

REMEDIAL DESIGN WORK PLAN

WORK ASSIGNMENT D009803-36.2

ERDLE PERFORATING SITE
SITE NO. 828072
TOWN OF GATES, MONROE COUNTY, NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Sean Mahar, Interim Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION

Prepared by:
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50 Lakefront Blvd., Suite 111
Buffalo, New York 14202

August 2024

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625 BROADWAY, 12th FLOOR
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LIST OF ABBREVIATIONS/ACRONYMS

AECOM	AECOM USA, Inc.
amsl	Above mean sea level
bgs	below ground surface
BMP	Best Management Practice
CVOC	chlorinated volatile organic compound
DCE	dichloroethane
DER	Division of Environmental Remediation
DO	dissolved oxygen
DPT	Direct-Push Technology
Erdle	Erdle Perforating Company
ERH	electrical resistivity heating
EVO	Emulsified Vegetable Oil
ft/ft	feet per foot
FS	Feasibility Study
GHG	Greenhouse Gas
H_2	hydrogen
HRC	Hydrogen Release Compound
IDW	investigation derived waste
IRM	Interim Remedial Measure
ISCO	In-situ chemical oxidation
ISCR	In-situ Chemical Reduction
JHA	Job Hazard Analysis
LCFAs	long-chain fatty acids
MACTEC	MACTEC Engineering and Consulting, P.C.
mg/kg	milligrams per kilogram (parts per million)
NAPL	non-aqueous phase liquid
Nothnagle	Nothnagle Drilling, Inc.
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	oxidation/reduction potential
PAHs	polynuclear (or polycyclic) aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	perchloroethene, aka tetrachloroethene or tetrachloroethylene or perchloroethylene
PDI	Pre-Design Investigation
PID	photoionization detector
ppm	parts per million
PVC	polyvinyl chloride
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
RI/FS	Remedial Investigation/ Feasibility Study
ROD	Record of Decision
RQD	rock-quality designation
SCGs	standards, criteria and guidance
SCOs	soil cleanup objectives
SDS	Safety Data Sheet
SSDS	Sub-slab Depressurization System
SVI	soil vapor intrusion
SVOC	semi-volatile organic compound
TAL	target analyte list
TCE	trichloroethene, aka trichloroethylene
UIC	Underground Injection Control

USEPA	United States Environmental Protection Agency
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compound

1.0 INTRODUCTION

This Remedial Design Work Plan (RDWP) presents the design rationale, criteria, computations, and analysis for a remedial design at the Erdle Perforating Site (Site - No. 828072) located in the Town of Gates, Monroe County, New York (Figure 1). This document presents the scope, site background, approach, and description of the remedial alternative selected for remediation of the Site in accordance with the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD) (NYSDEC, 2010) and subsequent modifications as presented in the Technical Design Memorandum (AECOM USA, Inc., September 2022b). AECOM USA, Inc. (AECOM) prepared this RDWP for the NYSDEC for the Site as part of Work Assignment D009803-36.1 of the AECOM standby engineering services contract with the NYSDEC. This RDWP will be provided to the NYSDEC Call-out contractor along with the design documents – drawings and specifications, to be followed during implementation of the remediation.

1.1 Site History

Erdle Perforating Company (Erdle) constructed the facility in 1968 on what was then farmland. Erdle used a variety of lubricants in its perforating processes which were removed from the finished product through the use of chlorinated degreasing solvents, such as trichloroethene (TCE). From the early 1970's to 1987, Erdle collected spent TCE degreasing solvent in a 2,000-gallon underground storage tank (UST) prior to shipping off-site for disposal. The TCE UST was located adjacent to the southwestern edge of the building. Erdle also stored waste oils in a UST next to the TCE UST. In February 1987, the TCE UST failed a pressure test. Subsequent soil and groundwater sampling confirmed that Site soil and groundwater had been impacted by TCE. The TCE tank and several other tanks (including the waste oils tank formerly adjacent to the TCE UST) were removed in 1987, along with approximately 100 cubic yards of contaminated soil. Erdle provided a report on these removals to the NYSDEC in July 1987. Because of the TCE release, the Site was listed as a Class 2 site in the NYSDEC Registry of Inactive Hazardous Waste Disposal Sites. A Class 2 site is defined as a "significant threat to public health or environment – action required".

1.1.1 Site Location and Description

The Site is approximately 9.2 acres and is bounded on the south by CSX railroad tracks and an undeveloped wooded area further south of the railroad tracks, on the north and east by light industry, and on the west by open land and Interstate 490. The Site contains one occupied 84,000 square foot facility building which was constructed in 1968. The main site feature is the building which is surrounded by an asphalt parking to the north and grass and wooded areas to the south, east, and west. The Site and

surrounding developed areas are serviced by public water. A townhouse development (Hidden Valley Development) is located approximately 800 feet south of the Site. The property and land south of the Site are fairly low lying, with areas of intermittent stagnant water. A drainage swale is located along the west side of the Site parcel. The drainage swale passes under the railroad tracks, through the undeveloped wooded land south of the Site and eventually along the western edge of the Hidden Valley Development to a small pond located along the western edge of the development.

The Site is currently active and is zoned for industrial purposes including manufacturing and processing. Site occupants include a manufacturer of various types of perforated sheet metal products. The surrounding parcels to the north, east and west, which include both undeveloped and developed properties, are also zoned for industrial purposes. The undeveloped and developed areas located south of the CSX railroad tracks are zoned for one-family residential. The Site Plan is presented as Figure 2.

1.2 Investigation and Remedial History

The following narratives provide a remedial history timeline and a brief summary of the available project records that document key investigative and remedial milestones for the Site:

- 1987: Leaking UST identified and removed along with contaminated soil (NYSDEC, 2010).
- 1987: Site listed as Class 2 site in Registry of Inactive Hazardous Waste Disposal Sites (NYSDEC, 2010).
- October 24, 1994: Consent Order B8-0185-87-05 signed by Erdle Perforating Company (NYSDEC, 2010).
- 1995: Phase I Site Investigation completed by Erdle Perforating Company (Radian Corporation, 1995).
- 1996: Phase II Site Investigation completed by Erdle Perforating Company (NYSDEC, 2010).
- 1997: Installation of a dual phase extraction system as an interim remedial measure (IRM), by Erdle Perforating Company (NYSDEC, 2010).
- 1998: Remedial Alternatives Feasibility Study completed by Erdle Perforating Company (Radian Corporation, 1998).

- 1999: Installation of off-site groundwater monitoring wells completed by Erdle Perforating Company (NYSDEC, 2010).
- 2002: Dual phase extraction system shut down by Erdle Perforating Company (NYSDEC, 2010).
- 2005: Off-site limited soil vapor intrusion (SVI) study by Erdle Perforating Company (NYSDEC, 2010).
- 2006: Erdle Perforating Company Site referred to State Superfund by NYSDEC (NYSDEC, 2010).
- 2007: Off-site SVI study performed by NYSDEC (NYSDEC, 2010).
- 2008-2010 Remedial Investigation/Feasibility Study (RI/FS) completed by MACTEC Engineering and Consulting, P.C. (MACTEC) for the NYSDEC (included installation of sub-slab depressurization systems [SSDSs]) (MACTEC, 2010).
- July 2012: Baseline groundwater sampling completed by MACTEC for the NYSDEC (MACTEC, 2012).
- June 2013: SSDSs installed at 391 Upper Valley Road and 394 Upper Valley Road, by Mitigation Tech (MACTEC, 2013).
- December 8, 2014: Dual phase extraction system removed by TRS (MACTEC, 2017).
- January 2015 - June 2015: electrical resistivity heating (ERH) system components installed by TRS (MACTEC, 2017).
- June 26, 2015 - April 2016: ERH system operated and maintained by TRS (MACTEC, 2017).
- May 2018: Post ERH groundwater sampling (MACTEC, 2018).
- May 2019: Groundwater sampling conducted for the NYSDEC (MACTEC, 2019).
- November 2019: Groundwater sampling conducted for the NYSDEC (MACTEC, 2020a).
- June 2020: Groundwater sampling conducted for the NYSDEC (MACTEC, 2020b).
- July 2022: Pre-Design Investigation (AECOM, 2022a)

Historical soil and groundwater analytical results are presented in Appendix A.

As mentioned above, activities performed by Erdle included several phases of Remedial Investigations (RIs), installation and sampling of on-site and off-site groundwater monitoring wells, a Feasibility Study (FS), and installation of a dual phase extraction system as an IRM to extract contaminated groundwater and vapor from the former TCE UST source area. The dual phase extraction system was installed in 1997 and operated for less than one year with minimal effect (MACTEC, 2010). NYSDEC retained MACTEC in 2007 to conduct an RI to better define the nature and distribution of contamination resulting from previous activities at the Site. The RI activities were conducted from 2007 to 2010 and included the following:

- Historical Site data review.
- Soil boring and monitoring well installations.
- Sampling of pore water point installations for volatile organic compound (VOC) analysis.
- Stream piezometer installation.
- Sampling of groundwater from overburden and bedrock monitoring wells for VOCs, semi-volatile organic compounds (SVOCs), and metals analysis.
- Sampling of soil for VOCs, SVOCs, metals, pesticides, and polychlorinated biphenyl (PCB) analysis.
- Sampling of soil vapor, indoor air, and outdoor air for VOC analysis, and
- Qualitative exposure assessment – Public Health Evaluation.

Based on the groundwater, soil, and soil vapor sampling, primary contaminants of concern are chlorinated VOCs (CVOC), including TCE and its associated breakdown products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC).

To address current and/or potential indoor air contamination from VOCs associated with SVI, ten SSDSs were installed at residential locations as IRMs between 2007 and 2010 and two residential SSDSs were installed in 2013 south of the Site. No further action was deemed necessary for the remaining 43 residential structures sampled (MACTEC, 2013).

Based on surface water sampling conducted by the Monroe County Department of Public Health in June 2007, no site-related surface water contamination was identified. There were no exceedances of Standards, Criteria, or Guidance (SCGs) for VOCs in surface water indicating that VOC-impacted groundwater has not impacted the surface water within the drainage swales or retention pond.

Sediment samples were not collected from the wooded area located south of the Site and downgradient of the soil source area because the area is only intermittently wet. Sediment samples were also not collected from the drainage swale because it is dredged regularly by the Department of Public Works. Soil samples collected within the wooded area did not reveal contaminant concentrations exceeding SCGs.

Following completion of the RI/FS, the NYSDEC ROD outlined the selected remedy for the Site:

- Implementation of a full-scale in-situ electrical resistance heating system to address on-site VOC soil and groundwater contamination. Implementation of this alternative will consist of the installation of electrodes throughout the source area on approximately fifteen-foot spacing. Each electrode will be paired with one vapor recovery extraction well for vapor recovery. The vapor recovery system will include vapor phase treatment.

- In-situ enhanced biodegradation could be implemented, if appropriate, to remediate site-related groundwater contamination contributing to the existing off-site soil vapor to indoor air pathway. The decision to conduct in-situ enhanced biodegradation during implementation of remedial action will be based upon the information from the Remedial Investigation, results of the pre-design investigation and data gathered to evaluate the effectiveness of the electrical resistance heating of the on-site source area. Full-scale implementation of in-situ enhanced biodegradation will consist of the injection of the selected amendment(s) into the contaminated overburden and shallow bedrock aquifers along two separate horizontal transects; transecting the groundwater plume at locations MW-7/7D and MW-8/8D. The installation of injection points as permanent wells will allow for multiple rounds of injection without the need for mobilization of heavy equipment and will also provide additional locations to monitor groundwater conditions. Subsequent rounds of in-situ biodegradation will be conducted, as appropriate, based upon evaluation of groundwater and vapor monitoring results.

- Institutional controls in the form of an environmental easement for the controlled property.

- Site Management Plan (NYSDEC, 2010).

The ERH system was installed and operated from June 2015 to April 2016. The goal of the remedial action was the cleanup of source area soils to meet the New York State Codes Rules and Regulations Part 375 Soil Cleanup Objectives (SCOs) for the protection of groundwater. Although post ERH soil sample analytical results indicated the soils met the SCOs, groundwater sampling conducted in May 2018 and May 2019 indicated that contaminants (primarily chlorinated compounds) were still present at concentrations above New York State groundwater standards in groundwater at and downgradient from the Site (MACTEC, 2018 and 2019). As a result, six new wells were installed (IW-1 to IW-6) and chemical oxidant cylinders (RemOx® SR In-situ chemical oxidation [ISCO] Reagent - a mix of potassium permanganate and sodium persulfate by Carus Corporation) were placed in the new wells and in four existing wells (MW-8, MW-8D, MW-9, and MW-9D) to oxidize the remaining contaminants present in groundwater.

Between June 1, 2021, and September 16, 2021, AECOM conducted pre-design investigation (PDI) activities which included the items listed below. AECOM procured Nothnagle Drilling, Inc. (Nothnagle) to perform geoprobe, drilling and monitoring well installation services for this work. AECOM prepared the PDI Report to summarize the field activities and present the data collected during the investigation. The PDI Report was submitted to NYSDEC in July 2022. A summary of the PDI results is presented below.

1.2.1 2021 PDI Field Activities

The following work elements were performed as part of the PDI:

- Advancement of Soil Borings and Soil Sampling using Direct-Push Technology (DPT).
- Installation of Two Overburden and Six Bedrock Monitoring Wells.
- Monitoring Well Development.
- Collection of Water Levels/Product Thickness.
- Collection of Groundwater Samples.
- Investigation Derived Waste (IDW) Handling, and
- Completed an engineering survey to refine the Site base map and establish the sampling locations.

1.2.2 2021 PDI Geology and Hydrogeology

The stratigraphic sequence at the Site includes heterogenous fill materials to a depth of approximately 4 to 8 feet below ground surface (bgs), overlying approximately 8 to 12 feet of generally natural deposits comprised of interstratified clay, clayey silt, and silty sand seams/layers down to the bedrock surface. The bedrock consists of the Penfield and DeCew Dolostone units of the lower Lockport Formation and underlying Gates Dolostone and Rochester Shale of the Rochester Shale Formation. The bedrock surface slopes gently toward the south and southwest. The contacts between the rock units were not readily distinguishable, which is demonstrated through the review of the rock cores obtained during the PDI. Bedrock was found to be very competent, with rock-quality designations (RQDs) ranging from the lower 80's to as high as 100 at depths between 30 and 40 feet bgs.

Groundwater occurs under unconfined conditions in both the overburden materials and bedrock. Groundwater flow in the overburden is generally toward the south-southeast with a low horizontal hydraulic gradient of approximately 0.004 feet per foot (ft/ft), see Figure 3. Groundwater in the bedrock flows through secondary porosity features including faults, joints, solution cavities, and bedding planes. Historical bedrock groundwater elevation data indicates groundwater flows locally toward the south, see Figure 4.

1.2.3 2021 PDI Soil Analytical Results

CVOCs were detected in numerous soil samples collected as part of the PDI, however, none of the samples contained concentrations exceeding Commercial Use SCOs. TCE concentrations ranged from 0.012 milligrams per kilogram (mg/kg) to 160 mg/kg with the highest concentration south of the former UST along the overburden/bedrock interface at a depth of approximately 14 feet bgs. CVOCs exceeding Protection of Groundwater SCOs included TCE, cis-1,2-DCE, VC, and tetrachloroethene (PCE), see Figure 5.

1.2.4 2021 PDI Groundwater Analytical Results

CVOCs were detected in groundwater samples at concentrations exceeding Class GA groundwater SCGs. TCE concentrations ranged from 0.48 µg/L to 140,000 µg/L with the highest concentration occurring in the overburden monitoring well OMW-2 located on the west of the staging area, in the vicinity where the highest concentration of TCE in soil was found. The next highest TCE concentrations were found in the shallow bedrock groundwater at well MW-1D, downgradient of OMW-2. TCE breakdown products cis-1,2-DCE and VC were found in the overburden and shallow bedrock wells. There were no exceedances found in the deep bedrock wells, see Figure 6.

1.2.5 2021 PDI Conclusions

The PDI confirmed that there is remaining contamination in the soil, overburden groundwater, and shallow bedrock groundwater within the ERH treatment area. The deeper bedrock, greater than approximately 30 feet, is not impacted.

The horizontal and vertical extent of the impacts in soil is situated near the northwestern, central and southeastern portions of the ERH area as shown in Figure 7. Within the overburden, the highest soil vapor photoionization detector (PID) readings occurred at depths between 10 and 16 feet bgs. The highest concentrations of TCE remaining in overburden soil occurred at grid 100N/20E, approximately forty feet directly south of the former UST. No non-aqueous phase liquid (NAPL) was found in overburden, but there was some staining reported in a few locations. A sheen of NAPL was identified in the BMW-2D rock core at 27.29 feet bgs.

Significant overburden groundwater impacts were identified within the north central portion of the ERH treatment area where TCE was reported at 140 parts per million (ppm) in OMW-2. Shallow bedrock groundwater was also impacted near OMW-2 and within the southeastern portion of the ERH treatment area, albeit at much lower concentrations (Figure 6). Deeper bedrock groundwater was not impacted with chlorinated VOCs around the building footprint. AECOM recommended to the NYSDEC to implement a remedial design for limited soil excavation and In-situ Chemical Reduction (ISCR) reagents injected into the overburden and shallow bedrock to address remaining soil and groundwater contamination south of the former UST.

2.0 SUMMARY OF THE SELECTED REMEDY

The NYSDEC issued the ROD for the Site in December 2010 (NYSDEC, December 2010). The elements of the selected remedy for the Site as presented in the ROD are as follows:

1. A remedial design program will be implemented to provide the details necessary for the construction, operation, maintenance and monitoring of the remedial program.

2. The selected remedy includes the implementation of a full-scale in-situ electrical resistance heating system to address on-site VOC soil and groundwater contamination. Implementation of this alternative will consist of the installation of electrodes throughout the source area on approximately fifteen-foot spacing. Each electrode will be paired with one vapor recovery extraction well for vapor recovery. The vapor recovery system will include vapor phase treatment. Refer to Figure 8 for an illustration of the proposed layout of the electrical resistance heating system.

3. In-situ enhanced biodegradation could be implemented, if appropriate, to remediate site-related groundwater contamination contributing to the existing off-site soil vapor to indoor air pathway. The decision to conduct in-situ enhanced biodegradation during implementation of remedial action will be based upon the information from the Remedial Investigation, results of the pre-design investigation and data gathered to evaluate the effectiveness of the electrical resistance heating of the on-site source area. Full-scale implementation of in-situ enhanced biodegradation will consist of the injection of the selected amendment(s) into the contaminated overburden and shallow bedrock aquifers along two separate horizontal transects; transecting the groundwater plume at locations MW-7/7D and MW-8/8D. The installation of injection points as permanent wells will allow for multiple rounds of injection without the need for mobilization of heavy equipment and will also provide additional locations to monitor groundwater conditions. Subsequent rounds of in-situ biodegradation will be conducted, as appropriate, based upon evaluation of groundwater and vapor monitoring results. Refer to Figure 9 for an illustration of the proposed layout of the in-situ enhanced biodegradation injection transects.

4. Site restoration will include placing topsoil and seed over areas disturbed during the installation and removal of the in-situ electrical resistance heating system.

5. The operation of the components of the remedy will continue until the remedial objectives have been achieved, or until the Department determines that continued operation is technically impracticable or not feasible.

6. Green remediation and sustainability efforts are considered in the design and implementation of the remedy to the extent practicable, including;

   - using renewable energy sources through the purchase of electricity generated by renewable sources.

7. Imposition of an institutional control in the form of an environmental easement for the controlled property that:

   (a) requires the remedial party or site owner to complete and submit to the Department a periodic certification of institutional and engineering controls in accordance with Part 375-1.8 (h)(3).
   (b) land use is subject to local zoning laws, the remedy allows the use and development of the controlled property for:
   __residential use__restricted residential use_X_commercial use__industrial use
   (c) restricts the use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the Department, NYSDOH or County DOH;
   (d) requires compliance with the Department approved Site Management Plan;

8. Since the remedy results in contamination remaining at the site that does not allow for unrestricted use, a Site Management Plan is required, which includes the following:

   (a) Institutional and Engineering Control Plan that identifies all use restrictions and engineering controls for the site and details the steps and media-specific requirements necessary to assure the following institutional and/or engineering controls remain in place and effective:

   Institutional Controls:

   To prevent exposure to contamination in groundwater until SCGs are met, institutional controls will include the implementation of land-use restrictions as set for the in Paragraph 7 above.

Engineering Controls:

The soil vapor mitigation systems will be in place and maintained to mitigate soil vapor intrusion in impacted properties.

This plan includes, but may not be limited to:

(i) Excavation Plan which details the provisions for management of future excavations in areas of remaining contamination;
(ii) descriptions of the provisions of the environmental easement including any land use and groundwater use restrictions;
(iii) provisions for the management and inspection of the identified engineering controls;
(iv) maintaining site access controls and Department notification; and
(v) the steps necessary for the periodic reviews and certification of the institutional and/or engineering controls;

(b) Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but will not necessarily be limited to:
(i) monitoring of groundwater to assess the performance and effectiveness of the remedy; monitoring will consist of the sampling and analysis of both on-site and off-site groundwater monitoring wells for VOCs until remediation goals are achieved; it is assumed that long-term monitoring will be conducted on a periodic basis;
(ii) a schedule of monitoring and frequency of submittals to the Department;
(iii) provision to evaluate the potential for vapor intrusion for any buildings developed on the site, including provision for mitigation of any impacts identified;
(iv) provision to evaluate the potential for soil vapor intrusion for the existing on-site building if building use changes significantly or if a vacant building becomes occupied.

(c) an Operation and Maintenance Plan to assure continued operation, maintenance, monitoring, inspection, and reporting of for any mechanical or physical components of the remedy. The plan includes, but is not limited to:
(i) compliance monitoring of treatment systems to assure proper O&M as well as providing the data for any necessary permit or permit equivalent reporting;
(ii) maintenance and any necessary installation of soil vapor mitigation systems for residential structures to mitigate the soil vapor intrusion;
(iii) maintaining site access controls and Department notification; and
(iv) providing the Department access to the site and O&M records.

Remedial goals identified for the Site in the ROD were:

Public Health Protection

Groundwater

- Prevent people from drinking groundwater with contaminant levels exceeding drinking water standards.
- Prevent inhalation of contaminants from groundwater.

Soil

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of contaminants volatilizing from the soil.

Soil Vapor

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into the indoor air of buildings at or near a site.

Environmental Protection

Groundwater

- Restore the groundwater aquifer to meet ambient groundwater quality criteria, to the extent feasible.

Soil

- Prevent migration of contaminants that would result in groundwater or surface water contamination.

3.0 DESIGN APPROACH BASED ON PDI AND GSR IMPLEMENTATION

3.1 Design Approach Based on PDI

The Record of Decision (ROD) for the Erdle Site was issued in December of 2010 and the remedial elements are summarized in Section 2.0. Prior investigation activities and the remedial history are summarized in Section 1.2. Because contamination remains in soil and groundwater following the ERH remedial action, NYSDEC tasked AECOM to complete the PDI to determine the horizontal and vertical extent of remaining contamination at the Site.

The Pre-Design investigation conducted in 2020 and 2021 included installation of overburden and bedrock monitoring wells in the source area south of the former UST, soil sampling in the source area and ERH treatment area, and sampling of new monitoring wells. The groundwater results from the Pre-Design Investigation are presented in Figure 6. The results for intermediate bedrock (BMW-1DD, BMW-2DD and BMW-3DD) show minimal or no contamination.

In the June 2010 FS and December 2010 ROD, and as an optional contingency measure, in-situ enhanced biodegradation was to be implemented to provide treatment of site-related groundwater contamination migrating from the Site. Full-scale implementation of in-situ enhanced biodegradation would consist of the injection of the selected amendment(s) into the contaminated overburden and shallow bedrock aquifers along two separate horizontal transects; transecting the groundwater plume at locations MW-7/7D and MW-8/8D south of the railroad tracks. Because groundwater contamination is generally present in the shallow bedrock over the extent of the contaminated groundwater plume, it was assumed for FS costing purposes that full-scale implementation would involve the injection of Hydrogen Release Compound^{TM} (HRC^{TM}) into permanently installed injection wells south of the railroad tracks. The use of permanent injection wells would allow for multiple rounds of injection without the need for mobilization of heavy equipment and would also provide additional locations to monitor groundwater conditions. Pre-design field and laboratory testing would be used to refine the full-scale injection design. In the FS, the conceptual injection design included injection of a total of 4,620 pounds of HRC^{TM} at 41 injection locations spaced 15 feet on-center across two sections of the groundwater plume as described above. Injection of the amendments would occur from the water table depth to a depth equivalent to the bottom of monitoring wells MW-7 (17.9 feet bgs) and MW-8 (27.9 feet bgs).

The soil and groundwater remediation work will be executed under the in-situ enhanced bioremediation remedial element as listed in the December 2010 ROD. Since remaining contamination in soil and groundwater is situated generally within the former ERH treatment area and north of the railroad tracks, remedial actions will be focused in these areas rather than those proposed in the FS. Soil remediation

in the affected areas will be completed via excavation of overburden just south of the former UST down to bedrock (an area of approximately 40 feet by 40 feet down to approximately 14 to 15 feet bgs) and via an ISCR reagent in overburden soil south of the UST and in a few overburden hotspots south of the planned soil excavation. Six existing monitoring wells situated within the excavated area will be removed, decommissioned and replaced in kind at/near their original location(s) after the excavation is backfilled. Groundwater remediation will be implemented using Emulsified Vegetable Oil (EVO) and was selected as the ISCR reagent at the site. EVO was selected because it is cost-effective and is a slow-release substrate. Other commonly used slow-release substrates include HRC manufactured by Regenesis and common edible vegetable oil. HRC was eliminated from consideration because it is a sole source product. EVO is chosen over edible vegetable oil because it is readily available from multiple sources, cost effective, easily implemented, and more effectively distributed in the formation. EVO is blended with Vitamin B12 which provides micronutrients for enhancing bioremediation. HRC would also need to be heated prior to injection.

After discussions with NYSDEC as part of the Technical Memorandum review, AECOM recommended application of an ISCR polishing reagent (i.e., Daramend® or equivalent) to the overburden/bedrock interface of the excavation area to promote reductive dechlorination. AECOM recommends treatment of the lower 7 feet of backfilled overburden using Daramend® Reagent (or equivalent). This reagent was originally formulated for surficial soil treatment via land farming techniques but is also frequently used in excavation / backfill applications to promote reductive dehalogenation of residual chlorinated solvents and their metabolites (e.g., cis-DCE and VC). Its coarse particle size provides cost advantages for backfill and trench applications in treating shallow groundwater and can enhance the longevity of the active treatment technology. Many soil mixing approaches, including simple excavator buckets and axial head mixers, can be used to achieve good distribution. Daramend® is a cost-effective solution while providing active treatment for five or more years in these applications.

The remedial design includes the following elements:

1. Excavate the overburden just south of the former UST down to bedrock (approximately 14 to 15 feet bgs), as shown in Figure 10. The southern, eastern, and western excavation walls will be sloped a minimum of 1V:2H; the northern excavation wall will be protected using shoring or a trench box as shown on the Contract Drawings. A performance specification is included in the design to direct the Contractor to perform the excavation using the safest and most effective means and methods.

2. Backfill the aforementioned excavation with clean and approved backfill. Mix 1 percent by weight of Daramend® to treat the lower 7 feet of backfilled overburden.

3. Install nine (9) shallow bedrock injection wells in the recently backfilled excavation area, equidistant from each other. Well spacing is based upon information obtained from comprehensive hydrogeological data from multiple sites in the vicinity.

4. Install three (3) pairs of overburden/shallow bedrock injection wells around BMW-3DD.

5. Install three (3) pairs of overburden/shallow bedrock injection wells around PDI grid node 60N/60E.

6. Install four (4) pairs of overburden/shallow bedrock injection wells immediately south of the former UST; between the former UST and proposed excavation area.

7. Implement in-situ chemical reduction. Conduct injections of ISCR reagent (EVO or equivalent) into the aforementioned injection wells. The dosage and injection schedule are listed in the Contract Drawings.

8. Install additional monitoring wells, conduct performance monitoring for in-situ groundwater parameters (i.e., oxidation-reduction potential, pH, temperature, specific conductivity, turbidity, and natural attenuation parameters), and collect groundwater samples from the new and existing monitoring wells as indicated in the Contract Drawings.

Following the injection of ISCR reagent for each of the planned two phases of injection, field parameters (water level, pH, oxidation/reduction potential [ORP], dissolved oxygen [DO], specific conductivity, temperature, turbidity, and color) will be measured in injection and monitoring wells every four weeks for the first quarter and quarterly for the next three quarters. These parameters will be measured at the 29 injection wells and all existing monitoring wells north of the railroad tracks. Field parameters will continue to be monitored until data indicates that ISCR is complete or nearly complete, anticipated to take approximately one year post injection of the ISCR reagent.

Groundwater will be sampled in selected monitoring wells prior to ISCR remediation. The groundwater samples will be analyzed for volatile organic compounds (VOC), target analyte list (TAL) metals – total and dissolved, chloride, nitrate-nitrogen, methane, ethene, sulfate, and alkalinity. Refer to Contract Drawings for sampling requirements and schedule. Groundwater will also be sampled at all monitoring wells north of the railroad tracks when ISCR has proceeded to an acceptable level and as directed by the Engineer. The results will be used to determine when the second phase of ISCR injections will be implemented.

3.2 Green and Sustainable Remediation Implementation

AECOM performed a sustainability baseline assessment for the Project so that green and sustainable remediation impacts could be considered as part of the 95% design. A Sustainability Assessment Report summarizing this effort is included as Appendix B. The design was evaluated using SiteWise™ for Greenhouse Gas (GHG) emissions, energy use, water use, accident risk (injury and fatality), and criteria pollutants. A summary of the sustainability metrics that were calculated as part of the SiteWise™ assessment are listed below:

GHG emissions: For this project, there are several significant contributors to GHG emissions. Consumables such as fill soil, well installation materials, and injectant contribute 48% of GHG emissions; residual handling, which includes transportation and landfill operations, contributes 30%; and on-site equipment use (loaders, bulldozers, excavators, pumps, etc.) contributes 17%. Transportation of personnel and equipment have the smallest impacts, at about 3% each of total GHG emissions. This is lower than for typical projects because almost all labor and materials for this project can be sourced locally.

Fill soil accounts for approximately 58% of consumables emissions, while emulsified vegetable oil accounts for about 35%. Residual handling is evenly divided between transportation and landfill operations. Over 75% of GHG emissions from on-site equipment use result from drilling using a hollow-stem auger.

Energy Use: The primary contributors to energy use are consumables (58%) and residual handling (27%). Similar to GHG emissions, transportation of personnel and equipment have the smallest impacts, at 2% each of total energy use.

Water Use: Nearly all water consumed for this project is directly consumed from the municipal water supply. Less than 1% of water consumption is related to electricity for dewatering operations during construction.

Criteria Pollutants: Total NOx emissions are divided between on-site equipment use (39% - local impact), consumables (38% - global impact), and residual handling (23% - global impact). Total SOx emissions are primarily from consumables (76%), while total PM10 emissions are primarily from residual handling (75%). The Erdle site is located in Monroe County, NY which is classified as an attainment area for criteria pollutants.

Accident Risk: Accident risk is highest for on-site equipment use. Residual handling and personnel transportation are also a factor due to road miles traveled.

The project will include the application of Best Management Practices (BMPs) during construction to reduce environmental impact where possible. The BMPs will include:

- Reduce impacts from consumables, residual handling, and criteria pollutants:
  - Re-use of overburden or other uncontaminated soils for a portion of backfill
- Consider alternative drill types such as direct push or sonic
- Use local staff when possible
- Recommend staff travel together rather than separately where possible
- Use lower emission vehicles such as electric vehicles or small trucks or SUVs rather than full-size, where appropriate

Material and equipment use will be tracked during construction and long-term monitoring to assess the effectiveness of BMPs. The New York State Department of Environmental Control Form A (Summary of Green Remediation Metrics) will be used for reporting. A copy of Form A is included as Attachment 3 in Appendix B.

4.0 EXCAVATION AND IN SITU CHEMICAL REDUCTION (ISCR)

4.1 Description of Remediation

As discussed in Section 3.0, the remediation at the site will employ soil excavation and ISCR.

4.2 Excavation Approach

Excavation in the overburden will be completed within the area generally bounded by grid nodes 120N/0E, 120N/40E, 80N/0E, 80N/40E just south of the former UST down to bedrock (approximately 14 to 15 feet bgs), as shown in Figure 10 and on the Contract Drawings. The southern, eastern, and western excavation walls will be sloped a minimum of 1V:2H; the northern excavation wall will be protected using shoring or a trench box. A performance specification is included in the Contract Specifications to direct the Contractor to perform the excavation using the safest and most effective means and methods.

The Contractor shall collect, treat, and dispose and/or discharge all contact water during the project. The Contractor shall design, provide, and operate dewatering systems required to maintain dry conditions during soil excavation, stockpiling, and backfilling. The Contractor shall coordinate dewatering and contact water treatment operations with the approved Stormwater Pollution Prevention Plan (SWPPP) and Soil Erosion and Sediment Control Plan. All soil and debris generated during excavation operations shall be thoroughly dewatered prior to transportation. Dewatering fluids collected shall be stored in on-site baker tanks or frac tanks for temporary storage, and then transported off site for disposal at an approved facility. The Contractor shall convey the water by truck to a liquid waste disposal facility, and design, construct, and operate an on-site pre-treatment system as necessary to meet the facility acceptance criteria.

Estimates of construction dewatering during excavation activities are on the order of 2,500 gallons per day but could be somewhat higher if the excavation is open for longer time periods. Potential inflow from the underlying bedrock could also contribute to increased daily dewatering volumes. The primary unit identified at the Site is the unconfined water-table aquifer present in both the overburden and bedrock. No confining unit was identified thus no barrier exists between the overburden and bedrock groundwater zones. The potentiometric surface in the overburden indicates groundwater flow to the south-southeast and ranges from approximately 553.96 feet above mean sea level (amsl) along the northern side of the Site to approximately 546.71 feet amsl approximately 1,200 feet south of the Site. The horizontal hydraulic gradient in the overburden is approximately 0.004 feet per foot (ft/ft).

Excavated soils will be transported and disposed in accordance with the waste characterization of the materials. The excavation area will be backfilled with clean soil or overburden materials previously

excavated from the site if determined to be non-impacted and as approved by the Engineer, and as specified in the Contract Drawings and Specifications. The lowermost seven feet of backfill material will be pre-treated with an approximately 1 percent by weight of Daramend® to promote reductive dechlorination of any residual chlorinated VOCs.

4.3 Injection Approach

After completion of excavation and backfilling, and groundwater monitoring, EVO injections will commence as directed by the Engineer. Two EVO injection phases will be completed approximately six months to one year apart. Performance monitoring will be conducted after the EVO injections as discussed in Section 4.7. Further injections could be implemented pending the results of performance monitoring. EVO (or equivalent) will be injected within overburden and shallow bedrock in the areas shown on Figure 10. The four paired overburden/shallow bedrock injection wells situated just south of the former UST will be installed at spacing of approximately 20 feet by 10 feet. Three paired overburden/shallow bedrock injection wells situated around each of the grid nodes 60N/0E and 20N/20E and will be installed at a spacing of approximately 20 feet. Nine shallow bedrock injection wells will be installed within the excavation area at a spacing of 10 feet. The overburden wells will include a 4-inch diameter schedule 40 polyvinyl chloride (PVC) casing and screen (0.020-inch continuous wrap) installed to the top of rock. The shallow bedrock wells will be installed as a 6-inch open hole in bedrock installed from the top of bedrock to approximately 31 feet bgs. In bedrock wells, the overburden will be sealed off with a nominal 6-inch inside diameter carbon steel casing. The injection areas are shown on the Contract Drawings. EVO will be mixed on site at a ratio of 4 gallons of water to 1 gallon of EOS™ concentrate. Five hundred milliliters of Vitamin B12 supplement, supplied by the manufacturer, will be added to each 55-gallon drum of EVO concentrate. In addition, sodium sulfite will be added as an oxygen scavenger to prevent the introduction of oxygen into the EVO mixture during injection. The dilute solution will be prepared and applied the saturated zone using a direct pressurized injection system that includes a motorized mixing hopper, hydraulic pump (with a minimum pressure rating of 15 pounds per square inch - psi), and pneumatic packer assembly. In shallow bedrock injection wells, the solution will be injected under pressure in two successive increments of approximately 7 to 8 feet, starting from the bottom of each open rock intake. Each zone will be isolated by the packers. Approximately 29 gallons of EOS mixed with water will be injected into each 7-to-8-foot increment. Approximately 61 gallons of distribution water will be injected into each well following application of the 20% EOS solution. In overburden injection wells, the solution will be injected under pressure in two successive increments of approximately 5 feet, starting from the bottom of each well screen. Each zone will be isolated by packer assembly. Approximately 103 gallons of EOS mixed with water will be injected into each 5-foot increment. Approximately 1,084 gallons of distribution water will be injected into each well following application of the 20% EOS solution.

All drilling equipment will be steam cleaned prior to use at the site and prior to demobilization from the site. Downhole equipment, such as drive points and rods, will also be cleaned between well and injection locations.

4.4 EVO Reagent

4.4.1 Chemistry

EVO is commonly used as a slowly fermentable substrate to stimulate anaerobic bioremediation. Commercially available EVO typically contains a mixture of 45 to 60% vegetable oil present in small (0.5 to 2.0 µm) droplets, more readily fermentable soluble substrates (e.g., fatty acids or alcohols), surfactants, nutrients and water. Following injection, the vegetable oil is hydrolyzed to glycerol and long-chain fatty acids (LCFAs), which are subsequently fermented to hydrogen (H_2) and acetate. The rate of LCFA fermentation and resulting H_2 production is limited by sorption to sediment surfaces and/or precipitation with divalent cations (Ca^{+2}, Mg^{+2}, Mn^{+2}, Fe^{+2}). Since H_2 is rapidly consumed near where it is produced, the oil droplets should be distributed as uniformly as possible throughout the target treatment zone. This involves injecting sufficient EVO and sufficient water to distribute the EVO throughout the treatment zone. The Safety Data Sheet (SDS), handling and storage instructions, and application instructions are included in Appendix A. The EVO reagent will be mixed on-site in accordance with the manufacturer's instructions in appropriate mixing vessels, using the municipally supplied potable water system. Injection and handling at the site shall comply with the Town of Gates Fire Department requirements.

4.4.2 Volume of Aquifer Treated

The volume of overburden aquifer treated is calculated as the product of the depth interval to which the injection is applied, and the area addressed by the injections. For the overburden injection well plan, the estimated area is estimated at 4,000 square feet and the depth interval is estimated be 10 feet (4 feet to 14 feet bgs) (Figure 10). For the shallow bedrock injection plan shown on Figure 10 and the Contract Drawings, the estimated area is approximately 6,000 square feet and the estimated interval is 15 feet (i.e., 16 feet to 31 feet bgs - the overburden and upper foot or two of bedrock will be sealed with a carbon steel casing and cement/bentonite grout).

4.4.3 Calculated EVO Injection Volumes.

The calculated volume of concentrated EVO required for remediation is 1,265 gallons which is equal to approximately 9,200 pounds of EVO. The basis for this volume is given in the calculation presented in Appendix C. Each gallon of EVO will be diluted with 4 gallons of water prior to injection. It is assumed that the total diluted volume of 6,325 gallons will be injected in two events. After injection is completed, distribution water will be injected into each well after each event. A total of 12,000 gallons of

distribution water will be injected after each event. Further details regarding EVO dilution and distribution are provided in Appendix C.

4.4.4 Remedial Components

The remedial components required to implement the remedial activities at the Site include installation of injection wells, EVO delivery, and reagent containment and safety measures. Remedial components may also include a temporary aboveground manifold for the new injection wells to enable injection in multiple wells at one time.

4.4.5 Injection Well and Monitoring Well Installation

A total of 29 injection wells will be installed in the overburden and shallow bedrock. The Remedial Construction Contract Drawings (Drawings) present a Well Schedule which is based on the available depth-specific information used to select the depth intervals. An injection well detail is also be presented on the Contract Drawings. Six monitoring wells will need to be replaced as they will be removed and decommissioned as part of the excavation work. These wells will be replaced in kind as specified on the Drawings.

All drill cuttings and water generated during the course of injection well installations will be drummed and picked up at regular intervals by the disposal contractor. Only temporary on-site storage of waste materials will be allowed.

4.4.6 Delivery System

Precise components of the delivery system will be considered means and methods to be proposed by the remediation contractor and will be subject to review and approval by NYSDEC and the Engineer. However, components of the delivery system are expected to generally include the items described in the following paragraph.

There will be EVO solution transfer from the transport container and mixing vessels (e.g., 2,100-gallon totes and large volume poly container on flatbed trailer, mixing vessels) to injection wells through flexible hoses. Secondary containment will be implemented around containers and other points of potential discharge. Hoses will be covered with traffic ramps to allow traffic as necessary. Flow meters will be used to measure the volume of EVO solution injected. Injection pressures will be measured with pressure gauges. Aboveground manifolds may be used to allow delivery of the EVO solution at several injection wells at one time, while monitoring flow rates and injections pressures to each well.

Materials used for aboveground hoses used for transfer of the EVO solution, pumps used for transfer or injection, and storage containers will be compatible with the solution. The manufacturer's

recommendations for decontamination and/or maintenance will be followed to prevent corrosion of hoses, pumps, and/or any equipment exposed to the solution.

4.4.7 Delivery and Mixing

EVO will be delivered to the site in 55 gallons drums. Mixing and solution preparation procedures are presented in Section 4.5. Storage, Containment and Safety Measures.

4.5 Storage, Containment and Safety Measures

EVO is non-hazardous and only routine general handling practices are required. The SDS is included in Appendix A and lists storage and handling requirements. The EVO will be staged and mixed at on-site in accordance with the manufacturer's recommendations.

Secondary containment will be implemented as a precaution required by and will comply with the NYSDEC bulk storage regulations. Secondary containment will be implemented for EVO transfer, storage, mixing and manifold operations and at connection points (e.g., hose and/or piping connections) secondary containment measures will be implemented. Any spilled EVO solution will be contained and, if possible, reused.

4.6 Injection Schedule

As listed in the Contract Drawings, an estimated 30,300 gallons of EVO solution and distribution water will be injected into 29 overburden and shallow bedrock injection wells. Two injection events are planned, with the second injection event to take place approximately 6 months to 12 months after the first event.

The first EVO application is anticipated to require approximately 2 to 3 weeks depending upon injection rate and the Call-out contractor's delivery system. This does not include mobilization, demobilization or travel time between injection wells. Site conditions and lithology at individual wells may allow for increased or require decreased flow rates. Injection may be conducted at several injection wells at one time, and/or through the use of manifolds. Both of these options would decrease the overall time frame required for remediation. The second injection application is anticipated to require approximately the same duration of the first application.

4.7 Performance Monitoring

Following the injection of EVO field parameters (water level, ORP, DO, pH, specific conductivity, turbidity, temperature) will be measured in injection and monitoring wells in accordance with the schedule

shown on the Drawings. These parameters will be measured at all injection wells and all existing and new monitoring wells north of the railroad tracks.

Groundwater will be sampled at all monitoring wells listed in the Contract Drawings prior to the initial ISCR application, following the first ISCR injection, following the second ISCR injection, and approximately six months after the second ISCR injection. The groundwater samples will be analyzed for VOCs, TAL metals (total and dissolved), alkalinity, sulfide, sulfate, methane, ethene, nitrite-nitrogen, and total organic carbon as shown on the Contract Drawings.

4.8 Utility Requirements for Injection

Since EVO solutions will be shipped to the Site, on site mixing will not be required, and utilities (electric and water) to accommodate mixing will not be required. Minimal power will be required for injection pumps that can be supplied by running a portable generator supplied by the remediation Call-out contractor. Water will need to be on hand to address spills if they occur. Water could be obtained from hydrants, or it could be trucked in. Hydrant permits will be obtained, if needed.

4.9 Access Requirements

All work during the active construction phase (i.e., excavation, dewatering and treatment, backfilling, injection and monitoring well installation) will be carried out on Site so no other access agreements should be required for this portion of the construction work. The property owner will need to provide access to the NYSDEC and Call-out contractor during the active construction phase. Additional access agreements will be required for adjacent properties/owners during the monitoring phases after ISCR injections, and the baseline monitoring event prior to the ISCR injection phases for off-site well locations as needed.

4.10 Engineering Survey and Environmental Easement

The Contractor shall perform a metes and bounds survey of property, and site topography and features as listed in the Contract Specifications. The survey shall include the limits of proposed work, limits of completed work, injection wells, monitoring wells, and other structures and other physical features where work was performed or that remains at the site. The final survey must meet the requirements for a NYSDEC Environmental Easement, and shall include the Environmental Easement Checklist (https://www.dec.ny.gov/chemical/65118.html) certified by the Remedial Party and the Remedial Party's attorney, along with supporting documentation.

5.0 PERMITS AND APPROVALS

Injection wells used for aquifer remediation and experimental technologies are distinguished from hazardous waste injection wells and are designated as Class V under the United States Environmental Protection Agency (USEPA) Underground Injection Control (UIC) Program. Class V wells covered by the Federal UIC Program are authorized by rule and do not require a separate UIC permit. However, an Inventory of Injection Wells Form must be submitted to the USEPA as required by the USEPA UIC Program to document well installation. The Call-out contractor will be required to obtain a hydrant permit for municipal water usage and coordinate all activities with the Engineer, NYSDEC, and Mr. Charles Gartley – Operations Manager for Erdle Perforating.

Prior to reestablishing power to the Construction Facilities, the Contractor must contact the Town of Gates Building Department to obtain a permit. An excavation permit may also be required.

The planned injections will comply with the NYSDEC Division of Environmental Remediation (DER) "*Guidance on Injections for Remediation*," dated April 21, 2014.

In addition, when the work is initiated, the Call-out contractor shall submit a Job Hazard Analysis (JHA).

6.0 REDUCING REAGENT PURCHASE AND CONSTRUCTION SEQUENCING

EVO products are available from several vendors within the United States including the following:

Evonik Active Oxygens, LLC
2005 Market Street, Suite 3200
Philadelphia, PA 19103 USA
Telephone: 517.669.5400
Contact: John Valkenburg
Email: John.Valkenburg@Evonik.com
Company Web Page: http://www.evonik.com/remediation

Regenesis, Inc.
1011 Calle Sombra
San Clemente, CA 92673
Telephone: 781.223.5201
Contact: Maureen Dooley
Email: MDooley@Regenesis.com
Company Web Page: http://www.regenesis.com

Hepure Technologies
40 Route 31, Suite 3200
Speedway Plaza - #75
Flemington, NJ 08822
Phone: 866.727.4776 ext. 3
Fax: 888.975.9840
Contact: Santo Auriemma
Email: santo@hepure.com
Company Web Page: http://www.hepure.com/

EOS Remediation, LLC
200 Quade Drive
Cary, NC 27513
Phone: 1 (919) 873-2204
Email: info@eosremediation.com

Company Web Page: http://www.eosremediation.com

This section presents a description of remediation sequencing. The remediation contractor will determine the actual sequence and duration of work segments within the time frame specified in the Contract Documents. The major remediation work elements presented in the expected sequence of implementation are described below.

1. Mobilization of Equipment, Manpower, and Temporary Facilities: It is expected that any temporary facilities required will be located at the site. The Call-out Contractor shall provide separate office trailers equipped with electric and internet services for their personnel and AECOM. The Call-out Contractor shall establish their work zones and construct improvements to the access road as listed in the Contract Drawings.

2. Baseline Monitoring: The Call-out Contractor shall collect a round of groundwater samples from 22 existing monitoring wells situated north of the railroad tracks which will be considered as the baseline groundwater concentration monitoring event.

3. Excavation, Backfill and Restoration: An area south of the former UST will be excavated as shown on the Contract Drawings. Excavation dewatering fluids will be pumped into a frac tank and subsequently treated for disposal. The area will be backfilled and restored in accordance with the Contract Drawings and Specifications.

4. Injection and Monitoring Well Installation: Ten overburden injection wells and nineteen shallow bedrock injection wells will be installed at locations depicted in the Contract Drawings.

5. ISCR Reagent: EVO solution will be injected during two events in the overburden and shallow bedrock wells during two events as listed on the Contract Drawings. Groundwater will be monitored in between each injection to evaluate the effectiveness of bioremediation. Adjustments to the dose may be implemented as appropriate based on the monitoring results.

6. Drummed Waste Materials: Drummed waste materials will be temporarily stored on-site and will be picked up on a routine basis.

7. Performance Monitoring: Performance monitoring will be in accordance with Contract Drawings Post-remediation monitoring will be conducted as directed by the NYSDEC.

8. Demobilization: All temporary facilities will be removed from the Site, temporary utilities discontinued, and disturbed areas restored to the original condition.

9. Well Decommissioning and final site restoration: Injection wells installed for this work will be decommissioned after monitoring is complete and accepted as directed by the NYSDEC. The ground surface will be restored to surrounding conditions.

The selected remediation contractor will submit a detailed construction schedule to NYSDEC and update the schedule as needed.

7.0 REFERENCES

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AECOM. 2022b. Technical Design Memorandum, Erdle Perforating Site (#828072). September.

MACTEC Engineering and Consulting, P.C. [MACTEC]. 2010. Final Remedial Investigation/Feasibility Study Report, Erdle Perforating Company Site # 828072. June.

MACTEC. 2012. Remedial Design (RD) Baseline Groundwater Sampling Letter Report Erdle Perforating Company Site – Site No. 828072. October 4.

MACTEC. 2013. Limited Site Data – Erdle Perforating Company. June.

MACTEC. 2017. Construction Completion Report – Erdle Perforating Company. Erdle Perforating Company Site – Site No. 828072. March.

MACTEC. 2018. May 2018 Post-ERH Remediation Groundwater Sampling Report. July 25.

MACTEC. 2019. May 2019 Groundwater Sampling Report. September 6.

MACTEC. 2020a. November 2019 Groundwater Sampling Report. September.

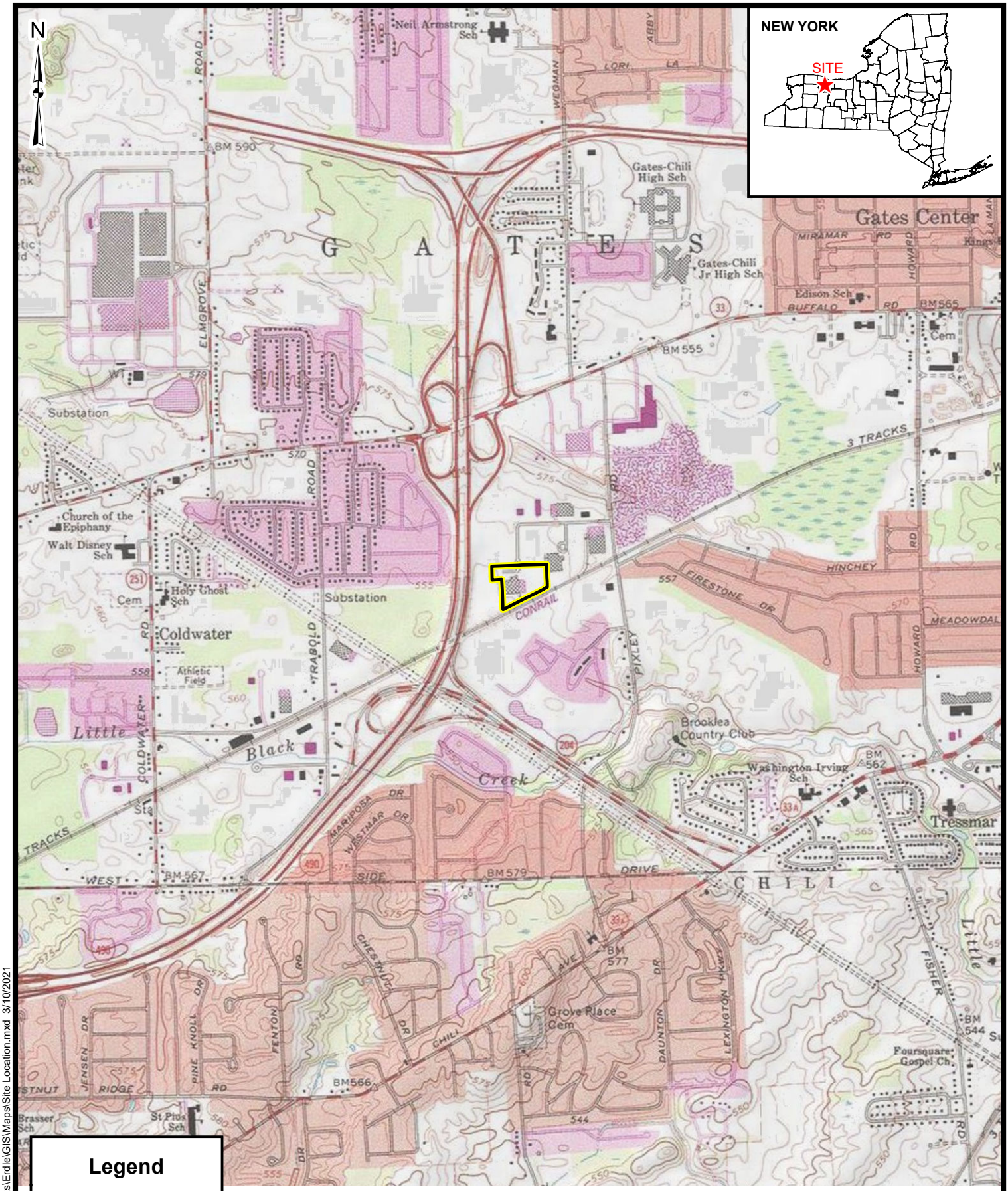
MACTEC. 2020b. June 2020 Groundwater Sampling Report. September 14

New York State Department of Environmental Conservation (NYSDEC). 2010. Record of Decision, Erdle Perforating. December.

Radian Corporation. 1995. Draft Remedial Investigation Report for Erdle Perforating Company Site No. 828072. June

Radian Corporation. 1998. Feasibility Study of Remedial Alternatives. Erdle Perforating Company Site No. 828072. June.

FIGURES

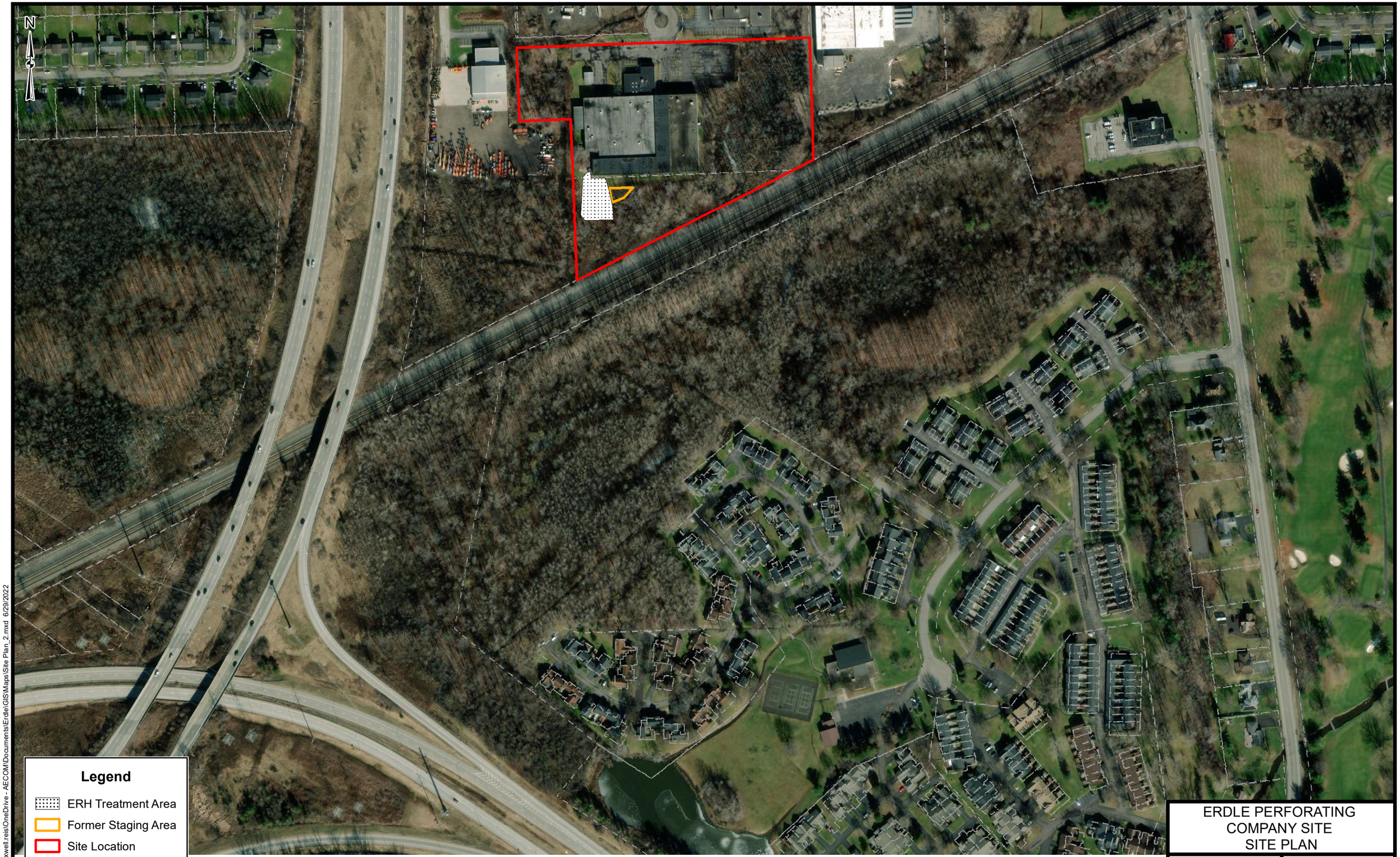


AECOM

ERDLE PERFORATING COMPANY SITE
SITE ID NO. 828072
TOWN OF GATES, MONROE COUNTY, NEW YORK
SITE LOCATION

FIGURE 1

C:\Users\maxwell.reis\Documents\Erdle\GIS\Maps\Site Location.mxd 3/10/2021



C:\Users\maxwell.reis\OneDrive - AECOM\Documents\Erdle\GIS\Maps\Site Plan_2.mxd 6/29/2022

ERDLE PERFORATING COMPANY SITE
SITE PLAN

AECOM

FIGURE 2

N

SEE INSET

MW-05, 553.96

MW-07, 552.39

MW-08, 551.80

MW-09, 552.71

MW-10, NM

MW-11, 547.92

MW-12, 547.80

MW-13, 548.29

MW-14, 548.04

MW-15, 546.71

MW-16, 547.53

MW-17, 547.51

MW-18, 547.62

MW-19, 546.88

MW-20, 548.04

553

552

551

550

549

548

547

INSET

OMW-2, 553.39

MW-02, NM

OMW-1, 553.86

MW-06, 553.03

80 0 80 Feet

250 0 250 Feet

Legend

- Monitoring Well
- Groundwater Flow Direction
- Groundwater Elevation Contour
- Site Location
- Parcel Boundary

ERDLE PERFORATING COMPANY SITE
GROUNDWATER ELEVATION CONTOURS
OVERBURDEN AQUIFER (8/11/21)

AECOM

FIGURE 3

C:\Users\maxwell.reis\Documents\Erdle\GIS\Maps\Groundwater_Elevation_Shallow.mxd 6/27/2022

N

SEE INSET

MW-05D, NM

MW-06D, 552.72

MW-07D, 552.99

MW-08D, 552.63

MW-09D, 552.65

MW-11D, 545.49

MW-13D, 547.93

MW-13DD, 550.53

MW-14D, 552.38

MW-15D, 548.17

MW-16D, 547.52

MW-17D, 547.79

MW-18D, 547.32

MW-19D, 547.28

MW-20D, 547.39

551

550

549

548

547

546

553

548

250 0 250 Feet

INSET

MW-01DD, 552.50

MW-01D, NM

553

BMW-2DD, 553.53

BMW-2D, 553.82

MW-02D, 552.87

MW-03D, 553.05

554

BMW-1DD, 553.61

BMW-3D, 554.10

BMW-1D, 553.88

BMW-3DD, 553.49

80 0 80 Feet

Legend

- Monitoring Well
- Groundwater Flow Direction
- Groundwater Elevation Contour
- Site Location
- Parcel Boundary

ERDLE PERFORATING COMPANY SITE
GROUNDWATER ELEVATION CONTOURS
BEDROCK AQUIFER (8/11/21)

AECOM

FIGURE 4

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N

ERDLE BUILDING

ROAD

140N -20E (11' - 12')	CRIT 1	CRIT 2	06/21		
VOCs:					
Acetone	0.05	500	0.062		

120N 0E (2' - 2.5')	CRIT 1	CRIT 2	06/21		
VOCs:					
Acetone	0.05	500	0.13		

120N -20E (2' - 4')	CRIT 1	CRIT 2	06/21		
VOCs:					
Acetone	0.05	500	0.17		

120N -20E (12' - 13')	CRIT 1	CRIT 2	06/21		
VOCs:					
Trichloroethene	0.47	200	5.6		

100N -20E (12' - 13')	CRIT 1	CRIT 2	06/21		
VOCs:					
Acetone	0.05	500	0.056		

100N 0E (10.5' - 11')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	2.5		
Trichloroethene	0.47	200	4.4		

100N 0E (13' - 13.5')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	0.32		
Vinyl chloride	0.02	13	0.75		

120N 20E (3.9' - 4')	CRIT 1	CRIT 2	06/21		
VOCs:					
Acetone	0.05	500	0.065		

120N 20E (14.5' - 14.9')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	2.1		
Trichloroethene	0.47	200	46		

120N 40E (5.3' - 5.7')	CRIT 1	CRIT 2	06/21		
VOCs:					
Acetone	0.05	500	0.058		

120N 40E (10' - 11')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	1.2		

100N 20E (14' - 14.4')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	2.5		
Tetrachloroethene	1.3	150	2.6		
Trichloroethene	0.47	200	160		

OMW-2 (13' - 14')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	0.53		
Trichloroethene	0.47	200	31		

105N 140E (14' - 14.3')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	3.9		

80N 20E (13.5' - 14')	CRIT 1	CRIT 2	06/21		
VOCs:					
Acetone	0.05	500	0.17		
Vinyl chloride	0.02	13	1		

60N 80E (10.5' - 11')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	0.38		
Trichloroethene	0.47	200	4.6		

60N 0E (11' - 11.5')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	6.4		

60N 0E (12.5' - 13')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	2.5		
Trichloroethene	0.47	200	0.83		

60N 60E (11' - 11.5')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	0.62		
Trichloroethene	0.47	200	24		

60N 20E (10.5' - 11')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	4.2		
Trichloroethene	0.47	200	0.66		

20N 20E (11' - 11.5')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	10		
Trichloroethene	0.47	200	13		

20N 40E (13.9' - 14.1')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	0.42		
Trichloroethene	0.47	200	1.4		

0N 0E (12' - 13')	CRIT 1	CRIT 2	06/21		
VOCs:					
Trichloroethene	0.47	200	2		

BMW-3DD (13' - 14')	CRIT 1	CRIT 2	06/21		
VOCs:					
1,2-Dichloroethene (cis)	0.25	500	2.1		
Trichloroethene	0.47	200	19		

140N -40E
120N -60E
120N -80E
120N 100E
120N 120E
120N 140E
105N 120E
100N 80E
100N 100E
100N -40E
100N 60E
80N -20E
80N 0E
80N 40E
80N 60E
60N 40E
40N 0E
40N 20E
40N 60E
20N 0E
20N 60E
0N -20E
0N 20E

Legend

- Soil Boring
- 20'x20' Grid
- ERH Treatment Area
- Former Staging Area
- Site Location
- Parcel Boundary
- Approximate Treeline

Depth (ft) | Criteria

Location ID — 80N 20E (13.5' - 14') | CRIT 1 | CRIT 2 | 06/21 — Date

VOCs: Acetone | 0.05 | 500 | 0.17

Parameter — Concentration (mg/kg)

NOTES:
CRIT 1 = 6 NYCRR Part 375.6, Remedial Program Soil Cleanup Objectives, Effective 12/14/06. Restricted Use. Protection of Groundwater, including CP-51 Table 1, Effective 12/2/10.
CRIT 2 = 6 NYCRR Part 375.6, Remedial Program Soil Cleanup Objectives, Effective 12/14/06. Protection of Public Health, Commercial, including CP-51 Table 1, Effective 12/2/10.

20 0 20 Feet

ERDLE PERFORATING COMPANY SITE
SOIL ANALYTICAL RESULTS

AECOM

FIGURE 5

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N

ERDLE BUILDING

ROAD

OMW-2	CRIT	08/21
VOCs:		
1,2-Dichloroethene (cis)	5	27000
Trichloroethene	5	140000
Vinyl chloride	2	2200

BMW-2DD

BMW-2D	CRIT	08/21
VOCs:		
1,2-Dichloroethene (cis)	5	190
Trichloroethene	5	150
Vinyl chloride	2	8.7

BMW-1DD

OMW-1	CRIT	08/21
VOCs:		
1,2-Dichloroethene (cis)	5	260
Vinyl chloride	2	99

BMW-3D

BMW-3DD

BMW-1D	CRIT	08/21
VOCs:		
1,2-Dichloroethene (cis)	5	490
Trichloroethene	5	2300

Legend

- Monitoring Well
- ERH Treatment Area
- Former Staging Area
- Site Location
- Parcel Boundary
- Approximate Treeline

Criteria

Location ID — BMW-1D | CRIT | 08/21 — Date

VOCs:
1,2-Dichloroethene (cis) | 5 | 490

Parameter — Concentration (ug/l)

NOTE:
CRIT = NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 and 6/2004 Addenda) Class GA.

20 0 20 Feet

ERDLE PERFORATING COMPANY SITE GROUNDWATER ANALYTICAL RESULTS

AECOM

FIGURE 6

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N

ERDLE BUILDING

ROAD

140N -40E
12'-13', ND

140N -20E
11'-12', ND

120N -20E
12'-13', 5.6

120N 0E
2'-2.5', 0.014

120N 20E
14.5'-14.9', 46

120N 40E
5.3'-5.7', 0.0034

120N 60E
8.5'-9.5', 0.022

120N 80E
13.9'-14.6', 0.0012

120N 100E
14.5'-15.1', 0.0012

120N 120E
14'-14.6', ND

120N 140E
14'-14.3', 0.0027

105N 140E
14'-14.3', ND

105N 120E
4'-4.5', ND

100N -20E
12'-13', ND

100N 0E
10.5'-11', 4.4

100N 20E
14'-14.4', 160

100N 40E
14'-14.5', 0.006

100N 60E
14'-14.5', 0.0019

100N 80E
14.2'-14.4', 0.0023

100N 100E
14'-14.2', ND

OMW-2
13'-14', 31

80N -20E
12'-13', 0.0036

80N 20E
13.5'-14', 0.0035

80N 40E
13.5'-14.3', 0.0015

80N 60E
7'-7.5', 0.0016

80N 0E
13'-13.7', ND

60N 0E
12.5'-13', 0.83

60N 20E
10.5'-11', 0.66

60N 40E
10.5'-11.5', ND

60N 60E
11'-11.5', 24

60N 80E
10.5'-11', 4.6

40N 0E
13'-13.9', 0.0025

40N 20E
2.5'-3', 0.053

40N 60E
0.002

BMW-3DD
13'-14', 19

20N 60E
13.5'-14.3', 0.0019

20N 0E
7.5'-8.1', 0.0049

20N 20E
11'-11.5', 13

20N 40E
13.9'-14.1', 1.4

0N -20E
11'-12', 0.0014

0N 0E
12'-13', 2

0N 20E
12'-13', 0.003

Legend

Maximum Trichloroethene Concentartion (mg/kg)

- ND
- <1
- 1-10
- 10-50
- 50-100
- >100

TCE Isoconcentration

- 1
- 10
- 100
- 20'x20' Grid
- ERH Treatment Area
- Former Staging Area
- Site Location
- Parcel Boundary
- Approximate Treeline

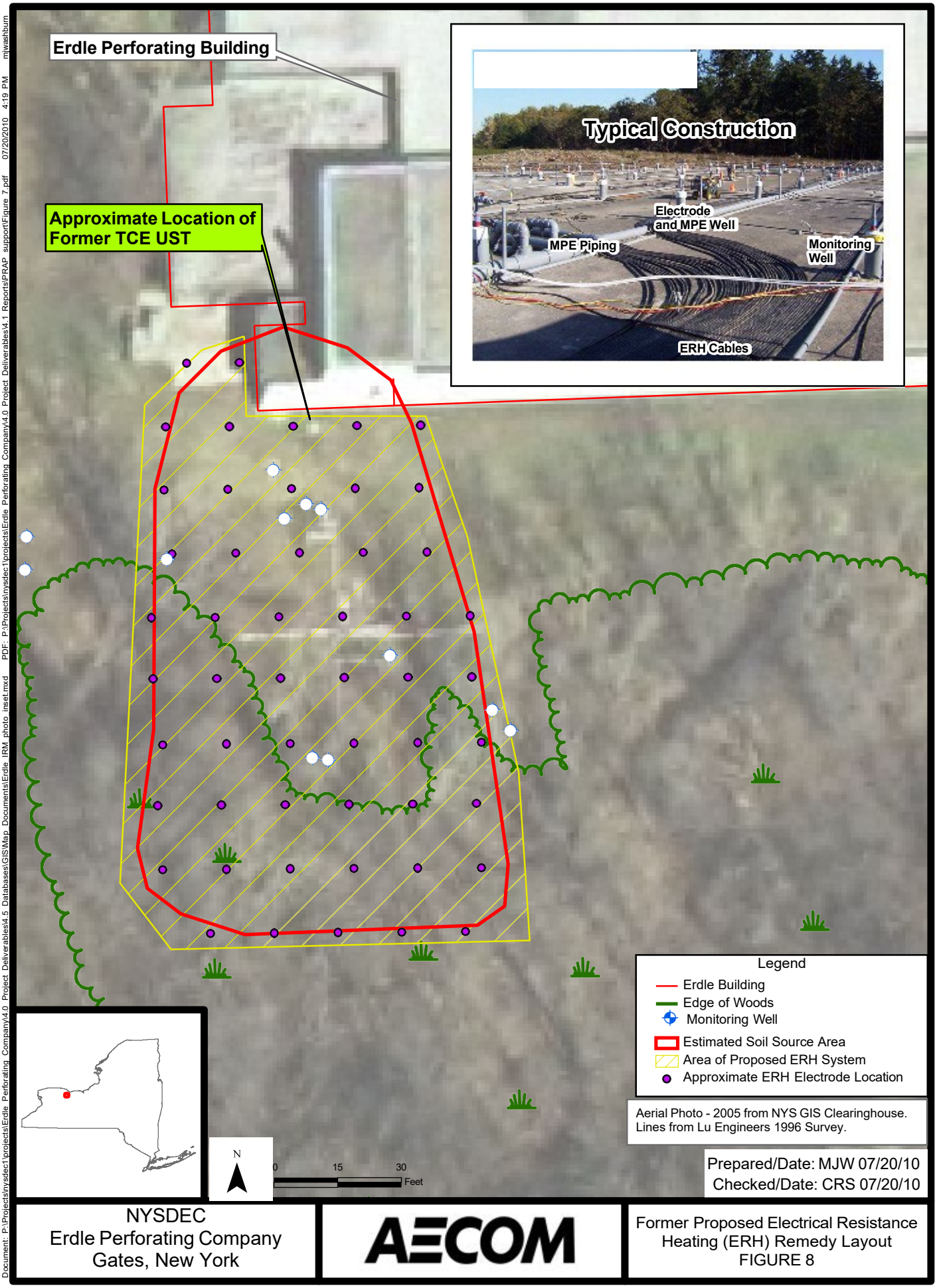
20 0 20 Feet

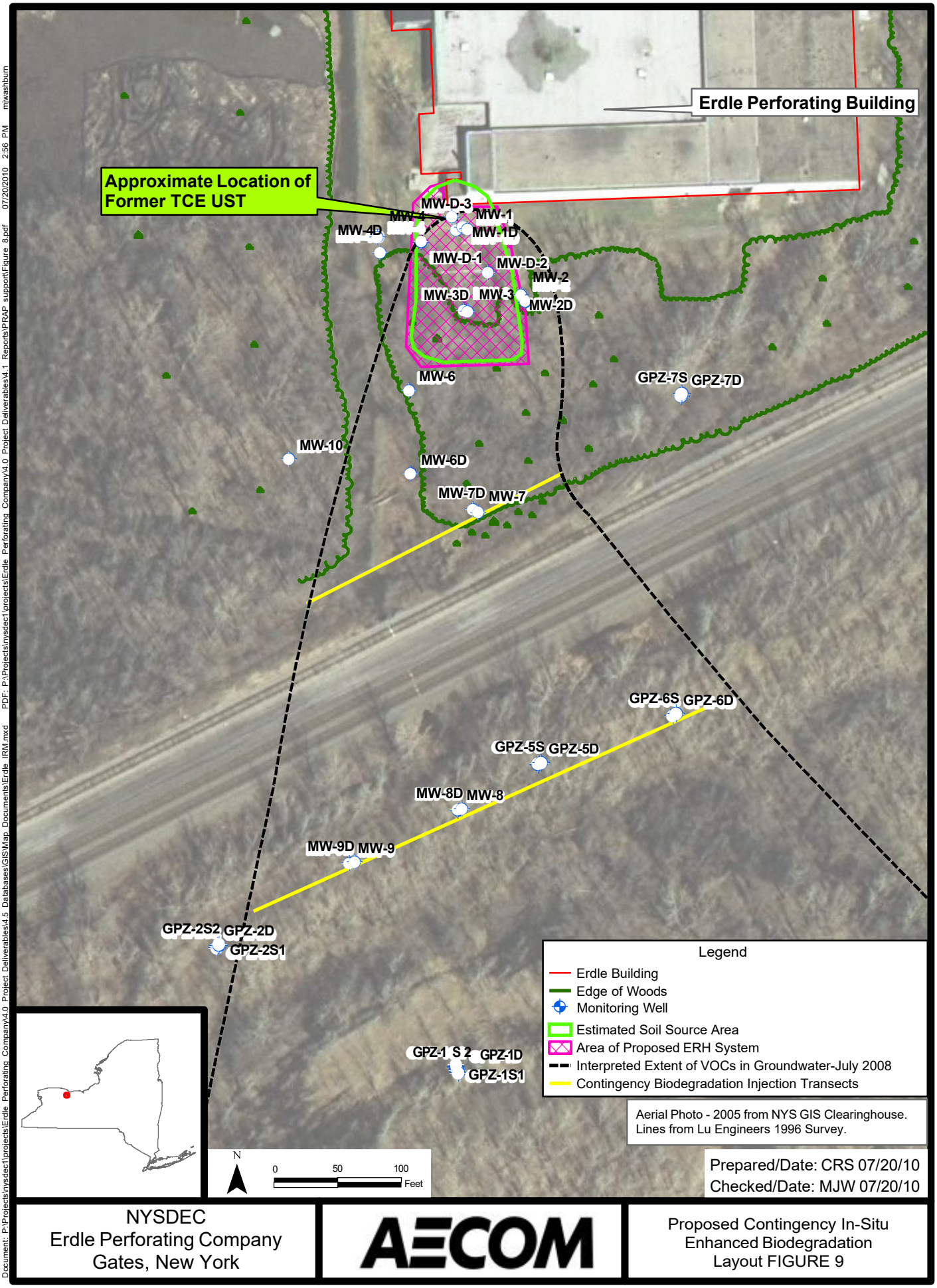
ERDLE PERFORATING
COMPANY SITE
SOIL TCE ISOCONCENTRATION

AECOM

FIGURE 7

C:\Users\maxwell.reis\Documents\Erdle\GIS\Maps\Soil_TCE_Isocontour.mxd 6/30/2022


Erdle Perforating Building
Approximate Location of Former TCE UST
Typical Construction
Electrode and MPE Well
MPE Piping
Monitoring Well
ERH Cables
Legend
Erdle Building
Edge of Woods
Monitoring Well
Estimated Soil Source Area
Area of Proposed ERH System
Approximate ERH Electrode Location
Aerial Photo - 2005 from NYS GIS Clearinghouse.
Lines from Lu Engineers 1996 Survey.
N
0
15
30
Feet
Prepared/Date: MJW 07/20/10
Checked/Date: CRS 07/20/10
NYSDEC
Erdle Perforating Company
Gates, New York
AECOM
Former Proposed Electrical Resistance Heating (ERH) Remedy Layout
FIGURE 8
Document: P:\Projects\nysdec1\projects\Erdle Perforating Company\V4.0 Project Deliverables\4.5 Databases\GISMap Documents\Erdle IRM photo inset.mxd PDF: P:\Projects\nysdec1\projects\Erdle Perforating Company\V4.0 Project Deliverables\4.1 Reports\PRAP support\Figure 7.pdf 07/20/2010 4:19 PM mjwashburn


Erdle Perforating Building
Approximate Location of Former TCE UST
MW-D-3
MW-1
MW-1D
MW-4D
MW-D-1
MW-D-2
MW-2
MW-3D
MW-3
MW-2D
MW-6
GPZ-7S
GPZ-7D
MW-10
MW-6D
MW-7D
MW-7
GPZ-6S
GPZ-6D
GPZ-5S
GPZ-5D
MW-8D
MW-8
MW-9D
MW-9
GPZ-2S2
GPZ-2D
GPZ-2S1
GPZ-1S2
GPZ-1D
GPZ-1S1
Legend
Erdle Building
Edge of Woods
Monitoring Well
Estimated Soil Source Area
Area of Proposed ERH System
Interpreted Extent of VOCs in Groundwater-July 2008
Contingency Biodegradation Injection Transects
Aerial Photo - 2005 from NYS GIS Clearinghouse.
Lines from Lu Engineers 1996 Survey.
N
0
50
100
Feet
Prepared/Date: CRS 07/20/10
Checked/Date: MJW 07/20/10
NYSDEC
Erdle Perforating Company
Gates, New York
AECOM
Proposed Contingency In-Situ
Enhanced Biodegradation
Layout FIGURE 9
Document: P:\Projects\nysdec1\projects\Erdle Perforating Company\v4.0 Project Deliverables\4.5 Databases\GISMap Documents\Erdle IRM.mxd PDF: P:\Projects\nysdec1\projects\Erdle Perforating Company\v4.0 Project Deliverables\4.1 Reports\PRAP support\Figure 8.pdf 07/20/2010 2:56 PM mjwashburn

N

ERDLE BUILDING

ROAD

140N -40E
12'-13', ND

140N -20E
11'-12', ND

120N -20E
12'-13', 5.6

120N 0E
2'-2.5', 0.014

120N 20E
14.5'-14.9', 46

120N 40E
5.3'-5.7', 0.0034

120N 60E
8.5'-9.5', 0.022

120N 80E
13.9'-14.6', 0.0012

120N 100E
14.5'-15.1', 0.0012

120N 120E
14'-14.6', ND

120N 140E
14'-14.3', 0.0027

105N 140E
14'-14.3', ND

105N 120E
4'-4.5', ND

100N -20E
12'-13', ND

100N 0E
10.5'-11', 4.4

100N 20E
14'-14.4', 160

100N 40E
14'-14.5', 0.006

100N 60E
14'-14.5', 0.0019

100N 80E
14.2'-14.4', 0.0023

100N 100E
14'-14.2', ND

OMW-2
13'-14', 31

80N -20E
12'-13', 0.0036

80N 20E
13.5'-14', 0.0035

80N 40E
13.5'-14.3', 0.0015

80N 60E
7'-7.5', 0.0016

80N 0E
13'-13.7', ND

60N 0E
12.5'-13', 0.83

60N 20E
10.5'-11', 0.66

60N 40E
10.5'-11.5', ND

60N 60E
11'-11.5', 24

60N 80E
10.5'-11', 4.6

40N 0E
13'-13.9', 0.0025

40N 20E
2.5'-3', 0.053

40N 60E
0.002

BMW-3DD
13'-14', 19

20N 60E
13.5'-14.3', 0.0019

20N 0E
7.5'-8.1', 0.0049

20N 20E
11'-11.5', 13

20N 40E
13.9'-14.1', 1.4

0N -20E
11'-12', 0.0014

0N 0E
12'-13', 2

0N 20E
12'-13', 0.003

Legend

Maximum Trichloroethene Concentration (mg/kg)

- ND
- <1
- 1-10
- 10-50
- 50-100
- >100

TCE Isoconcentration

- 1
- 10
- 100
- 20'x20' Grid
- Proposed Shallow Bedrock Injection Well
- Proposed Overburden/Shallow Bedrock Injection Well Pair
- Approximate Location of Former TCE UST
- Proposed Soil Excavation Area
- Former ERH Treatment Area
- Former Staging Area
- Site Location
- Parcel Boundary
- Approximate Treeline

20 0 20 Feet

ERDLE PERFORATING COMPANY SITE
SOIL TCE ISOCONCENTRATION &
CONCEPTUAL DESIGN - INJECTION
WELL LOCATION & EXCAVATION AREA

AECOM

FIGURE 10

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APPENDIX A

SAFETY DATA SHEET

EOS Remediation, LLC

EOS PRO

SAFETY DATA SHEET

Section 1: Identification	
Product Name:	**EOS Pro**
Chemical Description:	Mixture; vegetable oil emulsion
Manufacturer:	EOS Remediation PO Box 14266 Research Triangle Park NC 27709 (P): 919-873-2204 www.eosremediation.com
Recommended Use:	Groundwater bioremediation (environmental applications)
Restricted Use:	Not for human consumption.
24-Hour Emergency Contact:	ChemTel: United States (P): 800-255-3924 ChemTel: International (P): 813-248-0585

Section 2: Hazard(s) Identification	
Hazard Classification:	Irritant (skin and eye)
Signal Word:	Warning
Hazard Statement(s):	Potential eye and skin irritant.
Pictograms:	
Precautionary Statement(s):	Not for human consumption. Do not store near excessive heat or oxidizers. Avoid contact with eyes and skin. Wear protective gloves and eye protection.

Section 3: Composition/Information on Ingredients		
Common Name(s)	**CAS NO.**	**% by Weight**
Soybean Oil	8001-22-7	60
Food Grade Emulsifiers Trade Secret[1,2]	111-03-5	10
Soluble Substrates (glycerol) Trade Secret[1,2]	56-81-5	4
Water	7732-18-5	26

1 – The precise composition of this product is proprietary information. A more complete disclosure will be provided to a physician in the event of a medical emergency.
2 – The soluble substrates and emulsifiers are generally recognized as safe for food contact.

Section 4: First-Aid Measures	
Routes of Exposure	**Emergency First-Aid Procedures**
Inhalation	Remove to fresh air.
Eye Contact	Flush with water for 15 minutes; if irritation persists see a physician.
Skin Contact	Wash with mild soap and water.
Ingestion	Product is non-toxic. If nausea occurs, induce vomiting and seek medical attention.

Section 5: Fire-Fighting Measures	
Extinguishing Media:	CO_2, foam, dry chemical Note: Water, fog and foam may cause frothing and spattering.
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and chemical resistant clothing. Use water spray to cool fire exposed containers.
Fire Hazard(s):	Burning will cause oxides of carbon.

Section 6: Accidental Release Measures	
Personal Precautions:	Avoid contact with eyes and skin. Do not consume.
Emergency Procedures:	N/A
Methods & Materials used for Containment:	Compatible granular absorbent
Cleanup Procedures:	Spread compatible granular absorbent over spill area and sweep using broom and pan; dispose in appropriate receptacle. Clean area with water.

Section 7: Handling and Storage	
Safe Handling & Storage:	Do not store near excessive heat or oxidizers.
Other Precautions:	Consumption of food and beverages should be prevented in work area where product is being used. After handling product, always wash hands and face thoroughly with soap and water before eating, drinking, or smoking.

Section 8: Exposure Controls/Personal Protection		
Exposure Limits		
OSHA PEL:	NE	
ACGIH TLV:	NE	
NIOSH REL:	NE	
Personal Protective Measures		
Respiratory Protection:	Not normally required. P95 respirator if aerosols might be generated.	
Hand Protection:	Protective gloves are recommended	
Eye Protection:	Recommended	
Engineering Measures:	Local exhaust ventilation if aerosols are generated	
Hygiene Measures:	Wash promptly with soap & water if skin becomes irritated from contact.	
Other Protection:	Wear appropriate clothing to prevent skin contact.	

Section 9: Physical and Chemical Properties			
Appearance:	White Liquid	Explosive Limits:	NE
Odor:	Vegetable Oil	Vapor Pressure:	NE
Odor Threshold:	NE	Vapor Density:	Heavier than air
pH:	6.0-7.0 (su)	Relative Density:	0.96-0.98
Melting Point/Freezing Point:	Liquid at room temperature	Solubility:	Dispersible
Boiling Point:	212°F (100°C)	Partition coefficient:	NE
Flash Point:	>300°F (149°C)	Auto-ignition Temperature:	NE
Evaporation Rate:	NE	Decomposition Temperature:	N/A
Flammability (solid, gas):	NE	Viscosity:	500-1500 cP

NE – Not Established

Section 10: Stability and Reactivity	
Stability:	Stable
Incompatibility:	Strong acids and oxidizers
Hazardous Decomposition Products:	Thermal decomposition may produce oxides of carbon
Hazardous Reactions/Polymerization:	Will not occur
Conditions to Avoid:	None known

Section 11: Toxicological Information		
Likely Routes of Exposure:		Ingestion, dermal and eye contact
Signs and Symptoms of Exposure:		None known
Health Hazards		
	Acute:	Potential eye and skin irritant
	Chronic:	None known
Carcinogenicity		
	NTP:	No
	IARC:	No
	OSHA:	No

Section 12: Ecological Information (non-mandatory)
There is no data on the ecotoxicity of this product.

Section 13: Disposal Considerations (non-mandatory)	
Waste Disposal Methods:	Dispose of according to Federal and local regulations for non-hazardous waste. Recycle, if practical.

Section 14: Transport Information (non-mandatory)
The product is not covered by international regulation on the transport of dangerous goods.
No transport warning required.

Section 15: Regulatory Information (non-mandatory)
N/A

Section 16: Other Information	
Date of Preparation:	29 May 2014
Last Modified Date:	27 June 2019
The information contained herein is based on available data and is believed to be correct. However, EOS Remediation, LLC makes no warranty, expressed or implied, regarding the accuracy of this data or the results to be obtained thereof. This information and product are furnished on the condition that the person receiving them shall make his/her own determination as to the suitability of the product for his/her particular purpose.	

APPENDIX B

BASELINE SUSTAINABILITY CALCULATION

AECOM
248 Chapman Road
Suite 101
Newark, DE 19702
www.aecom.com

302 781 5900 tel
302 781 5901 fax

Memorandum

To	File	Page	1
Subject	**Baseline Sustainability Calculation Erdle Perforating Site Gates, New York**		
From	Maureen McBride		
Date	April 11, 2024		

Overview

AECOM conducted a sustainability baseline calculation for the Erdle Perforating site in Gates, New York in support of the 95% Design Report. The sustainability of remediation options is typically evaluated against a number of indicators using metrics to quantify each indicator. Indicators are generally grouped under the three sustainability pillars (environmental, social and economic). A sustainability assessment may include a single pillar (most commonly environmental) or a combination of pillars depending on the stakeholders and goals for the site. For this project, environmental factors were quantified using SiteWise™ to set a baseline using standard operational practices. This baseline will be compared to actual operations to assess the effectiveness of Best Management Practices (BMPs) implemented during the construction and long-term monitoring phases of remediation.

SiteWise™

SiteWise™ is a series of publicly available Microsoft Excel spreadsheets used to calculate the environmental footprint of remediation activities in terms of sustainability metrics. This tool is a footprint estimator based on life cycle equivalents. SiteWise™ was developed in a joint effort by Battelle Memorial Institute, the US Navy, and the US Army Corps of Engineers (NAVFAC, 2015). Use of the SiteWise™ tool involves developing a conceptual design for each remediation alternative and using these designs as the basis for the inputs in the tool.

The SiteWise™ tool calculates the following metrics using life cycle equivalents (i.e. published emission factors, consumption rates, and accident statistics):

- Air emissions, including:
  - Greenhouse gases (GHGs), reported as the combined total of carbon dioxide (CO_2) methane (CH_4), and nitrous oxide (N_2O)
  - On-site and total nitrogen oxides (NO_X)
  - On-site and total sulfur oxides (SO_X)
  - On-site and total airborne particulate matter (PM_{10})
- Energy use
- Accident risk (injury and fatality)
- Hazardous and non-hazardous waste quantities

SiteWise™ calculations comprise materials production (including raw materials and other construction/treatment materials); transportation of materials, personnel, and equipment to the site; on-site construction activities (i.e., excavation and capping equipment operation); on-site labor; transportation of waste for off-site disposal; and management of landfills proportional to the quantity of waste disposed. The emissions factors in SiteWise™ reflect the full life cycle of materials and waste.

Calculations for a typical remediation assessment include the following principal elements:

- Development of a conceptual design for each remediation scenario and identifying the necessary SiteWise™ inputs for each.
- Critical evaluation of the inputs of each remediation option to develop a consistent and defensible baseline for each option within the SiteWise™ domain.
- Running the SiteWise™ model for each scenario and optimizing the model parameters to generate realistic outputs, and conducting a technical review for consistency and 'real-world' practicality.
- Interpreting data and outputs in terms of sustainability metrics to evaluate the net benefits and impacts of each remediation alternative.

Once the conceptual designs and inputs and assumptions tables are generated and reviewed by the assessment team, the SiteWise™ tool is run for each remedial alternative individually, and then compiled to create a final summary which compares the environmental footprint of all of the remedial alternatives. Estimates and assumptions used in the assessment are included in Attachment 1. For this assessment, the environmental impacts of the selected remedial alternative were calculated to generate a baseline.

SiteWise™ provides a detailed breakdown of how each activity of a remedial alternative (i.e. transportation, equipment use, materials, etc.) contributes to the various environmental metrics. The individual results for each alternative provide insight as to which stages of the remedial process and which activities produce the highest environmental impacts. Results for the baseline remedial alternative are included in Attachment 2.

The final summary comparison results from the SiteWise™ tool focus on the bigger picture and highlight the differences in environmental impacts for various remedial alternatives. A final summary will be generated for this project after a period of operation to evaluate the effectiveness of BMPs in reducing the environmental impact of operations during the construction and long-term monitoring phases of remediation.

Remediation Scope

The scope of operations for construction and long-term monitoring at the Erdle site is as follows:

- Install injection and monitoring wells
- Soil excavation
- Emulsified vegetable oil injections
- Peformance monitoring and post-remediation sampling
- Waste disposal

Sustainability Assessment

SiteWise™ Results

As described above, the SiteWise™ inputs were generated based on the current scope for site maintenance and monitoring activities. The scope of work, including assumptions and references, is outlined in the inputs and assumptions table. This table, included in Attachment 1, serves as the basis for the SiteWise™ input sheets and includes details for each component of the scope. The inputs and assumptions were based on information known from project results to date, previous experience, and on sound engineering judgement.

The results summarized in this section are based on the detailed breakdown of contributions to individual environmental metrics from each remedial activity.

GHG emissions: For this project, there are several significant contributors to GHG emissions. Consumables such as fill soil, well installation materials, and injectant contribute 48% of GHG emissions; residual handling, which includes transportation and landfill operations, contributes 30%; and on-site equipment use (loaders, bulldozers, excavators, pumps, etc.) contributes 17%. Transportation of personnel and equipment have the smallest impacts, at about 3% each of total GHG emissions. This is lower than for typical projects because almost all labor and materials for this project can be sourced locally.

Fill soil accounts for approximately 58% of consumables emissions, while emulsified vegetable oil accounts for about 35%. Residual handling is evenly divided between transportation and landfill operations. Over 75% of GHG emissions from on-site equipment use result from drilling using a hollow-stem auger.

Energy Use: The primary contributors to energy use are consumables (58%) and residual handling (27%). Similar to GHG emissions, transportation of personnel and equipment have the smallest impacts, at 2% each of total energy use.

Water Use: Nearly all water consumed for this project is directly consumed from the municipal water supply. Less than 1% of water consumption is related to electricity for dewatering operations during construction.

Criteria Pollutants: Total NO_x emissions are divided between on-site equipment use (39% - local impact), consumables (38% - global impact), and residual handling (23% - global impact). Total SOx emissions are primarily from consumables (76%), while total PM_{10} emissions are primarily from residual handling (75%). The Erdle site is located in Monroe County, NY which is classified as an attainment area for criteria pollutants.

Accident Risk: Accident risk is highest for on-site equipment use. Residual handling and personnel transportation are also a factor due to road miles traveled.

Recommendation

Apply BMPs to reduce environmental impact where possible. Potential BMPs may include:

- To reduce impacts from consumables, residual handling, and criteria pollutants:
  - Consider additional delineation to minimize excavation area
  - Consider re-use of overburden or other uncontaminated soils for a portion of backfill

- Consider bench-scale testing to refine/reduce the amount of injectant used for enhanced bioremediation
- Consider alternative drill types such as direct push or sonic
- Use local staff when possible
- Staff will travel together rather than separately where possible
- Use lower emission vehicles such as electric vehicles or small trucks or SUVs rather than full-size, where appropriate

Materal and equipment use will be tracked during construction and long-term monitoring to assess the effectiveness of BMPs. The New York State Department of Environmental Control Form A (Summary of Green Remediation Metrics) will be used for reporting. A copy of Form A is included as Attachment 3.

List of Attachments

Attachment 1 SiteWise™ Inputs and Assumptions
Attachment 2 SiteWise™ Detailed Results for Baseline Calculation
Attachment 3 Best Management Practices Reporting Sheet

Attachments

AECOM

Attachment 1
SiteWise™ Estimates and Assumptions
Erdle Perforating Site
Site No. 828072
Excavation and ISCO Injections

Remedy Task	Item	Quantity	Units	Quantity	Units	Assumptions
Excavation	Excavator	1,500	cy	21	tons equipment weight	170 hp; from Caterpillar site, 21 tons
	Loader	1,500	cy	16	tons equipment weight	Per project team: Volvo L70. Specs: 27,556 - 34,172 lbs; use 32,000 lb
	Dozer	1,500	cy	34	tons equipment weight	Per project team: Komatsu 300. Specs: 67,900 – 69,470 lb. Use 68,500 lb
	Skid Steer	160	hours operation	160	gallons diesel	1 week at 1 gallon per hour; 8 hours per day. Mid-size (74 hp) approx. 7,000 lb per Bobcat specs.
	Equipment delivery	20	miles one-way	8	trips	Each arrives separately. Weights shown above.
	Laborer (2)	320	hours	20	days	Heavy-duty truck
	Travel	20	trips	20	miles round trip	Travel together
	Operator (2)	320	hours	20	days	Light-duty truck
	Travel	5	trips each	20	miles round trip	Travel separately
	Foreman (Input as laborer) (1)	160	hours	20	days	Light-duty truck
	Travel	20	trips	20	miles round trip	Travel separately
Excavation Dewatering	Pump	1	hP	120	operating hours	Excavation - 1 weeks = 21 days
	Frac tank - 21,000 gallons	20	miles one-way	2	trips	2 trips - deliver & return
		13	tons			Weight spec from Rain for Rent
	Non-hazardous Waste Transportation	5,500	gallons per trip	10	truckloads	Vacuum truck
		10	trips	50	miles each way	
	Labor	-				Accounted for in Excavation task
Excavation Waste Handling - Soil	Non-hazardous Waste Disposal	1,800	tons	5	miles each way	1.5 tons/cy
	Non-hazardous Waste Transportation	82	trips			22 tons per trip
	Non-hazardous landfill ops	1,800	tons			
	Hazardous Waste Transportation	450	tons	500	miles each way	1.5 tons/cy
		21	trips			22 tons per trip
	Hazardous Waste Landfill ops	450	tons			
Backfill	Transport Backfill to Site	2,250	tons	10	miles each way	
		103	trips	1,030	miles one way total	22 tons per trip
	Amendment - Daramend	6	tons	75	miles each way	1% by weight of 33% of backfill amount
		1	trips			
	Direct placement - Excavator and Dozer	1,500	cy			Backfill + amendment. Daramend density 0.75-0.95 kg/L per SDS. Use 0.85; = 0.72 tons per cy.
	Labor	-				Accounted for in Excavation task
Injection Well Installation	Well materials	41	wells; 2", 4" , 6" nominal diameter	14/31/40	ft deep	Schedule 40 PVC/Steel Casing; flush mount construction; 15-foot screen
		364	kg sand, per well			Materials from project team
		16	kg bentonite, per well			
		-	-			
		136	kg concrete, per well			
		5	kg cast iron, per well			
	Materials Transportation	23	tons	20	miles each way	
		1	trip			
	Municipal water used for installation	40,000	gallons			
	Drill Rig - Hollow Stem Auger	256	hours total			From project team
	Drill Rig Operator (2)	512	hours	32	days	Heavy-duty truck + drill rig
	Travel	32	trips	20	miles round trip	Travel together
	Foreman (Input as laborer) (1)	256	hours	32	days	Light-duty truck
	Travel	32	trips	20	miles round trip	Travel separately
Well Install - Development Water	Pump	1	hP	82	operating hours	Intermittent operation. About 50 gallons per well at 1 gpm = 1 hour per well.
	Frac tank - 21,000 gallons	-	miles one-way	-	trips	Accounted for in excavation
		-	tons			
	Total gallons wastewater	10,000	gallons			
	Non-hazardous Waste Transportation	5,000	gallons per trip	2	truckloads	Vacuum truck
		2	trips	50	miles each way	
	Labor	-				Accounted for in Injection Well installation task
Well Install Waste Handling - Soil	Non-hazardous Waste Transportation	25	tons	25	miles each way	1.5 tons per cy.
		1	trips			
	Non-hazardous Waste Disposal	25	tons			Landfill operations
ISCR Injections	Diaphragm pump for injection - gasoline operation, 4-stroke, 6-11 hp (pump selection from SiteWise)	60	days	360	hours drill pump ops	Duration from project team. Drill rig ops 6 hours per day.
	Municipal water used for injections	40,000	gallons			From project team: 33 gallons water per gallon EOS
	Emulsified Vegetable Oil	8,800	gallons	36	tons	From sds: specific gravity average 0.97
	Vegetable Oil Transportation	20	miles each way	2	loads	16, 275-gallon totes
	Well development water	100	gallons per well	4,100	total gallons	
	Frac tank - 21,000 gallons	20	miles one-way	2	trips	2 events, 2 trips each - deliver & return
		13	tons			Weight spec from Rain for Rent
	Non-hazardous Waste Transportation	5,500	gallons per trip	8	trips	Vacuum truck
		8	trips	50	miles each way	
	Laborer (3)	720	hours	30	days	Light-duty truck.
	Travel	30	trips	20	miles round trip	Travel together
	Laborer (2)	480	hours	30	days	Light-duty truck.
	Travel	30	trips	20	miles round trip	Travel together
Monitoring	Labor - Scientific & technical	400	hours	20	miles round trip	2 staff, travel together; 15 events, 2.25 days each (20 wells); 8 drums purge water + 1 drum IDW per event. Light truck.
				7	trips	
	Materials	24	55-gallon steel drums	960	pounds steel	Per Grainger catalog: 40 lb each
	Materials delivery	20	miles each way	0.2	tons per trip	
	Non-hazardous Waste Transportation	2	tons per trip			Loaded drums = 500 lb average
		7	trips	10	miles each way	
Oversight	Scientific & Technical (1)	200	hours	150	days	Light truck
	Travel	150	trips	20	miles round trip	

Attachment 2
Baseline Environmental Impacts
Erdle Perforating Site

Sustainable Remediation Summary - Component 1

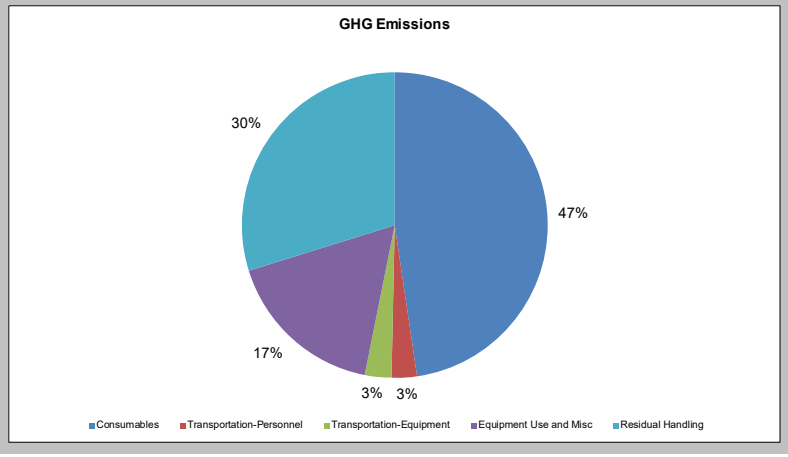
Activities	GHG Emissions	Percent Total	Total Energy Used	Percent Total	Water Consumption	Percent Total	Electricity Usage	Percent Total	Onsite NOx Emissions	Percent Total	Onsite SOx Emissions	Percent Total	Onsite PM10 Emissions	Percent Total	Total NOx Emissions	Percent Total	Total SOx Emissions	Percent Total	Total PM10 Emissions	Percent Total	Accident Risk Fatality	Percent Total	Accident Risk Injury	Percent Total
	metric ton	%	MMBTU	%	gallons	%	MWH	%	metric ton	%	metric ton	%	metric ton	%	metric ton	%	metric ton	%	metric ton	%		%		%
Consumables	80.84	47.7	1.7E+03	57.0	NA	NA	NA	NA	NA	-	NA	-	NA	-	2.5E-01	37.9	3.6E-01	76.3	1.2E-01	21.0	NA	NA	NA	NA
Transportation-Personnel	4.54	2.7	5.8E+01	1.9	NA	NA	NA	NA	NA	-	NA	-	NA	-	1.7E-03	0.3	4.8E-05	0.0	2.2E-04	0.0	7.5E-05	17.3	6.0E-03	6.8
Transportation-Equipment	4.75	2.8	6.2E+01	2.0	NA	NA	NA	NA	NA	-	NA	-	NA	-	1.5E-03	0.2	2.6E-05	0.0	1.3E-04	0.0	1.2E-05	2.8	9.7E-04	1.1
Equipment Use and Misc	28.90	17.0	3.6E+02	12.0	8.0E+04	100.0	1.5E-01	100.0	2.4E-01	100.0	2.6E-02	100.0	2.2E-02	100.0	2.6E-01	38.6	3.4E-02	7.2	2.5E-02	4.4	2.5E-04	58.4	7.4E-02	83.6
Residual Handling	50.58	29.8	8.2E+02	27.0	NA	NA	NA	NA	0.0E+00	-	0.0E+00	-	0.0E+00	-	1.5E-01	23.0	7.9E-02	16.5	4.2E-01	74.5	9.4E-05	21.6	7.5E-03	8.5
Total	169.61	100.0	3.03E+03	100.0	8.01E+04	100.0	1.51E-01	100.0	2.43E-01	100.0	2.55E-02	100.0	2.22E-02	100.0	6.72E-01	100.0	4.78E-01	100.0	5.66E-01	100.0	4.34E-04	100.0	8.88E-02	100.0

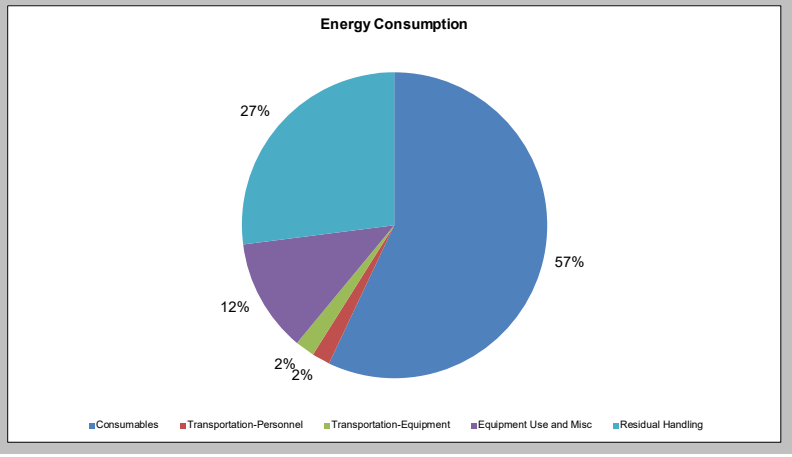
Additional Sustainability Metrics

Non-Hazardous Waste Landfill Space (tons)	1825.0
Hazardous Waste Landfill Space (tons)	450.0
Topsoil Consumption (yd^3)	0.0
Cost of Phase ($)	0.0
Lost Hours - Injury	0.7

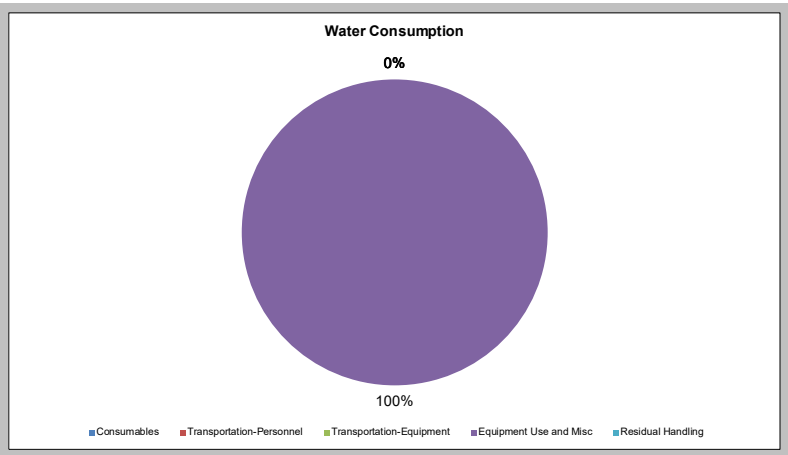
Footprint Reduction

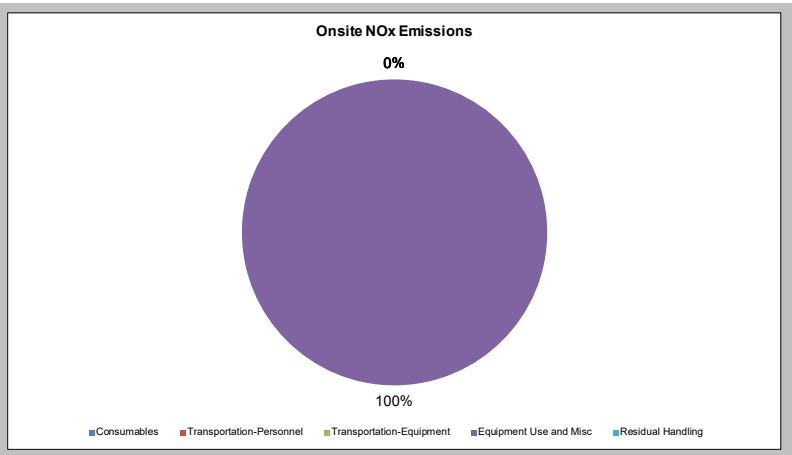
Total electricity replacement (MWh)	0.00E+00
Total electricity replacement (mmBtu)	0.00E+00
Percent electricity from renewable sources (%)	24.2%
Landfill gas reduction (metric ton CO_2 e)	0.00E+00
GHG emissions (metric ton CO2 e)	0.00E+00
NOx emissions (metric ton)	0.00E+00
SOx emissions (metric ton)	0.00E+00
PM10 emissions (metric ton)	0.00E+00

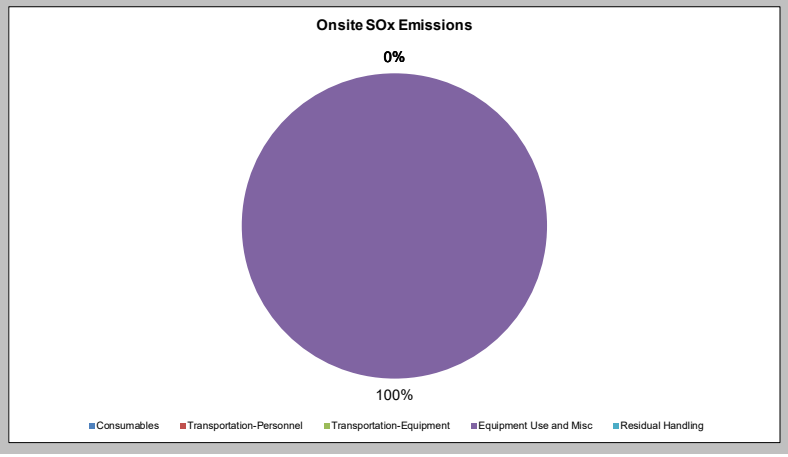


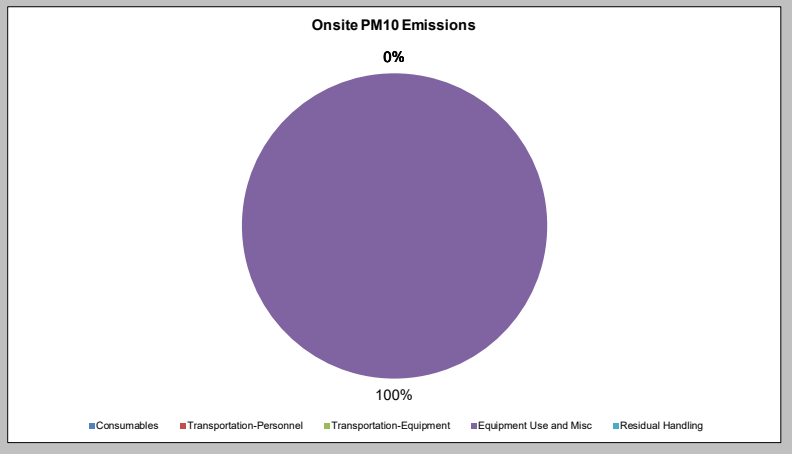


Attachment 2
Baseline Environmental Impacts
Erdle Perforating Site

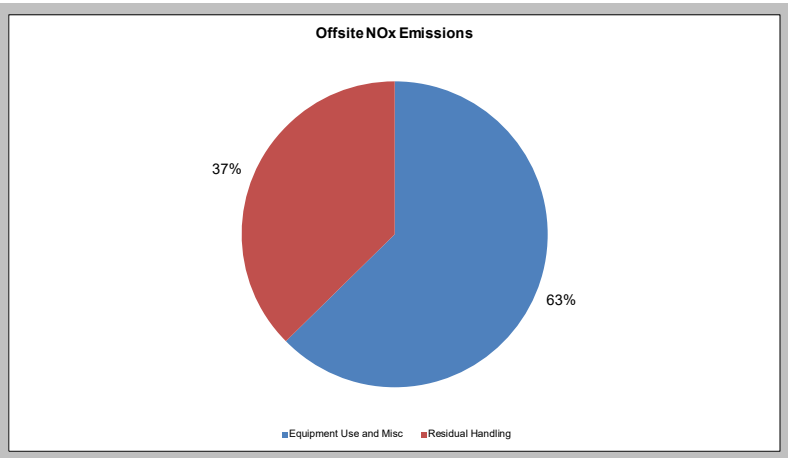


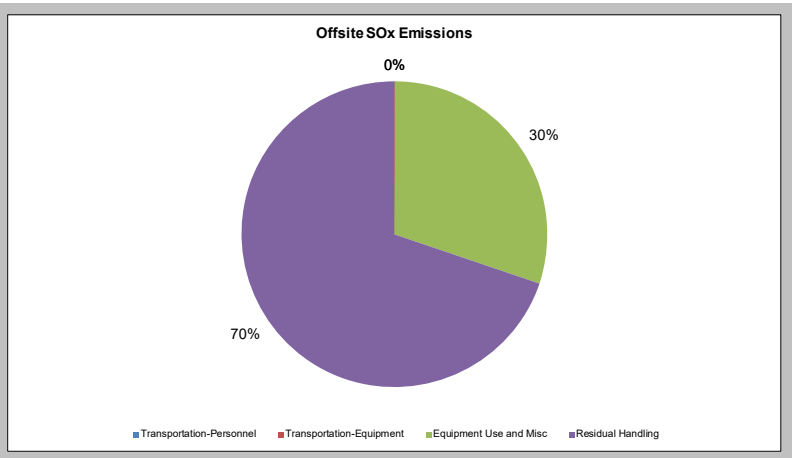


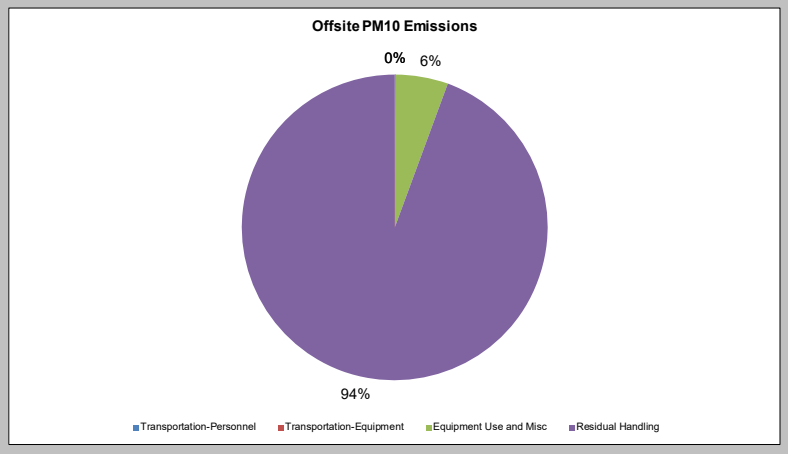


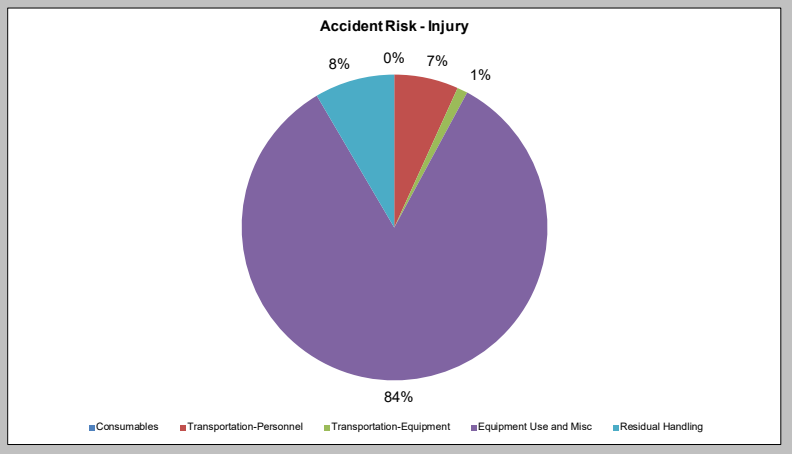


Attachment 2
Baseline Environmental Impacts
Erdle Perforating Site

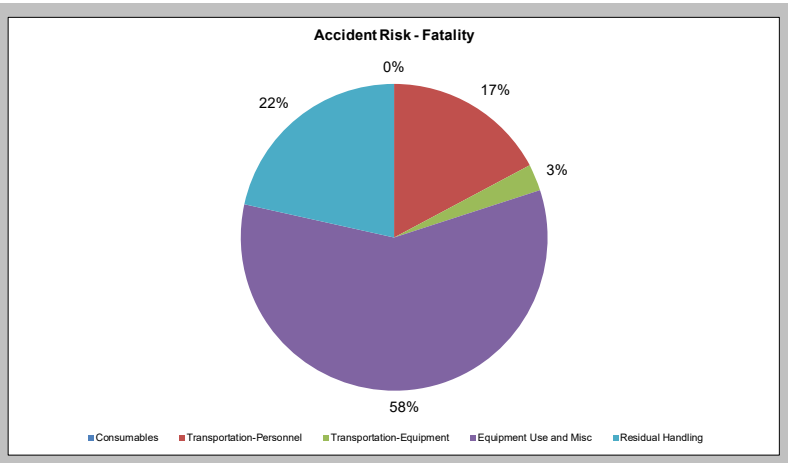








Attachment 2
Baseline Environmental Impacts
Erdle Perforating Site



Attachment 3
Form A
Summary of Green Remediation Metrics

Site Name: _____ Site Code: _____ Operable Unit: _____
Address: _____ City: _____
State: _____ Zip: _____ County: _____

Reporting Period
Contract Period From: _____To: _____
Reporting Period From: _____To: _____ Is this a Final Report? Yes ☐ No ☐

Contact Information
Preparer's Name: _____ Phone No.: _____
Preparer's Affiliation: _____ Company Code: _____
Contract No. _____

Materials & Waste Generation: Quantify the materials used or consumed and the management of waste generated on-site.

	Current Reporting Period (Include Units)	Total to Date (Include Units)
Materials Brought to the Site		
• Topsoil		
• Fill		
• Silt Fence		
• Silt Logs		
• Aggregate Base Course		
• Geotextile		
• Solidification Additives		
• Activated carbon		
• Other:		
• Other:		
• Other:		
• Other:		
• Other:		
• Other:		
• Other:		
Total Wastes Generated On-Site		
• Remedy Generated Waste		
• Contractor Generated Waste		
• Other:		
• Other:		
• Other:		
• Other:		
• Other:		
• Other:		
• Other:		

Provide a description of any implemented waste reduction programs appropriate for this project in the space provided on the certification page.

Recycled and Bio-Based Content in Imported Products and Materials: Quantify all materials and products imported to the site, including cost of materials/dollar values. Provide total percentages of recycled and bio-based of products and materials.

List Products and Materials Below	Total $ Value Provided	Total Percent of Recycled Content	Total Percent of Bio-based Content

Provide additional descriptions, as necessary, in the space provided on certification page.

Solid Waste Disposal and Diversion: Quantify all solid wastes generated, and indicate whether material was disposed or diverted for recycling or reuse.

Solid Waste Material	Date	Disposed or Diverted	Volume (Ton or CY)	Disposal/Recycling Facility Name	Comments (if not diverted, state why)
TSCA Contaminated Sediment					
Non-TSCA Contaminated Sediment					
Cleared Vegetation					
Spent Granular Activated Carbon					
Monitoring Well Removal Debris					
Other:					
Other:					
Other:					
Other:					
Other:					
Other:					

Provide descriptions in the space provided on the certification page of all wastes that were redirected for recycling or reuse. Indicate full names and addresses of facilities.

Energy Usage: Quantify the amount of energy used on-site and portion of that voluntarily derived from renewable energy sources.

	Current Reporting Period (KWh)	Total to Date (KWh)
Total electricity usage		
Of that total amount, provide quantity:		
• Derived from renewable source (i.e., solar, wind)		
• Other:		

Provide descriptions in the space provided on the certification page of all reported energy use reduction programs appropriate to this project, including use of electricity derived from renewable sources.

Water Usage: Quantify the volume of water used on-site from difference sources.

	Current Reporting Period (Gallons)	Total to Date (Gallons)
Total quantity of water used on-site		
Of that total amount, provide the quantity obtained from:		
• Public potable water supply		
• Surface water		
• On-site treated groundwater		
• Reclaimed treated water		
• Collected or diverted storm water		
• Re-Injected groundwater		
• Other:		
• Other:		

Provide descriptions in the space provided on the certification page of any reported water use reduction programs applied. Please note if reused/injected groundwater is pre-treated.

Emissions: Quantify the distance traveled for delivery of supplies and removal of waste.

	Current Reporting Period (Miles)	Total to Date (Miles)
Off-site mobile fuel combustion		
Other:		

Provide descriptions in the space provided on the certification page of practices such as use of local vendors within 150 miles of the site and on-site stationary fuel use reduction programs.

Quantify the number of hours that diesel and other equipment with the potential to emit hazardous air pollutants (HAPs) or greenhouse gas (GHG) emissions was operated on-site.

	Current Reporting Period (Hours)	Total to Date (Hours)
On-site diesel excavation/construction equipment usage		
Other on-site processes generating emissions		
Other:		

Quantify the VOC emissions from active remediation systems on-site.

	Current Reporting Period (lbs VOCs emitted)	Total to Date (lbs VOCs emitted)
Operating soil remediation equipment		
Operating groundwater remediation equipment		
Other:		

Provide descriptions in the space provided on the certification page of the type of equipment used, rating, emission control devices used and other means to reduce emissions.

Land and Ecosystem: Quantify the amount of land and/or ecosystems disturbed by construction and the area of land and/or ecosystems restored to a natural condition.

	Current Reporting Period (Acres)	Total to Date (Acres)
Total land area disturbed		
Total land area restored		
Increase in area for storm water infiltration (vs pre-disturbed conditions)		
Increase in area of native species plantings (vs pre-disturbed conditions)		
Other:		

Quantify the amount of land and/or ecosystems remediated.

	Current Reporting Period (Acres)	Total to Date (Acres)
Total area of land impacted by contamination		
Total area of land remediated to unrestricted use		
Total area of land remediated to other future site use		

Additional Comments on Green Remediation Programs Implemented: *Provide descriptions in the space provided of other green remediation practices performed during the project.*

Descriptions of green remediation programs reported above (Attach additional sheet if needed)
Materials and Products Imported:
Waste Generation:

Descriptions of green remediation programs reported above (Attach additional sheet if needed)
Recycled and Bio-Based Content in Imported Products and Materials:
Solid Waste Disposal and Diversion:
Energy Use:
Water Use:
Emissions:
Land and Ecosystem:
Other:

CERTIFICATION BY CONTRACTOR
I, _____ (**Name**) do hereby certify that I am _____ (**Title**) of the Company/Corporation herein referenced and contractor for the work described in the foregoing application for payment. According to my knowledge and belief, all items and amounts shown on the face of this application for payment are correct, all work has been performed and/or materials supplied, the foregoing is a true and correct statement of the contract account up to and including the last day of the period covered by this application. _____ _____ **Date** **Contractor**

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APPENDIX C

EOS CALCULATION

JOB NO.: 60644886

MADE BY: C. Pawlewski DATE: May 3,2024

CHECKED BY: L. Hunka DATE: May 3,2024

PROJECT: Erdle Design

SUBJECT: EOS Calculations

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1. **Background and Purpose Background and Purpose**

The Remedial Design Work Plan specifies the injection of Emulsified Vegetable Oil (EVO) or its equivalent into contaminated groundwater areas of overburden and bedrock at the Erdle site. The purpose of this calculation is to determine the quantity of EVO required for groundwater remediation at the site.

2. **Methodology**

The methodology and approach to the calculations presented below are based on input and consultation with Redox Technologies, the supplier of EOS, an EVO used for groundwater remediation.

The quantity of EVO required for remediation of groundwater in bedrock at the Chem Sales site was calculated by EOS Remediation, LLC (now known as Redox Tech) in June 2023. This calculation is provided in Attachment A. The Erdle site is located near the Chem Sales site and site conditions (e.g., bedrock type, bedrock porosity, and consequently the oil retention factor and the contaminant types and concentrations, etc.) are similar to the Chem Sales site. On this basis, the quantity of EVO required for remediation of groundwater in bedrock at the Erdle site is determined by scaling the quantity calculated for the Chem Sales as shown below.

Quantity EOS Erdle Site (Bedrock) = Quantity EOS Chem Sales Site x Volume Treated Erdle/Volume Treated Chem Sales

The methodology for determining the quantity of EVO required for remediation of groundwater in the overburden at the Erdle site was provided by Redox Tech. The quantity is determined using the formula given below.

Quantity of EOS (Overburden) = 0.15 lb EOS/cubic feet of Overburden x Volume of Overburden Treated in cubic feet

3. Design Criteria

Design criteria used for calculating the amount of EVO required for remediation are discussed below.

a. Area of Remediation

For the overburden injection plan (see Attachment B), the estimated area of remediation is 4,000 square feet. For the shallow bedrock injection plan (see Attachment B) the estimated area of remediation is 6,000 square feet.

b. Saturated Thickness

Overburden wells are screened from 4 feet bgs to 14 feet bgs resulting in a 10-foot vertical thickness for remediation. Bedrock wells are screened from 16 feet bgs to 31 feet bgs resulting in a 15-foot vertical thickness for remediation.

c. Volume of Treatment

Based on the above saturated thickness, the volume of overburden to be treated is 4,000 square feet times 10 feet or 40,000 cubic feet (CF). The volume of bedrock to be treated is 6,000 square feet times 15 feet or 90,000 CF. The total volume to be treated is 130,000 CF.

EVO Required for Remediation

As shown in Attachment A, the estimated quantity of EOS required for bedrock remediation at the Chem Sales site is 213 drum or 11,715 gallons .

The treatment volume for the Chem Sales site is equal to 380 feet (length of treatment area) times 250 feet (width of treatment area) times 55 feet (thickness of treatment area) for a total volume of 5,225,000 CF for the treatment volume.

For the Erdle site, the EOS requirement for bedrock remediation is calculated as follows:

90,000 CF/5,225,000 CF x 213 drums, which equals 3.7 drums.

There are more uncertainties associated with fractured bedrock verses unconsolidated deposits, therefore, for design, it is conservatively assumed that 8 drums of EOS will be used for bedrock remediation to account for the greater uncertainties associated with bedrock. This is equal to 440 gallons of EOS.

For overburden remediation at the Erdle site, the EOS requirement is calculated as follow:

40,000 CF x 0.15 lb EOS/CF, which equals 6,000 lb.

This equals approximately 748 gallons or 13.6 drums of EOS. Since uncertainties associated with unconsolidated deposits are considerably less than bedrock, for design, it is assumed that 15 drums or 825 gallons of EOS will be used for overburden.

4. Injection Dilution

Each gallon of EOS will be diluted with 4 gallons of water to create an approximately 20% solution. This results in a total injection volume of 2,200 gallons for bedrock and 4,125 gallons for overburden. This volume will be injected into 19 bedrock wells with a screened interval of 15 feet, and 10 overburden wells with a screened interval of 10 feet. Thus, the 2,200 gallons of solution will be injected over 285 feet of screen or an injection rate of 7.7 gallons per foot of screen for bedrock wells. A total of 4,125 gallons of solution will be injected over 100 feet of screen or an injection rate of 41.25 gallons per foot of screen for the overburden wells. For overburden wells, a total of 412.5 gallons of solution will be injected into each well and for bedrock wells, a total of 115.8 gallons of solution will be injected into each well. It is assumed that two injection events will occur meaning about 206 gallons of

solution will be injected into overburden wells for each event and about 58 gallons of solution will be injected into bedrock wells during each event.

After each injection event, distribution water will be injected into each well. For the overburden, the quantity of distribution water plus the quantity of EOS solution injected should equal approximately 20% of the saturated volume. For overburden wells, 20% of the saturated volume is equal the treatment area (4,000 square feet) times the injection thickness (10 feet) times the effective porosity of the overburden (0.25) times 0.20 which equals 2,000 cubic feet or 14,960 gallons. The quantity of distribution water is the equal to 14,960 gallons minus 4,125 gallons (the quantity of EOS solution injected) or 10,835 gallons. Therefore, approximately 1,084 gallons of distribution water will be injected into each overburden well during each event. For the bedrock, the quantity of distribution water plus the quantity of EOS solution injected should equal approximately 50% of the saturated volume. For bedrock wells, 50% of the saturated volume is equal the treatment area (6,000 square feet) times the injection thickness (15 feet) times the effective porosity of bedrock (0.01) times 0.50 which equals 450 cubic feet or 3,366 gallons. The quantity of distribution water is the equal to 3,366 gallons minus 2,200 gallons (the quantity of EOS solution injected) or 1,166 gallons. So, 61 gallons of distribution water will be injected into each bedrock wells during each event.

ATTACHMENT A

Attachment A

EOS Remediation, LLC **Site: Chemical Sales Site**

919-873-2204 **www.eosremediation.com**

Design Summary: Input parameters for the volume estimate are outlined below. When a parameter was unknown with no laboratory or field information provided by the client, a default value was used. A safety factor of 2 is used in our calculations. If your assumptions are different from those included in this table, or you obtain more information following a pilot test, please let us provide another estimate as the product(s) or volume proposed for this site could change.

Treatment Type		Value	Units	Default	Site Value
	Barrier or Source Treatment	Source Area			
	EOS Product	EOS Pro			
	Length of treatment area parallel to groundwater flow, 'x'	380	ft		√
	Width of treatment area perpendicular to groundwater flow, "y"	250	ft		√
	Treatment thickness, "z"	55	ft		√
	Nominal soil type	Fractured Bedrock			√
	Estimated Porosity (total)	0.12			√
	Effective Porosity	0.01			√
	Soil bulk density	172	pcf	Calculated	
Biogeochemical					
	pH of groundwater	7.30	SU		√
	Acid demand of aquifer material	0.0	OH^- meq/Kg		√
	Acidity of groundwater	0.0	OH^- meq/L		√
	Acidity values based on laboratory data	No			
Geohydrology					
	Hydraulic Conductivity	0.28346457	ft/d		√
	Hydraulic Gradient	0.035	ft/ft		√
	Seepage Velocity	0.886	ft/d	Calculated	
	Contact time	60	days	√	
	Design Life per application	3	yrs.	√	
Analytical					
	Dissolved Oxygen (DO)	2	mg/L		√
	Nitrate Nitrogen (NO_3^- - N)	1	mg/L		√
	Sulfate (SO_4^{2-})	100	mg/L		√
	Tetrachloroethene (PCE), C_2Cl_4	0.621	mg/L		√
	Trichloroethene (TCE), C_2HCl_3	6.548	mg/L		√
	cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$	18	mg/L		√
	Vinyl Chloride (VC), C_2H_3Cl	3.019	mg/L		√
	Carbon tetrachloride, CCl_4	0	mg/L		√
	Chloroform, $CHCl_3$	0.0011	mg/L		√
	sym-tetrachloroethane, $C_2H_2Cl_4$	0	mg/L		√
	1,1,1-Trichloroethane (TCA), CH_3CCl_3	28.4	mg/L		√
	1,1-Dichloroethane (DCA), $C_2H_4Cl_2$	10.9	mg/L		√
	Chloroethane, C_2H_5Cl	5.349	mg/L		√
	Perchlorate, ClO_4^-	0	mg/L		√
	Hexavalent Chromium, Cr[VI]	0	mg/L		√
	Pentachlorophenol	0	mg/L		√
	User added	0	mg/L		
	User added	0	mg/L		
	Estimated Amount of $Fe2^+$ Formed	10	mg/L	√	
	Estimated Amount of Manganese (Mn^{2+}) Formed	5	mg/L	√	
	Estimated Amount of CH_4 Formed	5	mg/L	√	
	Target Amount of DOC to Release	60	mg/L	√	
Design					
	Design Factor	2	times	√	
	Stoichiometric Hydrogen Demand	4100.4	lbs	Calculated	
	Effective treatment thickness for substrate, "z_e"	4%		√	
	Maximum Oil Retention	0.0017		√	
	DOC Released	10778	lbs	Calculated	
	Base Required for Sediment	0	OH^- eq	Calculated	
	Base Required for Aquifer	0	OH^- eq	Calculated	
	Mass to be treated	31,395,980	lbs	Calculated	
	Estimated total groundwater volume treated over design life	5,807,703	gal	Calculated	
	ZVI				
Calculated Substrate Requirement					
	Substrate Requirement Based on Hydrogen Demand and Carbon Loss	**27,225**	**lbs**		
	Substrate Requirement Based on Oil Entrapment by Aquifer Material	**89,253**	**lbs**		
	EOS Pro Requirement			**213**	**Drums**
	Quantity of Dechlorinating Consortium BAC-9	**166**	**L**		

Please note that EOS Remediation, LLC offers a family of highly-acclaimed bioremediation products that are licensed under various patented methods for bioremediation. Product sheets, brochures, instructions, technical advice, suggested recommendations by our staff, or other information provided by EOS Remediation is provided as guidelines for the convenience of Buyer only and should not be construed as a substitute for appropriate engineering and geologic design by qualified professionals. We are not a professional engineering firm and do not provide professional advice. Soil and other environmental conditions vary and requirements for use and the effectiveness of our products will vary according to the specific circumstances. Our products may not be suitable for some applications. Bioaugmentation culture is calculated at an unconcentrated strenght, however any orders place over 19L will be concentrated up to 10x, please verify the concentration strenght before injection.

ATTACHMENT B

N

ERDLE BUILDING

ROAD

140N -40E
12'-13', ND

140N -20E
11'-12', ND

120N -20E
12'-13', 5.6

120N 0E
2'-2.5', 0.014

120N 20E
14.5'-14.9', 46

120N 40E
5.3'-5.7', 0.0034

120N 60E
8.5'-9.5', 0.022

120N 80E
13.9'-14.6', 0.0012

120N 100E
14.5'-15.1', 0.0012

120N 120E
14'-14.6', ND

120N 140E
14'-14.3', 0.0027

105N 140E
14'-14.3', ND

105N 120E
4'-4.5', ND

100N -20E
12'-13', ND

100N 0E
10.5'-11', 4.4

100N 20E
14'-14.4', 160

100N 40E
14'-14.5', 0.006

100N 60E
14'-14.5', 0.0019

100N 80E
14.2'-14.4', 0.0023

100N 100E
14'-14.2', ND

OMW-2
13'-14', 31

80N -20E
12'-13', 0.0036

80N 20E
13.5'-14', 0.0035

80N 40E
13.5'-14.3', 0.0015

80N 60E
7'-7.5', 0.0016

80N 0E
13'-13.7', ND

60N 0E
12.5'-13', 0.83

60N 20E
10.5'-11', 0.66

60N 40E
10.5'-11.5', ND

60N 60E
11'-11.5', 24

60N 80E
10.5'-11', 4.6

40N 0E
13'-13.9', 0.0025

40N 20E
2.5'-3', 0.053

40N 60E
0.002

BMW-3DD
13'-14', 19

20N 60E
13.5'-14.3', 0.0019

20N 0E
7.5'-8.1', 0.0049

20N 20E
11'-11.5', 13

20N 40E
13.9'-14.1', 1.4

0N -20E
11'-12', 0.0014

0N 0E
12'-13', 2

0N 20E
12'-13', 0.003

Legend

Maximum Trichloroethene Concentration (mg/kg)

- ND
- <1
- 1-10
- 10-50
- 50-100
- >100

TCE Isoconcentration

- 1
- 10
- 100
- 20'x20' Grid
- Proposed Shallow Bedrock Injection Well
- Proposed Overburden/Shallow Bedrock Injection Well Pair
- Approximate Location of Former TCE UST
- Proposed Soil Excavation Area
- Former ERH Treatment Area
- Former Staging Area
- Site Location
- Parcel Boundary
- Approximate Treeline

20 0 20 Feet

ERDLE PERFORATING COMPANY SITE
SOIL TCE ISOCONCENTRATION &
DESIGN - INJECTION WELL
LOCATION & EXCAVATION AREA

AECOM

ATTACHMENT B

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