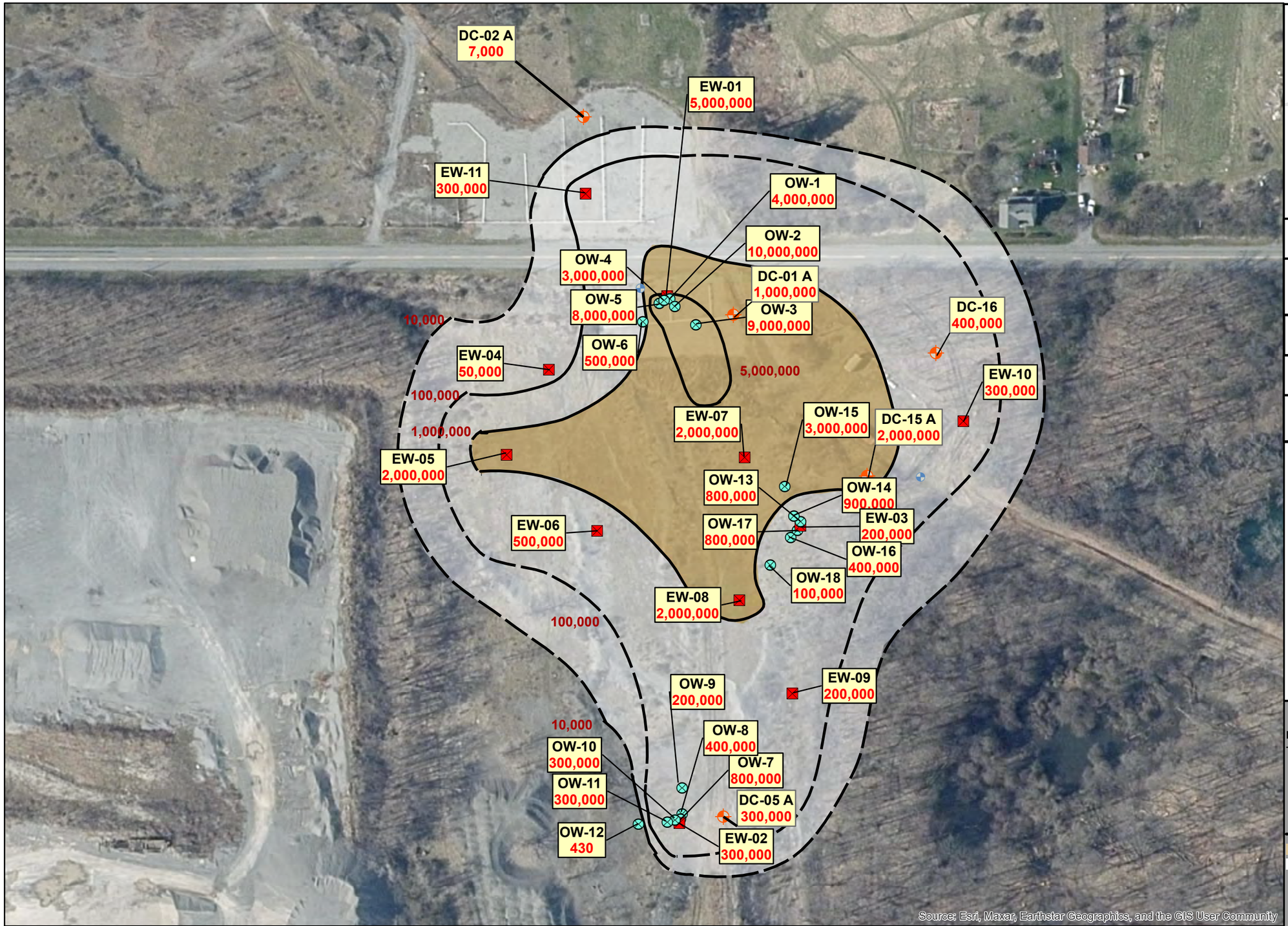
Mud Creek Elevation and TCE Concentration Profiles
Historical Spring/ Surface Water TCE Concentrations

Figure 2-15

Author: MEH	Checked: NRH/ZDD
Project #:2032	Created: 06/01/2022
Revised:	Source: Dr. Paul Richards

File Name: Fig2-15_Profiles





0 100 200 400 Feet

TCE Bedrock Vapor Map

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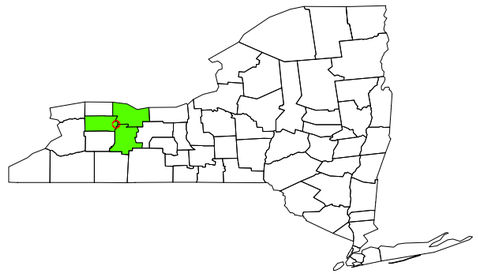
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-16

Author: RTM	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 2/7/23
Scale: 1 in:110 ft	**File:** Fig2-16_EW_TCE_MG

New York State



● = Approximate Site Location

Legend

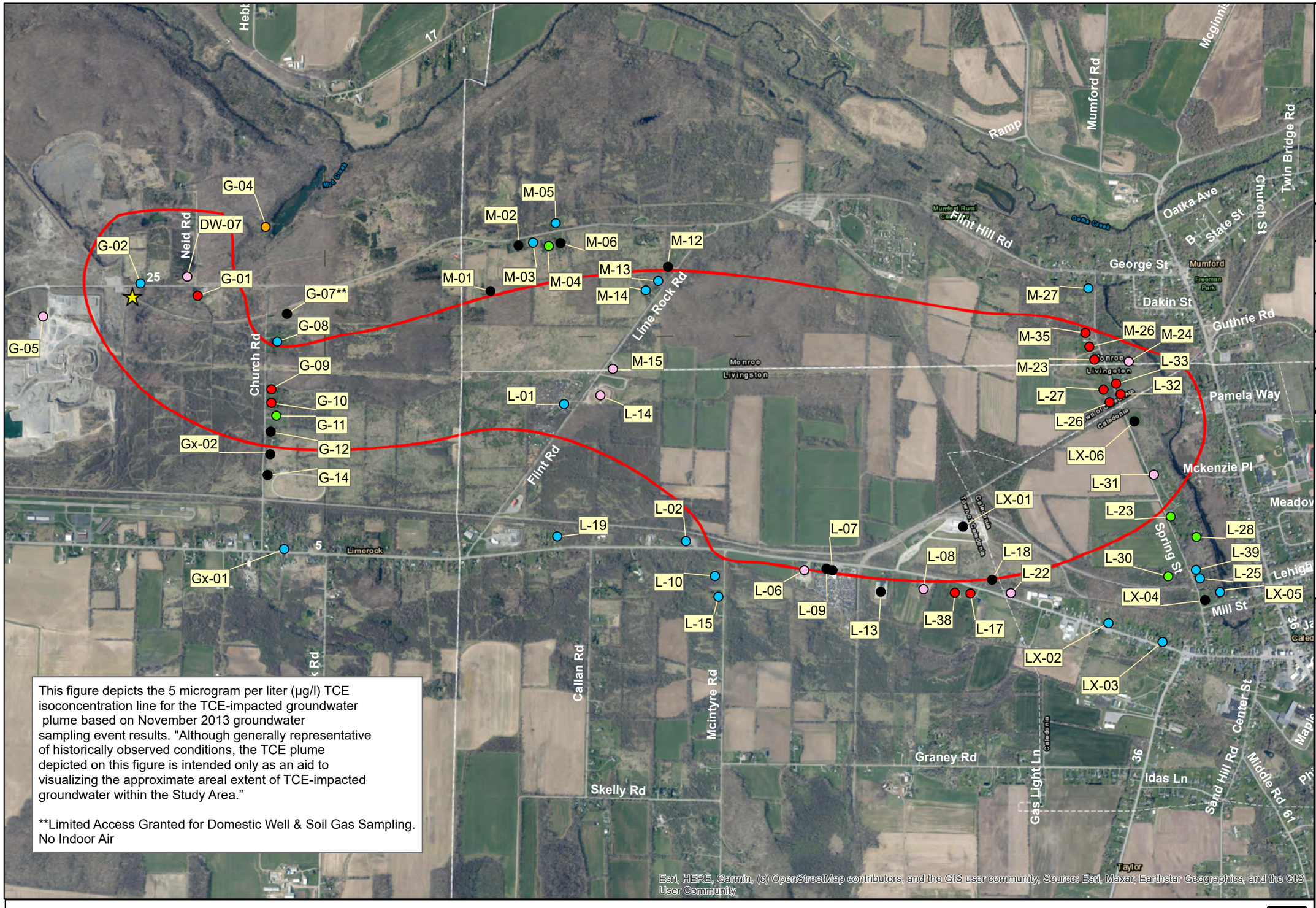
Extraction Wells

TYPE

- Observation Wells
- Extraction Wells
- Monitoring Well
- DEC Well Clusters
- TCE Concentration Contour from November 2013 Extraction Well Sampling
- Proposed 2 Acre Study Area
- Proposed 10 Acre Study Area

Concentrations in µg/m³ for Extraction Well Samples

Bedrock TCE Concentration Map was from the Remedial Investigation Report from December 2014



This figure depicts the 5 microgram per liter (µg/l) TCE isoconcentration line for the TCE-impacted groundwater plume based on November 2013 groundwater sampling event results. "Although generally representative of historically observed conditions, the TCE plume depicted on this figure is intended only as an aid to visualizing the approximate areal extent of TCE-impacted groundwater within the Study Area."

**Limited Access Granted for Domestic Well & Soil Gas Sampling. No Indoor Air

1,000 500 0 1,000 2,000 Feet

Indoor Air Alternative
Area of Interest

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FIGURE 2-17

Author: RTM | **Checked By:** ----

Project #: 2032 | **Created:** 7/11/10 | **Revised:** 3/10/20

Scale: 1 in:1,698 ft | **File:** Fig2-18_AirSample_Locs_2020

New York State



= Approximate Site Location

Legend

- Refused
- Sampled
- Not Sampled
- Mitigated
- ID Source
- No Further Action
- **UMC Site Trailer**
- 5 µg/l Isoconcentration Line



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Figure 2-18
Feasibility Study Report

Author: RTM	**Checked By:** ----
Project #: 2032	**Created:** 7/11/10 **Revised:** 2/7/23
Scale: 1 in:669 ft	**File:** Fig2-18_AirSample_Church

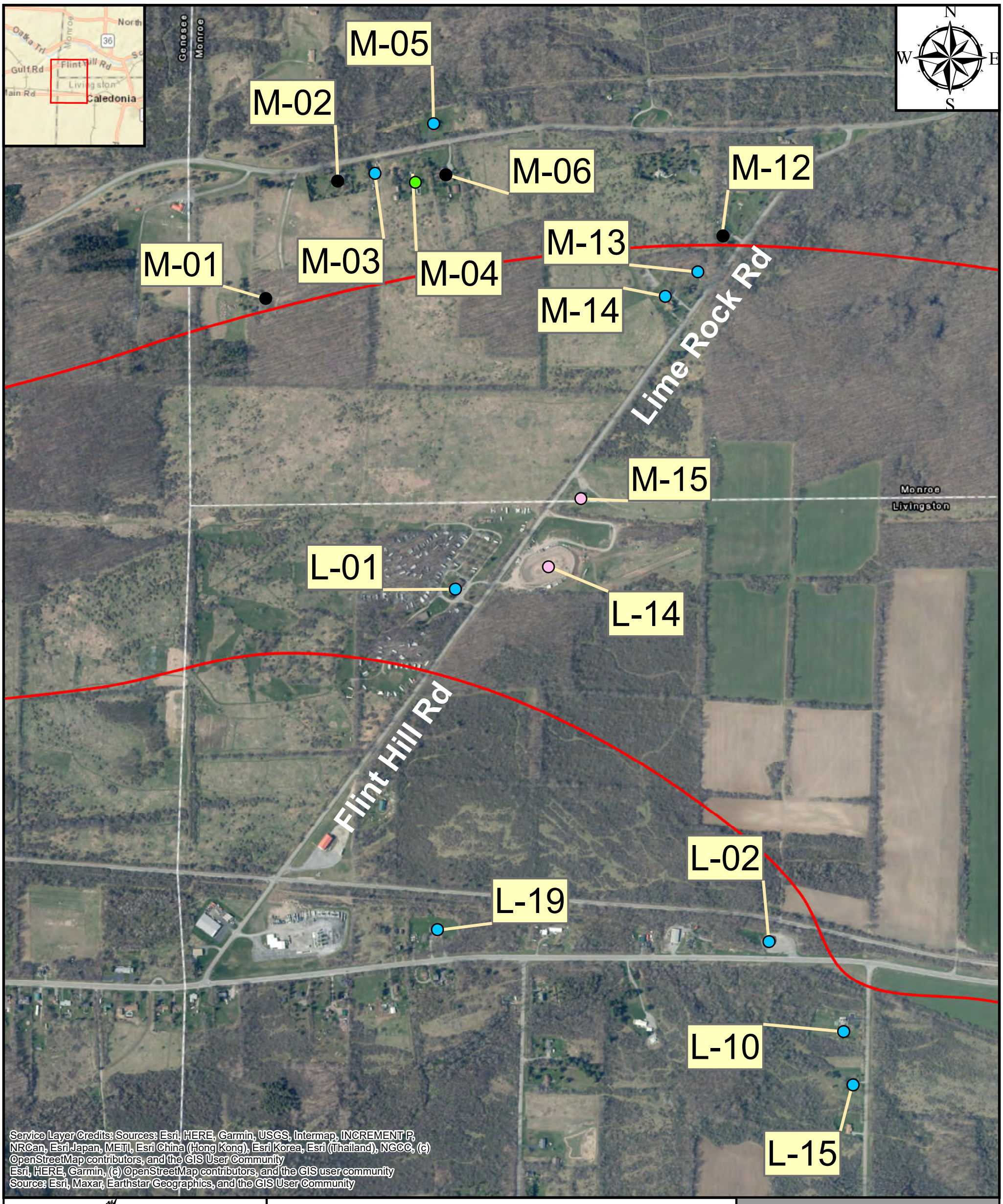
Indoor Air Monitoring Location Map- Church Road Area

This figure depicts the 5 microgram per liter (µg/l) TCE isoconcentration line for the TCE-impacted groundwater plume based on November 2013 groundwater sampling event results. "Although generally representative of historically observed conditions, the TCE plume depicted on this figure is intended only as an aid to visualizing the approximate areal extent of TCE-impacted groundwater within the Study Area."

0 500 1,000 2,000 Feet

Legend

- Refused
- Sampled
- Not Sampled
- Mitigated
- ID Source
- No Further Action
- 5 µg/l Isoconcentration Line



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Figure 2-19
Feasibility Study Report

Author: RTM	**Checked By:** ----
Project #: 2032	**Created:** 7/11/10 **Revised:** 2/7/23
Scale: 1 in:666 ft	**File:** Fig2-19_AirSampleFlint

Indoor Air Monitoring Location Map- Flint Hill and Lime Rock Road Area

This figure depicts the 5 microgram per liter (µg/l) TCE isoconcentration line for the TCE-impacted groundwater plume based on November 2013 groundwater sampling event results. "Although generally representative of historically observed conditions, the TCE plume depicted on this figure is intended only as an aid to visualizing the approximate areal extent of TCE-impacted groundwater within the Study Area."

0 470 940 1,880 Feet

Legend

- Refused
- Sampled
- Not Sampled
- Mitigated
- ID Source
- No Further Action
- 5 µg/l Isoconcentration Line



Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 2-20
Feasibility Study Report

Author: RTM	**Checked By:** ----
Project #: 2032	**Created:** 7/11/10 **Revised:** 2/7/23
Scale: 1 in:833 ft	**File:** Fig2-20_AirSampleSpring

Indoor Air Monitoring Location Map- Spring Street Area

This figure depicts the 5 microgram per liter (µg/l) TCE isoconcentration line for the TCE-impacted groundwater plume based on November 2013 groundwater sampling event results. "Although generally representative of historically observed conditions, the TCE plume depicted on this figure is intended only as an aid to visualizing the approximate areal extent of TCE-impacted groundwater within the Study Area."

0 500 1,000 2,000 Feet

Legend

- Refused
- Sampled
- Not Sampled
- Mitigated
- ID Source
- No Further Action
- 5 µg/l Isoconcentration Line

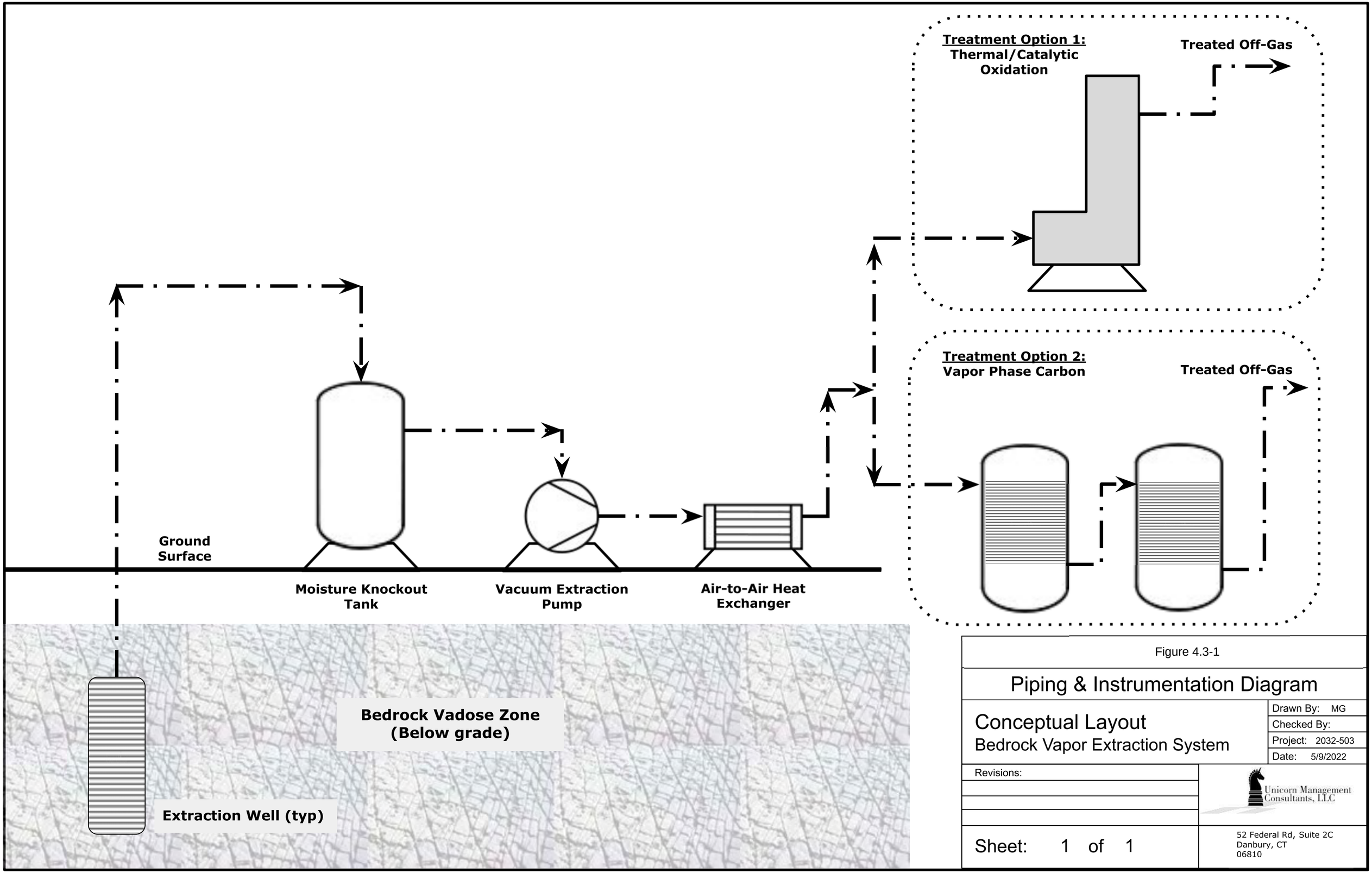


Figure 4.3-1

Piping & Instrumentation Diagram

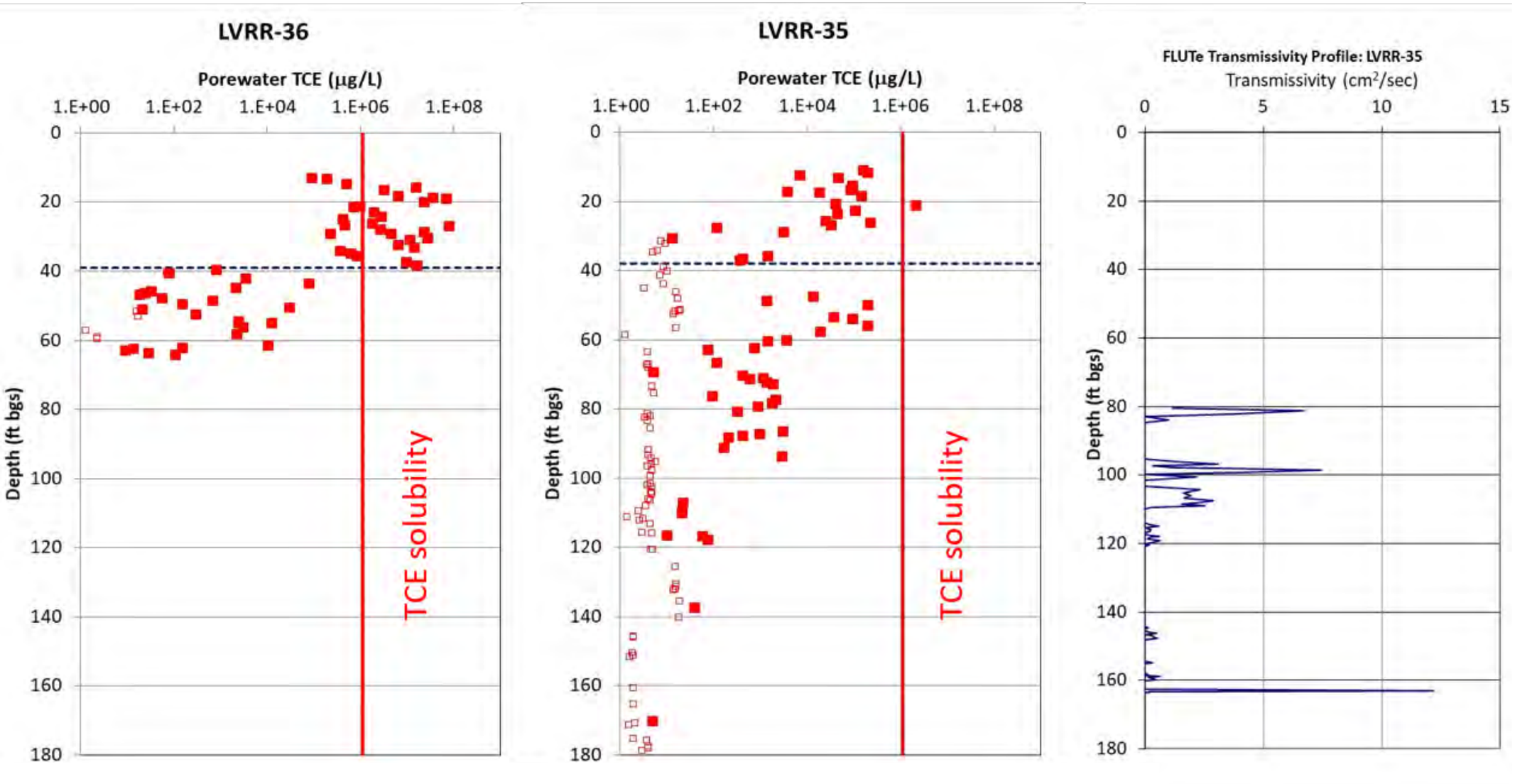
Conceptual Layout
Bedrock Vapor Extraction System

Drawn By: MG
Checked By:
Project: 2032-503
Date: 5/9/2022

Revisions:

Sheet: 1 of 1

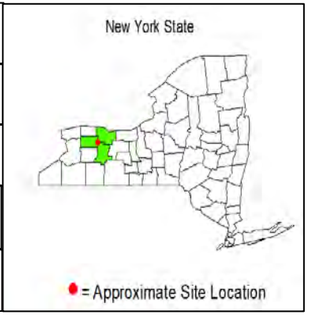
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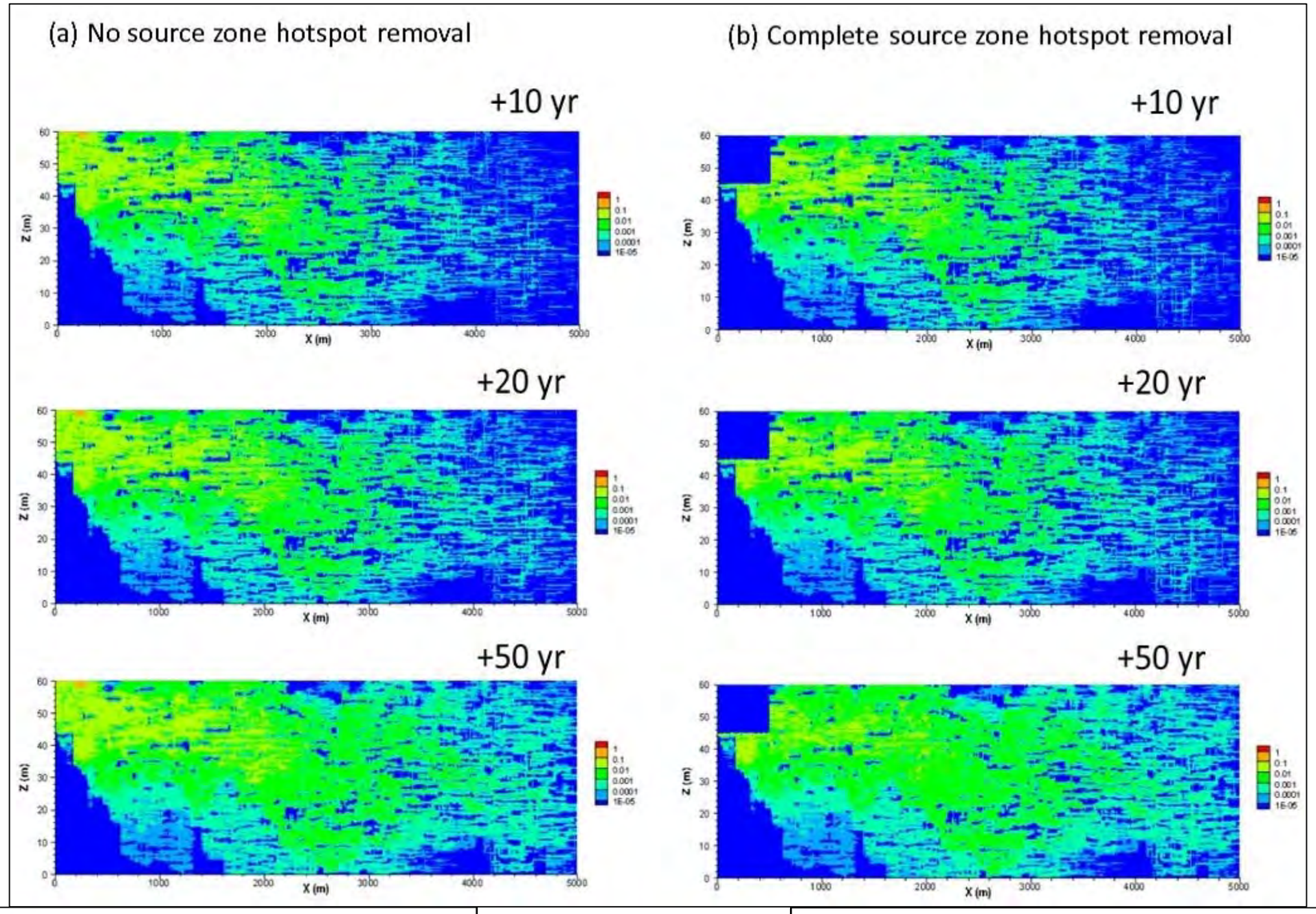
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Figure 4.3-2	
Author: MEH	Project # 2032
Checked By: MP	Created: 06/02/2022
Revised:	Source: Stone Environmental, INC.
File: Figure 4.3-2 Rock Core Profile Comparison	



DFN Modeling Results with and without Remediation



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Figure 4.3-3

Author: MEH	Project # 2032
Checked By: MP	Created: 06/02/2022
Revised:	Source: Stone Environmental, INC.

File: Figure 4.3-3 DFN Modeling Results with and without Remediation



Figure 4.3-4
Depth To Water DC-01B (2015)

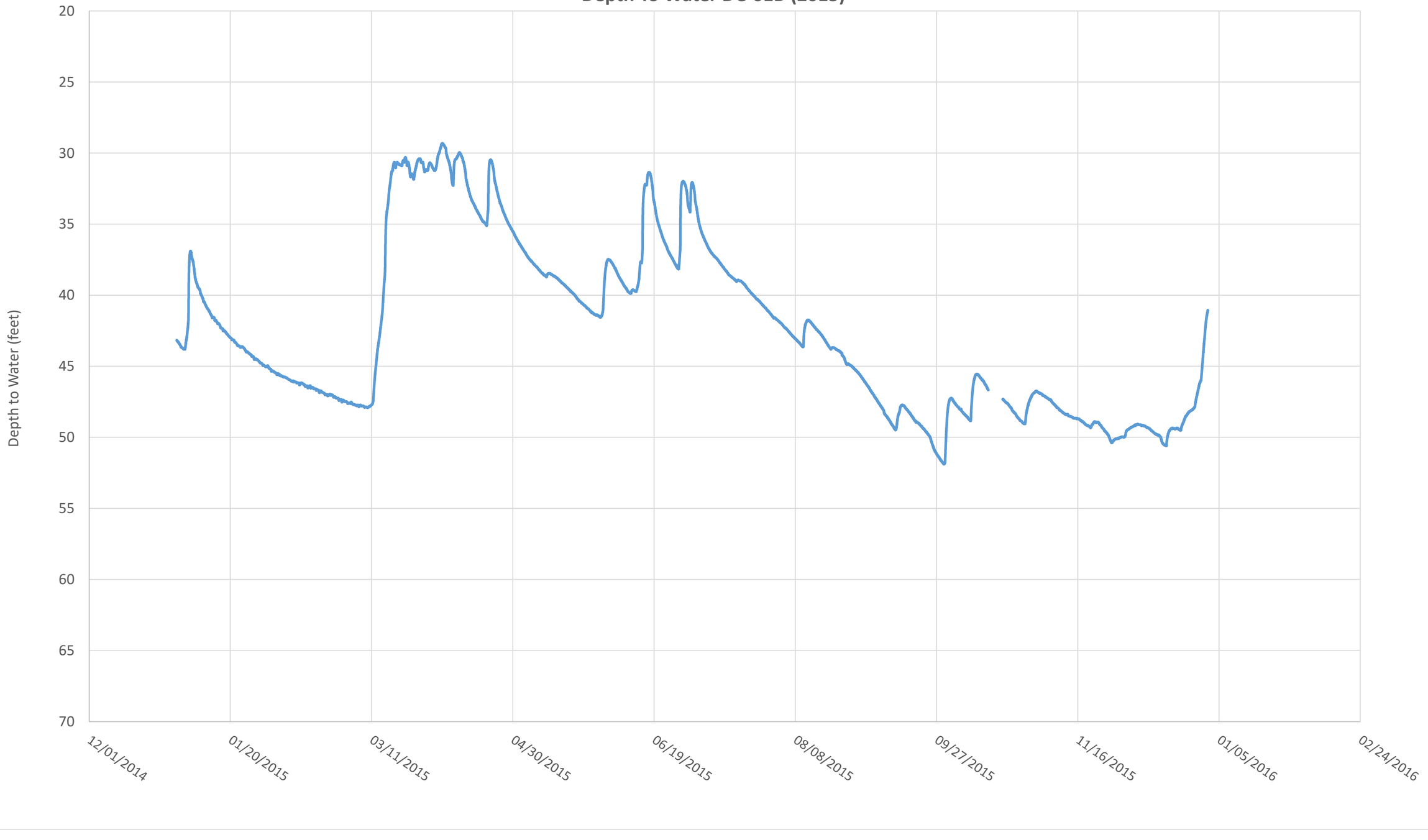


Figure 4.3-5
Depth To Water DC-01B (2016)

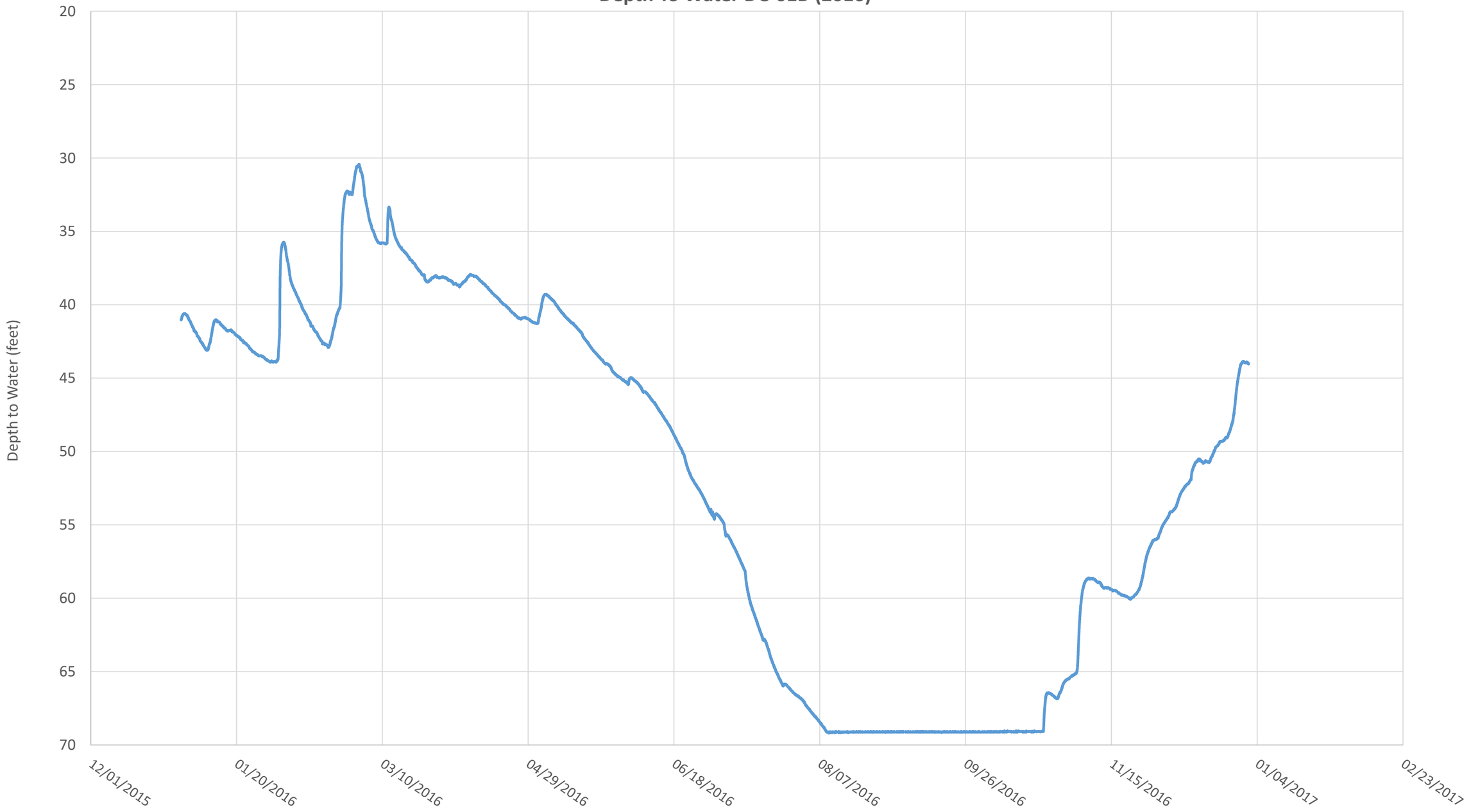


Figure 4.3-6
Depth To Water DC-01B (2017)

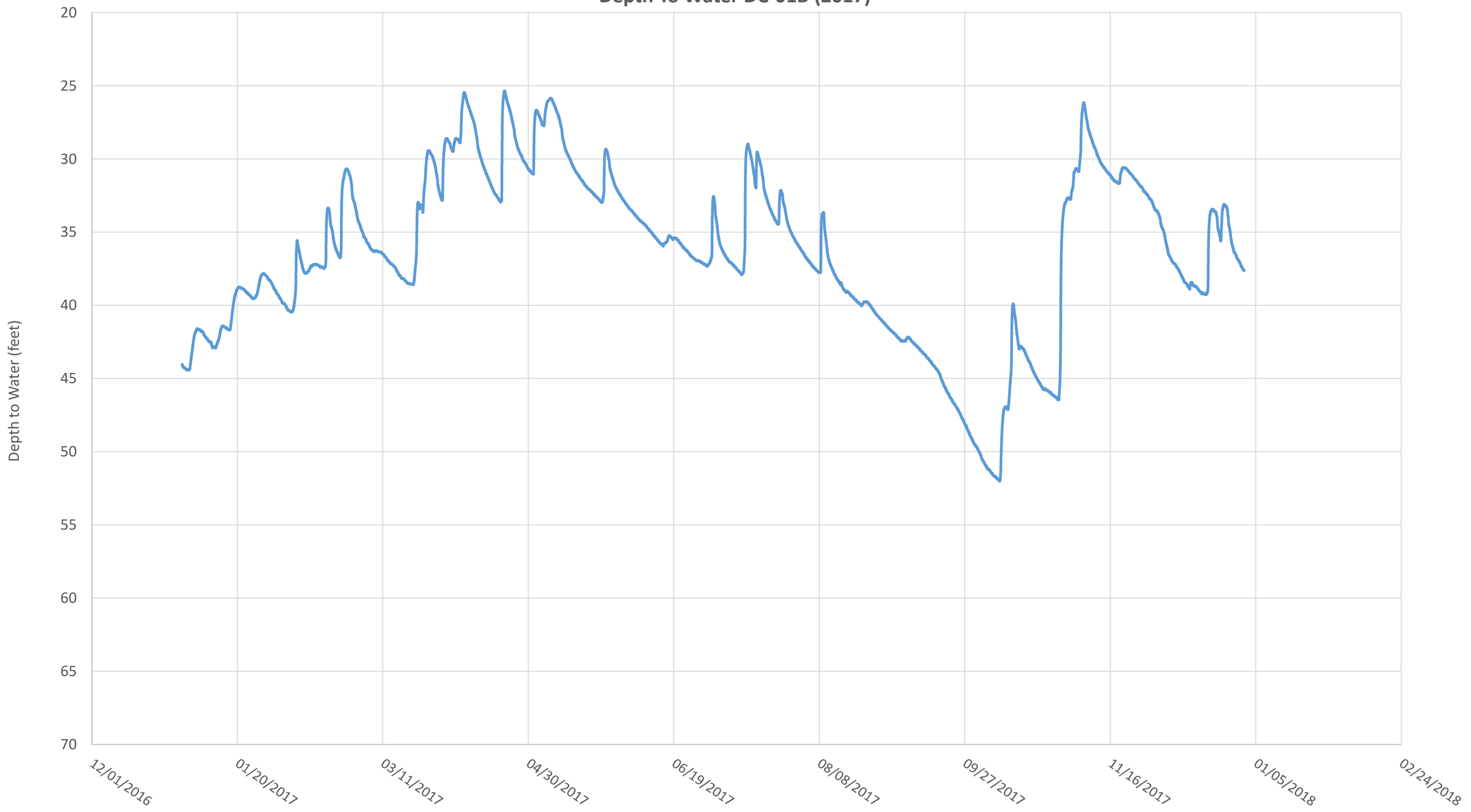


Figure 4.3-7
Depth To Water DC-01B (2018)

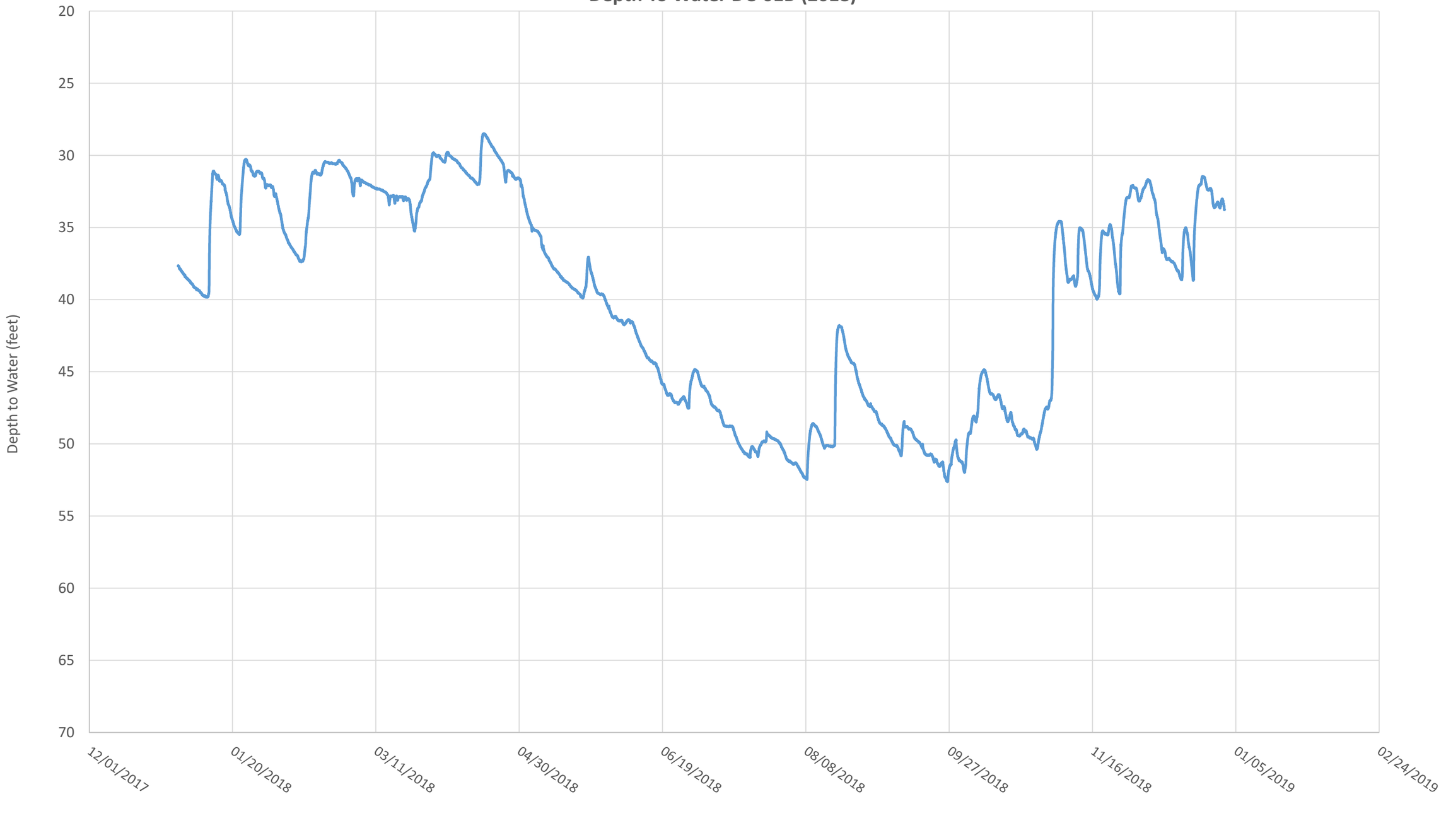


Figure 4.3-8
Depth To Water DC-01B (2019)

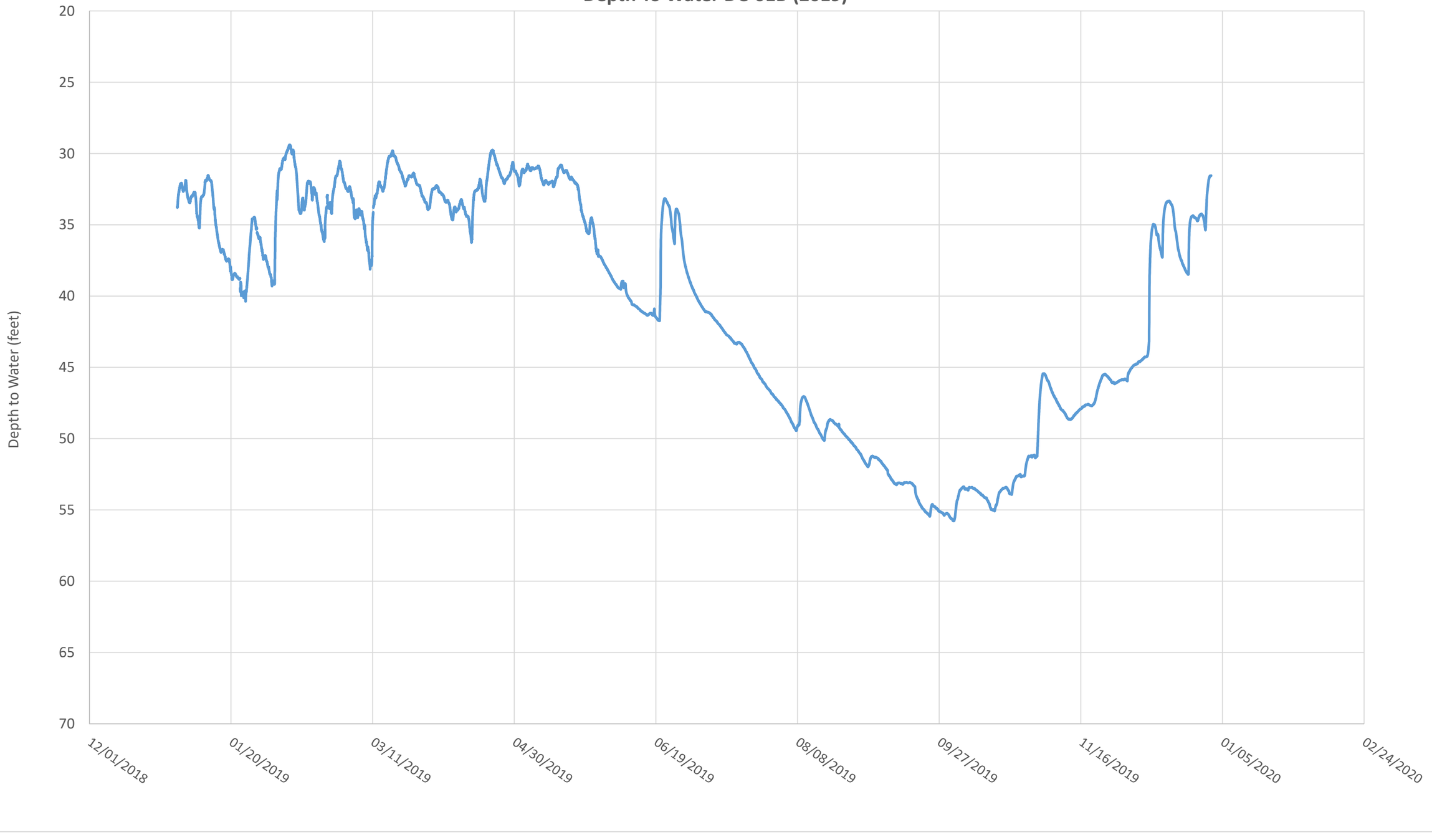
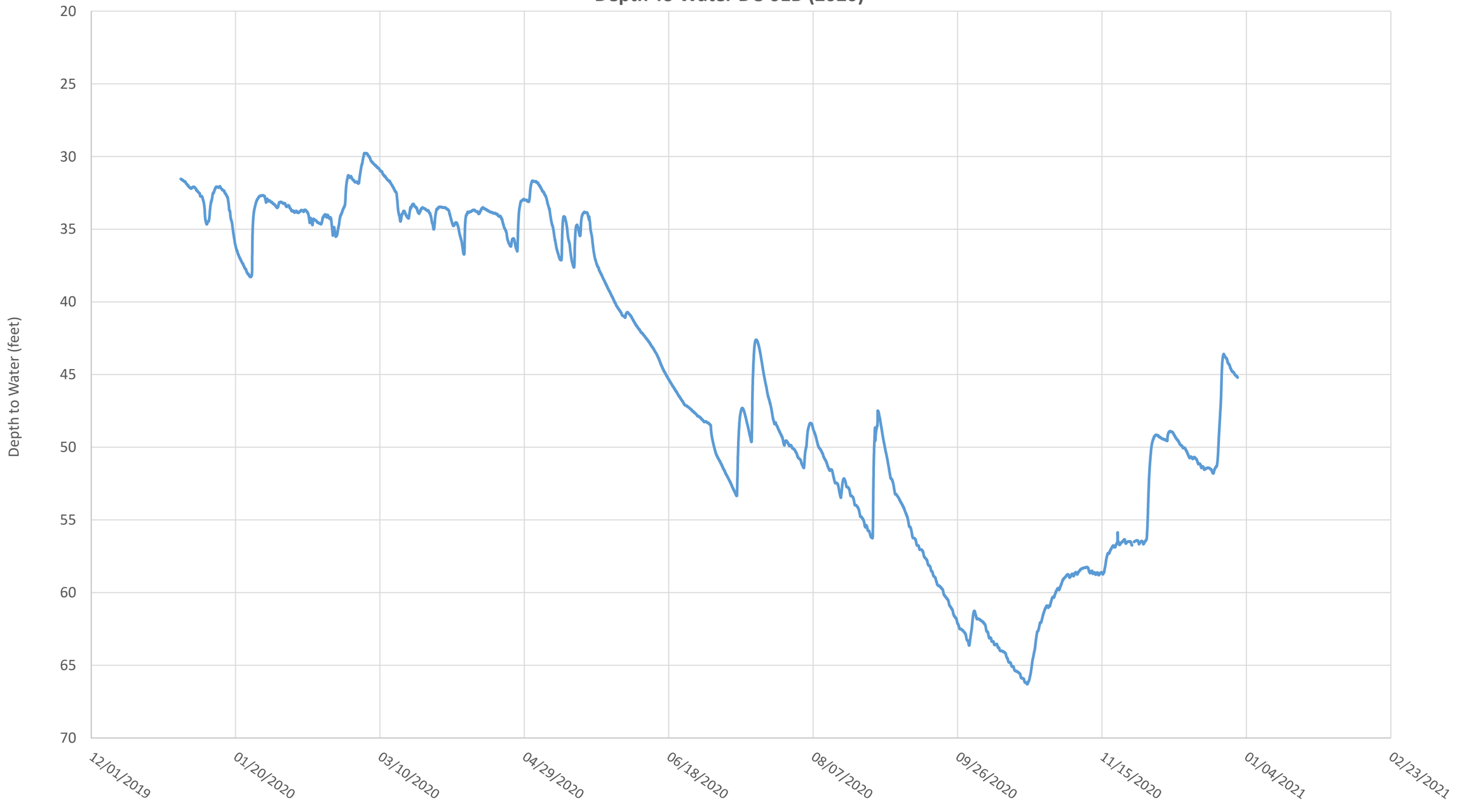


Figure 4.3-9
Depth To Water DC-01B (2020)

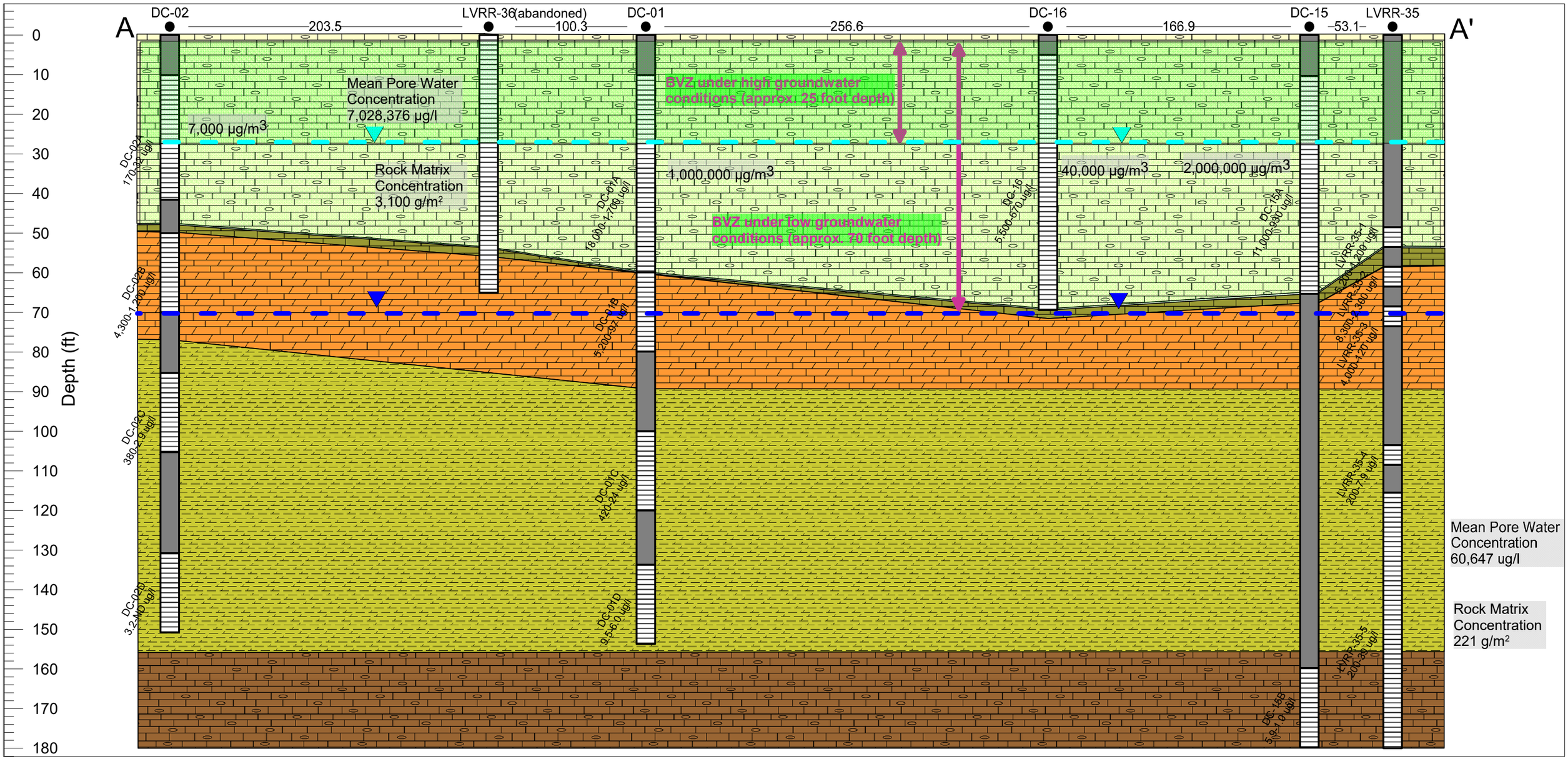


Project Name:

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Derailment Superfund Site

Figure 4.3-10
Extent of the Bedrock Vadose Zone (Section View)

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Vertical Exaggeration: 2.52

- Average Seasonally High Groundwater Level
- Average Seasonally Low Groundwater Level
- Sample Interval

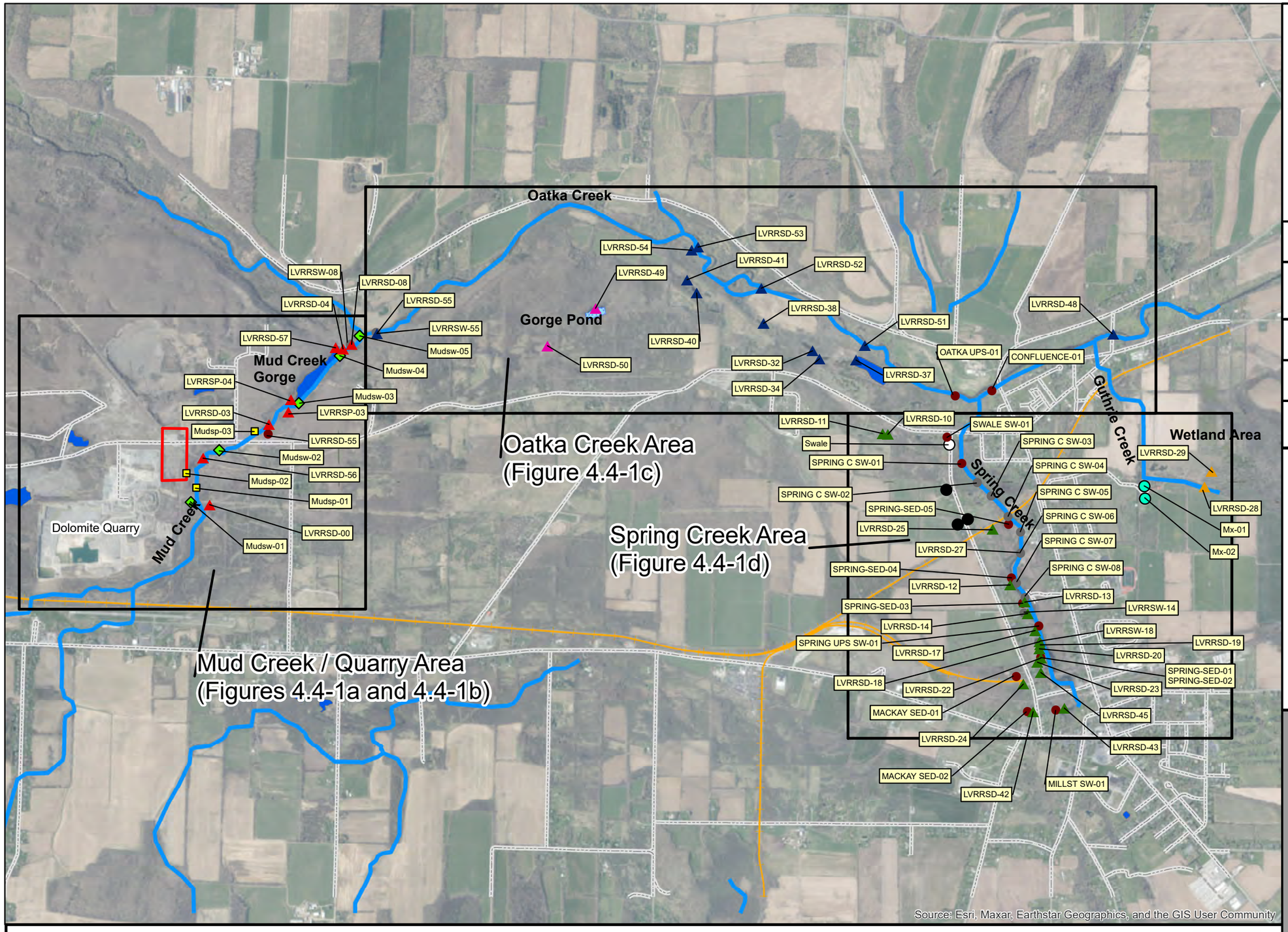
Formations

- Onondaga
- Bois Blanc
- Bertie
- Camillus
- Syracuse

Notes:

1) The seasonally high/low groundwater levels were calculated from transducer data collected from monitoring well DC-1B (2016 through 2020)
2) Figure indicates the range of TCE concentrations in micrograms per liter (µg/l) observed in groundwater samples collected from each sample interval during the 1st through 12th quarter sampling events.
3) Figure indicates the bedrock vapor concentrations observed in DC-1A, DC-2A, DC-15 and DC-16 in micrograms per cubic meter (µg/m^3).
4) Figure indicates the mean pore water and rock matrix concentrations reported by Stone in LVRR-35 and LVRR-36 in µg/l and grams per square meter (g/m$_2$), respectively.

Author: CRW
Date: 1/5/15
File: Figure 4.3-10 - Spill_Zone_Cross_Section



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

0 2,000 4,000 8,000 Feet

Spring/Seep, Surface Water and Sediment Sampling Locations
2009/2010, 2012, 2017 and 2018 Locations

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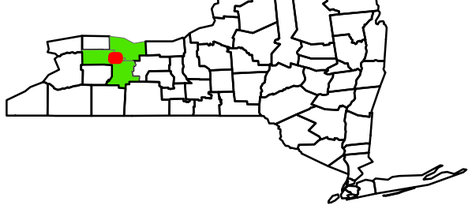
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Project Name:	Lehigh Valley Railroad Derailment Superfund Site

Figure 4.4-1

Author:	NRH	**Checked By:**	
Project #:	2032	**Created:**	9/24/08
		Revised:	1/30/23
Scale:	1 in:2,277 ft	**File:**	Fig4.4-1_ReferenceLocs

New York State

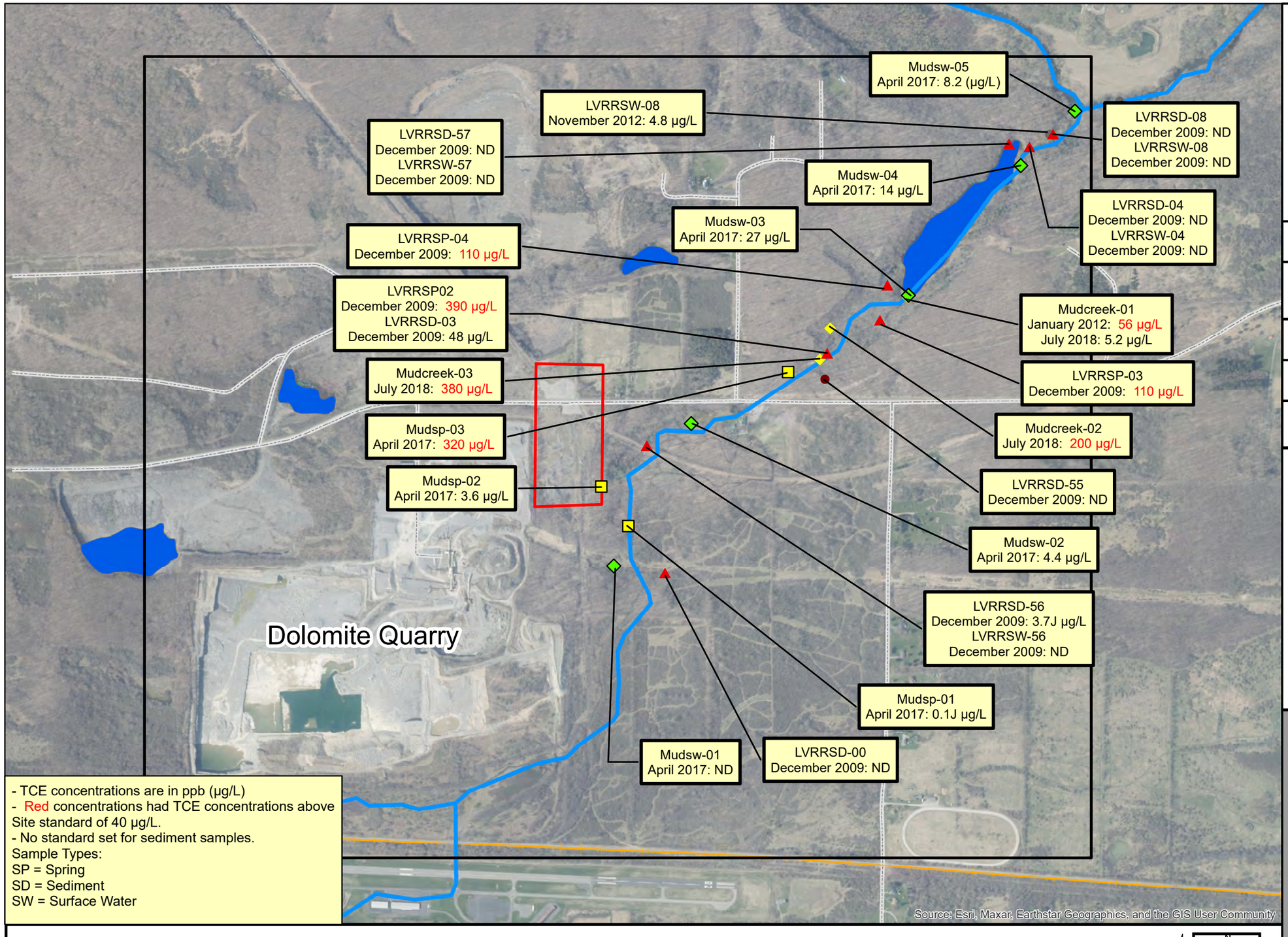


● = Approximate Study Area

Legend

Spring/Seep, Surface Water and Sediment Sampling Locations

- Mud Creek Drainage
- Oatka Creek Drainage
- Gorge Pond
- Spring Creek Drainage
- Wetland Area East of Spring Creek
- January 2012 Location
- November 2012 Location
- Mud Creek Spring Sample- April 2017
- Mud Creek Surface Water Sample- April 2017
- Residential Sump Sample- May 2017
- Residential Water Supply Sample- May 2017
- Swale Sample- May 2017
- Railroad
- Roads
- Streams
- Gorge Pond
- Sample Areas
- Approximate Spill Zone



- TCE concentrations are in ppb (µg/L)
- Red concentrations had TCE concentrations above Site standard of 40 µg/L.
- No standard set for sediment samples.

Sample Types:
SP = Spring
SD = Sediment
SW = Surface Water

0 500 1,000 2,000 Feet

Spring/Seep, Surface Water and Sediment Sampling Locations (Mud Creek/Quarry Area) 2009/2010, 2012, 2017 and 2018 Locations

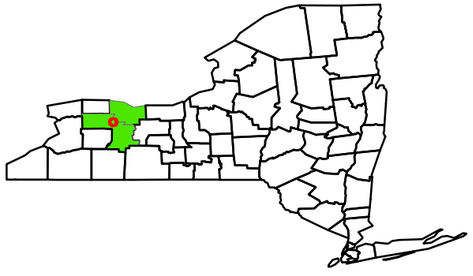
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Project Name:	Lehigh Valley Railroad Derailment Superfund Site

Figure 4.4-1a

Author:	NRH	**Checked By:**	
Project #:	2032	**Created:**	9/24/08
		Revised:	1/31/23
Scale:	1 in:833 ft	**File:**	Fig4.4-1a_MudCrResults

New York State



● = Approximate Study Area

Legend

Spring/Seep, Surface Water and Sediment Sampling Locations

- Mud Creek Drainage
- Oatka Creek Drainage
- Gorge Pond
- Spring Creek Drainage
- Wetland Area East of Spring Creek
- January 2012 Location
- November 2012 Location
- Mud Creek Spring Sample- April 2017
- Mud Creek Surface Water Sample- April 2017
- Mud Creek Sample Location- 2018

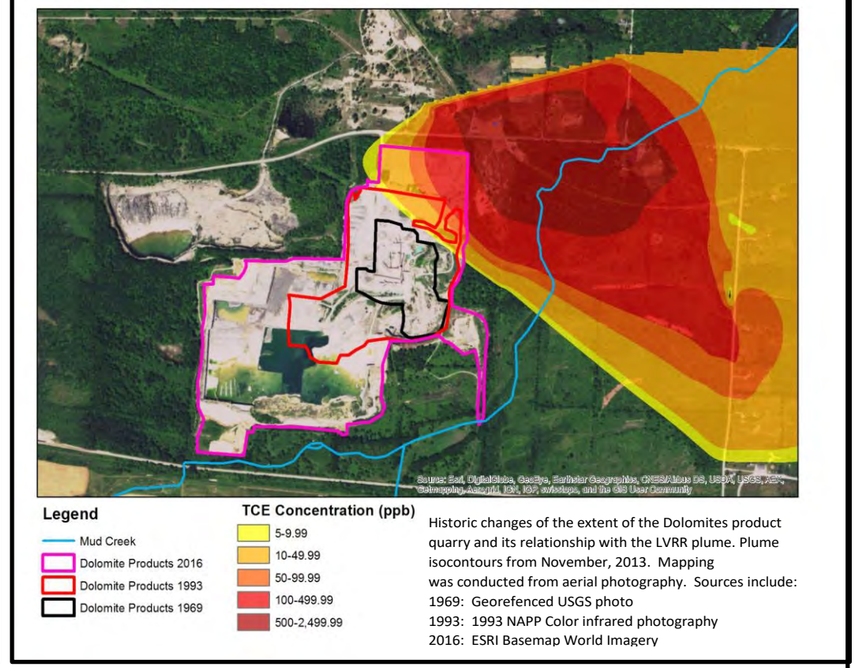
- Railroad
- Roads
- Streams
- Gorge Pond
- Approximate Spill Zone
- Mud Creek / Quarry Area



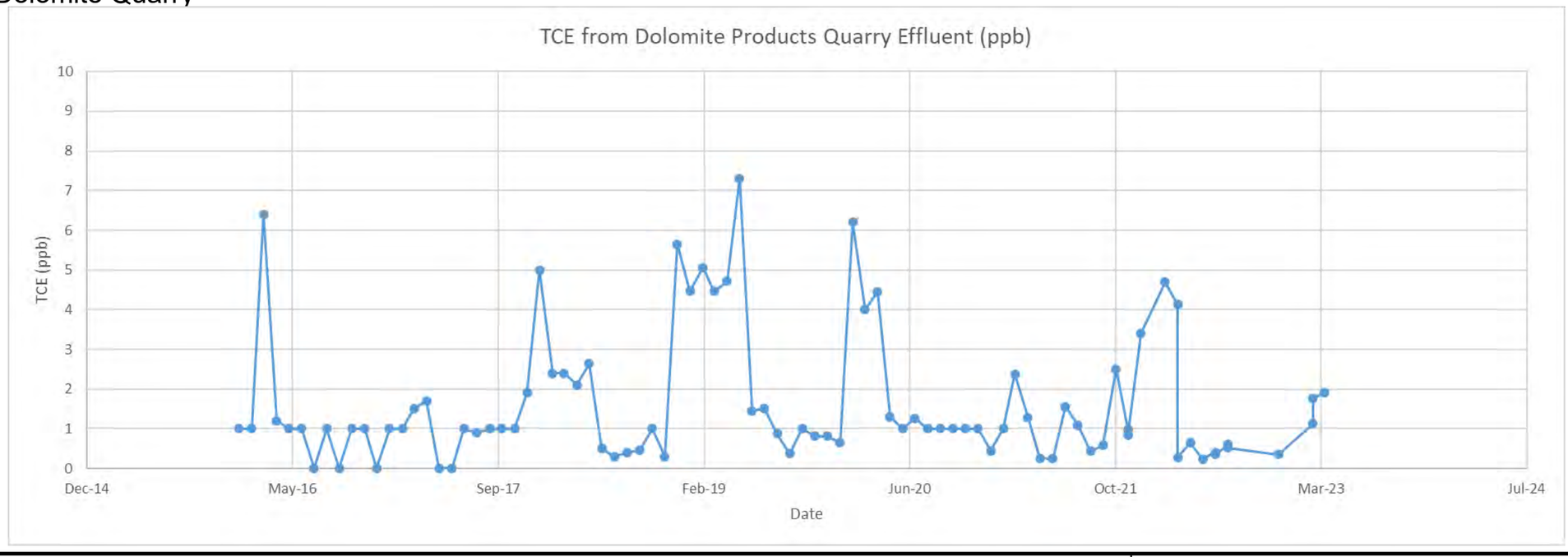
SPDES Discharge Location of Dolomite Quarry



Surface Water Samples Near Quarry



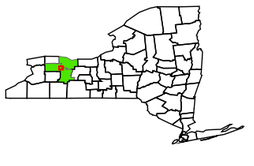
Dolomite Quarry Expansion Over Time

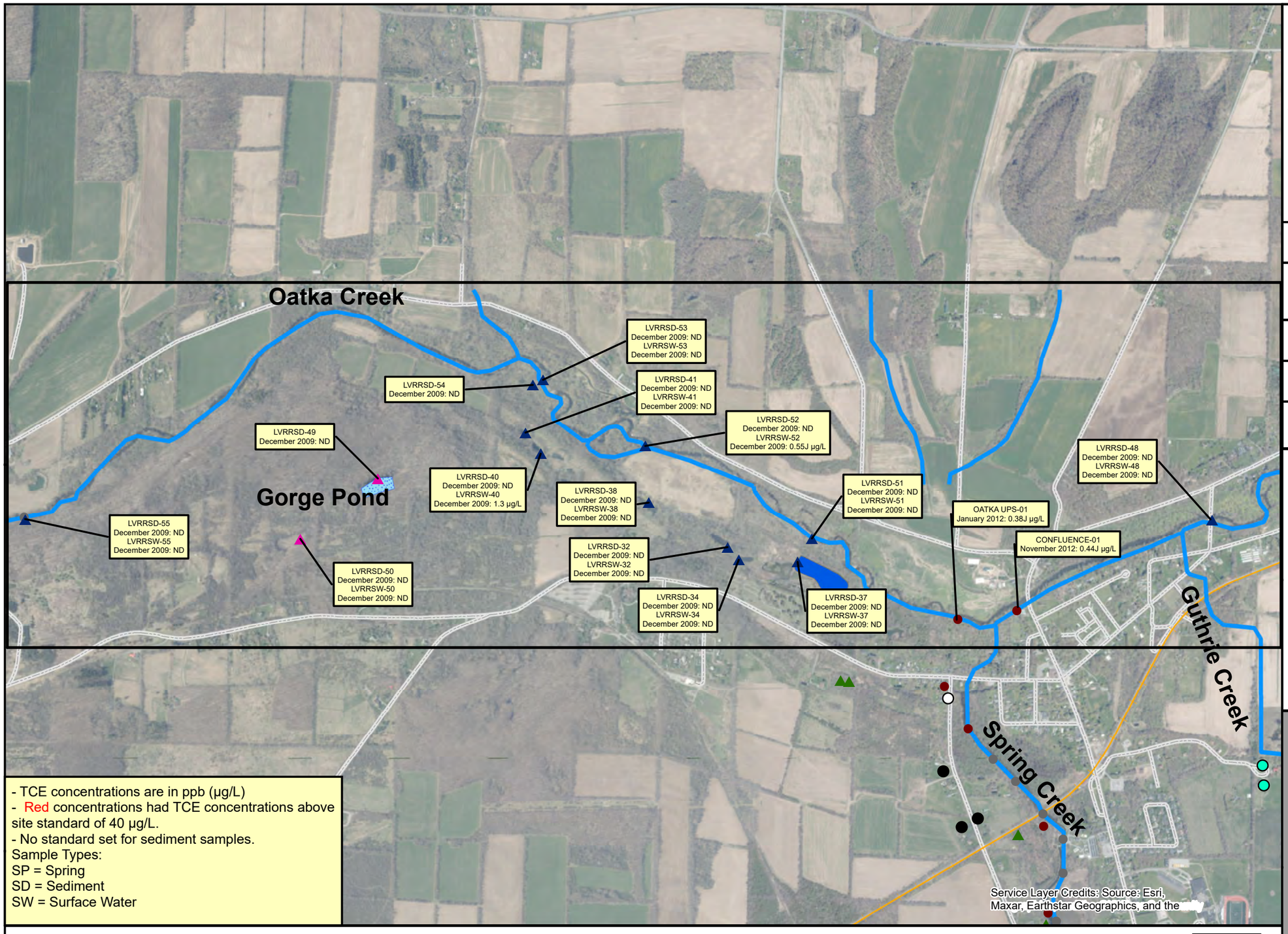


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Dolomite Products Quarry
TCE Concentrations at SPDES Effluent

Figure 4.4-1b			
Author:	NRH	Checked by:	
Project #:	2032	Created:	1/31/2023
Revised:	5/26/23	File Name:	Fig4.4-1_QuarryTCE





- TCE concentrations are in ppb (µg/L)
- Red concentrations had TCE concentrations above site standard of 40 µg/L.
- No standard set for sediment samples.

Sample Types:
SP = Spring
SD = Sediment
SW = Surface Water

0 1,250 2,500 5,000 Feet

Spring/Seep, Surface Water and Sediment Sampling Locations (Oatka Creek Area) 2009/2010, 2012, 2017 and 2018 Locations

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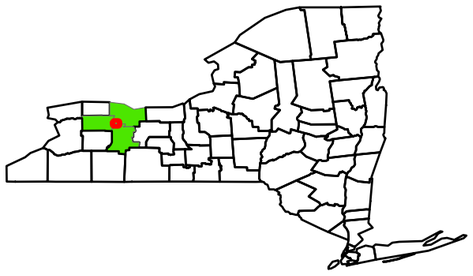
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 4.4-1c

Author:	NRH	**Checked By:**	AL
Project #:	2032	**Created:**	9/24/08
		Revised:	7/26/23
Scale:	1 in:1,413 ft	**File:**	Fig4.4-1c_OatkaResults

New York State

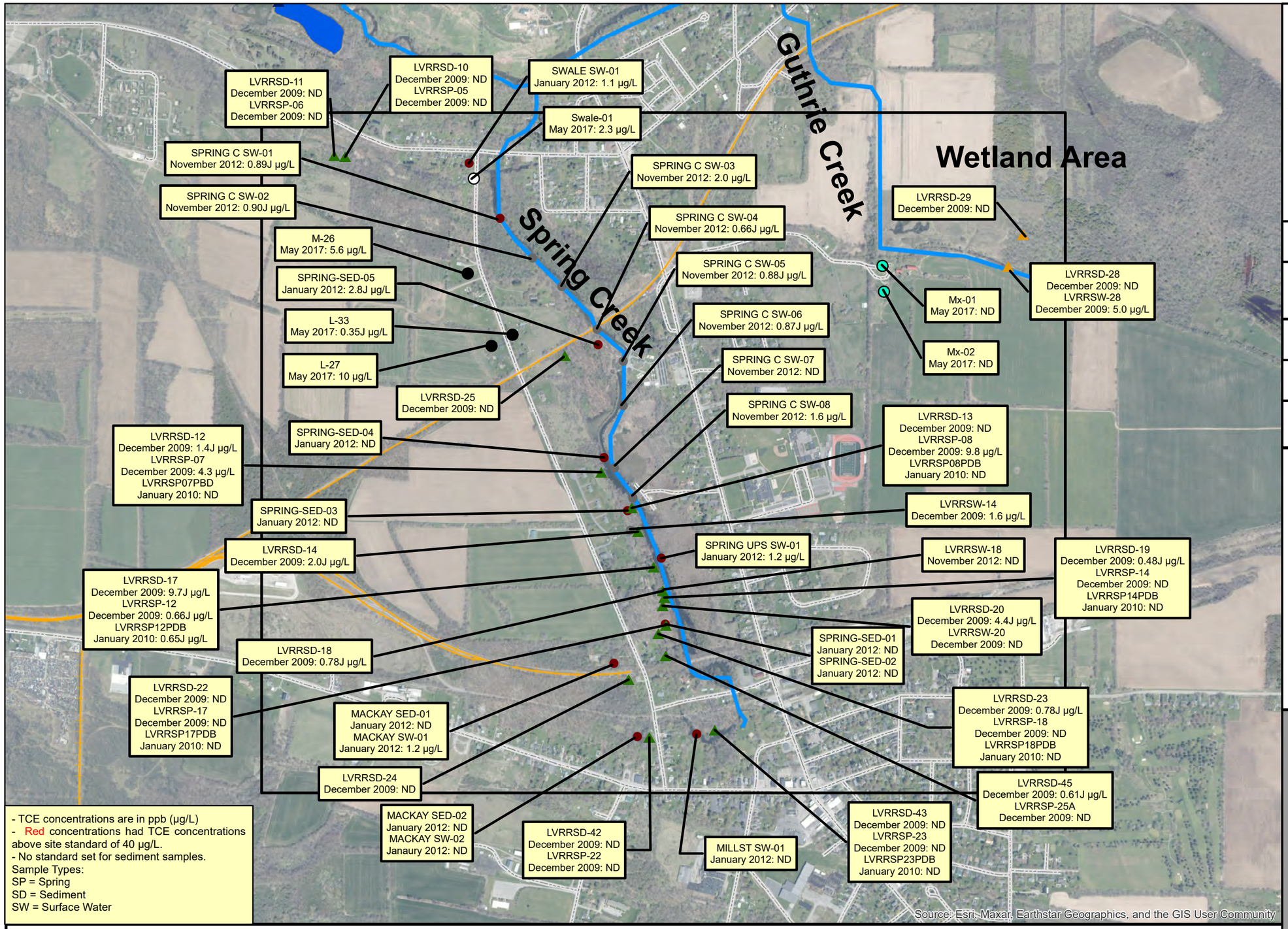


= Approximate Study Area

Legend

Spring/Seep, Surface Water and Sediment Sampling Locations

- Mud Creek Drainage
- Oatka Creek Drainage
- Gorge Pond
- Spring Creek Drainage
- Wetland Area East of Spring Creek
- January 2012 Location
- November 2012 Location
- Residential Sump Sample- May 2017
- Residential Water Supply Sample- May 2017
- Swale Sample- May 2017
- Railroad
- Roads
- Streams
- Gorge Pond
- Oatka Creek Area



- TCE concentrations are in ppb (µg/L)
- Red concentrations had TCE concentrations above site standard of 40 µg/L.
- No standard set for sediment samples.

Sample Types:
SP = Spring
SD = Sediment
SW = Surface Water

0 750 1,500 3,000 Feet

Spring/Seep, Surface Water and Sediment Sampling Locations (Spring Creek Area) 2009/2010, 2012, 2017 and 2018 Locations

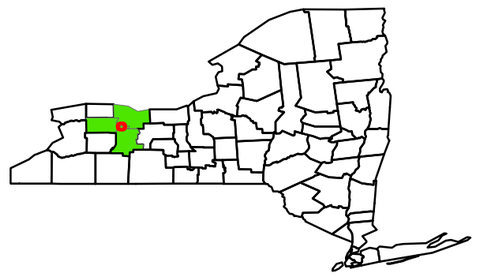
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Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 4.4-1d

Author:	NRH	**Checked By:**	
Project #:	2032	**Created:**	9/24/08
		Revised:	1/31/23
Scale:	1 in:1,090 ft	**File:**	Fig4.4-1d_SpringCrResults

New York State



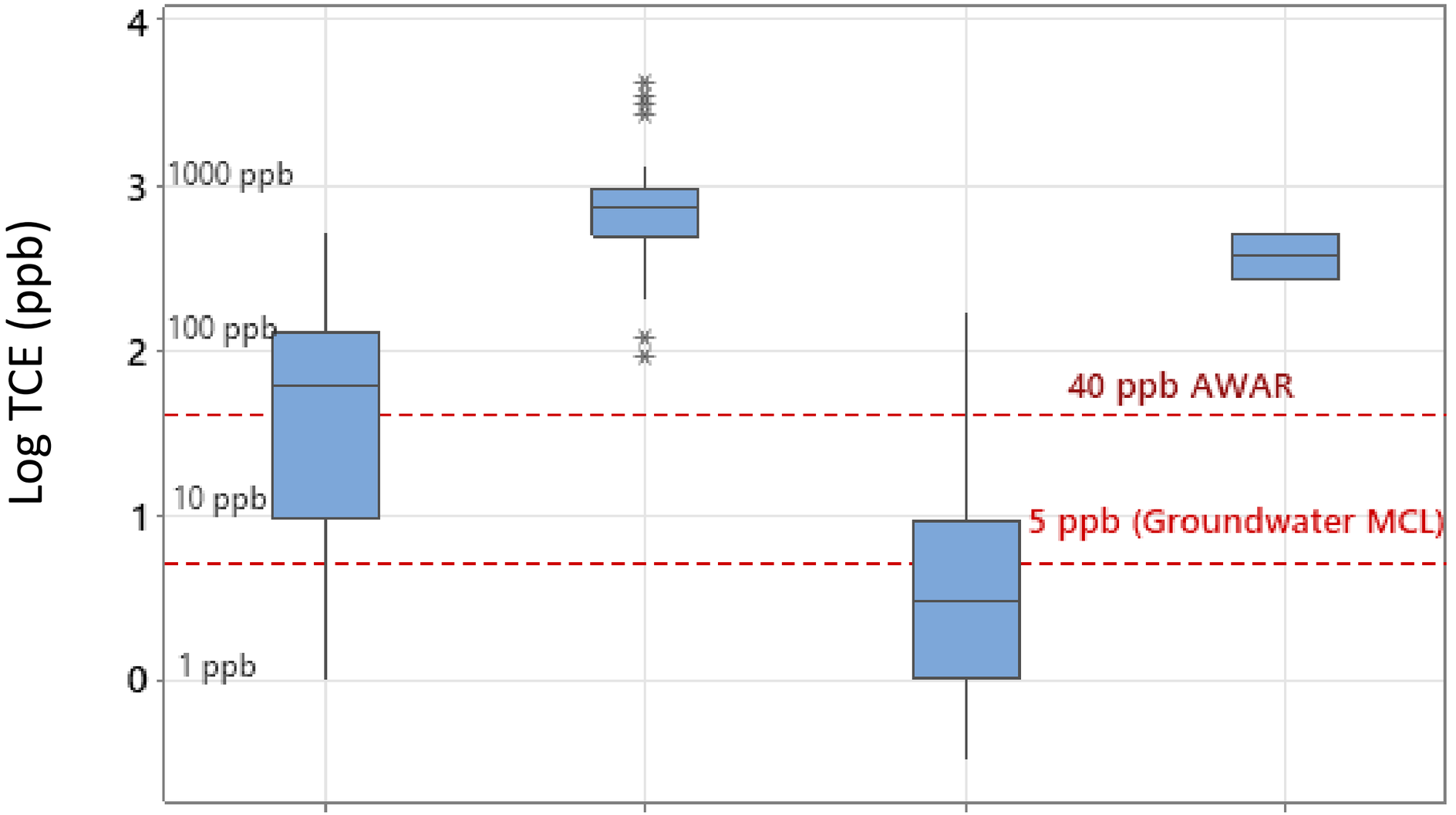
● = Approximate Study Area

Legend

Spring/Seep, Surface Water and Sediment Sampling Locations

- Mud Creek Drainage
- Oatka Creek Drainage
- Gorge Pond
- Spring Creek Drainage
- Wetland Area East of Spring Creek
- January 2012 Location
- November 2012 Location
- Residential Sump Sample- May 2017
- Residential Water Supply Sample- May 2017
- Swale Sample- May 2017
- Railroad
- Roads
- Streams
- Gorge Pond
- Spring Creek Area

Comparison of Seep to Groundwater by Geology



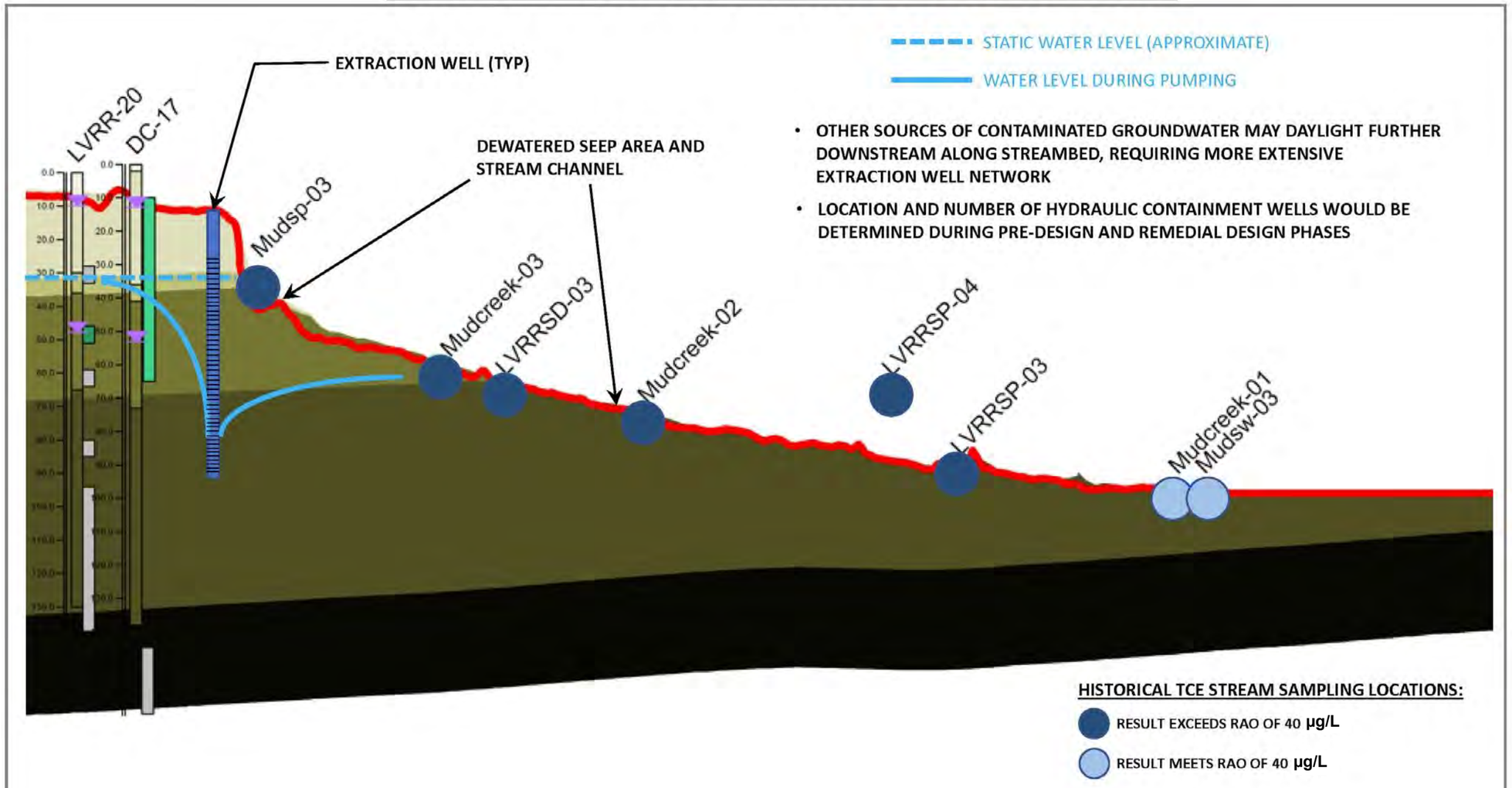
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Figure 4.4-2	
Author: MEH	Project # 2032
Checked By: MG	Created: 06/01/2022
Revised:	Source: Dr. Paul Richards
File: Figure 4.4-2 - Comparison of Seep to Groundwater by Geology	



FIGURE 4.4-3 - HYDRAULIC CONTROL - CONCEPTUAL DESIGN



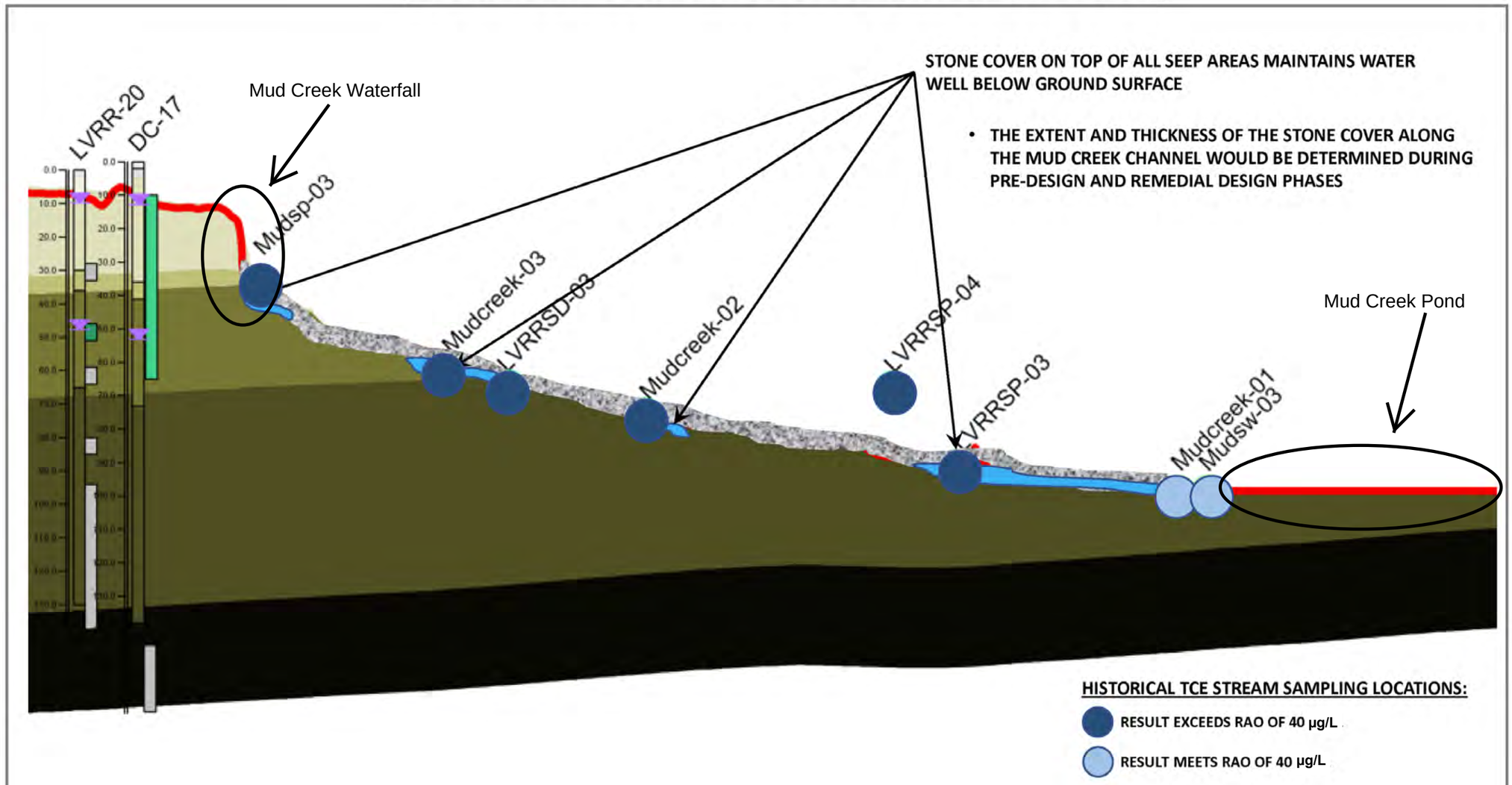
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Figure 4.4-3	
Author: NRH	Project # 2032
Checked By:	Created: 06/03/2022
Revised:	Source: Stone Environmental, INC.
File: Figure 4.4-3 Hydraulic Control REV SEP8	



FIGURE 4.4-4 – STREAMBED COVER CONCEPTUAL DESIGN



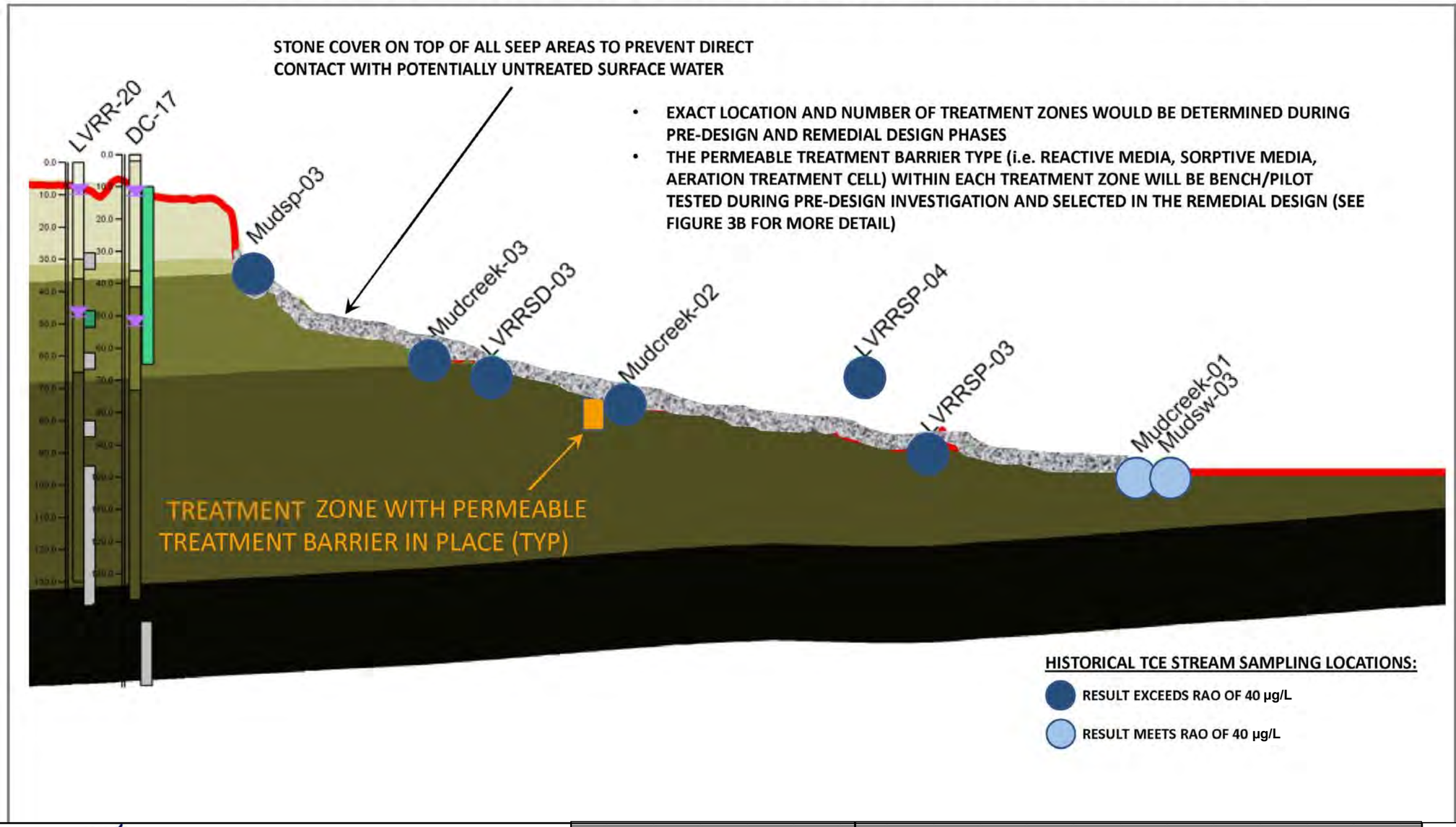
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Figure 4.4-4	
Author: NRH	Project # 2032
Checked By: ZDD	Created: 06/03/2022
Revised: 03/31/2023	Source: Stone Environmental, INC.
File: Figure 4.4-4 Streambed Cover Conceptual	



FIGURE 4.4-5 – TREATMENT ZONE w/STREAMBED COVER CONCEPTUAL DESIGN



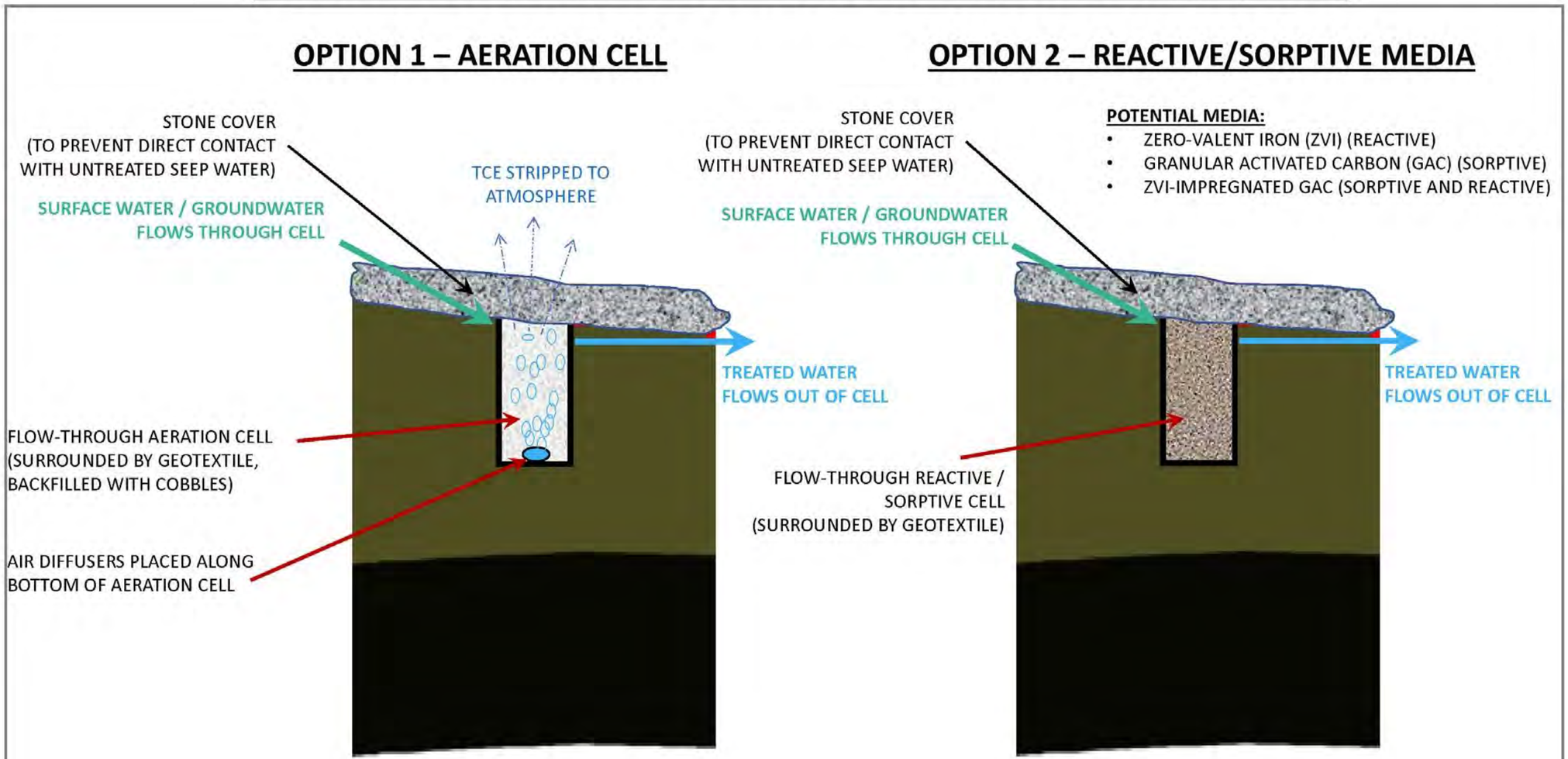
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Figure 4.4-5	
Author: NRH	Project # 2032
Checked By: ZDD	Created: 06/03/2022
Revised:	Source: Stone Environmental, INC.
File: Figure 4.4-5 Treatment Zone Streambed Cover	



FIGURE 4.4- 6- PERMEABLE TREATMENT BARRIER CONCEPTUAL DESIGN (MEDIA)



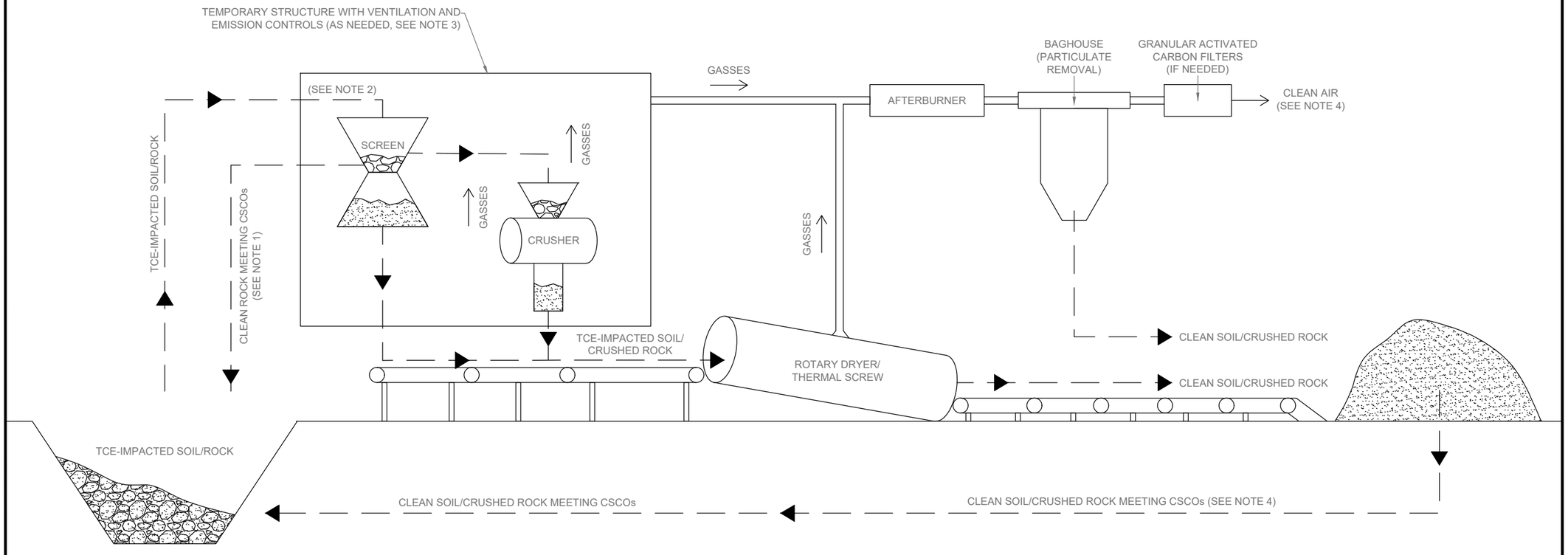
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Figure 4.4-6	
Author: NRH	Project # 2032
Checked By: ZDD	Created: 06/03/2022
Revised:	Source: Stone Environmental, INC.
File: Figure 4.4-6 Permeable Treatment Barrier	



F:\CAD\Benchmark\Unicorn\Feasibility Study\LTTD Design.dwg, 5/23/2023 11:43:31 AM, DWG To PDF.pc3



NOTES:
1. PRE-DESIGN TESTING WILL BE COMPLETED TO ESTABLISH PARTICLE SIZES THAT MEET 6 NYCRR PART 376 COMMERCIAL SOIL CLEANUP OBJECTIVES (CSCOs).
2. PRE-DESIGN TESTING WILL BE COMPLETED TO EVALUATE WHETHER LARGER PARTICLES EXCEEDING CSCOs REQUIRE SCREENING/CRUSHING PRIOR TO TREATMENT.
3. PRE-DESIGN TESTING WILL BE COMPLETED TO EVALUATE WHETHER VOLATILIZATION IS A CONCERN DURING SCREENING/CRUSHING (IF NEEDED). IF CRITERIA ARE NOT MET, SCREENING/CRUSHING WILL BE PERFORMED IN A TEMPORARY STRUCTURE WITH APPROPRIATE VENTILATION AND EMISSION CONTROLS.
4. ANALYTICAL TESTING WILL BE COMPLETED TO ENSURE THE TREATED OVERBURDEN MEETS CSCOs AND THE EMISSIONS CONTROLS ARE FUNCTIONING AS INTENDED.

DATE: MAY 2023
DRAFTED BY: CNK

BENCHMARK
2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218,
(716) 856-0599

JOB NO.: B0276-014-001

EX SITU THERMAL TREATMENT CONCEPTUAL DESIGN

FEASIBILITY STUDY REPORT

LEHIGH VALLEY RAILROAD DERAILMENT SUPERFUND SITE
INDEX NO. CERCLA-02-2006-2006
LEROY, NEW YORK

PREPARED FOR

LEHIGH VALLEY RAILROAD COMPANY

FIGURE 4.5-1

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Appendix A
Revised EHS PRG Support Documents



Appendix A.1

Table A-1
Summary of PRGs - Groundwater
Lehigh Valley Railroad Superfund Site
Gulf Road, Le Roy, New York

							ARARs			
Scenario Timeframe	**Medium**	**Exposure Medium**	**Exposure Point**	**Receptor Population**	**Constituent of Concern (COC)**	**Units**	**National Primary Drinking Water Standards (MCLs)[1]**	**NYS Groundwater Quality Standards[2]**	**NYSDOH Drinking Water Quality Standards[3]**	**PRG[4]**
Future	Groundwater	Groundwater	Tap Water	Resident, Commercial/Industrial Worker	cis-1,2-Dichloroethene (DCE)	ug/L	70	5	5	5
					trans-1,2-DCE	ug/L	100	5	5	5
					Trichloroethene	ug/L	5	5	5	5
					Vinyl Chloride	ug/L	2	2	2	2

Notes:

1 - Maximum contaminant levels (MCLs) as found in EPA National Primary Drinking Water Standards (May 2009, EPA 816-F-09-004)

2 - NYSDEC - Part 703: Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations for Class C surface water

3 - NYSDOH - Subpart 5-1 Public Water Supplies, 5-1.52 Tables (effective January 19, 2022).

4 - The PRG is selected based on the lowest of the state and federal drinking water standards.

ug/L = micrograms per liter

ARAR = Applicable or Relevant and Appropriate Requirement

PRG = Preliminary Remediation Goal

Table A-2
Summary of PRGs - Surface Water
Lehigh Valley Railroad Superfund Site
Gulf Road, Le Roy, New York

								ARARs	*TBC*	*Other*		
Scenario Timeframe	**Medium**	**Exposure Medium**	**Exposure Point**	**Receptor Population**	**Constituent of Concern (COC)**	**Units**	**1997 ROD**	**NYSDEC Surface Water Quality Standard[1]**	**NRWQC[2]**	**Risk-Based Screening Level (Swimming)[3]**		**PRG[4]**
Current/Future	Surface water	Surface water	SW EU 1: Mud Creek	Recreational User (Adult/Child)	Trichloroethene	ug/L	11	40	7	10 c	67 nc	40

Notes:

1 - NYSDEC - Part 703: Surface Water Quality Standards for Class C surface waters.

2 - USEPA - National Recommended Water Quality Criteria (NRWQC), Human Health for consumption of organisms only (2015).

3 - Risk-based PRGs protective of human health for the dermal contact and incidental ingestion surface water pathways derived in Appendix A.2.
c - value based on $1x10^{-6}$ cancer risk; nc - value based on a hazard quotient (HQ) of 1

4 - The PRG selected is based on NYS water quality standards.

ug/L = micrograms per liter
ARAR = Applicable or Relevant and Appropriate Requirement
NYSDEC = New York State Department of Environmental Conservation
PRG = Preliminary Remediation Goal
ROD = Record of Decision
TBC = To be considered

Table A-3
Summary of PRGs - Spill Zone Soil
Lehigh Valley Railroad Superfund Site
Gulf Road, Le Roy, New York

							ARARs			*TBC*			*Other*		
Scenario Timeframe	**Medium**	**Exposure Medium**	**Exposure Point**	**Receptor Population**	**Constituent of Concern (COC)**	**Units**	**NYSDEC ISCO[1]**	**NYSDEC CSCO[1]**	**NYSDEC ESCO[1]**	**Draft NYSDEC SCO[2]**	**USEPA RSL Com/Ind[3]**		**Risk-Based PRG[4]**		**PRG[5]**
Future	Soil	Soil	Spill Zone Surface Soil	Commercial/Industrial Worker	Trichloroethene	mg/kg	400	200	2	54	19 nc	6 c			200
			Spill Zone Subsurface Soil	Construction Worker									4.2 c	34 nc	

Notes:
1 - 6 NYCRR Part 375 Soil Cleanup Objectives (SCO)
2 - Draft SCOs for commerical and industrial land uses as found in NYSDEC's July 2020 *New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document 2020 Addendum* .
3 - USEPA RSL for industrial soil (November 2022 update); non-cancer RSL (nc) based on a hazard quotient (HQ) of 1, cancer (c) RSL based on cancer risk of $1x10^{-6}$
4 - Soil risk-based PRG derived in Appendix A.3. Values shown as 2 significant figures. non-cancer PRG (nc) based on a hazard quotient (HQ) of 1, cancer (c) PRG based on cancer risk of $1x10^{-6}$
5 - The PRG selected is based on NYS soil cleanup objectives.

mg/kg - milligram per kilogram
ESCO - Ecological Resources Soil Cleanup Objective
ISCO - Industrial Soil Cleanup Objective
CSCO - Commercial Soil Cleanup Objective
NYSDEC = New York State Department of Environmental Conservation
PRG - Preliminary Remediation Goal
RSL - USEPA Regional Screening Level



Appendix A.2

Appendix A.2 – Surface Water PRG

Background

The Site is a 10-acre area centered on the physical location of the train derailment that occurred in December 1970, near the intersection of the former Lehigh Valley Railroad Company (LVRR) rail line and Gulf Road. During the derailment, the release of approximately 30,000 gallons of trichloroethylene (TCE) and 1 ton of cyanide crystals occurred. The Site is generally divided into two areas of interest: the Spill Zone and the Study Area (see Figure 1-2 in Attachment A). The Spill Zone is an irregularly shaped area centered around the former railroad crossing that contains residual soil contamination. The TCE-impacted groundwater plume, which is referred to as the Study Area, extends from the Spill Zone east approximately 4 miles to Spring Creek.

Currently, the Spill Zone is mostly undeveloped industrial, commercial, residential, and passive recreational land largely covered with grass, brush, and wooded areas. The land between the Spill Zone and Spring Creek is mostly agricultural with a mixture of private residences and commercial establishments. Wooded land is located between the sections used for farming.

Receptors, Exposure Pathways, Media and Constituents of Concern

During the course of the Remedial Investigation (RI), a concerted effort was made to identify all springs and seeps in the Study Area between the Spill Zone and Spring Creek. These locations were sampled to determine which were contaminated. Contaminated springs were found in two areas: along the lower reaches of Mud Creek below the falls (about 800 feet northeast of the Spill Zone) and along Spring Creek between LeRoy and Caledonia (approximately 3 to 4 miles east of the Site). In both cases, the springs are located in very shallow pools along the banks of streams. Detailed descriptions of the springs and the contaminant levels can be found in the RI Report (Rust, 1996).

The February 2016 *Final Baseline Human Health Risk Assessment* (HHRA) evaluated two surface water exposure units (EUs): SW-EU1/SED-EU1 and SW-EU2/SED-EU2. SW-EU1 and SED-EU1 includes the Mud Creek drainage, which is comprised of waterbodies located adjacent to the Spill Zone, including Mud Creek and Mud Creek Gorge (also referred to as Mud Creek Pond). SW-EU2 and SED-EU2 include the Oatka and Spring Creek drainages, starting downstream from Mud Creek and extending approximately 3 to 4 miles east of the Spill Zone. SW-EU2 and SED-EU2 also includes Gorge Pond (not be confused with Mud Creek Gorge) and several un-named ponds and low-lying areas (see Figure 3 in Attachment A).

As concluded in the HHRA, in the Mud Creek exposure area, total hazard indices (HIs) ranged between 6 (adult recreational user) and 16 (child recreational user), and the total HI by target organ ranged between 3 and 6. USEPA's target HI is 1 for groups of toxicants that affect the same target organ (USEPA, 1989). Cumulative cancer risk estimates were within the acceptable risk range of one in one million (1×10^{-6}) to one in ten thousand (1×10^{-4}). The primary Spill Area-related constituent of concern (COC) was TCE, and ingestion of and dermal contact with surface water (including spring water) while swimming were the exposure pathways of concern.

Sediment was not identified as a medium of concern for exposure to Spill Area-related COCs. In the Spring Creek/Oatka Creek exposure area, cancer risk estimates and noncancer hazards were within the acceptable risk levels for Spill Area-related constituents in surface water and sediment. Consequently, Spill-Area related COCs identified for preliminary remediation goal (PRG) development are limited to TCE in surface water for the Mud Creek exposure area.

Surface Wat.er Preliminary Remediation Goals Protective of Recreational Land Use Pathways

The State of New York has classified Mud Creek as a Class C stream (6NYCRR Part 821). Class C waters are classified for primary and secondary contact recreation and fishing, but not as a drinking water supply. As detailed in the BHHRA, consumption of fish caught in Mud Creek is not considered a complete pathway, because the primary constituents associated with the train derailment (TCE and cyanide) have a low potential to bioaccumulate or bioconcentrate in fish and animals (AECOM, 2016).

As a result, risk-based screening levels have been derived for a primary contact recreational scenario (swimming). Site-specific exposure assumptions selected for this scenario are the same as the reasonable maximum exposure (RME) scenario evaluated in the USEPA-approved BHHRA.

- Surface Water Ingestion Rate: Consistent with USEPA recommendations (USEPA, 1989), a surface water ingestion rate of 50 mL/hour was assumed for recreational RME exposures since splashing may result in ingesting a small amount of water during swimming activities.
- Exposed Skin Surface Area: The recreational scenario assumes that the entire body is exposed during swimming. USEPA default body surface areas for adults (20,900 cm^2) and younger children age 0 to 6 years (6,378 cm^2) were assumed. Age-specific body part measurements were used to calculate exposed skin surface area for adolescent (age 6 to 16 years) (13,350 cm^2) (USEPA, 2008).
- Exposure Frequency: A site-specific estimate for RME exposure frequency equal to 105 days/year was based on best professional judgment. Given the average high fall temperatures in Batavia, NY (located approximately 10 miles from LeRoy), which range from 37°F to 61°F, recreational swimming is unlikely during this time period (The Weather Channel, LLC 2014). The exposure frequency assumes that a recreator would visit the Mud Creek exposure area three times per week in spring months and five times per week in the summer months when children are not attending school.
- Exposure Time: An RME exposure time of 2.5 hour per day (or 150 minutes/day) was assumed for surface water exposures based on best professional judgment. The value is consistent with time spent outdoors while playing (Table 16-20 in USEPA, 2011: average of 90th percentile values for ages 1->64 age groups) and time spent at a pool, river or lake (Table 16-19 in USEPA, 2011: average of 98th percentile values for age groups 2 – 21) and far exceeds that recommended for swimming (Table 16-1 in USEPA, 2011 - 181 minutes/month for all ages).

These risk-based screening levels, while site-specific, are considered conservative values to evaluate remedial measure alternatives and support remedial action objectives (RAOs). These values are considered conservative for the Mud Creek exposure area since portions of Mud Creek where swimming is assumed to occur 105 days per year is limited in extent to the inlet to Mud Creek Pond and Mud Creek Pond. Sustained flow at depths sufficient for swimming does not occur at a frequency nearing that

assumed in the screening level derivation in other portions of Mud Creek (e.g., springs at and directly downstream of the Mud Creek waterfall).

Screening levels were derived using USEPA's Regional Screening Level (RSL) on-line calculator. To provide a range of values for consideration during the remedial alternatives evaluation, screening levels were derived for $1x10^{-6}$, $1x10^{-5}$ and $1x10^{-4}$ cancer risk levels and a target hazard quotient (HQ) of 1. The following table provides a summary of the calculated values for each scenario. The RSL calculator inputs and outputs, including exposure assumptions and toxicity factors, are provided in Attachment B to this appendix.

Scenario	TCE Screening Level[1] (µg/L)			
	HQ=1	CR=10^{-6}	CR=10^{-5}	CR=10^{-4}
Swimming	67	10	98	980

1 – Screening levels derived in RSL Calculator based on a HQ=1 and CR=10-6. Values presented have been adjusted to the target risk/hazard shown. Values are rounded to two significant figures.

Protectiveness of ARARs, TBC and Risk-Based Screening Levels

Risk-based screening levels for the swimming scenario were compiled along with health-based Applicable or Relevant and Appropriate Requirement (ARARs) and "To Be Considered" (TBC) values to identify a PRG to support RAOs and evaluate remedial alternatives analyses. Compiled ARARs, TBC values and risk-based screening levels are provided in the table below.

		ARARs		*TBC*	*Other*	
Constituent of Concern (COC)	**Units**	**1997 ROD**	**NYSDEC Surface Water Quality Standard**	**NRWQC**	**Risk-Based Screening Level (Swimming)**	
					HQ=1	**CR=10^{-6}**
Trichloroethene	µg/L	11	40	7	67	10

ROD - record of decision
NYSDEC - Part 703: Surface Water Quality Standards for Class C surface waters
USEPA - National Recommended Water Quality Criteria (NRWQC), Human Health for consumption of organisms only (2015)

The promulgated NYSDEC surface water quality standard of 40 micrograms per liter (µg/L) is recommended as the PRG for surface water remedial alternatives analysis. In comparison to site-specific exposure scenarios, this ARAR is less than the risk-based screening level based on non-cancer hazards (HQ of 1) and is at the low end of the risk-based screening levels which represent USEPA's acceptable cancer risk range of $1x10^{-6}$ to $1x10^{-4}$ (representing a 4×10^{-6} risk level); and, therefore, would be considered sufficiently protective of both non-cancer hazards and cancer risks meeting the intent of the National Contingency Plan (NCP) point of departure.

References

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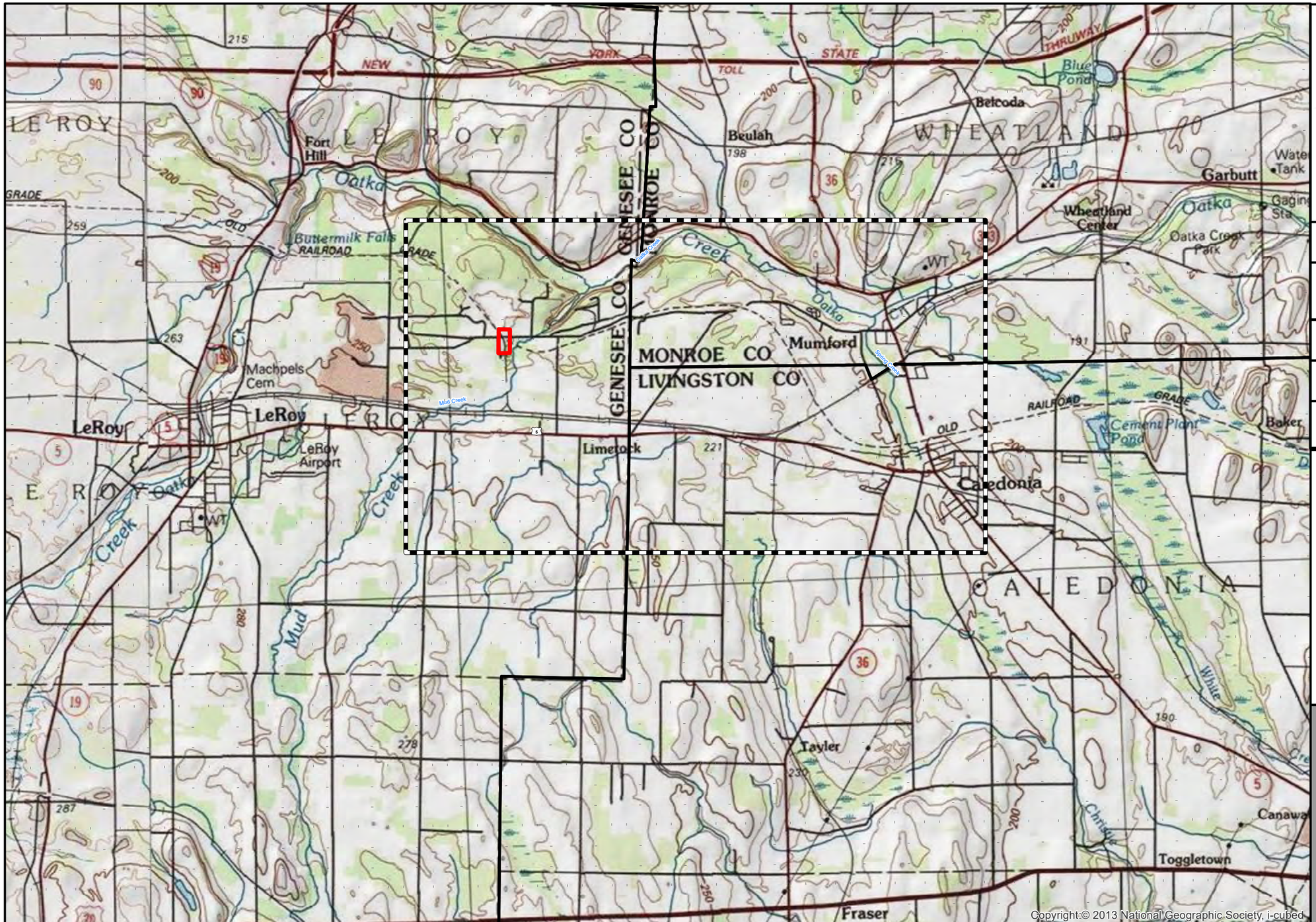
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Attachment A
Figures



Unicorn Management Consultants, LLC

52 Federal Road
Suite 2C
Danbury, CT
06810

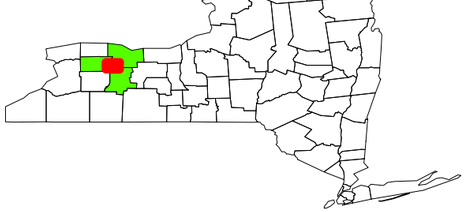
(203) 205-9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1-2
Feasibility Study Report

Author:	RTM	**Checked By:**	NRH/ZDD
Project #:	2032	**Created:**	10/27/09
		Revised:	8/11/20
Scale:	1 in:5,000 ft	**File:**	Fig1-2_Regional

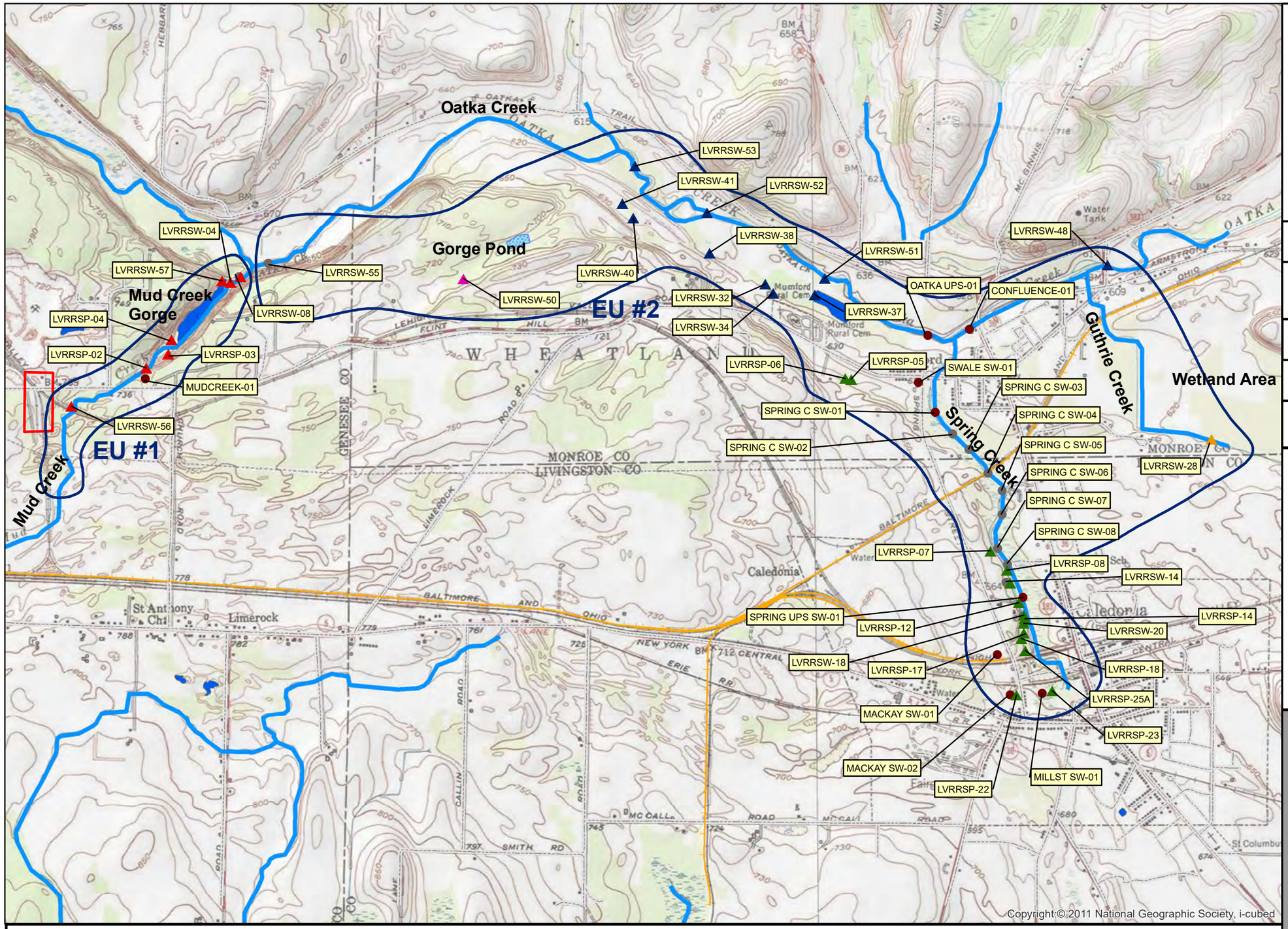
New York State



●= Approximate Study Area

Legend

- Approximate Spill Zone
- Approximately Study Area
- County Boundary



0 1,250 2,500 5,000 7,500 10,000 Feet

Spring/Seep and Surface Water Sampling Locations 2009/2010 and 2012 Locations

M/N

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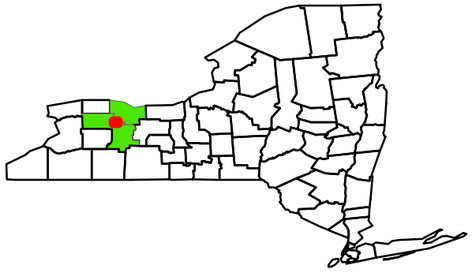
(203) 205 9000

Project Name:	Lehigh Valley Railroad Derailment Superfund Site

Figure 3

Author:	RTM	**Checked By:**	
Project #:	2032	**Created:**	9/24/08
		Revised:	10/13/14
Scale:	1 in:2,000 ft	**File:**	Figure3_sw

New York State



● = Approximate Study Area

Legend

- Approximate Spill Area
- Streams
- Railroad
- Roads
- Gorge Pond

Spring/Seep and Surface Water Sample Locations

- Mud Creek Drainage
- Oatka Creek Drainage
- Gorge Pond
- Spring Creek Drainage
- Wetland Area East of Spring Creek
- January 2012 Location
- November 2012 Location

Attachment B
RSL Calculator Inputs and Outputs

Site-Specific
Recreator Surface Water Inputs - Swimming Scenario
RSL Calculator

Variable	Recreator Surface Water Default Value	Site-Specific Value	Comment
BW_{0-2} (body weight) kg	15	15	
BW_{2-6} (body weight) kg	15	15	
BW_{6-16} (body weight) kg	80	80	
BW_{16-30} (body weight) kg	80	80	
BW_{a} (body weight - adult) kg	80	80	
BW_{rec-a} (body weight - adult) kg	80	80	
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	717407.25	Calculated value
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	2228640.75	Calculated value
ED_{rec} (exposure duration - recreator) years	26	26	
ED_{0-2} (exposure duration) years	2	2	
ED_{2-6} (exposure duration) years	4	4	
ED_{6-16} (exposure duration) years	10	10	
ED_{16-30} (exposure duration) years	10	10	
ED_{rec-a} (exposure duration - adult) years	20	20	
EF_{rec-w} (exposure frequency) days/year	0	105	HHRA Appendix A Table 4.5 RME
EF_{2-6} (exposure frequency) days/year	0	105	HHRA Appendix A Table 4.5 RME
EF_{6-16} (exposure frequency) days/year	0	105	HHRA Appendix A Table 4.5 RME
EF_{16-30} (exposure frequency) days/year	0	105	HHRA Appendix A Table 4.5 RME
EF_{rec-a} (adult exposure frequency) days/year	0	105	HHRA Appendix A Table 4.5 RME
ET_{0-2} (exposure time) hours/event	0	2.5	HHRA Appendix A Table 4.5 RME
ET_{2-6} (exposure time) hours/event	0	2.5	HHRA Appendix A Table 4.5 RME
ET_{6-16} (exposure time) hours/event	0	2.5	HHRA Appendix A Table 4.5 RME
ET_{16-30} (exposure time) hours/event	0	2.5	HHRA Appendix A Table 4.5 RME
ET_{rec-a} (adult exposure time) hours/event	0	2.5	HHRA Appendix A Table 4.5 RME
EV_{0-2} (events) events/day	0	1	HHRA Appendix A Table 4.5 RME
EV_{2-6} (events) events/day	0	1	HHRA Appendix A Table 4.5 RME
EV_{6-16} (events) events/day	0	1	HHRA Appendix A Table 4.5 RME
EV_{16-30} (events) events/day	0	1	HHRA Appendix A Table 4.5 RME
EV_{rec-a} (adult) events/day	0	1	HHRA Appendix A Table 4.5 RME
THQ (target hazard quotient) unitless	0.1	1	HHRA Appendix A Table 4.5 RME
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	8.531	Calculated value
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	34.563	Calculated value
IRW_{0-2} (water intake rate) L/hour	0.12	0.05	HHRA Appendix A Table 4.5 RME
IRW_{2-6} (water intake rate) L/hour	0.12	0.05	HHRA Appendix A Table 4.5 RME
IRW_{6-16} (water intake rate) L/hour	0.124	0.05	HHRA Appendix A Table 4.5 RME
IRW_{16-30} (water intake rate) L/hour	0.0985	0.05	HHRA Appendix A Table 4.5 RME
IRW_{rec} (water intake rate - adult) L/day	0.11	0.05	HHRA Appendix A Table 4.5 RME
IRW_{rec-a} (water intake rate - adult) L/hr	0.11	0.05	HHRA Appendix A Table 4.5 RME
LT (lifetime - recreator) years	70	70	
SA_{0-2} (skin surface area) cm^2	6365	6378	HHRA Appendix A Table 4.5 RME
SA_{2-6} (skin surface area) cm^2	6365	6378	HHRA Appendix A Table 4.5 RME
SA_{6-16} (skin surface area) cm^2	19652	13350	HHRA Appendix A Table 4.5 RME
SA_{16-30} (skin surface area) cm^2	19652	20900	HHRA Appendix A Table 4.5 RME
SA_{rec} (skin surface area - adult) cm^2	19652	17125	HHRA Appendix A Table 4.5 RME
SA_{rec-a} (skin surface area - adult) cm^2	19652	17125	HHRA Appendix A Table 4.5 RME
Apparent thickness of stratum corneum (cm)	0.001	0.001	
TR (target risk) unitless	0.000001	0.000001	

Output generated 28MAR2022:20:14:07

Site-Specific
Recreator Surface Water Output - Swimming Scenario
RSL Calculator

Site-specific

Recreator Regional Screening Levels (RSL) for Surface Water

Key: I = IRIS; ca = cancer; nc = noncancer

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_oRef	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?
Trichloroethylene	79-01-6	Yes	Yes	Organics	Organics	4.60E-02	I	5.00E-04	I	2.00E-03	I	1.00E+00	1.16E-02	1.31E+02	1.00E+00	Yes

Output generated 28MAR2022:20:14:07

Site-Specific
Recreator Surface Water Output - Swimming Scenario
RSL Calculator

Site-specific

Recreator Regional Screening Levels (RSL) for Surface Water

Key: I = IRIS; ca = cancer; nc = noncancer

Chemical	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$	$DA_{event\ (nc\ adult)}$	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)
Trichloroethylene	5.41E-04	4.09E-03	8.12E-03	4.01E+01	1.30E+01	9.83E+00	2.09E+02	9.84E+01	6.69E+01	1.11E+03	1.95E+02	1.66E+02

Output generated 28MAR2022:20:14:07



Appendix A.3

Appendix A.3 – Soil PRG

Background

The Site is a 10-acre area centered on the physical location of the train derailment that occurred in December 1970, near the intersection of the former Lehigh Valley Railroad Company (LVRR) rail line and Gulf Road. During the derailment, the release of approximately 30,000 gallons of trichloroethylene (TCE) and 1 ton of cyanide crystals occurred. The Site is generally divided into two areas of interest: the Spill Zone and the Study Area (see Figure 1-2 in Attachment A). The Spill Zone is an irregularly shaped area centered around the former railroad crossing that contains residual soil contamination. The TCE-impacted groundwater plume, which is referred to as the Study Area, extends from the Spill Zone east approximately 4 miles to Spring Creek.

Currently, the Spill Zone is mostly undeveloped industrial (quarry), commercial, residential, and passive recreational land largely covered with grass, brush, and wooded areas. The land between the Spill Zone and Spring Creek is mostly agricultural with a mixture of private residences and commercial establishments. Wooded land is located between the sections used for farming.

Remedial measures have been implemented at the Spill Zone to address TCE-impacted soil. As part of the United States Environmental Protection Agency (USEPA)-approved source-control area remedy, a soil vapor extraction system (SVE) was installed at the Spill Zone in 2015 to treat the contaminated soil. The SVE system was shut down on July 21, 2017, after having removed over 284 pounds of volatile organic compounds (VOCs) over its 2-year operation. However, post-SVE data indicated concentrations remaining in the overburden above concentration-based performance objectives (Benchmark, 2018).

The extent of site-related constituents in Spill Zone soil has been defined. Figure 1 details TCE concentrations in soil in comparison to New York State Department of Environmental Conservation (NYSDEC) Unrestricted Use soil cleanup objectives (SCOs).

Receptors, Exposure Pathways, Media and Constituents of Concern

Currently, with the exception of remediation activities, Spill Zone soil is not used for any activities or uses. The northern portion of the Spill Zone is sparsely vegetated and contains the remains of a concrete foundation for the former Knickerbocker Hotel. Approximately 375 feet north of the former Knickerbocker Hotel is an approximate 50-foot-deep abandoned limestone quarry. The active General Crushed Stone Company limestone quarry is located west of the Spill Zone and has been excavated to a depth of approximately 100 feet. A portion of the quarry property comprises the west portion of the Spill Zone. This area consists of sparse vegetation, little or no soil cover and stockpiled limestone gravel. Residential land within the eastern portion of the Spill Zone appears to be associated with farmland (where TCE concentrations are less than Unrestricted Use SCOs). Areas within the southern portion of the Spill Zone and to the south and east of the Spill Zone are generally wooded properties owned by the Town of Leroy and the Northwoods Sportsman's Club (see Figure 1.3-2 in Attachment A).

The Spill Zone is generally unsecured with the exception of two fenced areas accessible through locked entry gates: an area which formerly contained trailers that house the SVE mechanical systems; and, the

support zone area which contains an office trailer, equipment storage, and investigation derived wastes storage. USEPA Regional Screening Level (RSL) for industrial soil exceedances are located beneath a 6-inch layer of clean fill, synthetic impermeable liner and gravel cover. This existing cover system prevents current exposure through direct human contact (ingestion and dermal contact) and indirect human contact via inhalation of soil-derived particulates or vapors. It also does not provide sufficient habitat for small carnivorous ecological receptors. However, if the existing cover is removed, there is a potential for future habitat to be present for ecological receptors (small carnivorous mammals).

Future land use at the Spill Zone will be non-residential through the use of institutional controls (i.e., environmental easement) that will be established for the Site. Future land use surrounding the Spill Zone is expected to remain predominantly agricultural and forested lands, but residential areas may increase. Continued recreational land use of the surrounding area is also expected (see Figure 1).

In January 2002, USEPA Region II completed a focused risk assessment to evaluate the hazards and risks from exposure to soil at the Spill Zone. Results of the risk assessment were compared to USEPA's acceptable risk range of one in ten thousand (1×10^{-4}) to one in one million (1×10^{-6}) cumulative excess cancer risk, and a hazard index (HI) of 1 for groups of toxicants that affect the same target organ (USEPA, 1989). Noncancer hazards were above USEPA's target noncancer effects level of 1. The highest total HI was 6.4 for the child resident. Likewise, the highest cumulative cancer risk estimate (1.1×10^{-4}) was above the acceptable risk range (1×10^{-6} to 1×10^{-4}). As a result, USEPA recommended remedial action for the Site soils.

In October 2021, USEPA Region II prepared a Supplemental Human Health Risk Evaluation (USEPA, 2021a) and a Supplemental Ecological Risk Evaluation (USEPA, 2021b). The objective of the Supplemental Human Health Risk Evaluation was to estimate risks to current and future on-Site commercial and construction workers from exposure to Spill Zone soil. The purpose of the evaluation was to supplement the prior 2002 soil evaluations and ensure that previously reached risk conclusions remain valid for current Site conditions (i.e., for residual soil contamination in the Spill Zone soils post-SVE treatment). Estimated cancer risks for on-site commercial workers exposed to surface soil and on-site construction workers exposed to the soil column were within USEPA's acceptable cancer risk range ($1x10^{-6}$ to $1x10^{-4}$). Cumulative cancer risks were 8×10^{-5} and 1×10^{-5} for on-site commercial workers and on-site construction workers, respectively. However, non-cancer hazards exceeded the target non-cancer effects level of 1. HIs were 25 and 91 for on-site commercial workers and on-site construction workers, respectively. The soil inhalation pathway was the exposure pathway of concern. USEPA concluded that residual TCE in Site soil poses an unacceptable non-cancer risk to human health and the need to take remedial action remains valid (USEPA, 2021a).

The objective of the Supplemental Ecological Risk Evaluation was to estimate the potential for adverse effects to ecological receptors exposed to contaminated soils on the Site (USEPA, 2021b). Analytical data used in the Supplemental Risk Evaluation included TCE concentrations measured in post-SVE soil boring samples collected in August 2017 from 0.5 to 2.5 feet below ground surface (ft bgs). The risk was evaluated for surface soils because exposure pathways to terrestrial ecological receptors are only complete in surface soil. Exposure point concentrations (EPC) calculated by USEPA were compared to the 2 mg/kg value for protection of ecological receptors established by the NYSDEC. This NYSDEC value assumes that the soil-to-earthworm-to-small mammal exposure pathway is the most sensitive wildlife ingestion pathway. In calculating the 2 mg/kg value, NYSDEC assumed an exposure scenario where short-tailed shrews (*Blarina brevicauda*) consume 100 percent of their diet in earthworms and the TCE

bioaccumulation from soil to earthworm tissue is based on general bioaccumulation models for organic compounds based on octanol-water partitioning coefficients. Based on this comparison, USEPA calculated a hazard quotient (HQ) for the Spill Zone of 230 based on an EPC of 460.2 milligrams per kilogram (mg/kg).

LVRR contracted EHS Support to review the Supplemental Ecological Risk Evaluation (EHS Support, 2021). The purpose of the technical review was to 1) evaluate the technical approach used by USEPA, and 2) to assess the applicability of the conclusions for potential remedial decision-making in the Spill Zone. On November 10, 2021, the Supplemental Ecological Risk Evaluation and subsequent review by EHS Support was discussed between USEPA, LVRR and EHS Support.

During that meeting, USEPA agreed with the position presented by LVRR and EHS Support that exposure pathways for ecological receptors are incomplete under current site exposure conditions. The placement of a stone cover as part of the SVE system prevents the establishment of habitat to support a forage base (e.g., earthworms, vegetation, etc.) for ecological receptors and minimizes incidental soil ingestion.

Soil Preliminary Remedial Goals Protective of Future Construction Workers

Based on the findings of USEPA's 2021 Supplemental Human Health Risk Evaluation, unacceptable non-cancer hazards were identified for future commercial workers and future construction workers exposed to TCE in Spill Zone soil. Promulgated standards (NYSDEC SCOs) are available to evaluate remedial alternatives for future commercial workers. However, because there are no promulgated standards (Applicable or Relevant and Appropriate Requirement [ARARs]) that are available for future construction workers, risk-based preliminary remediation goal (PRGs) for this scenario were developed.

The future construction worker is assumed to be is a short-term adult receptor who is exposed to TCE during an 8-hour workday for the duration of a single construction project (typically a year or less) (USEPA, 2002). Daily activities are assumed to result in an incidental ingestion rate of 330 mg of soil/dust per day as a result of short-term intrusive activities performed 250 days per year for 1 year (USEPA, 2002). The worker is assumed to have only their arms, hands, and face exposed during work hours (3,527 cm^2) and a soil adherence factor of 0.3 mg/cm^2 (USEPA, 2004).

PRGs were derived using USEPA's Regional Screening Level (RSL) on-line calculator. To provide a range of values for consideration during the remedial alternatives evaluation, PRGs were derived for $1x10^{-6}$, $1x10^{-5}$ and $1x10^{-4}$ cancer risk levels and a target hazard quotient (HQ) of 1. The following table provides a summary of the calculated values. The RSL calculator inputs and outputs, including exposure assumptions and toxicity factors, are provided in Attachment B.

Scenario	TCE PRG[1] (mg/kg)			
	HQ=1	CR=10^{-6}	CR=10^{-5}	CR=10^{-4}
Construction Worker	4.2	34	340	3400

1 - Remedial goals derived in RSL Calculator based on a HQ=1 and CR=10-6. Values presented have been adjusted to the target risk/hazard shown. Values are rounded to two significant figures.

Protectiveness of ARARs, TBC and Risk-Based PRGs

Remedial action objectives (RAOs) are specific goals for protecting human health and the environment. RAOs established for Spill Zone soil include:

- Prevent unacceptable risk to human health from incidental ingestion of and inhalation exposure to Spill Zone soil (i.e., contaminated overburden fill material/debris/soil) exceeding remedial goals.
- Prevent migration of contaminants in Spill Zone overburden fill material/debris/soil that would result in further groundwater impacts.

The development of these goals involves consideration of ARARs and other "To Be Considered" (TBC) advisories, criteria, or guidance, as well as the results of the risk assessments. As a result, to support evaluation of these RAOs, construction worker risk-based PRGs were compiled along with health-based ARARs and TBC values.

ARARs include NYSDEC Industrial SCOs (ISCOs), NYSDEC Commercial SCOs (CSCOs) and NYSDEC Ecological SCOs (ESCOs). ISCOs are applicable for properties within the Spill Zone zoned industrial and CSCOs and ESCOs are applicable for properties within the Spill Zone zoned recreational. CSCOs were derived by NYSDEC to be protective of exposure scenarios protective of adult outdoor workers and child visitors. An adult outdoor worker was selected by NYSDEC because these workers would have a greater potential than indoor workers for exposure to soil contaminants (NYSDEC, 2006). CSCOs are also considered protective of passive recreational land use. NYSDEC regulations at 6NYCRR Part 375 allow for passive recreational uses under the definition of commercial use. Passive recreational uses are public uses with limited potential for soil contact. ESCOs are considered applicable and relevant under future land use conditions.

NYSDEC Residential SCOs have not been included as an ARAR. TCE soil concentrations in parcels within the Spill Zone currently zoned residential and used for farmland are less than unrestricted residential SCOs (0.47 mg/kg) (see Figure 1).

Protection of Groundwater SCOs (PGWSCO) and numeric RAOs established for soil in the 1997 ROD protective of groundwater are also potential ARARs. However, based on the rationale presented in Section 4.5.4 of the Feasibility Study, these values were not retained for further consideration as PRGs and are not discussed further within this Appendix.

In addition to the ARARs identified, USEPA RSLs for industrial soil and proposed NYSDEC revisions to SCOs (NYSDEC, 2020) are TBCs. USEPA RSLs for industrial soil were derived by USEPA to be protective of

both commercial and industrial workers, including indoor workers and outdoor workers. Draft NYSDEC SCOs for commercial and industrial use were revised to incorporate updates to toxicity values and the methods and data used to estimate soil-related exposures (NYSDEC, 2020).

Compiled ARARs, TBC and risk-based PRGs protective of human health are provided in the table below.

		ARARs		*TBC*			*Other*	
Constituent of Concern (COC)	**Units**	**NYSDEC ISCO**	**NYSDEC CSCO**	**Draft NYSDEC SCO[1]**	**USEPA RSL Commercial/ Industrial**		**Risk-Based PRG Construction Worker**	
					HQ=1	**CR=10^{-6}**	**HQ=1**	**CR=10^{-6}**
Trichloroethene	mg/kg	400	200	54	19	6	4.2	34

1 – The draft commercial SCO and draft industrial SCO are both 54 mg/kg

These values were compared to TCE concentrations in Spill Zone soil to identify a PRG that would attain the RAO. The TCE soil data set used in the evaluation is provided as Attachment C and consists of soil data collected pre-SVE in 2010 and post-SVE in 2017. The following observations are noted:

- The most restrictive human health-based ARAR (CSCO value of 200 mg/kg) was used to demarcate an area of elevated TCE concentrations (see orange outline in Figure 1). Within this area, TCE concentrations range between 0.012 mg/kg and 810 mg/kg. Average TCE concentrations (95 percent [%] upper confidence limit of the arithmetic mean [UCL_{95}]) in surface soil are 406 mg/kg and in the soil column (surface and subsurface soil) are 356 mg/kg, both of which above the CSCO (200 mg/kg). UCL calculations are provided in Attachment C. A portion of this area is covered by Gulf Road. The remainder is currently covered by clean fill, a synthetic impermeable liner and gravel cover.
- Outside of this area, TCE concentrations range between 0.013 mg/kg and 67 mg/kg in surface soil and 0.013 mg/kg and 100 mg/kg in the soil column. Average TCE concentrations (UCL_{95}) in surface soil are 3.8 mg/kg, which is less than the most restrictive ARAR (200 mg/kg) and the most restrictive TBC value (6 mg/kg). Average TCE concentrations (UCL_{95}) in the soil column (surface and subsurface soil) are 5.6 mg/kg, which is greater than the risk-based PRG for construction workers (4.2 mg/kg). Similar to above, concentrations greater than the TBC or risk-based PRG values are currently covered by clean fill, a synthetic impermeable liner and gravel cover.

  Consistent with USEPA's 2021 risk evaluation, resultant cancer risks and non-cancer hazards for this area were estimated for a future construction worker. A future recreational user (adult/older child) was also considered assuming that the current cover was removed. As detailed in Attachment D, the estimated cancer risks for an adult construction worker exposed to the soil column and the future recreational user exposed to surface soil were less than USEPA's acceptable cancer risk range ($1x10^{-6}$ to $1x10^{-4}$). Cumulative cancer risks were 2×10^{-7} and 3×10^{-8} for construction workers and recreational users, respectively. For non-carcinogenic effects, USEPA's non-cancer threshold value of 1 was not exceeded for recreational users. The non-cancer hazard for a construction worker exposed to the soil column was 1.

Remedial alternatives being considered in the Feasibility Study includes institutional controls (e.g., groundwater and land use restrictions, Operations and Maintenance [O&M] Plan, and Environmental Easement) and engineering controls (e.g., containment/cover, removal) as components of the final remedy.

The engineering controls being evaluated would remove, treat, immobilize and/or cover TCE in Spill Zone soil above the CSCO. As a result, these engineering controls would prevent future unacceptable exposure through direct human contact (ingestion and dermal contact) and indirect human contact via inhalation of soil-derived particulates or vapors.

Outside the extent of the engineering controls, as discussed in the bullets above, there are no unacceptable risks or hazards to future commercial workers and future recreational users potentially exposed to residual TCE in surface soil.

Further, an O&M Plan, which will include an Excavation Work Plan (EWP) to address procedures for post-remedial excavation activities, would address construction worker exposure pathways involving direct contact with subsurface soil or inhalation of soil-derived particulates or vapors during intrusive activities. In addition, an Environmental Easement would restrict land uses (i.e., residential).

Finally, as detailed in Section 4.5.4 of the Feasibility Study, in regard to protection of groundwater there would be no further groundwater impact from alternatives that meet the CSCO.

In regard to ecological resources, under current conditions, ecological exposure to TCE in soil within the Spill Zone is mitigated by the placement of the stone cover as part of the SVE system that minimizes direct or indirect soil exposure and prevents the establishment of habitat to support a sufficient forage base (e.g., earthworms, vegetation, etc.) to sustain wildlife populations.

Under a future exposure scenario, following the potential removal of the stone cover and implementation of remedial measures within the area exceeding the CSCO, potential ecological exposure is not likely to adversely affect ecological receptor populations based on the limited spatial extent of soil concentrations exceeding the NYSDEC ESCO of 2 mg/kg TCE. Population-level effects are not likely based on the findings of an evaluation of future exposure scenarios:

- The extent of residual TCE that may remain in surface soil under a future scenario would be less than or equal to the typical foraging range of a short-tailed shrew (0.96-acres; Sample and Suter, 1994), the wildlife receptor that is the basis of the NYSDEC ESCO.[1]
- South of Gulf Road, the maximum extent of the area potentially exceeding 2 mg/kg TCE following the potential removal of the stone cover and implementation of engineering controls (within the area exceeding the CSCO) is approximately 0.4 acres (see Figure 1). Applying an area use factor (AUF) of 0.42, which is the ratio of the exposure area to the typical foraging range of a short-tailed shrew (AUF = 0.4 acres/0.96 acres = 0.42), a short-tailed shrew exposed to an average soil TCE concentration of 2 mg/kg in areas outside of the extent of remedial excavation

[1] The short-tailed shrew was the most sensitive of five wildlife receptors that NYSDEC modeled to derive the ESCO (NYSDEC, 2006). Therefore, soil concentrations protective of short-tailed shrew populations are assumed to be protective of less sensitive wildlife receptors.

limits would obtain approximately 42% of the lowest observed adverse effect level (LOAEL) dose used in the ESCO derivation. Exposure below the LOAEL dose would not be expected to result in adverse effects to individuals or populations of short-tailed shrews or other less sensitive wildlife receptors NYSDEC modeled to derive the ESCO. Therefore, no adverse effects to receptor populations would be expected in the area south of Gulf Road.

- North of Gulf Road, the maximum extent of the area potentially exceeding 2 mg/kg TCE following the potential removal of the stone cover and implementation of engineering controls (within the area exceeding the CSCO) is approximately 1 acre (see Figure 1). Based on a typical foraging range of 0.96 acres, it is estimated that an individual shrew foraging entirely within the maximum extent of the area exceeding 2 mg/kg TCE (AUF ~1) following the potential removal of the stone cover and implementation of remedial measures would obtain a TCE dose equivalent to the dose used to establish the ECSO. However, given that the typical density of short-tailed shrews ranges from 2 – 10 individuals per acre (Saunders, 1988), only 2 – 10 shrews would potentially be affected if those shrews foraged entirely within the maximum extent of the area north of Gulf Road exceeding 2 mg/kg TCE following the potential removal of the stone cover and implementation of engineering controls. The limited number of individuals that may be adversely affected by exposure to TCE in soil following the removal of the stone cover and implementation of engineering controls would not be sufficient to impact overall populations.

Ecological exposure in these areas would be further mitigated by the restoration of the area currently covered by stone through the potential placement of topsoil and revegetation following the removal of the stone cover. As stated in Section 4.5.4.2 of the Revised FS, one foot of clean topsoil and seed will be placed over areas outside of the remedial excavation limits that are currently covered by poly sheeting and stone ballast and will extend to areas of the Spill Zone where surface soils were identified at TCE concentrations exceeding 2 mg/kg (see Figure 1.5-3a in the FS). The placement of one foot of topsoil and seed will promote the restoration of the site and mitigate ecological exposure pathways to soils with TCE concentrations exceeding 2 mg/kg.

Based on these factors, the ARAR (CSCO) is recommended as the PRG to support Spill Zone soil RAOs and evaluate remedial alternatives analyses. The analysis presented within this memorandum demonstrates that this value is protective of both current and reasonably future land use at the Spill Zone, including potential future human and ecological receptors.

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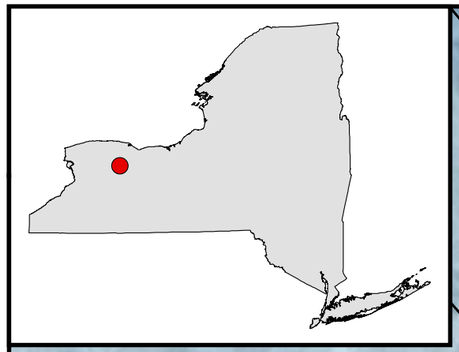
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USEPA. 2021b. Supplemental Ecological Risk Evaluation for the Lehigh Valley Railroad Derailment Superfund Site, LeRoy, New York. October 29, 2021.

Figures



Legend

Soil Samples with Highest TCE Concentrations

- TCE Below NYS Unrestricted use of 0.47 ppm
- TCE between 0.47 ppm - 1.99 ppm
- TCE between 2 - 7 ppm
- TCE between 7 - 199.99 ppm
- TCE above CSCO of 200 ppm
- TCE above ISCO of 400 ppm
- Le Roy Tax Parcels
- Area Exceeding 2 mg/kg TCE based on Existing Surficial Soil Data[1]
- Approximate Extent of Proposed Engineering Controls
- Current Gravel Cover

Future Land Use - Per Town of Le Roy 2017 Comprehensive Plan

- Industrial
- Recreational

Concentrations shown represent highest TCE Concentration that was recorded at the location from 2009 - 2017.

80 40 0 80

Scale In Feet

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES

Pre and Post Remedial Design Soil Samples with TCE Concentrations and Future Land Use

Lehigh Valley Railroad
Derailment Superfund Site

EHS Support

FIGURE 1

Reviewed By:

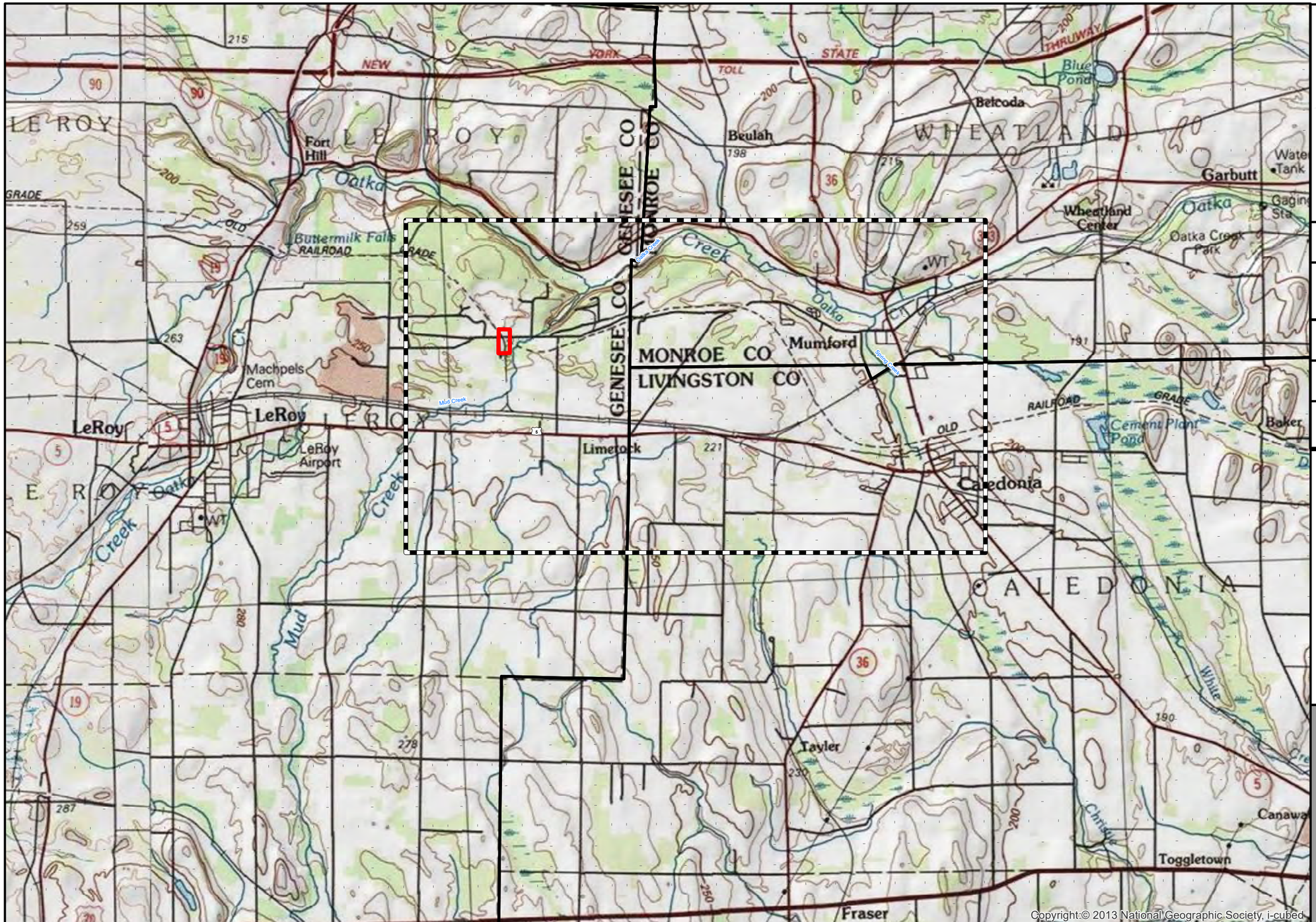
1 - Layer shown in FS Figure 1.5-3a

J:\EHSS_GIS\C03651_LehighValleyRR101_ANALYSIS\20230201_RemDesignSoilSamplF001_Pre_Post_RemDesign_Alt.mxd

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Attachment A

Feasibility Study Figures



Unicorn Management Consultants, LLC

52 Federal Road
Suite 2C
Danbury, CT
06810

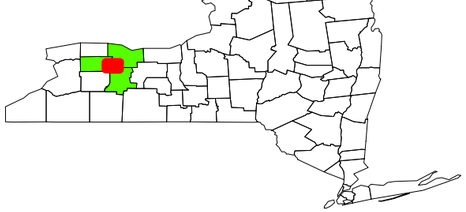
(203) 205-9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1-2
Feasibility Study Report

Author:	RTM	**Checked By:**	NRH/ZDD
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		Revised:	8/11/20
Scale:	1 in:5,000 ft	**File:**	Fig1-2_Regional

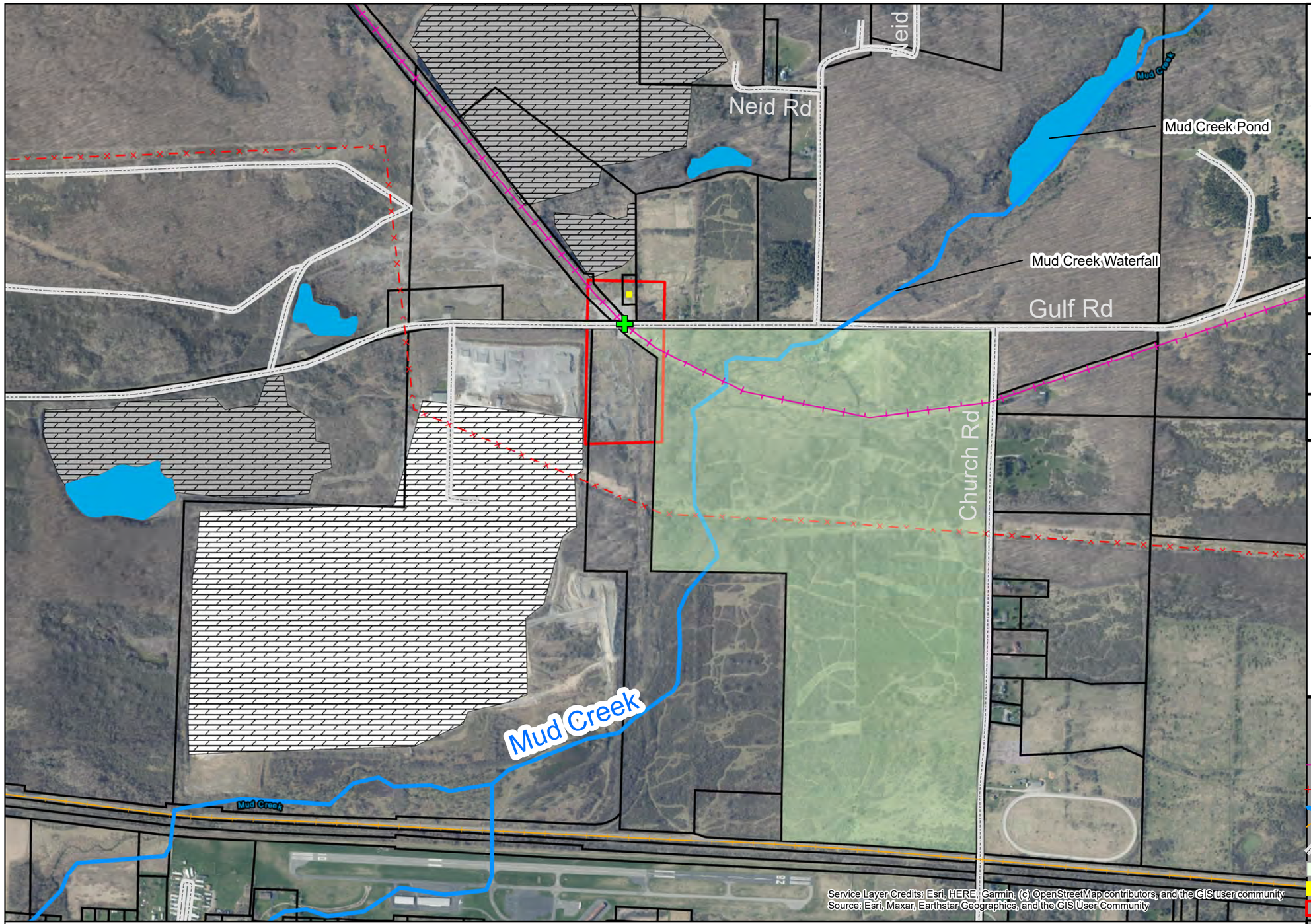
New York State



●= Approximate Study Area

Legend

- Approximate Spill Zone
- Approximately Study Area
- County Boundary



0 750 1,500 3,000 Feet

Spill Zone Map

M/N

N
W E
S

Unicorn Management Consultants, LLC

52 Federal Road
Suite 2C
Danbury, CT
06810

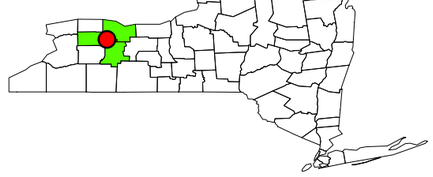
(203) 205 9000

Project Name: Lehigh Valley Railroad Derailment Superfund Site

Figure 1.3-2

Author: NRH	**Checked By:**
Project #: 2032	**Created:** 10/27/09 **Revised:** 01/30/23
Scale: 1 in:1,005 ft	**File:** Fig1-3-2_SpillZone

New York State



● = Approximate Study Area

Legend

- Location of LVRR Derailment
- Former LVRR Railroad
- Major Transmission Line
- Streams
- Railroad
- Roads
- Northwoods Sportsman Association Property
- Approximate Foundation of Former Knickerbocker Hotel
- Approximate Spill Zone
- Parcels
- Active Quarry
- Abandoned Quarry

Attachment B
RSL Calculator Inputs and Outputs – Construction Worker

Site-Specific
Construction Worker
RSL Calculator

Variable	Construction Worker Soil - Other Default Value	Site-Specific Value	Comment
$A_{c\text{-}doz}$ (areal extent of dozing) acres	0	10	Site-specific value, size of Spill Area
A_{excav} (area of excavation site) m^2	0	1.4	Default recommended value in Appendix E of USEPA, 2002
$A_{c\text{-}grade}$ (areal extent of grading) acres	0	1.4	Default recommended value in Appendix E of USEPA, 2002
A (PEF Dispersion Constant)	2.4538	2.4538	
A_{surf} (areal extent of site) m^2	2023.43	2023.43	
A_{till} (areal extent of tilling) acres	0	1.4	Default recommended value in Appendix E of USEPA, 2002
$B_{l\text{-}doz}$ (dozing blade length) m	0	2.44	Default recommended value in Appendix E of USEPA, 2002
$B_{l\text{-}grade}$ (grading blade length) m	0	2.44	Default recommended value in Appendix E of USEPA, 2002
B (PEF Dispersion Constant)	17.566	17.566	
C (PEF Dispersion Constant)	189.0426	189.0426	
d_{excav} (average depth of excavation site) m	0	1.22	Site-specific value
F_D Unitless Dispersion Correction Factor	0.185837208	0.185837208	
F(x) (function dependant on U_m/U_t derived using Cowherd et al. (1985))	0.194	0.194	
$M_{m\text{-}doz}$ (Gravimetric soil moisture content) %	7.9	7.9	
$M_{m\text{-}excav}$ (Gravimetric soil moisture content) %	12	12	
M_{wind} (dust emitted by wind erosion) g	51288.84717	51288.84717	
$N_{A\text{-}doz}$ (number of times site was dozed)	0	2	Default recommended value in Appendix E of USEPA, 2002
$N_{A\text{-}dump}$ (number of times soil is dumped)	2	2	
$N_{A\text{-}grade}$ (number of times site was graded)	0	2	Default recommended value in Appendix E of USEPA, 2002
$N_{A\text{-}till}$ (number of times soil is tilled)	2	2	
Q/C_{sa} (g/m^2-s per kg/m^3)	14.31407	14.31407	
p_{soil} (density) g/cm^3 - chemical-specific	1.68	1.68	
s_{doz} (soil silt content) %	6.9	6.9	
AF_{cw} (skin adherence factor - construction worker) mg/cm^2	0.3	0.3	
AT_{cw} (averaging time - construction worker) days	365	365	
BW_{cw} (body weight - construction worker) kg	80	80	
ED_{cw} (exposure duration - construction worker) yr	1	1	
EF_{cw} (exposure frequency - construction worker) day/yr	250	250	
ET_{cw} (exposure time - construction worker) hr/day	8	8	
THQ (target hazard quotient) unitless	0.1	1	Target HQ of 1
IRS_{cw} (soil ingestion rate - construction worker) mg/day	330	330	
LT (lifetime) yr	70	70	
SA_{cw} (surface area - construction worker) cm^2/day	3527	3527	
TR (target cancer risk) unitless	0.000001	0.000001	
S_{doz} (dozing speed) kph	11.4	11.4	
S_{grade} (grading speed) kph	11.4	11.4	
s_{till} (soil silt content) %	18	18	
t_c (overall duration of construction) hours	8400	8400	
T_c (overall duration of construction) s	30240000	30240000	
T (time over which traffic occurs) s	7200000	7200000	
T_t (overall duration of traffic) s	7200000	7200000	
U_m (mean annual wind speed) m/s	4.69	4.69	
U_t (equivalent threshold value) m/s	11.32	11.32	
V (fraction of vegetative cover)	0	0	

Output generated 16MAY2022:15:54:06

USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Emergency and Remedial Response. OSWER 9355.4-24. December.

Site-Specific
Construction Worker
RSL Calculator

Site-specific Construction Worker Regional Screening Levels (RSL) for Soil - Other Construction Activities

Key: I = IRIS; A = ATSDR

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o(mg/kg-day)$^{-1}$	Sfo Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} (cm^3/g)	K_d (cm^3/g)	HLC (atm-m^3/mole)
Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	I	4.10E-06	I	5.00E-04	A /Subchronic	2.15E-03	A /Subchronic	1.00E+00	-	1.00E+00	6.92E+02	1.28E+03	6.07E+01	3.64E-01	9.85E-03

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Site-Specific
Construction Worker
RSL Calculator

Site-specific Construction Worker Regional Screening Levels (RSL) for Soil - Other Construction Activities

Key: I = IRIS; A = ATSDR

Chemical	CAS Number	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature T_C (K)	T_C Ref	Chemical Type	D_{ia} (cm^2/s)	D_{iw} (cm^2/s)	D_A (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor Unlimited Reservoir (m^3/kg)	Volatilization Factor Mass Limit (m^3/kg)	Volatilization Factor Selected (m^3/kg)
Trichloroethylene	79-01-6	4.03E-01	PHYSPROP	3.60E+02	PHYSPROP	5.71E+02	YAWS	VOC	6.87E-02	1.02E-05	2.73E-03	1.83E+07	-	-	4.79E+02

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Site-Specific
Construction Worker
RSL Calculator

Site-specific Construction Worker Regional Screening Levels (RSL) for Soil - Other Construction Activities

Key: I = IRIS; A = ATSDR

Chemical	CAS Number	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL THQ=1 (mg/kg)	Dermal SL THQ=1 (mg/kg)	Inhalation SL THQ=1 (mg/kg)	Noncarcinogenic SL THI=1 (mg/kg)
Trichloroethylene	79-01-6	5.39E+02	-	3.58E+01	3.36E+01	1.70E+02	-	4.33E+00	4.22E+00

Output generated 16MAY2022:15:54:06

Attachment C

TCE Soil Data Set and Calculated UCLs

TCE Spill Zone Surface Soil Data Set

Locations Outside Extent of CSCO Demarcated Area

Sample ID	Top of sample	Bottom of sample	TCE	D_TCE
Biased Sample 1/ BS-1 (0-1.5)	0	1.5	0.005	0
Biased Sample 2/ BS-2 (0-2)	0	2	0.064	1
Biased Sample 5/ BS-5 (0-2)	0	2	0.65	1
Biased Sample 6/ BS-6 (0-2)	0	2	1.3	1
A1 (0-2)	0	2	0.005	0
A2(0-2)	0	2	0.005	0
A3 (0-2)	0	2	0.005	0
A4 (0-2)	0	2	0.005	0
A5 (0-2)	0	2	0.17	1
A6 (0-2)	0	2	0.018	1
A7 (0-2)	0	2	0.005	0
A8 (0-2)	0	2	0.005	0
A9 (0-1.3)	0	1.3	0.044	1
Ai (0-2)	0	2	0.81	1
Aii (0-2)	0	2	0.47	1
Aiii (0-2)	0	2	0.017	1
B1 (0-2)	0	2	33	1
B2 (0-2)	0	2	0.2	1
B3 (0-2)	0	2	0.068	1
B6 (0-2)	0	2	0.089	1
B8 (0-2)	0	2	0.005	0
B9 (0-1.2)	0	1.2	0.015	1
Bi (0-2)	0	2	0.11	1
Bii (0-2)	0	2	0.005	0
Biii (0-1.8)	0	1.8	0.005	0
C1 (0-2)	0	2	23	1
C2 (0-2)	0	2	67	1
C5 (0-2)	0	2	1.9	1
C6 (0-2)	0	2	0.52	1
C7 (0-2)	0	2	0.037	1
C8 (0-2)	0	2	0.98	1
C9 (0-1.6)	0	1.6	0.016	1
C10 (0-0.9)	0	0.9	0.005	0
Ci (0-2)	0	2	3.8	1
Cii (0-2)	0	2	0.005	0
Ciii (0-2)	0	2	0.005	0
D1 (0-2)	0	2	0.19	1
D2 (0-2)	0	2	7.6	1
D8 (0-2)	0	2	0.039	1
D9 (0-2)	0	2	0.005	0
D10 (0-1.1)	0	1.1	0.13	1
D11 (0-1.6)	0	1.6	0.013	1
D12 (0-1)	0	1	0.02	1
Di (0-2)	0	2	0.033	1
Dii (0-2)	0	2	0.005	0
Diii (0-2)	0	2	0.005	0
E1 (0-2)	0	2	0.07	1
E2 (0-2)	0	2	7.8	1
E3 (0-2)	0	2	19	1
E7 (0-2)	0	2	0.36	1
E8 (0-2)	0	2	2	1
E9 (0-2)	0	2	1.7	1
Ei (0-2)	0	2	0.47	1

TCE Spill Zone Surface Soil Data Set

Sample ID	Top of sample	Bottom of sample	TCE	D_TCE
Eii (0-2)	0	2	0.005	0
Eiii (0-2)	0	2	0.005	0
F1 (0-1.8)	0	1.8	0.081	1
F2 (0-2)	0	2	0.35	1
F3 (0-2)	0	2	1.3	1
F7 (0-2)	0	2	0.022	1
F9 (0-2)	0	2	0.005	0
Fi (0-1.5)	0	1.5	0.018	1
Fii (0-2)	0	2	0.026	1
Fiii (0-2)	0	2	0.022	1
G1 (0-2)	0	2	0.024	1
G2 (0-2)	0	2	0.005	0
G3 (0-1.9)	0	1.9	0.005	0
G4 (0-2)	0	2	8.1	1
G5 (0-2)	0	2	5.2	1
G6 (0-2)	0	2	0.89	1
G7 (0-2)	0	2	29	1
G8 (0-1.9)	0	1.9	0.93	1
G9 (0-2)	0	2	0.25	1
H1 (0-1.5)	0	1.5	0.03	1
H2 (0-2)	0	2	0.005	0
H3 (0-1.7)	0	1.7	0.075	1
H4 (0-1.8)	0	1.8	0.005	0
H5 (0-1.5)	0	1.5	0.66	1
H6 (0-1.9)	0	1.9	0.005	0
H7 (0-2)	0	2	3.5	1
H8 (0-2)	0	2	6.3	1
H9 (0-2)	0	2	0.52	1
I1 (0-2)	0	2	0.048	1
I2 (0-2)	0	2	0.005	0
I3 (0-2)	0	2	0.005	0
I4 (0-1.6)	0	1.6	0.005	0
I5 (0-1.9)	0	1.9	0.005	0
I6 (0-2)	0	2	0.005	0
I7 (0-2)	0	2	0.005	0
I9 (0-2)	0	2	0.005	0
K7 (0-2)	0	2	0.005	0
Z1 (0-2)	0	2	0.005	0
Z2 (0-2)	0	2	0.005	0
Z3 (0-2)	0	2	0.005	0
Z4 (0-2)	0	2	0.005	0
Z5 (0-2)	0	2	0.005	0
Z6 (0-2)	0	2	0.005	0
Zi (0-2)	0	2	0.005	0

Data collected pre-SVE in 2010
Units in mg/kg

TCE Spill Zone Surface Soil Data Set

Locations Inside Extent of CSCO Demarcated Area

Sample ID	Top of sample	Bottom of sample	TCE	D_TCE
E5S Gulf Road (1.5-2)	1.5	2	340	1
E6 (0.5-2.25)	0.5	2.25	68	1
F5N (1-2)	1	2	300	1
F5E (1-2)	1	2	240	1
F5S (2-2.5)	2	2.5	0.62	1
F5W (0.5-2.5)	0.5	2.5	0.012	1
F6 (0.5-1.5)	0.5	1.5	810	1
Gulf Road (0.5-1.5)	0.5	1.5	20	1

Data collected post-SVE in 2017, locations were not sampled in 2010
Units in mg/kg

TCE Spill Zone Soil Column Data Set

Locations Outside Extent of CSCO Demarcated Area

Sample ID	Top of sample	Bottom of sample	TCE	D_TCE
Biased Sample 1/ BS-1 (0-1.5)	0	1.5	0.005	0
Biased Sample 2/ BS-2 (0-2)	0	2	0.064	1
Biased Sample 2/ BS-2 (2-4)	2	4	0.058	1
Biased Sample 5/ BS-5 (0-2)	0	2	0.65	1
Biased Sample 5/ BS-5 (2-4)	2	4	0.093	1
Biased Sample 5/ BS-5 (4-5)	4	5	0.005	0
Biased Sample 6/ BS-6 (0-2)	0	2	1.3	1
Biased Sample 6/ BS-6 (2-4)	2	4	0.25	1
Biased Sample 6/ BS-6 (4-6)	4	6	0.18	1
Biased Sample 6/ BS-6 (6-7.7)	6	7.7	1.4	1
A1 (0-2)	0	2	0.005	0
A1 (2-4)	2	4	0.005	0
A1(4-4.5)	4	4.5	0.017	1
A2(0-2)	0	2	0.005	0
A2(2-4)	2	4	0.005	0
A2(4-6)	4	6	0.005	0
A2(6-8)	6	8	0.005	0
A2(8-8.3)	8	8.3	0.017	1
A3 (0-2)	0	2	0.005	0
A3 (2-4)	2	4	0.021	1
A3 (4-6)	4	6	0.1	1
A3 (6-8)	6	8	0.045	1
A3 (8-8.4)	8	8.4	0.026	1
A4 (0-2)	0	2	0.005	0
A4 (2-4)	2	4	0.005	0
A4 (4-6)	4	6	0.005	0
A4 (6-6.3)	6	6.3	0.005	0
A5 (0-2)	0	2	0.17	1
A5 (2-4)	2	4	0.56	1
A5 (4-6)	4	6	1.2	1
A5 (6-6.3)	6	6.3	0.35	1
A6 (0-2)	0	2	0.018	1
A6 (2-4)	2	4	0.072	1
A7 (0-2)	0	2	0.005	0
A8 (0-2)	0	2	0.005	0
A8 (2-2.9)	2	2.9	0.005	0
A9 (0-1.3)	0	1.3	0.044	1
Ai (0-2)	0	2	0.81	1
Ai (2-4)	2	4	0.005	0
Aii (0-2)	0	2	0.47	1
Aiii (0-2)	0	2	0.017	1
B1 (0-2)	0	2	33	1
B1 (2-4)	2	4	0.25	1
B1 (4-6)	4	6	0.18	1
B2 (0-2)	0	2	0.2	1
B2 (2-4)	2	4	0.16	1
B2 (4-5.9)	4	5.9	0.47	1
B3 (0-2)	0	2	0.068	1
B3 (2-4)	2	4	0.4	1
B3 (4-6)	4	6	0.44	1
B3 (6-7.8)	6	7.8	0.31	1
B4 (4-6)	4	6	31	1
B4 (6-8)	6	8	0.77	1
B4 (8-8.4)	8	8.4	14	1
B5 (4-6)	4	6	75	1
B5 (6-7.5)	4	6	1.1	1
B6 (0-2)	0	2	0.089	1
B6 (2-4)	2	4	1.7	1
B6 (4-6)	4	6	0.094	1
B6 (6-7)	6	7	0.02	1
B8 (0-2)	0	2	0.005	0
B9 (0-1.2)	0	1.2	0.015	1
Bi (0-2)	0	2	0.11	1
Bi (2-2.8)	2	2.8	0.005	0
Bii (0-2)	0	2	0.005	0
Biii (0-1.8)	0	1.8	0.005	0
C1 (0-2)	0	2	23	1
C1 (2-4)	2	4	23	1

TCE Spill Zone Soil Column Data Set

Sample ID	Top of sample	Bottom of sample	TCE	D_TCE
C1 (4-6)	4	6	100	1
C1 (6-7.5)	6	7.5	1.2	1
C2 (0-2)	0	2	67	1
C2 (1-4)	1	4	100	1
C2 (2-4)	2	4	19	1
C2 (4-6)	4	6	0.45	1
C2 (6-7)	6	7	2.3	1
C3 (4-6)	4	6	1.1	1
C3 (4-7)	4	7	0.026	1
C3 (6-6.4)	6	6.4	16	1
C4 (2.5-4)	2.5	4	39	1
C4 (4-6)	4	6	23	1
C4 (8-8.4)	8	8.4	3.7	1
C5 (0-2)	0	2	1.9	1
C5 (2-4)	2	4	8.1	1
C5 (4-6)	4	6	3.8	1
C5 (6-8)	6	8	25	1
C5 (8-8.6)	8	8.6	3.8	1
C6 (0-2)	0	2	0.52	1
C6 (1-5)	1	5	0.4	1
C6 (2-4)	2	4	0.83	1
C6 (4-6)	4	6	35	1
C6 (6-8)	6	8	0.051	1
C6 (10-11)	10	11	1	1
C7 (0-2)	0	2	0.037	1
C7 (2-3)	2	3	0.13	1
C8 (0-2)	0	2	0.98	1
C8 (2-4)	2	4	0.037	1
C9 (0-1.6)	0	1.6	0.016	1
C10 (0-0.9)	0	0.9	0.005	0
Ci (0-2)	0	2	3.8	1
Ci (2-4)	2	4	0.005	0
Ci (4-4.6)	4	4.6	0.035	1
Cii (0-2)	0	2	0.005	0
Ciii (0-2)	0	2	0.005	0
D1 (0-2)	0	2	0.19	1
D1 (2-4)	2	4	0.35	1
D1 (4-6)	4	6	2.2	1
D1 (6-7.4)	6	7.4	0.005	0
D2 (0-2)	0	2	7.6	1
D2 (6-8)	6	8	22	1
D3 (2-4)	2	4	54	1
D3 (4-5.5)	4	5.5	2.3	1
D3 (6-8)	6	8	6	1
D7 (0-2)	0	2	0.33	1
D8 (0-2)	0	2	0.039	1
D8 (2-3)	2	3	0.005	0
D9 (0-2)	0	2	0.005	0
D10 (0-1.1)	0	1.1	0.13	1
D11 (0-1.6)	0	1.6	0.013	1
D12 (0-1)	0	1	0.02	1
Di (0-2)	0	2	0.033	1
Di (2-4)	2	4	0.067	1
Di (4-5.8)	4	5.8	0.005	0
Dii (0-2)	0	2	0.005	0
Dii (2-4)	2	4	0.005	0
Dii (4-6)	4	6	0.005	0
Diii (0-2)	0	2	0.005	0
Diii (2-4)	2	4	0.005	0
Diii (4-4.8)	4	4.8	0.005	0
E1 (0-2)	0	2	0.07	1
E1 (2-4)	2	4	0.27	1
E1 (4-6)	4	6	0.026	1
E1 (6-6.6)	6	6.6	0.05	1
E2 (0-2)	0	2	7.8	1
E2 (0.5-4)	0.5	4	6.6	1
E2 (2-4)	2	4	0.7	1
E2 (4-4.6)	4	4.6	1.8	1
E3 (0-2)	0	2	19	1

TCE Spill Zone Soil Column Data Set

Sample ID	Top of sample	Bottom of sample	TCE	D_TCE
E3 (2-3.1)	2	3.1	2.5	1
E3 (6-8)	6	8	0.4	1
E7 (0-2)	0	2	0.36	1
E7 (2-2.9)	2	2.9	1.7	1
E8 (0-2)	0	2	2	1
E8 (2-3)	2	3	1.1	1
E9 (0-2)	0	2	1.7	1
E9 (2-3.6)	2	3.6	0.15	1
Ei (0-2)	0	2	0.47	1
Ei (2-4)	2	4	0.064	1
Eii (0-2)	0	2	0.005	0
Eii (2-4)	2	4	0.005	0
Eii (4-6)	4	6	0.005	0
Eiii (0-2)	0	2	0.005	0
Eiii (2-4)	2	4	0.005	0
F1 (0-1.8)	0	1.8	0.081	1
F2 (0-2)	0	2	0.35	1
F2 (2-2.4)	2	2.4	0.31	1
F3 (0-2)	0	2	1.3	1
F3 (2-3.2)	2	3.2	0.13	1
F7 (0-2)	0	2	0.022	1
F8 (2-3.7)	2	3.7	0.005	0
F9 (0-2)	0	2	0.005	0
F9 (2-3.9)	2	3.9	0.16	1
Fi (0-1.5)	0	1.5	0.018	1
Fii (0-2)	0	2	0.026	1
Fiii (0-2)	0	2	0.022	1
G1 (0-2)	0	2	0.024	1
G1 (2-3.1)	2	3.1	0.02	1
G2 (0-2)	0	2	0.005	0
G2 (2-3.5)	2	3.5	0.005	0
G3 (0-1.9)	0	1.9	0.005	0
G4 (0-2)	0	2	8.1	1
G4 (2-4)	2	4	0.14	1
G4 (4-5)	4	5	0.69	1
G5 (0-2)	0	2	5.2	1
G5 (2-3)	2	3	1	1
G6 (0-2)	0	2	0.89	1
G6 (2-4)	2	4	0.078	1
G6 (4-6)	4	6	0.097	1
G6 (6-7.6)	6	7.6	1.4	1
G7 (0-2)	0	2	29	1
G7 (2-3.1)	2	3.1	1.1	1
G7 (4-6)	4	6	77	1
G8 (0-1.9)	0	1.9	0.93	1
G9 (0-2)	0	2	0.25	1
H1 (0-1.5)	0	1.5	0.03	1
H2 (0-2)	0	2	0.005	0
H2 (2-4)	2	4	0.005	0
H2 (4-4.5)	4	4.5	0.005	0
H3 (0-1.7)	0	1.7	0.075	1
H4 (0-1.8)	0	1.8	0.005	0
H5 (0-1.5)	0	1.5	0.66	1
H6 (0-1.9)	0	1.9	0.005	0
H7 (0-2)	0	2	3.5	1
H7 (2-3.5)	2	3.5	0.27	1
H8 (0-2)	0	2	6.3	1
H8 (2-3.9)	2	3.9	1.5	1
H9 (0-2)	0	2	0.52	1
H9 (2-2.7)	2	2.7	3	1
I1 (0-2)	0	2	0.048	1
I1 (2-2.1)	2	2.1	0.031	1
I2 (0-2)	0	2	0.005	0
I2 (2-2.8)	2	2.8	0.005	0
I3 (0-2)	0	2	0.005	0
I3 (2-3.3)	2	3.3	0.005	0
I4 (0-1.6)	0	1.6	0.005	0
I5 (0-1.9)	0	1.9	0.005	0
I6 (0-2)	0	2	0.005	0

TCE Spill Zone Soil Column Data Set

Sample ID	Top of sample	Bottom of sample	TCE	D_TCE
I6 (2-3.9)	2	3.9	0.005	0
I7 (0-2)	0	2	0.005	0
I7 (2-3.5)	2	3.5	0.005	0
I9 (0-2)	0	2	0.005	0
I9 (2-2.8)	2	2.8	0.051	1
K7 (0-2)	0	2	0.005	0
Z1 (0-2)	0	2	0.005	0
Z1 (2-3.5)	0	2	0.005	0
Z2 (0-2)	0	2	0.005	0
Z2 (2-4)	2	4	0.005	0
Z2 (4-6)	4	6	0.005	0
Z2 (6-8)	4	6	0.005	0
Z3 (0-2)	0	2	0.005	0
Z3 (2-4)	2	4	0.005	0
Z3 (4-6)	4	6	0.005	0
Z3 (6-7.9)	6	7.9	0.005	0
Z4 (0-2)	0	2	0.005	0
Z4 (2-4)	2	4	0.005	0
Z4 (4-6)	4	6	0.005	0
Z5 (0-2)	0	2	0.005	0
Z5 (2-4)	2	4	0.005	0
Z5 (4-5)	4	5	0.005	0
Z6 (0-2)	0	2	0.005	0
Z6 (2-4)	2	4	0.005	0
Z6 (4-6)	4	6	0.005	0
Z6 (6-7.5)	6	7.5	0.005	0
Zi (0-2)	0	2	0.005	0
Zi (2-4)	2	4	0.028	1

Data collected pre-SVE in 2010 and post-SVE in 2017
Yellow highlighting indicates either the location was not sampled in 2010 or the location was re-sampled post-SVE 2017 and the post-SVE result was used
Units in mg/kg

TCE Spill Zone Soil Column Data Set

Locations Inside Extent of CSCO Demarcated Area

Sample ID	Top of Sample	Bottom of Sample	TCE
Biased Sample 3/ BS-3 (4-8)	4	8	340
Biased Sample 4/ BS-4 (6-8)	6	8	480
D5 (8-9)	8	9	390
D5N (4-6)	4	6	220
D5E (8-10.5)	8	10.5	280
D5W (1-5)	1	5	27
D5S (4-8)	4	8	370
E4 (0.5 - 4)	0.5	4	200
E5N (4-6.5)	4	6.5	300
E5E (1.5-3.5)	1.5	3.5	300
E5S Gulf Road (1.5-2)	1.5	2	340
E5W (3-4)	3	4	170
E6 (0.5-2.25)	0.5	2.25	68
F5 (0.5-4)	0.5	4	370
F5N (1-2)	1	2	300
F5E (1-2)	1	2	240
F5S (2-2.5)	2	2.5	0.62
F5W (0.5-2.5)	0.5	2.5	0.012
F6 (0.5-1.5)	0.5	1.5	810
F6N (1-3)	1	3	560
F6E (1-3)	1	3	450
F6S (1.5-4)	1.5	4	530
F6W (2.5-4)	2.5	4	120
Gulf Road (0.5-1.5)	0.5	1.5	20

Data collected post-SVE in 2017
Units in mg/kg

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 1/2/2023 9:41:28 PM
From File	SSDataSet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TCE - Surface Soil Outside Extent of CSCO

General Statistics

Total Number of Observations	97	Number of Distinct Observations	54
Number of Detects	58	Number of Non-Detects	39
Number of Distinct Detects	53	Number of Distinct Non-Detects	1
Minimum Detect	0.013	Minimum Non-Detect	0.005
Maximum Detect	67	Maximum Non-Detect	0.005
Variance Detects	117.3	Percent Non-Detects	40.21%
Mean Detects	3.984	SD Detects	10.83
Median Detects	0.3	CV Detects	2.719
Skewness Detects	4.27	Kurtosis Detects	21.01
Mean of Logged Detects	-1.103	SD of Logged Detects	2.354

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.43	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.366	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.134	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.384	KM Standard Error of Mean	0.873
90KM SD	8.528	95% KM (BCA) UCL	3.93
95% KM (t) UCL	3.835	95% KM (Percentile Bootstrap) UCL	3.93
95% KM (z) UCL	3.821	95% KM Bootstrap t UCL	5.255
90% KM Chebyshev UCL	5.004	95% KM Chebyshev UCL	6.191
97.5% KM Chebyshev UCL	7.839	99% KM Chebyshev UCL	11.07

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.6	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.873	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.19	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.127	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only			
k hat (MLE)	0.28	k star (bias corrected MLE)	0.277
Theta hat (MLE)	14.2	Theta star (bias corrected MLE)	14.36
nu hat (MLE)	32.54	nu star (bias corrected)	32.19
Mean (detects)	3.984		
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	2.386
Maximum	67	Median	0.024
SD	8.572	CV	3.593
k hat (MLE)	0.215	k star (bias corrected MLE)	0.215
Theta hat (MLE)	11.09	Theta star (bias corrected MLE)	11.08
nu hat (MLE)	41.75	nu star (bias corrected)	41.79
Adjusted Level of Significance (β)	0.0475		
Approximate Chi Square Value (41.79, α)	27.97	Adjusted Chi Square Value (41.79, β)	27.8
95% Gamma Approximate UCL	3.565	95% Gamma Adjusted UCL	3.586
Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	2.384	SD (KM)	8.528
Variance (KM)	72.73	SE of Mean (KM)	0.873
k hat (KM)	0.0781	k star (KM)	0.0826
nu hat (KM)	15.16	nu star (KM)	16.02
theta hat (KM)	30.51	theta star (KM)	28.86
80% gamma percentile (KM)	1.206	90% gamma percentile (KM)	5.764
95% gamma percentile (KM)	13.88	99% gamma percentile (KM)	41.58
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (16.02, α)	7.979	Adjusted Chi Square Value (16.02, β)	7.893
95% KM Approximate Gamma UCL	4.788	95% KM Adjusted Gamma UCL	4.84
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Approximate Test Statistic	0.929	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk P Value	0.00265	Detected Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.108	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.106	Detected Data Not Lognormal at 10% Significance Level	
Detected Data Not Lognormal at 10% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	2.383	Mean in Log Scale	-3.507
SD in Original Scale	8.573	SD in Log Scale	3.674
95% t UCL (assumes normality of ROS data)	3.829	95% Percentile Bootstrap UCL	3.932
95% BCA Bootstrap UCL	4.352	95% Bootstrap t UCL	4.994
95% H-UCL (Log ROS)	216.9		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	-2.79	KM Geo Mean	0.0614
KM SD (logged)	2.736	95% Critical H Value (KM-Log)	4.389
KM Standard Error of Mean (logged)	0.28	95% H-UCL (KM -Log)	8.837
KM SD (logged)	2.736	95% Critical H Value (KM-Log)	4.389
KM Standard Error of Mean (logged)	0.28		

DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.383	Mean in Log Scale	-3.069
SD in Original Scale	8.573	SD in Log Scale	3.016
95% t UCL (Assumes normality)	3.829	95% H-Stat UCL	19.06

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use			
95% KM (t) UCL	3.835		

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.

Please verify the data were collected from random locations.

If the data were collected using judgmental or other non-random methods,

then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 1/2/2023 10:26:23 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TCE Surface Soil - Locations inside extent of CSCO

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	0.012	Mean	222.3
Maximum	810	Median	154
SD	274.9	Std. Error of Mean	97.18
Coefficient of Variation	1.236	Skewness	1.57

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.814	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level
Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	406.4	95% Adjusted-CLT UCL (Chen-1995)	439.8
		95% Modified-t UCL (Johnson-1978)	415.4

Gamma GOF Test

A-D Test Statistic	0.368	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.794	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.236	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.316	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level
Note GOF tests may be unreliable for small sample sizes

Gamma Statistics			
k hat (MLE)	0.318	k star (bias corrected MLE)	0.282
Theta hat (MLE)	700	Theta star (bias corrected MLE)	788.9
nu hat (MLE)	5.082	nu star (bias corrected)	4.509
MLE Mean (bias corrected)	222.3	MLE Sd (bias corrected)	418.8
		Approximate Chi Square Value (0.05)	0.933
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	0.592
Assuming Gamma Distribution			
95% Approximate Gamma UCL	1075	95% Adjusted Gamma UCL	1692
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.831	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.224	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level	
Data appear Approximate Lognormal at 10% Significance Level			
Note GOF tests may be unreliable for small sample sizes			
Lognormal Statistics			
Minimum of Logged Data	-4.423	Mean of logged Data	3.253
Maximum of Logged Data	6.697	SD of logged Data	3.842
Assuming Lognormal Distribution			
95% H-UCL	6.950E+11	90% Chebyshev (MVUE) UCL	8358
95% Chebyshev (MVUE) UCL	11156	97.5% Chebyshev (MVUE) UCL	15040
99% Chebyshev (MVUE) UCL	22669		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution			
Nonparametric Distribution Free UCLs			
95% CLT UCL	382.2	95% BCA Bootstrap UCL	434.8
95% Standard Bootstrap UCL	375.2	95% Bootstrap-t UCL	509.1
95% Hall's Bootstrap UCL	920.3	95% Percentile Bootstrap UCL	387.6
90% Chebyshev(Mean, Sd) UCL	513.9	95% Chebyshev(Mean, Sd) UCL	645.9
97.5% Chebyshev(Mean, Sd) UCL	829.2	99% Chebyshev(Mean, Sd) UCL	1189
Suggested UCL to Use			
95% Student's-t UCL	406.4		
The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.			
Please verify the data were collected from random locations.			
If the data were collected using judgmental or other non-random methods,			
then contact a statistician to correctly calculate UCLs.			

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 12/30/2022 6:14:18 PM
From File	TCEDataSet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TCE - Soil Column Outside Extent of CSCO

General Statistics

Total Number of Observations	234	Number of Distinct Observations	108
Number of Detects	151	Number of Non-Detects	83
Number of Distinct Detects	107	Number of Distinct Non-Detects	1
Minimum Detect	0.013	Minimum Non-Detect	0.005
Maximum Detect	100	Maximum Non-Detect	0.005
Variance Detects	286.2	Percent Non-Detects	35.47%
Mean Detects	6.344	SD Detects	16.92
Median Detects	0.4	CV Detects	2.667
Skewness Detects	3.851	Kurtosis Detects	15.85
Mean of Logged Detects	-0.696	SD of Logged Detects	2.365

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.431	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.374	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.0838	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	4.095	KM Standard Error of Mean	0.91
90KM SD	13.88	95% KM (BCA) UCL	5.643
95% KM (t) UCL	5.599	95% KM (Percentile Bootstrap) UCL	5.654
95% KM (z) UCL	5.593	95% KM Bootstrap t UCL	6.116
90% KM Chebyshev UCL	6.827	95% KM Chebyshev UCL	8.064
97.5% KM Chebyshev UCL	9.781	99% KM Chebyshev UCL	13.15

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	9.641	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.881	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.195	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0833	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.275	k star (bias corrected MLE)	0.274
Theta hat (MLE)	23.07	Theta star (bias corrected MLE)	23.16

nu hat (MLE)	83.05	nu star (bias corrected)	82.73
Mean (detects)	6.344		
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	4.097
Maximum	100	Median	0.061
SD	13.91	CV	3.395
k hat (MLE)	0.209	k star (bias corrected MLE)	0.209
Theta hat (MLE)	19.58	Theta star (bias corrected MLE)	19.57
nu hat (MLE)	97.91	nu star (bias corrected)	97.99
Adjusted Level of Significance (β)	0.049		
Approximate Chi Square Value (97.99, α)	76.15	Adjusted Chi Square Value (97.99, β)	76.04
95% Gamma Approximate UCL	5.272	95% Gamma Adjusted UCL	5.28
Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	4.095	SD (KM)	13.88
Variance (KM)	192.7	SE of Mean (KM)	0.91
k hat (KM)	0.087	k star (KM)	0.0888
nu hat (KM)	40.74	nu star (KM)	41.55
theta hat (KM)	47.05	theta star (KM)	46.13
80% gamma percentile (KM)	2.357	90% gamma percentile (KM)	10.31
95% gamma percentile (KM)	23.86	99% gamma percentile (KM)	68.99
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (41.55, α)	27.77	Adjusted Chi Square Value (41.55, β)	27.71
95% KM Approximate Gamma UCL	6.126	95% KM Adjusted Gamma UCL	6.142
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Approximate Test Statistic	0.935	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk P Value	9.7138E-8	Detected Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.0694	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.0663	Detected Data Not Lognormal at 10% Significance Level	
Detected Data Not Lognormal at 10% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	4.095	Mean in Log Scale	-2.736
SD in Original Scale	13.91	SD in Log Scale	3.521
95% t UCL (assumes normality of ROS data)	5.597	95% Percentile Bootstrap UCL	5.666
95% BCA Bootstrap UCL	5.869	95% Bootstrap t UCL	5.88
95% H-UCL (Log ROS)	101.6		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	-2.328	KM Geo Mean	0.0974
KM SD (logged)	2.904	95% Critical H Value (KM-Log)	4.252
KM Standard Error of Mean (logged)	0.19	95% H-UCL (KM -Log)	14.84
KM SD (logged)	2.904	95% Critical H Value (KM-Log)	4.252
KM Standard Error of Mean (logged)	0.19		

DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	4.094	Mean in Log Scale	-2.574
SD in Original Scale	13.91	SD in Log Scale	3.17
95% t UCL (Assumes normality)	5.596	95% H-Stat UCL	29.99

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL	5.599		

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.

Please verify the data were collected from random locations.

If the data were collected using judgmental or other non-random methods,

then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 1/2/2023 9:06:11 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TCE Soil Column - Inside Extent of CSCO

General Statistics

Total Number of Observations	24	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	0.012	Mean	286.9
Maximum	810	Median	300
SD	198.8	Std. Error of Mean	40.57
Coefficient of Variation	0.693	Skewness	0.547

Normal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.884	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.0936	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.205	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	356.4	95% Adjusted-CLT UCL (Chen-1995)	358.5
		95% Modified-t UCL (Johnson-1978)	357.2

Gamma GOF Test

A-D Test Statistic	2.04	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.786	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.257	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.185	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.712	k star (bias corrected MLE)	0.65
Theta hat (MLE)	403.2	Theta star (bias corrected MLE)	441.1
nu hat (MLE)	34.16	nu star (bias corrected)	31.22
MLE Mean (bias corrected)	286.9	MLE Sd (bias corrected)	355.7
		Approximate Chi Square Value (0.05)	19.46
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	18.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	460.4	95% Adjusted Gamma UCL	476.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.613	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.93	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.302	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.162	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.423	Mean of logged Data	4.812
Maximum of Logged Data	6.697	SD of logged Data	2.474

Assuming Lognormal Distribution

95% H-UCL	32841	90% Chebyshev (MVUE) UCL	5213
95% Chebyshev (MVUE) UCL	6777	97.5% Chebyshev (MVUE) UCL	8948
99% Chebyshev (MVUE) UCL	13212		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs			
95% CLT UCL	353.6	95% BCA Bootstrap UCL	357.5
95% Standard Bootstrap UCL	350.9	95% Bootstrap-t UCL	357.6
95% Hall's Bootstrap UCL	360.2	95% Percentile Bootstrap UCL	353.9
90% Chebyshev(Mean, Sd) UCL	408.6	95% Chebyshev(Mean, Sd) UCL	463.7
97.5% Chebyshev(Mean, Sd) UCL	540.3	99% Chebyshev(Mean, Sd) UCL	690.6
Suggested UCL to Use			
95% Student's-t UCL	356.4		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

Attachment D

RSL Calculator Inputs and Outputs – Risk Evaluation

Summary of Calculated Risks and Hazards
Spill Zone Soil Outside of Extent of Potential Engineering Controls

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Point	Constituent of Concern (COC)	Carcinogenic Risk			Non-Carcinogenic Hazard Quotient		
			Ingestion	Inhalation	Exposure Route Total	Ingestion	Inhalation	Exposure Route Total
Soil	Soil Column	Trichloroethene	1E-08	2E-07	**2E-07**	0.03	1	**1**

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Older Child/Adult

Medium	Exposure Point	Constituent of Concern (COC)	Carcinogenic Risk			Non-Carcinogenic Hazard Quotient		
			Ingestion	Inhalation	Exposure Route Total	Ingestion	Inhalation	Exposure Route Total
Soil	Surface Soil	Trichloroethene	1E-08	2E-08	**3E-08**	0.002	0.006	**0.008**

Footnotes:
Surface soil depths encompass soils 0 to 2.5 ft bgs
Soil column depths encompass soils 0 to 10.5 ft bgs

Site-specific
Construction Worker Inputs

Variable	Construction Worker Soil - Other Default Value	Site-Specific Value
A (PEF Dispersion Constant)	2.4538	2.4538
A (VF Dispersion Constant)	2.4538	2.4538
B (PEF Dispersion Constant)	17.5660	17.5660
B (VF Dispersion Constant)	17.5660	17.5660
C (PEF Dispersion Constant)	189.0426	189.0426
C (VF Dispersion Constant)	189.0426	189.0426
F_D Unitless Dispersion Correction Factor	0.185837208	0.185837208
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependant on U_m/U_t derived using Cowherd et al. (1985))	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
ρ_b (dry soil bulk density) g/cm ^{3}	1.5	1.5
ρ_b (dry soil bulk density) g/cm ^{3}	1.5	1.5
ρ_s (soil particle density) g/cm ^{3}	2.65	2.65
Q/C_{sa} (g/m^2-s per kg/m^3)	14.31407	8.4149953836850
Q/C_{vol} (g/m^2-s per kg/m^3)	14.31407	14.31407
Q/C_{sa} (g/m^2-s per kg/m^3)	14.31407	14.31407
A_s ($VF_{mlim-sc}$ acres)	0.5	0.5
A_s ($VF_{ulim-sc}$ acres)	0.5	0.5
AF_{con} (skin adherence factor - construction worker) mg/cm ^{2}	0.3	0.3
AT_{con} (averaging time - construction worker) days	365	365
AT_{con-a} (averaging time - construction worker) days	350	350
BW_{con} (body weight - construction worker) kg	80	80
ED_{con} (exposure duration - construction worker) yr	1	1
EF_{con} (exposure frequency - construction worker) day/yr	250	250
ET_{con} (exposure time - construction worker) hr/day	8	8
THQ (target hazard quotient) unitless	0.1	1
IRS_{con} (soil ingestion rate - construction worker) mg/day	330	330
LT (lifetime) yr	70	70
SA_{con} (surface area - construction worker) cm ^{2}/day	3527	3527
TR (target cancer risk) unitless	1.0E-06	1.0E-06

Output generated 01JAN2023:16:53:04

Site-specific
Construction Worker Inputs

Variable	Construction Worker Soil - Other Default Value	Site-Specific Value
t_c (overall duration of construction) hours	8400	8400
T_c (overall duration of construction) s	30240000	30240000
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (time over which traffic occurs) s	7200000	7200000
T_t (overall duration of traffic) s	7200000	7200000
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value) m/s	11.32	11.32
$VF_{mlim-sc}$ (volitization factor) m^3_{air}/kg_{soil}	.	0
V (fraction of vegetative cover)	0	0

Site-specific
Construction Worker Risk for Soil - Other Construction Activities

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)
Trichloroethylene	4.60E-02	I	4.10E-06	I	5.00E-04	A /Subchronic	2.15E-03	A /Subchronic	1	-	1	6.92E+02	1.28E+03	6.07E+01
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-

K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature T_C \ (K)	T_C \ Ref	Chemical Type	D_{ia} \ (cm^2/s)	D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor Unlimited Reservoir (m^3/kg)
3.64E-01	9.85E-03	4.03E-01	PHYSPROP	360.35	PHYSPROP	571	YAWS	VOC	6.87E-02	1.02E-05	2.73E-03	7.09E+07	-
-	-	-		-		-			-	-	-	-	-

Volatilization Factor Mass Limit (m^3/kg)	Volatilization Factor Selected (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Dermal HQ	Inhalation HQ	Noncarcinogenic HI
-	4.79E+02	5.60E+00	1.04E-08	-	1.56E-07	1.67E-07	3.30E-02	-	1.29E+00	1.33E+00
-	-	-	*1.04E-08*	-	*1.56E-07*	*1.67E-07*	*3.30E-02*	-	*1.29E+00*	*1.33E+00*

Site-specific
Recreator Soil Inputs

Variable	Recreator Soil Default Value	Site-Specific Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - mass limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - mass limit)	18.4385	18.4385
City (PEF Climate Zone) Selection	Default	Default
City (VF Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - mass limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_h (dry soil bulk density) g/cm ^{3}	1.5	1.5
p_h (dry soil bulk density - mass limit) g/cm ^{3}	1.5	1.5
PEF (particulate emission factor) m ^{3}/kg	1359344438	1359344438
p_s (soil particle density) g/cm ^{3}	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3 - mass limit)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (skin adherence factor) mg/cm ^{2}	.	0
AF_{2-6} (skin adherence factor) mg/cm ^{2}	.	0
AF_{6-16} (skin adherence factor) mg/cm ^{2}	.	0.2
AF_{16-30} (skin adherence factor) mg/cm ^{2}	.	0.2
AF_{rec-a} (skin adherence factor - adult) mg/cm ^{2}	.	0.2
AF_{rec-c} (skin adherence factor - child) mg/cm ^{2}	.	0
AT_{rec} (averaging time)	365	365

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Site-specific
Recreator Soil Inputs

Variable	Recreator Soil Default Value	Site-Specific Value
BW_{0-2} (body weight) kg	15	0
BW_{2-6} (body weight) kg	15	0
BW_{6-16} (body weight) kg	80	80
BW_{16-30} (body weight) kg	80	80
BW_{rec-a} (body weight - adult) kg	80	80
BW_{rec-c} (body weight - child) kg	15	0
$DFS_{rec-adj}$ (age-adjusted soil dermal factor) mg/kg	.	19302.4
$DFSM_{rec-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	.	38604.8
ED_{rec} (exposure duration - recreator) years	26	20
ED_{0-2} (exposure duration) year	2	0
ED_{2-6} (exposure duration) year	4	0
ED_{6-16} (exposure duration) year	10	10
ED_{16-30} (exposure duration) year	10	10
ED_{rec-c} (exposure duration - child) years	6	0
EF_{rec} (exposure frequency) days/year	.	64
EF_{0-2} (exposure frequency) days/year	.	0
EF_{2-6} (exposure frequency) days/year	.	0
EF_{6-16} (exposure frequency) days/year	.	64
EF_{16-30} (exposure frequency) days/year	.	64
EF_{rec-a} (exposure frequency - adult) days/year	.	64
EF_{rec-c} (exposure frequency - child) days/year	.	0
ET_{rec} (exposure time - recreator) hours/day	.	1
ET_{0-2} (exposure time) hours/day	.	0
ET_{2-6} (exposure time) hours/day	.	0
ET_{6-16} (exposure time) hours/day	.	1
ET_{16-30} (exposure time) hours/day	.	1
ET_{rec-a} (adult exposure time) hours/day	.	1
ET_{rec-c} (child exposure time) hours/day	.	0
THQ (target hazard quotient) unitless	0.1	1
$IFS_{rec-adj}$ (age-adjusted soil ingestion factor) mg/kg	.	1600
$IFSM_{rec-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	.	3200

Output generated 02JAN2023:21:54:05

Site-specific
Recreator Soil Inputs

Variable	Recreator Soil Default Value	Site-Specific Value
IRS_{0-2} (soil intake rate) mg/day	200	0
IRS_{2-6} (soil intake rate) mg/day	200	0
IRS_{6-16} (soil intake rate) mg/day	100	100
IRS_{16-30} (soil intake rate) mg/day	100	100
IRS_{rec-a} (soil intake rate - adult) mg/day	100	100
IRS_{rec-c} (soil intake rate - child) mg/day	200	0
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2/day	2373	0
SA_{2-6} (skin surface area) cm^2/day	2373	0
SA_{6-16} (skin surface area) cm^2/day	6032	6032
SA_{16-30} (skin surface area) cm^2/day	6032	6032
SA_{rec-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{rec-c} (skin surface area - child) cm^2/day	2373	0
TR (target risk) unitless	1.0E-06	1.0E-06
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-Specific
Recreational User (Adult/Older Child)
References for Site-Specific RSL Calculator Inputs

Variable	Recreator Site-Specific Value	Comment
AF_{6-16} (skin adherence factor) mg/cm^2	0.2	Upper end adherence factor, based on average adherence factor for children playing in wet soil (from Exhibit 3-3 of EPA, 2004)
AF_{16-30} (skin adherence factor) mg/cm^2	0.2	Upper end adherence factor, based on average adherence factor for children playing in wet soil (from Exhibit 3-3 of EPA, 2004)
EF_{6-16} (exposure frequency) days/year	64	Best professional judgement, based on 2 days/week during warm weather months defined by NYSDEC (32 weeks)
EF_{16-30} (exposure frequency) days/year	64	Best professional judgement, based on 2 days/week during warm weather months defined by NYSDEC (32 weeks)
ET_{6-16} (exposure time) hours/day	1	Best professional judgement, based on inadvertent access to the Site while accessing adjacent properties for recreational land use. Value is consistent with time spent outdoors while playing (Table 16-1 in USEPA, 2011: 50th percentile for general population).
ET_{16-30} (exposure time) hours/day	1	Best professional judgement, based on inadvertent access to the Site while accessing adjacent properties for recreational land use. Value is consistent with time spent outdoors while playing (Table 16-1 in USEPA, 2011: 50th percentile for general population).
ET_{rec-a} (adult exposure time) hours/day	1	

NYSDEC, 2020. Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document 2020 Addendum. Prepared by New York State Department of Environmental Conservation, July 2020.

EPA, 2004: Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual. Part E Supplemental Guidance for Dermal Risk Assessment) Final (with 2007 update).

EPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F. September.

All other exposure factors used were default values

Site-specific
Recreator Risk for Soil

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Trichloroethylene	4.60E-02	I	4.10E-06	I	5.00E-04	I	2.00E-03	I	1	-	1	6.92E+02	1.28E+03	6.07E+01	3.64E-01	9.85E-03
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-	-

Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature T_c\ (K)	T_c\ Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor Unlimited Reservoir (m^3/kg)	Volatilization Factor Mass Limit (m^3/kg)	Volatilization Factor Selected (m^3/kg)
4.03E-01	PHYSPROP	360.35	PHYSPROP	571	YAWS	VOC	6.87E-02	1.02E-05	2.73E-03	1.36E+09	2.21E+03	-	2.21E+03
-		-		-			-	-	-	-	-	-	-

Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
3.80E+00	1.32E-08	-	1.83E-08	3.15E-08	-	-	-	-	1.67E-03	-	6.28E-03	7.95E-03
-	*1.32E-08*	-	*1.83E-08*	*3.15E-08*	-	-	-	-	*1.67E-03*	-	*6.28E-03*	*7.95E-03*

Output generated 02JAN2023:21:54:05

Appendix B
USDA Soil Resource Report and Rubble Land Definition

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Genesee County, New York



November 16, 2021

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map (LVRR Site (Spill Area))



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Genesee County, New York
Survey Area Data: Version 22, Aug 29, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 31, 2012—Sep 16, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (LVRR Site (Spill Area))

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BeB	Benson soils, 0 to 8 percent slopes	49.5	34.1%
BeD	Benson soils, 8 to 25 percent slopes	6.7	4.6%
BeE	Benson soils, 25 to 40 percent slopes	5.2	3.6%
GP	Gravel pits	21.1	14.5%
QU	Quarries	6.4	4.4%
Ru	Rubbleland	39.4	27.2%
Uf	Udorthents, loamy skeletal	9.4	6.5%
W	Water	1.6	1.1%
Wk	Wakeville silt loam	5.6	3.9%
Totals for Area of Interest		**145.0**	**100.0%**

Map Unit Descriptions (LVRR Site (Spill Area))

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a

given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Genesee County, New York

BeB—Benson soils, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: b3xd
Elevation: 90 to 1,000 feet
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Benson and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Benson

Setting

Landform: Benches, ridges, till plains
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Channery loamy till underlain by limestone or calcareous shale

Typical profile

H1 - 0 to 9 inches: channery loam
H2 - 9 to 19 inches: very channery loam
H3 - 19 to 29 inches: unweathered bedrock

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: D
Ecological site: F101XY011NY - Shallow Till Upland
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent
Hydric soil rating: No

Aurora
Percent of map unit: 7 percent
Hydric soil rating: No

Wassaic
Percent of map unit: 7 percent
Hydric soil rating: No

Rock outcrop
Percent of map unit: 1 percent
Hydric soil rating: Unranked

BeD—Benson soils, 8 to 25 percent slopes

Map Unit Setting
National map unit symbol: b3xf
Elevation: 90 to 1,000 feet
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition
Benson and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Benson

Setting
Landform: Benches, ridges, till plains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Channery loamy till underlain by limestone or calcareous shale

Typical profile
H1 - 0 to 9 inches: channery loam
H2 - 9 to 19 inches: very channery loam
H3 - 19 to 29 inches: unweathered bedrock

Properties and qualities
Slope: 8 to 25 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: F101XY011NY - Shallow Till Upland
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent
Hydric soil rating: No

Wassaic

Percent of map unit: 8 percent
Hydric soil rating: No

Rock outcrop

Percent of map unit: 2 percent
Hydric soil rating: Unranked

BeE—Benson soils, 25 to 40 percent slopes

Map Unit Setting

National map unit symbol: b3xg
Elevation: 90 to 1,000 feet
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Benson and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Benson

Setting

Landform: Benches, ridges, till plains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Channery loamy till underlain by limestone or calcareous shale

Typical profile

H1 - 0 to 9 inches: channery loam
H2 - 9 to 19 inches: very channery loam

H3 - 19 to 29 inches: unweathered bedrock

Properties and qualities

Slope: 25 to 40 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F101XY011NY - Shallow Till Upland
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent
Hydric soil rating: No

Wassaic

Percent of map unit: 5 percent
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Hydric soil rating: Unranked

GP—Gravel pits

Map Unit Setting

National map unit symbol: b3yl
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Gravel pits: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Unnamed soils
Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Phelps
Percent of map unit: 5 percent
Hydric soil rating: No

Fredon
Percent of map unit: 5 percent
Hydric soil rating: No

Arkport
Percent of map unit: 5 percent
Hydric soil rating: No

QU—Quarries

Map Unit Setting
National map unit symbol: 1hfsk
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition
Quarries: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Benson
Percent of map unit: 5 percent
Hydric soil rating: No

Appleton
Percent of map unit: 5 percent
Hydric soil rating: No

Wassaic
Percent of map unit: 5 percent
Hydric soil rating: No

Lyons
Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Ru—Rubbleland

Map Unit Setting

National map unit symbol: p9g0
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Rubbleland: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Rock outcrop

Percent of map unit: 5 percent
Hydric soil rating: Unranked

Benson

Percent of map unit: 5 percent
Hydric soil rating: No

Newstead

Percent of map unit: 5 percent
Hydric soil rating: No

Wassaic

Percent of map unit: 5 percent
Hydric soil rating: No

Marilla

Percent of map unit: 5 percent
Hydric soil rating: No

Uf—Udorthents, loamy skeletal

Map Unit Setting

National map unit symbol: 1jq4y
Elevation: 100 to 1,600 feet
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents, loamy skeletal and similar soils: 85 percent

Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents, Loamy Skeletal

Typical profile
H1 - 0 to 24 inches: gravelly loamy sand
H2 - 24 to 72 inches: variable

Properties and qualities
Slope: 0 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.06 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Minor Components

Unnamed soils
Percent of map unit: 15 percent
Hydric soil rating: No

W—Water

Map Unit Setting
National map unit symbol: b41j
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition
Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Wk—Wakeville silt loam

Map Unit Setting
National map unit symbol: p8yc
Elevation: 750 to 1,740 feet
Mean annual precipitation: 31 to 38 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 140 to 175 days

Farmland classification: Prime farmland if drained

Map Unit Composition

Wakeville and similar soils: 70 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wakeville

Setting

Landform: Flood plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Silty alluvium washed from areas of glacial drift derived mainly from shale, siltstone, and sandstone, with some limestone

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 41 inches: silt loam
H3 - 41 to 72 inches: fine sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: OccasionalNone
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Available water supply, 0 to 60 inches: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B/D
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent
Hydric soil rating: No

Wayland

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

Udifluvents

Percent of map unit: 5 percent
Hydric soil rating: No

Teel

Percent of map unit: 5 percent

Hydric soil rating: No

Fluvaquents

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

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Part 627 – Legend Development and Data Collection

Subpart B – Exhibits

627.10 Miscellaneous Areas

Miscellaneous areas have essentially no soil or are bodies of soil that are heavily disturbed. They can result from active erosion and deposition, flooding and ponding, unfavorable edaphic conditions, or human activities. Some miscellaneous areas can be made productive, but only after major reclamation efforts. The paragraphs below discuss the 20 miscellaneous areas that are approved for use as component names. No other miscellaneous area names are used. See section 627.4F(2) for the process to revise the list of areas. Phase terms are not populated in the component name column of the database. Map unit names can consist of the concatenated miscellaneous area name and the local phase term (e.g., "Water, saline"). Local phase terms are developed as needed and have no finite limit or national approval process.

Badland is moderately steep to very steep barren land that is dissected by many intermittent drainage channels. Ordinarily, the areas are not stony. Badland is most common in semiarid and arid regions where streams and surface runoff have cut into soft bedrock such as shale. Local relief generally ranges from 10 to 200 meters in height. Potential runoff is very high and erosion is active.

Beaches are sandy, gravelly, or cobbly shores that are washed and rewashed by waves. The areas may be partly covered with water during high tides or storms.

Chutes are elongated areas on steep mountain slopes. The vegetation has been removed by avalanche or mass movement processes. Chutes consist of exposed bedrock, rock fragments, and large woody debris. Their slopes are parallel to the slope of the mountain and their lengths are at least ten times their widths.

Cinder land is composed of loose cinders and other scoriaceous tephra. The water-holding capacity of the tephra is very low and the trafficability is poor. Cinder land is commonly associated with cinder cone volcanoes, but not all cinder land occurs on the flanks of volcanic hills or mountains.

Dams are artificial structures, oriented across a watercourse or natural drainage area, for the purpose of impounding or diverting water.

Dumps are areas of smoothed or uneven accumulations or piles of waste rock and general refuse. Some dumps that are closely associated with pits are mapped as a complex map unit of dumps and pits.

Dune land consists of sand in ridges and intervening troughs that shift with the wind.

Glaciers are large masses of ice that formed, at least in part, on land by the compaction and recrystallization of snow. They may be moving slowly downslope or outward in all directions because of the stress of their own weight, they may be retreating, or they may be stagnant. Rocks and some earthy material may be on the surface of or imbedded within the ice. Permanent snowfields are associated with glaciers in some regions.

Gullied land consists of areas where erosion has cut a network of V-shaped or U-shaped channels. The areas resemble miniature badlands. Generally, gullies are so deep that extensive reshaping is necessary

for most uses. Small areas can be shown by spot symbols. Phases that indicate the kind of material remaining may be useful for some areas.

Lava flows are areas covered with barren lava. In most humid regions, the flows are of Holocene age, but in arid and very cold regions they may be older. Some flows have sharp, jagged surfaces, crevices, and angular blocks that are characteristic of slow-moving viscous lava. The Hawaiian term for a basaltic lava flow with these features is named "aa." Other lava flows are relatively smooth and have a ropy, glazed surface due to hotter eruption temperatures, lower viscosity, and rapid flow rates. The Hawaiian term for this form of lava flow is "pahoehoe." A little earthy material, ash, cinders, or accumulations of fresh organic material may be in a few fractures and sheltered pockets, but the flows are virtually devoid of soil. Lava flows have no vegetation other than lichens or other plant life growing in small pockets.

Mined land is areas which are significantly altered by mining activities. Soil material and rock has been moved into, out of, or within the areas designated. Because access to mined land may be limited by permissions or hazardous materials, identification of soil components can be difficult or impossible. Mined land may also have associated small excavations which could be correlated and delineated as pits if needed.

Oil-waste land consists of areas where liquid oily wastes, principally of salt water and oil, have accumulated. It includes slush pits and adjacent areas that are affected by the liquid wastes. The land is barren, although some of it can be reclaimed at high cost.

Pits are open excavations from which soil and commonly underlying material have been removed, exposing either rock or other material. Common kinds of pits are those that result from mining, gravel operations, and quarries. Pits are often closely associated with dumps.

Playas are barren flats in closed basins in arid regions. The largest playas occupy the dry beds of ancient, pluvial lakes. The sediments in playas are mainly fine-grained lacustrine deposits that accumulate from silt and clay particles settling in still water. Many playas are subject to removal of sediments by wind action and are a local source of fine particulate matter. Many playas are saline, sodic, or both and may have mineral crusts of soluble salts. Some nearly level playas are subject to intermittent ponding following periods of heavy precipitation, snowmelt, or both. The water table may be near the surface at times, or it may remain at depth.

Riverwash is unstabilized sandy, silty, clayey, or gravelly sediment that is flooded, washed, and reworked frequently by rivers or streams that little or no vegetation can become established. The recent deposition of fresh alluvium precludes soil development.

Rock outcrop consists of exposures of barren bedrock, other than lava flows, chutes, and rock-lined pits. Some areas are large and are only broken by small areas of soil. Most rock outcrops are hard rock, but some are soft rock such as thin beds of weakly cemented shale interbedded with thick beds of strongly cemented sandstone.

Rubble land consists of areas of cobbles, flagstones, stones, and boulders in unstable deposits of sufficient thickness to significantly limit the establishment of vegetation. Rubble land is commonly at the base of mountains but in some areas consists of deposits of large rock fragments left on mountain slopes by glaciation or by periglacial processes.

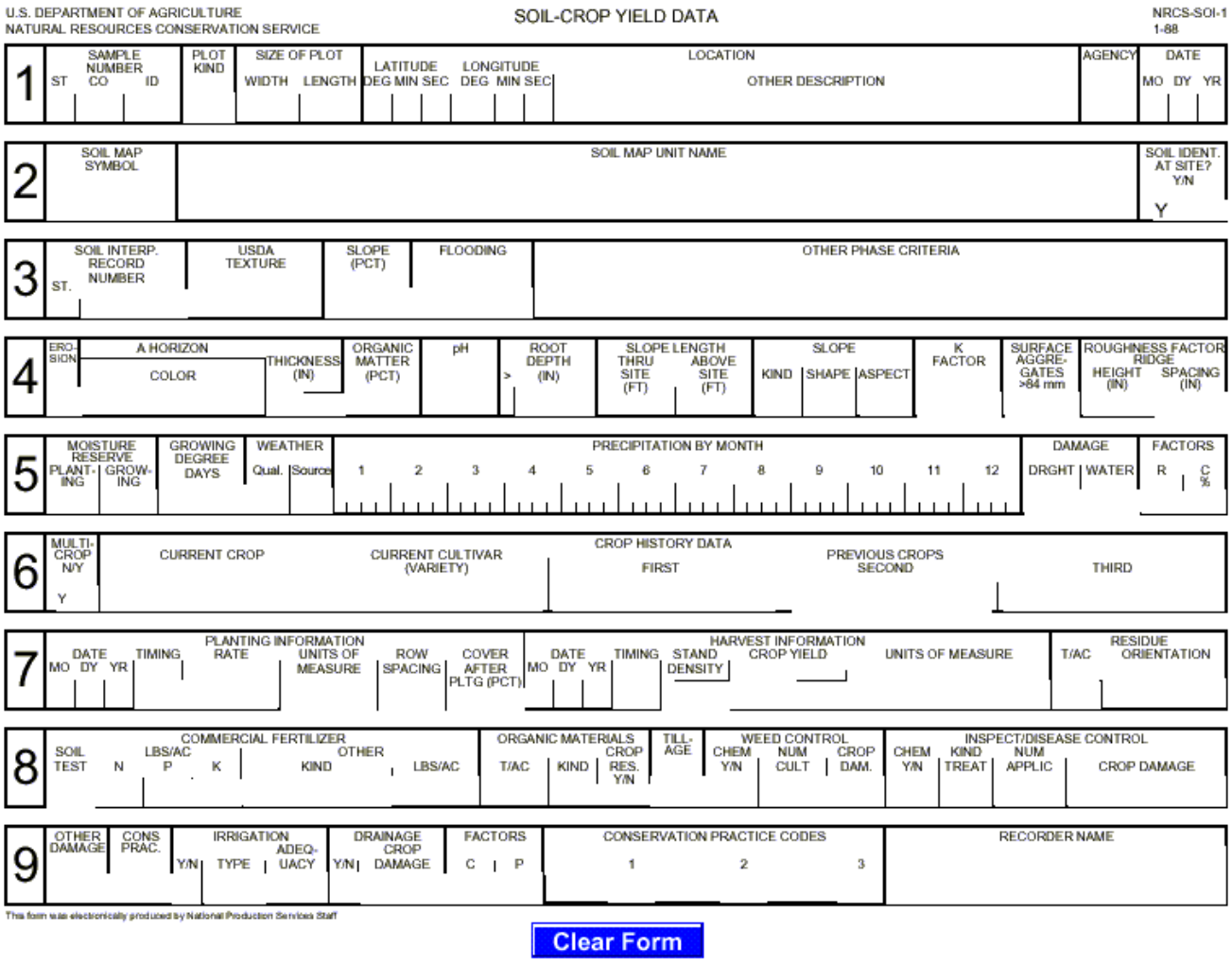
Slickens are accumulations of fine textured material, such as that separated in placer mine and ore mill operations. Slickens from ore mills consist largely of freshly ground rock that commonly has undergone

chemical treatment during the milling process. Slickens are usually confined in specially constructed basins and are often contaminated by metallic compounds.

Urban land is land covered by pavement, buildings, storage tanks, bridges, and other impervious, human-manufactured surfaces and structures. Pavement is a hard-layered surface of concrete or asphalt that forms a walkway, road, street, highway lane, runway, parking lot, or similar paved area. Urban land can occur in urban areas such as large cities and industrial centers as well as in suburban neighborhoods and rural towns. If correlated properly, urban land consists of 100-percent manufactured surface. Older soil surveys correlating urban land with a less strict concept may consist of as little as 75-percent manufactured surface. Some modern soil surveys require identification of the materials below urban land. Urban land is an anthropogenic type of miscellaneous area that does not necessarily represent a permanent condition.

Water includes streams, lakes, ponds, and estuaries more than about 2.5 meters deep or less than 2.5 meters deep and lacks either distinguishable horizons or rooted vegetation in the bottom sediment. These areas are covered with water in most years, at least during the period that is warm enough for plants to grow. Many areas are covered throughout the year. Pits and playas that contain water most of the time are mapped as water.

627.11 Example of Form NRCS-SOI-1, "Soil-Crop Yield Data"


U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

SOIL-CROP YIELD DATA

NRCS-SOI-1
1-88

1 | SAMPLE NUMBER ST CO ID | PLOT KIND | SIZE OF PLOT WIDTH LENGTH | LATITUDE DEG MIN SEC | LONGITUDE DEG MIN SEC | LOCATION OTHER DESCRIPTION | AGENCY | DATE MO DY YR

2 | SOIL MAP SYMBOL | SOIL MAP UNIT NAME | SOIL IDENT. AT SITE? Y/N Y

3 | SOIL INTERP. RECORD NUMBER ST. | USDA TEXTURE | SLOPE (PCT) | FLOODING | OTHER PHASE CRITERIA

4 | EROSION | A HORIZON COLOR THICKNESS (IN) | ORGANIC MATTER (PCT) | pH | ROOT DEPTH > (IN) | SLOPE LENGTH THRU SITE (FT) ABOVE SITE (FT) | SLOPE KIND SHAPE ASPECT | K FACTOR | SURFACE AGGREGATES >84 mm | ROUGHNESS FACTOR RIDGE HEIGHT (IN) SPACING (IN)

5 | MOISTURE RESERVE PLANTING GROWING | GROWING DEGREE DAYS | WEATHER Qual. Source | PRECIPITATION BY MONTH 1 2 3 4 5 6 7 8 9 10 11 12 | DAMAGE DRGHT WATER | FACTORS R C %

6 | MULTI-CROP N/Y Y | CURRENT CROP | CURRENT CULTIVAR (VARIETY) | CROP HISTORY DATA FIRST SECOND THIRD

7 | PLANTING INFORMATION DATE MO DY YR TIMING RATE UNITS OF MEASURE ROW SPACING COVER AFTER PLTG (PCT) | HARVEST INFORMATION DATE MO DY YR TIMING STAND DENSITY CROP YIELD UNITS OF MEASURE | RESIDUE T/AC ORIENTATION

8 | SOIL TEST | COMMERCIAL FERTILIZER LBS/AC N P K OTHER KIND LBS/AC | ORGANIC MATERIALS T/AC KIND CROP RES. Y/N | TILLAGE | WEED CONTROL CHEM Y/N NUM CULT CROP DAM. | INSPECT/DISEASE CONTROL CHEM Y/N KIND TREAT NUM APPLIC CROP DAMAGE

9 | OTHER DAMAGE | CONS PRAC. | IRRIGATION Y/N TYPE ADEQUACY | DRAINAGE Y/N CROP DAMAGE | FACTORS C P | CONSERVATION PRACTICE CODES 1 2 3 | RECORDER NAME

This form was electronically produced by National Production Services Staff

Clear Form

627.12 Instructions for Completing Form NRCS-SOI-1, "Soil-Crop Yield Data"

(a) Line 1

(1) Sample number.

(i) State code. Use the two-character alphabetic Federal Information Processing Standards (FIPS) code, for example, VA.

(ii) County code. Use the three-character numerical FIPS code.

(iii) Site identification number within county. Set up a sequence of two-digit numbers for each field and another sequence of two-digit numbers for each site within the field. Keep a log of these numbers as a record for testing at the same sites in subsequent years.

(2) Kind of plot.

Enter one of the following codes:

1 = Yield measurements in commercial farm fields.

2 = Yield measurements in field trials of special treatment practices (fertilizer field trials, variety trials, conservation tillage trials).

3 = Yield measurements of small research plots at experiment stations (variety tests, fertilizer tests).

4 = Yield estimates.

(3) Size of plot.

Enter width x length in feet, for example, 4 x 10.9

(4) Location.

Use a map such as a 7½° quad, aerial photograph or soil survey to record the location.

(i) X coordinate. Enter latitude north. Separate degrees, minutes, and seconds by a hyphen, for example, 25-05-03.

(ii) Y coordinate. Enter longitude west, for example 108-25-49.

(iii) Other location description, for example NE¼ sec. 12, T. 31 N., R. 11 W.

(5) Agency.

Enter the abbreviation of the agency entering the data.

(6) Date.

Enter the date the form is filled out, for example, 8/14/81.

(b) Line 2

(1) Soil symbol.

Enter the soil symbol of the area at the sample site (if known).

(2) Soil name.

Enter the name of the soil identified at the sample site or through reference to the soil survey, for example, NORFOLK FINE SANDY LOAM, 3-5 PERCENT SLOPE.

(3) Soil identified at site?

Indicate whether soil scientists identified the site. Enter Y for yes or N or no.

(c) Line 3

(1) XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

(2) USDA texture.

Enter the codes for texture class and texture modifier of the surface layer, for example, GR-L for gravelly loam. Use only the approved codes shown in the Part 618, Subpart B, Section 618.94, "Texture Class, Texture Modifier, and Terms Used in Lieu of Texture."

(3) Slope.

Enter the percent slope gradient to the nearest whole number on slopes of 1 percent or more; enter to the nearest 0.1 percent for slopes less than 1 percent.

(4) Flooding.

Enter the flooding frequency (see part 618 of this handbook) that most nearly represents sample site. Use NONE, VERY RARE, RARE, OCCASIONAL, FREQUENT, or VERY FREQUENT.

(5) Other phase criteria.
Enter phases used to name soil map unit components (see section 627.6), other than surface texture, slope, or flooding, that are needed to select the correct capability and yield interpretations for the component, for example, SEVERELY ERODED.

(d) Line 4

(1) Erosion.
Enter the code that most nearly represents the estimate of erosion:
1 = Slight
2 = Moderate
3 = Severe

(2) Color of A horizon.
Enter the color (Munsell notation) of the A horizon.

(3) Thickness of A horizon (inches).
Enter the thickness of the A horizon.

(4) Organic matter.
Enter an estimate or measurement of the percent of organic matter (organic carbon x 1.72) in the A horizon.

(5) pH.
Enter the pH of the surface 4 inches at the time of harvest, for example, 6.7.

(6) Rooting depth (inches).
Measure the depth to fragipan, bedrock, gravel, or other root-impeding layer. If greater than 60 inches, enter >60.

(7) Slope length.
(i) Through site (ft.). Enter the length of slope through the sample site, in feet. On terraced land enter the distance between terraces. Slope length is the distance from the point of origin of overland flow to either (a) the point where the slope decreases to the extent that deposition begins or (b) the point where runoff enters an area of concentrated flow or channel.
(ii) Above site (ft). Enter the length of slope from point or origin of overland flow to the sample point in feet.

(8) Slope.
(i) Kind.
Enter the code that most nearly represents kind of slope at the sample site:
1 = Summit
2 = Shoulder
3 = Back slope
4 = Foot slope
(ii) Shape.
Enter the code that most nearly represents the slope shape:
1 = Convex
2 = Plane
3 = Concave
4 = Undulating
5 = Complex

(9) Aspect.
On slopes where aspect is important, enter one of the 8 points of the compass that the slope faces, for example, NE.

(10) K factor.
Enter the soil erodibility (Kf) factor.

(e) Line 5

(1) Moisture reserve at planting time.
Enter one of the following codes:

1 = Above normal
2 = Normal
3 = Below normal

(2) Moisture reserve at beginning of spring growing season following fall planting (winter wheat, and rye).
Enter one of the following codes:
1 = Above normal
2 = Normal
3 = Below normal

(3) Precipitation during the growing season.
(i) Qualitative. Enter the code that represents qualitative judgment:
1 = Above normal
2 = Normal
3 = Below normal
(ii) By month. If monthly records are available, enter to the nearest inch the precipitation for each month.

(4) Drought damage.
Enter the code that represents the judgment of the amount of crop damage caused by drought:
1 = None
2 = Slight
3 = Moderate
4 = Severe

(5) Water damage.
Enter the code that describes the amount of crop damage caused by excessive wetness:
1 = None
2 = Slight
3 = Moderate
4 = Severe

(6) R factor.
Enter the R (rainfall) factor.

(f) Line 6

(1) Multiple-cropped.
Is the site double or triple cropped? Enter Y for yes, or N for no.

(2) Current crop.
Enter the crop name or code from the crop name and units of measure list in the NASIS-related metadata at
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/tools/?cid=nrcs142p2_053548
http://soils.usda.gov/technical/nasis/documents/metadata/. Then follow the link to the "NASIS Version 76.x" index webpage. On the NASIS Version index webpage see the file named "Domains.pdf" for the most current list of crop names and crop yield units.

(3) Cultivar (variety).
Enter the name or identification of the crop variety.

(4) Previous crops.
Enter the names or codes of the crops grown in first, second, and third previous crop seasons.

(g) Line 7

(1) Planting information.
(i) Date.
Enter the date of planting (month/day/year) if known, for example 5/15/86.
(ii) Timing.
Enter the code that describes timeliness of planting:
1 = Early

2 = Normal
3 = Late
(iii) Crop yield.
Enter the amount of harvested crop per acre, for example, 110. Use standard procedures for measuring yield.
(iv) Unit of measure.
Enter the unit of measure (see part 618 of this handbook) for the crop, for example, bu/acre.
(v) Residue yield (t/acre).
Enter the air-dry tons per acre of crop residue (estimate if necessary).

(h) Line 8

(1) Commercial fertilizer.
(i) NPK
Enter the pounds of elemental nitrogen, phosphorus, and potassium applied per acre.
(ii) Other fertilizer materials (excluding lime).
(A) Specify kind, for example, ZINC.
(B) Enter the pounds per acre applied.

(2) Organic materials
(i) Enter tons of manure applied per acre.
(ii) Enter the code representing the kind of manure:
1 = Cattle
2 = Poultry
3 = Hog
4 = Horse
5 = Sludge (human)
6 = Other

(3) Crop residues returned.
Enter Y for yes, or N for no.

(4) Tillage.
Enter the code that represents the kind of tillage practice at the sample site:
1 = No till (slot tillage)
2 = Strip till
3 = Other conservation tillage
4 = Nonconservation tillage (moldboard, disk plow, lister)

(5) Weed control.
(i) Were herbicides used for this crop?
Enter Y for yes, or N for no.
(ii) Enter the number of cultivations used primarily or partly for weed control.
(iii) Enter the code that represents the extent of weed damage on this crop:
0 = None
1 = Slight
2 = Moderate
3 = Severe

(6) Insect and disease control.
(i) Were chemicals used to control insects or disease?
Enter Y for yes, or N for no.
(ii) If chemical control was used, enter the code that represents the kind of treatment:
1 = Foliage
2 = Seed
3 = Soil
4 = Two or more of the above treatments
(iii) If foliage treatment, enter the number of chemical applications.

(iv) Enter the code that represents the extent of insect or disease damage on this crop:
0 = None
1 = Slight
2 = Moderate
3 = Severe

(i) Line 9

(1) Other damage.
Enter the code that represents the extent of damage from other causes such as hail, wind, lodging, and freezing:
0 = None
1 = Slight
2 = Moderate
3 = Severe

(2) Conservation practices, other than tillage and cropping sequence.
Enter one of the following conservation practices codes. If more than one used, enter the code listed first:
0 = None
1 = Terraces
2 = Stripcropping, contour
3 = Stripcropping, field
4 = Stripcropping, wind
5 = Contour farming

(3) Irrigation.
(i) Was irrigation water applied to this crop?
Enter Y for yes, or N for no.
(ii) Type:
1 = Furrow
2 = Sprinkle
3 = Drip
4 = Flood
(iii) Enter the code that represents the adequacy of the irrigation in meeting crop moisture requirements:
1 = Good
2 = Fair
3 = Poor

(4) Drainage.
(i) Is this soil artificially drained?
Enter Y for yes, or N for no.
(ii) Enter the code that represents the damage to the crop caused by inadequate drainage system:
0 = None
1 = Slight
2 = Moderate
3 = Severe

(5) Factors.
(i) C factor. Enter the C factor (cover-management factor used in the Revised Universal Soil Loss Equation) applicable to the site.
(ii) P factor. Enter the P factor (support practices factor used in the Revised Universal Soil Loss Equation) applicable to the site.

(6) Conservation Practice Codes
Enter the practice code applicable to the site.

(7) Recorder Name. The name of the individual recording the data.

627.13 Identification Legend of Map Unit Symbols and Names

Example of an alphabetic map unit legend for Alpha County, Any State:

Map Unit Symbol	Map Unit Name
AaA	Alpha silt loam, 0 to 3 percent slopes
AaB	Alpha silty clay loam, 3 to 6 percent slopes
AAE	Alpha association, moderately steep
AAG	Alpha association, very steep
Ab	Alpha-Beta complex
AbA	Alpha, rarely flooded-Beta, occasionally flooded complex
ABG	Alpha-Beta association, very steep
BTF	Beta-Gamma association, steep
GE	Gamma and Beta soils
ROF	Rock outcrop
STC	Sigma and Gamma soils, rolling
W	Water
ZAB	Zeta association, rolling

Example of an alphanumeric map unit legend for Beta County, Any State:

Map Unit Symbol	Map Unit Name
12A	Alpha silt loam, 0 to 2 percent slopes
12B	Alpha silt loam, 2 to 4 percent slopes
12B2	Alpha silt loam, 2 to 4 percent slopes, eroded
13	Beta silty clay loam
14	Beta silty clay loam, stony
17	Water, fresh
20	Water, saline
21	Gamma muck
23	Rock outcrop
27A	Sigma sandy loam, 0 to 2 percent slopes
29A	Sigma sandy loam, saline, 0 to 2 percent slopes
51D2	Zeta loamy sand, 8 to 15 percent slopes, eroded
52B	Zeta fine sandy loam, 2 to 5 percent slopes
52C	Zeta fine sandy loam, 5 to 8 percent slopes

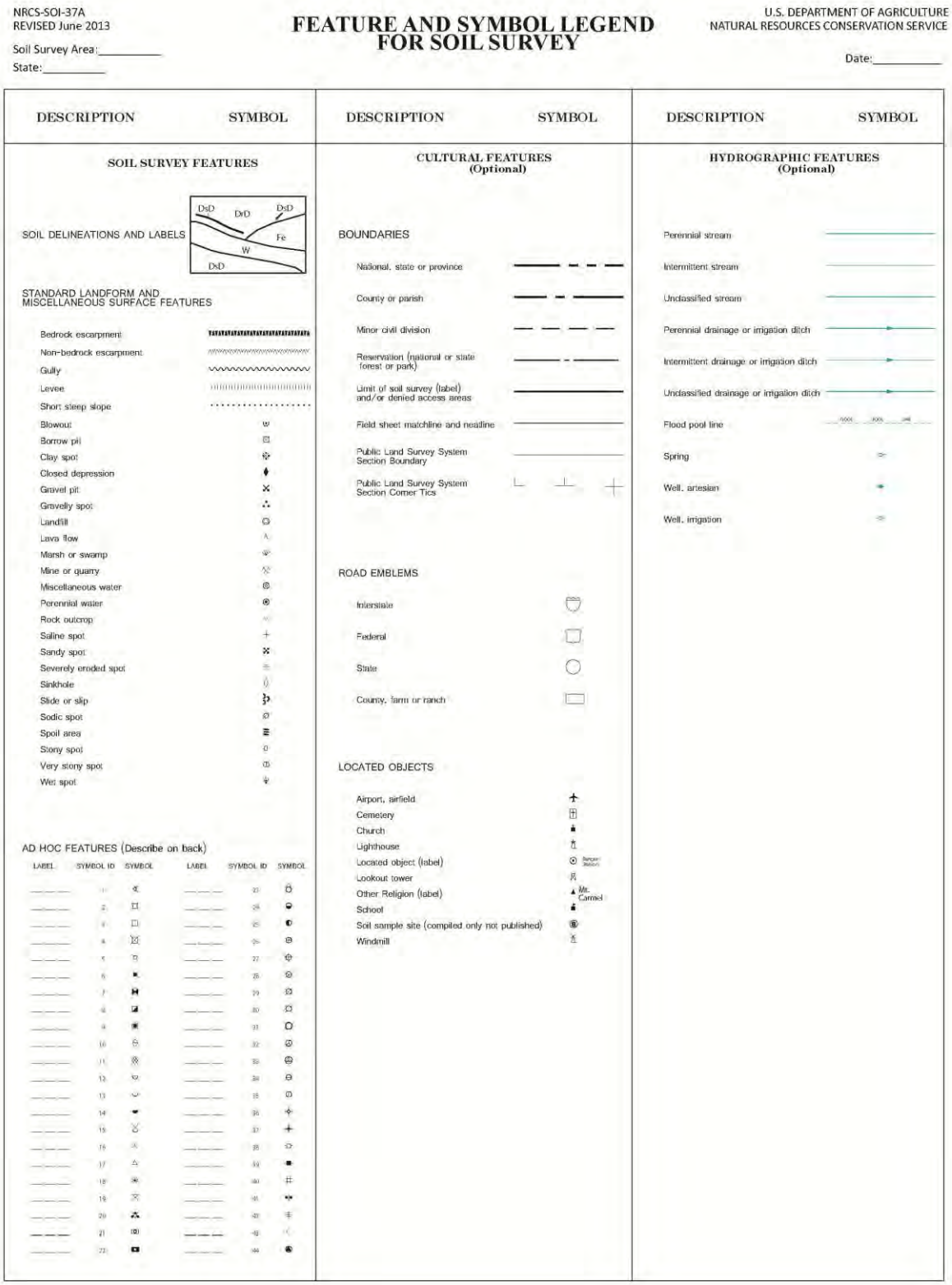
Example of a numeric map unit legend for Gamma County, Any State:

Map Unit Symbol	Map Unit Name
10	Alpha silt loam, 0 to 2 percent slopes
11	Alpha silt loam, 2 to 4 percent slopes
12	Alpha silt loam, 2 to 4 percent slopes, eroded
14	Zeta fine sandy loam, 2 to 5 percent slopes
15	Zeta fine sandy loam, 5 to 8 percent slopes
16	Zeta loamy fine sand, 8 to 15 percent slopes
17	Rock outcrop
20	Beta silty clay loam
21	Beta silty clay loam, stony
60	Sigma sandy loam, 0 to 2 percent slopes

62	Sigma sandy loam, saline, 0 to 2 percent slopes
99	Water
145	Gamma muck

627.14 Form NRCS-SOI-37A, "Feature and Symbol Legend for Soil Survey"

Electronic version: https://www.nrcs.usda.gov/Internet/FSE_MEDIA/nrcs142p2_050696.jpg



NRCS-SOI-37A
REVISED June 2013

Soil Survey Area:_____
State:_____

FEATURE AND SYMBOL LEGEND FOR SOIL SURVEY

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

Date:_____

DESCRIPTION	SYMBOL

SOIL SURVEY FEATURES

SOIL DELINEATIONS AND LABELS

STANDARD LANDFORM AND MISCELLANEOUS SURFACE FEATURES

- Bedrock escarpment
- Non-bedrock escarpment
- Gully
- Levee
- Short steep slope
- Blowout
- Borrow pit
- Clay spot
- Closed depression
- Gravel pit
- Gravelly spot
- Landfill
- Lava flow
- Marsh or swamp
- Mine or quarry
- Miscellaneous water
- Perennial water
- Rock outcrop
- Saline spot
- Sandy spot
- Severely eroded spot
- Sinkhole
- Slide or slip
- Sodic spot
- Spoil area
- Stony spot
- Very stony spot
- Wet spot

AD HOC FEATURES (Describe on back)

LABEL	SYMBOL ID	SYMBOL	LABEL	SYMBOL ID	SYMBOL
_____	1		_____	23	
_____	2		_____	24	
_____	3		_____	25	
_____	4		_____	26	
_____	5		_____	27	
_____	6		_____	28	
_____	7		_____	29	
_____	8		_____	30	
_____	9		_____	31	
_____	10		_____	32	
_____	11		_____	33	
_____	12		_____	34	
_____	13		_____	35	
_____	14		_____	36	
_____	15		_____	37	
_____	16		_____	38	
_____	17		_____	39	
_____	18		_____	40	
_____	19		_____	41	
_____	20		_____	42	
_____	21		_____	43	
_____	22		_____	44	

CULTURAL FEATURES (Optional)

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national or state forest or park)
- Limit of soil survey (label) and/or denied access areas
- Field sheet matchline and neatline
- Public Land Survey System Section Boundary
- Public Land Survey System Section Corner Tics

ROAD EMBLEMS

- Interstate
- Federal
- State
- County, farm or ranch

LOCATED OBJECTS

- Airport, airfield
- Cemetery
- Church
- Lighthouse
- Located object (label)
- Lookout tower
- Other Religion (label) — Mt. Carmel
- School
- Soil sample site (compiled only not published)
- Windmill

HYDROGRAPHIC FEATURES (Optional)

- Perennial stream
- Intermittent stream
- Unclassified stream
- Perennial drainage or irrigation ditch
- Intermittent drainage or irrigation ditch
- Unclassified drainage or irrigation ditch
- Flood pool line
- Spring
- Well, artesian
- Well, irrigation

DESCRIPTIONS FOR STANDARD LANDFORM AND MISCELLANEOUS SURFACE FEATURES

LABEL	NAME	DESCRIPTION
BLO	Blowout	A saucer-, cup-, or trough-shaped depression formed by wind erosion on a pre-existing dune or other sand deposit, especially in an area of shifting sand or loose soil or where protective vegetation is disturbed or destroyed. The adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Blowouts are commonly small. Typically ___ to ___ acres.
BPI	Borrow pit	An open excavation from which soil and underlying material have been removed, usually for construction purposes. Typically ___ to ___ acres.
CLA	Clay spot	A spot where the surface texture is silty clay or clay in areas where the surface layer of the soils in the surrounding map unit is sandy loam, loam, silt loam, or coarser. Typically ___ to ___ acres.
DEP	Depression, closed	A shallow, saucer-shaped area that is slightly lower on the landscape than the surrounding area and that does not have a natural outlet for surface drainage. Typically ___ to ___ acres.
ESB	Escarpment, bedrock	A relatively continuous and steep slope or cliff, produced by erosion or faulting, that breaks the general continuity of more gently sloping land surfaces. Exposed material is hard or soft bedrock.
ESO	Escarpment, nonbedrock	A relatively continuous and steep slope or cliff, which generally is produced by erosion but can be produced by faulting, that breaks the continuity of more gently sloping land surfaces. Exposed earthy material is nonsoil or very shallow soil.
GPI	Gravel pit	An open excavation from which soil and underlying material have been removed and used, without crushing, as a source of sand or gravel. Typically ___ to ___ acres.
GRA	Gravelly spot	A spot where the surface layer has more than 35 percent, by volume, rock fragments that are mostly less than 3 inches in diameter in an area that has less than 15 percent rock fragments. Typically ___ to ___ acres.
GUL	Gully	A small, steep-sided channel caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage whereas a rill is of lesser depth and can be smoothed over by ordinary tillage.
LDF	Landfill	An area of accumulated waste products of human habitation, either above or below natural ground level. Typically ___ to ___ acres.
LAV	Lava flow	A solidified, commonly lobate body of rock formed through lateral, surface outpouring of molten lava from a vent or fissure. Typically ___ to ___ acres.
LVS	Levee	An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow onto lowlands.
MAR	Marsh or swamp	A water saturated, very poorly drained area that is intermittently or permanently covered by water. Sedges, cattails, and rushes are the dominate vegetation in marshes, and trees or shrubs are the dominant vegetation in swamps. Not used in map units where the named soils are poorly drained or very poorly drained. Typically ___ to ___ acres.
MPI	Mine or quarry	An open excavation from which soil and underlying material have been removed and in which bedrock is exposed. Also denotes surface openings to underground mines. Typically ___ to ___ acres.
MIS	Miscellaneous water	Small, constructed bodies of water that are used for industrial, sanitary, or mining applications and that contain water most of the year. Typically ___ to ___ acres.
WAT	Perennial water	Small, natural or constructed lakes, ponds, or pits that contain water most of the year. Typically ___ to ___acres.
ROC	Rock outcrop	An exposure of bedrock at the surface of the earth. Not used where the named soils of the surrounding map unit are shallow over bedrock or where "Rock outcrop" is a named component of the map unit. Typically ___ to ___ acres.
SAL	Saline spot	An area where the surface layer has an electrical conductivity of 8 mmhos/cm more than the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has an electrical conductivity of 2 mmhos/cm or less. Typically ___ to ___ acres.
SAN	Sandy spot	A spot where the surface layer is loamy fine sand or coarser in areas where the surface layer of the named soils in the surrounding map unit is very fine sandy loam or finer. Typically ___ to ___ acres.
ERO	Severely eroded spot	An area where, on the average, 75 percent or more of the original surface layer has been lost because of accelerated erosion. Not used in map units in which "severely eroded", "very severely eroded", or "gullied" is part of the map unit name. Typically ___ to ___ acres.
SLP	Short, steep slope	A narrow area of soil having slopes that are at least two slope classes steeper than the slope class of the surrounding map unit.
SNK	Sinkhole	A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography. Typically ___ to ___ acres.
SLI	Slide or slip	A prominent landform scar or ridge caused by fairly recent mass movement or descent of earthy material resulting from failure of earth or rock under shear stress along one or several surfaces. Typically ___ to ___ acres.
SOD	Sodic spot	An area where the surface layer has a sodium adsorption ratio that is at least 10 more than that of the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has a sodium adsorption ratio of 5 or less. Typically ___ to ___ acres.
SPO	Spoil area	A pile of earthy materials, either smoothed or uneven, resulting from human activity. Typically ___ to ___ acres.
STN	Stony spot	A spot where 0.01 to 0.1 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surrounding soil has no surface stones. Typically ___ to ___ acres.
STV	Very stony spot	A spot where 0.1 to 3.0 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surface of the surrounding soil is covered by less than 0.01 percent stones. Typically ___ to ___ acres.
WET	Wet spot	A somewhat poorly drained to very poorly drained area that is at least two drainage classes wetter than the named soils in the surrounding map unit. Typically ___to ___ acres.

DESCRIPTION FOR AD HOC FEATURES

___	_____	_____
___	_____	_____
___	_____	_____
___	_____	_____
___	_____	_____
___	_____	_____

627.15 Ecological Site and Soil Correlation Checklist

(Use to Supplement Soil Survey Quality Assurance Worksheet)

1. Name of area (including county, State and MLRA(s)) _____
   _____

2. Level of detail for vegetative data (indicate rangeland ecological site, forestland ecological site, rangeland similarity index, or other special studies)

3. Has soil survey memo of understanding been reviewed in regard to vegetative (rangeland, forestland, etc. (management needs)? Yes ___, No _____.

4. Do soil survey project members and field office staff have copies of site descriptions being used? Yes ____, No _____.

5. Is a site assigned to each soil component in the identification legend? Yes ____, No _____.

6. Are all sections of the ecological site descriptions written? Yes ____, No ____.

7. Does documentation for each site support all soils correlated to the site? Yes ____, No ____.

8. Field notes (how kept, by whom). _____

9. Are soil-plant relationships adequately described and documented? Yes ___, No ____.

10. Is the range of characteristics of the site description adequate? (Note kinds of deficiencies)

    a. Site Characteristics:
       1. Physiographic features
       2. Climatic features
       3. Influencing water features
       4. Representative soil features

    b. Plant Communities
       1. Description of the vegetation dynamics of the site
       2. State and transition model diagram
       3. Description of the common states that occur on the site and the transitions between the states. If needed, describe the plant communities and community pathways within the state.
       4. Plant community composition
       5. Ground cover and structure
       6. Annual production
       7. Growth curves
       8. Photos of each state or community

11. Are interpretations for the ecological site description adequate? (Note kinds of deficiencies)

Site Interpretations:

1. Animal community
2. Hydrology functions
3. Recreation uses
4. Wood products
5. Other products
6. Other information

12. Is the supporting information for the site description adequate? (Note kinds of deficiencies)

Supporting Information:

1. Associate sites
2. Similar sites
3. Inventory data references
4. State correlation
5. Type locality
6. Relationship to other established classification systems

13. Is the supporting information for the site description adequate to separate this site from other sites?
Yes ____, No ____.

14. List of sites reviewed and status. (Indicate soils correlated to each site during this review.)

15. Have sites been correlated with existing site descriptions? Yes___No___

16. Have sites been correlated to adjoining soil survey areas? Yes___No___

17. Have sites been named and numbered correctly? Yes___No___

18. Have appropriate Federal and State agencies reviewed or assisted in writing site descriptions? Yes___No___

19. Have field office staff provided input or reviewed site descriptions? Yes___No___

20. Deficiencies noted and recommended actions. (Be specific and provide dates for completion)

21. Scheduled dates for completion of the vegetation inventory are compatible with the scheduled dates of the soil survey? Yes ____, No ____.

Date: _____

Signature _____

627.16 Ecological Site Checklist

1. Name of Area(s) _____
(County(s) State(s) MLRA(s))

2. Type of Survey(s) _____
(Level of detail - soil and vegetation)

3. Participants _____
_____
_____
_____

4. Site Content (Number reviewed _____)

   a. Field sheets, maps, etc.

   b. Range of characteristics for physiographic features:

   c. Climatic features:

   d. Water features:

   e. Soil features and official soil series descriptions:

      Range of soil properties for the site:

   f. Vegetation data (417s, etc., and plant association tables)

   g. Animal data:

   h. General (field notes, photographs, etc.)

5. Sites with deficiencies:

6. Recommended actions:

7. Site description completed _____(date)

Date: _____

Signature(s) _____

627.17 Matrix of Investigation Intensity of Soil Surveys and Documentation

The table below is a generalized matrix showing investigation intensity of soil survey (order) by the dominant type of documentation.

Within physiographic areas, percentages for the number of delineations can be assigned to the entries to specify required documentation. (i.e., 25% would indicate 25 of 100 delineations)

Key type of documentation to verify or identify map units in soil delineations

	Order 1	Order 2	Order 3	Order 4
Traversing	Primary	Primary	Secondary	Secondary
Observation	----------	Secondary	Primary	Secondary
Remotely sensed/ancillary data	----------	Secondary	Primary	Primary
Key type of documentation to determine composition of a map unit				
Transecting	----------	Primary	Primary	Primary

Identification or verification of soil map units with a delineation is made by one of three methods. These methods provide documentation to the survey when the method is either recorded in the database or on the map as to type. These methods are—

-Traversing – Describing the soil and conditions at stops selected to reference vegetation, position on the landform, photo tone, etc. This is an onsite identification of the soil and verification of the projected assignment of the map unit.

-Observation – Visual notation of items as geologic features, vegetation, surface conditions, disturbed areas, etc. without borings. This drive by or other sighted observation does not involve a soil examination, and instead relies on surface characteristics observed by the surveyor.

-Remotely sensed/ancillary data – includes photo tone on aerial photographs, three-dimensional digital elevation models, topographic maps, geology maps, vegetative maps, etc.

-Primary – the principal way polygons and properties are verified.
-Secondary – additional methods in support of primary methods.
-No entry – This category is generally not used in the specified order.

-Transecting – Describing the soils and conditions at points (or continuously as with GPR) along a fixed length at regular intervals or by selecting points to represent measured line segments of various patterns. Transecting is used to identify the composition of a delineation and to design a map unit. A very small percentage of the total number of delineations of any one map unit have transects unless there are very few delineations of the map unit. As soil order increases the length and intervals of the transect would generally increase. A transect is different from grid or line mapping used for determining line placement.

Appendix C
Governmental Institutional Controls Memo

Appendix C

Lehigh Valley Railroad Derailment Superfund Site

Institutional Controls: Governmental Controls and Informational Devices for Groundwater

Governmental Controls are a type of Institutional Control (IC) that impose restrictions on land or resources using the authority of a government entity. Typical examples of governmental controls include zoning; building codes; state, tribal, or local groundwater use regulations; and commercial fishing bans and sports/recreational fishing limits posed by federal, state and/or local entities and/or public health agencies. As discussed herein, New York State law and local ordinances provide a legal foundation to help limit exposure to remaining groundwater contamination at the Site.

Informational devices provide information or notification that residual contamination may remain on site and are usually used as a secondary "layer" to help ensure the overall reliability of other ICs. Informational devices are discussed herein and include advisories or other communications that inform the public about the need to limit the use of land, water, or other resources.

Governmental Controls for Groundwater

New York State statutes and local ordinances serve to restrict usage of the Site's contaminated groundwater plume. First, the New York State Sanitary Code, which is applicable throughout New York,[i] includes Appendix 5-B (Standards for Water Wells) and Appendix 5-D (Special Requirements for Wells Serving Public Water Systems) that restrict groundwater wells from being installed within 300 feet of "landfill waste disposal area[s], or hazardous or radiological waste disposal area[s]" and otherwise restrict wells (within 100 feet for App. 5-B and 200 feet for App. 5-D) in proximity to "all known sources of contamination."[ii] The groundwater plume from the Site is a "known source of contamination" and a "hazardous waste disposal area." Accordingly, installing a well within the groundwater plume and the buffer areas established by Appendices 5-B and 5-D would be in violation of the Sanitary Code. Secondly, installing a groundwater well within the restricted areas established by Appendices 5-B and 5-D would be in violation of the New York State Uniform Fire Prevention and Building Code (the Uniform Code). The Uniform Code also applies throughout the state.[iii] Two sections of the Uniform Code relevant to residential properties and commercial properties, the 2020 Plumbing Code of New York State (the Plumbing Code) and the 2020 Residential Code of New York State (the Residential Code), both specifically require and incorporate the well standards from the New York State Sanitary Code.[iv] Therefore, installation of a well within the contaminated groundwater plume would also be in violation of the Uniform Code.

At the County level, the Site's groundwater plume exists within the jurisdictions of Genesee County, Monroe County, and Livingston County. The respective County Codes all authorize the issuance of penalties for violations of the State and County Sanitary Codes[v] and thus the local governments all have authority to enforce the state groundwater well restrictions. Further, Genesee County specifically requires permits for the installation of groundwater wells.[vi]

At the municipal level, the Site's groundwater plume exists within the jurisdictions of Town of LeRoy (Genesee Co.), Town of Wheatland (Monroe Co.),[vii] Village of Caledonia (Livingston Co.), and Town of Caledonia (Livingston Co.). Each of those municipalities require compliance with the Uniform Code and authorize the issuance of penalties for noncompliance with the Uniform Code.[viii]

The table below provides additional information and citations for the respective governmental controls in jurisdictions at issue:

Governmental Authority	**Applicable Institutional Controls**
State	
	• The New York Public Health Law establishes the New York State Sanitary Code to be applicable throughout the State. *See* N.Y. Pub. Health Law § 228 (McKinney) available at https://codes.findlaw.com/ny/public-health-law/pbh-sect-228.html. • The New York State Sanitary Code can be found here: Official Compilation of Codes, Rules & Regulations of the State of New York (West), available at https://govt.westlaw.com/nycrr/Browse/Home/NewYork/NewYorkCodesRulesandRegulations?guid=Id86117a0b65511ddb903a4af59fec65a&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default). • The State Sanitary Code establishes the authority of local boards of health and authorizes enforcement mechanisms for non-compliance with the code by local boards of health. New York state law also establishes that the provisions of a County sanitary code have the force of law. *See* N.Y. Pub. Health Law §§ 347-348 (McKinney), available at https://codes.findlaw.com/ny/public-health-law/pbh-sect-347.html and https://codes.findlaw.com/ny/public-health-law/pbh-sect-348.html. • The State Sanitary Code includes Appendix 5-B – Standards for Water Wells, and Appendix 5-D – Special Requirements for Wells Serving Public Water Systems. *See* N.Y. Pub. Health Law § 228 (McKinney); *see also* 10 NYCRR App. 5- B, Table 1 & 10 NYCRR App. 5-D, Table 1 (Appendix 5-B, available at https://www.health.ny.gov/regulations/nycrr/title_10/part_5/appendix_5b.htm); and Appendix 5-D (https://www.health.ny.gov/regulations/nycrr/title_10/part_5/appendix_5d.htm). • Appendices 5-B and 5-D restrict groundwater wells within 300 feet proximity of "landfill waste disposal area[s], or hazardous or radiological waste disposal area[s]" and otherwise restrict wells (within 100 feet for App. 5-B and 200 feet for App. 5-D) in proximity to "all known sources of contamination." *See id.* • The New York State Uniform Fire Prevention and Building Code (the Uniform Code) applies throughout the state and specifically requires and incorporates the well standards from the New York State Sanitary Code. *See* N.Y. Exec. Law § 381 (McKinney); *see also* Plumbing Code NYS, § 602.3.1 (2020); Residential Code NYS, § P2602.1.1 (2020). The Uniform Code, corresponding

	regulations, the Residential Code and Plumbing Code can be found here: https://dos.ny.gov/building-standards-and-codes. • Local governments are empowered to administer and enforce the Uniform Code. *See* N.Y. Exec. Law § 381 (McKinney), available at https://codes.findlaw.com/ny/executive-law/exc-sect-381/. • New York requires that the water well drillers register with the Department of Environmental Conservation. *See* Environmental Conservation Law § 15-1525(1), available at https://www.nysenate.gov/legislation/laws/ENV/15-1525. Additionally, water well drillers shall file preliminary notices with the Department before the commencement of drilling any water well and file a completion report to the Department following completion of the well. *See id.* at §15-1525(3).

County	
Livingston County	**Sanitary Code** • The local laws of Livingston County can be found on the County's website at https://www.livingstoncounty.us/Archive.aspx?AMID=64. • Local Law No 4 (2020) is the Sanitary Code of the County of Livingston, available at https://www.livingstoncounty.us/ArchiveCenter/ViewFile/Item/936. • Enforcement of the County and State Sanitary Codes is the duty of the Board of Health. *See* Livingston County Sanitary Code, Article VI § 1.1 (Enforcement), available at weblink provided *supra*. **Uniform Code** • Local Law No. 5 (2017) also provides for the administration and enforcement of the Uniform Code, where code enforcement officers may enforce all provisions of the Uniform Code and pursue such legal action and proceedings as may be necessary to enforce the Uniform Code. *See* Local Law No. 5, Section 3(9) & (10) (2017), available at https://www.livingstoncounty.us/ArchiveCenter/ViewFile/Item/662.

Monroe County	**Sanitary Code** • The local laws of Monroe County can be found in the Monroe County Code on the County website at https://ecode360.com/MO0860. • Monroe County has its own Sanitary Code entitled the "Sanitary Code of the Monroe County Health District." *See* Monroe County Code, Chapter 569, available at https://ecode360.com/11765530. • Monroe County Code Section 569-3 (available at https://ecode360.com/11943454) adopts the Sanitary Code throughout Monroe County and provides local board of health with enforcement authority.[ix] • The provisions of the Sanitary Code shall be in force throughout Monroe County. As provided by the Charter and the Public Health Law, the provisions of this code shall have the force and effect of law. *See* Monroe Code, §569-3, available at weblink provided *supra*. • It shall be the duty of each local board of health and of each local health officer in Monroe County, existing pursuant to law, to enforce every regulation of the Sanitary Code. *See* Monroe Code, §569-4, available at weblink provided *supra*. • The regulations of this code shall be supplemental to the regulations, rules and orders of the State Sanitary Code, Public Health Law, and other New York State laws relating to public health and shall, as to matters to which they refer, and in the territory prescribed therefor by law, supersede all local ordinances heretofore or hereafter enacted inconsistent therewith. *See* Monroe Code, §569-5, available at weblink provided *supra*. • The Monroe County Board of Health Public Health Administrative Hearing Procedure adopted by the Legislature of the County of Monroe, (Resolution Number 126 of 1996), effective March 15, 1996, shall be the administrative proceedings utilized to correct and impose civil penalties for, violations of the Monroe County Sanitary Code, the New York State Sanitary Code, the New York State Public Health Law and the pertinent provisions of the administrative rules and regulations of the Board of Health. *See* Monroe Code, §569-9.1, available at weblink provided *supra*. • Specific to water supplies, the Code provides that, "[n]o person shall provide or make accessible a supply of water for human

Monroe County, cont.	consumption or other domestic uses unless such water supply is potable and is protected from actual or potential sources of pollution and is so maintained as to deliver potable water of safe sanitary quality at all times. Whenever a public water supply is available to serve such building or dwelling, no other supply shall be furnished for drinking and domestic purposes unless such other supply is potable. The Director may order the treatment, abandonment, sealing or posting of any water supply not deemed of a safe sanitary quality." *See* Monroe Code § 569-13, Water supplies, available at https://ecode360.com/11943501. • When a builder/owner completes the construction of a private well, the Monroe County Health Director must be notified. *See* Monroe Code, §569-29, available at https://ecode360.com/11943573.
Genesee County	**Sanitary Code** • Genesee County Sanitary Code, Section 4.1 (2015) adopts the New York Public Health Law and the State Sanitary Code. *See* Sanitary Code, Genesee County Health Department, https://www.co.genesee.ny.us/docs/Genesee_County_Sanitary_Code_2015.pdf. • Genesee County Sanitary Code, Sections 15.2.1-15.2.2 (2015) (available at weblink provided *supra*.), further provide that "[a]ll owners who intend to construct new or replace/repair individual water wells must first make application for a permit," and the "standards for new and replacement individual water wells in New York State are those prescribed in Appendix 5-B, 10 NYCRR." • The Genesee County Sanitary Code has enforcement provisions. Genesee County Sanitary Code, 14.4.1 (available at weblink provided *supra*.) authorizes the issuance of penalties for noncompliance with the Code, whereby "Any non-compliance or non-conformance with an order issued by the Board of Health and/ or Commissioner pursuant to this Article may be subject to the imposition of a civil penalty pursuant to Section 309 of the Public Health Law."

Municipality	
Village of Caledonia (Livingston Co.)	**Enforcement - Uniform Code** • The Village of Caledonia Code can be found at: https://ecode360.com/CA0015. • The Village of Caledonia Code provides for the administration and enforcement of the Uniform Code in the Village of Caledonia. This chapter was adopted pursuant to § 10 of the Municipal Home Rule Law. Except as otherwise provided in the Uniform Code, other state law, or other section of this chapter, all buildings, structures, and premises, regardless of use or occupancy, are subject to the provisions this chapter. *See* Village of Caledonia, NY, Part II: General Legislation, Chapter 113, Fire Prevention and Building Code Administration, § 113-1, available at https://ecode360.com/12317122. • The Village of Caledonia requires compliance with the Uniform Code and is authorized to issue penalties for noncompliance. *See* Village of Caledonia, NY, Part II: General Legislation, Chapter 113, Fire Prevention and Building Code Administration, § 113-3, available at weblink provided *supra*.
Town of Caledonia (Livingston Co.)	**Enforcement - Uniform Code** • The Town of Caledonia Code can be found at https://townofcaledoniany.org/building-and-zoning/. • The Town of Caledonia, Livingston County, Chapter 54 - Building Construction and Fire Prevention, provides for the administration and enforcement of the New York State Uniform Fire Prevention and Building Code (the Uniform Code) and the State Energy Conservation Construction Code (the Energy Code) by the Town of Caledonia. This chapter was adopted pursuant to § 10 of the Municipal Home Rule Law. Except as otherwise provided in the Uniform Code, other state law, or other section of this chapter, all buildings, structures and premises, regardless of use or occupancy, are subject to the provisions of this chapter. *See* Town of Caledonia, Part II, General Legislation, Chapter 54 Building Construction and Fire Prevention § 54-1, available at https://ecode360.com/8753461. • The Town of Caledonia requires compliance with the Uniform Code and is authorized to issue penalties for noncompliance. *See* Town of Caledonia, Part II, General Legislation, Chapter 54 Building Construction and Fire Prevention § 54-3, available at weblink provided *supra*.

Town of Wheatland (Monroe Co.)	**Enforcement - Uniform Code** • The Town of Wheatland Code can be found on the Town's website at https://www.townofwheatland.org/general-faqs. • The Town of Wheatland adopted the New York State Uniform Fire Prevention and Building Code, including the administrative provisions of 19 NYCRR 1203 and all subsequent amendments thereto. *See* Town of Wheatland Code, §§ 54-1 (https://ecode360.com/10499431) & 54-3 (https://ecode360.com/10499435). • The Town of Wheatland also requires that in "all cases where there is to be installation of new plumbing or alteration of existing plumbing, a plumbing permit must be obtained." *See* Town of Wheatland Code, §54-12(F), available at weblink provided *supra*. • The Town of Wheatland requires compliance with the Uniform Code and is authorized to issue penalties for noncompliance. *See* Town of Wheatland, NY, Part II, General Legislation, Chapter 54 Building Construction and Fire Prevention § 54-25(B), available at weblink *supra*.
Hamlet of Mumford, Town of Wheatland (Monroe Co.)	• The Town of Wheatland Building Department confirmed that the Hamlet of Mumford does not have any additional regulations beyond those of the Town.
Town of LeRoy (Genesee Co.)	**Enforcement - Uniform Code** • The Town of LeRoy Code can be found on the Town's website at: https://leroyny.org/. • The Town of LeRoy Code requires compliance with the Uniform Code. *See* Town of LeRoy, Genesee County, Chapter 51, Article I Administration and Enforcement of Uniform Fire Prevention and Building Code, § 51-1.A ("A building permit shall be required for all work which must conform to the New York State Uniform Fire Prevention and Building Code (Uniform Code)"), available at https://ecode360.com/27818863. • The Town of LeRoy Code authorizes the issuance of penalties for noncompliance with the Uniform Code. *See* Town of LeRoy, Genesee County, Chapter 51, Article I Administration and Enforcement of Uniform Fire Prevention and Building Code, § 51-1 *et seq*., available at weblink provided *supra*.; *see also*, Chapter 53, Buildings, Unsafe § 53-1 *et seq*., available at https://ecode360.com/27821343; and Chapter 20, Article IV § 20-5, Code Enforcement Officer, Enforcement Authority, https://ecode360.com/27821324.

Informational Devices

As the contaminated groundwater plume associated with the Site spans numerous governmental jurisdictions, additional Institutional Controls in the form of informational devices would be appropriate and could include advisories published in newspapers, periodic letters sent to State and local authorities informing them of the need to prevent well installation, and inspection of State and local land use and health department records to insure that no wells are installed that could impact the groundwater plume or result in exposure to contaminated groundwater.

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[i] *See* N.Y. Pub. Health Law § 228 (McKinney) ("The provisions of the sanitary code, unless otherwise stated by the public health and health planning council, shall apply to and be effective in all portions of the state and shall supersede all local ordinances heretofore or hereafter enacted inconsistent therewith."); *see also* N.Y. Pub. Health Law § 347 (McKinney) (establishing the authority for local boards of health); N.Y. Pub. Health Law § 348 (McKinney) ("The provisions of the sanitary code of a county or part-county health district shall have the force and effect of law" and states that non-compliance with a provision of the sanitary code shall be punishable); Government Authority table *supra,* including County-specific citations for the adoption and enforcement of the State Sanitary Code.

[ii] *See* 10 NYCRR App. 5-B, Table 1 & 10 NYCRR App. 5-D, Table 1.

[iii] *See* N.Y. Exec. Law § 381 (McKinney) ("Except as may be provided in regulations of the secretary pursuant to subdivision one of this section, every local government shall administer and enforce the uniform fire prevention and building code and the state energy conservation construction code."); *see also* Livingston County Local Law No.5-2017, providing for the administration and enforcement of the uniform code within the County, as well was applying the law to the towns and villages within Livingston County*;* Government Authority table *supra,* including locality-specific citations to adoption and enforcement of the Uniform Code.

[iv] *See* Plumbing Code NYS, §602.3.1 (2020).; *see also id*. at §602.3.4; Residential Code NYS, § P2602.1.1 (2020).

[v] *See* Genesee County Sanitary Code, Section 14.4 (2015); Monroe County Sanitary Code, § 569-9.1; Livingston County Sanitary Code, §1.2; *see also* Livingston County Local Law No. 4, 2020 Sanitary Code of the County of Livingston, noting that "Sanitary Code" shall mean the rules adopted pursuant to Section 347 of the State Public Health Law; Livingston County Local Law No 4, 2012, appointing a county public health director with authority to enforce the New York Public Health law*;* and Monroe County Code Section 569-3, adopting the Sanitary Code throughout Monroe County and providing local board of health with enforcement authority.

[vi] *See* Genesee County Sanitary Code, 15.2.1-15.2.2 (2015), Individual Water Supplies ("[a]ll owners who intend to construct new or replace/repair individual water wells must first make application for a permit," and the "standards for new and replacement individual water wells in New York State are those prescribed in Appendix 5-B, 10 NYCRR.")

[vii] The Hamlet of Mumford is located in the western section of the Town of Wheatland and the Town of Wheatland Building Department confirmed that the Hamlet of Mumford does not have any additional regulations beyond those of the Town of Wheatland.

[viii] Town of LeRoy, Genesee County, Chapter 51, Article I Administration and Enforcement of Uniform Fire Prevention and Building Code. § 51-1 *et seq*.; Town of Wheatland, NY, Part II, General Legislation, Chapter 54 Building Construction and Fire Prevention § 54-25(B); Town of Caledonia, Part II, General Legislation, Chapter 54 Building Construction and Fire Prevention § 54-3; Village of Caledonia, NY, Part II: General Legislation, Chapter 113, Fire Prevention and Building Code Administration, § 113-3.

[ix] On April 14, 2022, Blank Rome spoke with Laura Smith (Chief Deputy Attorney of Monroe County) and Scott Hallock (Associate Public Health Sanitarian). These officials confirmed that the New York State Sanitary Code,

including the 5-B and 5-D well standards, are the primary control and are the minimum allowable standards in Monroe County. Only Monroe County Sanitary Code regulations that are more stringent and go beyond the State Sanitary Code supplement the State Code. They also advised that private wells are subject to DEC program regulations and in most parts of the county, new homes are required to connect to the public water supply. *See* ECL §15-1525, additional information available at DEC Water Well Contract Program, available at https://www.dec.ny.gov/lands/4997.html and *Private Wells*, New York State Department of Health, available at https://www.health.ny.gov/environmental/water/drinking/private_wells.htm and Monroe County Sanitary Code § 569-13, available at https://ecode360.com/11943501. Private wells are also subject to regulation by the public water system and mandatory enrollment in a public water program is required to ensure no cross-contamination with the public water supply. *See* NYRCC Section 5-1.31, available at https://regs.health.ny.gov/volume-title-10/653916609/section-5-131-cross-connection-control; *see also* Plumbing Code NYS, §608.7 (2020), available at https://codes.iccsafe.org/content/NYSPC2020P1/chapter-6-water-supply-and-distribution and Residential Code NYS, § P2902.1 (2020), available at https://codes.iccsafe.org/content/NYSRC2020P1/chapter-29-water-supply-and-distribution

Appendix D
SPLP Data and Calculations

Leachability Calculations

Ratio Analysis		
TCE in SPLP Leachate[1]	424	ug/L
Total TCE Concentration	190	mg/kg
Ratio[2]	2.23	ugkg/mgL

DAF[3]	100

Analysis of Dissolved TCE due to Leachate						
Use-Based PRGs			Leachable TCE		Dissolved TCE	
Commercial SCO	200	mg/kg	446	ug/L	4.5	ug/L
Industrial SCO	400	mg/kg	893	ug/L	8.9	ug/L

Notes:

1. Calculations are based on the maximum reported TCE concentration in overburden leachage generated through SPLP testing and corresponding total TCE concentration.
2. Gives the ratio of TCE concentration in SPLP leachate to the total TCE concentration in overburden soil.
3. The dilution and attenuation factor (DAF) accounts for dilution of contamints when soil water enters the groundwater.

Definitions:

TCE = trichloroethene
mg/kg = milligrams per kilogram
ug/L - micrograms per liter
PRG = preliminary remediation goals
SCO = Soil Cleanup Objective

Appendix E
SVE Imported Topsoil Analytical

BENCHMARK

TABLE 1
SUMMARY OF IMPORT COVER TOPSOIL ANALYTICAL RESULTS
BATAVIA BORROW SOURCE
OU-1 SPILL ZONE SOILS CLEANUP
LVRR DERAILMENT SUPERFUND SITE
LEROY, NEW YORK

PARAMETER[1]	Unrestricted Use [2]	If Ecological Resources are Present [2]	Residential Use [2]	Restricted Residential Use [2]	Sample ID		
					Comp #1	Comp # 2	Comp # 3
					5/28/2015		
Volatile Organic Compounds (VOCs) - mg/Kg [3]							
Methylene chloride	**0.05**	**12**	**0.05**	**0.05**	0.0189	0.014	0.0155
Semi-Volatile Organic Compounds (SVOCs) - mg/Kg [3]							
Benzo(a)anthracene	**1**	**--**	**1**	**1**	0.023 J	0.0191 J	ND
Benzo(b)fluoranthene	**1**	**--**	**1**	**1**	0.0321	0.0276 J	ND
Chrysene	**1**	**--**	**1**	**1**	0.0175 J	0.019 J	0.0161 J
Fluoranthene	**100**	**--**	**100**	**100**	0.0393 J	0.0266 J	0.0256 J
Phenanthrene	**100**	**--**	**100**	**100**	0.0175 J	ND	ND
Pyrene	**100**	**30**	**100**	**100**	0.0309 J	0.0226 J	0.0199 J
Total Metals - mg/Kg							
Arsenic	**13**	**13**	**16**	**16**	4.1	3.6	4
Barium	**350**	**433**	**350**	**400**	64.2	56.1	51.3
Beryllium	**7.2**	**10**	**14**	**47**	0.42 J	0.4 J	0.36 J
Cadmium	**2.5**	**4**	**2.5**	**4.3**	0.26 J	0.17 J	ND
Chromium, Trivalent	**30**	**41**	**36**	**180**	15.8	11.9	11.8
Copper	**50**	**50**	**270**	**270**	9.7	7.4	6.5
Cyanide - Total	**27**	**--**	**27**	**27**	ND	ND	ND
Lead	**63**	**63**	**400**	**400**	18.4	15.4	16.5
Manganese	**1600**	**1600**	**2000**	**2000**	498	339	449
Mercury	**0.18**	**0.18**	**0.73**	**0.73**	0.062	0.055 J	0.037 J
Nickel	**30**	**30**	**130**	**130**	13.4	10.6	11.6
Selenium	**3.9**	**3.9**	**4**	**4**	ND	ND	ND
Silver	**2**	**2**	**8.3**	**8.3**	ND	ND	ND
Zinc	**109**	**109**	**2200**	**2480**	81.8	67.8 B	61.9
Polychlorinated biphenyls (PCBs) - mg/Kg							
Aroclor 1260	**See Total PCBS**				ND	0.02 J	ND
Total PCBs	**0.1**	**1**	**1**	**1**	ND	0.02 J	ND
Pesticides and Herbicides - mg/Kg [3]							
4,4'-DDE	**0.0033**	**0.0033**	**1.8**	**8.9**	0.00099 J, B	ND	ND

Notes:

1. Only those parameters detected at a minimum of one sample location are presented in this table; other compounds were reported as non-detect.
2. Values per NYSDEC DER-10 Appendix 5 Allowable Constituent Levels for Imported Fill or Soil.
3. Sample results were reported by the laboratory in ug/kg and converted to mg/kg for comparisons to 6NYCRR Part 375 Soil Cleanup Objectives (SCOs).

Definitions:

ND = Parameter not detected above laboratory detection limit.
"--" = No value available for the parameter; Parameter not analyzed for.
J = Estimated value; result is less than the sample quantitation limit but greater than zero.
B = Compound was found in the blank and sample.

Bold	= Result exceeds Unrestricted Use SCOs.
Bold	= Result exceeds Residential Use SCOs.
Bold	= Result exceeds Restricted Residential Use SCOs.
Bold	= Result exceeds If Ecological Resources are Present.

ALS Environmental

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

June 10, 2015

Ms. Janice Jaeger
ALS Environmental-Rochester NY
1565 Jefferson Road, Bldg. 300
Suite 360
Rochester, NY 14623

Certificate of Analysis

Project Name:	**Primary**	Workorder:	**2074295**
Purchase Order:	**58R1504196**	Workorder ID:	**AER090|R1504196**

Dear Ms. Jaeger:

Enclosed are the analytical results for samples received by the laboratory on Tuesday, June 2, 2015.

The ALS Environmental laboratory in Middletown, Pennsylvania is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory and as such, certifies that all applicable test results meet the requirements of NELAP.

If you have any questions regarding this certificate of analysis, please contact Mrs. Vanessa N Badman (Project Coordinator) at (717) 944-5541.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program and any applicable state requirements. The test results meet requirements of the current NELAP standards or state requirements, where applicable. For a specific list of accredited analytes, refer to the certifications section of the ALS website at www.alsglobal.com/en/Our-Services/Life-Sciences/Environmental/Downloads.

This laboratory report may not be reproduced, except in full, without the written approval of ALS Environmental.

ALS Spring City: 10 Riverside Drive, Spring City, PA 19475 610-948-4903

CC: Ms. Tracy Christ , Ms. Karen Bunker

This page is included as part of the Analytical Report and must be retained as a permanent record thereof.

Vanessa N. Badman

Mrs. Vanessa N Badman
Project Coordinator

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SAMPLE SUMMARY

Workorder: 2074295 AER090|R1504196

Lab ID	Sample ID	Matrix	Date Collected	Date Received	Collected By
2074295001	R1504196-001	Solid	5/28/2015 16:00	6/2/2015 09:00	Collected by Client

Notes

-- Samples collected by ALS personnel are done so in accordance with the procedures set forth in the ALS Field Sampling Plan (20 - Field Services Sampling Plan).
-- All Waste Water analyses comply with methodology requirements of 40 CFR Part 136.
-- All Drinking Water analyses comply with methodology requirements of 40 CFR Part 141.
-- Unless otherwise noted, all quantitative results for soils are reported on a dry weight basis.
-- The Chain of Custody document is included as part of this report.
-- All Library Search analytes should be regarded as tentative identifications based on the presumptive evidence of the mass spectra. Concentrations reported are estimated values.
-- Parameters identified as "analyze immediately" require analysis within 15 minutes of collection. Any "analyze immediately" parameters not listed under the header "Field Parameters" are preformed in the laboratory and are therefore analyzed out of hold time.
-- Method references listed on this report beginning with the prefix “S” followed by a method number (such as S2310B-97) refer to methods from “Standard Methods for the Examination of Water and Wastewater”.

Standard Acronyms/Flags

J	Indicates an estimated value between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) for the analyte
U	Indicates that the analyte was Not Detected (ND)
N	Indicates presumptive evidence of the presence of a compound
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
RDL	Reporting Detection Limit
ND	Not Detected - indicates that the analyte was Not Detected at the RDL
Cntr	Analysis was performed using this container
RegLmt	Regulatory Limit
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
DUP	Sample Duplicate
%Rec	Percent Recovery
RPD	Relative Percent Difference
LOD	DoD Limit of Detection
LOQ	DoD Limit of Quantitation
DL	DoD Detection Limit
I	Indicates reported value is greater than or equal to the Method Detection Limit (MDL) but less than the Report Detection Limit (RDL)

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PROJECT SUMMARY

Workorder: 2074295 AER090|R1504196

Sample Comments

Lab ID: 2074295001 **Sample ID:** R1504196-001 **Sample Type:** SAMPLE

This sample was collected in a soil jar for the volatile analysis. The sample was received and prepared by Method 5035 after the 48-hour holding time.

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074295 AER090|R1504196

Lab ID: **2074295001** Date Collected: 5/28/2015 16:00 Matrix: Solid

Sample ID: **R1504196-001** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS											
Acetone	ND		ug/kg	11.5	5.3	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Benzene	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Bromochloromethane	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Bromodichloromethane	ND		ug/kg	2.3	0.82	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Bromoform	ND		ug/kg	2.3	0.60	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Bromomethane	ND		ug/kg	2.3	0.60	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
2-Butanone	ND		ug/kg	11.5	3.7	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Carbon Disulfide	ND		ug/kg	2.3	0.73	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Carbon Tetrachloride	ND		ug/kg	2.3	0.59	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Chlorobenzene	ND		ug/kg	2.3	0.59	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Chlorodibromomethane	ND		ug/kg	2.3	0.78	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Chloroethane	ND		ug/kg	5.8	0.98	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Chloroform	ND		ug/kg	2.3	0.61	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Chloromethane	ND		ug/kg	2.3	0.63	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Cyclohexane	ND		ug/kg	2.3	0.59	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,2-Dibromo-3-chloropropane	ND		ug/kg	5.8	3.3	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,2-Dibromoethane	ND		ug/kg	2.3	0.62	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,2-Dichlorobenzene	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,3-Dichlorobenzene	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,4-Dichlorobenzene	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Dichlorodifluoromethane	ND		ug/kg	2.3	0.77	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,1-Dichloroethane	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,2-Dichloroethane	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,1-Dichloroethene	ND		ug/kg	2.3	0.60	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
cis-1,2-Dichloroethene	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
trans-1,2-Dichloroethene	ND		ug/kg	2.3	0.60	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,2-Dichloropropane	ND		ug/kg	2.3	0.69	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
cis-1,3-Dichloropropene	ND		ug/kg	2.3	0.63	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
trans-1,3-Dichloropropene	ND		ug/kg	2.3	0.67	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,4-Dioxane	ND		ug/kg	86.4	20.5	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Ethylbenzene	ND		ug/kg	2.3	0.78	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Freon 113	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
2-Hexanone	ND		ug/kg	11.5	3.2	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Isopropylbenzene	ND		ug/kg	2.3	0.70	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Methyl acetate	ND		ug/kg	2.3	0.68	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Methyl cyclohexane	ND		ug/kg	2.3	0.65	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A

ANALYTICAL RESULTS

Workorder: 2074295 AER090|R1504196

Lab ID: **2074295001** Date Collected: 5/28/2015 16:00 Matrix: Solid

Sample ID: **R1504196-001** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Methyl t-Butyl Ether	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
4-Methyl-2-Pentanone(MIBK)	ND		ug/kg	11.5	4.4	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Methylene Chloride	18.9	4	ug/kg	2.3	0.90	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Styrene	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,1,2,2-Tetrachloroethane	ND		ug/kg	2.3	0.65	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Tetrachloroethene	ND		ug/kg	2.3	0.69	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Toluene	ND		ug/kg	2.3	0.77	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,2,3-Trichlorobenzene	ND		ug/kg	5.8	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,2,4-Trichlorobenzene	ND		ug/kg	5.8	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,1,1-Trichloroethane	ND		ug/kg	2.3	0.71	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
1,1,2-Trichloroethane	ND		ug/kg	2.3	0.65	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Trichloroethene	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Trichlorofluoromethane	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Vinyl Chloride	ND		ug/kg	2.3	0.58	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
o-Xylene	ND		ug/kg	2.3	0.67	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
mp-Xylene	ND		ug/kg	4.6	0.96	SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	101		%	56 - 124		SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
4-Bromofluorobenzene (S)	106		%	51 - 128		SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Dibromofluoromethane (S)	111		%	62 - 123		SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
Toluene-d8 (S)	110		%	59 - 131		SW846 8260C	6/4/15	JPA	6/4/15 05:45	JPA	A
SEMIVOLATILES											
Acenaphthene	ND		ug/kg	107	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Acenaphthylene	ND		ug/kg	107	11.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Acetophenone	ND		ug/kg	107	10.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Anthracene	ND		ug/kg	107	10.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Atrazine	ND		ug/kg	107	27.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Benzaldehyde	ND		ug/kg	288	44.8	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Benzo(a)anthracene	23.0J	J	ug/kg	107	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Benzo(a)pyrene	ND		ug/kg	107	17.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Benzo(b)fluoranthene	32.1J	J	ug/kg	107	25.6	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Benzo(g,h,i)perylene	ND		ug/kg	107	22.4	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Benzo(k)fluoranthene	ND		ug/kg	107	20.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Biphenyl	ND		ug/kg	107	13.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
4-Bromophenyl-phenylether	ND		ug/kg	107	24.5	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Butylbenzylphthalate	ND		ug/kg	107	27.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Caprolactam	ND		ug/kg	288	77.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A

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ANALYTICAL RESULTS

Workorder: 2074295 AER090|R1504196

Lab ID: **2074295001** Date Collected: 5/28/2015 16:00 Matrix: Solid

Sample ID: **R1504196-001** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Carbazole	ND		ug/kg	107	13.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
4-Chloro-3-methylphenol	ND		ug/kg	288	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
4-Chloroaniline	ND		ug/kg	288	143	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
bis(2-Chloroethoxy)methane	ND		ug/kg	107	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
bis(2-Chloroethyl)ether	ND		ug/kg	107	21.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
bis(2-Chloroisopropyl)ether	ND		ug/kg	107	26.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Chloronaphthalene	ND		ug/kg	107	14.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Chlorophenol	ND		ug/kg	288	19.2	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
4-Chlorophenyl-phenylether	ND		ug/kg	107	17.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Chrysene	17.5J	J	ug/kg	107	13.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
mp-Cresol	ND		ug/kg	288	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
o-Cresol	ND		ug/kg	288	23.5	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Di-n-Butylphthalate	ND		ug/kg	107	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Di-n-Octylphthalate	ND		ug/kg	288	41.6	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Dibenzo(a,h)anthracene	ND		ug/kg	107	12.8	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Dibenzofuran	ND		ug/kg	107	11.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
3,3-Dichlorobenzidine	ND		ug/kg	160	74.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,4-Dichlorophenol	ND		ug/kg	213	19.2	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Diethylphthalate	ND		ug/kg	107	13.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,4-Dimethylphenol	ND		ug/kg	288	82.2	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Dimethylphthalate	ND		ug/kg	107	17.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,4-Dinitrophenol	ND		ug/kg	213	68.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,4-Dinitrotoluene	ND		ug/kg	107	30.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,6-Dinitrotoluene	ND		ug/kg	107	25.6	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
1,4-Dioxane	ND		ug/kg	107	29.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
bis(2-Ethylhexyl)phthalate	ND		ug/kg	107	24.5	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Fluoranthene	39.3J	J	ug/kg	107	20.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Fluorene	ND		ug/kg	107	21.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Hexachlorobenzene	ND		ug/kg	107	20.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Hexachlorobutadiene	ND		ug/kg	107	27.7	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Hexachlorocyclopentadiene	ND		ug/kg	288	92.8	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Hexachloroethane	ND		ug/kg	107	18.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Indeno(1,2,3-cd)pyrene	ND		ug/kg	107	19.2	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Isophorone	ND		ug/kg	107	17.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Methyl-4,6-dinitrophenol	ND		ug/kg	288	61.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Methylnaphthalene	ND		ug/kg	107	17.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Naphthalene	ND		ug/kg	107	25.6	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Nitroaniline	ND		ug/kg	288	139	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A

ANALYTICAL RESULTS

Workorder: 2074295 AER090|R1504196

Lab ID: **2074295001** Date Collected: 5/28/2015 16:00 Matrix: Solid

Sample ID: **R1504196-001** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
3-Nitroaniline	ND		ug/kg	384	189	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
4-Nitroaniline	ND		ug/kg	299	149	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Nitrobenzene	ND		ug/kg	107	22.4	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Nitrophenol	ND		ug/kg	288	28.8	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
4-Nitrophenol	ND		ug/kg	288	108	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
N-Nitroso-di-n-propylamine	ND		ug/kg	107	18.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
N-Nitrosodiphenylamine	ND		ug/kg	107	18.1	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Pentachlorophenol	ND		ug/kg	213	38.4	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Phenanthrene	17.5J	J	ug/kg	107	14.9	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Phenol	ND		ug/kg	288	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Pyrene	30.9J	J	ug/kg	107	19.2	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
1,2,4,5-Tetrachlorobenzene	ND		ug/kg	107	16.0	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,3,4,6-Tetrachlorophenol	ND		ug/kg	288	22.4	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,4,5-Trichlorophenol	ND		ug/kg	288	21.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2,4,6-Trichlorophenol	ND		ug/kg	213	21.3	SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	84.9		%	37 - 123		SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Fluorobiphenyl (S)	80.8		%	45 - 105		SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
2-Fluorophenol (S)	79.7		%	35 - 104		SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Nitrobenzene-d5 (S)	84		%	41 - 110		SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Phenol-d5 (S)	82.3		%	40 - 100		SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
Terphenyl-d14 (S)	76.2		%	38 - 113		SW846 8270D	6/4/15	BS	6/4/15 10:33	GEC	A
PCBs											
Aroclor-1016	ND		mg/kg	0.037	0.0067	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1221	ND		mg/kg	0.037	0.0034	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1232	ND		mg/kg	0.037	0.0067	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1242	ND		mg/kg	0.037	0.010	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1248	ND		mg/kg	0.037	0.0067	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1254	ND		mg/kg	0.037	0.0067	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1260	ND		mg/kg	0.037	0.0067	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1262	ND		mg/kg	0.037	0.0079	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Aroclor-1268	ND		mg/kg	0.037	0.010	SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	124	3	%	46 - 120		SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
Tetrachloro-m-xylene (S)	72.4		%	52 - 115		SW846 8082A	6/8/15	KAC	6/9/15 02:49	EGO	A
PESTICIDES											

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074295 AER090|R1504196

Lab ID: **2074295001** Date Collected: 5/28/2015 16:00 Matrix: Solid

Sample ID: **R1504196-001** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Aldrin	ND		ug/kg	1.9	0.62	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
alpha-BHC	ND		ug/kg	1.9	0.17	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
beta-BHC	ND		ug/kg	1.9	0.20	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
delta-BHC	ND		ug/kg	1.9	0.15	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
gamma-BHC	ND		ug/kg	1.9	0.16	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
alpha-Chlordane	ND		ug/kg	1.9	0.20	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
gamma-Chlordane	ND		ug/kg	1.9	0.33	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
4,4'-DDD	ND		ug/kg	3.7	0.30	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
4,4'-DDE	0.99J	J	ug/kg	3.7	0.51	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
4,4'-DDT	ND		ug/kg	3.7	0.43	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Dieldrin	ND		ug/kg	3.7	0.43	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Endosulfan I	ND		ug/kg	1.9	0.24	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Endosulfan II	ND		ug/kg	3.7	0.78	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Endosulfan Sulfate	ND		ug/kg	3.7	0.25	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Endrin	ND		ug/kg	3.7	0.27	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Endrin Aldehyde	ND		ug/kg	3.7	0.40	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Endrin Ketone	ND		ug/kg	3.7	0.52	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Heptachlor	ND		ug/kg	1.9	0.19	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Heptachlor Epoxide	ND		ug/kg	1.9	0.19	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Methoxychlor	ND		ug/kg	3.7	0.49	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Toxaphene	ND		ug/kg	14.6	6.5	SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	90		%	30 - 135		SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
Tetrachloro-m-xylene (S)	73.3		%	30 - 111		SW846 8081B	6/8/15	KAC	6/8/15 21:49	RWS	A
WET CHEMISTRY											
Cyanide, Total	ND		mg/kg	0.28	0.10	SW846 9012B	6/4/15	SYB	6/5/15 10:37	LJF	A
Moisture	11.6		%	0.1	0.01	S2540G-11			6/4/15 10:03	JP	A
Total Solids	88.4		%	0.1	0.01	S2540G-11			6/4/15 10:03	JP	A
METALS											
Aluminum, Total	13400		mg/kg	9.4	3.1	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Antimony, Total	ND		mg/kg	1.9	0.63	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Arsenic, Total	4.1		mg/kg	1.9	0.63	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Barium, Total	64.2		mg/kg	0.94	0.31	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Beryllium, Total	0.42J	J	mg/kg	0.94	0.31	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Cadmium, Total	0.26J	J	mg/kg	0.47	0.16	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Calcium, Total	6400	1	mg/kg	9.4	3.1	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Chromium, Total	15.8		mg/kg	0.94	0.31	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074295 AER090|R1504196

Lab ID: **2074295001** Date Collected: 5/28/2015 16:00 Matrix: Solid

Sample ID: **R1504196-001** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Cobalt, Total	6.0		mg/kg	0.94	0.31	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Copper, Total	9.7		mg/kg	1.9	0.63	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Iron, Total	17300		mg/kg	9.4	3.1	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Lead, Total	18.4		mg/kg	1.9	0.63	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Magnesium, Total	3950		mg/kg	9.4	3.1	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Manganese, Total	498	2	mg/kg	0.94	0.31	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Mercury, Total	0.062		mg/kg	0.052	0.017	SW846 7471B	6/8/15	MNP	6/8/15 11:52	MNP	A2
Nickel, Total	13.4		mg/kg	1.9	0.63	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Potassium, Total	1190		mg/kg	47.1	15.7	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Selenium, Total	ND		mg/kg	4.7	1.6	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Silver, Total	ND		mg/kg	0.47	0.16	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Sodium, Total	75.4		mg/kg	47.1	15.7	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Thallium, Total	ND		mg/kg	2.8	0.94	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Vanadium, Total	27.6		mg/kg	0.94	0.31	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3
Zinc, Total	81.8		mg/kg	1.9	0.63	SW846 6010C	6/5/15	JPS	6/9/15 00:59	ZMC	A3

Vanessa N. Badman

Mrs. Vanessa N Badman
Project Coordinator

PARAMETER QUALIFIERS

Lab ID	#	Sample ID	Analytical Method	Analyte
2074295001	1	R1504196-001	SW846 6010C	Calcium, Total

The method blank associated with this sample was positive for calcium at 10.3 mg/kg. The calcium analyte concentration in the sample was greater than ten times the concentration of the blank. According to the method, the sample was commented and reported. SRT 06.09.15

Lab ID	#	Sample ID	Analytical Method	Analyte
2074295001	2	R1504196-001	SW846 6010C	Manganese, Total

The method blank associated with this sample was positive for manganese at 3.7 mg/kg. The manganese analyte concentration in the sample was greater than ten times the concentration of the blank. According to the method, the sample was commented and reported. SRT 06.09.15

Lab ID	#	Sample ID	Analytical Method	Analyte
2074295001	3	R1504196-001	SW846 8082A	Decachlorobiphenyls

The surrogate Decachlorobiphenyls for method SW846 8082A was outside of control limits. The % Recovery was reported as 124 and the control limits were 46 to 120. This result was reported at a dilution of 1.

Lab ID	#	Sample ID	Analytical Method	Analyte
2074295001	4	R1504196-001	SW846 8260C	Methylene Chloride

The QC sample type LCSD for method SW846 8260C was outside the control limits for the analyte Methylene Chloride. The % Recovery was reported as 134 and the control limits were 68 to 133.

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QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: EXTR/39545 **Analysis Method:** SW846 8270D

QC Batch Method: SW846 3546

Associated Lab Samples: 2074295001

METHOD BLANK: 2186556

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
1,4-Dioxane	ND	ug/kg	100	
Benzaldehyde	ND	ug/kg	270	
Phenol	ND	ug/kg	270	
bis(2-Chloroethyl)ether	ND	ug/kg	100	
2-Chlorophenol	ND	ug/kg	270	
bis(2-Chloroisopropyl)ether	ND	ug/kg	100	
o-Cresol	ND	ug/kg	270	
Acetophenone	ND	ug/kg	100	
N-Nitroso-di-n-propylamine	ND	ug/kg	100	
mp-Cresol	ND	ug/kg	270	
Hexachloroethane	ND	ug/kg	100	
Nitrobenzene	ND	ug/kg	100	
Isophorone	ND	ug/kg	100	
2-Nitrophenol	ND	ug/kg	270	
2,4-Dimethylphenol	ND	ug/kg	270	
bis(2-Chloroethoxy)methane	ND	ug/kg	100	
2,4-Dichlorophenol	ND	ug/kg	200	
Naphthalene	ND	ug/kg	100	
4-Chloroaniline	ND	ug/kg	270	
Hexachlorobutadiene	ND	ug/kg	100	
Caprolactam	ND	ug/kg	270	
4-Chloro-3-methylphenol	ND	ug/kg	270	
2-Methylnaphthalene	ND	ug/kg	100	
1,2,4,5-Tetrachlorobenzene	ND	ug/kg	100	
Hexachlorocyclopentadiene	ND	ug/kg	270	
2,4,6-Trichlorophenol	ND	ug/kg	200	
2,4,5-Trichlorophenol	ND	ug/kg	270	
Biphenyl	ND	ug/kg	100	
2-Chloronaphthalene	ND	ug/kg	100	
2-Nitroaniline	ND	ug/kg	270	
Dimethylphthalate	ND	ug/kg	100	
2,6-Dinitrotoluene	ND	ug/kg	100	
Acenaphthylene	ND	ug/kg	100	
3-Nitroaniline	ND	ug/kg	360	
Acenaphthene	ND	ug/kg	100	
2,4-Dinitrophenol	ND	ug/kg	200	
4-Nitrophenol	ND	ug/kg	270	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Dibenzofuran	ND	ug/kg	100
2,4-Dinitrotoluene	ND	ug/kg	100
2,3,4,6-Tetrachlorophenol	ND	ug/kg	270
Diethylphthalate	ND	ug/kg	100
4-Chlorophenyl-phenylether	ND	ug/kg	100
Fluorene	ND	ug/kg	100
4-Nitroaniline	ND	ug/kg	280
2-Methyl-4,6-dinitrophenol	ND	ug/kg	270
N-Nitrosodiphenylamine	ND	ug/kg	100
4-Bromophenyl-phenylether	ND	ug/kg	100
Hexachlorobenzene	ND	ug/kg	100
Atrazine	ND	ug/kg	100
Pentachlorophenol	ND	ug/kg	200
Phenanthrene	ND	ug/kg	100
Anthracene	ND	ug/kg	100
Carbazole	ND	ug/kg	100
Di-n-Butylphthalate	ND	ug/kg	100
Fluoranthene	ND	ug/kg	100
Pyrene	ND	ug/kg	100
Butylbenzylphthalate	ND	ug/kg	100
3,3-Dichlorobenzidine	ND	ug/kg	150
Benzo(a)anthracene	ND	ug/kg	100
Chrysene	ND	ug/kg	100
bis(2-Ethylhexyl)phthalate	ND	ug/kg	100
Di-n-Octylphthalate	ND	ug/kg	270
Benzo(b)fluoranthene	ND	ug/kg	100
Benzo(k)fluoranthene	ND	ug/kg	100
Benzo(a)pyrene	ND	ug/kg	100
Indeno(1,2,3-cd)pyrene	ND	ug/kg	100
Dibenzo(a,h)anthracene	ND	ug/kg	100
Benzo(g,h,i)perylene	ND	ug/kg	100
2,4,6-Tribromophenol (S)	96.8	%	37 - 123
2-Fluorobiphenyl (S)	81.4	%	45 - 105
2-Fluorophenol (S)	84.8	%	35 - 104
Nitrobenzene-d5 (S)	84.3	%	41 - 110
Phenol-d5 (S)	86.8	%	40 - 100
Terphenyl-d14 (S)	85.8	%	38 - 113

LABORATORY CONTROL SAMPLE: 2186557

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
1,4-Dioxane	79.3	ug/kg	3330	2640	14 - 63	
Benzaldehyde	93.2	ug/kg	3330	3110	29 - 133	
Phenol	96.2	ug/kg	6670	6410	36 - 119	
bis(2-Chloroethyl)ether	84.1	ug/kg	3330	2800	51 - 119	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

2-Chlorophenol	92.6	ug/kg	6670	6170	51 - 113
bis(2-Chloroisopropyl)ether	85.4	ug/kg	3330	2850	46 - 133
o-Cresol	93.6	ug/kg	6670	6240	56 - 109
Acetophenone	72.1	ug/kg	3330	2400	38 - 92
N-Nitroso-di-n-propylamine	88.3	ug/kg	3330	2940	46 - 118
mp-Cresol	94.5	ug/kg	6670	6300	50 - 111
Hexachloroethane	83.3	ug/kg	3330	2780	45 - 109
Nitrobenzene	85.2	ug/kg	3330	2840	56 - 111
Isophorone	83.8	ug/kg	3330	2790	54 - 114
2-Nitrophenol	99.3	ug/kg	6670	6620	59 - 108
2,4-Dimethylphenol	96.1	ug/kg	6670	6410	61 - 115
bis(2-Chloroethoxy)methane	83.1	ug/kg	3330	2770	57 - 116
2,4-Dichlorophenol	95.2	ug/kg	6670	6350	63 - 112
Naphthalene	86.9	ug/kg	3330	2900	68 - 117
4-Chloroaniline	68	ug/kg	3330	2270	15 - 105
Hexachlorobutadiene	98.9	ug/kg	3330	3300	48 - 133
Caprolactam	89.8	ug/kg	3330	2990	13 - 152
4-Chloro-3-methylphenol	97.1	ug/kg	6670	6470	60 - 113
2-Methylnaphthalene	86.3	ug/kg	3330	2880	61 - 105
1,2,4,5-Tetrachlorobenzene	88.5	ug/kg	3330	2950	50 - 108
Hexachlorocyclopentadiene	58.7	ug/kg	3330	1960	16 - 118
2,4,6-Trichlorophenol	99.4	ug/kg	6670	6630	60 - 121
2,4,5-Trichlorophenol	96.6	ug/kg	6670	6440	60 - 119
Biphenyl	90.1	ug/kg	3330	3000	60 - 104
2-Chloronaphthalene	86.9	ug/kg	3330	2900	62 - 110
2-Nitroaniline	111	ug/kg	3330	3700	64 - 119
Dimethylphthalate	87.4	ug/kg	3330	2910	63 - 109
2,6-Dinitrotoluene	103	ug/kg	3330	3450	65 - 117
Acenaphthylene	91.8	ug/kg	3330	3060	66 - 114
3-Nitroaniline	93.7	ug/kg	3330	3120	28 - 112
Acenaphthene	89.9	ug/kg	3330	3000	63 - 113
2,4-Dinitrophenol	89.8	ug/kg	6670	5990	45 - 130
4-Nitrophenol	111	ug/kg	6670	7380	36 - 139
Dibenzofuran	91.3	ug/kg	3330	3040	65 - 113
2,4-Dinitrotoluene	96.9	ug/kg	3330	3230	66 - 123
2,3,4,6-Tetrachlorophenol	91.8	ug/kg	6670	6120	47 - 122
Diethylphthalate	84.2	ug/kg	3330	2810	63 - 119
4-Chlorophenyl-phenylether	84.3	ug/kg	3330	2810	62 - 115
Fluorene	91.1	ug/kg	3330	3040	64 - 117
4-Nitroaniline	101	ug/kg	3330	3370	52 - 109
2-Methyl-4,6-dinitrophenol	102	ug/kg	6670	6770	61 - 119
N-Nitrosodiphenylamine	109	ug/kg	3330	3650	75 - 134
4-Bromophenyl-phenylether	86.8	ug/kg	3330	2890	63 - 117
Hexachlorobenzene	89.2	ug/kg	3330	2970	59 - 123
Atrazine	91.5	ug/kg	3330	3050	60 - 119
Pentachlorophenol	105	ug/kg	6670	7030	61 - 136

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Phenanthrene	90.4	ug/kg	3330	3010	68 - 117
Anthracene	92.8	ug/kg	3330	3090	67 - 114
Carbazole	105	ug/kg	3330	3510	66 - 118
Di-n-Butylphthalate	81.8	ug/kg	3330	2730	63 - 118
Fluoranthene	98.9	ug/kg	3330	3300	67 - 116
Pyrene	91.1	ug/kg	3330	3040	60 - 121
Butylbenzylphthalate	85	ug/kg	3330	2830	65 - 127
3,3-Dichlorobenzidine	60.8	ug/kg	6670	4050	12 - 103
Benzo(a)anthracene	91.2	ug/kg	3330	3040	66 - 117
Chrysene	93.3	ug/kg	3330	3110	67 - 120
bis(2-Ethylhexyl)phthalate	78.4	ug/kg	3330	2610	67 - 124
Di-n-Octylphthalate	70.1	ug/kg	3330	2340	65 - 127
Benzo(b)fluoranthene	91.4	ug/kg	3330	3050	64 - 120
Benzo(k)fluoranthene	89.6	ug/kg	3330	2990	65 - 119
Benzo(a)pyrene	90.9	ug/kg	3330	3030	64 - 118
Indeno(1,2,3-cd)pyrene	88.4	ug/kg	3330	2950	66 - 120
Dibenzo(a,h)anthracene	90.2	ug/kg	3330	3010	60 - 124
Benzo(g,h,i)perylene	91.8	ug/kg	3330	3060	65 - 119
2,4,6-Tribromophenol (S)	92.5	%			37 - 123
2-Fluorobiphenyl (S)	82.4	%			45 - 105
2-Fluorophenol (S)	90.3	%			35 - 104
Nitrobenzene-d5 (S)	86.3	%			41 - 110
Phenol-d5 (S)	89	%			40 - 100
Terphenyl-d14 (S)	79.2	%			38 - 113

MATRIX SPIKE SAMPLE: 2186558 ORIGINAL:

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MS % Rec	% Rec Limit	Qualifiers
1,4-Dioxane		ug/kg	3210	2312.74	72.2*	14 - 63	
Benzaldehyde		ug/kg	3210	3230.19	101	29 - 133	
Phenol	214.225	ug/kg	6410	6691.96	101	36 - 119	
bis(2-Chloroethyl)ether	0	ug/kg	3210	2821.79	88	51 - 119	
2-Chlorophenol	0	ug/kg	6410	6336.89	98.9	51 - 113	
bis(2-Chloroisopropyl)ether	0	ug/kg	3210	2843.27	88.7	46 - 133	
o-Cresol	160.575	ug/kg	6410	6811.73	104	56 - 109	
Acetophenone		ug/kg	3210	2608.03	81.4	38 - 92	
N-Nitroso-di-n-propylamine	0	ug/kg	3210	3213.99	100	46 - 118	
mp-Cresol	553.855	ug/kg	6410	6964.01	100	50 - 111	
Hexachloroethane	0	ug/kg	3210	2863.03	89.3	45 - 109	
Nitrobenzene	0	ug/kg	3210	2964.26	92.5	56 - 111	
Isophorone	0	ug/kg	3210	3174.33	99	54 - 114	
2-Nitrophenol	0	ug/kg	6410	6819.48	106	59 - 108	
2,4-Dimethylphenol	0	ug/kg	6410	7242.04	113	61 - 115	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

bis(2-Chloroethoxy)methane	0	ug/kg	3210	2911.16	90.8	57 - 116
2,4-Dichlorophenol	0	ug/kg	6410	7009.37	109	63 - 112
Naphthalene	1842.7	ug/kg	3210	3448.83	50.1*	68 - 117
4-Chloroaniline	0	ug/kg	3210	2749.17	85.8	15 - 105
Hexachlorobutadiene	0	ug/kg	3210	3347.14	104	48 - 133
Caprolactam		ug/kg	3210	10752.8	335*	13 - 152
4-Chloro-3-methylphenol	0	ug/kg	6410	7055.82	110	60 - 113
2-Methylnaphthalene	786.757	ug/kg	3210	3503.86	84.8	61 - 105
1,2,4,5-Tetrachlorobenzene		ug/kg	3210	3146.49	98.2	50 - 108
Hexachlorocyclopentadiene	0	ug/kg	3210	483.148	15.1*	16 - 118
2,4,6-Trichlorophenol	0	ug/kg	6410	7094.65	111	60 - 121
2,4,5-Trichlorophenol	0	ug/kg	6410	7229.87	113	60 - 119
Biphenyl		ug/kg	3210	3231.66	97.1	60 - 104
2-Chloronaphthalene	0	ug/kg	3210	3059.17	95.4	62 - 110
2-Nitroaniline	0	ug/kg	3210	3824.49	119	64 - 119
Dimethylphthalate	0	ug/kg	3210	2986.69	93.2	63 - 109
2,6-Dinitrotoluene	0	ug/kg	3210	3372.24	105	65 - 117
Acenaphthylene	253.382	ug/kg	3210	3288.27	94.7	66 - 114
3-Nitroaniline	0	ug/kg	3210	3721.55	116*	28 - 112
Acenaphthene	161.381	ug/kg	3210	3331.62	98.9	63 - 113
2,4-Dinitrophenol	0	ug/kg	6410	347.853	5.43*	45 - 130
4-Nitrophenol	0	ug/kg	6410	7298.68	114	36 - 139
Dibenzofuran	194.632	ug/kg	3210	3351.13	98.5	65 - 113
2,4-Dinitrotoluene	0	ug/kg	3210	3750.45	117	66 - 123
2,3,4,6-Tetrachlorophenol		ug/kg	6410	6043.94	94.3	47 - 122
Diethylphthalate	0	ug/kg	3210	2802.05	87.4	63 - 119
4-Chlorophenyl-phenylether	0	ug/kg	3210	3071.02	95.8	62 - 115
Fluorene	183.649	ug/kg	3210	3319.37	97.8	64 - 117
4-Nitroaniline	0	ug/kg	3210	3430.53	107	52 - 109
2-Methyl-4,6-dinitrophenol	0	ug/kg	6410	1435.75	22.4*	61 - 119
N-Nitrosodiphenylamine	0	ug/kg	3210	0	0*	75 - 134
4-Bromophenyl-phenylether	0	ug/kg	3210	3279.57	102	63 - 117
Hexachlorobenzene	0	ug/kg	3210	3263.61	102	59 - 123
Atrazine		ug/kg	3210	3245.01	101	60 - 119
Pentachlorophenol	0	ug/kg	6410	5969.35	93.1	61 - 136
Phenanthrene	1582.22	ug/kg	3210	3913.77	72.7	68 - 117
Anthracene	417.798	ug/kg	3210	3558.74	98	67 - 114
Carbazole	207.288	ug/kg	3210	3528.7	104	66 - 118
Di-n-Butylphthalate	0	ug/kg	3210	2814.6	87.8	63 - 118
Fluoranthene	2673.75	ug/kg	3210	4528.85	57.9*	67 - 116
Pyrene	2766.05	ug/kg	3210	4863.02	65.4	60 - 121
Butylbenzylphthalate	0	ug/kg	3210	2884.14	90	65 - 127
3,3-Dichlorobenzidine	0	ug/kg	6410	5360.01	83.6	12 - 103
Benzo(a)anthracene	1235.73	ug/kg	3210	3710.18	77.2	66 - 117
Chrysene	1414.52	ug/kg	3210	3864.89	76.5	67 - 120
bis(2-Ethylhexyl)phthalate	87.3168	ug/kg	3210	2674.08	80.7	67 - 124

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Di-n-Octylphthalate	0	ug/kg	3210	2360.9	73.7	65 - 127
Benzo(b)fluoranthene	1554.28	ug/kg	3210	3807.33	70.3	64 - 120
Benzo(k)fluoranthene	617.578	ug/kg	3210	3318.46	84.3	65 - 119
Benzo(a)pyrene	1221.38	ug/kg	3210	3680.67	76.7	64 - 118
Indeno(1,2,3-cd)pyrene	784.63	ug/kg	3210	3287.04	78.1	66 - 120
Dibenzo(a,h)anthracene	231.157	ug/kg	3210	3143.54	90.9	60 - 124
Benzo(g,h,i)perylene	815.519	ug/kg	3210	3308.28	77.8	65 - 119
2,4,6-Tribromophenol (S)	107	%				37 - 123
2-Fluorobiphenyl (S)	89.9	%				45 - 105
2-Fluorophenol (S)	93.3	%				35 - 104
Nitrobenzene-d5 (S)	93.6	%				41 - 110
Phenol-d5 (S)	97.4	%				40 - 100
Terphenyl-d14 (S)	87.3	%				38 - 113

SAMPLE DUPLICATE: 2186559 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
1,4-Dioxane		ug/kg	0	NC	30	
Benzaldehyde		ug/kg	0	NC	30	
Phenol	0	ug/kg	0	NC	23	
bis(2-Chloroethyl)ether	0	ug/kg	0	NC	24	
2-Chlorophenol	0	ug/kg	0	NC	22	
bis(2-Chloroisopropyl)ether	0	ug/kg	0	NC	22	
o-Cresol	0	ug/kg	0	NC	21	
Acetophenone		ug/kg	0	NC	21	
N-Nitroso-di-n-propylamine	0	ug/kg	0	NC	20	
mp-Cresol	0	ug/kg	0	NC	20	
Hexachloroethane	0	ug/kg	0	NC	28	
Nitrobenzene	0	ug/kg	0	NC	20	
Isophorone	0	ug/kg	0	NC	19	
2-Nitrophenol	0	ug/kg	0	NC	23	
2,4-Dimethylphenol	0	ug/kg	0	NC	23	
bis(2-Chloroethoxy)methane	0	ug/kg	0	NC	18	
2,4-Dichlorophenol	0	ug/kg	0	NC	20	
Naphthalene	191.82	ug/kg	141.539	30.2*	21	
4-Chloroaniline	0	ug/kg	0	NC	22	
Hexachlorobutadiene	0	ug/kg	0	NC	22	
Caprolactam		ug/kg	0	NC	23	
4-Chloro-3-methylphenol	0	ug/kg	0	NC	20	
2-Methylnaphthalene	84.9186	ug/kg	35.7448	81.5*	21	
1,2,4,5-Tetrachlorobenzene		ug/kg	0	NC	19	
Hexachlorocyclopentadiene	0	ug/kg	0	NC	29	
2,4,6-Trichlorophenol	0	ug/kg	0	NC	20	
2,4,5-Trichlorophenol	0	ug/kg	0	NC	22	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Biphenyl		ug/kg	0	NC	14
2-Chloronaphthalene	0	ug/kg	0	NC	19
2-Nitroaniline	0	ug/kg	0	NC	19
Dimethylphthalate	0	ug/kg	0	NC	18
2,6-Dinitrotoluene	0	ug/kg	0	NC	20
Acenaphthylene	80.6595	ug/kg	49.5758	47.7*	17
3-Nitroaniline	0	ug/kg	0	NC	22
Acenaphthene	50.5988	ug/kg	29.4782	52.8*	17
2,4-Dinitrophenol	0	ug/kg	0	NC	30
4-Nitrophenol	0	ug/kg	0	NC	21
Dibenzofuran	70.1529	ug/kg	41.4945	51.3*	18
2,4-Dinitrotoluene	0	ug/kg	0	NC	21
2,3,4,6-Tetrachlorophenol		ug/kg	0	NC	20
Diethylphthalate	0	ug/kg	0	NC	18
4-Chlorophenyl-phenylether	0	ug/kg	0	NC	18
Fluorene	55.314	ug/kg	0	NC	16
4-Nitroaniline	0	ug/kg	0	NC	19
2-Methyl-4,6-dinitrophenol	0	ug/kg	0	NC	30
N-Nitrosodiphenylamine	0	ug/kg	0	NC	21
4-Bromophenyl-phenylether	0	ug/kg	0	NC	21
Hexachlorobenzene	0	ug/kg	0	NC	21
Atrazine		ug/kg	0	NC	22
Pentachlorophenol	0	ug/kg	0	NC	25
Phenanthrene	669.058	ug/kg	479.874	32.9*	20
Anthracene	186.943	ug/kg	143.849	26.1*	20
Carbazole	69.8169	ug/kg	52.4621	28.4*	20
Di-n-Butylphthalate	0	ug/kg	0	NC	20
Fluoranthene	1338.27	ug/kg	1003.85	28.6*	21
Pyrene	1390.07	ug/kg	1031.39	29.6*	20
Butylbenzylphthalate	0	ug/kg	0	NC	18
3,3-Dichlorobenzidine	0	ug/kg	0	NC	26
Benzo(a)anthracene	895.611	ug/kg	644.284	32.6*	22
Chrysene	969.058	ug/kg	757.189	24.5*	20
bis(2-Ethylhexyl)phthalate	151.726	ug/kg	113.872	28.5*	21
Di-n-Octylphthalate	0	ug/kg	0	NC	20
Benzo(b)fluoranthene	1378.21	ug/kg	1061.06	26	28
Benzo(k)fluoranthene	516.969	ug/kg	387.305	28.7*	22
Benzo(a)pyrene	990.876	ug/kg	739.047	29.1*	24
Indeno(1,2,3-cd)pyrene	793.958	ug/kg	568.699	33.1*	30
Dibenzo(a,h)anthracene	207.113	ug/kg	145.971	34.6*	28
Benzo(g,h,i)perylene	806.927	ug/kg	591.112	30.9*	30
2,4,6-Tribromophenol (S)	6377.51	%	5550.85	13.9	
2-Fluorobiphenyl (S)	2682.47	%	2508.4	6.71	
2-Fluorophenol (S)	4475.69	%	4500.31	.55	
Nitrobenzene-d5 (S)	2455.12	%	2514.36	2.38	
Phenol-d5 (S)	5083.38	%	4886	3.96	
Terphenyl-d14 (S)	2948.48	%	2504.4	16.3	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: EXTR/39587 **Analysis Method:** SW846 8082A

QC Batch Method: SW846 3546

Associated Lab Samples: 2074295001

METHOD BLANK: 2188143

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Aroclor-1016	ND	mg/kg	0.033	
Aroclor-1221	ND	mg/kg	0.033	
Aroclor-1232	ND	mg/kg	0.033	
Aroclor-1242	ND	mg/kg	0.033	
Aroclor-1248	ND	mg/kg	0.033	
Aroclor-1254	ND	mg/kg	0.033	
Aroclor-1260	ND	mg/kg	0.033	
Decachlorobiphenyls (S)	129	%	46 - 120	
Tetrachloro-m-xylene (S)	78.9	%	52 - 115	

LABORATORY CONTROL SAMPLE: 2188144

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Aroclor-1016	86.3	mg/kg	.33	0.29	43 - 132	
Aroclor-1221		mg/kg		ND		
Aroclor-1232		mg/kg		ND		
Aroclor-1242		mg/kg		ND		
Aroclor-1248		mg/kg		ND		
Aroclor-1254		mg/kg		ND		
Aroclor-1260	108	mg/kg	.33	0.36	53 - 134	
Decachlorobiphenyls (S)	131	%			46 - 120	
Tetrachloro-m-xylene (S)	78.9	%			52 - 115	

MATRIX SPIKE: 2188145 DUPLICATE: 2188146 ORIGINAL: 2074778001

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Aroclor-1016	0	mg/kg	.32	.25298	.24457	78.4	76.8	43 - 132	3.38	40	
Aroclor-1221		mg/kg		0	0				NC	40	
Aroclor-1232		mg/kg		0	0				NC	40	
Aroclor-1242		mg/kg		0	0				NC	40	
Aroclor-1248		mg/kg		0	0				NC	40	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Aroclor-1254		mg/kg		0	0				NC	40
Aroclor-1260	.02386	mg/kg	.32	.32464	.31491	93.2	91.4	53 - 134	3.04	40
Decachlorobiphenyls (S)	121	%				121*	121	46 - 120	.92	
Tetrachloro-m-xylene (S)	64.9	%				64.9	65.5	52 - 115	.36	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: EXTR/39588 **Analysis Method:** SW846 8081B

QC Batch Method: SW846 3546

Associated Lab Samples: 2074295001

METHOD BLANK: 2188147

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
alpha-BHC	ND	ug/kg	1.7	
beta-BHC	ND	ug/kg	1.7	
gamma-BHC	ND	ug/kg	1.7	
delta-BHC	ND	ug/kg	1.7	
Heptachlor	ND	ug/kg	1.7	
Aldrin	ND	ug/kg	1.7	
Heptachlor Epoxide	ND	ug/kg	1.7	
alpha-Chlordane	ND	ug/kg	1.7	
Endosulfan I	ND	ug/kg	1.7	
gamma-Chlordane	ND	ug/kg	1.7	
Dieldrin	ND	ug/kg	3.3	
4,4'-DDE	ND	ug/kg	3.3	
Endrin	ND	ug/kg	3.3	
Endosulfan II	ND	ug/kg	3.3	
4,4'-DDD	ND	ug/kg	3.3	
Endrin Aldehyde	ND	ug/kg	3.3	
Endosulfan Sulfate	ND	ug/kg	3.3	
4,4'-DDT	ND	ug/kg	3.3	
Endrin Ketone	ND	ug/kg	3.3	
Methoxychlor	ND	ug/kg	3.3	
Toxaphene	ND	ug/kg	13.0	
Decachlorobiphenyls (S)	103	%	30 - 135	
Tetrachloro-m-xylene (S)	74	%	30 - 111	

LABORATORY CONTROL SAMPLE: 2188148

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
alpha-BHC	85.7	ug/kg	33.3	28.6	57 - 105	
beta-BHC	74.6	ug/kg	33.3	24.9	53 - 106	
gamma-BHC	95.3	ug/kg	33.3	31.8	59 - 102	
delta-BHC	84.2	ug/kg	33.3	28.1	60 - 103	
Heptachlor	99.3	ug/kg	33.3	33.1	51 - 105	
Aldrin	90.4	ug/kg	33.3	30.1	58 - 103	
Heptachlor Epoxide	92.4	ug/kg	33.3	30.8	62 - 99	
alpha-Chlordane	95.3	ug/kg	33.3	31.8	62 - 98	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Endosulfan I	91.2	ug/kg	33.3	30.4	57 - 98
gamma-Chlordane	97.9	ug/kg	33.3	32.6	58 - 103
Dieldrin	96.4	ug/kg	33.3	32.1	62 - 109
4,4'-DDE	94.6	ug/kg	33.3	31.5	63 - 112
Endrin	91.2	ug/kg	33.3	30.4	63 - 108
Endosulfan II	112	ug/kg	33.3	37.3	59 - 112
4,4'-DDD	87.7	ug/kg	33.3	29.2	57 - 111
Endrin Aldehyde	76.4	ug/kg	33.3	25.5	21 - 92
Endosulfan Sulfate	88.4	ug/kg	33.3	29.5	27 - 96
4,4'-DDT	87.3	ug/kg	33.3	29.1	60 - 122
Endrin Ketone	95.9	ug/kg	33.3	32.0	32 - 103
Methoxychlor	97.9	ug/kg	33.3	32.6	50 - 114
Toxaphene		ug/kg		ND	
Decachlorobiphenyls (S)	91.6	%			30 - 135
Tetrachloro-m-xylene (S)	63.5	%			30 - 111

MATRIX SPIKE: 2188149 DUPLICATE: 2188150 ORIGINAL: 2074181009

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
alpha-BHC	0	ug/kg	33.1	26.8332	26.7847	81	82	57 - 105	.18	40	
beta-BHC	0	ug/kg	33.1	27.7664	26.9818	83.9	82.6	53 - 106	2.87	40	
gamma-BHC	0	ug/kg	33.1	29.5592	28.8538	89.3	88.3	59 - 102	2.42	40	
delta-BHC	0	ug/kg	33.1	26.1894	25.3251	79.1	77.5	60 - 103	3.36	40	
Heptachlor	0	ug/kg	33.1	30.6562	31.5769	92.6	96.6	51 - 105	2.96	40	
Aldrin	0	ug/kg	33.1	28.7457	29.5311	86.8	90.4	58 - 103	2.7	40	
Heptachlor Epoxide	.38596	ug/kg	33.1	30.0915	30.4515	89.7	92	62 - 99	1.19	35	
alpha-Chlordane	0	ug/kg	33.1	30.5916	30.7171	92.4	94	62 - 98	.41	40	
Endosulfan I	0	ug/kg	33.1	38.5842	40.0622	117*	123*	57 - 98	3.76	40	
gamma-Chlordane	0	ug/kg	33.1	31.2426	32.0282	94.4	98	58 - 103	2.48	40	
Dieldrin	0	ug/kg	33.1	31.2297	31.2834	94.3	95.7	62 - 109	.17	40	
4,4'-DDE		ug/kg		185.66	233.292				22.7	40	
Endrin	0	ug/kg	33.1	31.1353	30.2194	94	92.5	63 - 108	2.99	40	
Endosulfan II	0	ug/kg	33.1	39.5477	38.7301	119*	119*	59 - 112	2.09	40	
4,4'-DDD		ug/kg		42.0273	43.6411				3.77	40	
Endrin Aldehyde	0	ug/kg	33.1	23.654	23.2115	71.4	71	21 - 92	1.89	40	
Endosulfan Sulfate	0	ug/kg	33.1	29.689	29.2021	89.7	89.4	27 - 96	1.65	40	
4,4'-DDT		ug/kg		96.1164	116.191				18.9	40	
Endrin Ketone	0	ug/kg	33.1	29.5944	29.1033	89.4	89.1	32 - 103	1.67	40	
Methoxychlor	0	ug/kg	33.1	33.3789	31.7393	101	97.1	50 - 114	5.04	40	
Toxaphene		ug/kg		0	0				NC	40	
Decachlorobiphenyls (S)	87.1	%				87.1	87.9	30 - 135	.43	40	
Tetrachloro-m-xylene (S)	65.1	%				65.1	74	30 - 111	11.6	40	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

MATRIX SPIKE: 2188151 DUPLICATE: 2188152 ORIGINAL: 2074184003

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
alpha-BHC	0	ug/kg	32.5	25.515	26.2184	78.6	82.3	57 - 105	2.72	40	
beta-BHC	0	ug/kg	32.5	26.6912	30.3137	82.2	95.2	53 - 106	12.7	40	
gamma-BHC	0	ug/kg	32.5	27.8717	29.0471	85.8	91.2	59 - 102	4.13	40	
delta-BHC	0	ug/kg	32.5	25.287	25.854	77.9	81.2	60 - 103	2.22	40	
Heptachlor	0	ug/kg	32.5	29.3308	29.0002	90.3	91.1	51 - 105	1.13	40	
Aldrin	0	ug/kg	32.5	27.38	27.0964	84.3	85.1	58 - 103	1.04	40	
Heptachlor Epoxide	0	ug/kg	32.5	27.7245	27.5469	85.4	86.5	62 - 99	.64	35	
alpha-Chlordane	0	ug/kg	32.5	29.2366	28.4978	90	89.5	62 - 98	2.56	40	
Endosulfan I	0	ug/kg	32.5	28.7341	27.4646	88.5	86.2	57 - 98	4.52	40	
gamma-Chlordane	0	ug/kg	32.5	29.1589	28.8683	89.8	90.6	58 - 103	1	40	
Dieldrin	0	ug/kg	32.5	29.3224	29.0507	90.3	91.2	62 - 109	.93	40	
4,4'-DDE		ug/kg		46.9267	40.1955				15.5	40	
Endrin	0	ug/kg	32.5	28.3855	27.927	87.4	87.7	63 - 108	1.63	40	
Endosulfan II	0	ug/kg	32.5	37.1868	36.7725	115*	115*	59 - 112	1.12	40	
4,4'-DDD	1.1028	ug/kg	32.5	30.2339	28.4478	89.7	85.9	57 - 111	6.09	40	
Endrin Aldehyde	0	ug/kg	32.5	21.2676	22.5045	65.5	70.7	21 - 92	5.65	40	
Endosulfan Sulfate	0	ug/kg	32.5	27.8415	27.8744	85.8	87.5	27 - 96	.12	40	
4,4'-DDT		ug/kg		40.7973	33.9486				18.3	40	
Endrin Ketone	0	ug/kg	32.5	27.9948	27.9002	86.2	87.6	32 - 103	.34	40	
Methoxychlor	0	ug/kg	32.5	29.4167	29.7188	90.6	93.3	50 - 114	1.02	40	
Toxaphene		ug/kg		0	0				NC	40	
Decachlorobiphenyls (S)	82.8	%				82.8	80.4	30 - 135	4.9	40	
Tetrachloro-m-xylene (S)	68.5	%				68.5	65.2	30 - 111	6.82	40	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: MDIG/51170 **Analysis Method:** SW846 7471B

QC Batch Method: SW846 7471B

Associated Lab Samples: 2074295001

METHOD BLANK: 2187576

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Mercury, Total	ND	mg/kg	0.050	

LABORATORY CONTROL SAMPLE: 2187577

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Mercury, Total	97.5	mg/kg	.4	0.39	80 - 120	

MATRIX SPIKE: 2187578 DUPLICATE: 2187579 ORIGINAL: 2073663005

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Mercury, Total	.012	mg/kg	.98	1	1.04	101	103	80 - 120	3.92	20	

MATRIX SPIKE: 2187580 DUPLICATE: 2187581 ORIGINAL: 2074811021

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Mercury, Total	.02111	mg/kg	.89	.35714	.26604	37.6*	26*	80 - 120	29.2*	20	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: MDIG/51174 **Analysis Method:** SW846 6010C

QC Batch Method: SW846 3051

Associated Lab Samples: 2074295001

METHOD BLANK: 2187616

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Aluminum, Total	8.8J	mg/kg	10.0	
Antimony, Total	ND	mg/kg	2.0	
Arsenic, Total	ND	mg/kg	2.0	
Barium, Total	ND	mg/kg	1.0	
Beryllium, Total	ND	mg/kg	1.0	
Cadmium, Total	ND	mg/kg	0.50	
Calcium, Total	10.3	mg/kg	10.0	
Chromium, Total	0.45J	mg/kg	1.0	
Cobalt, Total	ND	mg/kg	1.0	
Copper, Total	ND	mg/kg	2.0	
Iron, Total	ND	mg/kg	10.0	
Lead, Total	ND	mg/kg	2.0	
Magnesium, Total	3.8J	mg/kg	10.0	
Manganese, Total	3.7	mg/kg	1.0	
Nickel, Total	ND	mg/kg	2.0	
Selenium, Total	ND	mg/kg	5.0	
Silver, Total	ND	mg/kg	0.50	
Thallium, Total	ND	mg/kg	3.0	
Vanadium, Total	ND	mg/kg	1.0	
Zinc, Total	0.84J	mg/kg	2.0	
Sodium, Total	ND	mg/kg	50.0	
Potassium, Total	ND	mg/kg	50.0	

LABORATORY CONTROL SAMPLE: 2187617

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Aluminum, Total	92.6	mg/kg	100	92.6	80 - 120	
Antimony, Total	103	mg/kg	40	41.3	80 - 120	
Arsenic, Total	103	mg/kg	40	41.1	80 - 120	
Barium, Total	92.8	mg/kg	100	92.8	80 - 120	
Beryllium, Total	103	mg/kg	40	41.2	80 - 120	
Cadmium, Total	99.6	mg/kg	20	19.9	80 - 120	
Calcium, Total	94.4	mg/kg	500	472	80 - 120	
Chromium, Total	105	mg/kg	20	20.9	80 - 120	
Cobalt, Total	94.2	mg/kg	100	94.2	80 - 120	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Copper, Total	91.8	mg/kg	100	91.8	80 - 120
Iron, Total	93.9	mg/kg	1000	939	80 - 120
Lead, Total	92.5	mg/kg	100	92.5	80 - 120
Magnesium, Total	92.2	mg/kg	500	461	80 - 120
Manganese, Total	104	mg/kg	20	20.8	80 - 120
Nickel, Total	94.9	mg/kg	100	94.9	80 - 120
Selenium, Total	94.2	mg/kg	100	94.2	80 - 120
Silver, Total	102	mg/kg	20	20.4	80 - 120
Thallium, Total	107	mg/kg	100	107	80 - 120
Vanadium, Total	103	mg/kg	20	20.6	80 - 120
Zinc, Total	93.1	mg/kg	100	93.1	80 - 120
Sodium, Total	93.6	mg/kg	500	468	80 - 120
Potassium, Total	91.1	mg/kg	500	456	80 - 120

MATRIX SPIKE: 2187619 DUPLICATE: 2187620 ORIGINAL: 2073810001

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Aluminum, Total		mg/kg		2507.894	2383.962				5.07	20	
Antimony, Total		mg/kg		35.85965	37.90566				5.55	20	
Arsenic, Total		mg/kg		35.62281	37.87736				6.13	20	
Barium, Total		mg/kg		86.53509	88.98113				2.79	20	
Beryllium, Total		mg/kg		35.46491	37.50943				5.6	20	
Cadmium, Total		mg/kg		17.24561	18.20755				5.43	20	
Calcium, Total		mg/kg		1060.526	1063.207				.25	20	
Chromium, Total		mg/kg		21.01754	22.12264				5.12	20	
Cobalt, Total		mg/kg		81.21053	85.4434				5.08	20	
Copper, Total		mg/kg		83.19298	86.58491				4	20	
Iron, Total		mg/kg		885.0877	914.0566				3.22	20	
Lead, Total		mg/kg		79.61404	83.82075				5.15	20	
Magnesium, Total		mg/kg		424.9122	441.2264				3.77	20	
Manganese, Total		mg/kg		19.23684	20.09434				4.36	20	
Nickel, Total		mg/kg		82.61404	87.30189				5.52	20	
Selenium, Total		mg/kg		84.38596	89.15094				5.49	20	
Silver, Total		mg/kg		17.72807	18.65094				5.07	20	
Thallium, Total		mg/kg		90.52632	95.4717				5.32	20	
Vanadium, Total		mg/kg		18.15789	18.88679				3.94	20	
Zinc, Total		mg/kg		90.70175	102.7358				12.4	20	
Sodium, Total		mg/kg		597.8070	613.0188				2.51	20	
Potassium, Total	60.34259	mg/kg	439	458.0701	469.8113	90.7	86.8	75 - 125	2.53	20	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: VOMS/36123 **Analysis Method:** SW846 8260C

QC Batch Method: SW846 5035

Associated Lab Samples: 2074295001

METHOD BLANK: 2186667

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Dichlorodifluoromethane	ND	ug/kg	2.0	
Chloromethane	ND	ug/kg	2.0	
Vinyl Chloride	ND	ug/kg	2.0	
Bromomethane	ND	ug/kg	2.0	
Chloroethane	ND	ug/kg	5.0	
Trichlorofluoromethane	ND	ug/kg	2.0	
Acetone	5.7J	ug/kg	10.0	
1,1-Dichloroethene	ND	ug/kg	2.0	
Methylene Chloride	ND	ug/kg	2.0	
Methyl acetate	ND	ug/kg	2.0	
Freon 113	ND	ug/kg	2.0	
Carbon Disulfide	ND	ug/kg	2.0	
trans-1,2-Dichloroethene	ND	ug/kg	2.0	
Methyl t-Butyl Ether	ND	ug/kg	2.0	
1,1-Dichloroethane	ND	ug/kg	2.0	
2-Butanone	ND	ug/kg	10.0	
cis-1,2-Dichloroethene	ND	ug/kg	2.0	
Bromochloromethane	ND	ug/kg	2.0	
Chloroform	ND	ug/kg	2.0	
1,2-Dichloroethane	ND	ug/kg	2.0	
1,1,1-Trichloroethane	ND	ug/kg	2.0	
Cyclohexane	ND	ug/kg	2.0	
Carbon Tetrachloride	ND	ug/kg	2.0	
Benzene	ND	ug/kg	2.0	
1,2-Dichloropropane	ND	ug/kg	2.0	
Trichloroethene	ND	ug/kg	2.0	
Bromodichloromethane	ND	ug/kg	2.0	
1,4-Dioxane	ND	ug/kg	75.0	
Methyl cyclohexane	ND	ug/kg	2.0	
cis-1,3-Dichloropropene	ND	ug/kg	2.0	
4-Methyl-2-Pentanone(MIBK)	ND	ug/kg	10.0	
trans-1,3-Dichloropropene	ND	ug/kg	2.0	
1,1,2-Trichloroethane	ND	ug/kg	2.0	
Toluene	ND	ug/kg	2.0	
2-Hexanone	ND	ug/kg	10.0	
Chlorodibromomethane	ND	ug/kg	2.0	
1,2-Dibromoethane	ND	ug/kg	2.0	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Tetrachloroethene	ND	ug/kg	2.0
Chlorobenzene	ND	ug/kg	2.0
Ethylbenzene	ND	ug/kg	2.0
mp-Xylene	ND	ug/kg	4.0
Bromoform	ND	ug/kg	2.0
Styrene	ND	ug/kg	2.0
1,1,2,2-Tetrachloroethane	ND	ug/kg	2.0
o-Xylene	ND	ug/kg	2.0
Isopropylbenzene	ND	ug/kg	2.0
1,3-Dichlorobenzene	ND	ug/kg	2.0
1,4-Dichlorobenzene	ND	ug/kg	2.0
1,2-Dichlorobenzene	ND	ug/kg	2.0
1,2-Dibromo-3-chloropropane	ND	ug/kg	5.0
1,2,4-Trichlorobenzene	ND	ug/kg	5.0
1,2,3-Trichlorobenzene	ND	ug/kg	5.0
1,2-Dichloroethane-d4 (S)	96	%	56 - 124
4-Bromofluorobenzene (S)	106	%	51 - 128
Dibromofluoromethane (S)	106	%	62 - 123
Toluene-d8 (S)	109	%	59 - 131

LABORATORY CONTROL SAMPLE: 2186668 DUPLICATE: 2186669

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	LCSD Result	LCSD % Rec	% Rec Limit	RPD	Max	Qualifi
Dichlorodifluoromethane	11.0	ug/kg	20	11.1	11.0	54.8	16 - 152	1.33	40	
Chloromethane	13.9	ug/kg	20	14.5	13.9	69.5	44 - 139	4.4	40	
Vinyl Chloride	15.5	ug/kg	20	16.2	15.5	77.3	53 - 141	4.9	40	
Bromomethane	15.6	ug/kg	20	15.8	15.6	78	43 - 148	1.49	40	
Chloroethane	17.3	ug/kg	20	17.7	17.3	86.3	1 - 141	2.64	40	
Trichlorofluoromethane	17.8	ug/kg	20	18.0	17.8	89.1	40 - 130	.79	40	
Acetone	108	ug/kg	100	103	108	108	58 - 146	5.53	40	
1,1-Dichloroethene	23.4	ug/kg	20	23.6	23.4	117	59 - 139	.65	40	
Methylene Chloride	26.9	ug/kg	20	23.7	26.9	134	68 - 133	12.5	40	
Methyl acetate	55.2	ug/kg	20	49.8	55.2	276	70 - 130	10.3	40	*
Freon 113	25.1	ug/kg	20	25.3	25.1	125	40 - 109	.85	40	*
Carbon Disulfide	22.1	ug/kg	20	21.8	22.1	110	47 - 144	1.28	40	
trans-1,2-Dichloroethene	23.8	ug/kg	20	23.7	23.8	119	66 - 133	.24	40	
Methyl t-Butyl Ether	20.3	ug/kg	20	19.8	20.3	101	70 - 118	2.51	40	
1,1-Dichloroethane	22.2	ug/kg	20	21.5	22.2	111	74 - 131	2.88	40	
2-Butanone	84.1	ug/kg	100	82.2	84.1	84.1	64 - 148	2.32	40	
cis-1,2-Dichloroethene	22.5	ug/kg	20	22.1	22.5	113	75 - 128	2.03	40	
Bromochloromethane	22.5	ug/kg	20	21.9	22.5	113	71 - 120	2.75	40	
Chloroform	21.5	ug/kg	20	21.4	21.5	107	73 - 126	.23	40	
1,2-Dichloroethane	22.0	ug/kg	20	21.8	22.0	110	69 - 132	1.11	40	
1,1,1-Trichloroethane	22.0	ug/kg	20	21.8	22.0	110	68 - 131	.67	40	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

Cyclohexane	24.5	ug/kg	20	23.9	24.5	122	62 - 143	2.31	40
Carbon Tetrachloride	22.6	ug/kg	20	25.5	22.6	113	64 - 136	12.1	40
Benzene	23.1	ug/kg	20	22.5	23.1	115	75 - 132	2.49	40
1,2-Dichloropropane	22.1	ug/kg	20	21.3	22.1	110	78 - 131	3.56	40
Trichloroethene	22.1	ug/kg	20	22.0	22.1	110	72 - 129	.27	40
Bromodichloromethane	21.3	ug/kg	20	21.1	21.3	106	74 - 127	1	40
1,4-Dioxane	533	ug/kg	500	492	533	107	9 - 267	8.1	40
Methyl cyclohexane	25.4	ug/kg	20	24.7	25.4	127	70 - 130	2.84	40
cis-1,3-Dichloropropene	20.6	ug/kg	20	19.6	20.6	103	76 - 123	4.89	40
4-Methyl-2-Pentanone(MIBK)	94.8	ug/kg	100	86.4	94.8	94.8	64 - 143	9.21	40
trans-1,3-Dichloropropene	16.9	ug/kg	20	15.9	16.9	84.5	77 - 123	6.26	40
1,1,2-Trichloroethane	20.3	ug/kg	20	19.4	20.3	102	79 - 123	4.87	40
Toluene	20.2	ug/kg	20	19.8	20.2	101	73 - 129	2.01	40
2-Hexanone	83.3	ug/kg	100	75.1	83.3	83.3	62 - 147	10.5	40
Chlorodibromomethane	20.8	ug/kg	20	20.0	20.8	104	75 - 124	3.81	40
1,2-Dibromoethane	20.7	ug/kg	20	20.4	20.7	103	76 - 127	1.53	40
Tetrachloroethene	21.5	ug/kg	20	21.5	21.5	108	58 - 137	.12	40
Chlorobenzene	21.3	ug/kg	20	20.4	21.3	106	76 - 125	4.09	40
Ethylbenzene	21.3	ug/kg	20	20.6	21.3	106	73 - 133	3.09	40
mp-Xylene	41.8	ug/kg	40	40.7	41.8	104	72 - 130	2.54	40
Bromoform	19.1	ug/kg	20	18.6	19.1	95.4	68 - 131	2.25	40
Styrene	20.4	ug/kg	20	19.8	20.4	102	77 - 130	2.78	40
1,1,2,2-Tetrachloroethane	19.5	ug/kg	20	18.5	19.5	97.7	72 - 134	5.4	40
o-Xylene	20.3	ug/kg	20	19.6	20.3	102	75 - 129	3.36	40
Isopropylbenzene	20.7	ug/kg	20	20.2	20.7	104	71 - 137	2.78	40
1,3-Dichlorobenzene	20.4	ug/kg	20	19.9	20.4	102	72 - 127	2.22	40
1,4-Dichlorobenzene	20.0	ug/kg	20	19.8	20.0	100	72 - 126	.9	40
1,2-Dichlorobenzene	20.4	ug/kg	20	19.3	20.4	102	75 - 126	5.63	40
1,2-Dibromo-3-chloropropane	18.3	ug/kg	20	17.8	18.3	91.7	52 - 151	2.95	40
1,2,4-Trichlorobenzene	19.4	ug/kg	20	18.1	19.4	97.2	63 - 132	7.13	40
1,2,3-Trichlorobenzene	19.1	ug/kg	20	16.8	19.1	95.6	68 - 129	12.9	40
1,2-Dichloroethane-d4 (S)	98.1	%			98.1		56 - 124	.47	
4-Bromofluorobenzene (S)	103	%			103		51 - 128	.25	
Dibromofluoromethane (S)	106	%			106		62 - 123	1.33	
Toluene-d8 (S)	107	%			107		59 - 131	2.42	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: WCPR/32405 **Analysis Method:** SW846 9012B

QC Batch Method: SW846 9012B

Associated Lab Samples: 2074295001

METHOD BLANK: 2186920

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Cyanide, Total	ND	mg/kg	0.25	

LABORATORY CONTROL SAMPLE: 2186921

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Cyanide, Total	100	mg/kg	6.3	6.3	90 - 110	

MATRIX SPIKE: 2186922 DUPLICATE: 2186923 ORIGINAL: 2073952003

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Cyanide, Total	.05051	mg/kg	5.1	5.30612	5.25	103	104	80 - 120	1.06	20	

MATRIX SPIKE SAMPLE: 2186924 ORIGINAL:

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MS % Rec	% Rec Limit	Qualifiers
Cyanide, Total	0	mg/kg	5	5	100	80 - 120	

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

QC Batch: WETC/154975 **Analysis Method:** S2540G-11

QC Batch Method: S2540G-11

Associated Lab Samples: 2074295001

SAMPLE DUPLICATE: 2186876 ORIGINAL: 2074295001

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	11.5907	%	10.3548	11.3*	10	
Total Solids	88.4092	%	89.6451	1.39	5	

SAMPLE DUPLICATE: 2186877 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	11.349	%	13.4886	17.2*	10	
Total Solids	88.6509	%	86.5113	2.44	5	

SAMPLE DUPLICATE: 2186878 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	1.2158	%	1.6447	30*	10	
Total Solids	98.7841	%	98.3552	.44	5	

SAMPLE DUPLICATE: 2186880 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	10.8848	%	10.8771	.07	10	
Total Solids	89.1151	%	89.1228	.009	5	

SAMPLE DUPLICATE: 2186881 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	16.8787	%	18.6518	9.98	10	
Total Solids	83.1212	%	81.3481	2.16	5	

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

QUALITY CONTROL DATA

Workorder: 2074295 AER090|R1504196

SAMPLE DUPLICATE: 2186882 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	38.5307	%	35.9801	6.85	10	
Total Solids	61.4692	%	64.0198	4.07	5	

SAMPLE DUPLICATE: 2186883 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	8.4914	%	8.9586	5.35	10	
Total Solids	91.5085	%	91.0413	.51	5	

QUALITY CONTROL DATA QUALIFIERS

Workorder: 2074295 AER090|R1504196

QUALITY CONTROL PARAMETER QUALIFIERS

Lab ID	#	Sample Type	Analytical Method	Analyte
2186668	1	Lab Control Standard	SW846 8260C	Freon 113

The QC sample type LCS for method SW846 8260C was outside the control limits for the analyte Freon 113. The % Recovery was reported as 126 and the control limits were 40 to 109.

Lab ID	#	Sample Type	Analytical Method	Analyte
2186668	2	Lab Control Standard	SW846 8260C	Methyl acetate

The QC sample type LCS for method SW846 8260C was outside the control limits for the analyte Methyl acetate. The % Recovery was reported as 249 and the control limits were 70 to 130.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Workorder: 2074295 AER090|R1504196

Lab ID	Sample ID	Prep Method	Prep Batch	Analysis Method	Analysis Batch
2074295001	R1504196-001	SW846 3546	EXTR/39545	SW846 8270D	SVMS/23574
2074295001	R1504196-001	SW846 5035	VOMS/36123	SW846 8260C	VOMS/36124
2074295001	R1504196-001			S2540G-11	WETC/154975
2074295001	R1504196-001	SW846 9012B	WCPR/32405	SW846 9012B	WETC/155035
2074295001	R1504196-001	SW846 7471B	MDIG/51170	SW846 7471B	META/48617
2074295001	R1504196-001	SW846 3051	MDIG/51174	SW846 6010C	META/48628
2074295001	R1504196-001	SW846 3546	EXTR/39587	SW846 8082A	SVGC/38285
2074295001	R1504196-001	SW846 3546	EXTR/39588	SW846 8081B	SVGC/38292

ALS Environmental Chain of Custody

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VB

ALS Co

2074295

Project Number: R1504196
Project Manager: Janice Jaeger

Lab Code	Sample ID	# of Cont.	Matrix	Sample Date	Sample Time	Lab ID	Ag T 6010C	Al T 6010C	As T 6010C	Ba T 6010C	Be T 6010C	Ca T 6010C	Cd T 6010C	CN Tot 9012B	Co T 6010C
R1504196-001	Comp-1 Topsoil	3	Soil	5/28/15	1600	Middletown ALS	X	X	X	X	X	X	X	X	X
~~R1504196-002~~	~~Comp-2 Topsoil~~		~~Soil~~	~~5/28/15~~	~~1610~~	~~Middletown ALS~~	X	X	X	X	X	X	X	X	X
~~R1504196-003~~	Comp-3 Topsoil		Soil	5/28/15	1615	Middletown ALS	X	X	X	X	X	X	X	X	X

On Seperate
WO # 2074297
AT 6/2/15

AT
6/3/15

	Y	N	Initials
Custody Seals Present?			
(if present) Seals Intact?			
Received on Ice?			AT
COC/Lbls Complete			
Cont in Good Cond?			
Correct Containers?			
Correct Samp Vol?			
Correct Preservation?			
Headspace/Volatiles?			

Cooler Temp: 5 °C
Cooler #:
Therm ID: IR291
Ship Carrier: (FedEx) UPS DHL
Tracking #: 629675588321

Special Instructions/Comments

need DECEQUIS EDD
need 1 week TAT on sample 1
std on others

H - Test is On Hold P - Test is Authorized for Prep Only

Turnaround Requirements

___RUSH (Surcharges Apply)

PLEASE CIRCLE WORK DAYS
1 2 3 4 5

___ STANDARD

Requested FAX Date: _____

Requested Report Date: 06/03/15

Report Requirements

___ I. Results Only

___ II. Results + QC Summaries

___ III. Results + QC and Calibration Summaries

X IV. Data Validation Report with Raw Data

PQL/MDL/J N
EDD N

Invoice Information

PO#
58R1504196

Bill to

Relinquished By: [signature] 6/1/15/1645

Received By: [signature] 6/2/15 0900

Airbill Number: _____

							Cr T 6010C	Cu T 6010C	Fe T 6010C	Hg 7471B	K T 6010C	Mg T 6010C	Mn T 6010C	Na T 6010C	Ni T 6010C
R1504196-001	Comp-1 Topsoil		Soil	5/28/15	1600	Middletown ALS	X	X	X	X	X	X	X	X	X
R1504196-002	Comp-2 Topsoil		Soil	5/28/15	1610	Middletown ALS	X	X	X	X	X	X	X	X	X
R1504196-003	Comp-3 Topsoil		Soil	5/28/15	1615	Middletown ALS	X	X	X	X	X	X	X	X	X

ALS

R1504196-001	Comp-1 Topsoil		Soil	5/28/15	1600	Middletown ALS	X	X	X	X	X	X	X	X	X	X	X	X	X
R1504196-002	Comp-2 Topsoil		Soil	5/28/15	1610	Middletown ALS	X	X	X	X	X	X	X	X	X	X	X	X	X
R1504196-003	Comp-3 Topsoil		Soil	5/28/15	1615	Middletown ALS	X	X	X	X	X	X	X	X	X	X	X	X	X

							VOC FP 8260C	Zn T 6010C
R1504196-001	Comp-1 Topsoil		Soil	5/28/15	1600	Middletown ALS	X	X
R1504196-002	Comp-2 Topsoil		Soil	5/28/15	1610	Middletown ALS	X	X
R1504196-003	Comp-3 Topsoil		Soil	5/28/15	1615	Middletown ALS	X	X

ALS

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ALS Contact: Janice Jaeger

Project Number: R1504196
Project Manager: Janice Jaeger

R1504196

Ship To: Middletown ALS
ALS Laboratory Group
34 Dogwood Lane
Middletown, PA 17057

PC _____ Date 6/1/15
SMO _____ Date _____

Instructions:

Ice _____
Dry Ice _____
No Ice _____

Shipping:

Overnight _____
2nd Day _____
Ground _____

Bill to Client Account _____

Comments:

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

June 16, 2015

Ms. Janice Jaeger
ALS Environmental-Rochester NY
1565 Jefferson Road, Bldg. 300
Suite 360
Rochester, NY 14623

Certificate of Analysis

Project Name:	**Primary**	Workorder:	**2074297**
Purchase Order:	**58R1504196**	Workorder ID:	**AER091|R1504196**

Dear Ms. Jaeger:

Enclosed are the analytical results for samples received by the laboratory on Tuesday, June 2, 2015.

The ALS Environmental laboratory in Middletown, Pennsylvania is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory and as such, certifies that all applicable test results meet the requirements of NELAP.

If you have any questions regarding this certificate of analysis, please contact Mrs. Vanessa N Badman (Project Coordinator) at (717) 944-5541.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program and any applicable state requirements. The test results meet requirements of the current NELAP standards or state requirements, where applicable. For a specific list of accredited analytes, refer to the certifications section of the ALS website at www.alsglobal.com/en/Our-Services/Life-Sciences/Environmental/Downloads.

This laboratory report may not be reproduced, except in full, without the written approval of ALS Environmental.

ALS Spring City: 10 Riverside Drive, Spring City, PA 19475 610-948-4903

CC: Ms. Lisa Reyes , Ms. Tracy Christ , Ms. Karen Bunker

This page is included as part of the Analytical Report and must be retained as a permanent record thereof.

Vanessa N. Badman

Mrs. Vanessa N Badman
Project Coordinator

ALS Environmental

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SAMPLE SUMMARY

Workorder: 2074297 AER091|R1504196

Lab ID	Sample ID	Matrix	Date Collected	Date Received	Collected By
2074297001	R1504196-002	Solid	5/28/2015 16:10	6/2/2015 09:00	Collected by Client
2074297002	R1504196-003	Solid	5/28/2015 16:15	6/2/2015 09:00	Collected by Client

Notes

-- Samples collected by ALS personnel are done so in accordance with the procedures set forth in the ALS Field Sampling Plan (20 - Field Services Sampling Plan).
-- All Waste Water analyses comply with methodology requirements of 40 CFR Part 136.
-- All Drinking Water analyses comply with methodology requirements of 40 CFR Part 141.
-- Unless otherwise noted, all quantitative results for soils are reported on a dry weight basis.
-- The Chain of Custody document is included as part of this report.
-- All Library Search analytes should be regarded as tentative identifications based on the presumptive evidence of the mass spectra. Concentrations reported are estimated values.
-- Parameters identified as "analyze immediately" require analysis within 15 minutes of collection. Any "analyze immediately" parameters not listed under the header "Field Parameters" are preformed in the laboratory and are therefore analyzed out of hold time.
-- Method references listed on this report beginning with the prefix “S” followed by a method number (such as S2310B-97) refer to methods from “Standard Methods for the Examination of Water and Wastewater”.

Standard Acronyms/Flags

J	Indicates an estimated value between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) for the analyte
U	Indicates that the analyte was Not Detected (ND)
N	Indicates presumptive evidence of the presence of a compound
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
RDL	Reporting Detection Limit
ND	Not Detected - indicates that the analyte was Not Detected at the RDL
Cntr	Analysis was performed using this container
RegLmt	Regulatory Limit
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
DUP	Sample Duplicate
%Rec	Percent Recovery
RPD	Relative Percent Difference
LOD	DoD Limit of Detection
LOQ	DoD Limit of Quantitation
DL	DoD Detection Limit
I	Indicates reported value is greater than or equal to the Method Detection Limit (MDL) but less than the Report Detection Limit (RDL)

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PROJECT SUMMARY

Workorder: 2074297 AER091|R1504196

Sample Comments

Lab ID: 2074297001 **Sample ID:** R1504196-002 **Sample Type:** SAMPLE

This sample was collected in a soil jar for the volatile analysis. The sample was received and prepared by Method 5035 after the 48-hour holding time.
This sample was analyzed at a dilution in the 8081 Pesticide analysis due to sample matrix interference. Reporting limits were adjusted accordingly.

Lab ID: 2074297002 **Sample ID:** R1504196-003 **Sample Type:** SAMPLE

This sample was collected in a soil jar for the volatile analysis. The sample was received and prepared by Method 5035 after the 48-hour holding time.
This sample was analyzed at a dilution in the 8081 Pesticide analysis due to sample matrix interference. Reporting limits were adjusted accordingly.

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ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297001** Date Collected: 5/28/2015 16:10 Matrix: Solid

Sample ID: **R1504196-002** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS											
Acetone	ND		ug/kg	10.7	4.9	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Benzene	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Bromochloromethane	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Bromodichloromethane	ND		ug/kg	2.1	0.76	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Bromoform	ND		ug/kg	2.1	0.56	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Bromomethane	ND		ug/kg	2.1	0.56	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
2-Butanone	ND		ug/kg	10.7	3.4	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Carbon Disulfide	ND		ug/kg	2.1	0.67	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Carbon Tetrachloride	ND		ug/kg	2.1	0.55	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Chlorobenzene	ND		ug/kg	2.1	0.55	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Chlorodibromomethane	ND		ug/kg	2.1	0.73	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Chloroethane	ND		ug/kg	5.3	0.91	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Chloroform	ND		ug/kg	2.1	0.57	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Chloromethane	ND		ug/kg	2.1	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Cyclohexane	ND		ug/kg	2.1	0.55	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,2-Dibromo-3-chloropropane	ND		ug/kg	5.3	3.1	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,2-Dibromoethane	ND		ug/kg	2.1	0.58	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,2-Dichlorobenzene	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,3-Dichlorobenzene	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,4-Dichlorobenzene	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Dichlorodifluoromethane	ND		ug/kg	2.1	0.72	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,1-Dichloroethane	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,2-Dichloroethane	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,1-Dichloroethene	ND		ug/kg	2.1	0.56	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
cis-1,2-Dichloroethene	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
trans-1,2-Dichloroethene	ND		ug/kg	2.1	0.56	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,2-Dichloropropane	ND		ug/kg	2.1	0.64	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
cis-1,3-Dichloropropene	ND		ug/kg	2.1	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
trans-1,3-Dichloropropene	ND		ug/kg	2.1	0.62	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,4-Dioxane	ND		ug/kg	80.2	19.0	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Ethylbenzene	ND		ug/kg	2.1	0.73	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Freon 113	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
2-Hexanone	ND		ug/kg	10.7	3.0	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Isopropylbenzene	ND		ug/kg	2.1	0.65	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Methyl acetate	ND		ug/kg	2.1	0.63	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Methyl cyclohexane	ND		ug/kg	2.1	0.60	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297001** Date Collected: 5/28/2015 16:10 Matrix: Solid

Sample ID: **R1504196-002** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Methyl t-Butyl Ether	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
4-Methyl-2-Pentanone(MIBK)	ND		ug/kg	10.7	4.1	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Methylene Chloride	14.0	1	ug/kg	2.1	0.83	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Styrene	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,1,2,2-Tetrachloroethane	ND		ug/kg	2.1	0.60	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Tetrachloroethene	ND		ug/kg	2.1	0.64	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Toluene	ND		ug/kg	2.1	0.72	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,2,3-Trichlorobenzene	ND		ug/kg	5.3	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,2,4-Trichlorobenzene	ND		ug/kg	5.3	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,1,1-Trichloroethane	ND		ug/kg	2.1	0.66	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
1,1,2-Trichloroethane	ND		ug/kg	2.1	0.60	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Trichloroethene	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Trichlorofluoromethane	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Vinyl Chloride	ND		ug/kg	2.1	0.53	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
o-Xylene	ND		ug/kg	2.1	0.62	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
mp-Xylene	ND		ug/kg	4.3	0.89	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A

Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	99.9		%	56 - 124	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
4-Bromofluorobenzene (S)	109		%	51 - 128	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Dibromofluoromethane (S)	107		%	62 - 123	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A
Toluene-d8 (S)	111		%	59 - 131	SW846 8260C	6/4/15	JPA	6/4/15 06:08	JPA	A

SEMIVOLATILES

Acenaphthene	ND		ug/kg	112	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Acenaphthylene	ND		ug/kg	112	12.4	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Acetophenone	ND		ug/kg	112	11.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Anthracene	ND		ug/kg	112	11.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Atrazine	ND		ug/kg	112	29.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Benzaldehyde	ND		ug/kg	303	47.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Benzo(a)anthracene	19.1J	J	ug/kg	112	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Benzo(a)pyrene	ND		ug/kg	112	18.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Benzo(b)fluoranthene	27.6J	J	ug/kg	112	27.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Benzo(g,h,i)perylene	ND		ug/kg	112	23.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Benzo(k)fluoranthene	ND		ug/kg	112	21.3	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Biphenyl	ND		ug/kg	112	14.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
4-Bromophenyl-phenylether	ND		ug/kg	112	25.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Butylbenzylphthalate	ND		ug/kg	112	29.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Caprolactam	ND		ug/kg	303	82.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297001** Date Collected: 5/28/2015 16:10 Matrix: Solid

Sample ID: **R1504196-002** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Carbazole	ND		ug/kg	112	14.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
4-Chloro-3-methylphenol	ND		ug/kg	303	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
4-Chloroaniline	ND		ug/kg	303	150	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
bis(2-Chloroethoxy)methane	ND		ug/kg	112	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
bis(2-Chloroethyl)ether	ND		ug/kg	112	22.5	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
bis(2-Chloroisopropyl)ether	ND		ug/kg	112	28.1	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Chloronaphthalene	ND		ug/kg	112	15.7	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Chlorophenol	ND		ug/kg	303	20.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
4-Chlorophenyl-phenylether	ND		ug/kg	112	18.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Chrysene	19.0J	J	ug/kg	112	14.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
mp-Cresol	ND		ug/kg	303	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
o-Cresol	ND		ug/kg	303	24.7	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Di-n-Butylphthalate	ND		ug/kg	112	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Di-n-Octylphthalate	ND		ug/kg	303	43.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Dibenzo(a,h)anthracene	ND		ug/kg	112	13.5	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Dibenzofuran	ND		ug/kg	112	12.4	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
3,3-Dichlorobenzidine	ND		ug/kg	168	78.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,4-Dichlorophenol	ND		ug/kg	225	20.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Diethylphthalate	ND		ug/kg	112	14.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,4-Dimethylphenol	ND		ug/kg	303	86.5	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Dimethylphthalate	ND		ug/kg	112	18.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,4-Dinitrophenol	ND		ug/kg	225	71.9	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,4-Dinitrotoluene	ND		ug/kg	112	32.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,6-Dinitrotoluene	ND		ug/kg	112	27.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
1,4-Dioxane	ND		ug/kg	112	31.4	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
bis(2-Ethylhexyl)phthalate	ND		ug/kg	112	25.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Fluoranthene	26.6J	J	ug/kg	112	21.3	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Fluorene	ND		ug/kg	112	22.5	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Hexachlorobenzene	ND		ug/kg	112	21.3	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Hexachlorobutadiene	ND		ug/kg	112	29.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Hexachlorocyclopentadiene	ND		ug/kg	303	97.7	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Hexachloroethane	ND		ug/kg	112	19.1	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Indeno(1,2,3-cd)pyrene	ND		ug/kg	112	20.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Isophorone	ND		ug/kg	112	18.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Methyl-4,6-dinitrophenol	ND		ug/kg	303	65.1	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Methylnaphthalene	ND		ug/kg	112	18.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Naphthalene	ND		ug/kg	112	27.0	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Nitroaniline	ND		ug/kg	303	146	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297001** Date Collected: 5/28/2015 16:10 Matrix: Solid

Sample ID: **R1504196-002** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
3-Nitroaniline	ND		ug/kg	404	199	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
4-Nitroaniline	ND		ug/kg	314	157	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Nitrobenzene	ND		ug/kg	112	23.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Nitrophenol	ND		ug/kg	303	30.3	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
4-Nitrophenol	ND		ug/kg	303	113	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
N-Nitroso-di-n-propylamine	ND		ug/kg	112	19.1	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
N-Nitrosodiphenylamine	ND		ug/kg	112	19.1	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Pentachlorophenol	ND		ug/kg	225	40.4	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Phenanthrene	ND		ug/kg	112	15.7	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Phenol	ND		ug/kg	303	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Pyrene	22.6J	J	ug/kg	112	20.2	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
1,2,4,5-Tetrachlorobenzene	ND		ug/kg	112	16.8	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,3,4,6-Tetrachlorophenol	ND		ug/kg	303	23.6	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,4,5-Trichlorophenol	ND		ug/kg	303	22.5	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2,4,6-Trichlorophenol	ND		ug/kg	225	22.5	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A

Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	86.1		%	37 - 123	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Fluorobiphenyl (S)	78.6		%	45 - 105	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
2-Fluorophenol (S)	76.3		%	35 - 104	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Nitrobenzene-d5 (S)	80		%	41 - 110	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Phenol-d5 (S)	78.1		%	40 - 100	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A
Terphenyl-d14 (S)	79.4		%	38 - 113	SW846 8270D	6/4/15	BS	6/4/15 11:23	GEC	A

PCBs

Aroclor-1016	ND		mg/kg	0.037	0.0066	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1221	ND		mg/kg	0.037	0.0033	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1232	ND		mg/kg	0.037	0.0066	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1242	ND		mg/kg	0.037	0.010	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1248	ND		mg/kg	0.037	0.0066	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1254	ND		mg/kg	0.037	0.0066	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1260	0.020J	J	mg/kg	0.037	0.0066	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1262	ND		mg/kg	0.037	0.0078	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Aroclor-1268	ND		mg/kg	0.037	0.010	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A

Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	94.5		%	46 - 120	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A
Tetrachloro-m-xylene (S)	84.6		%	52 - 115	SW846 8082A	6/10/15	KAC	6/10/15 15:39	EGO	A

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297001** Date Collected: 5/28/2015 16:10 Matrix: Solid

Sample ID: **R1504196-002** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Aldrin	ND		ug/kg	9.4	3.0	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
alpha-BHC	ND		ug/kg	9.4	0.83	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
beta-BHC	ND		ug/kg	9.4	1.0	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
delta-BHC	ND		ug/kg	9.4	0.72	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
gamma-BHC	ND		ug/kg	9.4	0.78	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
alpha-Chlordane	ND		ug/kg	9.4	1.0	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
gamma-Chlordane	ND		ug/kg	9.4	1.6	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
4,4'-DDD	ND		ug/kg	18.3	1.5	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
4,4'-DDE	ND		ug/kg	18.3	2.5	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
4,4'-DDT	ND		ug/kg	18.3	2.1	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Dieldrin	ND		ug/kg	18.3	2.1	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Endosulfan I	ND		ug/kg	9.4	1.2	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Endosulfan II	ND		ug/kg	18.3	3.8	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Endosulfan Sulfate	ND		ug/kg	18.3	1.2	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Endrin	ND		ug/kg	18.3	1.3	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Endrin Aldehyde	ND		ug/kg	18.3	2.0	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Endrin Ketone	ND		ug/kg	18.3	2.5	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Heptachlor	ND		ug/kg	9.4	0.94	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Heptachlor Epoxide	ND		ug/kg	9.4	0.94	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Methoxychlor	ND		ug/kg	18.3	2.4	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Toxaphene	ND		ug/kg	72.0	32.1	SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	62		%	30 - 135		SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
Tetrachloro-m-xylene (S)	55.3		%	30 - 111		SW846 8081B	6/10/15	KAC	6/12/15 12:13	RWS	A
WET CHEMISTRY											
Cyanide, Total	ND		mg/kg	0.30	0.11	SW846 9012B	6/9/15	SYB	6/10/15 13:46	LJF	A
Moisture	11.0		%	0.1	0.01	S2540G-11			6/4/15 10:03	JP	A
Total Solids	89.0		%	0.1	0.01	S2540G-11			6/4/15 10:03	JP	A
METALS											
Aluminum, Total	9630		mg/kg	9.7	3.2	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Antimony, Total	ND		mg/kg	1.9	0.65	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Arsenic, Total	3.6		mg/kg	1.9	0.65	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Barium, Total	56.1		mg/kg	0.97	0.32	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Beryllium, Total	0.40J	J	mg/kg	0.97	0.32	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Cadmium, Total	0.17J	J	mg/kg	0.48	0.16	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Calcium, Total	5830		mg/kg	9.7	3.2	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Chromium, Total	11.9		mg/kg	0.97	0.32	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297001** Date Collected: 5/28/2015 16:10 Matrix: Solid

Sample ID: **R1504196-002** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	*Cntr*
Cobalt, Total	4.8		mg/kg	0.97	0.32	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Copper, Total	7.4		mg/kg	1.9	0.65	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Iron, Total	13500		mg/kg	9.7	3.2	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Lead, Total	15.4		mg/kg	1.9	0.65	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Magnesium, Total	3310		mg/kg	9.7	3.2	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Manganese, Total	339		mg/kg	0.97	0.32	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Mercury, Total	0.055J	J	mg/kg	0.056	0.018	SW846 7471B	6/11/15	MNP	6/11/15 12:38	MNP	A2
Nickel, Total	10.6		mg/kg	1.9	0.65	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Potassium, Total	598		mg/kg	48.4	16.2	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Selenium, Total	ND		mg/kg	4.8	1.6	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Silver, Total	ND		mg/kg	0.48	0.16	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Sodium, Total	46.7J	J	mg/kg	48.4	16.2	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Thallium, Total	ND		mg/kg	2.9	0.97	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Vanadium, Total	20.2		mg/kg	0.97	0.32	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1
Zinc, Total	67.8		mg/kg	1.9	0.65	SW846 6010C	6/9/15	JPS	6/10/15 14:11	SRT	A1

Vanessa N. Badman

Mrs. Vanessa N Badman
Project Coordinator

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297002** Date Collected: 5/28/2015 16:15 Matrix: Solid

Sample ID: **R1504196-003** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS											
Acetone	ND		ug/kg	11.8	5.4	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Benzene	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Bromochloromethane	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Bromodichloromethane	ND		ug/kg	2.4	0.84	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Bromoform	ND		ug/kg	2.4	0.61	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Bromomethane	ND		ug/kg	2.4	0.61	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
2-Butanone	ND		ug/kg	11.8	3.8	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Carbon Disulfide	ND		ug/kg	2.4	0.74	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Carbon Tetrachloride	ND		ug/kg	2.4	0.60	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Chlorobenzene	ND		ug/kg	2.4	0.60	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Chlorodibromomethane	ND		ug/kg	2.4	0.80	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Chloroethane	ND		ug/kg	5.9	1.0	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Chloroform	ND		ug/kg	2.4	0.63	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Chloromethane	ND		ug/kg	2.4	0.65	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Cyclohexane	ND		ug/kg	2.4	0.60	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,2-Dibromo-3-chloropropane	ND		ug/kg	5.9	3.4	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,2-Dibromoethane	ND		ug/kg	2.4	0.64	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,2-Dichlorobenzene	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,3-Dichlorobenzene	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,4-Dichlorobenzene	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Dichlorodifluoromethane	ND		ug/kg	2.4	0.79	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,1-Dichloroethane	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,2-Dichloroethane	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,1-Dichloroethene	ND		ug/kg	2.4	0.61	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
cis-1,2-Dichloroethene	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
trans-1,2-Dichloroethene	ND		ug/kg	2.4	0.61	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,2-Dichloropropane	ND		ug/kg	2.4	0.71	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
cis-1,3-Dichloropropene	ND		ug/kg	2.4	0.65	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
trans-1,3-Dichloropropene	ND		ug/kg	2.4	0.69	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,4-Dioxane	ND		ug/kg	88.6	21.0	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Ethylbenzene	ND		ug/kg	2.4	0.80	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Freon 113	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
2-Hexanone	ND		ug/kg	11.8	3.3	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Isopropylbenzene	ND		ug/kg	2.4	0.72	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Methyl acetate	ND		ug/kg	2.4	0.70	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Methyl cyclohexane	ND		ug/kg	2.4	0.66	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297002** Date Collected: 5/28/2015 16:15 Matrix: Solid

Sample ID: **R1504196-003** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Methyl t-Butyl Ether	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
4-Methyl-2-Pentanone(MIBK)	ND		ug/kg	11.8	4.5	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Methylene Chloride	15.5	1	ug/kg	2.4	0.92	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Styrene	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,1,2,2-Tetrachloroethane	ND		ug/kg	2.4	0.66	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Tetrachloroethene	ND		ug/kg	2.4	0.71	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Toluene	ND		ug/kg	2.4	0.79	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,2,3-Trichlorobenzene	ND		ug/kg	5.9	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,2,4-Trichlorobenzene	ND		ug/kg	5.9	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,1,1-Trichloroethane	ND		ug/kg	2.4	0.73	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
1,1,2-Trichloroethane	ND		ug/kg	2.4	0.66	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Trichloroethene	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Trichlorofluoromethane	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Vinyl Chloride	ND		ug/kg	2.4	0.59	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
o-Xylene	ND		ug/kg	2.4	0.69	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
mp-Xylene	ND		ug/kg	4.7	0.98	SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	100		%	56 - 124		SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
4-Bromofluorobenzene (S)	104		%	51 - 128		SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Dibromofluoromethane (S)	109		%	62 - 123		SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
Toluene-d8 (S)	107		%	59 - 131		SW846 8260C	6/4/15	JPA	6/4/15 06:31	JPA	A
SEMIVOLATILES											
Acenaphthene	ND		ug/kg	110	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Acenaphthylene	ND		ug/kg	110	12.1	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Acetophenone	ND		ug/kg	110	11.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Anthracene	ND		ug/kg	110	11.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Atrazine	ND		ug/kg	110	28.7	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Benzaldehyde	ND		ug/kg	298	46.3	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Benzo(a)anthracene	ND		ug/kg	110	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Benzo(a)pyrene	ND		ug/kg	110	17.6	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Benzo(b)fluoranthene	ND		ug/kg	110	26.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Benzo(g,h,i)perylene	ND		ug/kg	110	23.2	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Benzo(k)fluoranthene	ND		ug/kg	110	21.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Biphenyl	ND		ug/kg	110	14.3	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
4-Bromophenyl-phenylether	ND		ug/kg	110	25.4	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Butylbenzylphthalate	ND		ug/kg	110	28.7	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Caprolactam	ND		ug/kg	298	80.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297002** Date Collected: 5/28/2015 16:15 Matrix: Solid

Sample ID: **R1504196-003** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Carbazole	ND		ug/kg	110	14.3	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
4-Chloro-3-methylphenol	ND		ug/kg	298	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
4-Chloroaniline	ND		ug/kg	298	148	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
bis(2-Chloroethoxy)methane	ND		ug/kg	110	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
bis(2-Chloroethyl)ether	ND		ug/kg	110	22.1	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
bis(2-Chloroisopropyl)ether	ND		ug/kg	110	27.6	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Chloronaphthalene	ND		ug/kg	110	15.4	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Chlorophenol	ND		ug/kg	298	19.9	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
4-Chlorophenyl-phenylether	ND		ug/kg	110	17.6	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Chrysene	16.1J	J	ug/kg	110	14.3	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
mp-Cresol	ND		ug/kg	298	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
o-Cresol	ND		ug/kg	298	24.3	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Di-n-Butylphthalate	ND		ug/kg	110	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Di-n-Octylphthalate	ND		ug/kg	298	43.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Dibenzo(a,h)anthracene	ND		ug/kg	110	13.2	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Dibenzofuran	ND		ug/kg	110	12.1	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
3,3-Dichlorobenzidine	ND		ug/kg	165	77.2	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,4-Dichlorophenol	ND		ug/kg	221	19.9	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Diethylphthalate	ND		ug/kg	110	14.3	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,4-Dimethylphenol	ND		ug/kg	298	84.9	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Dimethylphthalate	ND		ug/kg	110	17.6	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,4-Dinitrophenol	ND		ug/kg	221	70.6	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,4-Dinitrotoluene	ND		ug/kg	110	32.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,6-Dinitrotoluene	ND		ug/kg	110	26.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
1,4-Dioxane	ND		ug/kg	110	30.9	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
bis(2-Ethylhexyl)phthalate	ND		ug/kg	110	25.4	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Fluoranthene	25.6J	J	ug/kg	110	21.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Fluorene	ND		ug/kg	110	22.1	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Hexachlorobenzene	ND		ug/kg	110	21.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Hexachlorobutadiene	ND		ug/kg	110	28.7	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Hexachlorocyclopentadiene	ND		ug/kg	298	96.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Hexachloroethane	ND		ug/kg	110	18.8	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Indeno(1,2,3-cd)pyrene	ND		ug/kg	110	19.9	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Isophorone	ND		ug/kg	110	17.6	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Methyl-4,6-dinitrophenol	ND		ug/kg	298	64.0	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Methylnaphthalene	ND		ug/kg	110	17.6	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Naphthalene	ND		ug/kg	110	26.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Nitroaniline	ND		ug/kg	298	143	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297002** Date Collected: 5/28/2015 16:15 Matrix: Solid

Sample ID: **R1504196-003** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
3-Nitroaniline	ND		ug/kg	397	195	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
4-Nitroaniline	ND		ug/kg	309	154	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Nitrobenzene	ND		ug/kg	110	23.2	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Nitrophenol	ND		ug/kg	298	29.8	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
4-Nitrophenol	ND		ug/kg	298	111	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
N-Nitroso-di-n-propylamine	ND		ug/kg	110	18.8	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
N-Nitrosodiphenylamine	ND		ug/kg	110	18.8	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Pentachlorophenol	ND		ug/kg	221	39.7	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Phenanthrene	ND		ug/kg	110	15.4	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Phenol	ND		ug/kg	298	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Pyrene	19.9J	J	ug/kg	110	19.9	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
1,2,4,5-Tetrachlorobenzene	ND		ug/kg	110	16.5	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,3,4,6-Tetrachlorophenol	ND		ug/kg	298	23.2	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,4,5-Trichlorophenol	ND		ug/kg	298	22.1	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2,4,6-Trichlorophenol	ND		ug/kg	221	22.1	SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	88.4		%	37 - 123		SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Fluorobiphenyl (S)	77.3		%	45 - 105		SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
2-Fluorophenol (S)	74.7		%	35 - 104		SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Nitrobenzene-d5 (S)	76		%	41 - 110		SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Phenol-d5 (S)	75.5		%	40 - 100		SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
Terphenyl-d14 (S)	77		%	38 - 113		SW846 8270D	6/4/15	BS	6/4/15 11:48	GEC	A
PCBs											
Aroclor-1016	ND		mg/kg	0.037	0.0067	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1221	ND		mg/kg	0.037	0.0033	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1232	ND		mg/kg	0.037	0.0067	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1242	ND		mg/kg	0.037	0.010	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1248	ND		mg/kg	0.037	0.0067	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1254	ND		mg/kg	0.037	0.0067	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1260	ND		mg/kg	0.037	0.0067	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1262	ND		mg/kg	0.037	0.0078	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Aroclor-1268	ND		mg/kg	0.037	0.010	SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	93.7		%	46 - 120		SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
Tetrachloro-m-xylene (S)	80.6		%	52 - 115		SW846 8082A	6/10/15	KAC	6/10/15 15:51	EGO	A
PESTICIDES											

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297002** Date Collected: 5/28/2015 16:15 Matrix: Solid

Sample ID: **R1504196-003** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	Cntr
Aldrin	ND		ug/kg	9.4	3.1	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
alpha-BHC	ND		ug/kg	9.4	0.83	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
beta-BHC	ND		ug/kg	9.4	1.0	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
delta-BHC	ND		ug/kg	9.4	0.72	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
gamma-BHC	ND		ug/kg	9.4	0.78	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
alpha-Chlordane	ND		ug/kg	9.4	1.0	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
gamma-Chlordane	ND		ug/kg	9.4	1.6	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
4,4'-DDD	ND		ug/kg	18.3	1.5	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
4,4'-DDE	ND		ug/kg	18.3	2.5	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
4,4'-DDT	ND		ug/kg	18.3	2.1	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Dieldrin	ND		ug/kg	18.3	2.1	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Endosulfan I	ND		ug/kg	9.4	1.2	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Endosulfan II	ND		ug/kg	18.3	3.8	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Endosulfan Sulfate	ND		ug/kg	18.3	1.2	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Endrin	ND		ug/kg	18.3	1.3	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Endrin Aldehyde	ND		ug/kg	18.3	2.0	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Endrin Ketone	ND		ug/kg	18.3	2.6	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Heptachlor	ND		ug/kg	9.4	0.94	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Heptachlor Epoxide	ND		ug/kg	9.4	0.94	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Methoxychlor	ND		ug/kg	18.3	2.4	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Toxaphene	ND		ug/kg	72.2	32.2	SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*		*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	65.2		%	30 - 135		SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
Tetrachloro-m-xylene (S)	58.4		%	30 - 111		SW846 8081B	6/10/15	KAC	6/12/15 12:28	RWS	A
WET CHEMISTRY											
Cyanide, Total	ND		mg/kg	0.28	0.099	SW846 9012B	6/9/15	SYB	6/10/15 13:46	LJF	A
Moisture	9.9		%	0.1	0.01	S2540G-11			6/4/15 10:03	JP	A
Total Solids	90.1		%	0.1	0.01	S2540G-11			6/4/15 10:03	JP	A
METALS											
Aluminum, Total	10400		mg/kg	9.3	3.1	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Antimony, Total	ND		mg/kg	1.9	0.62	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Arsenic, Total	4.0		mg/kg	1.9	0.62	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Barium, Total	51.3		mg/kg	0.93	0.31	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Beryllium, Total	0.36J	J	mg/kg	0.93	0.31	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Cadmium, Total	ND		mg/kg	0.46	0.15	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Calcium, Total	2340		mg/kg	9.3	3.1	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Chromium, Total	11.8		mg/kg	0.93	0.31	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1

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NELAP Certifications: NJ PA010 , NY 11759 , PA 22-293 DoD ELAP: A2LA 0818.01
State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2074297 AER091|R1504196

Lab ID: **2074297002** Date Collected: 5/28/2015 16:15 Matrix: Solid

Sample ID: **R1504196-003** Date Received: 6/2/2015 09:00

Parameters	Results	Flag	Units	RDL	MDL	Method	Prepared	By	Analyzed	By	*Cntr*
Cobalt, Total	6.1		mg/kg	0.93	0.31	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Copper, Total	6.5		mg/kg	1.9	0.62	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Iron, Total	14500		mg/kg	9.3	3.1	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Lead, Total	16.5		mg/kg	1.9	0.62	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Magnesium, Total	2400		mg/kg	9.3	3.1	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Manganese, Total	449		mg/kg	0.93	0.31	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Mercury, Total	0.037J	J	mg/kg	0.049	0.016	SW846 7471B	6/11/15	MNP	6/11/15 12:39	MNP	A2
Nickel, Total	11.6		mg/kg	1.9	0.62	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Potassium, Total	806		mg/kg	46.3	15.5	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Selenium, Total	ND		mg/kg	4.6	1.5	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Silver, Total	ND		mg/kg	0.46	0.15	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Sodium, Total	44.5J	J	mg/kg	46.3	15.5	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Thallium, Total	ND		mg/kg	2.8	0.93	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Vanadium, Total	21.2		mg/kg	0.93	0.31	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1
Zinc, Total	61.9		mg/kg	1.9	0.62	SW846 6010C	6/9/15	JPS	6/10/15 14:14	SRT	A1

Vanessa N. Badman

Mrs. Vanessa N Badman
Project Coordinator

PARAMETER QUALIFIERS

Lab ID	#	Sample ID	Analytical Method	Analyte
2074297001	1	R1504196-002	SW846 8260C	Methylene Chloride
The QC sample type LCSD for method SW846 8260C was outside the control limits for the analyte Methylene Chloride. The % Recovery was reported as 134 and the control limits were 68 to 133.				
2074297002	1	R1504196-003	SW846 8260C	Methylene Chloride
The QC sample type LCSD for method SW846 8260C was outside the control limits for the analyte Methylene Chloride. The % Recovery was reported as 134 and the control limits were 68 to 133.				

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: EXTR/39545 **Analysis Method:** SW846 8270D

QC Batch Method: SW846 3546

Associated Lab Samples: 2074297001, 2074297002

METHOD BLANK: 2186556

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
1,4-Dioxane	ND	ug/kg	100	
Benzaldehyde	ND	ug/kg	270	
Phenol	ND	ug/kg	270	
bis(2-Chloroethyl)ether	ND	ug/kg	100	
2-Chlorophenol	ND	ug/kg	270	
bis(2-Chloroisopropyl)ether	ND	ug/kg	100	
o-Cresol	ND	ug/kg	270	
Acetophenone	ND	ug/kg	100	
N-Nitroso-di-n-propylamine	ND	ug/kg	100	
mp-Cresol	ND	ug/kg	270	
Hexachloroethane	ND	ug/kg	100	
Nitrobenzene	ND	ug/kg	100	
Isophorone	ND	ug/kg	100	
2-Nitrophenol	ND	ug/kg	270	
2,4-Dimethylphenol	ND	ug/kg	270	
bis(2-Chloroethoxy)methane	ND	ug/kg	100	
2,4-Dichlorophenol	ND	ug/kg	200	
Naphthalene	ND	ug/kg	100	
4-Chloroaniline	ND	ug/kg	270	
Hexachlorobutadiene	ND	ug/kg	100	
Caprolactam	ND	ug/kg	270	
4-Chloro-3-methylphenol	ND	ug/kg	270	
2-Methylnaphthalene	ND	ug/kg	100	
1,2,4,5-Tetrachlorobenzene	ND	ug/kg	100	
Hexachlorocyclopentadiene	ND	ug/kg	270	
2,4,6-Trichlorophenol	ND	ug/kg	200	
2,4,5-Trichlorophenol	ND	ug/kg	270	
Biphenyl	ND	ug/kg	100	
2-Chloronaphthalene	ND	ug/kg	100	
2-Nitroaniline	ND	ug/kg	270	
Dimethylphthalate	ND	ug/kg	100	
2,6-Dinitrotoluene	ND	ug/kg	100	
Acenaphthylene	ND	ug/kg	100	
3-Nitroaniline	ND	ug/kg	360	
Acenaphthene	ND	ug/kg	100	
2,4-Dinitrophenol	ND	ug/kg	200	
4-Nitrophenol	ND	ug/kg	270	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Dibenzofuran	ND	ug/kg	100
2,4-Dinitrotoluene	ND	ug/kg	100
2,3,4,6-Tetrachlorophenol	ND	ug/kg	270
Diethylphthalate	ND	ug/kg	100
4-Chlorophenyl-phenylether	ND	ug/kg	100
Fluorene	ND	ug/kg	100
4-Nitroaniline	ND	ug/kg	280
2-Methyl-4,6-dinitrophenol	ND	ug/kg	270
N-Nitrosodiphenylamine	ND	ug/kg	100
4-Bromophenyl-phenylether	ND	ug/kg	100
Hexachlorobenzene	ND	ug/kg	100
Atrazine	ND	ug/kg	100
Pentachlorophenol	ND	ug/kg	200
Phenanthrene	ND	ug/kg	100
Anthracene	ND	ug/kg	100
Carbazole	ND	ug/kg	100
Di-n-Butylphthalate	ND	ug/kg	100
Fluoranthene	ND	ug/kg	100
Pyrene	ND	ug/kg	100
Butylbenzylphthalate	ND	ug/kg	100
3,3-Dichlorobenzidine	ND	ug/kg	150
Benzo(a)anthracene	ND	ug/kg	100
Chrysene	ND	ug/kg	100
bis(2-Ethylhexyl)phthalate	ND	ug/kg	100
Di-n-Octylphthalate	ND	ug/kg	270
Benzo(b)fluoranthene	ND	ug/kg	100
Benzo(k)fluoranthene	ND	ug/kg	100
Benzo(a)pyrene	ND	ug/kg	100
Indeno(1,2,3-cd)pyrene	ND	ug/kg	100
Dibenzo(a,h)anthracene	ND	ug/kg	100
Benzo(g,h,i)perylene	ND	ug/kg	100
2,4,6-Tribromophenol (S)	96.8	%	37 - 123
2-Fluorobiphenyl (S)	81.4	%	45 - 105
2-Fluorophenol (S)	84.8	%	35 - 104
Nitrobenzene-d5 (S)	84.3	%	41 - 110
Phenol-d5 (S)	86.8	%	40 - 100
Terphenyl-d14 (S)	85.8	%	38 - 113

LABORATORY CONTROL SAMPLE: 2186557

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
1,4-Dioxane	79.3	ug/kg	3330	2640	14 - 63	
Benzaldehyde	93.2	ug/kg	3330	3110	29 - 133	
Phenol	96.2	ug/kg	6670	6410	36 - 119	
bis(2-Chloroethyl)ether	84.1	ug/kg	3330	2800	51 - 119	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

2-Chlorophenol	92.6	ug/kg	6670	6170	51 - 113
bis(2-Chloroisopropyl)ether	85.4	ug/kg	3330	2850	46 - 133
o-Cresol	93.6	ug/kg	6670	6240	56 - 109
Acetophenone	72.1	ug/kg	3330	2400	38 - 92
N-Nitroso-di-n-propylamine	88.3	ug/kg	3330	2940	46 - 118
mp-Cresol	94.5	ug/kg	6670	6300	50 - 111
Hexachloroethane	83.3	ug/kg	3330	2780	45 - 109
Nitrobenzene	85.2	ug/kg	3330	2840	56 - 111
Isophorone	83.8	ug/kg	3330	2790	54 - 114
2-Nitrophenol	99.3	ug/kg	6670	6620	59 - 108
2,4-Dimethylphenol	96.1	ug/kg	6670	6410	61 - 115
bis(2-Chloroethoxy)methane	83.1	ug/kg	3330	2770	57 - 116
2,4-Dichlorophenol	95.2	ug/kg	6670	6350	63 - 112
Naphthalene	86.9	ug/kg	3330	2900	68 - 117
4-Chloroaniline	68	ug/kg	3330	2270	15 - 105
Hexachlorobutadiene	98.9	ug/kg	3330	3300	48 - 133
Caprolactam	89.8	ug/kg	3330	2990	13 - 152
4-Chloro-3-methylphenol	97.1	ug/kg	6670	6470	60 - 113
2-Methylnaphthalene	86.3	ug/kg	3330	2880	61 - 105
1,2,4,5-Tetrachlorobenzene	88.5	ug/kg	3330	2950	50 - 108
Hexachlorocyclopentadiene	58.7	ug/kg	3330	1960	16 - 118
2,4,6-Trichlorophenol	99.4	ug/kg	6670	6630	60 - 121
2,4,5-Trichlorophenol	96.6	ug/kg	6670	6440	60 - 119
Biphenyl	90.1	ug/kg	3330	3000	60 - 104
2-Chloronaphthalene	86.9	ug/kg	3330	2900	62 - 110
2-Nitroaniline	111	ug/kg	3330	3700	64 - 119
Dimethylphthalate	87.4	ug/kg	3330	2910	63 - 109
2,6-Dinitrotoluene	103	ug/kg	3330	3450	65 - 117
Acenaphthylene	91.8	ug/kg	3330	3060	66 - 114
3-Nitroaniline	93.7	ug/kg	3330	3120	28 - 112
Acenaphthene	89.9	ug/kg	3330	3000	63 - 113
2,4-Dinitrophenol	89.8	ug/kg	6670	5990	45 - 130
4-Nitrophenol	111	ug/kg	6670	7380	36 - 139
Dibenzofuran	91.3	ug/kg	3330	3040	65 - 113
2,4-Dinitrotoluene	96.9	ug/kg	3330	3230	66 - 123
2,3,4,6-Tetrachlorophenol	91.8	ug/kg	6670	6120	47 - 122
Diethylphthalate	84.2	ug/kg	3330	2810	63 - 119
4-Chlorophenyl-phenylether	84.3	ug/kg	3330	2810	62 - 115
Fluorene	91.1	ug/kg	3330	3040	64 - 117
4-Nitroaniline	101	ug/kg	3330	3370	52 - 109
2-Methyl-4,6-dinitrophenol	102	ug/kg	6670	6770	61 - 119
N-Nitrosodiphenylamine	109	ug/kg	3330	3650	75 - 134
4-Bromophenyl-phenylether	86.8	ug/kg	3330	2890	63 - 117
Hexachlorobenzene	89.2	ug/kg	3330	2970	59 - 123
Atrazine	91.5	ug/kg	3330	3050	60 - 119
Pentachlorophenol	105	ug/kg	6670	7030	61 - 136

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Phenanthrene	90.4	ug/kg	3330	3010	68 - 117
Anthracene	92.8	ug/kg	3330	3090	67 - 114
Carbazole	105	ug/kg	3330	3510	66 - 118
Di-n-Butylphthalate	81.8	ug/kg	3330	2730	63 - 118
Fluoranthene	98.9	ug/kg	3330	3300	67 - 116
Pyrene	91.1	ug/kg	3330	3040	60 - 121
Butylbenzylphthalate	85	ug/kg	3330	2830	65 - 127
3,3-Dichlorobenzidine	60.8	ug/kg	6670	4050	12 - 103
Benzo(a)anthracene	91.2	ug/kg	3330	3040	66 - 117
Chrysene	93.3	ug/kg	3330	3110	67 - 120
bis(2-Ethylhexyl)phthalate	78.4	ug/kg	3330	2610	67 - 124
Di-n-Octylphthalate	70.1	ug/kg	3330	2340	65 - 127
Benzo(b)fluoranthene	91.4	ug/kg	3330	3050	64 - 120
Benzo(k)fluoranthene	89.6	ug/kg	3330	2990	65 - 119
Benzo(a)pyrene	90.9	ug/kg	3330	3030	64 - 118
Indeno(1,2,3-cd)pyrene	88.4	ug/kg	3330	2950	66 - 120
Dibenzo(a,h)anthracene	90.2	ug/kg	3330	3010	60 - 124
Benzo(g,h,i)perylene	91.8	ug/kg	3330	3060	65 - 119
2,4,6-Tribromophenol (S)	92.5	%			37 - 123
2-Fluorobiphenyl (S)	82.4	%			45 - 105
2-Fluorophenol (S)	90.3	%			35 - 104
Nitrobenzene-d5 (S)	86.3	%			41 - 110
Phenol-d5 (S)	89	%			40 - 100
Terphenyl-d14 (S)	79.2	%			38 - 113

MATRIX SPIKE SAMPLE: 2186558 ORIGINAL:

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MS % Rec	% Rec Limit	Qualifiers
1,4-Dioxane		ug/kg	3210	2312.74	72.2*	14 - 63	
Benzaldehyde		ug/kg	3210	3230.19	101	29 - 133	
Phenol	214.225	ug/kg	6410	6691.96	101	36 - 119	
bis(2-Chloroethyl)ether	0	ug/kg	3210	2821.79	88	51 - 119	
2-Chlorophenol	0	ug/kg	6410	6336.89	98.9	51 - 113	
bis(2-Chloroisopropyl)ether	0	ug/kg	3210	2843.27	88.7	46 - 133	
o-Cresol	160.575	ug/kg	6410	6811.73	104	56 - 109	
Acetophenone		ug/kg	3210	2608.03	81.4	38 - 92	
N-Nitroso-di-n-propylamine	0	ug/kg	3210	3213.99	100	46 - 118	
mp-Cresol	553.855	ug/kg	6410	6964.01	100	50 - 111	
Hexachloroethane	0	ug/kg	3210	2863.03	89.3	45 - 109	
Nitrobenzene	0	ug/kg	3210	2964.26	92.5	56 - 111	
Isophorone	0	ug/kg	3210	3174.33	99	54 - 114	
2-Nitrophenol	0	ug/kg	6410	6819.48	106	59 - 108	
2,4-Dimethylphenol	0	ug/kg	6410	7242.04	113	61 - 115	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

bis(2-Chloroethoxy)methane	0	ug/kg	3210	2911.16	90.8	57 - 116
2,4-Dichlorophenol	0	ug/kg	6410	7009.37	109	63 - 112
Naphthalene	1842.7	ug/kg	3210	3448.83	50.1*	68 - 117
4-Chloroaniline	0	ug/kg	3210	2749.17	85.8	15 - 105
Hexachlorobutadiene	0	ug/kg	3210	3347.14	104	48 - 133
Caprolactam		ug/kg	3210	10752.8	335*	13 - 152
4-Chloro-3-methylphenol	0	ug/kg	6410	7055.82	110	60 - 113
2-Methylnaphthalene	786.757	ug/kg	3210	3503.86	84.8	61 - 105
1,2,4,5-Tetrachlorobenzene		ug/kg	3210	3146.49	98.2	50 - 108
Hexachlorocyclopentadiene	0	ug/kg	3210	483.148	15.1*	16 - 118
2,4,6-Trichlorophenol	0	ug/kg	6410	7094.65	111	60 - 121
2,4,5-Trichlorophenol	0	ug/kg	6410	7229.87	113	60 - 119
Biphenyl		ug/kg	3210	3231.66	97.1	60 - 104
2-Chloronaphthalene	0	ug/kg	3210	3059.17	95.4	62 - 110
2-Nitroaniline	0	ug/kg	3210	3824.49	119	64 - 119
Dimethylphthalate	0	ug/kg	3210	2986.69	93.2	63 - 109
2,6-Dinitrotoluene	0	ug/kg	3210	3372.24	105	65 - 117
Acenaphthylene	253.382	ug/kg	3210	3288.27	94.7	66 - 114
3-Nitroaniline	0	ug/kg	3210	3721.55	116*	28 - 112
Acenaphthene	161.381	ug/kg	3210	3331.62	98.9	63 - 113
2,4-Dinitrophenol	0	ug/kg	6410	347.853	5.43*	45 - 130
4-Nitrophenol	0	ug/kg	6410	7298.68	114	36 - 139
Dibenzofuran	194.632	ug/kg	3210	3351.13	98.5	65 - 113
2,4-Dinitrotoluene	0	ug/kg	3210	3750.45	117	66 - 123
2,3,4,6-Tetrachlorophenol		ug/kg	6410	6043.94	94.3	47 - 122
Diethylphthalate	0	ug/kg	3210	2802.05	87.4	63 - 119
4-Chlorophenyl-phenylether	0	ug/kg	3210	3071.02	95.8	62 - 115
Fluorene	183.649	ug/kg	3210	3319.37	97.8	64 - 117
4-Nitroaniline	0	ug/kg	3210	3430.53	107	52 - 109
2-Methyl-4,6-dinitrophenol	0	ug/kg	6410	1435.75	22.4*	61 - 119
N-Nitrosodiphenylamine	0	ug/kg	3210	0	0*	75 - 134
4-Bromophenyl-phenylether	0	ug/kg	3210	3279.57	102	63 - 117
Hexachlorobenzene	0	ug/kg	3210	3263.61	102	59 - 123
Atrazine		ug/kg	3210	3245.01	101	60 - 119
Pentachlorophenol	0	ug/kg	6410	5969.35	93.1	61 - 136
Phenanthrene	1582.22	ug/kg	3210	3913.77	72.7	68 - 117
Anthracene	417.798	ug/kg	3210	3558.74	98	67 - 114
Carbazole	207.288	ug/kg	3210	3528.7	104	66 - 118
Di-n-Butylphthalate	0	ug/kg	3210	2814.6	87.8	63 - 118
Fluoranthene	2673.75	ug/kg	3210	4528.85	57.9*	67 - 116
Pyrene	2766.05	ug/kg	3210	4863.02	65.4	60 - 121
Butylbenzylphthalate	0	ug/kg	3210	2884.14	90	65 - 127
3,3-Dichlorobenzidine	0	ug/kg	6410	5360.01	83.6	12 - 103
Benzo(a)anthracene	1235.73	ug/kg	3210	3710.18	77.2	66 - 117
Chrysene	1414.52	ug/kg	3210	3864.89	76.5	67 - 120
bis(2-Ethylhexyl)phthalate	87.3168	ug/kg	3210	2674.08	80.7	67 - 124

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Di-n-Octylphthalate	0	ug/kg	3210	2360.9	73.7	65 - 127
Benzo(b)fluoranthene	1554.28	ug/kg	3210	3807.33	70.3	64 - 120
Benzo(k)fluoranthene	617.578	ug/kg	3210	3318.46	84.3	65 - 119
Benzo(a)pyrene	1221.38	ug/kg	3210	3680.67	76.7	64 - 118
Indeno(1,2,3-cd)pyrene	784.63	ug/kg	3210	3287.04	78.1	66 - 120
Dibenzo(a,h)anthracene	231.157	ug/kg	3210	3143.54	90.9	60 - 124
Benzo(g,h,i)perylene	815.519	ug/kg	3210	3308.28	77.8	65 - 119
2,4,6-Tribromophenol (S)	107	%				37 - 123
2-Fluorobiphenyl (S)	89.9	%				45 - 105
2-Fluorophenol (S)	93.3	%				35 - 104
Nitrobenzene-d5 (S)	93.6	%				41 - 110
Phenol-d5 (S)	97.4	%				40 - 100
Terphenyl-d14 (S)	87.3	%				38 - 113

SAMPLE DUPLICATE: 2186559 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
1,4-Dioxane		ug/kg	0	NC	30	
Benzaldehyde		ug/kg	0	NC	30	
Phenol	0	ug/kg	0	NC	23	
bis(2-Chloroethyl)ether	0	ug/kg	0	NC	24	
2-Chlorophenol	0	ug/kg	0	NC	22	
bis(2-Chloroisopropyl)ether	0	ug/kg	0	NC	22	
o-Cresol	0	ug/kg	0	NC	21	
Acetophenone		ug/kg	0	NC	21	
N-Nitroso-di-n-propylamine	0	ug/kg	0	NC	20	
mp-Cresol	0	ug/kg	0	NC	20	
Hexachloroethane	0	ug/kg	0	NC	28	
Nitrobenzene	0	ug/kg	0	NC	20	
Isophorone	0	ug/kg	0	NC	19	
2-Nitrophenol	0	ug/kg	0	NC	23	
2,4-Dimethylphenol	0	ug/kg	0	NC	23	
bis(2-Chloroethoxy)methane	0	ug/kg	0	NC	18	
2,4-Dichlorophenol	0	ug/kg	0	NC	20	
Naphthalene	191.82	ug/kg	141.539	30.2*	21	
4-Chloroaniline	0	ug/kg	0	NC	22	
Hexachlorobutadiene	0	ug/kg	0	NC	22	
Caprolactam		ug/kg	0	NC	23	
4-Chloro-3-methylphenol	0	ug/kg	0	NC	20	
2-Methylnaphthalene	84.9186	ug/kg	35.7448	81.5*	21	
1,2,4,5-Tetrachlorobenzene		ug/kg	0	NC	19	
Hexachlorocyclopentadiene	0	ug/kg	0	NC	29	
2,4,6-Trichlorophenol	0	ug/kg	0	NC	20	
2,4,5-Trichlorophenol	0	ug/kg	0	NC	22	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Biphenyl		ug/kg	0	NC	14
2-Chloronaphthalene	0	ug/kg	0	NC	19
2-Nitroaniline	0	ug/kg	0	NC	19
Dimethylphthalate	0	ug/kg	0	NC	18
2,6-Dinitrotoluene	0	ug/kg	0	NC	20
Acenaphthylene	80.6595	ug/kg	49.5758	47.7*	17
3-Nitroaniline	0	ug/kg	0	NC	22
Acenaphthene	50.5988	ug/kg	29.4782	52.8*	17
2,4-Dinitrophenol	0	ug/kg	0	NC	30
4-Nitrophenol	0	ug/kg	0	NC	21
Dibenzofuran	70.1529	ug/kg	41.4945	51.3*	18
2,4-Dinitrotoluene	0	ug/kg	0	NC	21
2,3,4,6-Tetrachlorophenol		ug/kg	0	NC	20
Diethylphthalate	0	ug/kg	0	NC	18
4-Chlorophenyl-phenylether	0	ug/kg	0	NC	18
Fluorene	55.314	ug/kg	0	NC	16
4-Nitroaniline	0	ug/kg	0	NC	19
2-Methyl-4,6-dinitrophenol	0	ug/kg	0	NC	30
N-Nitrosodiphenylamine	0	ug/kg	0	NC	21
4-Bromophenyl-phenylether	0	ug/kg	0	NC	21
Hexachlorobenzene	0	ug/kg	0	NC	21
Atrazine		ug/kg	0	NC	22
Pentachlorophenol	0	ug/kg	0	NC	25
Phenanthrene	669.058	ug/kg	479.874	32.9*	20
Anthracene	186.943	ug/kg	143.849	26.1*	20
Carbazole	69.8169	ug/kg	52.4621	28.4*	20
Di-n-Butylphthalate	0	ug/kg	0	NC	20
Fluoranthene	1338.27	ug/kg	1003.85	28.6*	21
Pyrene	1390.07	ug/kg	1031.39	29.6*	20
Butylbenzylphthalate	0	ug/kg	0	NC	18
3,3-Dichlorobenzidine	0	ug/kg	0	NC	26
Benzo(a)anthracene	895.611	ug/kg	644.284	32.6*	22
Chrysene	969.058	ug/kg	757.189	24.5*	20
bis(2-Ethylhexyl)phthalate	151.726	ug/kg	113.872	28.5*	21
Di-n-Octylphthalate	0	ug/kg	0	NC	20
Benzo(b)fluoranthene	1378.21	ug/kg	1061.06	26	28
Benzo(k)fluoranthene	516.969	ug/kg	387.305	28.7*	22
Benzo(a)pyrene	990.876	ug/kg	739.047	29.1*	24
Indeno(1,2,3-cd)pyrene	793.958	ug/kg	568.699	33.1*	30
Dibenzo(a,h)anthracene	207.113	ug/kg	145.971	34.6*	28
Benzo(g,h,i)perylene	806.927	ug/kg	591.112	30.9*	30
2,4,6-Tribromophenol (S)	6377.51	%	5550.85	13.9	
2-Fluorobiphenyl (S)	2682.47	%	2508.4	6.71	
2-Fluorophenol (S)	4475.69	%	4500.31	.55	
Nitrobenzene-d5 (S)	2455.12	%	2514.36	2.38	
Phenol-d5 (S)	5083.38	%	4886	3.96	
Terphenyl-d14 (S)	2948.48	%	2504.4	16.3	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: EXTR/39624 **Analysis Method:** SW846 8082A

QC Batch Method: SW846 3546

Associated Lab Samples: 2074297001, 2074297002

METHOD BLANK: 2189121

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Aroclor-1016	ND	mg/kg	0.033	
Aroclor-1221	ND	mg/kg	0.033	
Aroclor-1232	ND	mg/kg	0.033	
Aroclor-1242	ND	mg/kg	0.033	
Aroclor-1248	ND	mg/kg	0.033	
Aroclor-1254	ND	mg/kg	0.033	
Aroclor-1260	ND	mg/kg	0.033	
Decachlorobiphenyls (S)	91.8	%	46 - 120	
Tetrachloro-m-xylene (S)	89.2	%	52 - 115	

LABORATORY CONTROL SAMPLE: 2189122

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Aroclor-1016	85.8	mg/kg	.33	0.29	43 - 132	
Aroclor-1221		mg/kg		ND		
Aroclor-1232		mg/kg		ND		
Aroclor-1242		mg/kg		ND		
Aroclor-1248		mg/kg		ND		
Aroclor-1254		mg/kg		ND		
Aroclor-1260	90.3	mg/kg	.33	0.30	53 - 134	
Decachlorobiphenyls (S)	98.7	%			46 - 120	
Tetrachloro-m-xylene (S)	90.4	%			52 - 115	

SAMPLE DUPLICATE: 2189124 ORIGINAL: 2074297002

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Aroclor-1016	0	mg/kg	0	NC	40	
Aroclor-1221	0	mg/kg	0	NC	40	
Aroclor-1232	0	mg/kg	0	NC	40	
Aroclor-1242	0	mg/kg	0	NC	40	
Aroclor-1248	0	mg/kg	0	NC	40	
Aroclor-1254	0	mg/kg	0	NC	40	
Aroclor-1260	0	mg/kg	0	NC	40	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Decachlorobiphenyls (S)	.07808	%	.06716	15
Tetrachloro-m-xylene (S)	.06713	%	.05696	16.4

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: EXTR/39625 **Analysis Method:** SW846 8081B

QC Batch Method: SW846 3546

Associated Lab Samples: 2074297001, 2074297002

METHOD BLANK: 2189125

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
alpha-BHC	ND	ug/kg	1.7	
beta-BHC	ND	ug/kg	1.7	
gamma-BHC	ND	ug/kg	1.7	
delta-BHC	ND	ug/kg	1.7	
Heptachlor	ND	ug/kg	1.7	
Aldrin	ND	ug/kg	1.7	
Heptachlor Epoxide	ND	ug/kg	1.7	
alpha-Chlordane	ND	ug/kg	1.7	
Endosulfan I	ND	ug/kg	1.7	
gamma-Chlordane	ND	ug/kg	1.7	
Dieldrin	ND	ug/kg	3.3	
4,4'-DDE	ND	ug/kg	3.3	
Endrin	ND	ug/kg	3.3	
Endosulfan II	ND	ug/kg	3.3	
4,4'-DDD	ND	ug/kg	3.3	
Endrin Aldehyde	ND	ug/kg	3.3	
Endosulfan Sulfate	ND	ug/kg	3.3	
4,4'-DDT	ND	ug/kg	3.3	
Endrin Ketone	ND	ug/kg	3.3	
Methoxychlor	ND	ug/kg	3.3	
Toxaphene	ND	ug/kg	13.0	
Decachlorobiphenyls (S)	73.1	%	30 - 135	
Tetrachloro-m-xylene (S)	54.6	%	30 - 111	

LABORATORY CONTROL SAMPLE: 2189126

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
alpha-BHC	59.9	ug/kg	33.3	20.0	57 - 105	
beta-BHC	61.7	ug/kg	33.3	20.6	53 - 106	
gamma-BHC	60.7	ug/kg	33.3	20.2	59 - 102	
delta-BHC	65.9	ug/kg	33.3	22.0	60 - 103	
Heptachlor	61.3	ug/kg	33.3	20.4	51 - 105	
Aldrin	63.1	ug/kg	33.3	21.0	58 - 103	
Heptachlor Epoxide	63.5	ug/kg	33.3	21.2	62 - 99	
alpha-Chlordane	63.4	ug/kg	33.3	21.1	62 - 98	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Endosulfan I	63.9	ug/kg	33.3	21.3	57 - 98
gamma-Chlordane	62.4	ug/kg	33.3	20.8	58 - 103
Dieldrin	65.8	ug/kg	33.3	21.9	62 - 109
4,4'-DDE	75.4	ug/kg	33.3	25.1	63 - 112
Endrin	72	ug/kg	33.3	24.0	63 - 108
Endosulfan II	85.3	ug/kg	33.3	28.4	59 - 112
4,4'-DDD	68.2	ug/kg	33.3	22.7	57 - 111
Endrin Aldehyde	55.1	ug/kg	33.3	18.4	21 - 92
Endosulfan Sulfate	69.6	ug/kg	33.3	23.2	27 - 96
4,4'-DDT	78.7	ug/kg	33.3	26.2	60 - 122
Endrin Ketone	65.3	ug/kg	33.3	21.8	32 - 103
Methoxychlor	85.7	ug/kg	33.3	28.6	50 - 114
Toxaphene		ug/kg		ND	
Decachlorobiphenyls (S)	60.8	%			30 - 135
Tetrachloro-m-xylene (S)	47.5	%			30 - 111

SAMPLE DUPLICATE: 2189128 ORIGINAL: 2074297002

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
alpha-BHC	0	ug/kg	0	NC	40	
beta-BHC	0	ug/kg	0	NC	40	
gamma-BHC	0	ug/kg	0	NC	40	
delta-BHC	0	ug/kg	0	NC	40	
Heptachlor	0	ug/kg	0	NC	40	
Aldrin	0	ug/kg	0	NC	40	
Heptachlor Epoxide	0	ug/kg	0	NC	35	
alpha-Chlordane	0	ug/kg	0	NC	40	
Endosulfan I	0	ug/kg	0	NC	40	
gamma-Chlordane	0	ug/kg	0	NC	40	
Dieldrin	0	ug/kg	0	NC	40	
4,4'-DDE	0	ug/kg	0	NC	40	
Endrin	0	ug/kg	0	NC	40	
Endosulfan II	0	ug/kg	0	NC	40	
4,4'-DDD	0	ug/kg	0	NC	40	
Endrin Aldehyde	0	ug/kg	0	NC	40	
Endosulfan Sulfate	0	ug/kg	0	NC	40	
4,4'-DDT	0	ug/kg	0	NC	40	
Endrin Ketone	0	ug/kg	0	NC	40	
Methoxychlor	0	ug/kg	0	NC	40	
Toxaphene	0	ug/kg	0	NC	40	
Decachlorobiphenyls (S)	54.3675	%	46.3242	16	40	
Tetrachloro-m-xylene (S)	48.6886	%	41.4851	16	40	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: MDIG/51218 **Analysis Method:** SW846 6010C

QC Batch Method: SW846 3051

Associated Lab Samples: 2074297001, 2074297002

METHOD BLANK: 2188908

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Aluminum, Total	ND	mg/kg	10.0	
Antimony, Total	ND	mg/kg	2.0	
Arsenic, Total	ND	mg/kg	2.0	
Barium, Total	ND	mg/kg	1.0	
Beryllium, Total	ND	mg/kg	1.0	
Cadmium, Total	ND	mg/kg	0.50	
Calcium, Total	6.9J	mg/kg	10.0	
Chromium, Total	ND	mg/kg	1.0	
Cobalt, Total	ND	mg/kg	1.0	
Copper, Total	ND	mg/kg	2.0	
Iron, Total	ND	mg/kg	10.0	
Lead, Total	ND	mg/kg	2.0	
Magnesium, Total	ND	mg/kg	10.0	
Manganese, Total	ND	mg/kg	1.0	
Nickel, Total	ND	mg/kg	2.0	
Selenium, Total	ND	mg/kg	5.0	
Silver, Total	ND	mg/kg	0.50	
Thallium, Total	ND	mg/kg	3.0	
Vanadium, Total	ND	mg/kg	1.0	
Zinc, Total	ND	mg/kg	2.0	
Sodium, Total	ND	mg/kg	50.0	
Potassium, Total	ND	mg/kg	50.0	

LABORATORY CONTROL SAMPLE: 2188909

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Aluminum, Total	105	mg/kg	100	105	80 - 120	
Antimony, Total	99.1	mg/kg	40	39.6	80 - 120	
Arsenic, Total	98.3	mg/kg	40	39.3	80 - 120	
Barium, Total	100	mg/kg	100	100	80 - 120	
Beryllium, Total	99	mg/kg	40	39.6	80 - 120	
Cadmium, Total	95.8	mg/kg	20	19.2	80 - 120	
Calcium, Total	101	mg/kg	500	507	80 - 120	
Chromium, Total	99.4	mg/kg	20	19.9	80 - 120	
Cobalt, Total	101	mg/kg	100	101	80 - 120	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Copper, Total	101	mg/kg	100	101	80 - 120
Iron, Total	101	mg/kg	1000	1010	80 - 120
Lead, Total	101	mg/kg	100	101	80 - 120
Magnesium, Total	101	mg/kg	500	506	80 - 120
Manganese, Total	101	mg/kg	20	20.1	80 - 120
Nickel, Total	101	mg/kg	100	101	80 - 120
Selenium, Total	98.8	mg/kg	100	98.8	80 - 120
Silver, Total	102	mg/kg	20	20.4	80 - 120
Thallium, Total	104	mg/kg	100	104	80 - 120
Vanadium, Total	99.6	mg/kg	20	19.9	80 - 120
Zinc, Total	100	mg/kg	100	100	80 - 120
Sodium, Total	102	mg/kg	500	511	80 - 120
Potassium, Total	101	mg/kg	500	506	80 - 120

MATRIX SPIKE: 2188911 DUPLICATE: 2188912 ORIGINAL: 2074645003

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Aluminum, Total		mg/kg		271.8012	281.6479				3.56	20	
Antimony, Total		mg/kg		2.5354	2.64045				4.06	20	
Arsenic, Total	.0855	mg/kg	2.5	2.5354	2.63795	98.6	102	75 - 125	3.96	20	
Barium, Total		mg/kg		10.37267	10.81149				4.14	20	
Beryllium, Total		mg/kg		2.39752	2.50562				4.41	20	
Cadmium, Total		mg/kg		1.18137	1.22784				3.86	20	
Calcium, Total		mg/kg		346.5838	359.0511				3.53	20	
Chromium, Total		mg/kg		1.51739	1.58302				4.23	20	
Cobalt, Total		mg/kg		5.9882	6.26092				4.45	20	
Copper, Total		mg/kg		15.57143	15.799				1.45	20	
Iron, Total		mg/kg		158.1987	163.8576				3.51	20	
Lead, Total		mg/kg		6.28571	6.42946				2.26	20	
Magnesium, Total		mg/kg		87.3913	90.6367				3.65	20	
Manganese, Total		mg/kg		13.13043	13.50811				2.84	20	
Nickel, Total		mg/kg		6.15466	6.44819				4.66	20	
Selenium, Total		mg/kg		6.86335	7.1161				3.62	20	
Silver, Total		mg/kg		1.27081	1.32335				4.05	20	
Thallium, Total		mg/kg		6.10124	6.37328				4.36	20	
Vanadium, Total		mg/kg		1.39503	1.45318				4.08	20	
Zinc, Total		mg/kg		15.32298	15.81149				3.14	20	
Sodium, Total		mg/kg		154.7826	160.3620				3.54	20	
Potassium, Total		mg/kg		90.43478	93.88265				3.74	20	

ALS Environmental

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: MDIG/51264 **Analysis Method:** SW846 7471B

QC Batch Method: SW846 7471B

Associated Lab Samples: 2074297001, 2074297002

METHOD BLANK: 2190217

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Mercury, Total	ND	mg/kg	0.050	

LABORATORY CONTROL SAMPLE: 2190218

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Mercury, Total	102	mg/kg	.4	0.41	80 - 120	

MATRIX SPIKE: 2190219 DUPLICATE: 2190220 ORIGINAL: 2073996004

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Mercury, Total	.07655	mg/kg	.91	.83818	.90377	83.8	87.7	80 - 120	7.53	20	

MATRIX SPIKE: 2190221 DUPLICATE: 2190222 ORIGINAL: 2075627009

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Mercury, Total	.01887	mg/kg	.94	.89434	.92453	92.8	96	80 - 120	3.32	20	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: VOMS/36123 **Analysis Method:** SW846 8260C

QC Batch Method: SW846 5035

Associated Lab Samples: 2074297001, 2074297002

METHOD BLANK: 2186667

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Dichlorodifluoromethane	ND	ug/kg	2.0	
Chloromethane	ND	ug/kg	2.0	
Vinyl Chloride	ND	ug/kg	2.0	
Bromomethane	ND	ug/kg	2.0	
Chloroethane	ND	ug/kg	5.0	
Trichlorofluoromethane	ND	ug/kg	2.0	
Acetone	5.7J	ug/kg	10.0	
1,1-Dichloroethene	ND	ug/kg	2.0	
Methylene Chloride	ND	ug/kg	2.0	
Methyl acetate	ND	ug/kg	2.0	
Freon 113	ND	ug/kg	2.0	
Carbon Disulfide	ND	ug/kg	2.0	
trans-1,2-Dichloroethene	ND	ug/kg	2.0	
Methyl t-Butyl Ether	ND	ug/kg	2.0	
1,1-Dichloroethane	ND	ug/kg	2.0	
2-Butanone	ND	ug/kg	10.0	
cis-1,2-Dichloroethene	ND	ug/kg	2.0	
Bromochloromethane	ND	ug/kg	2.0	
Chloroform	ND	ug/kg	2.0	
1,2-Dichloroethane	ND	ug/kg	2.0	
1,1,1-Trichloroethane	ND	ug/kg	2.0	
Cyclohexane	ND	ug/kg	2.0	
Carbon Tetrachloride	ND	ug/kg	2.0	
Benzene	ND	ug/kg	2.0	
1,2-Dichloropropane	ND	ug/kg	2.0	
Trichloroethene	ND	ug/kg	2.0	
Bromodichloromethane	ND	ug/kg	2.0	
1,4-Dioxane	ND	ug/kg	75.0	
Methyl cyclohexane	ND	ug/kg	2.0	
cis-1,3-Dichloropropene	ND	ug/kg	2.0	
4-Methyl-2-Pentanone(MIBK)	ND	ug/kg	10.0	
trans-1,3-Dichloropropene	ND	ug/kg	2.0	
1,1,2-Trichloroethane	ND	ug/kg	2.0	
Toluene	ND	ug/kg	2.0	
2-Hexanone	ND	ug/kg	10.0	
Chlorodibromomethane	ND	ug/kg	2.0	
1,2-Dibromoethane	ND	ug/kg	2.0	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Tetrachloroethene	ND	ug/kg	2.0
Chlorobenzene	ND	ug/kg	2.0
Ethylbenzene	ND	ug/kg	2.0
mp-Xylene	ND	ug/kg	4.0
Bromoform	ND	ug/kg	2.0
Styrene	ND	ug/kg	2.0
1,1,2,2-Tetrachloroethane	ND	ug/kg	2.0
o-Xylene	ND	ug/kg	2.0
Isopropylbenzene	ND	ug/kg	2.0
1,3-Dichlorobenzene	ND	ug/kg	2.0
1,4-Dichlorobenzene	ND	ug/kg	2.0
1,2-Dichlorobenzene	ND	ug/kg	2.0
1,2-Dibromo-3-chloropropane	ND	ug/kg	5.0
1,2,4-Trichlorobenzene	ND	ug/kg	5.0
1,2,3-Trichlorobenzene	ND	ug/kg	5.0
1,2-Dichloroethane-d4 (S)	96	%	56 - 124
4-Bromofluorobenzene (S)	106	%	51 - 128
Dibromofluoromethane (S)	106	%	62 - 123
Toluene-d8 (S)	109	%	59 - 131

LABORATORY CONTROL SAMPLE: 2186668 DUPLICATE: 2186669

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	LCSD Result	LCSD % Rec	% Rec Limit	RPD	Max	Qualifi
Dichlorodifluoromethane	11.0	ug/kg	20	11.1	11.0	54.8	16 - 152	1.33	40	
Chloromethane	13.9	ug/kg	20	14.5	13.9	69.5	44 - 139	4.4	40	
Vinyl Chloride	15.5	ug/kg	20	16.2	15.5	77.3	53 - 141	4.9	40	
Bromomethane	15.6	ug/kg	20	15.8	15.6	78	43 - 148	1.49	40	
Chloroethane	17.3	ug/kg	20	17.7	17.3	86.3	1 - 141	2.64	40	
Trichlorofluoromethane	17.8	ug/kg	20	18.0	17.8	89.1	40 - 130	.79	40	
Acetone	108	ug/kg	100	103	108	108	58 - 146	5.53	40	
1,1-Dichloroethene	23.4	ug/kg	20	23.6	23.4	117	59 - 139	.65	40	
Methylene Chloride	26.9	ug/kg	20	23.7	26.9	134	68 - 133	12.5	40	
Methyl acetate	55.2	ug/kg	20	49.8	55.2	276	70 - 130	10.3	40	*
Freon 113	25.1	ug/kg	20	25.3	25.1	125	40 - 109	.85	40	*
Carbon Disulfide	22.1	ug/kg	20	21.8	22.1	110	47 - 144	1.28	40	
trans-1,2-Dichloroethene	23.8	ug/kg	20	23.7	23.8	119	66 - 133	.24	40	
Methyl t-Butyl Ether	20.3	ug/kg	20	19.8	20.3	101	70 - 118	2.51	40	
1,1-Dichloroethane	22.2	ug/kg	20	21.5	22.2	111	74 - 131	2.88	40	
2-Butanone	84.1	ug/kg	100	82.2	84.1	84.1	64 - 148	2.32	40	
cis-1,2-Dichloroethene	22.5	ug/kg	20	22.1	22.5	113	75 - 128	2.03	40	
Bromochloromethane	22.5	ug/kg	20	21.9	22.5	113	71 - 120	2.75	40	
Chloroform	21.5	ug/kg	20	21.4	21.5	107	73 - 126	.23	40	
1,2-Dichloroethane	22.0	ug/kg	20	21.8	22.0	110	69 - 132	1.11	40	
1,1,1-Trichloroethane	22.0	ug/kg	20	21.8	22.0	110	68 - 131	.67	40	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

Cyclohexane	24.5	ug/kg	20	23.9	24.5	122	62 - 143	2.31	40
Carbon Tetrachloride	22.6	ug/kg	20	25.5	22.6	113	64 - 136	12.1	40
Benzene	23.1	ug/kg	20	22.5	23.1	115	75 - 132	2.49	40
1,2-Dichloropropane	22.1	ug/kg	20	21.3	22.1	110	78 - 131	3.56	40
Trichloroethene	22.1	ug/kg	20	22.0	22.1	110	72 - 129	.27	40
Bromodichloromethane	21.3	ug/kg	20	21.1	21.3	106	74 - 127	1	40
1,4-Dioxane	533	ug/kg	500	492	533	107	9 - 267	8.1	40
Methyl cyclohexane	25.4	ug/kg	20	24.7	25.4	127	70 - 130	2.84	40
cis-1,3-Dichloropropene	20.6	ug/kg	20	19.6	20.6	103	76 - 123	4.89	40
4-Methyl-2-Pentanone(MIBK)	94.8	ug/kg	100	86.4	94.8	94.8	64 - 143	9.21	40
trans-1,3-Dichloropropene	16.9	ug/kg	20	15.9	16.9	84.5	77 - 123	6.26	40
1,1,2-Trichloroethane	20.3	ug/kg	20	19.4	20.3	102	79 - 123	4.87	40
Toluene	20.2	ug/kg	20	19.8	20.2	101	73 - 129	2.01	40
2-Hexanone	83.3	ug/kg	100	75.1	83.3	83.3	62 - 147	10.5	40
Chlorodibromomethane	20.8	ug/kg	20	20.0	20.8	104	75 - 124	3.81	40
1,2-Dibromoethane	20.7	ug/kg	20	20.4	20.7	103	76 - 127	1.53	40
Tetrachloroethene	21.5	ug/kg	20	21.5	21.5	108	58 - 137	.12	40
Chlorobenzene	21.3	ug/kg	20	20.4	21.3	106	76 - 125	4.09	40
Ethylbenzene	21.3	ug/kg	20	20.6	21.3	106	73 - 133	3.09	40
mp-Xylene	41.8	ug/kg	40	40.7	41.8	104	72 - 130	2.54	40
Bromoform	19.1	ug/kg	20	18.6	19.1	95.4	68 - 131	2.25	40
Styrene	20.4	ug/kg	20	19.8	20.4	102	77 - 130	2.78	40
1,1,2,2-Tetrachloroethane	19.5	ug/kg	20	18.5	19.5	97.7	72 - 134	5.4	40
o-Xylene	20.3	ug/kg	20	19.6	20.3	102	75 - 129	3.36	40
Isopropylbenzene	20.7	ug/kg	20	20.2	20.7	104	71 - 137	2.78	40
1,3-Dichlorobenzene	20.4	ug/kg	20	19.9	20.4	102	72 - 127	2.22	40
1,4-Dichlorobenzene	20.0	ug/kg	20	19.8	20.0	100	72 - 126	.9	40
1,2-Dichlorobenzene	20.4	ug/kg	20	19.3	20.4	102	75 - 126	5.63	40
1,2-Dibromo-3-chloropropane	18.3	ug/kg	20	17.8	18.3	91.7	52 - 151	2.95	40
1,2,4-Trichlorobenzene	19.4	ug/kg	20	18.1	19.4	97.2	63 - 132	7.13	40
1,2,3-Trichlorobenzene	19.1	ug/kg	20	16.8	19.1	95.6	68 - 129	12.9	40
1,2-Dichloroethane-d4 (S)	98.1	%			98.1		56 - 124	.47	
4-Bromofluorobenzene (S)	103	%			103		51 - 128	.25	
Dibromofluoromethane (S)	106	%			106		62 - 123	1.33	
Toluene-d8 (S)	107	%			107		59 - 131	2.42	

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: WCPR/32445 **Analysis Method:** SW846 9012B

QC Batch Method: SW846 9012B

Associated Lab Samples: 2074297001, 2074297002

METHOD BLANK: 2188883

Parameter	Blank Result	Units	Reporting Limit	Qualifiers
Cyanide, Total	ND	mg/kg	0.25	

LABORATORY CONTROL SAMPLE: 2188884

Parameter	LCS % Rec	Units	Spike Conc.	LCS Result	% Rec Limit	Qualifiers
Cyanide, Total	107	mg/kg	6.2	6.6	90 - 110	

MATRIX SPIKE: 2188885 DUPLICATE: 2188886 ORIGINAL: 2075103002

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Cyanide, Total	-.05	mg/kg	5.1	5.80808	5.44554	116	111	80 - 120	6.44	20	

MATRIX SPIKE SAMPLE: 2188887 ORIGINAL:

****NOTE - The Original Result shown below is a raw result and is only used for the purpose of calculating Matrix Spike percent recoveries. This result is not a final value and cannot be used as such.

Parameter	Original Result	Units	Spike Conc.	MS Result	MS % Rec	% Rec Limit	Qualifiers
Cyanide, Total	-.05051	mg/kg	5	5.64356	115	80 - 120	

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

QC Batch: WETC/154975 **Analysis Method:** S2540G-11

QC Batch Method: S2540G-11

Associated Lab Samples: 2074297001, 2074297002

SAMPLE DUPLICATE: 2186876 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	11.5907	%	10.3548	11.3*	10	
Total Solids	88.4092	%	89.6451	1.39	5	

SAMPLE DUPLICATE: 2186877 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	11.349	%	13.4886	17.2*	10	
Total Solids	88.6509	%	86.5113	2.44	5	

SAMPLE DUPLICATE: 2186878 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	1.2158	%	1.6447	30*	10	
Total Solids	98.7841	%	98.3552	.44	5	

SAMPLE DUPLICATE: 2186880 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	10.8848	%	10.8771	.07	10	
Total Solids	89.1151	%	89.1228	.009	5	

SAMPLE DUPLICATE: 2186881 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	16.8787	%	18.6518	9.98	10	
Total Solids	83.1212	%	81.3481	2.16	5	

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

QUALITY CONTROL DATA

Workorder: 2074297 AER091|R1504196

SAMPLE DUPLICATE: 2186882 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	38.5307	%	35.9801	6.85	10	
Total Solids	61.4692	%	64.0198	4.07	5	

SAMPLE DUPLICATE: 2186883 ORIGINAL:

Parameter	Original Result	Units	DUP Result	RPD	Max RPD	Qualifiers
Moisture	8.4914	%	8.9586	5.35	10	
Total Solids	91.5085	%	91.0413	.51	5	

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

QUALITY CONTROL DATA QUALIFIERS

Workorder: 2074297 AER091|R1504196

QUALITY CONTROL PARAMETER QUALIFIERS

Lab ID	#	Sample Type	Analytical Method	Analyte
2186668	1	Lab Control Standard	SW846 8260C	Freon 113

The QC sample type LCS for method SW846 8260C was outside the control limits for the analyte Freon 113. The % Recovery was reported as 126 and the control limits were 40 to 109.

Lab ID	#	Sample Type	Analytical Method	Analyte
2186668	2	Lab Control Standard	SW846 8260C	Methyl acetate

The QC sample type LCS for method SW846 8260C was outside the control limits for the analyte Methyl acetate. The % Recovery was reported as 249 and the control limits were 70 to 130.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Workorder: 2074297 AER091|R1504196

Lab ID	Sample ID	Prep Method	Prep Batch	Analysis Method	Analysis Batch
2074297001	R1504196-002	SW846 3546	EXTR/39545	SW846 8270D	SVMS/23574
2074297002	R1504196-003	SW846 3546	EXTR/39545	SW846 8270D	SVMS/23574
2074297001	R1504196-002	SW846 5035	VOMS/36123	SW846 8260C	VOMS/36124
2074297002	R1504196-003	SW846 5035	VOMS/36123	SW846 8260C	VOMS/36124
2074297001	R1504196-002			S2540G-11	WETC/154975
2074297002	R1504196-003			S2540G-11	WETC/154975
2074297001	R1504196-002	SW846 9012B	WCPR/32445	SW846 9012B	WETC/155216
2074297002	R1504196-003	SW846 9012B	WCPR/32445	SW846 9012B	WETC/155216
2074297001	R1504196-002	SW846 3051	MDIG/51218	SW846 6010C	META/48657
2074297002	R1504196-003	SW846 3051	MDIG/51218	SW846 6010C	META/48657
2074297001	R1504196-002	SW846 3546	EXTR/39624	SW846 8082A	SVGC/38325
2074297002	R1504196-003	SW846 3546	EXTR/39624	SW846 8082A	SVGC/38325
2074297001	R1504196-002	SW846 3546	EXTR/39625	SW846 8081B	SVGC/38354
2074297002	R1504196-003	SW846 3546	EXTR/39625	SW846 8081B	SVGC/38354
2074297001	R1504196-002	SW846 7471B	MDIG/51264	SW846 7471B	META/48671
2074297002	R1504196-003	SW846 7471B	MDIG/51264	SW846 7471B	META/48671

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* 2074297 *

Project Number: R1504196
Project Manager: Janice Jaeger

Lab Code	Sample ID	# of Cont.	Matrix	Sample Date	Sample Time	Lab ID	Ag T 6010C	Al T 6010C	As T 6010C	Ba T 6010C	Be T 6010C	Ca T 6010C	Cd T 6010C	CN-Tot 9012B	Co T 6010C
~~R1504196-001~~	~~Comp-1 Topsoil~~	~~3~~	~~Soil~~	~~5/28/15~~	~~1600~~	~~Middletown ALS~~	X	X	X	X	X	X	X	X	X
R1504196-002	Comp-2 Topsoil	↓	Soil	5/28/15	1610	Middletown ALS	X	X	X	X	X	X	X	X	X
R1504196-003	Comp-3 Topsoil	↓	Soil	5/28/15	1615	Middletown ALS	X	X	X	X	X	X	X	X	X

AT 6/2/15 on WO# 2074295

AT 6/3/15

	Y	N	Initials	Cooler Temp:
Custody Seals Present?			AT	5 °C
(if present) Seals Intact?				Cooler #:
Received on Ice?				
COC/Labels Complete				Therm ID: IR291
Cont in Good Cond?				
Correct Containers?				Ship Carrier:
Correct Samp Vol?				FedEx UPS
Correct Preservation?				DHL
Headspace/Volatiles?				

Tracking #: 629675587321

Special Instructions/Comments

need DECEQUIS EDD

need 1 week TAT on sample 1

std on others

H - Test is On Hold F - Test is Authorized for Prep Only

Turnaround Requirements

____ RUSH (Surcharges Apply)

PLEASE CIRCLE WORK DAYS

1 2 3 4 5

____ STANDARD

Requested FAX Date: _____

Requested Report Date: 06/03/15

Report Requirements

____ I. Results Only

____ II. Results + QC Summaries

____ III. Results + QC and Calibration Summaries

X IV. Data Validation Report with Raw Data

PQL/MDL/J N

EDD N

Invoice Information

PO# 58R1504196

Bill to

Relinquished By: _____ 6/1/15/1645

Received By: _____ 6/2/15 0900

Airbill Number: _____

ALS

							Cr T 6010C	Cu T 6010C	Fe T 6010C	Hg 7471B	K T 6010C	Mg T 6010C	Mn T 6010C	Na T 6010C	Ni T 6010C
R1504196-001	Comp-1 Topsoil		Soil	5/28/15	1600	Middletown ALS	X	X	X	X	X	X	X	X	X
R1504196-002	Comp-2 Topsoil		Soil	5/28/15	1610	Middletown ALS	X	X	X	X	X	X	X	X	X
R1504196-003	Comp-3 Topsoil		Soil	5/28/15	1615	Middletown ALS	X	X	X	X	X	X	X	X	X