FEASIBILITY STUDY REPORT

FORMER ALUMINUM LOUVRE CORPORATION

(NYSDEC Site Number 130195)

OFF-SITE CONTAMINATION (OPERABLE UNIT 2)

NYSDEC STANDBY ENGINEERING CONTRACT

Work Assignment D006129-10 & D007625-29

PREPARED FOR

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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Table of Contents

Table of Contents

Table of Contents

List of Tables

List of Figures (following tables)

Appendices

List of Acronyms

AOCs	Areas of Concern
AS	Air Sparging
AS/SVE	Air Sparging/Soil Vapor Extraction
AST	Aboveground Storage Tank
BGS	Below Ground Surface
COC	Contaminants of Concern
CVOCs	Chlorinated Volatile Organic Compounds
DCE	Cis-1,2-dichloroethene
ECL	Environmental Conservation Law
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FT	Feet
GAC	Granulated Activated Carbon
GPM	Gallons Per Minute
GRA	General Response Actions
GWQS	Groundwater Quality Standards
HDR	Henningson, Durham, & Richardson Architecture and Engineering, P.C.
ISCO	In-Situ Chemical Oxidation
ISTT	In-Situ Thermal Treatment
LTM	Long Term Monitoring
MNA	Monitored Natural Attenuation
NCDH	Nassau County Department of Heath
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	Operation and Maintenance
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethylene also known as Perchloroethylene
POGW	Protection of Groundwater
POTW	Publicly-owned Treatment Works
RAOs	Remedial Action Objectives
RI	Remedial Investigation
ROD	Record of Decision
SCG	Standards, criteria and guidance
S/S	Solidification/Stabilization
SSF	State Superfund Program
SARA	Superfund Amendments and Reauthorization Act
SCO	Soil Cleanup Objective
SSDS	Subslab Depressurization System
SVOCs	Semi-Volatile Organic Compounds

List of Acronyms (continued)

1,1,1-TCA	1,1,1-Trichloroethane
TCE	Trichloroethylene
TCLP	Toxicity characteristic leaching procedure
TOC	Total Organic Carbon
TSDF	Treatment, storage and disposal facility
URU	Unrestricted Use
URU/ POGW	Unrestricted Use and Protection of Groundwater Soil Cleanup Objectives
UV	Ultraviolet
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

Henningson, Durham, & Richardson Architecture and Engineering, P.C. (HDR) was retained by the New York State Department of Environmental Conservation (NYSDEC) to conduct a Remedial Investigation (RI) and Feasibility Study (FS) of the Former Aluminum Louvre Site (NYSDEC Site #130195) Operable Unit 2 (OU2), located at 161 Bethpage-Sweethollow Road and 301 Winding Road in the Hamlet of Old Bethpage, Town of Oyster Bay, Nassau County, New York. This FS provides an analysis of remedial alternatives for the remediation of groundwater within OU2, or the offsite portion of groundwater impacts attributable to Aluminum Louvre.

The remedial action objectives for remedial actions undertaken pursuant to the New York State Inactive Hazardous Waste Disposal Site Remedial Program (State Superfund Program or SSF), are defined by ECL, Article 27, Title 13. The goal of the SSF program is complete cleanup of the site, to the extent practicable, through the elimination of the significant threat to the environment posed by the disposal of hazardous wastes at the site and of the imminent danger of irreversible or irreparable damage to the environment caused by such disposal. Groundwater within OU2 was therefore evaluated against NYSDEC Class GA ambient groundwater quality standards (GWQS). Based on this evaluation, the extent of groundwater impacted by trichloroethene (TCE), the primary constituent attributed to the Aluminum Louvre Site, extends well south and east of the active Claremont Polychemical Superfund Site groundwater treatment plant. The extent of impacted groundwater to the south and east of the Claremont treatment plant has not yet been fully defined; therefore, based on discussions with the NYSDEC the southern extent of OU2 has been defined as the Claremont treatment plant for the purpose of this FS.

The following remedial action objectives (RAOs) were developed for groundwater within OU2:

<u>Groundwater RAOs for Public Health Protection</u>

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards; and
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

Groundwater RAOs for Environmental Protection

Restore groundwater to pre-disposal/pre-release conditions, to the extent practicable.

- Reduce the concentrations of volatile organic compounds (VOCs) in groundwater at the site;
- Limit off-site migration of VOCs in groundwater at concentrations greater than the Class GA GWQS; and
- Reduce or remove the source of groundwater contamination, to the extent practicable.

The evaluation criteria include overall protection of human health and the environment; compliance with Standards, Criteria and Guidance (SCG); long-term effectiveness and permanence; reduction of toxicity, mobility, or volume of wastes; short-term effectiveness; implementability; cost; and land use. An overview of the alternatives proposed within this FS is provided below.

Alternative G1 – No Action

The no action option is included as a basis for comparison with active groundwater remediation technologies in accordance with Section 4.2 of NYSDEC DER-10. If no remedial action is taken, contaminants already present in the groundwater will remain in place and/or move down gradient in the direction of groundwater flow. Contaminants, particularly chlorinated VOCs, will possibly degrade via natural processes and transform to form other compounds over time. The No Action alternative is retained for further evaluation. It is assumed that land and groundwater resource use will not change over time and that any existing institutional controls will remain in place and be enforced by other regulatory programs.

Alternative G2 – ISCO

Alternative G2 consists of ISCO with long-term monitoring (LTM) for the remediation of VOCs in groundwater. This alternative would include the installation of shallow (65 to 110 feet bgs) and deep (130 to 205 feet bgs) permanent injection wells throughout the groundwater remediation area to inject the chemical oxidation solution to degrade the organic contaminants. LTM would consist of a network of wells located within and down gradient from the Site boundary. The performance of a pre-design investigation and pilot testing are assumed in the evaluation of this alternative, as is the installation of a large number of injection wells, periodic introduction of reagent and performance monitoring.

Alternative G3 – Bioremediation System

The approach to site remediation under Alternative G3 includes implementing bioremediation in the active remediation area of contaminated groundwater (groundwater with TCE > 400 µg/l) in conjunction with institutional controls and LTM for protection of human health and the environment. Based on conversations with the NYSDEC regarding the potential efficacy of bioremediation at the Aluminum Louvre Site, HDR collected groundwater samples from monitoring wells MW-301-1-S and EW-7C during May 2015 and submitted them to Microbial Insights, Inc. for determination of total eubacteria count, total methane oxidizing bacteria count and soluble methane monooxygenase (SMMO) using their CENSUS® quantification approach. The analytical results indicate that bioremediation is a viable approach for this site; however, it may be necessary to increase the density of injection wells to increase the effectiveness of the approach. The performance of a pre-design investigation and pilot testing are therefore assumed in the evaluation of this alternative, as is the installation of a large number of injection wells, periodic introduction of reagent and performance monitoring.

Alternative G4 – Extraction and Treatment with treatment at Claremont Treatment Plant

Alternative G4 consists of a groundwater extraction system to capture the shallow as well as deep VOC-contaminated groundwater and treat it at the surface in the existing Claremont Treatment Plant by upgrading the capacity of the plant and implementing remedial technologies such as air stripping, a vapor phase granular activated carbon (GAC) system, and finally discharge/disposal of treated groundwater. Under Alternative G4, a photovoltaic (solar) power system would be installed to provide electricity to the treatment plant. Alternative G4 also includes LTM with institutional controls.

Alternative G5 – Extraction and Treatment with treatment at new off-site groundwater treatment plant

Alternative G5 consists of a groundwater extraction system to capture the shallow as well as deep VOC-contaminated groundwater and treat it at the surface in a newly constructed groundwater treatment facility (GWTF) off-site by implementing remedial technologies such as air stripping, a vapor phase GAC system, and finally discharge/disposal of treated groundwater. Under Alternative G5, groundwater extraction wells operated by Claremont that currently capture impacted groundwater associated with the Aluminum Louvre Site would be decommissioned and replaced with new extraction wells. As in Alternative G4, a photovoltaic system would be installed to provide electricity to the treatment plant. Alternative G5 also includes LTM with institutional controls.

Vapor Intrusion

The results of a soil vapor investigation conducted within buildings located in the OU2 area indicated that no indoor air samples collected contained constituents attributable to Aluminum Louvre at concentrations above New York State Department of Health (NYSDOH) action levels. However, the concentration of TCE in sub-slab soil vapor for which NYSDOH recommends mitigation to minimize current or potential exposure, regardless of indoor air concentrations (250 $\mu g/m^3$; NYSDOH 2006, Soil Vapor/Indoor Air Matrix 1) was exceeded at sub-slab soil vapor sample location 303-W-SS. Based on the NYSDOH guidance, a vapor intrusion mitigation system is recommended for the building at 303 Winding Road. The discussion and costing of a sub-slab depressurization system (SSDS) for 303 Winding Road has therefore been included within this FS.

1.0 INTRODUCTION

HDR was retained by the NYSDEC to conduct a RI/FS of the Former Aluminum Louvre Site (NYSDEC Site #130195) OU2, located at 161 Bethpage-Sweethollow Road and 301 Winding Road in the Hamlet of Old Bethpage, Town of Oyster Bay, Nassau County, New York.

The on-site RI was conducted from 2011 through 2012 and included delineation of an on-site source of soil contaminated with VOCs, primarily TCE, an on-site soil vapor investigation and an on- and off-site groundwater investigation. TCE was the primary contaminant in groundwater based on the data collected during the groundwater investigation.

The OU2 RI was conducted to further delineate the extent of off-site VOC contamination in the underlying aquifer and vapor intrusion in neighboring buildings including 175 Bethpage-Sweethollow Road (hereafter referred to as 175), 195 Bethpage-Sweethollow Road (hereafter referred to as 195), 303 Winding Road (hereafter referred to as 303) and New England Motor Freight at One Arlene Way (hereafter referred to as NEMF). A nearby National Priorities List (NPL) site, Claremont Polychemical (Claremont), was also included in the OU2 study area.

The investigation involved the installation of soil vapor implants and monitoring wells, and the collection of groundwater samples, sub-slab soil vapor samples, and indoor and outdoor ambient air samples. Thirty-five groundwater samples were collected to evaluate OU2. The groundwater sampling extended to deeper portions of the aquifer than in prior investigations. Soil vapor samples were collected from three newly installed permanent soil vapor points and at co-located indoor air sampling locations to assess the potential for vapor intrusion into the two buildings adjacent to the site.

Groundwater samples were subsequently collected on July 28, 2015 from two monitoring wells at the site for evaluation of total bacteria count, total methane oxidizing bacteria count and for the production of SMMO as an indicator of bioremediation potential.

2.0 SITE DESCRIPTION AND HISTORY

2.1 General Site Description

Operable Unit 1 (OU1)

The Former Aluminum Louvre Corporation site is located at the southeast corner of Bethpage-Sweethollow Road and Winding Road in the Hamlet of Old Bethpage, Town of Oyster Bay in a suburban portion of Nassau County, New York (Figure 1). The site is approximately 3.36 acres in size and consists of two tax parcels with the respective addresses of 161 Bethpage-Sweethollow Road (tax parcel 47-A-265, approximately 2.14 acres) and 301 Winding Road (tax parcel 47-A-263, approximately 1.22 acres). Each of the two lots contains one commercial/industrial building.

The surrounding properties to the north, east and south are used for commercial and light industrial purposes. To the west and southwest are an inactive municipal waste incinerator and the former Old Bethpage Landfill operated by the Town of Oyster Bay.

The Aluminum Louvre Corporation formerly owned 161 and also owned or leased the 301 property, and simultaneously occupied both lots that comprise the site. Aluminum Louvre manufactured louvers at the site, which involved the stamping, cutting, and shaping of metal stock and degreasing and painting. Nassau County records indicate that Aluminum Louvre used tetrachloroethene (PCE), TCE and 1,1,1-trichloroethane (1,1,1-TCA) at the site from 1986-1994, and generated halogenated solvent waste and oily wastes during this time.

Additional background information for the site can be found in the on-site RI report dated January 2013. Subsequent to the January 2013 RI report, the site was divided into operable units with OU1 covering all on-site contamination and OU2 covering the off-site contamination.

Operable Unit 2 (OU2)

OU2, the subject of this report, includes adjoining properties to the south and east and off-site areas along the extent of the contaminated groundwater plume up to the extraction wells at the Claremont groundwater treatment plant (Figure 2). Claremont is a NPL site that has groundwater primarily contaminated with PCE. The southern boundary of the OU2 study area was initially arbitrary and was decided based on the presumed extent of the Aluminum Louvre plume prior to undertaking the OU2 investigation. Table 1 lists the properties where investigation work was undertaken as part of the OU2 RI.

Table 1 – List of OU2 Properties

OU2 Property Address	Acronym	Location Relative to Aluminum Louvre
175 Bethpage-Sweethollow Road	175	Adjoining to the east
303 Winding Road	303	Adjoining to the south
195 Bethpage-Sweethollow Road	195	Three properties to the east. Furthest eastern extent of OU2 investigation
One Arlene Way. New England Motor Freight property	NEMF	Adjoining 195 Bethpage-Sweethollow Road to the south. Adjoining Claremont to the north.
505 Winding Road. Claremont Polychemical property	Claremont	South of NEMF. Furthest southern extent of OU2 investigation.

2.2 Physical Setting

The Aluminum Louvre site lies at an elevation of between approximately 127 and 135 feet above sea level. The general area around the site and the site itself slope towards the southeast. The area northeast of the site has an approximate elevation of 200 feet above sea level and gradually grades lower to the southeast. At the southern border of the NEMF property with an average elevation of roughly 140 feet, there is a rather abrupt increase in elevation up to the Claremont property. Within Claremont and further south throughout a large portion of Bethpage State Park, the elevation is roughly 160 feet until reaching off-site Claremont well EW-3C where the topography begins to slope back down to off-site Claremont well EW-14D where it reaches its lowest point within the investigation area of approximately 100 feet.

With the exceptions of narrow strips of grass around parking areas and adjoining roadways, the northern portion of the OU2 study area is entirely paved and built over and has no surface water features. There are no natural water bodies within one mile of the site. The nearest man-made water body is Nassau County Stormwater Recharge Basin No. 528 to the northwest of the intersection of Winding Road and Bethpage-Sweethollow Road. Stormwater drains towards drywells within the industrial park. From the Claremont property south, Bethpage State Park is a vast expanse of undeveloped land with almost no impervious cover – a stark contrast to the adjoining industrial park to the north. Stormwater within the park infiltrates the ground contributing to groundwater recharge in this area.

The observed depth to groundwater at the site and vicinity during the RI and earlier investigations ranged from approximately 60 to 75 feet bgs. Previous work conducted at the Former Aluminum Louvre site and adjacent off-site areas indicated that shallow groundwater flow is generally to the south-southeast (CDM 2008, Malcolm Pirnie 2010, Weston 2008a and 2008b) (Figure 3). The upper glacial aquifer deposits are mostly absent in the area and the Magothy Formation is the uppermost geologic unit (approximately 750 feet thick in the area) and stratigraphic unit of concern.

2.3 History

The site is named after the Aluminum Louvre Corporation, a former owner of 161 Bethpage-Sweethollow Road. Aluminum Louvre also owned or leased the 301 Winding Road property and used it for manufacturing operations.

<u>161 Bethpage-Sweethollow Road</u>

The building at 161 was erected in 1966 as a warehouse/light industrial use facility and was expanded in 1986. The property was occupied by New Dimensions Research from 1966 to 1985, by Aluminum Louvre Corporation from 1986 to 1994, and by a waste management company, Allen Waste, from an unknown time after 1994 until approximately 2004. Allen Waste used the property as a transfer station for plastic and glass recycling. The building at 161 is currently occupied by three tenants: a paving company (New York Paving), AAA of New York, and a general contracting company (Perry Mechanical Contractors). AAA in turn sub-leases a portion of their area to a heating, ventilation and air conditioning (HVAC) contractor.

301 Winding Road

The building at 301 was erected in 1965 as a manufacturing/processing facility. It was occupied by New Dimensions Research from 1966 to 1985 and by Aluminum Louvre Corporation from 1986 to approximately 1994, when it was used to manufacture louvers, including the stamping, cutting, and shaping of steel and aluminum stock, degreasing and painting. The former owners of Aluminum Louvre Corporation bought the 301 property through a tax sale under a new company name (Mel Frank Realty Corporation) at an unknown time after 1994 and entered into a Voluntary Cleanup Agreement (VCA) with NYSDEC in 1996. Global Pottery, Inc. purchased the property from Mel Frank Realty under the name 310 Winding Road[1] Realty Corporation for use as a warehouse for the storage and distribution of pottery and decorative flower pots. At the start of the on-site RI, Global Pottery had discontinued its operations at the property and the building was vacant. During the on-site RI, the office space was leased to a tenant (name unknown) and the warehouse was rented for the storage of new tires. In 2012, the building was leased to a new tenant, Intelligen Power, a company that processes waste vegetable oil for eventual use as biodiesel. Intelligen Power does not produce biodiesel at the property. The processed (cleaned) waste vegetable oil is sent to an offsite biodiesel facility.

A number of investigations and remedial activities have been conducted at the Former Aluminum Louvre Corporation site, including the on-site RI. Detailed descriptions of investigations conducted prior to the OU2 RI are provided in the on-site RI report.

[1] Many historical records use the address of 310 Winding Road instead of 301 Winding Road.

3.0 REMEDIAL INVESTIGATION AND EXPOSURE ASSESSMENT SUMMARY

3.1 Remedial Investigation Summary

The OU2 RI was conducted to further delineate the extent of off-site VOC contamination in the underlying aquifer and vapor intrusion in neighboring buildings including 175 Bethpage-Sweethollow Road, 195 Bethpage-Sweethollow Road, 303 Winding Road and New England Motor Freight at One Arlene Way. The Claremont Site was also included in the OU2 study area.

The OU2 RI consisted of the following:

1. Sampling and analysis of groundwater from six existing on- and off-site monitoring wells for VOCs and to perform 3-D Compound Specific Isotope Analysis (3-D CSIA);

2. A geophysical survey to mark underground utilities and subsurface features prior to intrusive activities;

3. Installation and sampling of multi-level monitoring well clusters at five off-site locations (175, 303, and three within the NEMF property);

4. Installation and sampling of sub-slab soil vapor and co-located indoor air points at two off-site properties, 175 and 303 plus an outdoor air sample between the two properties; and

5. Additional off-site monitoring well sampling for 3-D CSIA to delineate the downgradient extent of the Aluminum Louvre plume beyond OU2 and determine the isotopic fingerprint of the Claremont on-site plume to distinguish it from the Aluminum Louvre plume. This activity was added to the scope while the OU2 investigation was on-going.

All field activities were conducted in accordance with the HDR – NYSDEC Program Field Activities Plan (FAP) and Program Quality Assurance Project Plan (QAPP).

The scope of investigation within OU2 of the Aluminum Louvre Site is discussed in greater detail within the OU2 RI Report submitted under separate cover.

3.1.1 Site Characterization Criteria

The RI/FS must characterize the site and identify and evaluate alternatives which are capable of achieving the goal, which is cleanup to pre-disposal or unrestricted use conditions. However, the FS may also evaluate alternatives to achieve a cleanup necessary to meet an identified use of the site.

3.1.2 Groundwater Contamination

Groundwater analytical results were compared to NYSDEC Class GA GWQS (NYSDEC 1999) and are presented in Table 2. For compounds without established GWQS, the applicable groundwater values from the Division of Water Technical and Operational Guidance Series 1.1.1 (TOGS 1.1.1) were used as screening criteria.

One round of groundwater samples was collected from seven groundwater monitoring well clusters installed off-site to the east and southeast in 2012 through 2013. In total, 28 samples (26 normal and 2 duplicate) were collected from the well clusters. Groundwater samples were analyzed for VOCs by EPA Method 8260.

Compounds exceeding NYSDEC Class GA standards included TCE (15 of 28 samples, including duplicates), PCE (2 samples), 1,1,1-TCA (4 samples), 1,1-dichloroethane (1,1-DCA, 1 sample), and 1,1-dichloroethene (1,1-DCE, 4 samples).

TCE was detected at concentrations between 0.56 and 190 µg/l, PCE detections ranged from 0.8 to 22 µg/l, and 1,1-DCE was detected from 0.74J to 4.2 µg/l. The highest detection of TCE in 2013 (190 µg/l) was for the sample from the intermediate depth (85-95 ft. bgs) interval at well MW-303-1-ID. The highest concentration of 1,1,1-TCA was encountered at the intermediate interval (90-100 feet bgs) at off-site location MW-195-1, 30 µg/l, almost twice as high as the highest on-site concentration detected during the on-site RI in 2012 (20 µg/l at water table well ALC-MW3). Groundwater sampling results are shown on Figure 4.

As part of 3-D CSIA, nine groundwater samples (8 locations and 1 duplicate) were also analyzed for VOCs. Seven of these samples are included in the total groundwater sample count for OU2, for a total of 35 groundwater samples. The remaining two samples were collected from outside the OU2 study area and were only analyzed for VOCs to perform the 3-D CSIA.

3.1.3 Groundwater Elevations

Groundwater elevation measurements were collected during the single round of groundwater sampling during the OU2 RI (December 2013). As indicated on Figure 3, groundwater elevations were highest to the northwest near the corner of Bethpage-Sweethollow Road and Winding Road (approximately 65.3 feet above sea level) and decreased towards the south and east (approximately 63.7 feet above sea level at an off-site well near NEMF). Elevations for the wells installed at the three different depth intervals varied slightly. The highest elevations were recorded at the water table wells; the elevations at the intermediate depth wells were, in general, approximately one foot lower, and the elevations at the deep wells were lower again, in general, by approximately 0.5 feet. This is indicative of a downward vertical gradient.

The elevations obtained for the water table wells indicate flow to the east-southeast at 301 and in the immediate vicinity. Away from 301, further east and south, the flow direction at the water table "turns" towards the southeast which is the reported regional flow direction. The elevation measurements for both the intermediate and deep wells indicate flow to the southeast for both OU1 and OU2 of the Aluminum Louvre Site.

Previous work conducted at Aluminum Louvre and adjacent off-site areas (CDM 2008, Malcolm Pirnie 2010, Weston 2008a and 2008b) indicated that shallow groundwater flow is generally to the south-southeast. The eastward flow of shallow groundwater on-site is thought to reflect the influence of groundwater mounding from the Nassau County Recharge Basin No. 528, located to the northwest of the intersection of Winding Road and Bethpage-Sweethollow Road. Three nearby remediation sites with groundwater extraction and treatment systems (TOBAY Old Bethpage Landfill, Claremont and the Nassau County Firemen's Training Center) have the potential to influence groundwater flow locally; all three sites are to the south (southwest to southeast) of the Aluminum Louvre site.

3.1.4 Soil Vapor and Ambient Air Monitoring Results

3.1.4.1 Sub-Slab Vapor Results

HDR installed and sampled three sub-slab soil vapor sampling points inside the 175 (one location) and 303 buildings (two locations). Co-located indoor air samples were collected adjacent to each of the three sub-slab vapor points. An outdoor air sample was collected between 175 and 303 on the same day as the sub-slab/indoor air samples. The ranges of detections for VOCs in sub-slab soil vapor samples, and the frequency of exceedance of applicable standards are presented in Table 3.

New York State does not currently have any standards, criteria, or guidance values for subsurface vapors (NYSDOH 2006). Several VOC contaminants of concern (COCs) were detected in the sub-slab vapor samples collected at 175 and 303.

At 175, 1,1,1-TCA (7.9 µg/m^3), PCE (23J µg/m^3) and TCE (0.66J µg/m^3) were detected at soil vapor point 175-W-SS in the western part of the building. The concentrations of 1,1,1-TCA and TCE detected at 175-W-SS result in a recommendation that a responsible party take reasonable and practical actions to identify source(s) and reduce exposure (NYSDOH 2006, Soil Vapor/Indoor Air Matrices 1 and 2).

At 303, soil vapor point 303-W-SS from the northwestern portion of the building in the former masonry company unit had the highest concentrations of 1,1,1-TCA (120 µg/m^3), PCE (480 µg/m^3) and TCE (1,100 µg/m^3). The concentration of TCE in sub-slab soil vapor for which NYSDOH recommends mitigation to minimize current or potential exposure, regardless of indoor air concentrations (250 µg/m^3; NYSDOH 2006, Soil Vapor/Indoor Air Matrix 1) was exceeded at sub-slab soil vapor sample location 303-W-SS. For location 303-E-SS, the concentrations of 1,1,1-TCA (1.4 µg/m^3), PCE (13 µg/m^3) and TCE (21 µg/m^3) result in a recommendation for no action (NYSDOH 2006, Soil Vapor/Indoor Air Matrices 1 and 2).

3.1.4.2 Indoor Air Results

The co-located indoor air samples had low concentrations of the three detected compounds for which NYSDOH has established air guideline values (PCE: 30 µg/m^3, TCE: 2 µg/m^3 and methylene chloride: 60 µg/m^3). The indoor air sample concentrations for PCE (0.69 J µg/m^3 to 2.8 J µg/m^3), TCE (0.22 ND µg/m^3 to 1.1 µg/m^3) and methylene chloride (0.88 µg/m^3 to 3 µg/m^3) in these samples were below the NYSDOH air guideline values.

Location 175-W-IA had the highest indoor air concentration of 1,1,1-TCA (96 µg/m^3). The adjoining sub-slab soil vapor sample 175-W-SS had a 1,1,1-TCA concentration of only 7.9 µg/m^3. There is no air guideline value for 1,1,1-TCA.

Carbon tetrachloride, which is not an OU2 COC, was detected at a concentration of 0.45NJ at indoor air sample location 303-E-IA but was not detected in the adjoining sub-slab soil vapor sample 303-E-SS. This concentration of carbon tetrachloride in indoor air results in a recommendation that a responsible party take reasonable and practical actions to identify source(s) and reduce exposure (NYSDOH 2006, Soil Vapor/Indoor Air Matrix 1). However, this result could be from infiltration of outdoor air inside the building which is discussed below.

The ranges of detections for VOCs in indoor air samples, and the frequency of exceedance of applicable standards are presented in Table 4.

3.1.4.3 Outdoor Air Results

TCE (0.55 $\mu g/m^3$) and carbon tetrachloride (0.7 $\mu g/m^3$) were detected in the outdoor air sample collected at the 175/303 property boundary. It is noteworthy that the indoor air concentration of carbon tetrachloride at 175-W-IA is the same as the outdoor air concentration. Further, the indoor air concentrations of carbon tetrachloride at 303 (0.45NJ and 0.64 $\mu g/m^3$) may be a result of the outdoor air concentration measured at the property boundary. The outdoor air concentration of TCE was generally less than the measured indoor air concentrations at 175 and 303.

3.2 Nature and Extent of Contamination

3.2.1 Groundwater

OU2 groundwater is impacted with chlorinated VOCs above applicable standards for TCE, 1,1,1-TCA, PCE, 1,1-DCE, cis-1,2-dichloroethane (cDCE) and 1,1-DCA. TCE is the predominant COC and the highest concentration is more than an order of magnitude greater than the highest concentrations of the other COCs. TCE, PCE and cDCE contamination appears to be associated with Aluminum Louvre while the 1,1,1-TCA, 1,1-DCA and 1,1-DCE contamination is not.

As shown in Figure 4, the highest TCE concentration in the water table wells is centered in the OU1 soil source area to the east of the 301 building (MW-301-1-S, 2,800D µg/l). The highest off-site concentrations of TCE are to the southeast in the direction of groundwater flow and reflect a steep vertical gradient within OU2. Upgradient of Claremont, well EW-7C (very deep, 189-199 ft. bgs) had a TCE concentration of 320D µg/l.

Lesser TCE contamination is found to the east-southeast of Aluminum Louvre but still well above the NYSDEC Class GA standard. The eastern extent of the plume is generally defined as being located between wells located at 175 and 195 Bethpage-Sweethollow Road, while the western extent of the plume is well defined by a series of wells on the west sides of 301 to the north and Claremont to the south that are mostly free of VOCs. Impacted groundwater is less well defined at the southeast end of OU2. Monitoring well EW-12D (225 ft. bgs) located in the vicinity of the Claremont treatment plant was found to contain TCE at a concentration of 7.8 µg/l, and it is possible based on results obtained from upgradient wells that a deeper well is necessary at this location to fully delineate the vertical extent of impacted groundwater.

A considerable portion of the OU2 plume appears to be captured by the on-site Claremont extraction and treatment system. Three things appear to happen to the plume at this location: 1. Most of the shallow plume is captured by the Claremont extraction wells; 2. A portion of the plume may be too deep and is not captured by the extraction and treatment system's extraction wells which are screened from just below the water table to approximately 90 feet below the water table; and 3. The eastern portion of the plume is outside the influence of the extraction wells. This last assumption is supported by the results of 3-D CSIA of off-site Claremont well EW-14D (185-195 ft. bgs), which is over 4,000 feet southeast of Aluminum Louvre. 3-D CSIA indicates the TCE in well EW-14D (270 µg/l in November 2013) shares the same isotopic signature as the TCE from the Aluminum Louvre contamination and not Claremont or another plume.

The extent of the plume proposed for active treatment is a subset of the larger plume of impacted groundwater. The footprint of the plume to be addressed by active remediation is shown on Figures 2, 4, 5 and 6, and is defined within this FS as that portion of the groundwater plume containing TCE at concentrations approximately greater than or equal to 400 µg/l. As shown on Figures 5 and 6, the plume proposed for active treatment measures approximately 130 feet wide, approximately 960 feet long, 15 feet thick and 200 feet deep in the vicinity of monitoring wells EW-7C and EW-7D.

Data gaps for the OU2 plume in the vicinity of the Claremont Site are primarily associated with lack of wells deeper than 300 feet. Further southeast and downgradient of Claremont, it is also difficult to discern the horizontal extent of the plume because of a scarcity of wells and sporadic and low-concentration detections of COCs. At this time there is insufficient data to describe the exact mechanisms that lead to the vertical distribution of the noted contamination. It is reasonable to conclude that they are related to the localized groundwater flow patterns in the complex sequence of inter-bedded sand, silt and clay in this area. Additional investigation would be required to confirm that the Aluminum Louvre plume actually extends as far southeast as well EW-14D and to determine how much deeper and further it extends in that direction. For purposes of defining the extent of OU2 with the data available at this time, the southern boundary of OU2 is considered to roughly coincide with the Claremont groundwater treatment plant.

3.2.2 Vapor Intrusion

Contaminated soil vapor migration from the source area at 301 is apparent at the northwestern portion of the 303 building (sub-slab TCE and PCE concentrations of 1,100 µg/m^3 and 480 µg/m^3, respectively). Because this location is not downgradient of the 301 source area, it is more likely a result of soil vapor migration through the vadose zone rather than from the groundwater plume.

TCE and PCE concentrations within the sub-slab sample obtained from 175 Bethpage-Sweethollow Road resulted in a recommendation for additional investigation. Contaminant concentrations within one of the sub-slab samples obtained from 303 Winding Road warranted mitigation.

3.3 Exposure Assessment

The most significant potential exposure pathway is the intrusion of vapor-phase chlorinated VOCs from contaminated groundwater and soil into overlying structures at the site and from contaminated groundwater and vadose zone migration into overlying structures off-site. Direct contact and ingestion were not identified as exposure routes within the RI. Table 5 provides a Summary of the Qualitative Human Health Exposure Assessment.

4.0 REMEDIAL GOALS AND REMEDIAL ACTION OBJECTIVES

4.1 Remedial Goals

The remedial action goals for remedial actions undertaken pursuant to the New York State Inactive Hazardous Waste Disposal Site Remedial Program (State Superfund Program or SSF), are defined by ECL, Article 27, Title 13. The goal of the SSF program is complete cleanup of the site through the elimination of the significant threat to the environment posed by the disposal of hazardous wastes at the site and of the imminent danger of irreversible or irreparable damage to the environment caused by such disposal.[2]

4.2 Remedial Action Objectives

RAOs are developed for a site to determine the levels to what site-specific concerns must be addressed to protect human health and the environment. The RAOs for the Former Aluminum Louvre Site are presented below.

<u>Groundwater RAOs for Public Health Protection</u>

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

<u>Groundwater RAOs for Environmental Protection</u>

- Restore groundwater to pre-disposal/pre-release conditions, to the extent practicable.
- Reduce the concentrations of VOCs in groundwater at the site.
- Limit off-site migration of VOCs in groundwater at concentrations greater than the Class GA GWQS.

[2] Environmental Conservation Law, Article 27, Title 13, §27-1313 Remedial Programs.

Chapter X - Division of Water, Part 703: Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, contains promulgated water quality standards and groundwater effluent limitations for discharges to Class GA waters to be used for the restoration of the groundwater aquifer to pre-disposal/pre-release conditions. VOCs have been detected in the groundwater within OU2 at concentrations greater than the groundwater Class GA ambient water quality standards.

Groundwater is not used for potable or production purposes at the property since the site and vicinity are serviced by a municipal water system. Therefore, there is no direct exposure to contaminants in groundwater.

Soil Vapor RAOs for Public Health Protection

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

New York State does not currently have any SCGs for subsurface vapors; however, the matrices in Section 3.4.2 of the Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006 were used to determine the most appropriate actions given the concentrations of TCE, PCE and 1,1,1-TCA in sub-slab soil vapor off site. NYSDOH Air Guideline Values of 30 $\mu g/m^3$ for PCE and 2 $\mu g/m^3$ for TCE are used for indoor air sample results. There is currently no Air Guideline Value for 1,1,1-TCA.

5.0 GENERAL RESPONSE ACTIONS

As described in Sections 3 and 4, groundwater has been impacted off-site. VOCs have been detected in groundwater at concentrations exceeding SCGs. VOCs have also been identified in sub-slab soil vapor samples at concentrations greater than NYSDOH guidance values. General Response Actions (GRAs) are broad categories of remedial alternatives and include non-technology specific types such as treatment, containment, excavation, extraction, disposal, institutional controls or various combinations. Table 6 lists the GRAs for groundwater and for vapor intrusion. Information for each type of GRA includes an estimate of the areas and volumes of contaminated media to be addressed and remediated; the medium being addressed; the identified use of that area of the site; and whether or not the GRA category includes a Presumptive Remedy.

6.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

6.1 Introduction

Specific technologies associated with the GRAs are further assessed in the following sections. The technologies are screened to identify those that appear to be most appropriate to the site-specific conditions and off-site groundwater contamination, technically implementable, and capable of achieving the site's RAOs. Further, presumptive remedies are given preference. Presumptive remedies include technologies that are proven and appropriate for the specific sets of site conditions which, based on experience gained at remediated Sites and NYSDEC's scientific and engineering evaluation of performance data, can be used to streamline the remedy selection process (DER-15, p 1).

Site-specific conditions, including contamination type, concentration, location (aerial extent and depth), geology/hydrogeology and estimated quantity were considered during the initial screening process. Estimated dimensions / quantity of contaminated groundwater are provided on Table 6. The initial screening was also based on the effectiveness for treating the contaminants present at the site, implementability given site-specific conditions, and relative cost.

Remedial technologies that were deemed to be not technically appropriate or cost prohibitive were dropped from further consideration. Table 7 summarizes the technology identification and screening process for groundwater. The table is grouped by the GRA (i.e., in-situ treatment, ex-situ treatment, containment, and reduction). Technologies that may be appropriate for addressing the contaminants at the site and that were thus retained for further evaluation are identified on the second to last columns of Table 7. Technologies that were screened out and not retained for further analysis are designated as "no" in the second to last columns of Table 7.

The most promising technologies were combined into remedial alternatives, which are described in the development of alternatives section of this report.

6.2 Identification and Screening of Technologies for Groundwater and Soil Vapor Intrusion

As discussed in Section 3, VOCs have been detected in groundwater at concentrations greater than the NYS Class GA groundwater standards. TCE is the most prevalent VOC with the greatest concentrations and was therefore used to define the groundwater area requiring treatment. As shown on Figures 5 and 6, the estimated off-site groundwater treatment area is approximately 130 feet wide by 960 feet long and 15 feet thick, and estimated to dive in the southeasterly direction to a maximum estimated depth of approximately 200 feet bgs. This proposed treatment area extends to the southeast limits of OU2, or approximately to the Claremont treatment plant.

The vertical extent of the proposed groundwater treatment area at the southeastern limits of OU2 has not yet been fully delineated; but has been estimated based on the vertical profile of the plume identified within upgradient wells, and assuming a consistent downward vertical gradient across OU2. Additional monitoring well installation will be required during the design process to collect delineation data required to complete the remedial design. A summary of the type and range of groundwater contamination at the site is provided in Table 2.

It is our understanding that the NYSDEC currently operates the Claremont treatment plant, and that this treatment plant may also be capturing a large portion of the impacted groundwater from the Aluminum Louvre Site. As such, the evaluation of each alternative, including the no action alternative, assumes that the NYSDEC will continue to operate the Claremont treatment plant at its current capacity. Costs currently incurred by the NYSDEC to operate the Claremont treatment plant are not included in the evaluation of remedial costs. Costs for each alternative are, therefore, estimated as the additional cost to implement the alternative over and above current operating costs.

Soil vapor intrusion will be addressed through mitigation. The most common mitigation method recommended by the NYSDOH is the use of SSDS, a presumptive remedy which includes a network of vapor collection points or horizontal pipes under a building. These systems are designed to collect vapor from below floor slabs and prevent accumulation of contaminated vapor and subsequent infiltration in the work area of a building or structure. The network of collection points or horizontal pipes is connected to a blower designed to maintain a continuous flow of air under the building or structure. Based on the contaminant concentrations, the vapor is either treated and discharged to the atmosphere or discharged without treatment.

As indicated above, the concentrations of PCE and TCE detected within 175 Bethpage-Sweethollow Road resulted in a recommendation of further investigation; but not mitigation. The concentrations of PCE and TCE detected within 303 Winding Road resulted in a recommendation of mitigation. To that end, SSDS for the 303 Winding Road building is included with all groundwater alternatives and is retained for further analysis with the exception of the no action alternative.

The GRAs for impacted on-site groundwater include no action, institutional controls, monitored natural attenuation (MNA), containment, treatment, and removal. Remedial technologies are grouped by GRA and discussed in detail in the following sections. A summary of the groundwater screening process is provided in Table 7.

6.2.1 Containment

Containment involves remediation technologies such as physical barriers to slow groundwater flow and minimize migration of contaminated groundwater off-site. Subsurface physical barriers generally consist of vertically excavated trenches filled with slurry and often are used where the waste mass is too large for treatment and where soluble and mobile constituents pose an imminent threat to a sensitive receptor. Also, physical barriers are more effective when geologic conditions allow for connection to a low permeability layer to enhance the containment.

Groundwater contamination proposed for treatment at the site is up to 200 feet bgs and not suitable for installing a physical barrier. Also, there are no known continuous low-permeability layers in the area to enhance the containment. Therefore, based on the site geology and depth of contamination, containment has been screened out from further evaluation.

6.2.2 In-Situ Biological Treatment

- Bioremediation: Bioremediation is a process that attempts to accelerate the natural biodegradation process by introducing nutrients, electron acceptors, and/or competent contaminant-degrading microorganisms to the subsurface. The rate of bioremediation can be enhanced by increasing the concentration of oxygen for aerobic degradation or adding a carbon substrate to support anaerobic degradation. Factors that may limit the applicability and effectiveness of these processes at the site include the time needed to remediate the plume, which may require years; air injection that may result in vapor generation and accumulation in buildings; and the potential incomplete degradation of chlorinated volatile organic compounds (CVOCs) to toxic by-products (e.g., vinyl chloride). Enhanced bioremediation would involve creating the proper conditions by adding microorganisms or nutrients to the subsurface to accelerate the biodegradation of the CVOC contamination. Here, bioremediation will likely consist of the injection of a carbon substrate into the groundwater to create anaerobic conditions in the aquifer, which is necessary for the reductive dechlorination of CVOCs. Enhanced bioremediation has been retained for further evaluation for the site.

- Monitored Natural Attenuation: MNA is a process where natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels. Regulatory approval of this option usually requires modeling and evaluation of contaminant degradation rates and pathways, and predicting contaminant concentration at potential down gradient receptor points. The primary objective of site modeling is to demonstrate that natural processes of contaminant degradation will reduce contaminant concentrations below regulatory standards or risk-based levels before potential exposure pathways are completed. In addition, long term monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives. MNA can be implemented with other active remediation technologies and has been retained for further evaluation for the site.

6.2.3 In-Situ Physical/Chemical Treatment

- Air Sparging: Air sparging is an in-situ technology and presumptive remedy in which clean air is injected into a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating a subsurface “air stripper” that removes contaminants by volatilization. The injected air helps to flush the contaminants upward into the unsaturated zone where a vapor extraction system is usually implemented in conjunction with air sparging to remove the generated vapor phase contamination. Because of site-specific geology/hydrogeology (i.e. a long and narrow deep plume) and possibility of generating uncontrolled vapor-phase contamination that could impact indoor air quality, air sparging has not been retained for further evaluation.

- In-Situ Chemical Oxidation: ISCO chemically converts contaminants to less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, potassium permanganate, persulfate, hypochlorites, chlorine, and chlorine dioxide. Matching the oxidant and in-situ delivery system to the contaminants of concern and the site conditions is the key to successful implementation and achieving performance goals. ISCO is a presumptive remedy that is a viable remediation technology for mass reduction of organic contaminants in groundwater. Chemical oxidation can have a relatively rapid treatment time, and can be implemented with readily available equipment. Limitations associated with chemical oxidation include: requirements for handling and administering large quantities of hazardous oxidizing chemicals; and naturally occurring organic material in the formation can consume large quantities of oxidant. Because of its effectiveness in reducing VOCs in rapid treatment time, ISCO has been retained for further analysis.
- Directional Wells: Drilling techniques can be modified to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling. Directional drilling may be used to enhance vapor mitigation or other in-situ or in-well technologies such as groundwater pumping, SVE, soil flushing, and in-well air stripping. Based on site conditions, directional wells do not appear to be an applicable technology. Therefore, this technology will not be retained for further evaluation.
- Thermal Treatment: In this technology, heat is forced into an aquifer through injection wells to vaporize VOCs and semi-volatile organic compounds (SVOCs). Vaporized components rise to the unsaturated zone where they are removed by

vacuum extraction and the off-gases are treated. Groundwater contamination proposed for treatment at the site is up to 200 feet bgs and not suitable for implementing thermal treatment that deep. Therefore, based on the site geology, thermal treatment has not been retained for further evaluation.

- In-Well Air Stripping: With in-well air stripping technology, air is injected into a vertical well that has been screened at two depths. The lower screen is set in the groundwater saturated zone, and the upper screen is set in the unsaturated zone. Pressurized air is injected into the well below the water table, aerating the water. The aerated water rises in the well and flows out of the system at the upper screen, inducing localized movement of groundwater into and up the well as contaminated groundwater is drawn into the system at the lower screen. VOCs vaporize within the well at the top of the water table. The contaminated vapors accumulating in the wells are collected via vapor extraction contained within the well. Vapor phase treatment typically occurs above grade. The partially treated groundwater is never brought to the surface; it is forced into the unsaturated zone, and the process is repeated as water follows a hydraulic circulation pattern or cell that allows continuous cycling of groundwater. As groundwater circulates through the treatment system in-situ, and vapor is extracted, contaminant concentrations are gradually reduced.

  Although in-well air stripping is a presumptive remedy, there are a limited number of vendors that are available to design and construct the remedy (DER-15, p. 7) making it difficult to obtain competitive bids and evaluate it against other technologies for cost effectiveness. Therefore, in-well air stripping has not been retained for further evaluation.

- Passive/Reactive Treatment Walls: Treatment walls or, treatment barriers allow the passage of impacted groundwater while causing the degradation or removal of contaminants. Passive/reactive treatment walls do not appear to be an efficient/effective technology for addressing groundwater contaminants given the physical characteristics of the site and concentrations, configuration and depth of the groundwater plume. Therefore, passive/reactive treatment walls have been screened out and will not be evaluated further.

6.2.4 Ex-Situ Biological Treatment

Ex-situ biological treatment involves the pumping of impacted groundwater at the site and implementing biological treatments such as bioreactors and constructed wetlands. Ex-situ biological treatment requires a portion of the site dedicated for treatment for a moderate to long term timeframe. Given the physical characteristics, limited space and active commercial use of the off-site area, ex-situ biological treatments have been screened out and not retained for further evaluation.

6.2.5 Ex-Situ Physical/Chemical Treatment

Ex-situ physical/chemical treatment involves the pumping of impacted groundwater at the site and implementing physical/chemical treatment such as adsorption, advanced oxidation process, air stripping, ion exchange, precipitation/coagulation/flocculation, separation, and/or sprinkler irrigation.

- Adsorption: The adsorption process consists of passing contaminated groundwater through a sorbent media. Contaminants are adsorbed onto the media, reducing their concentration in the bulk liquid phase. The most common adsorbent is GAC which is also a presumptive remedy. Adsorption is a viable technology for VOC treatment of extracted groundwater and vapors. Therefore adsorption via GAC has been retained for further evaluation.
- Advanced Oxidation Processes: Advanced oxidation processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as impacted water is pumped into a treatment vessel. If ozone is used as the oxidizer, an ozone destruction unit(s) may be required to treat off-gases from the treatment tank and where ozone gas may accumulate or escape. Advance oxidation technology is associated with high energy requirements. Therefore, advanced oxidation process technology has been screened out and will not be retained for further analysis.

- Air Stripping: Air stripping is a presumptive remedy that involves the mass transfer of volatile contaminants from water to air. VOCs are separated from extracted groundwater by exposing the contaminated water to a flow of air. Air stripping configurations include packed towers, diffused aeration, tray aeration, and spray aeration. Given the large size of the plume, flow rates of an extraction and treatment system are likely to be in a range where air stripping will be more cost-effective. Treatment of the air stripper effluent air stream with vapor phase GAC would be required with this process option. This is a well-established technology that can be effective in reducing contaminant toxicity, mobility and concentration through the use of treatment equipment that is readily available, although it is likely to have an extended remedial timeframe and relatively high capital and operational costs. Air stripping has been retained for further analysis.
- Groundwater Extraction and Treatment: Extraction and treatment is a presumptive remedy. Groundwater extraction consists of pumping groundwater from an aquifer to remove dissolved phase contaminants and/or achieve hydraulic containment of contaminated groundwater to prevent migration. Processes typically evaluated or used in extraction and treatment systems include ex-situ physical and chemical treatments. Generally, treatment and monitoring of extracted groundwater is required. A multiple treatment train may be required for groundwater with multiple types of contaminants. A groundwater monitoring program is a component of any groundwater extraction system to verify its effectiveness. Potentially long time periods are required for groundwater pumping to achieve remediation goals. Operation and maintenance considerations associated with treatment systems may be more extensive than other treatment technologies. Groundwater pumping has been retained for further analysis due to its proven and long track record as a remediation technology.

6.2.6 Discharge/Disposal

Groundwater that has undergone treatment must ultimately be disposed of or discharged. Groundwater treated by the above technologies can be discharged to the sanitary sewer, surface water or re-injected to groundwater. Discharge options including those utilizing surface water, the sanitary sewer and POTW have been retained. Air emissions and GAC adsorption media will also require discharge, disposal or regeneration.

6.3 Evaluation of Technologies and Selection of Representative Technologies

As listed in Table 7, groundwater remedial technologies under each type of GRAs were screened for potential applicability, effectiveness, and implementation at the site. In addition to no action, the following technologies pass the screening process:

- LTM
- Bioremediation
- ISCO
- Adsorption
- Air Stripping
- Extraction and Treatment
- Disposal/Discharge

7.0 DEVELOPMENT AND ANALYSIS OF ALTERNATIVES

7.1 Alternative Development

In accordance with NYSDEC's *DER-10 Technical Guidance for Site Investigation and Remediation*, May 3, 2010 and DER-15: *Presumptive /Proven Remedial Technologies for New York State's Remedial Programs*, February 27, 2007, remedial alternatives are developed by combining the remedial technologies that have successfully passed the screening stage into a range of alternatives.

NYSDEC's *DER-10* requires a no action alternative and an alternative that would restore the site to "pre-disposal conditions". Other alternatives are to be included based on:

- Current, intended, and reasonably anticipated future use of the site;
- Removal of source areas of contamination; and
- Containment of contamination.

7.1.1 Groundwater and Soil Vapor Intrusion Alternative Development

VOCs were detected in on- and off-site groundwater at concentrations greater than the NYSDEC Class GA groundwater standards to a depth of up to 300 feet bgs at monitoring well EW-12D located at the edge of the OU2 FS area. Groundwater flow is easterly to southeasterly. TCE that appears to have originated on-site has migrated vertically downward and horizontally in the direction of groundwater flow. For the purpose of this FS, the active groundwater remediation area is assumed to be approximately 130 feet wide by 960 feet long by 15 feet thick. The plume of impacted groundwater to be remediated begins at a starting depth of 65 feet bgs at the southern edge of OU1, and dives downward as it flows in a southeasterly direction, with an ending depth of approximately 200 feet bgs in the vicinity of monitoring wells EW-7C and EW-7D.

The groundwater remedial technologies retained for further analysis include:

- LTM
- Bioremediation
- ISCO
- Adsorption (Vapor Phase)

- Air Stripping
- Extraction and Treatment
- Disposal/Discharge

LTM and institutional controls will not be included as an individual alternative but they will be used in conjunction with, or as enhancements to the other remedial technologies. LTM would consist of a network of wells located within and downgradient of the OU2 boundary. It is assumed that this well network will include off-site wells including those located on the Claremont property. The selection of specific wells will depend on the layout of the remedial technologies and can be adjusted during the treatability, remedial design and implementation phases of the project. LTM for a period of 30 years will be used to monitor any diluted residual plume that may remain after the conclusion of active remedial actions for each of the alternatives.

In addition to the GRAs, alternatives were assembled to provide containment to minimize further migration of contaminated groundwater. Based on the retained remedial technologies and OU2-specific conditions, groundwater remedial alternatives were developed, and are described in the following sections.

A SSDS is paired with each of the groundwater remedial technologies to mitigate vapor intrusion into the 303 Winding Road building. Although not retained as a separate remedial technology, institutional controls such as environmental easements will be included in conjunction with, or supplemental to the other remedial technologies. Institutional controls will not reduce the mass of contamination at the site; but are effective at reducing access and exposure to the site contaminants.

Five remedial alternatives were developed, based on the retained remedial technologies and site-specific conditions, and are described in the following sections. Except for the no action alternative, each of the five alternatives includes SSDS for the 303 Winding Road building located west of the OU2 site. In addition, except for Alternative G5, each alternative assumes that the Claremont treatment plant will continue to operate under the supervision of the NYSDEC, and that existing extraction wells associated with this treatment plant will continue to remove impacted groundwater from within OU2.

Sub-slab Depressurization System

SSDS uses a fan-powered vent and piping to draw vapor from the soil beneath the building's slab (i.e., essentially creating a small negative pressure beneath the slab) and discharge the vapors to the atmosphere. This results in lower sub-slab air pressure relative to indoor air pressure, which prevents the infiltration of contaminated sub-slab soil vapors into the building. The depressurization approach needs to be determined on a building-specific basis due to building-specific features that may be conductive to a specific depressurization approach. A pilot test will be performed at the 303 Winding Road building to measure the ability of a pressure field and air flow to extend through the material beneath the slab. This test is commonly conducted by applying suction on a centrally located penetration drilled through the concrete slab and simultaneously measuring the vacuum at various locations across the slab using a digital micro manometer or comparable instrument. Depending on test results, multiple slab penetration points may be needed to achieve the desired effectiveness of the system. The system design will be based on the results of the pilot test and may be different for each building.

For the purpose of this FS, SSDS system installation includes one system for the building located at 303 Winding Road. The building is approximately 345 feet long by 300 feet wide. As shown in Figure 7, approximately four extraction points located in the northwest corner of the building will be connected to the fans designed to maintain a continuous flow of air. The locations of the extraction points were determined based on the soil vapor sample results in the sub-slab samples. Based on the contaminant concentrations, the vapor will be either treated through GAC and discharged to the atmosphere or discharged without treatment. All the piping required for the SSDS is assumed to be co-located with other utility conduit runs.

7.1.1.1 Alternative G1 – No Action

The No Action option is included as a basis for comparison with active groundwater remediation technologies in accordance with Section 4.2 of NYSDEC DER-10. If no remedial action is taken, contaminants already present in the groundwater will remain in place and/or move downgradient in the direction of groundwater flow. Contaminants, particularly CVOCs, will possibly degrade via natural processes and transform to form other compounds over time. The No Action alternative is retained for further evaluation as required under NYSDEC DER-10 as a point of comparison to other remedial alternatives. It is assumed that land and groundwater resource use will not change over time and that any existing institutional controls will remain in place and enforced by other regulatory programs. The no action alternative also assumes that the NYSDEC will continue to operate the Claremont treatment plant at the current configuration and flow rate.

7.1.1.2 **Alternative G2 – ISCO and SSDS**

Alternative G2 consists of ISCO with LTM for the remediation of VOCs in groundwater. ISCO consists of the injection of reagent into the aquifer that chemically reacts with the contamination. To be effective, ISCO relies on dispersion of the oxidizing reagent across the aquifer to achieve the required direct contact with the contaminant plume. Chlorinated solvents can also be degraded via reductive processes. In-situ chemical reduction (ISCR) utilizes specific types of ferric materials to reduce contaminants in the subsurface. ISCR can minimize the formation of vinyl chloride and push reaction kinetics past DCE if stalled, to achieve complete dechlorination to ethene.

Chemical oxidation would consist of the injection of a chemical /reagent such as liquid peroxide (H_2O_2), permanganate ($KMnO_4$) or Modified Fenton’s Reagent® into the subsurface to degrade the organic contaminants. The chemical oxidant used for cost estimating purposes was Modified Fenton’s Reagent® (MFR) from Isotec. Fenton's Reagent is very effective at destroying organic contamination through co-existing chemical oxidation and reduction; however its shortcomings include incomplete treatment, explosive reactions, organic vapor generation and contaminant migration. MFR was selected because it is equally as effective as Fenton’s Reagent but its catalysts allow reagents at background neutral pH conditions to be effectively distributed within the aquifer, destroying contaminants in groundwater without generating organic vapors or high temperatures.

The radius of influence of ISCO/ISCR injection points is usually relatively low (i.e., generally 10 to 15 feet in similar aquifers). To achieve complete coverage of the aquifer, a large number of injection points would be required for plumes with a large areal extent. Therefore, a robust pre-design investigation and pilot testing to reduce the footprint of the horizontal and vertical extent of the plume are assumed in the evaluation of this alternative. For the purpose of developing the conceptual design and cost estimate for comparison with other technologies in this FS, a transect configuration at approximately every 75 feet was evaluated to represent implementation of the

ISCO technology. Treatability studies, performance monitoring, use of LTM outside of active remediation areas and institutional controls are assumed to occur. This or any other conceptual design would require further evaluation if chosen to be implemented; it is possible that the final design would vary significantly from the concept used in this FS depending on the vendor performing the work.

The duration of the treatment would be determined by the time required for one pore volume of the contaminated groundwater to travel to the treatment bands. For the purpose of the FS, a hydraulic conductivity of 60 feet per day was used based on the site geology/hydrogeology to determine the time required for one pore volume of contaminated groundwater to travel to the treatment bands. The depth of the injection wells would vary from shallow to deeper as groundwater contamination was detected shallow near the upgradient area and deeper near the edge of OU2 FS area boundary. A detailed pre-design investigation would be required to determine the exact depths of the nested well at each transects. For the purpose of this FS, an average monitoring well depth close to the on-site area is assumed to be shallow (65 to 110 feet bgs), and deeper (130 to 205 feet bgs) farther down gradient within the plume.

Figure 8 provides the conceptual ISCO injection wells plan and performance monitoring within the active remediation area, and LTM locations within the OU2 FS area. The conceptual design includes approximately 105 injection locations. The injection wells are placed approximately 15 feet apart with assumed radius of influence of 10 feet based on the site geology. The locations of permanent injection wells were also determined with consideration of the need to access inside the buildings located at 303 Winding Road and 191 Bethpage-Sweethollow Rd. Permanent injection wells with an injection vault are also shown on Figure 8.

Pilot testing and field measurement during the pre-design phase of the work will determine the exact number, placement, and depth of injection wells. Bench testing will determine the most appropriate type of reagent and dosage. The groundwater remediation area will likely require multiple injection phases. Pressurized injection can also be employed to obtain better lateral transport (increase in radius of influence) using higher oxidant solutions, resulting in fewer injection points.

The time for remediation may be relatively short, on the order of two to three years, depending on the need for reapplications. Groundwater monitoring will occur subsequent to chemical oxidation events to confirm that VOC concentrations are being effectively reduced. Although a significant portion of the contaminant mass is reduced using ISCO, it is frequently subject to re-bound with concentrations returning to near pre-treatment levels in source areas. Based on the monitoring data, additional chemical oxidation injection events may be required.

For cost estimating, it was assumed that LTM will be conducted quarterly for the first 2 years, twice a year for years 3 and 4, and annually for years 5 through 30. Two rounds of injections have been assumed. Under this alternative, institutional controls (environmental easement, site Management Plan) will be required. Environmental easements are intended to prevent human contact with contaminated media through restrictions or limitations of site uses.

7.1.1.3 **Alternative G3 – Bioremediation and SSDS**

This remedial alternative consists of implementing bioremediation in the active remediation area. While laboratory testing has been completed to confirm the presence of methane oxidizing bacteria at the site (Appendix B), the performance of a pre-design investigation and pilot testing are assumed in the evaluation of this alternative, as is the installation of a large number of injection wells, periodic introduction of substrate and performance monitoring. It is also assumed that LTM will be implemented outside of any active remediation areas and institutional controls will be put in place to limit groundwater use.

Release of a viscous fluid substrate [e.g., hydrogen release compound (HRC®) or emulsified oil substrate (EOS)] to the subsurface would be used to effect treatment under this alternative. These substrates are known to last longer than some other soluble or solid substrates and require fewer rounds of injections. They are relatively immobile and rely on advection and dispersion for effective delivery throughout the aquifer. In many cases, the sole use of an organic substrate is sufficient to stimulate anaerobic bioremediation.

Bioaugmentation may also be used in this alternative should the indigenous population of dechlorinating microorganisms be insufficient to stimulate complete anaerobic reductive dechlorination. Bioaugmentation involves the injection of a microbial amendment known to specifically degrade the targeted chlorinated compounds to facilitate the remedial process.

Enhanced bioremediation can be implemented in different system configurations, including a grid or transect configuration using well injection system; or a combination of both. A grid configuration for plume-wide restoration option has been shown to maximize the mass removal within a relatively short period of time. It involves injection of substrate within the entire plume area. A transect configuration installed within the easily accessible area involves construction of permanent injection wells and a multi-year injection program. This option would remove the contaminant mass at a moderate rate. Methods to deliver substrate include temporary direct push wells, permanent injections well, recirculation of the substrate using the push-pull method, or emplacement of solid substrate in biowall trenches.

For the purpose of developing the conceptual design and cost estimate for comparison with other technologies in this FS, a transect configuration located approximately every 150 feet within the easily accessible areas was evaluated to represent implementation of the bioremediation technology. This or any other conceptual design would require further evaluation if chosen to be implemented; it is possible that the final design would vary significantly from the concept used in this FS depending on the vendor selected for the implementation.

The duration of the treatment will be determined by the time required for one pore volume of the contaminated groundwater to travel to the treatment areas. Figure 9 provides the conceptual bioremediation injection, performance monitoring and LTM monitoring locations within the off-site plume area. A typical spacing of the injection wells, based on the conceptual alternative is approximately 15 feet. Similar to Alternative G2, a single injection well will be installed at each location to achieve direct contact with the approximately fifteen feet thick contaminated plume. The depth of the injection wells will vary from shallow to deeper as groundwater contamination was detected shallow near the upgradient area and deeper near monitoring wells EW-7C and EW-7D. The conceptual injection locations were selected based on the site geology and assumed radius of influence of 10 feet. For the purpose of this FS, two rounds of injections are assumed at 57 injection locations. The locations of permanent injection wells were also determined with consideration of the need to install them within the commercial buildings located within the off-site plume area. Permanent injection wells with an injection vault are also shown on Figure 9. Field pilot testing to determine the most appropriate substrate, microbial sufficiency and pre-design parameters on injection well spacing, substrate loading rate, injection frequency, and substrate amendments (e.g., pH buffering compounds, contaminant degrading microorganisms) is required. The actual design, spacing and substrate requirements could vary significantly.

Based on the estimated time of travel using the conceptual design assumptions, this option is expected to remove the contaminant mass within 10 years in the active remediation area. LTM will be conducted for 30 years. For cost estimating, it was assumed that LTM will be conducted quarterly for the first 5 years, twice a year from years 5 to 10, and annual sampling from year 10 to 30. Under this alternative, institutional controls (environmental easement, Site Management Plan) will be required. Environmental easements are intended to prevent human contact with contaminated media through restrictions or limitations of site uses.

7.1.1.4 **Alternative G4 – Extraction and Treatment at Claremont Treatment Plant and SSDS**

Alternative G4 consists of a groundwater extraction system to capture the shallow, intermediate and deep VOC-contaminated groundwater and treat it at the surface by implementing remedial technologies such as air stripping, a vapor phase GAC system, and finally discharge/disposal of treated groundwater. This alternative of extraction and treatment of groundwater will remove contaminant mass from the OU2 plume and establish hydraulic control of the aquifer to minimize further migration of the groundwater plume. This alternative assumes treatment of the extracted groundwater will occur at the Claremont Treatment Plant.

Conceptually, two groundwater pumping wells as shown on Figure 10 will be installed to extract contaminated groundwater not already captured by the Claremont treatment system extraction wells. The pumping wells will be placed upgradient of the existing Claremont extraction wells to capture the most shallow and deepest portions of the contaminant plume not currently captured by the Claremont treatment system. A pump test in the pre-design phase of the work will provide information to more accurately determine the adequate well spacing, capture zone, flow rates, and remediation time. For the purpose of the FS, a hydraulic conductivity of 60 feet per day was used to determine the number of wells, and pumping rates.

Alternative G4 includes installation of shallow and deep extraction wells as shown on Figure 10. One extraction well will be installed near temporary well 303-TP-E to a depth of approximately 65 feet bgs, with a screen length of about 20 feet to address removal of contaminant mass in the shallow zone. The second extraction well will be placed downgradient from monitoring wells, EW-7C and EW-7Dpproximately 200 feet bgs, with a screen length of 20 feet to establish hydraulic control of the aquifer and minimize migration of the groundwater plume beyond the boundary of OU2.

The pumping rate for each of the shallow and deep extraction wells is estimated to be about 100 gpm to affect a capture zone of approximately 150 ROI based on the site geology and hydraulic conductivity of 60 feet per day. The actual remedial pumping rates for the extraction wells will be optimized based on the results of the pump test and a comprehensive groundwater flow model of the site. The contaminated groundwater from each extraction well will be pumped to the on-site groundwater treatment system.

For the purposes of this FS, it has been assumed that the existing Claremont treatment plant will remain in operation, and that upgrades will be made, as necessary, to accommodate the additional flow rate from four additional extraction wells. Based on discussions with the operators of the Claremont treatment plant, treatment equipment within the current groundwater treatment system is sized to operate at an average flow rate of 500 gpm. An additional flow of approximately 200 gpm is estimated from the extraction well network. For the purposes of the FS, this alternative includes costs to increase the treatment capacity of the Claremont treatment plant to accommodate the additional flow anticipated from the new extraction wells.

After the pumped groundwater is metered from the outside storage tanks, it will enter a media filter to remove solids. The water will be pumped into an air stripper for treatment. The vapor phase emitted from the air stripper will be treated by passing through a vapor-phase GAC network. The liquid effluent from the air stripper will be passed through a liquid-phase GAC network. The treated effluent water will be discharged into re-injection dry wells located on property currently owned by the Claremont treatment plant. A schematic of the proposed process treatment of the system is shown in Figure 12 Pilot testing and field measurements in the pre-design phase of the work will be required to determine if any type of pre-treatment of the groundwater is required prior to passing through the air stripper. A pre-treatment for iron removal via manganese greensand is included in the cost estimate. The requirement to pre-treat for iron was determined from review of existing data of iron concentrations in groundwater included in the report "Site Characterization Report Old Bethpage Industrial Area Plume Trackdown", Malcolm Pirnie, Inc., February 2010. Iron concentrations in groundwater within the Old Bethpage Industrial Area frequently exceeded the Class GA GWQS for iron of 300 µg/l ranging from a marginal exceedance of 485 µg/l to over 21,000 µg/l. It should be noted that the current Claremont system has not needed to use the existing greensands filter as concentrations of iron have not been sufficiently elevated to require it.

The discharged effluent is subject to the New York State groundwater effluent limitations – Class GA and will be detailed in a State Pollutant Discharge Elimination System (SPDES) permit as issued by the NYSDEC.

To confirm that the groundwater extraction and treatment system is achieving remedial objectives, groundwater samples will be collected from monitoring wells installed for system performance monitoring and analyzed for VOCs. The results of these analyses will be used to determine whether remedial action objectives are being satisfied, and whether changes in the system design, configuration, and operation are required.

The time for remediation may be on the order of 20 to 30 years. For cost estimating purposes, it is assumed that the RAOs for the groundwater contaminants will be met in 30 years.

Contamination greater than the Class GA groundwater standards may remain within the OU2 plume under this alternative because of contributing contamination upgradient from OU1, LTM, institutional controls (environmental easement, Site Management Plan) will be required. LTM will be conducted on a periodic basis to determine if remedial objectives are being met. For cost estimating, it was assumed that LTM will be conducted quarterly for the first 2 years, and annually from year 3 to 30. Under this alternative, institutional controls (environmental easement, Site Management Plan) will be required. Environmental easements are intended to prevent human contact with contaminated media through restrictions or limitations of site uses. Environmental easements limit or prohibit certain uses or development within the plume area and serve to notify prospective owners of the existence of remaining contamination.

Based on discussions with the NYSDEC, HDR has included costs for the installation of a roof- and ground-based solar array capable of meeting the power demands of the treatment system, or at least 400,000 kilowatt-hours of power per year. Based on discussions with solar power vendors and a review of estimated costs, it is anticipated that the payback for a solar system of this type is ten years, with the system providing savings to the NYSDEC each year beyond year 10.

7.1.1.5 **Alternative G5 – Extraction and Treatment at a new GWTF and SSDS**

Alternative G5 consists of a groundwater extraction system to capture the shallow and deeper VOC-contaminated groundwater and treat it at the surface by implementing remedial technologies such as air stripping, vapor phase GAC system, and finally discharge/disposal of treated groundwater. This alternative of extraction and treatment of groundwater will remove contaminant mass from the OU2 plume and establish hydraulic control of the aquifer to minimize further migration of the groundwater plume. This alternative proposes the treatment of extracted groundwater in a new treatment plant rather than through the expansion of the existing treatment plant as in Alternative G4. Under this scenario, the existing Claremont treatment plant will be taken off line, and replaced with equipment necessary to fully capture and treat impacted groundwater associated with the Aluminum Louvre Site.

Alternative G5 includes installation of shallow and deep extraction wells as shown on Figure 11. One extraction well will be installed near temporary well 303-TP-E to a depth of approximately 65 feet bgs, with a screen length of about 20 feet to address removal of contaminant mass in in shallow zone. The second extraction well will be placed downgradient from monitoring wells EW-7C and EW-7D to a depth of approximately 200 feet bgs, with a screen length of 20 feet to maintain hydraulic control of the deeper aquifer in this area. The pumping rate for each of the shallow and deep extraction wells is estimated to be about 100 gpm to affect a capture zone of approximately 150 feet in radius based on the site geology and hydraulic conductivity of 60 feet per day. The actual remedial pumping rates for the extraction wells will be optimized based on the results of the pump test and a comprehensive groundwater flow model of the site. The contaminated groundwater from each extraction well will be pumped to a newly installed off-site groundwater treatment system.

For this alternative, a total peak flow of approximately 200 gpm is estimated from the extraction well network. An approximately 2,000- square foot groundwater treatment plant is proposed at a location adjacent to the existing Claremont treatment building; however, the actual location will be confirmed with the site owner during the design phase.

After the pumped groundwater has been metered from the outside storage tanks, it will enter a media filter to remove solids. Then the water will be fed into a tray air stripper for treatment. The vapor phase emitted from the air stripper will be treated by passing through a vapor phase GAC network. The liquid effluent from the air stripper will be passed through a liquid phase GAC network. The treated effluent water will be discharged into re-injection dry wells located near the northern and western boundaries of the building at 161 Bethpage-Sweethollow Road. A schematic of the proposed process treatment of the system is shown in Figure 11. Pilot testing and field measurements in the pre-design phase of the work will be required to determine if any type of pre-treatment of the groundwater is required prior to passing through the air stripper. A pre-treatment for iron removal via manganese greensand is included in the cost estimate. The requirement to pre-treat for iron was determined from review of existing data of iron concentrations in groundwater included in the report "Site Characterization Report Old Bethpage Industrial Area Plume Trackdown", Malcolm Pirnie, Inc., February 2010. Iron concentrations in groundwater within the Old Bethpage Industrial Area frequently exceeded the Class GA GWQS for iron of 300 µg/l ranging from a marginal exceedance of 485 µg/l to over 21,000 µg/l. It should be noted that the current Claremont system has not needed to use the existing greensands filter as concentrations of iron have not been sufficiently elevated to require it.

The discharged effluent is subject to the New York State groundwater effluent limitations – Class GA and will be detailed in a SPDES permit as issued by the NYSDEC.

To confirm that the groundwater extraction and treatment system is achieving remedial objectives, groundwater samples will be collected from monitoring wells installed for system performance monitoring and analyzed for VOCs. The results of these analyses will be used to determine whether remedial action objectives are being satisfied, and whether changes in the system design, configuration, and operation are required.

The time for remediation may be on the order of 20 to 30 years. For cost estimating purposes, it is assumed that the RAOs for the groundwater contaminants will be met in 30 years.

Contamination greater than the Class GA groundwater standards may remain within the OU2 plume under this alternative because of contributing contamination upgradient from OU1, LTM, institutional controls (environmental easement, Site Management Plan) will be required. LTM will be conducted on a periodic basis to determine if remedial objectives are being met. For cost estimating, it was assumed that LTM will be conducted quarterly for the first 2 years, and annually from year 3 to 30. Environmental easements are intended to prevent human contact with contaminated media through restrictions or limitations of site uses. Environmental easements limit or prohibit certain uses or development within the plume area and serve to notify prospective owners of the existence of remaining contamination.

Based on discussions with the NYSDEC, HDR has included costs for the installation of a roof- and ground-based solar array capable of meeting the power demands of the treatment system, or at least 400,000 kilowatt-hours of power per year. Based on discussions with solar power vendors and a review of estimated costs, it is anticipated that the payback for a solar system of this type is ten years, with the system providing savings to the NYSDEC each year beyond year 10.

7.2 Evaluation of Alternatives

7.2.1 Introduction

This Section presents the detailed evaluation of the remedial alternatives described in Section 7.1. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative as well as key trade-offs among the alternatives. The evaluation was based on criteria established under NYSDEC's *DER-10 Technical Guidance for Site Investigation and Remediation*, Section 4.2. The evaluation criteria are as follows:

- **Overall protection of human health and the environment:** This criterion is an evaluation of the alternative's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced or controlled through removal, treatment, engineering controls or institutional controls. The alternative's ability to achieve each of the RAOs is evaluated.

- **Compliance with Standards, Criteria and Guidance (SCGs):** This criterion evaluates the compliance of the alternative with all identified SCGs. All SCGs for the site will be listed along with a discussion of whether or not the remedy will achieve compliance.

- **Long term effectiveness and permanence**: Each alternative is evaluated for its long-term effectiveness after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated:

  - The magnitude of the remaining risks (i.e. will there be any significant threats, exposure pathways, or risks to the community and environment from the remaining wastes or treated residuals?);
  - The adequacy of the engineering and institutional controls intended to limit the risk;
  - The reliability of these controls, and;
  - The ability of the remedy to continue to meet RAOs in the future.

- **Reduction of toxicity, mobility, or volume of contamination through treatment:** The alternative's ability to reduce the toxicity, mobility or volume of site contamination is evaluated. Preference should be given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the site.

- **Short term impacts and effectiveness:** The potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during the construction and/or implementation are evaluated. A discussion of how the identified potential adverse impacts to the community or workers at the site will be controlled, and the effectiveness of the controls, should be presented. Provide a discussion of engineering controls that will be used to mitigate short term impacts (i.e., dust control measures). The length of time needed to achieve the remedial objectives is also estimated.

- **Implementability:** The technical and administrative feasibility of implementing each alternative is evaluated for this criterion. Technical feasibility includes the difficulties associated with the construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.
- **Cost Effectiveness:** This criterion is an evaluation of the overall cost effectiveness of an alternative or remedy. This criterion evaluates the estimated capital, operations, maintenance, and monitoring costs. Costs are estimated and presented on a present worth basis.
- **Land Use:** This criterion evaluates the current, intended and reasonably anticipated future use of the site and its surroundings, as it relates to an alternative or remedy, when unrestricted levels would not be achieved.

7.2.2 Groundwater Alternative Evaluation

The five groundwater alternatives that were identified and pre-screened for evaluation include:

- Alternative G1 – No Action
- Alternative G2 – ISCO and SSDS
- Alternative G3 – Biological Treatment and SSDS
- Alternative G4 – Extraction and Treatment and SSDS; Claremont Treatment Plant
- Alternative G5 – Extraction and Treatment and SSDS; new off-site Treatment Plant

An individual analysis of the groundwater alternatives against the criteria outlined in section 7.2.1 was conducted and is presented below. A summary of the evaluation is provided in Table 8. Cost breakdowns for each alternative are presented within Appendix A, and summarized in Table 9.

7.2.2.1 **Alternative G1 – No Action**

The no action option is included as a basis for comparison with active groundwater remediation technologies in accordance with Section 4.2 of DER-10. If no remedial action is taken, contaminants already present in the groundwater will remain in place.

- **Overall protection of human health and the environment:** Alternative G1 provides no control of exposure to contaminated groundwater and no reduction in risk to human health posed by contaminated groundwater. The no action alternative does not attain the groundwater RAOs (e.g., restoration of the resource) and does not enhance the protection of human health. The alternative allows for the continued migration of the OU2 contaminated groundwater plume.
- **Compliance with SCGs:** Alternative G1 does not comply with any of the applicable SCGs. Contaminated groundwater will continue to exhibit concentrations above the Class GA GWQS in the plume area being considered for active groundwater remediation.
- **Long term effectiveness and permanence**: Alternative G1 does not provide a degree of long-term effectiveness and permanence. Existing groundwater contamination poses potential unacceptable human health risks under current and likely future groundwater use scenarios. No long term management or controls for exposure are included in this alternative. Under the no action alternative, these risks would remain unchanged over the long- term for expected groundwater uses.
- **Reduction of toxicity, mobility, or volume of contamination through treatment:** Alternative G1 will not provide reduction in toxicity, mobility, or volume of the contaminated groundwater.
- **Short term impacts and effectiveness:** This alternative does not result in disruption of properties overlying the plume and therefore no additional risks are posed to the community, workers, or the environment as no remedial actions will occur. No remedial timeframe is associated with this alternative.
- **Implementability:** There are no implementability concerns posed by this remedy as no remedial actions are being implemented.
- **Cost Effectiveness:** Because this is a no action alternative, the capital, operations and maintenance, and net present value costs are estimated to be $0.
- **Land Use:** The no action alternative would result in groundwater contaminants exceeding standards remaining in the aquifer beneath the site and adjacent properties. No environmental easements would be put in place. This is not sufficient

for the current, intended and reasonably anticipated future use of the area which is commercial use.

7.2.2.2 **Alternative G2 – ISCO and SSDS**

Alternative G2 consists of ISCO, SSDS with LTM for the remediation of VOCs in groundwater. For the purpose of this FS, an average depth of nested wells close to the on-site area is assumed to be shallow (65 to 110 feet bgs) and deeper (130 to 200 feet bgs) within the downgradient portion of the plume. LTM would consist of a network of wells located within and downgradient of the site boundary

- **Overall protection of human health and the environment:** Alternative G2 would protect human health and the environment at the site through a combination of ISCO implementation throughout the active remediation area including underneath the building, institutional controls, and LTM. Institutional controls would be put in place to restrict local groundwater use. LTM would be implemented outside of any active remediation areas and as a contingency to monitor the contaminants concentrations in groundwater if needed after ISCO treatment.
- **Compliance with SCGs:** Alternative G2 is expected to achieve compliance with SCGs including Class GA GWQS for the active remedial area.
- **Long term effectiveness and permanence**: ISCO treatment has been demonstrated to be effective and reliable at numerous sites for groundwater treatment for VOCs and is expected to be effective at this site. ISCO treatment will significantly degrade VOCs in contaminated areas. It is assumed that although ISCO will significantly decrease the VOC concentrations in groundwater within the treatment area, the residual VOC concentrations will likely exceed the class GA GWQS. The VOC concentrations will be reduced to a level where natural attenuation processes will be sufficient to reach the class GA GWQS. However, groundwater concentrations may rebound depending of the effectiveness of the initial treatments. Multiple injection of ISCO treatment may be required to address rebounding. Institutional controls and LTM will provide adequate protection of

human health from a diluted residual plume if properly implemented and maintained.

- **Reduction of toxicity, mobility, or volume of contamination through treatment:** ISCO treatment uses chemical processes to degrade contaminants in groundwater to less harmful compounds. ISCO will reduce the toxicity, mobility and volume of contaminants in groundwater within the active treatment area; however, there will be limited reduction in toxicity, mobility or volume of contamination outside the active treatment area. LTM that will be used for a diluted residual plume provides minimal reduction in the toxicity, mobility or volume of contaminants, and will likely require long periods to reach RAOs through natural processes alone.
- **Short term impacts and effectiveness:** Implementation of Alternative G2 will result in considerable disruption to the site and additional risks will be imposed to the community, workers, and the environment. The additional risks will be generated from the potential administrative difficulties and potential safety concerns involved with handling hazardous material during its implementation. Hydraulic short circuiting and/or preferential pathways may result from migration of the oxidant into non-target off-site areas. These risks will be mitigated by the development of a design and operational guidelines and implementation of a Remedial Action Work Plan including a Health and Safety Plan. The active remedial timeframe for Alternative G2 is 5 years.
- **Implementability:** ISCO is a well-established technology and the equipment and services to install and operate the treatment injection system and to sample groundwater monitoring wells are commercially available. Additional measures will need to be implemented while handling oxidant and injecting within the building. Additional pre-design investigation and pilot testing would be necessary to determine optimal well placement, oxidant demand, flow rates and additional injection(s) that may be necessary.
- **Cost Effectiveness:** Alternative G2 cost is approximately $10.0M, including approximately $200,000 for the installation of a SSDS. The estimated cost for

Alternative G2 is summarized in Table 9, and a breakdown of costs for this alternative is provided within Appendix A. For purposes of developing a cost estimate for comparison purposes, the following assumptions were made:

- Approximately 105 injection points will be constructed on 15-foot centers;
- Well transects every 75 feet;
- Short-Duration Remedy (with remedial timeframes 5 years for shallow and deep remediation areas);
- Two rounds of injections within the first five years;
- LTM quarterly for the first 2 years, twice a year for years 3 and 4, and annually for year 5.

- **Land Use:** Alternative G2 will achieve compliance with Class GA GWQS which is sufficient for the current, intended and reasonably anticipated future use of the site which is commercial.

7.2.2.3 **Alternative G3 – Bioremediation and SSDS**

The approach to site remediation under Alternative G3 includes implementing bioremediation within the active remediation area of contaminated groundwater in conjunction with institutional controls and MNA/LTM for protection of human health and the environment. The performance of a pre-design investigation and pilot testing are assumed in the evaluation of this alternative, as is the installation of a large number of injection wells, periodic introduction of reagent and performance monitoring.

- **Overall protection of human health and the environment:** Alternative G3 would protect human health and the environment at the site through a combination of institutional controls, bioremediation, and MNA/LTM. Institutional controls would be put in place to restrict local groundwater use. Risks to workers and the public would be controlled during implementation of bioremediation activities through monitoring and site-specific health and safety plans. Bioremediation treatment of groundwater would reduce concentrations of contaminants in groundwater and would be expected to achieve RAOs and risk reduction in groundwater within the active remediation area. LTM would be continued for the anticipated 30-year duration of this alternative to monitor the reduction of contaminants in the groundwater plume.

- **Compliance with SCGs:** This alternative is expected to achieve compliance with applicable SCGs including the NYSDEC Class GA GWQS for the active remediation area within 10 years. In areas where active remediation may not be implemented, it is expected that ARARs will be met after an extended period of LTM, which will continue for 30 years. Under this alternative, an approval based on pilot test results and substrate used for enhanced bioremediation may be required before the site-wide implementation.
- **Long term effectiveness and permanence**: Bioremediation has been demonstrated to be effective and reliable at numerous sites for groundwater treatment for VOCs and is expected to be effective at this site. A bioremediation system will significantly reduce VOCs in contaminated areas. Institutional controls and LTM, if properly implemented and maintained, could provide adequate protection of human health from a residual diluted plume.
- **Reduction of toxicity, mobility, or volume of contamination through treatment:** A bioremediation system will reduce the volume of contamination present within the active treatment area by injecting HRC or EOS into the treatment area to stimulate anaerobic degradation of chlorinated VOCs. Bioaugmentation may also be used if the indigenous population of dechlorinating microorganisms is insufficient to stimulate complete anaerobic reductive dechlorination.
- **Short term impacts and effectiveness:** Implementation of Alternative G3 will result in minimal impacts to human health or the environment. However, normal site operations may temporarily be impacted during installation and startup, and increased traffic and noise during well installation is expected. The remedial timeframe for Alternative G3 is approximately 10 years.
- **Implementability:** Bioremediation is a well-established technology and the equipment and services required to implement the technology and to sample

groundwater monitoring wells are commercially available. Additional pre-design investigation and pilot testing will be necessary to determine the effectiveness of HRC and/or EOS at stimulating naturally-occurring dechlorinating bacteria, or whether it will be necessary to augment the natural system to achieve the desired results.

- **Cost Effectiveness:** The estimated cost for Alternative G3 is approximately $6.1M including the cost for a SSDS. This alternative includes costs for the performance of LTM for a period of 30 years. The estimated cost for Alternative G3 is summarized in Table 9, and a breakdown of costs for this alternative is provided within Appendix A. For purposes of developing a cost estimate for comparison purposes, the following assumptions were made:
    - Approximately 57 injection points will be constructed on 15-foot centers;
    - Well transects every 150 feet;
    - Remediation period of 10 years; and
    - LTM will be conducted quarterly for the first 5 years, twice a year from years 5 to 10, and annual sampling from year 10 to 30.
- **Land Use:** Alternative G3 will achieve compliance with Class GA GWQS which is sufficient for the current, intended and reasonably anticipated future use of the site which is commercial.

7.2.2.4 Alternative G4 – Extraction and Treatment and SSDS; Claremont Treatment Plant

Alternative G4 consists of a groundwater extraction system to capture the shallow as well as deep VOC-contaminated groundwater and treat it at the surface by implementing remedial technologies such as air stripping, a vapor phase GAC system, and finally discharge/disposal of treated groundwater. Treatment of the extracted groundwater is proposed to occur at the existing Claremont Treatment Plant. Alternative G4 also includes LTM with institutional controls.

- **Overall protection of human health and the environment:** Alternative G4 will protect human health and the environment at the site through a combination of extraction and treatment system implementation throughout the active remediation area, institutional controls, and LTM. Institutional controls will be put in place to restrict local groundwater use. LTM will be used to monitor the remediation progress throughout the operational years of the extraction and treatment system. This alternative will remove contaminant mass from the groundwater at the source area and establish hydraulic control of the aquifer to minimize off-site migration of the groundwater plume.

- **Compliance with SCGs:** Alternative G4 is expected to achieve compliance with applicable SCGs including the NYSDEC Class GA GWQS for the remediation area. Remedial activities for Alternative G4 will be continued until the NYSDEC Class GA GWQS are met. Treated effluent from groundwater treatment system will meet the New York State groundwater effluent limitations prior to being discharged to on-site dry wells.
- **Long term effectiveness and permanence**: Groundwater extraction and treatment systems have been demonstrated to be effective and reliable at numerous sites for groundwater treatment for VOCs and it is expected to be effective at this site. Extraction and treatment would significantly reduce VOCs in contaminated areas. Institutional controls and LTM could provide adequate protection of human health when properly implemented and maintained.
- **Reduction of toxicity, mobility, or volume of contamination through treatment:** The extraction and treatment system will reduce the volume of contamination by extracting groundwater from the shallow and deep remediation area and treating it above ground. Extraction of VOCs from the contaminated groundwater will effectively reduce the mobility, toxicity, and volume of VOCs in the underlying aquifer.
- **Short term impacts and effectiveness:** Implementation of Alternative G4 will result in minimal impacts to human health or the environment. However, normal site operations may temporarily be impacted during installation and startup, and increased traffic and noise during well installation is expected. The remedial timeframe for Alternative G4 is 30 years.
- **Implementability:** Extraction and treatment is a well-established technology and the equipment and services to install and operate the treatment system and to sample

groundwater monitoring wells are commercially available. Shallow and deep extraction wells are identified to remediate the aquifer at multiple depths. Additional pre-design investigation and pilot testing would be necessary to determine optimal well placement, flow rates and additional pre-treatment that may be necessary.

- **Cost Effectiveness:** The estimated cost for Alternative G4 cost is approximately $18.0M, This alternative includes the O&M cost associated with the operation of the extraction and treatment system, implementing the LTM program and installing the SSDS. The estimated cost for Alternative G4 is summarized in Table 9, and a breakdown of costs for this alternative is provided within Appendix A. For purposes of developing a cost estimate for comparison purposes, the following assumptions were made:
  - Long-duration remedy (with remedial timeframes of 30 years for shallow and deep remediation areas);
  - The existing Claremont treatment system will be expanded and used for groundwater treatment;
  - LTM conducted twice per year for 30 years beyond remediation system startup.
- **Land Use:** Alternative G4 will achieve compliance with Class GA GWQS which is sufficient for the current, intended and reasonably anticipated future use of the site which is commercial.

7.2.2.5 <u>**Alternative G5 – Extraction and Treatment and SSDS; new off-site Treatment Plant**</u>

Alternative G5 consists of a groundwater extraction system to capture the shallow as well as deep VOC-contaminated groundwater and treat it at the surface by implementing remedial technologies such as air stripping, a vapor phase GAC system, and finally discharge/disposal of treated groundwater. Treatment of the extracted groundwater is proposed to occur at a newly constructed off-site treatment plant. Alternative G5 also includes LTM with institutional controls.

- **Overall protection of human health and the environment:** Alternative G5 will protect human health and the environment at the site through a combination of extraction and treatment system implementation throughout the active remediation area, institutional controls, and LTM. Institutional controls will be put in place to restrict local groundwater use. LTM will be used to monitor the remediation progress throughout the operational years of the extraction and treatment system. This alternative will remove contaminant mass from the groundwater and establish hydraulic control of the aquifer to minimize off-site migration of the groundwater plume.

- **Compliance with SCGs:** Alternative G5 is expected to achieve compliance with applicable SCGs including the NYSDEC Class GA GWQS for the remediation area. Remedial activities for Alternative G5 will be continued until the NYSDEC Class GA GWQS are met. Treated effluent from groundwater treatment system will meet the New York State groundwater effluent limitations prior to being discharged to on-site dry wells.
- **Long term effectiveness and permanence**: Groundwater extraction and treatment systems have been demonstrated to be effective and reliable at numerous sites for groundwater treatment for VOCs and it is expected to be effective at this site. Extraction and treatment would significantly reduce VOCs in contaminated areas. Institutional controls and LTM could provide adequate protection of human health when properly implemented and maintained.
- **Reduction of toxicity, mobility, or volume of contamination through treatment:** The extraction and treatment system will reduce the volume of contamination by extracting groundwater from the shallow and deep remediation area and treating it above ground. Extraction of VOCs from the contaminated groundwater will effectively reduce the mobility, toxicity, and volume of VOCs in the underlying aquifer.
- **Short term impacts and effectiveness:** Implementation of Alternative G5 will result in minimal impacts to human health or the environment. However, normal site operations may temporarily be impacted during installation and startup, and increased traffic and noise during well installation and treatment system construction is expected. The remedial timeframe for Alternative G5 is 30 years.

- **Implementability:** Extraction and treatment is a well-established technology and the equipment and services to install and operate the treatment system and to sample groundwater monitoring wells are commercially available. Shallow and deep extraction wells are identified to remediate the aquifer at multiple depths. Additional pre-design investigation and pilot testing would be necessary to determine optimal well placement, flow rates and additional pre-treatment that may be necessary.
- **Cost Effectiveness:** Alternative G5 cost is approximately $25.4M. This alternative includes the capital cost associated with constructing a new off-site treatment plant, O&M cost associated with the operation of the extraction and treatment system, implementing the LTM program and installing the SSDS. The estimated cost for Alternative G5 is summarized in Table 9, and a breakdown of costs for this alternative is provided within Appendix A. For purposes of developing a cost estimate for comparison purposes, the following assumptions were made:
  - Long-Duration Remedy (with remedial timeframes of 30 years for shallow and deep remediation areas);
  - LTM conducted twice per year for 30 years beyond remediation system startup.
- **Land Use:** Alternative G5 will achieve compliance with Class GA GWQS which is sufficient for the current, intended and reasonably anticipated future use of the site which is commercial.

7.3 Comparative Analysis of Alternatives

In the previous sections, each of the remedial alternatives for groundwater was individually evaluated with respect to the eight evaluation criteria. In this section, a comparative analysis was completed where the alternatives were evaluated in relation to each other for each of the evaluation criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

7.3.1 Groundwater Alternative Comparative Evaluation

7.3.1.1 **Overall Protectiveness of Public Health and the Environment**

Alternative G1 provides no additional protection of human health and the environment. Alternatives G2, G3, G4 and G5 are protective of human health and the environment, and are expected to achieve groundwater RAOs throughout the remediation area. Alternative G3 has the potential to generate biodegradation byproducts and vapors that may temporarily decrease the protectiveness of public health and the environment. The in-situ dechlorination process could be stalled if insufficient data is collected during the PDI to verify that site conditions will be favorable to treatment using bioremediation with or without augmentation. Alternative G2 provides a high degree of protectiveness since contaminants will be chemically transformed to less toxic contaminants within a relatively short time period. Protectiveness under Alternatives G4 and G5 is achieved through hydraulic control to prevent further migration of contaminated groundwater from the treatment area and contaminant extraction and treatment. The NYSDEC Class GA GWQS is achieved in a shorter timeframe with the ISCO treatment in Alternative G2 than with Alternatives G3, G4 and G5. Alternatives G4 and G5 require the longest remedial timeframe to achieve the RAOs.

Alternatives G4 and G5 will transfer VOC concentrations from groundwater to vapor which is then mitigated with the use of GAC adsorption. The VOCs are then destroyed when the GAC is recycled and reactivated.

Under Alternatives G2, G3, G4 and G5 SSDSs will be installed in the 303 Winding Road building. The SSDS will reduce exposure of soil vapor from occupants inside the building. Vapors emitted from the SSDSs may be further treated using GAC prior to emitting to the atmosphere if exposures are determined to be unacceptable.

7.3.1.2 **Compliance with SCGs**

Alternative G1 will not achieve compliance with applicable SCGs. Alternatives G2 and G3 will reduce the concentrations of VOCs in groundwater allowing natural process to attenuate remaining contamination over time to comply with the SCGs. Alternatives G4 and G5 should meet SCGs at the Claremont property boundary and will provide hydraulic control to the contaminant plume.

7.3.1.3 **Long Term Effectiveness and Permanence**

Alternative G1 provides no active reduction in contaminant levels or risk therefore does not provide any long-term effectiveness.

ISCO treatment under Alternative G2 is a reliable method for reducing contaminant concentrations in groundwater. Bioremediation under Alternative G3, and extraction and treatment under Alternatives G4 and G5 are considered effective technologies for addressing contaminated groundwater. Alternatives G2, G4 and G5 are known to provide significant mass removal of contaminants and are expected to achieve RAOs in the remediation area. Alternative G3 may temporarily increase the level of contaminants as reductive dechlorination proceeds. If the process stalls at 1,2-DCE additional measures may be necessary to fully remediate the groundwater under this alternative. All the alternatives will rely on institutional controls and LTM for areas of groundwater contamination outside the active remediation zone.

Residual risk under Alternative G4 and G5 is likely reduced below applicable SCGs over a longer-term remedial timeframe as contaminant removal from groundwater is slower.

7.3.1.4 **Reduction of Toxicity, Mobility or Volume with Treatment**

Alternative G1 will not reduce toxicity, mobility or volume of groundwater contamination. Alternatives G2, G3, G4 and G5 will reduce the mass of VOC contamination in groundwater. Alternative G2 uses a chemical oxidation process to destroy contaminants and eliminate them from the aquifer. Alternative G3 uses bioremediation to anaerobically degrade contaminants into non harmful daughter compounds. Alternatives G4 and G5 uses mass removal and hydraulic control of the down gradient plume. Extracted groundwater is then treated using air stripping and GAC for vapor treatment. Spent GAC will be reactivated or destroyed which will permanently destroy VOC contaminants. Under Alternative G4, treatment will occur at the existing Claremont Treatment Plant while under Alternative G5, treatment will occur at a newly constructed off-site treatment plant.

All the active remediation alternatives (G2, G3, G4 and G5) include SSDS. SSDSs will collect soil vapors from beneath the buildings and emit them to the atmosphere. Prior to emitting the collected vapor to the atmosphere it maybe be treated using GAC if necessary. As with the extraction and treatment systems in Alternatives G4 and G5, spent GAC would be reactivated or destroyed which would permanently destroy VOC contaminants.

7.3.1.5 **Short Term Impacts and Effectiveness**

Alternative G1 creates no short-term impacts to human health or the environment because no action is conducted. Alternatives G2, G3, G4 and G5 will have short-term impacts to remediation workers, the public, and the environment during implementation. All these alternatives implement monitoring, that would provide the data needed for proper management of the remedial processes and a mechanism to address any potential impacts to the community, remediation workers, and the environment.

Alternatives G2 and G3 will have a higher degree of short term impacts compared to Alternatives G4 and G5 due to the number of injection wells needed to cover the remediation area and will require access to commercial parking and travel areas within the footprint of the active remediation area. Alternative G2 potentially poses greater risks to remediation workers due to the large quantities of hazardous chemicals used in the process. Alternative G3 will have the next highest degree of short term impacts due to the installation of injection wells needed to implement bioremediation. Under both Alternatives G2 and G3 access inside the building will be needed to install injection wells to treat contamination beneath the building. Construction during all the alternatives will create noise. Alternative G5 will potentially result in greater disruption that Alternative G4 due to the construction of a new groundwater treatment plant off-site. The potential for remediation workers to have direct contact with contaminants in groundwater occurs when the wells are installed for all the alternatives and when the groundwater remediation system is operating under Alternatives G4 and G5.

RAOs are achieved in Alternatives G2, G3, and Alternatives G4 & G5 within short, medium and longer timeframes, respectively. ISCO is expected to achieve groundwater RAOs within five years under Alternative G2, with LTM for 30years. Bioremediation is expected to achieve groundwater RAOs within ten years under Alternative G3, with LTM for 30 years. Alternatives G4 and G5, extraction and treatment, are expected to achieve RAOs in 30 years, with LTM for 30 years.

The operation of the SSDSs for the 303 Winding Road building was assumed to operate for the time frame estimated to achieve RAOS and complete LTM under Alternatives G2, G3, G4 and G5.

7.3.1.6 **Implementability**

Alternative G1, no action, is the easiest alternative to implement. Alternative G4 is a commercially available technology and is normally easy to install and operate. In addition, since the Claremont Treatment Plant is already in operation the expansion of this treatment plant (if necessary) will be easier to implement since the acquisition of land and permits to build a treatment plant will not be necessary. Alternative G5 is a commercially available technology and is normally easy to install and operate. However, the acquisition of land and permits to build a treatment plant will be necessary. Alternative G2 will be the most difficult to implement due to the number of injection wells needed to cover the active remediation area. Alternative G2 also requires the handling and storage of significant chemical volumes needed to fully remediate the active treatment zone. Alternative G3 also requires the installation of a large number of injection wells within the active treatment area, but requires a reduced number of injection points compared to Alternative G2.

The SSDS that will be implemented under all the active alternatives are commercially available and generally easy to implement.

7.3.1.7 **Cost**

Cost evaluation of each alternative includes an estimation of construction/capital costs and O&M costs. Table 9 provides a summary of estimated costs for groundwater alternatives G1 through G5, while Tables A-1 through A-5 within Appendix A include conceptual cost analyses (and assumptions) for these alternatives. The costing was based on conceptual remedy assumptions and the information developed for this FS (e.g., site geology; contaminant levels). The costs are presented in present worth basis for comparison purposes.

The cost for each alternative, presented in order of increasing cost is:

- Alternative G1 - $0, no action;
- Alternative G3 - $6.1M, bioremediation/SSDS;
- Alternative G2 - $10.1M, ISCO/SSDS;

- Alternative G4 - $18.1M, groundwater extraction and treatment/SSDS using the existing Claremont Treatment Plant; and

- Alternative G5 - $25.4M, groundwater extraction and treatment/SSDS using a new treatment plant constructed in the vicinity of the existing Claremont Treatment Plant.

7.3.1.8 **Land Use**

The area overlying the OU2 plume is zoned for industrial use. Commercial uses are also permitted. Alternatives G2, G3, G4 and G5 will likely achieve Class GA GWQS within the active treatment area. Current zoning would limit land use to commercial or industrial, so there would be no change in the current land use as a result of implementation of any of the alternatives.

8.0 CERTIFICATION

I Erich Zimmerman certify that I am currently a NYS registered professional engineer and that this Feasibility Study Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

Erich Zimmerman, P.E.

STATE OF NEW YORK
ERICH ZIMMERMAN
LICENSED PROFESSIONAL ENGINEER

7/7/17

9.0 REFERENCES

6 NYCRR Part 375, Environmental Remediation Programs, December 14, 2006.

40 CFR 300.430-National Oil and Hazardous Substances Pollution Contingency Plan

CDM, Nassau County DPW Firemen's Training Center Groundwater Model, April 2008.

Environmental Conservation Law, Article 27, Title 13, §27-1313 Remedial Programs

HDR, Former Aluminum Louvre Remedial Investigation Report for OU1, January 2013.

HDR, Former Aluminum Louvre Feasibility Study Report for OU1, January 2013.

HDR, Former Aluminum Louvre Remedial Investigation Report for OU2, January 2014.

Malcolm Pirnie, Inc., Site Characterization Report Old Bethpage Industrial Area Plume, February 2010.

NYSDEC, DER-10 Technical Guidance For Site Investigation and Remediation, May 3, 2010.

NYSDEC, DER-15: Presumptive /Proven Remedial Technologies, February 27, 2007.

NYSDEC, Division of Water Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, June 1998.

NYSDOH, Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006.

USEPA, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, October 1988.

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Table 2 – Range of VOCs in Groundwater

Detected Constituents	Concentration Range Detected (ug/L)		Standard or Criteria (ug/L)	Frequency Exceeding Standard/Total # of Samples
Trichloroethene	0.56 J	2800D	5	21/35
1,1,1-Trichloroethane	0.92 J	37 J	5	8/35
Tetrachloroethene	0.8 J	160 J	5	7/35
1,1-Dichloroethene	0.78 J	20	5	5/35
cis-1,2-Dichloroethene	0.74 J	73 J	5	3/35
1,1-Dichloroethane	1.9	6	5	2/35
1,1,1,2-Tetrachloroethane	1.1	1.1	5	0/35
Acetone	7 J	11 J	50	0/35
Chloroform	0.63 J	1.2 J	7	0/35
Methyl tert-butyl ether	0.75 J	7.8	10	0/35
Toluene	1	1	5	0/35
trans-1,2-Dichloroethene	0.87 J	1 J	5	0/35
Methylene chloride	*detected in trip blanks only		5	0/35
Criteria: Part 703: Surface Water and Groundwater Quality Standards (Class GA). J - estimated concentration.				

Table 3 – Range of VOCs in Subslab Soil Vapor

Detected Constituents	Concentration Range Detected (ug/m^3)		Standard or Criteria (ug/m^3)	Frequency Exceeding Standard/Total # of Samples
1,1,1-Trichloroethane	1.3	120	NA	0/3
1,1-Dichloroethane	2.8	2.8	NA	0/3
1,2,4-Trimethylbenzene	2.7 J	15 J	NA	0/3
1,3,5-Trimethylbenzene	1.1	2.5 J	NA	0/3
1,4-Dichlorobenzene	0.67 J	0.67 J	NA	0/3
2,2,4-Trimethylpentane	3.7 J	14	NA	0/3
2-Butanone	2.2	3.2 NJ	NA	0/3
4-Ethyltoluene	0.7 NJ	3.7	NA	0/3
Acetone	16	190	NA	0/3
Benzene	0.84	4.7	NA	0/3
Carbon disulfide	0.51	0.51	NA	0/3
cis-1,2-Dichloroethene	2.1	2.1	NA	0/3
Chloroform	2.1	2.1	NA	0/3
Chloromethane	0.8	0.8	NA	0/3
Cyclohexane	9.1	10	NA	0/3
Dichlorodifluoromethane	2.6	2.9	NA	0/3
Ethylbenzene	0.49 J	15	NA	0/3
m,p-Xylene	1.3	58	NA	0/3
Methylene chloride	0.88	2.6 NJ	NA	0/3
n-Heptane	7.9	9.6	NA	0/3
n-Hexane	1.1	10	NA	0/3
o-Xylene	0.97 J	13	NA	0/3
Tetrachloroethene	13	480	NA	0/3
Trichloroethene	0.66 J	1100	NA	0/3
Toluene	2.5	110	NA	0/3
Trichlorofluoromethane	1.5	5.5	NA	0/3
Trichlorotrifluoromethane	0.93 J	0.93 J	NA	0/3

Criteria: No criteria are available for subslab soil vapor.
ND - not detected. NA - not available.

Table 4 – Range of VOCs in Indoor (Ambient) Air

Detected Constituents	Concentration Range Detected (ug/m^3)		Indoor Air Guideline Value (ug/m^3)	Frequency Exceeding Standard/Total # of Samples
1,1,1-Trichloroethane	96	96	NA	0/3
1,1-Dichloroethane	0.58 NJ	0.58 NJ	NA	0/3
1,2,4-Trimethylbenzene	0.75	38	NA	0/3
1,3,5-Trimethylbenzene	11	11	NA	0/3
2,2,4-Trimethylpentane	0.62 J	72	NA	0/3
2-Butanone	1.6 NJ	2.3	NA	0/3
4-Ethyltoluene	12	12	NA	0/3
4-Methyl-2-pentanone	1 J	1 J	NA	0/3
Acetone	14	120	NA	0/3
Benzene	0.97	19	NA	0/3
Carbon disulfide	0.35 J	0.35 J	NA	0/3
Carbon tetrachloride	0.45 NJ	0.7 NJ	NA	0/3
Chloromethane	0.86	1.1	NA	0/3
Cyclohexane	45	45	NA	0/3
Dichlorodifluoromethane	2.3	2.9	NA	0/3
Ethyl acetate	0.44 J	0.44 J	NA	0/3
Ethylbenzene	0.66	36	NA	0/3
Isopropanol	18	18	NA	0/3
m,p-Xylene	1.7	150	NA	0/3
Methylene chloride	0.88	3	60	0/3
n-Heptane	0.71	60	NA	0/3
n-Hexane	0.79 NJ	71	NA	0/3
o-Xylene	0.57 J	39	NA	0/3
Tetrachloroethene	0.69 J	2.8 J	30	0/3
Styrene	0.56 NJ	16	NA	0/3
Trichloroethene	0.76	1.1	2	0/3
Toluene	4.5	130	NA	0/3
Trichlorofluoromethane	1.1	1.4	NA	0/3
Criteria: NYS Dept. of Health indoor air guideline values. Applies to indoor/ambient air samples only. ND - not detected. NA - not available.				

Table 5 - Summary of Qualitative Human Health Exposure Assessment

Environmental Media & Exposure Route	Human Exposure Assessment
Direct contact with surface soils (and incidental ingestion)	OU2 covers groundwater and vapor intrusion only. No soil risk identified.
Direct contact with subsurface soils (and incidental ingestion)	OU2 covers groundwater and vapor intrusion only. No soil risk identified.
Ingestion of groundwater	Contaminated groundwater is not being used for drinking water, as the area is served by the public water supply. There are no known potable or irrigation water supply wells in the OU2 area of groundwater contamination. Groundwater use should be restricted off-site to prevent private wells from being installed within the plume.
Direct contact with groundwater (contact during showering and washing)	Contaminated groundwater is not being used for drinking water, as the area is served by the public water supply. There are no known potable or irrigation water supply wells in the OU2 area of groundwater contamination. Groundwater use should be restricted off-site to prevent private wells from being installed within the plume.
Inhalation of air -exposures related to soil vapor intrusion including exposure to VOCs during showering	Exposures to contaminated soil vapor may occur if soil vapor migrates through cracks or other openings in the building floor or foundation. A soil vapor intrusion evaluation was conducted as part of the on- and off-site RIs. Concentrations of PCE TCE, and methylene chloride were below the applicable NYSDOH air guideline values in indoor air samples. Periodic monitoring of indoor air quality should be conducted to make certain air guideline value concentrations are not exceeded. A mitigation system should be installed at 303 because of the high sub-slab soil vapor concentration of TCE. Contaminated groundwater is not being used for drinking water, as the area is served by the public water supply. There are no known potable or irrigation water supply wells in the OU2 area of groundwater contamination. Groundwater use should be restricted off-site to prevent private wells from being installed within the plume.

Table 6 – General Response Actions

General Response Actions	Media	Remediation Area /Volume	Identified Use of Area	Presumptive Remedy
No Action – The no action option is included as a basis for comparison with the active groundwater remediation technologies.	Ground water	125,363 square feet /1.4 x 10^7 gallons	Commercial	No
Institutional Controls – Effective in reducing access and exposure to Site contaminants through restrictions or limitations of site use. Will be used in conjunction with, or as enhancements to a remedial technology.	Ground water	125,363 square feet /1.4 x 10^7 gallons	Commercial	No
Monitored Natural Attenuation – Relies on natural destructive (biodegradation and chemical reactions) and nondestructive mechanisms (dilution, volatilization, adsorption) to reduce contaminant concentrations within a reasonable timeframe. Can be implemented with other active remedial technologies.	Ground water	125,363 square feet /1.4 x 10^7 gallons	Commercial	No
Containment – Containment involves physical barriers to slow groundwater flow and minimize migration of contaminated groundwater off-site. However, contaminated groundwater at the site is deeper that 300 feet bgs and there are no known continuous low-permeability layers in the area to enhance the containment. Therefore, not suitable for installing a physical barrier.	Ground water	125,363 square feet /1.4 x 10^7 gallons	Commercial	No
In-situ Treatment – Several types of technologies may be applicable for the in-situ treatment of groundwater, and include biological, physical and chemical treatment.	Ground water	125,363 square feet /1.4 x 10^7 gallons	Commercial	**Yes (for biological and chemical only)**
Ex-situ Treatment – Involves the pumping of impacted groundwater and implementing physical/chemical treatment ex-situ. Pump and treat is an effective technology for hydraulic control and/or removal of groundwater contamination. Various technologies are available for treating organic contaminants in collected groundwater. On-site and off-site treatment/disposal options are available for the collected groundwater.	Ground water	125,363 square feet /1.4 x 10^7 gallons	Commercial	**Yes**
Discharge/Disposal – Collection is an effective technology for hydraulic control and/or removal of groundwater contamination. Various technologies are available for treating organic contaminants in collected groundwater. On-site and off-site treatment/disposal options are available for the collected groundwater.	Ground water	125,363 square feet /1.4 x 10^7 gallons	Commercial	**Yes**
Ex-situ Treatment – Involves the installation of a sub-slab depressurization system (SSDS) to intercept volatile organics migrating from contaminated groundwater to the vapor phase. SSDS is an effective technology for the control and/or removal of VOCs before they can migrate into indoor air. Treatment/disposal options are available for collected vapors.	Soil Vapor	22,500 square feet (approximately ¼ of the 303 Winding Road building)	Commercial	**Yes**

Table 7 – Identification and Screening of Technologies – Groundwater

	Presumptive Remedy	Established Technology	Complexity	Overall Cost and Performance: O&M	Overall Cost and Performance: Capital	Overall Cost and Performance: Reliability/ Maintain-ability	Overall Cost and Performance: Present-Worth Cost	Overall Cost and Performance: Time	Availability	Treatment Effectiveness: VOCs	Treatment Effectiveness: CVOCs	Treatment Effectiveness: SVOCs	Treatment Effectiveness: Inorganics	Implementable at Site	Retained for Alternative Evaluation	Reason(s)
Containment																Groundwater contamination is too deep for the use of physical barriers. Deep well injection can't be used because of the sole source aquifer designation on Long Island.
Physical Barriers	No	Yes	Medium	Medium	High	High	Medium-High	Medium-High	High	Effective	Effective	Effective	Effective	No	No	
Deep Well Injection	No	Yes	Low	Medium	Medium	Medium	Medium	High	High	Limited	Limited	Limited	Limited	No	No	
In-Situ Biological Treatment																Biological treatment is less proven than other technologies for CVOCs. Enhanced bioremediation would involve creating the proper conditions by injecting a carbon substrate into groundwater to create anaerobic conditions, which is necessary for reductive dechlorination of CVOCs. Long Term Monitoring will be utilized in conjunction with other technologies. Phytoremediation processes are limited to shallow groundwater and is not implementable at the site due to the depth of groundwater at the site.
Enhanced Bioremediation	*Yes	Yes	Medium	Medium-High	Medium	Medium	Medium	Medium-High	High	Effective	Effective	Effective	Not Effective	Yes	**YES**	
Monitored Natural Attenuation/ LTM	No	Yes	Low	Low	Medium	Medium	Low	Medium-High	High	Effective	Effective	Limited	Not Effective	Yes	**YES** (LTM only)	
Phytoremediation	No	Yes	Low	Low	Low	Low	Low	High	Medium	Limited	Limited	Limited	Limited	No	No	
In-Situ Physical/Chemical Treatment																
Air Sparging	Yes	Yes	Low	Low	Low-Medium	High	Low	Low-Medium	High	Effective	Effective	Limited	Not Effective	Yes	No	Air sparging was determined to not be suitable because of a long and narrow deep plume and the possibility of generating uncontrolled vapor-phase contamination that could impact indoor air quality.
Chemical Oxidation (ISCO)	Yes	Yes	Medium-High	Low	Medium-High	Medium	Medium-High	Low	High	Effective	Effective	Limited	Not Effective	Yes	**YES**	ISCO is a presumptive remedy that is very effective for the treatment of VOCs in groundwater.
Directional Wells (enhancement)	No	Yes	Medium	Medium	High	Medium	Medium	Medium	Medium	Limited	Limited	Limited	Limited	No	No	Directional wells are not implementable due to site conditions.
Thermal Treatment	No	Yes	High	High	High	Medium	Medium-High	Low-Medium	Medium	Effective	Effective	Effective	Not Effective	No	No	Thermal treatment is not suitable for the site due to groundwater contamination deeper than 300 feet bgs.
In-Well Air Stripping	Yes	Yes	Medium	High	High	Medium	Medium	High	Low	Effective	Effective	Limited	Not Effective	Yes	No	In-well air stripping is a group of proprietary technologies that limits competitive bidding. It is also more costly than equally effective technologies.
Passive/Reactive Treatment Walls	No	Yes	Medium	Medium	High	Medium-High	Medium-High	Medium-High	Medium	Effective	Effective	Effective	Limited	No	No	Groundwater contamination is too deep for the use of passive or reactive treatment walls.
Ex-Situ Biological Treatment																Due to the physical characteristics of the site, limited space and active commercial use of the off-site area, these technologies are not suitable.
Bioreactors	No	Yes	Medium	Medium	Medium	Medium	Low	Medium	High	Effective	Effective	Limited	Not Effective	No	No	
Constructed Wetlands	No	Yes	Low-Medium	Medium	Medium	Medium-High	Medium	Medium-High	Medium	Limited	Limited	Limited	Effective	No	No	

Table 7 – Identification and Screening of Technologies – Groundwater (continued)

	Presumptive Remedy	Established Technology	Complexity	Overall Cost and Performance					Availability	Treatment Effectiveness				Implementable at Site	Retained for Alternative Evaluation	Reason(s)
				O&M	Capital	Reliability/ Maintain-ability	Present-Worth Cost	Time		VOCs	CVOCs	SVOCs	Inorganics			
Ex-Situ Physical/Chemical Treatment (assuming groundwater extraction)																
Granulated Activated Carbon (GAC) Adsorption	Yes	Yes	Low	Medium-High	Medium	High	Medium	Medium-High	High	Effective	Effective	Effective	Not Effective	Yes		GAC and air stripping are technologies that are used as part of a pump and treat system. Together these are retained for further analysis.
Air Stripping	Yes	Yes	Medium	Medium-High	Medium	High	Medium	High	High	Effective	Effective	Not Effective	Not Effective	Yes	**YES**	Groundwater pumping has been retained for further analysis due to its proven track record as a remediation technology.
Groundwater Pumping/Pump & Treat	Yes	Yes	Medium	High	Medium-High	High	Medium-High	Medium-High	High	Effective	Effective	Limited	Effective	Yes		
Advanced Oxidation Processes	No	Yes	Medium	High	High	Medium	High	Medium-High	High	Effective	Effective	Effective	Not Effective	Yes	No	Advanced oxidation processes such as ultraviolet light have high energy requirements and are more costly relative to other equally effective technologies. These processes are not retained for further analysis.
Discharge/Disposal																
Disposal of treated groundwater to surface water, sanitary sewer or POTW	NA	Yes	Low	Low	Low	High	Low	NA	High	Effective	Effective	Effective	Effective	Yes	**YES**	In conjunction with other treatment technologies.

O&M – relative overall cost and performance of operation and maintenance. Capital – relative overall cost and performance of capital investment. Adapted from Federal Remediation Technologies Roundtable Technology Screening Matrix, 2007. www.frtr.gov.

Table 8 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness		Land Use Criteria
G1	**No Action**	- Will not meet any of the RAOs for the site.	- Will not meet SCGs.	- Contaminants remain in the environment. - Magnitude of remaining risks will be unchanged.	- Does not reduce toxicity, mobility or volume of contamination present at the site.	- Does not result in disruption of site operations or pose a short term threat to public health or the environment. - No remedial timeframe is associated with this alternative.	- No technical or administrative difficulties or constraints.	Capital Cost: Average Annual Site Management Cost: O&M Present Worth Cost: Periodic Present Worth Cost: Total Present Worth Cost:	$0 $0 $0 $0 $0	- Will not comply with SCGs. -Will not restore groundwater quality and does not provide any restrictions to prevent use of groundwater at the site.
G2	**In-Situ Chemical Oxidation** **Long Term Monitoring** **SSDS**	- Will result in a reduction of VOC concentrations in the active remediation area. Existing ICs will be put in place to restrict groundwater use. LTM will be implemented outside of active remediation areas to monitor contaminant concentrations over time. -SSDS will minimize exposure to vapor phase CVOCs from contaminated groundwater by eliminating vapor accumulating beneath the building.	- Will result in a reduction of VOC concentrations achieving the groundwater SCGs within the treatment area. -Will require UIC permit. -Will need to comply with EPCRA depending on quantities of chemicals used on site. -Areas outside treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -Emissions from the SSDS will comply with Federal and State air regulations.	- Permanent reduction of groundwater contaminants from active groundwater remediation. - May require multiple injections to achieve long term effectiveness. - Areas outside treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -SSDS will require routine maintenance to maintain effectiveness.	- Will reduce the volume of VOCs in groundwater on-site in the active treatment zone. - Active treatment in the source area and site boundary will reduce the volume of contaminated groundwater migrating off-site. -SSDS will reduce the toxicity, mobility or volume of contaminated vapor present under the building.	- Will greatly disrupt site operations during installation of wells (11-13 months assumed to install wells). -Handling, storage and use of chemicals will require proper PPE and training. - Will generate noise and traffic during construction. - Remedial time frame – 5 years. -LTM time frame – 15 years -SSDS time frame – 30 years.	- Installation is similar to monitoring wells. -Wells installed inside building will be difficult due to constraints in getting equipment inside the building. - Concerns with transport, storage and handling the oxidizing agent in the field	Capital Cost: Weighted Average Annual Site Management Cost: O&M Present Worth Cost: Periodic Present Worth Cost: Total Present Worth Cost:	$6,136,000 $152,000 $3,653,000 $214,000 $10,003,000	- Will comply with applicable SCGs. Will restrict use of groundwater as a potable water supply source until SCGs are met. -Will eventually restore groundwater quality of the site.

Table 8 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness		Land Use Criteria
G3	**Bioremediation** **Long Term Monitoring** **SSDS**	- Will result in a reduction of VOC concentrations in the active remediation area. ICs will be put in place to restrict groundwater use. LTM will be implemented outside of active remediation areas to monitor contaminant concentrations over time. - SSDS will minimize exposure to vapor phase CVOCs from contaminated groundwater by eliminating vapor accumulating beneath the building.	- Will result in a reduction of VOC concentrations achieving the groundwater SCGs within the treatment area. -Will require UIC permit. -Areas outside treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -Emissions from the SSDS will comply with Federal and State air regulations.	- Permanent reduction of groundwater contaminants from active groundwater remediation. - May stall at 1,2-DCE and require additional injections to achieve long term effectiveness. - Areas outside treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -SSDS will require routine maintenance to maintain effectiveness.	- Will reduce the volume of VOCs in groundwater on-site in the active treatment zone. -May temporarily increase the volume and toxicity due to formation of byproducts such as 1,2-DCE and VC. - Active treatment in the source area and site boundary will reduce the volume of contaminated groundwater migrating off-site. -SSDS will reduce the toxicity, mobility or volume of contaminated vapor present under the building.	- Will temporarily disrupt site operations during installation of wells (2-4 months assumed to install wells). - Will generate noise and traffic during construction. - Dust control and health and safety plan measures will be needed. - Remedial time frame – 10 years. -LTM time frame – 30 years -SSDS time frame – 30 years.	- Installation is similar to monitoring wells. -Will require PDI to determine whether subsurface characteristics are viable for implementation of remedy. -Lack of daughter compounds may suggest the existing conditions will not allow for implementation of this alternative.	Capital Cost: Weighted Average Annual Site Management Cost: O&M Present Worth Cost: Periodic Present Worth Cost: Total Present Worth Cost:	$1,486,000 $174,000 $4,219,000 $410,000 $6,115,000	- Will comply with applicable SCGs. Will restrict use of groundwater as a potable water supply source until SCGs are met. -Will eventually restore groundwater quality of the site.

Table 8 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness		Land Use Criteria
G4	**Pump and Treat; Claremont Treatment Plant** **Long Term Monitoring** **SSDS**	- Will remove contaminant mass from groundwater at the source area and establish hydraulic control to minimize off-site migration of the plume. ICs will be put in place to restrict groundwater use. LTM will be implemented outside of active remediation areas to monitor contaminant concentrations over time. - SSDS will minimize exposure to vapor phase CVOCs from contaminated groundwater by eliminating vapor accumulating beneath the building.	- Will result in a reduction of VOC concentrations achieving the groundwater SCGs within the treatment area. - Treated effluent from treatment system will meet State groundwater effluent limitations prior to discharge. -Areas outside treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -Emissions from the SSDS will comply with Federal and State air regulations.	- Permanent reduction of groundwater contaminants from active groundwater remediation. - Areas outside the treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -SSDS will require routine maintenance to maintain effectiveness.	- Will reduce the volume of VOCs in groundwater on-site in the active treatment zone. - Active treatment in the source area and site boundary will reduce the volume of contaminated groundwater migrating off-site. - Will establish hydraulic control of the aquifer to minimize off-site migration of the plume. -SSDS will reduce the toxicity, mobility or volume of contaminated vapor present under the building.	- Can be implemented with some temporary disruption of current site operations during construction of the pump and treat system. - Will generate minimal noise and traffic during construction. - Dust control and health and safety plan measures will be needed. - Remedial timeframe – 30 years. -LTM time frame – 30 years -SSDS time frame – 30 years.	- Requires limited excavation for construction. - Minimal technical or administrative difficulties or constraints.	Capital Cost: Weighted Average Annual Site Management Cost: O&M Present Worth Cost: Periodic Present Worth Cost: Total Present Worth Cost:	$3,391,000 $580,000 $14,404,000 $211,000 $18,006,000	- Will comply with applicable SCGs. Will restrict use of groundwater as a potable water supply source until SCGs are met. -Will eventually restore groundwater quality of the site.

Table 8 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness		Land Use Criteria
G5	**Pump and Treat; new off-site Treatment Plant** **Long Term Monitoring** **SSDS**	- Will remove contaminant mass from groundwater at the source area and establish hydraulic control to minimize off-site migration of the plume. Existing ICs will be put in place to restrict groundwater use. LTM will be implemented outside of active remediation areas to monitor contaminant concentrations over time. - SSDS will minimize exposure to vapor phase CVOCs from contaminated groundwater by eliminating vapor accumulating beneath the building.	- Will result in a reduction of VOC concentrations achieving the groundwater SCGs within the treatment area. - Treated effluent from treatment system will meet State groundwater effluent limitations prior to discharge. -Areas outside treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -Emissions from the SSDS will comply with Federal and State air regulations.	- Permanent reduction of groundwater contaminants from active groundwater remediation. - Areas outside the treatment zone will take longer to meet SCGs. Estimated time frame of 30 years was used for these areas. -SSDS will require routine maintenance to maintain effectiveness.	- Will reduce the volume of VOCs in groundwater on-site in the active treatment zone. - Active treatment in the source area and site boundary will reduce the volume of contaminated groundwater migrating off-site. - Will establish hydraulic control of the aquifer to minimize off-site migration of the plume. -SSDS will reduce the toxicity, mobility or volume of contaminated vapor present under the building.	- Can be implemented with some temporary disruption of current site operations during construction of the pump and treat system. - Will generate minimal noise and traffic during construction. - Dust control and health and safety plan measures will be needed. - Remedial timeframe – 30 years. -LTM time frame – 30 years -SSDS time frame – 30 years.	- Requires limited excavation for construction. - Minimal technical or administrative difficulties or constraints.	Capital Cost: Weighted Average Annual Site Management Cost: O&M Present Worth Cost: Periodic Present Worth Cost: Total Present Worth Cost:	$4,087,000 $850,000 $21,061,000 $211,000 $25,359,000	- Will comply with applicable SCGs. Will restrict use of groundwater as a potable water supply source until SCGs are met. -Will eventually restore groundwater quality of the site.

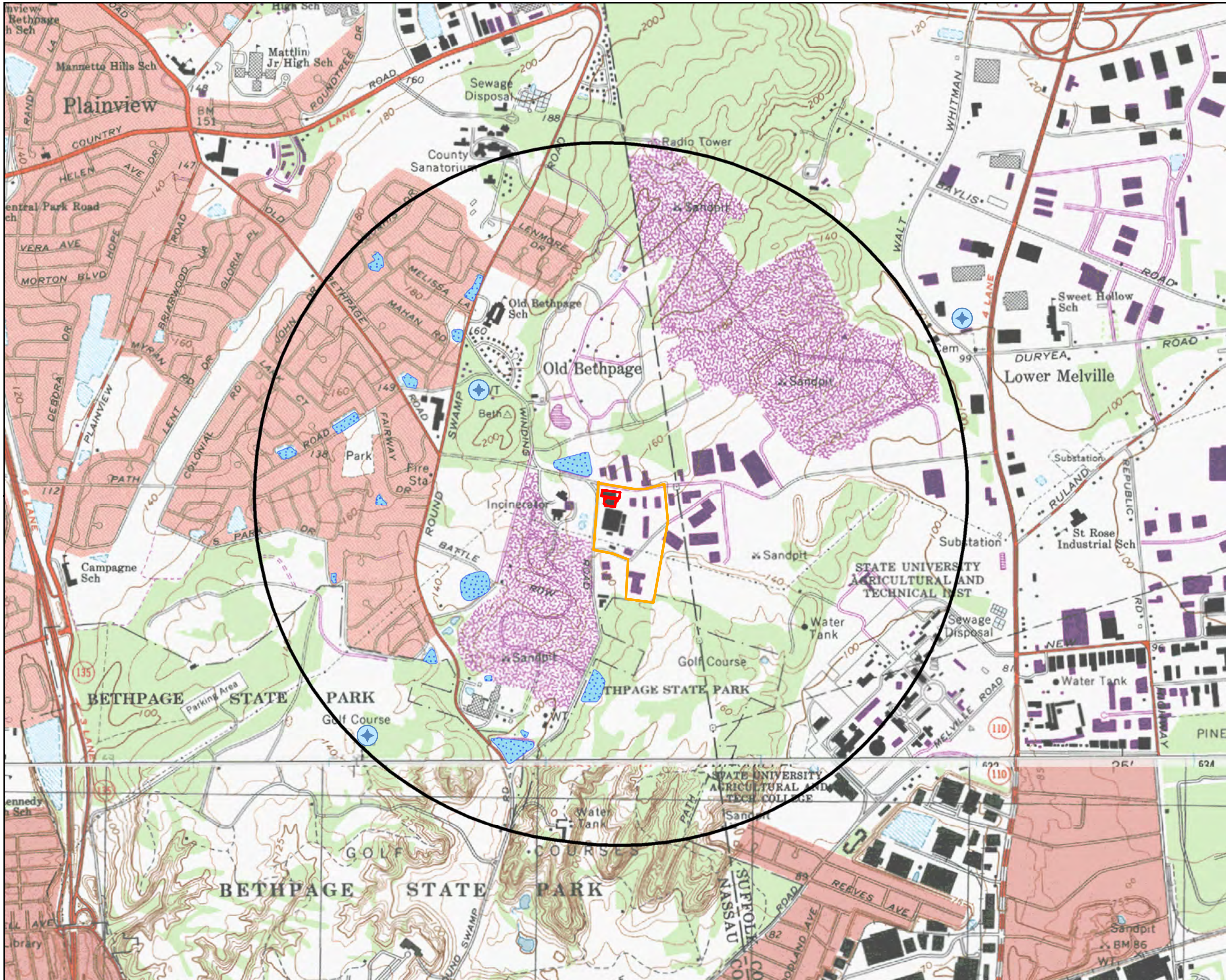
Table 9 – Summary of Cost Estimates

Evaluation Criterion	Alternative G1 No Action	Alternative G2 ISCO and SSDS	Alternative G3 Bioremediation and SSDS	Alternative G4 Extraction and Treatment and SSDS; Claremont Treatment Plant	Alternative G5 Extraction and Treatment and SSDS; new off-site Treatment Plant
Capital Cost	$0	$6,136,000	$1,486,000	$3,391,000	$4,087,000
Total O&M Cost	$0	$3,615,000	$4,219,000	$14,404,000	$21,061,000
Total Periodic Cost	$0	$214,000	$410,000	$211,000	$211,000
Total Present Value	$0	$10,003,000	$6,115,000	$18,006,000	$25,359,000
Estimated Project Duration (Years)	0	30	30	30	30

Notes:

1. This is an order-of-magnitude engineering cost estimate that is expected to be within -30 to +50% of the actual cost for each alternative.

2. For the purposes of comparing the costs with the FS text the values shown have been rounded to the nearest $100,000 within the text.



Site Location Map

Former Aluminum Louvre OU2 RI/FS
NYSDEC Site No. 130195

Old Bethpage, Nassau County, New York

Legend

- Potable Well Fields
- Aluminum Louvre Site (OU1)
- Area of Investigation for OU2
- Stormwater Recharge Basins
- One Mile Radius from Site

N

0 750 1,500 3,000 Feet

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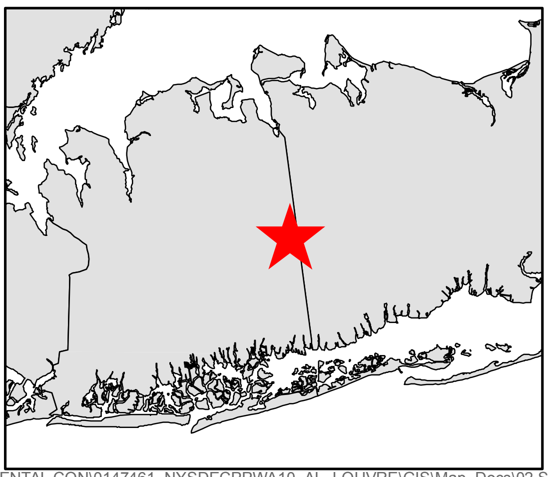
DATE	FIGURE
11-21-2016	1

Legend

- Groundwater Flow
- Claremont Polychemical Treatment Plant Extraction Well
- Aluminum Louvre OU1 Site Boundary
- Aluminum Louvre OU2 Site Boundary
- Estimated Extent of TCE in Groundwater
- Water Table Contours



Aluminum Louvre OU2 Site Boundary and Off-Site Claremont Wells

Former Aluminum Louvre OU2 RI/FS
NYSDEC Site No. 130195

Old Bethpage, Nassau County, New York

N

0 200 400 Feet

DATE 08-31-2016

FIGURE 2

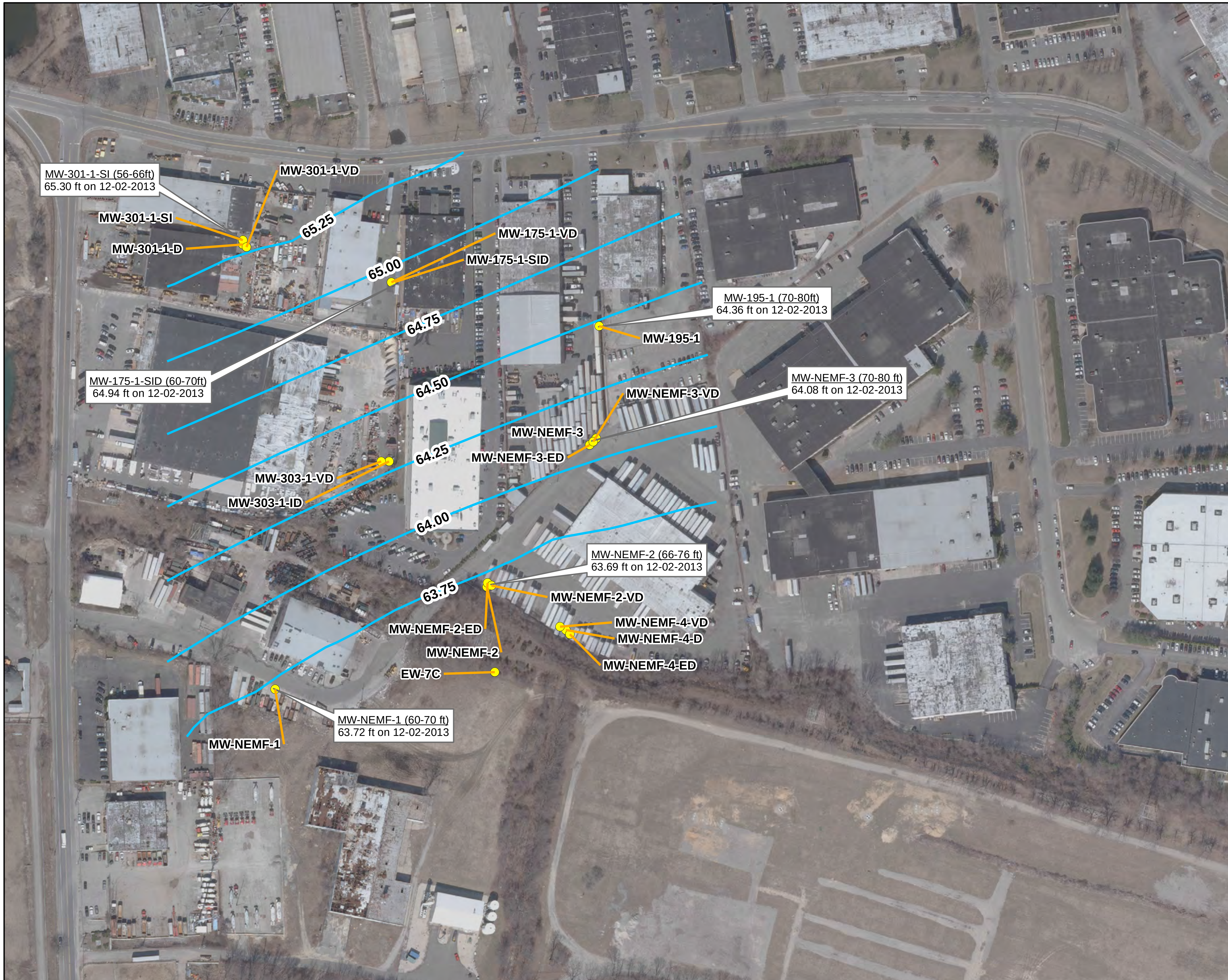
Department of Environmental Conservation

Document Path: \\mahpi-file01\GIS_Projects\202315_NEW YORK STATE DEPT OF ENVIRONMENTAL CON\0147461_NYSDECPPWA10_AL_LOUVRE\GIS\Map_Docs\02 Site Boundary and Wells_revised.mxd

Water Table Elevations December 2013

Former Aluminum Louvre OU2 RI/FS
NYSDEC Site No. 130195
Off-site Groundwater Investigation

Old Bethpage, Nassau County, New York



Legend

Well Location

Water Table Contour (in feet)

Well Designation
Screen Interval
MW-301-SI (56-66 ft)
65.30 ft on 12-02-2013
Date Measured
Groundwater Elevation

N

0 100 200 400 Feet

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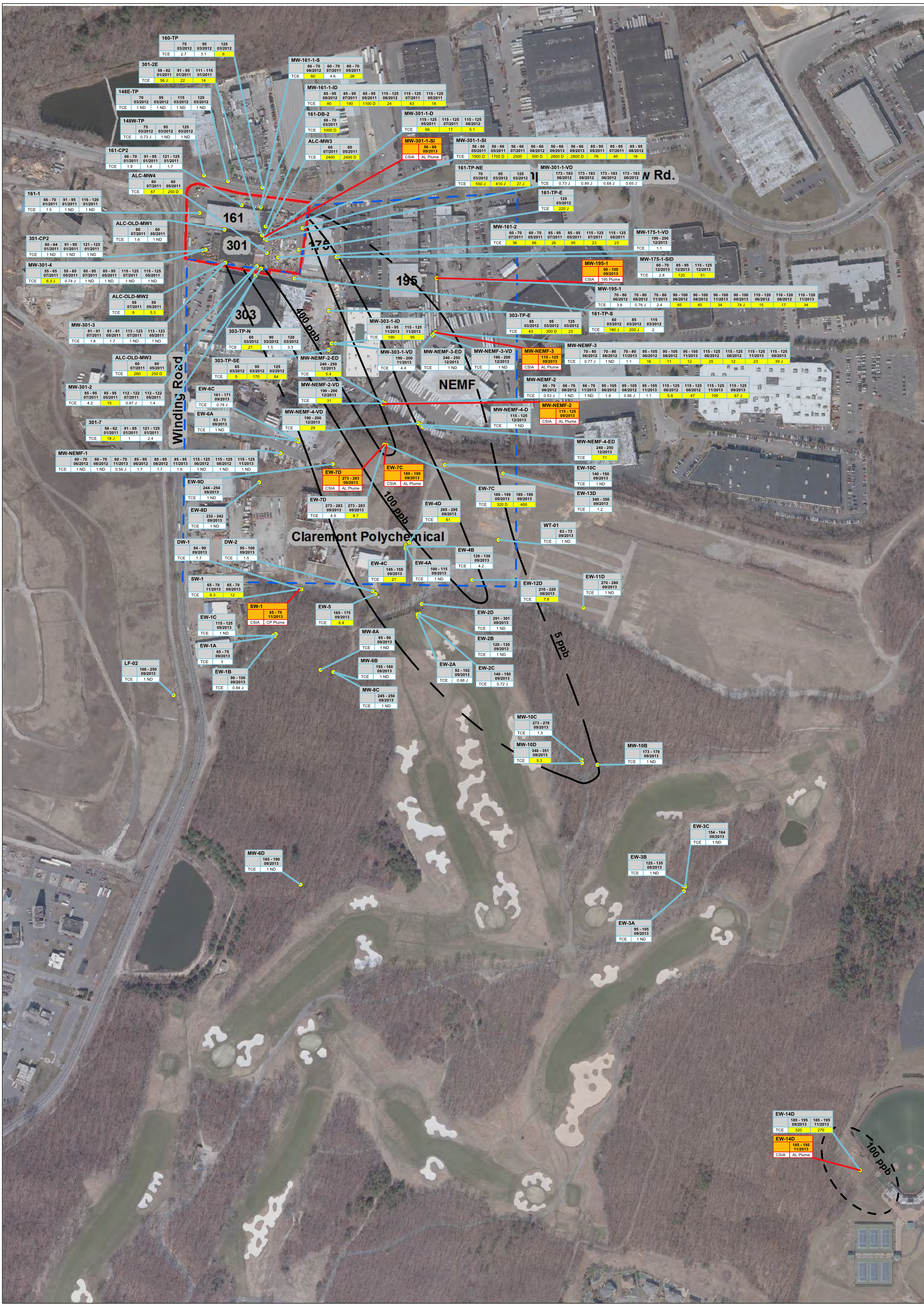
DATE 11-21-2016

FIGURE 3



Legend

Sample Location

Sample Depth (ft)

Sample Date

MW-1		
	115-125	190-200
	8/2012	9/2013
TCE	1 ND	10

Chemical Name

Result & Qualifier

Exceedance (yellow highlight)

CSIA Plumes:

AL Plume: Aluminum Louvre Plume

195 Plume: 195 Bethpage-Sweethollow Plume

CP Plume: Claremont Polychemical Plume

Groundwater Standards

TCE - Trichloroethene 5 ug/l

Notes:

OU-1 Site Boundary

OU-2 Site Boundary

Estimated extent of TCE in groundwater (ug/l) (Dashed where inferred)

All results are in ug/l.

ND - Not detected.

J - Estimated concentration.

D - Diluted sample.

CSIA - 3-D Compound Specific Isotope Analysis

Note: Boxes with orange headers are CSIA samples.

Site Location: Old Bethpage, NY

Groundwater and 3-D CSIA Sampling Results - 2013

OU2 and Off-Site Claremont Wells

Former Aluminum Louvre OU2 RI/FS

NYSDEC Site No. 130195

Old Bethpage, Nassau County, New York

N

0 250 500 feet

HDR

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

DATE

11-21-2016

FIGURE

4

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

ISSUE	DATE	DESCRIPTION
01	11/21/2016	DRAFT FEASIBILITY STUDY

PROJECT MANAGER P. PARVIS

PROJECT NUMBER 10039780

FEASIBILITY STUDY
OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE NO.130195
OLD BETHPAGE, NEW YORK

NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

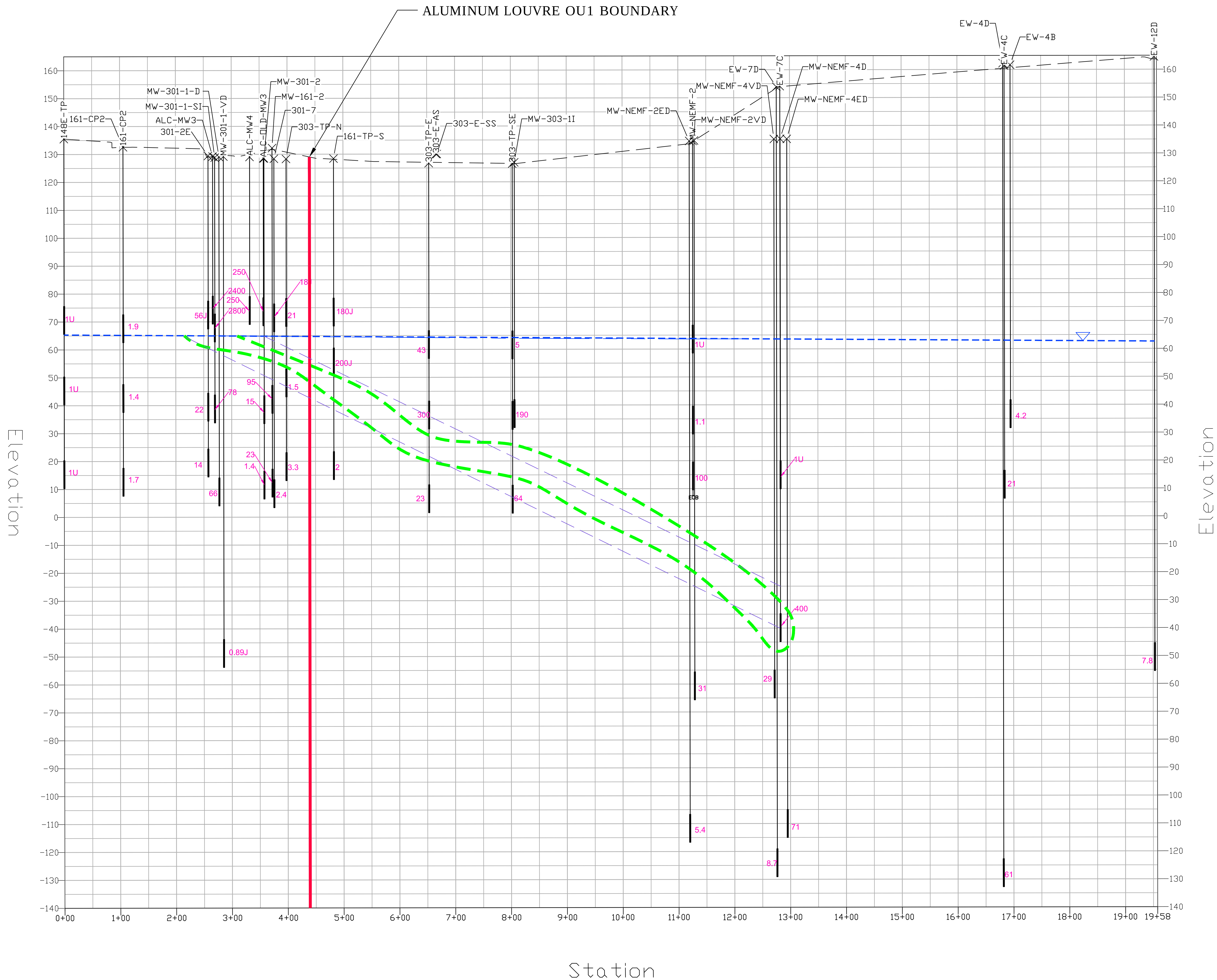
0 80 160

FILENAME

SCALE

SHEET

FIGURE 5



LEGEND:

PROPOSED GROUNDWATER ACTIVE REMEDIATION AREA

400 TCE(TRICHLOROETHYLENE) CONCENTRATION IN UG/L

WELL SCREEN

GROUNDWATER ELEVATION

CONCEPTUAL VERTICAL LIMIT OF THE PLUME FOR VOLUME CALCULATION. (APPROXIMATELY 15 FEET)

0 20 40
VERTICAL SCALE IN FEET

0 100 200
HORIZONTAL SCALE IN FEET

NOTE:

PROPOSED GROUNDWATER ACTIVE REMEDIATION AREA IS BASED ON ESTIMATED LIMIT OF TCE CONCENTRATION IN GROUNDWATER GREATER THAN 400 UG/L.

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

ISSUE	DATE	DESCRIPTION
01	11/21/2016	DRAFT FEASIBILITY STUDY

PROJECT MANAGER P. PARVIS

PROJECT NUMBER 10039780

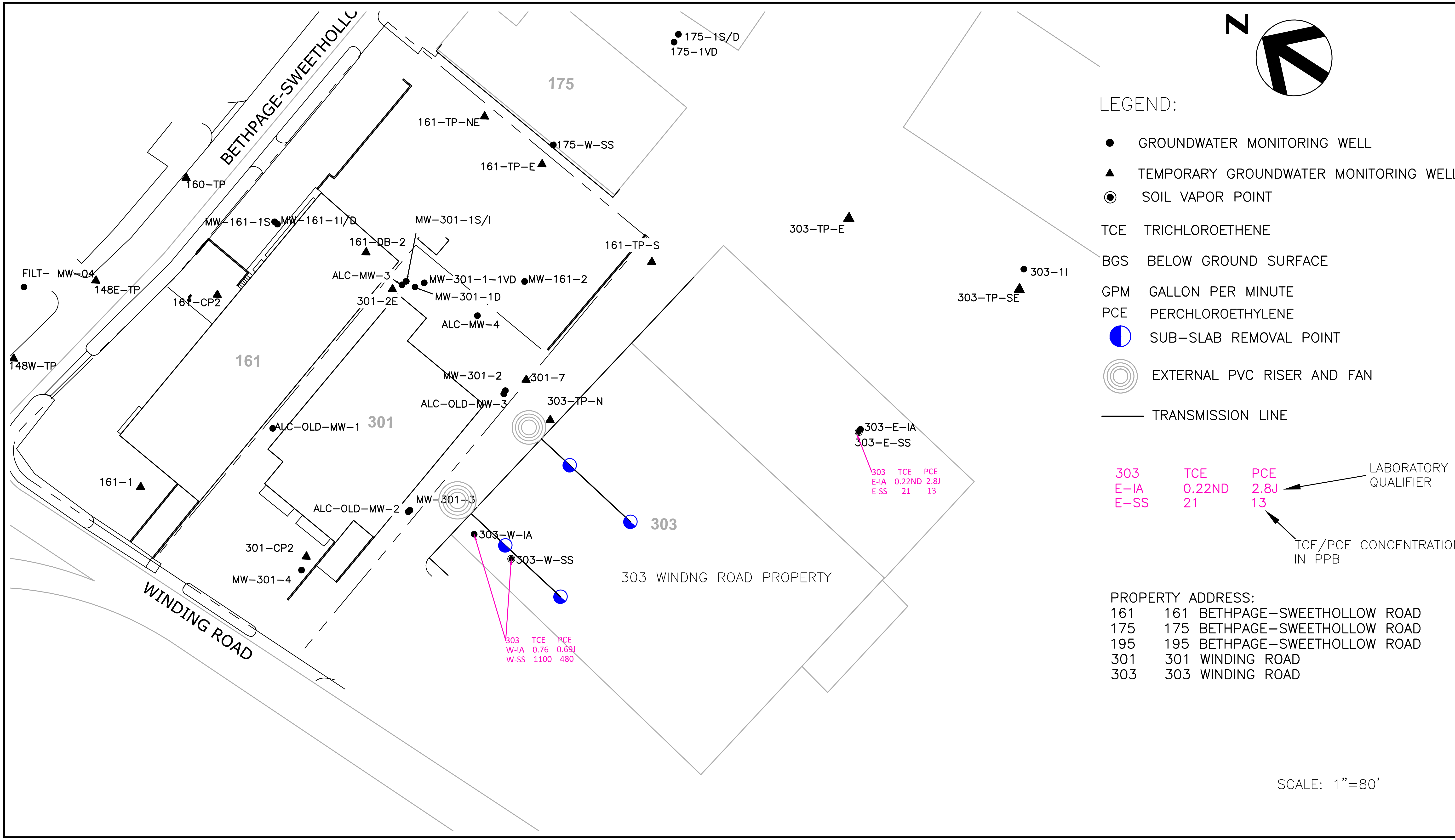
FEASIBILITY STUDY
OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE NO.130195
OLD BETHPAGE, NEW YORK

CROSS SECTION

FILENAME

SCALE

SHEET
FIGURE 6



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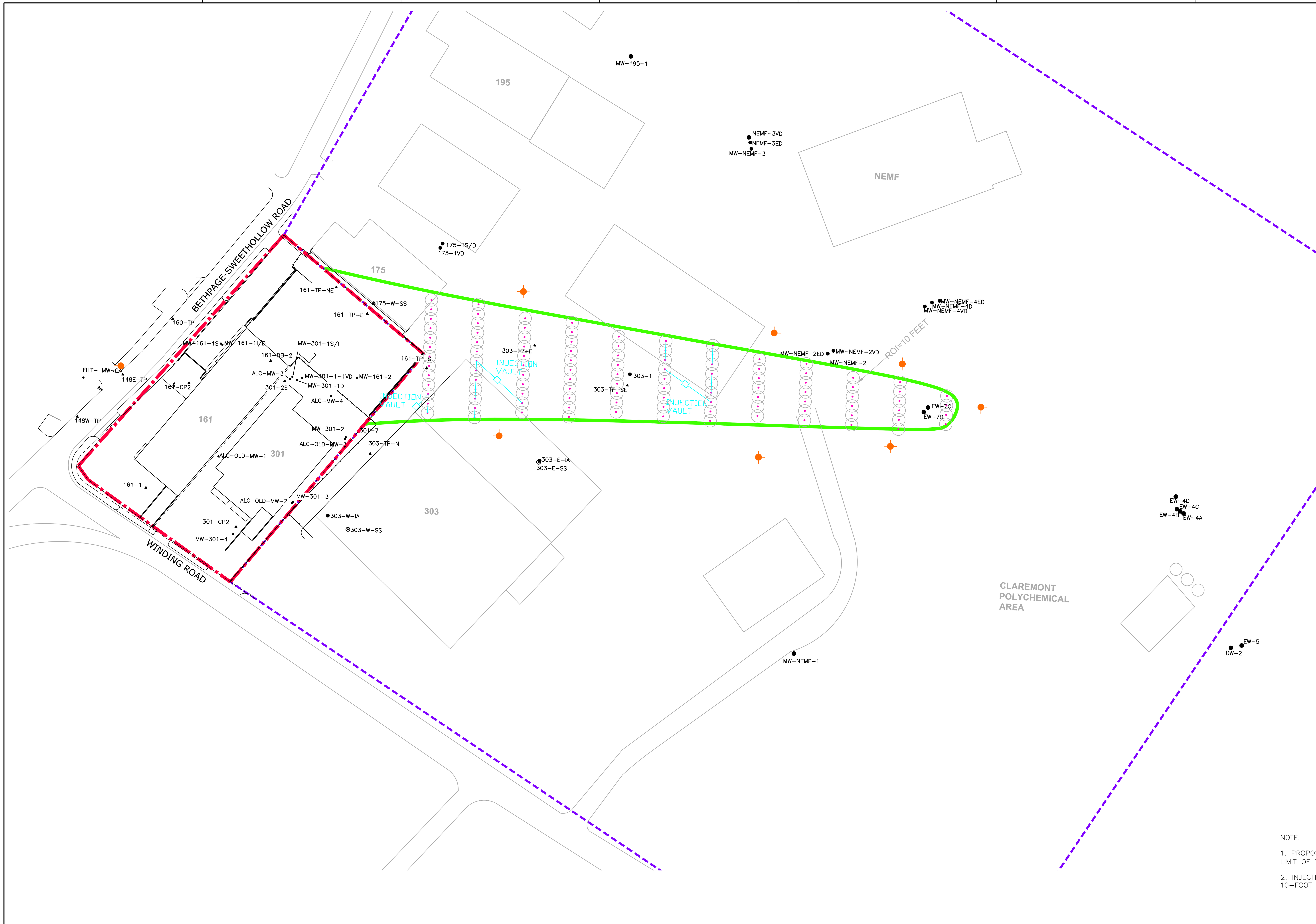
HDR

FEASIBILITY STUDY
OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE (# 130195)
OLD BETHPAGE, NEW YORK

PROPOSED VAPOR INTRUSION PLAN

DATE
11-21-201

FIGURE
FIGURE 7



LEGEND:

- OU2 FS BOUNDARY
- PROPOSED GROUNDWATER ACTIVE REMEDIATION
- ALUMINUM LOUVRE OU-1 SITE
- GROUNDWATER MONITORING WELL
- TEMPORARY GROUNDWATER MONITORING WELL
- SOIL VAPOR POINT
- INJECTION VAULT
- TRANSMISSION LINE
- GROUNDWATER ISCO INJECTION WELL (10-FOOT RADIUS OF INFLUENCE)
- PERFORMANCE MONITORING WELL

PROPERTY ADDRESS:

161	161 BETHPAGE-SWEETHOLLOW ROAD
175	175 BETHPAGE-SWEETHOLLOW ROAD
195	195 BETHPAGE-SWEETHOLLOW ROAD
301	301 WINDING ROAD
303	303 WINDING ROAD
NEMF	NEW ENGLAND MOTOR FREIGHT PROPERTY

NOTE:

1. PROPOSED GROUNDWATER ACTIVE REMEDIATION AREA IS BASED ON ESTIMATED LIMIT OF TCE CONCENTRATION IN GROUNDWATER GREATER THAN 400 UG/L.
2. INJECTION WELLS ARE LOCATED APPROXIMATELY 15 FEET APART WITH A 10-FOOT RADIUS OF INFLUENCE.

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

ISSUE	DATE	DESCRIPTION
01	11/21/2016	DRAFT FEASIBILITY STUDY

PROJECT MANAGER P. PARVIS

PROJECT NUMBER 10039780

FEASIBILITY STUDY
OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE NO.130195
OLD BETHPAGE, NEW YORK

ALTERNATIVE G2
CHEMICAL OXIDATION INJECTION WELL PLAN

0 80 160

FILENAME

SCALE

SHEET

FIGURE 8

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HDR

ISSUE	DATE	DESCRIPTION
01	11/21/2016	DRAFT FEASIBILITY STUDY

PROJECT MANAGER P. PARVIS

PROJECT NUMBER 10039780

FEASIBILITY STUDY

OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE NO.130195
OLD BETHPAGE, NEW YORK

ALTERNATIVE G3
BIOREMEDIATION INJECTION WELL PLAN

0 80 160

FILENAME

SCALE

SHEET
FIGURE 9

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

ISSUE	DATE	DESCRIPTION
01	11/21/2016	DRAFT FEASIBILITY STUDY

PROJECT MANAGER P. PARVIS

PROJECT NUMBER 10039780

FEASIBILITY STUDY

OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE NO.130195
OLD BETHPAGE, NEW YORK

ALTERNATIVE G4
PUMP AND TREAT EXTRACTION WELL PLAN
EXPANSION OF EXISTING CLAREMONT TREATMENT PLANT

0 80 160

FILENAME

SCALE

SHEET

FIGURE 10

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

ISSUE	DATE	DESCRIPTION
01	11/21/2016	DRAFT FEASIBILITY STUDY

PROJECT MANAGER: P. PARVIS

PROJECT NUMBER: 10039780

FEASIBILITY STUDY
OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE NO.130195
OLD BETHPAGE, NEW YORK

ALTERNATIVE G5
PUMP AND TREAT EXTRACTION WELL PLAN

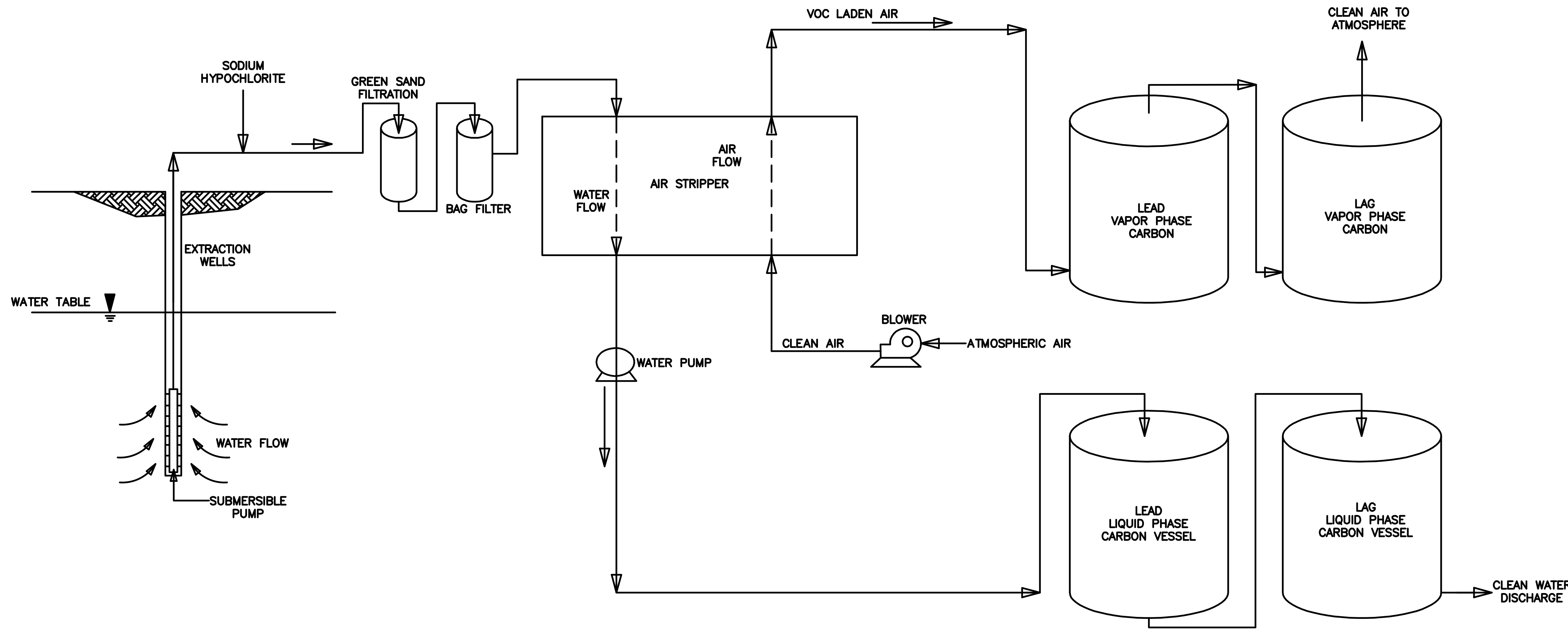
0 80 160

FILENAME

SCALE

SHEET

FIGURE 11



SCALE: NOT TO SCALE

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

FEASIBILITY STUDY
OFF-SITE GROUNDWATER CONTAMINATION (OU2)
FORMER ALUMINUM LOUVRE SITE (# 130195)
OLD BETHPAGE, NEW YORK

TYPICAL GROUNDWATER EXTRACTION AND TREATMENT SYSTEM PROCESS SCHEMATIC

DATE
11-21-201

FIGURE
FIGURE 12

Appendix A - Summary of Remedial Alternatives Costs

Site:	Former Aluminum Louvre Site (#130195)	**Base Year:**	2016
Location:	Old Bethpage, Nassau County, New York	**Date:**	December 18, 2016
Phase:	Feasibility Study (-30% - +50%)		

Description	Alternative G1 No Action	Alternative G2 In-Situ Chemical Oxidation with LTM	Alternative G3 In-Situ Bioremediation with LTM	Alternative G4 Pump and Treat at Claremont Treatment Plant and SSDS with LTM	Alternative G5 Pump and Treat at a new GWTF and SSDS with LTM
Estimated Active Project Duration (Years)	-	3	15	30	30
Estimated Long Term Monitoring (Years)	-	15	30	30	30
Capital Cost	$ -	$ 6,136,000	$1,486,000	$ 3,391,000	$ 4,087,000
Total O&M Cost	$ -	$ 3,653,000	$4,219,000	$ 14,404,000	$ 21,061,000
Total Periodic Cost	$ -	$ 214,000	$410,000	$ 211,000	$ 211,000
Total Present Value of Alternatives	**$ -**	**$ 10,003,000**	**$ 6,115,000**	**$ 18,006,000**	**$ 25,359,000**

Notes:

1. This is a order-of-magnitude engineering cost estimate that is expected to be within -30 to +50% of the actual cost for each alternative.
2. For consistency with the detailed cost backup for each alternative found in Appendix A the total value of each alternative is shown to the dollar.
3. For the purposes of comparing the costs with the FS text the values shown have been rounded to the nearest $100,000 within the text.

Alternative G1
No Action

COST ESTIMATE SUMMARY

Site:	Former Aluminum Louvre Site (#130195)	**Description:**	Alternative 1 does not consist of any active ground water remediation.
Location:	Old Bethpage, Nassau County, New York		
Phase:	Feasibility Study (-30% - +50%)		
Base Year:	2014		
Date:	December 18, 2016		

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:							
1	**LTM and Institutional Controls**						
		Institutional Controls					
	1.1	No IC Costs	0	EA		$ -	
		LTM					
	1.2	No LTM Costs	0	EA		$ -	
		Sub-Total				**$ -**	
	Sub-Total					**$ -**	Sub-Total All Construction Costs.
		Contingency	25%			$ -	10% scope + 15% bid.
	Sub-Total					**$ -**	
	Project Management					$ -	
	Remedial Design					$ -	
	Construction Management					$ -	
	Construction Oversight					$ -	
	TOTAL CAPITAL COST					**$ -**	

O&M COST:

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
1	**Annual O&M Costs**						
	1.1	No Annual O&M Costs	0	LS		$ -	
		Sub-Total				**$ -**	
2	**Maintenance**						
	2.1	No Maintenance Costs	0	LS	$ -	$ -	
		Sub-Total				**$ -**	
	Sub-Total					**$ -**	
		Contingency	15%			$ -	
	Sub-Total					**$ -**	
	Project Management					$ -	
	Technical Support					$ -	
	TOTAL ANNUAL O&M COST					**$ -**	

PERIODIC COSTS:

Item No.		Description		Quantity	Unit	Unit Cost	Total	Notes
1	**Five Year Review**							
	1.1	No Periodic Costs	5	0	LS		$ -	
		Sub-Total					**$ -**	

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.			Year	Total Cost	Present Value	Notes
1	**Capital Cost**		0		$ -	
2	**Annual O&M Cost**		1-30	$ -	$ -	
3	**Periodic Costs**					
	3.1	Year 1	1	$ -	$ -	
	3.2	Year 5	5	$ -	$ -	
	3.3	Year 10	10	$ -	$ -	
	3.4	Year 15	15	$ -	$ -	
	3.5	Year 20	20	$ -	$ -	
	3.6	Year 25	25	$ -	$ -	
	3.7	Year 30	30	$ -	$ -	
		Sub-Total			**$ -**	
	TOTAL PRESENT VALUE OF ALTERNATIVE				**$ -**	

Alternative G2
In-Situ Chemical Oxidation with LTM

COST ESTIMATE SUMMARY

Site: Former Aluminum Louvre Site (#130195)
Location: Old Bethpage, Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2016
Date: December 18, 2016

Description: Alternative G2 consists of implementing active In-Situ Chemical Oxidation in both the shallow and deep remediation zones. Long-term monitoring will be implemented outside of the active remediation area. SSDS for the 303 Winding Road Building.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Sub-Slab Depressurization System Installation**					
1.1	Connectivity Testing	1	LS	$ 15,000	$ 15,000	Pilot Study to optimize extraction points
1.2	Mobilization	1	LS	$ 2,000	$ 2,000	
1.3	Transmission Piping	250	LF	$ 15	$ 3,750	Includes pipe, grout, pipe supports, valves etc.
1.4	Blowers and Accessories	1	EA	$ 15,000	$ 15,000	Includes 10-hp blower, moisture separator, filters, muffler, valves, manual pump drain.
1.5	Equipment Enclosures	1	EA	$ 12,000	$ 12,000	includes 72"x96" fiberglass shelter, delivery to site and construction of concrete pad
1.6	Power Service	1	LS	$ 10,500	$ 10,500	
1.7	Electrical Controls	1	LS	$ 5,000	$ 5,000	
1.8	System Installation	1	LS	$ 15,000	$ 15,000	labor to install the system including 4 extraction points, enclosure, piping, etc.
1.9	System Startup	1	LS	$ 10,000	$ 10,000	
1.10	Permits	1	LS	$ 10,000	$ 10,000	
1.11	Reporting, Documentation and Surveying	1	LS	$ 15,000	$ 15,000	
1.12	IDW - Drum Disposal	1	EA	$ 250	$ 250	assumes disposal of 2 drums, nonhazardous, includes delivery of clean drums to site
	Sub-Total				**$ 113,500**	
2	**Pre-Design Investigation/Pilot Test**					
2.1	Investigation Work Plan	1	LS	$ 25,000	$ 25,000	Sampling Plan, QAPP, HASP
2.2	Groundwater Sampling (Baseline and Performance)	12	EA	$ 1,000	$ 12,000	Sampling 10 MWs; 20% QC samples; includes sampling and VOC analysis,and water chemistry
2.3	Permits	1	LS	$ 5,000	$ 5,000	UIC permits
2.4	Mob/Demob- Drilling subcontractor	1	LS	$ 6,000	$ 6,000	Hollow stem auger rig, decon pad
2.5	Mob/Demob- Injection subcontractor	1	LS	$ 5,500	$ 5,500	Pilot test equipment
2.6	Well Installation	2	EA	$ 10,000	$ 20,000	Wells vary from shallow (65 to 110 ft bgs)to deep (130 to 200 ft bgs)
2.7	Monitoring Points	6	EA	$ 1,800	$ 10,800	One inch wells, 65 to 200 ft deep, PVC riser, screen, assuming 3 per well location
2.8	Injection Substrate Material	2	EA	$ 5,400	$ 10,800	3,595 gallons per injection point
2.9	Injection Labor and Equipment	2	DAY	$ 8,000	$ 16,000	Labor and equipment for 2, 3 man crew + per diem
2.10	Water truck	2	DAY	$ 450	$ 900	2,000 -gal non-potable water
2.11	Temporary water storage tank	2	DAY	$ 30	$ 60	5,000 gal poly
2.12	Delivery fee of truck and tank	2	EA	$ 700	$ 1,400	includes drop off and pick up
2.13	IDW-nested wells	1	LS	$ 4,000	$ 4,000	Includes soil cuttings from installation and water disposal from development of nested wells and decon water
2.14	Pilot Study Sampling	12	EA	$ 1,000	$ 12,000	Sampling at 10 performance wells, includes sample and VOCs analysis, 20% QC samples
2.15	Data Reduction, Evaluation, Reporting	1	LS	$ 1,500	$ 1,500	
2.16	Surface Repair	0.89	SY	$ 40	$ 36	4 sf area per well installation
2.17	Flush-mount curb box with inner locking cap	2	EA	$ 1,500	$ 3,000	For nested injection wells
2.18	Submittals/Implementation Plans	1	LS	$ 25,000	$ 25,000	
2.19	Site Survey	1	LS	$ 15,000	$ 15,000	includes well survey
	Pre-Design Investigation Report	1	LS	$ 35,000	$ 35,000	
	Sub-Total				**$ 208,996**	
3	**Full Scale Injection Well Installation**					
3.1	Mob/Demob- Drilling subcontractor	1	LS	$ 100,000	$ 100,000	Hollow stem auger rig, decon pad, water truck
3.2	ISCO Well Installation	105	EA	$ 10,000	$ 1,050,000	Wells vary from shallow (65 to 110 ft bgs) to deep (130 to 200 ft bgs)
3.3	IDW- nested wells	1	LS	$ 25,000	$ 25,000	Includes soil cuttings from installation and water disposal from development of nested wells and decon water
3.4	Surface Repair- Asphalt	47	SY	$ 40	$ 1,867	4 sf area per well installation
3.5	Surface Repair- Concrete	23	CY	$ 80	$ 1,867	2*2*0.5 cf per well installation
3.6	Flush-mount curb box with inner locking cap	105	EA	$ 1,500	$ 157,500	For nested injection wells
3.7	Injection Well Piping	1,000	LF	$ 40	$ 40,000	
3.8	Saw Cut Slab	15	Day	$ 375	$ 5,625	Rental
3.9	Asphalt and concrete disposal	1,000	LF	$ 16	$ 16,000	From any trenching or saw cut work
3.10	Waste characterization testing	2	EA	$ 500	$ 1,000	
	Sub-Total				**$ 1,398,858**	

Appendix A2 - Cost Estimate for Alternative G2

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
4	**Initial Injections During Active Remediation Year-1**					
4.1	Injection Mob/Demob	1	LS	$ 20,000	$ 20,000	Full scale equipment
4.2	Injection Substrate Material	105	EA	$ 5,400	$ 567,000	3,595 gallons per injection point
4.3	Injection Labor and Equipment	105	DAY	$ 8,000	$ 840,000	Labor and equipment for 2 crews + per diem
4.4	Performance Sampling	12	EA	$ 550	$ 6,600	1 round of sampling for VOCs, labor, mobilization, data management and sample analysis at 10 performance wells, 20% QC samples
	Sub-Total				**$ 1,433,600**	
5	**Second Injections During Active Remediation Year-2**					
5.1	Injection Mob/Demob	1	LS	$ 20,000	$ 20,000	
5.2	Injection Substrate Material	105	EA	$ 5,400	$ 567,000	3,595 gallons per injection point
5.3	Injection Labor and Equipment	105	DAY	$ 8,000	$ 840,000	Labor and equipment for 2 crews + per diem
5.4	Performance Sampling	12	EA	$ 550	$ 6,600	1 round of sampling for VOCs, labor, mobilization, data management and sample analysis at 10 performance wells, 20% QC samples
	Sub-Total				**$ 1,433,600**	
6	**Reporting and Institutional Controls**					
6.1	Remedial Action Report	1	LS	$ 50,000	$ 50,000	
6.2	Institutional Control & Site Management Plan	1	LS	$ 15,000	$ 15,000	Environmental easement/deed restriction, legal fees.
6.3	Site Information Database	1	LS	$ 25,000	$ 25,000	Setup data management system.
6.4	Fate and Transport Modeling/Calculation	1	LS	$ 10,000	$ 10,000	
	Sub-Total				**$ 100,000**	
	Sub-Total				**$ 4,688,554**	Sub-Total All Construction Costs.
	Contingency	25%			$ 1,172,000	10% scope + 15% bid.
	Sub-Total				**$ 5,860,554**	
	Project Management				$ 50,000	
	Remedial Design				$ 60,000	
	Permitting				$ 15,000	
	Construction Management				$ 50,000	
	Construction Oversight				$ 100,000	
	TOTAL CAPITAL COST (Rounded up to $1K)				**$ 6,136,000**	

ANNUAL O&M COSTS:

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1	**Performance Monitoring - Years 1 & 2**					
1.1	Groundwater Sampling	120	EA	$ 500	$ 60,000	Monthly sampling of 10 performance wells
1.2	Groundwater Sample Laboratory Analysis	144	EA	$ 550	$ 79,200	Sampling 10 wells monthly for Total VOCs analysis + 20% QC samples.
1.3	Data Reduction, Evaluation and Reporting	12	EA	$ 3,000	$ 36,000	
	Sub-Total				**$ 175,200**	
2	**LTM and Institutional Controls - Years 1 & 2**					
2.1	Maintain Institutional Controls	1	LS	$ 6,000	$ 6,000	Site Management Plan
2.2	Groundwater Sampling	84	EA	$ 950	$ 79,800	Quarterly sampling of 21 wells
2.3	Groundwater Sample Laboratory Analysis	104	EA	$ 550	$ 57,200	Sampling 21 wells quarterly for Total VOCs analysis + 5 QC samples.
2.4	Data Reduction, Evaluation and Reporting	4	EA	$ 10,000	$ 40,000	
2.5	Quarterly Reports	4	EA	$ 15,000	$ 60,000	
2.6	Periodic Report	1	EA	$ 8,000	$ 8,000	Annually
	Sub-Total				**$ 251,000**	
3	**SSDS O&M - Years 1 & 2**					
3.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
3.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
3.3	Annual Report	1	LS	$ 3,000	$ 3,000	
3.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
3.5	Repair and Maintenance	1	LS	$ 500	$ 500	SSDS - 1 system
	Sub-Total				**$ 23,760**	
	Sub-Total				**$ 449,960**	
	Contingency	15%			$ 67,000	5% scope + 10% bid.
	Sub-Total				**$ 516,960**	
	Project Management				$ 6,000	
	Technical Support				$ 6,000	
	TOTAL ANNUAL O&M COST (Years 1-2)				**$ 528,960**	
4	**LTM and Institutional Controls - Years 3 & 4**					
4.1	Maintain Institutional Controls	1	LS	$ 6,000	$ 6,000	Site Management Plan
4.2	Groundwater Sampling	42	EA	$ 950	$ 39,900	Semi-annually sampling of 21 wells
4.3	Groundwater Sample Laboratory Analysis	52	EA	$ 550	$ 28,600	Sampling 21 wells semi-annually for Total VOCs analysis + 5 QC samples.
4.4	Data Reduction, Evaluation and Reporting	2	EA	$ 10,000	$ 20,000	Two reports per year.
4.5	Bi-Annual Reports	2	EA	$ 24,000	$ 48,000	
4.6	Periodic Report	1	EA	$ 8,000	$ 8,000	Annually
	Sub-Total				**$ 150,500**	

Appendix A2 - Cost Estimate for Alternative G2

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
5		**SSDS O&M - Years 3 & 4**					
	5.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
	5.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
	5.3	Annual Report	1	LS	$ 3,000	$ 3,000	
	5.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
	5.5	Repair and Maintenance	1	LS	$ 250	$ 250	SSDS - 1 system
		Sub-Total				**$ 23,510**	
Sub-Total						**$ 174,010**	
		Contingency	15%			$ 26,000	5% scope + 10% bid.
Sub-Total						**$ 200,010**	
Project Management						$ 6,000	
Technical Support						$ 6,000	
TOTAL ANNUAL O&M COST (Years 3-4)						**$ 212,010**	
6		**LTM and Institutional Controls - Years 5 to 30**					
	6.1	Maintain Institutional Controls	1	LS	$ 6,000	$ 6,000	Site Management Plan
	6.2	Groundwater Sampling	21	EA	$ 950	$ 19,950	Annually
	6.3	Groundwater Sample Laboratory Analysis	26	EA	$ 550	$ 14,300	Sampling 21 wells annually for Total VOCs analysis + 5 QC samples.
	6.4	Data Reduction, Evaluation and Reporting	1	EA	$ 10,000	$ 10,000	One report per year.
	6.5	Annual Report	1	EA	$ 24,000	$ 24,000	Includes periodic report
		Sub-Total				**$ 74,250**	
7		**SSDS O&M - Years 5 to 30**					
	7.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
	7.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
	7.3	Annual Report	1	LS	$ 3,000	$ 3,000	
	7.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
	7.5	Repair and Maintenance	1	LS	$ 250	$ 250	SSDS - 1 system
		Sub-Total				**$ 23,510**	
Sub-Total						**$ 97,760**	
		Contingency	15%			$ 15,000	5% scope + 10% bid.
Sub-Total						**$ 112,760**	
Project Management						$ 3,000	
Technical Support						$ 3,000	
TOTAL ANNUAL O&M COST (Years 5-30)						**$ 118,760**	

PERIODIC COSTS:

Item No.		Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1		**System Decommissioning**						
	1.1	Injection Well Abandonment	3	107	EA	$ 1,500	$ 160,500	Drilling subcontractor, abandonment of injection wells
	1.2	Performance Well Abandonment	3	6	EA	$ 1,500	$ 9,000	Drilling subcontractor, abandonment of performance wells
	1.3	Permitting and Reporting	3	1	LS	$ 5,000	$ 5,000	UIC permits
		Sub-Total					**$ 174,500**	
2		**Site Close Out**						
	2.1	Monitoring Well Abandonment	30	21	EA	$ 1,500	$ 31,500	Drilling subcontractor, abandonment of monitoring wells.
	2.2	Decommission SSDS- one system	30	1	LS	$ 5,000	$ 5,000	
	2.3	Final Closure Report	30	1	LS	$ 50,000	$ 50,000	
		Sub-Total					**$ 86,500**	

PRESENT VALUE ANALYSIS: Rate of Return: 5% Inflation Rate: 3%

Item No.		Description	Year	Total Cost	Present Value	Notes
1		**Capital Cost**	0		**$ 6,136,000**	
2		**Annual O&M Cost**				
	2.1	Years 1 to 2	1 to 2	$ 528,960	$ 1,027,886	
	2.2	Years 3 to 4	3 to 4	$ 212,010	$ 396,437	
	2.3	Years 5 to 30	5 to 30	$ 118,760	$ 2,228,386	
		Sub-Total (Rounded up to $1k)			**$ 3,653,000**	
3		**Periodic Costs**				
	3.1	Year 3	3	$ 174,500	$ 164,717	
	3.2	Year 30	30	$ 86,500	$ 48,580	
		Sub-Total (Rounded up to $1k)			**$ 214,000**	
		TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 10,003,000**	

	ROI Well	Depth	Area (ft2)	Volume (ft^3)/ point	# of Injection Points	Total volume (ft3)	Total Volume (gal)	Pore volume (gal)	Reagent Vol per zone (gal)	Anticipated events	Duration (days)	No. of crews
Shallow	12.00	15.00	452.16	6,782.40	52.00	841,017.60	6,290,811.65	1,887,250.00	188,725.00		37.00	
Intermediate	12.00	0.00	452.16	0.00	0.00	0.00	0.00	0.00	0.00		0.00	
Deep	12.00	15.00	452.16	6,782.40	53.00	841,017.60	6,290,811.65	1,887,250.00	188,725.00		37.00	
Total								**3,774,500.00**	**377,450.00**	**3.00**	**74.00**	**2**

Volume per well	**3,594.76**	**gallons per well**
Cost of oxidant	**1.50**	**$**
Cost per well	**5,400.00**	**$**
Total cost	**566,175.00**	**$**

Assume 5,000 gal per day

*Assume reagent volume is 10% pore volume

Alternative G3

In-Situ Bioremediation with LTM

COST ESTIMATE SUMMARY

Site: Former Aluminum Louvre Site (#130195)
Location: Old Bethpage, Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2016
Date: December 18, 2016

Description: Alternative G3 consists of implementing in-situ bioremediation in saturated shallow and deep remediation zones. Long-term monitoring will be implemented outside the area of active remediation. SSDS for the 303 Winding Road Building.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Sub-Slab Depressurization System Installation**					
1.1	Connectivity Testing	1	LS	$ 15,000	$ 15,000	Pilot Study to optimize extraction points
1.2	Mobilization	1	LS	$ 2,000	$ 2,000	
1.3	Transmission Piping	250	LF	$ 15	$ 3,750	Includes pipe, grout, pipe supports, valves etc.
1.4	Blowers and Accessories	1	EA	$ 15,000	$ 15,000	Includes 10-hp blower, moisture separator, filters, muffler, valves, manual pump drain.
1.5	Equipment Enclosures	1	EA	$ 12,000	$ 12,000	includes 72"x96" fiberglass shelter, delivery to site and construction of concrete pad
1.6	Power Service	1	LS	$ 10,500	$ 10,500	
1.7	Electrical Controls	1	LS	$ 5,000	$ 5,000	
1.8	System Installation	1	LS	$ 15,000	$ 15,000	labor to install the system including 4 extraction points, enclosure, piping, etc.
1.9	System Startup	1	LS	$ 10,000	$ 10,000	
1.10	Permits	1	LS	$ 10,000	$ 10,000	
1.11	Reporting, Documentation and Surveying	1	LS	$ 15,000	$ 15,000	
1.12	IDW - Drum Disposal	1	EA	$ 250	$ 250	assumes disposal of 2 drums, nonhazardous, includes delivery of clean drums to site
	Sub-Total				**$ 113,500**	
2	**Pre-Design Investigation/Pilot Test**					
2.1	Investigation Work Plan	1	LS	$ 25,000	$ 25,000	Sampling Plan, QAPP, HASP
2.2	Groundwater Sampling (Baseline and Performance)	24	EA	$ 1,500	$ 36,000	Sampling 20 wells; 20% QC samples; includes sampling, and analysis for VOCs, TOC, ORP, etc
2.3	Permits	1	LS	$ 5,000	$ 5,000	Street closure/traffic control permits
2.4	Mob/Demob- Drilling subcontractor	1	LS	$ 6,000	$ 6,000	Hollow stem auger rig, decon pad
2.5	Mob/Demob- Injection subcontractor	1	LS	$ 6,000	$ 6,000	Equipment for pilot test
2.6	Injection Well Installation - Shallow	1	EA	$ 3,500	$ 3,500	2-inch diameter; 65 to 110 ft deep, PVC riser, 15 ft screen
2.7	Injection Well Installation - Deep	1	EA	$ 7,500	$ 7,500	2-inch diameter; 130 to 200 ft deep, PVC riser, 15 ft screen
2.8	Monitoring Points	6	EA	$ 1,800	$ 10,800	One inch wells, 65 to 200 ft deep, PVC riser, screen, assuming 3 per well location
2.9	Injection Substrate Material	4	EA	$ 560	$ 2,240	2 drums of EOS per well
2.10	Injection Labor and Equipment	1	DAY	$ 6,000	$ 6,000	Labor and equipment for 1, 3man crew + per diem
2.11	Water truck	7	DAY	$ 450	$ 3,150	2,000 -gal non-potable water
2.12	Temporary water storage tank	7	DAY	$ 30	$ 210	5,000 gal poly
2.13	Delivery fee of truck and tank	2	EA	$ 700	$ 1,400	includes drop off and pick up
2.14	Pilot Study Sampling	6	EA	$ 550	$ 3,300	Sampling at 5 MWs, includes sample and VOCs analysis, 1 QC sample
2.15	Surface Repair- Asphalt	0.89	SY	$ 40	$ 36	4 sf disturbed area per well installation
2.16	Flush-mount curb box with inner locking cap	2	EA	$ 275	$ 550	For injection wells
2.17	Data Reduction, Evaluation, Reporting	1	LS	$ 15,000	$ 15,000	
2.18	IDW-injection wells	1	LS	$ 4,000	$ 4,000	Includes soil cuttings from installation and water disposal from development of injection wells and decon water
	Pre-Design Report	1	LS	$ 35,000	$ 35,000	
	Sub-Total				**$ 170,686**	
3	**Mobilization and Demobilization**					
3.1	Construction Equipment and Personnel Mob/Demob	1	LS	$ 50,000	$ 50,000	includes H&S
3.2	Site Survey	1	LS	$ 15,000	$ 15,000	includes well survey
3.3	Submittals/Implementation Plans	1	LS	$ 25,000	$ 25,000	QAPP, HASP, as builts and work plans
	Sub-Total				**$ 90,000**	
4	**Full Scale Injection Well Installation**					
4.1	Mob/Demob- Drilling subcontractor	1	LS	$ 6,000	$ 6,000	Hollow stem auger rig, decon pad, water truck
4.2	Injection Well Installation - Shallow	27	EA	$ 3,500	$ 94,500	2-inch diameter; 65 to 110 ft deep, PVC riser, 150 ft screen
4.3	Injection Well Installation - Deep	28	EA	$ 7,500	$ 210,000	2-inch diameter; 130 to 200 ft deep, PVC riser, 15 ft screen
4.4	Saw cut Slab	15	Day	$ 375	$ 5,625	Rental
4.5	Injection well piping	1,000	LF	$ 40	$ 40,000	
4.6	IDW-injection wells	1	LS	$ 15,000	$ 15,000	Includes soil cuttings from installation and water disposal from
4.7	Surface Repair- Asphalt	24	SY	$ 40	$ 978	4 sf area per well installation
4.8	Surface Repair- Concrete	12	CY	$ 80	$ 978	2*2*0.5 cf per well installation
4.9	Flush-mount curb box with inner locking cap	55	EA	$ 275	$ 15,125	For injection wells
	Sub-Total				**$ 388,206**	

Appendix A3 - Cost Estimate for Alternative G3

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
5	**Initial Injections During Active Remediation Year**					
5.1	Mob/Demob- Injection subcontractor	1	LS	$ 16,000	$ 16,000	Full scale equipment
5.2	Injection Substrate Material	114	EA	$ 560	$ 63,840	2 drums of EOS per well
5.3	Injection Labor and Equipment	29	DAY	$ 3,500	$ 99,750	Labor and equipment for 1 crew + per diem
5.4	Water Truck	29	DAY	$ 420	$ 11,970	2,000 -gal non-potable water
5.5	Temporary water storage tank	29	DAY	$ 28	$ 798	5,000 gal poly
5.6	Delivery fee of truck and tank	2	EA	$ 700	$ 1,400	includes drop off and pick up
6.7	Performance Sampling	24	EA	$ 1,500	$ 36,000	Sampling for VOCs, labor, mobilization, data management and sample analysis at 20 wells + 20% QC samples
	Sub-Total				**$ 229,758**	
6	**Reporting and Institutional Controls**					
6.1	Remedial Action Report	1	LS	$ 50,000	$ 50,000	
6.2	Institutional Control & Site Management Plan	1	LS	$ 15,000	$ 15,000	Environmental easement/deed restriction, legal fees.
6.3	Site Information Database	1	LS	$ 25,000	$ 25,000	Setup data management system.
6.4	Fate and Transport Modeling/Calculation	1	LS	$ 10,000	$ 10,000	
	Sub-Total				**$ 100,000**	
	Sub-Total				**$ 1,092,149**	Sub-Total All Construction Costs.
	Contingency	25%			$ 273,000	10% scope + 15% bid.
	Sub-Total				**$ 1,365,149**	
	Project Management				$ 20,000	
	Remedial Design				$ 50,000	
	Permitting				$ 10,000	
	Construction Management				$ 30,000	
	Construction Oversight				$ 10,000	
	TOTAL CAPITAL COST (Rounded up to $1K)				**$ 1,486,000**	

ANNUAL O&M COST:

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1	**LTM and Institutional Controls - Years 1 to 5**					
1.1	Maintain Institutional Controls	1	LS	$ 5,000	$ 5,000	Site Management Plan
1.2	Groundwater Sampling	84	EA	$ 950	$ 79,800	Quarterly sampling of 21 wells
1.3	Groundwater Sample Laboratory Analysis	101	EA	$ 550	$ 55,440	Sampling 21 wells quarterly for Total VOCs analysis + 20% QC samples.
1.4	Data Reduction, Evaluation and Reporting	4	EA	$ 10,000	$ 40,000	Four reports per year.
1.5	Quarterly Reports	4	EA	$ 24,000	$ 96,000	
1.6	Periodic Report	1	EA	$ 8,000	$ 8,000	Annually
	Sub-Total				**$ 284,240**	
2	**SSDS O&M - Years 1 to 5**					
2.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
2.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
2.3	Annual Report	1	LS	$ 3,000	$ 3,000	
2.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
2.5	Repair and Maintenance	1	LS	$ 250	$ 250	SSDS - 1 system
	Sub-Total				**$ 23,510**	
	Sub-Total				**$ 307,750**	
	Contingency	15%			$ 46,000	
	Sub-Total				**$ 353,750**	
	Project Management				$ 10,000	
	Technical Support				$ 10,000	
	TOTAL ANNUAL O&M COST (Years 1 to 5)				**$ 373,750**	
3	**LTM and Institutional Controls - Years 5 to 10**					
3.1	Maintain Institutional Controls	1	LS	$ 5,000	$ 5,000	Site Management Plan
3.2	Groundwater Sampling	42	EA	$ 950	$ 39,900	21 wells semi-annually
3.3	Groundwater Sample Laboratory Analysis	50	EA	$ 550	$ 27,720	Sampling 21 wells semi-annually for Total VOCs analysis + 20% QC samples.
3.4	Data Reduction, Evaluation and Reporting	2	EA	$ 10,000	$ 20,000	Two reports per year.
3.5	Bi-Annual Reports	2	EA	$ 24,000	$ 48,000	
3.6	Periodic Report	1	EA	$ 8,000	$ 8,000	Annually
	Sub-Total				**$ 148,620**	

Appendix A3 - Cost Estimate for Alternative G3

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
4	**SSDS O&M - Years 5 to 10**					
4.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
4.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
4.3	Annual Report	1	LS	$ 3,000	$ 3,000	
4.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
4.5	Repair and Maintenance	1	LS	$ 250	$ 250	SSDS - 1 system
	Sub-Total				**$ 23,510**	
	Sub-Total				**$ 172,130**	
	Contingency	15%			$ 26,000	
	Sub-Total				**$ 198,130**	
	Project Management				$ 3,000	
	Technical Support				$ 3,000	
	TOTAL ANNUAL O&M COST (Years 5 to 10)				**$ 204,130**	
5	**LTM and Institutional Controls - Year 10 to 30**					
5.1	Maintain Institutional Controls	1	LS	$ 5,000	$ 5,000	Site Management Plan
5.2	Groundwater Sampling	21	EA	$ 950	$ 19,950	21 wells annually
5.3	Groundwater Sample Laboratory Analysis	25	EA	$ 550	$ 13,860	Sampling 21 wells annually for Total VOCs analysis + 20% QC samples.
5.4	Data Reduction, Evaluation and Reporting	1	EA	$ 10,000	$ 10,000	One report per year
5.5	Annual Report	1	EA	$ 24,000	$ 24,000	Includes periodic report
	Sub-Total				**$ 72,810**	
6	**SSDS O&M - Year 10 to 30**					
6.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
6.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
6.3	Annual Report	1	LS	$ 3,000	$ 3,000	
6.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
6.5	Repair and Maintenance	1	LS	$ 250	$ 250	SSDS - 1 system
	Sub-Total				**$ 23,510**	
	Sub-Total				**$ 96,320**	
	Contingency	15%			$ 14,000	
	Sub-Total				**$ 110,320**	
	Project Management				$ 3,000	
	Technical Support				$ 3,000	
	TOTAL ANNUAL O&M COST (Year 10 to 30)				**$ 116,320**	

PERIODIC COSTS:

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**Second Injection Event**						
1.1	Mob/Demob- Injection subcontractor	3	1	LS	$16,000	$16,000	
1.2	Injection Substrate Material	3	114	EA	$560	$63,840	2 drums of EOS per well
1.3	Injection Labor and Equipment	3	50	DAY	$3,500	$175,000	Labor and equipment for 1 crew + per diem
1.4	Water Truck	3	50	DAY	$450	$22,500	2,000 -gal non-potable water
1.5	Temporary water storage tank	3	50	DAY	$30	$1,500	5,000 gal poly
1.6	Delivery fee of truck and tank	3	2	EA	$700	$1,400	includes drop off and pick up
1.7	Performance Sampling	3	19	EA	$550	$10,560	Sampling for VOCs, labor, mobilization, data management and sample analysis at 16 performance wells + 20% QC samples
	Sub-Total					**$ 290,800**	
2	**System Decommissioning**						
2.1	Injection Well Abandonment	5	57	EA	$ 1,500	$ 85,500	Drilling subcontractor, abandonment of injection wells
2.2	Permitting and Reporting	5	1	LS	$ 10,000	$ 10,000	
	Sub-Total					**$ 95,500**	
3	**Site Close Out**						
3.1	Monitoring Well Abandonment	30	21	EA	$ 1,500	$ 31,500	Drilling subcontractor, abandonment of monitoring wells.
3.2	Decommission SSDS- one system	30	1	LS	$ 5,000	$ 5,000	
3.3	Final Closure Report	30	1	LS	$ 50,000	$ 50,000	
	Sub-Total					**$ 86,500**	

PRESENT VALUE ANALYSIS: Rate of Return: 5% Inflation Rate: 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0		**$ 1,486,000**	
2	**Annual O&M Cost**				
2.1	Years 1 to 5	1 to 5	$ 373,750	$ 1,764,638	
2.2	Years 5 to 10	5 to 10	$ 204,130	$ 875,429	
2.3	Years 10 to 30	10 to 30	$ 116,320	$ 1,578,098	
	Sub-Total (Rounded up to $1K)			**$ 4,219,000**	
3	**Periodic Costs**				
3.1	Year 3	3	$ 290,800	$ 274,497	
3.2	Year 5	5	$ 95,500	$ 86,745	
3.3	Year 30	30	$ 86,500	$ 48,580	
	Sub-Total (Rounded up to $1K)			**$ 410,000**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 6,115,000**	

Appendix A4 - Cost Estimate for Alternative G4

Alternative G4

Pump and Treat at Claremont Treatment Plant and SSDS with LTM

COST ESTIMATE SUMMARY

Site: Former Aluminum Louvre Site (#130195)
Location: Old Bethpage, Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2016
Date: December 18, 2016

Description: Alternative G4 consists of extracting groundwater to remove mass from high concentration areas of the aquifer and to establish hydraulic control of the aquifer to minimize off-Site migration of the groundwater plume. Extracted groundwater will be treated at the Claremont Treatment Plant. Long-term monitoring will be implemented outside the area of active remediation. Includes installation of a SSDS for the 303 Winding Road Building.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Sub-Slab Depressurization System Installation**					
1.1	Connectivity Testing	1	LS	$ 15,000	$ 15,000	Pilot Study to optimize extraction points
1.2	Mobilization	1	LS	$ 2,000	$ 2,000	
1.3	Transmission Piping	250	LF	$ 15	$ 3,750	Includes pipe, grout, pipe supports, valves etc.
1.4	Blowers and Accessories	1	EA	$ 15,000	$ 15,000	Includes 10-hp blower, moisture separator, filters, muffler, valves, manual pump drain.
1.5	Equipment Enclosures	1	EA	$ 12,000	$ 12,000	includes 72"x96" fiberglass shelter, delivery to site and construction of concrete pad
1.6	Power Service	1	LS	$ 10,500	$ 10,500	
1.7	Electrical Controls	1	LS	$ 5,000	$ 5,000	
1.8	System Installation	1	LS	$ 15,000	$ 15,000	labor to install the system including 4 extraction points, enclosure, piping, etc.
1.9	System Startup	1	LS	$ 10,000	$ 10,000	
1.10	Permits	1	LS	$ 10,000	$ 10,000	
1.11	Reporting, Documentation and Surveying	1	LS	$ 15,000	$ 15,000	
1.12	IDW - Drum Disposal	2	EA	$ 250	$ 500	Assumes disposal of 2 drums, nonhazardous, includes delivery of clean drums to site
	Sub-Total				**$ 113,750**	
2	**Pre-Design Investigation**					
2.1	Investigation Work Plan	1	LS	$ 25,000	$ 25,000	Sampling Plan, QAPP, HASP
2.2	Well Driller Mob/Demob	1	LS	$ 6,000	$ 6,000	
2.3	Performance Monitoring Well Installation - Shallow	5	EA	$ 7,600	$ 38,000	Drilling, construction and development. 2-inch diameter; 65 ft depth
2.4	Performance Monitoring Well Installation - Deep	5	EA	$ 9,200	$ 46,000	Drilling, construction and development. 2-inch diameter; 200 ft depth
2.5	Flush-mount curb box with inner locking cap	10	EA	$ 275	$ 2,750	
2.6	IDW- performance wells	1	LS	$ 8,000	$ 8,000	
2.7	Aquifer Pump Test	1	LS	$ 75,000	$ 75,000	Includes the performance of a two-week step drawdown test using an existing monitoring well.
2.8	Water Level Measurements/Transducers	1	LS	$ 5,000	$ 5,000	
2.9	Groundwater Sampling (Baseline) and data evaluation	12	EA	$ 1,500	$ 18,000	Sampling 10 MWs; 20% QC samples; includes sampling and VOC analysis,and water chemistry
2.10	Permits	1	LS	$ 5,000	$ 5,000	Street closure/traffic control permits
2.11	Pre-Design Report	1	LS	$ 35,000	$ 35,000	
	Sub-Total				**$ 263,750**	
3	**EW Drilling and Installation**					
3.1	Well Driller Mob/Demob	1	LS	$ 18,000	$ 18,000	Hollow stem auger rig, water truck, decon pad
3.2	Extraction Well Installation - Shallow	1	EA	$ 75,000	$ 75,000	6-inch diameter to 65 ft bgs, stainless steel casing & 20 ft stainless steel screen
3.3	Extraction Well Installation - Deep	1	EA	$ 100,000	$ 100,000	6-inch diameter to 200 ft bgs, stainless steel casing & 20 ft stainless steel screen
3.4	Decon/ well development	2	EA	$ 15,000	$ 30,000	
3.5	Pump Installation and Testing	2	EA	$ 6,300	$ 12,600	includes drawdown testing
3.6	Extraction Well Pump, and Transducer	2	EA	$ 6,000	$ 12,000	
3.7	Well Vault	2	EA	$ 2,500	$ 5,000	For extraction wells, 4'x4'x4'
3.8	IDW-extraction wells	1	LS	$ 15,000	$ 15,000	Soil cuttings and wastewater from well installations, steam cleaning and well development.
3.9	Surface Repair- Asphalt	2	SY	$ 40	$ 80	9 sf area per well installation
					$ 267,680	
4	**Mobilization and Demobilization**					
4.1	Construction Equipment and Personnel	1	LS	$ 50,000	$ 50,000	includes H&S
4.2	Submittals/Implementation Plans	1	LS	$ 100,000	$ 100,000	QAPP, HASP, shop dwgs and work plans.
4.3	Waste Water Storage (Frac Tank)	3	Month	$ 1,500	$ 4,500	1 tank for 3 months
4.4	Site Survey	1	LS	$ 15,000	$ 15,000	includes well survey
4.5	Post Construction Submittals	1	LS	$ 40,000	$ 40,000	As-builts, O&M Manuals, warranties, etc.
	Sub-Total				**$ 209,500**	

Appendix A4 - Cost Estimate for Alternative G4

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
5	**Conveyance Piping**					
5.1	EW Trenching, Bedding, Pipe	1,000	LF	$ 50	$ 50,000	3-inch HDPE double walled pipe.
5.2	Surface Restoration	444	SY	$ 40	$ 17,778	
5.3	Effluent Discharge Pipe	1,000	LF	$ 50	$ 50,000	Pipe to injection wells and discharge to POTW for backwash
5.4	Backfill	370	CY	$ 30	$ 11,111	includes placement and compaction
5.5	Electrical	1,000	LF	$ 2	$ 2,000	from EW to PLC
5.6	Soil Disposal	222	Tons	$ 100	$ 22,222	1 foot x 2 foot wide by total length x 1.5 tons/CY.
5.7	Asphalt and concrete disposal	1,000	LF	$ 16	$ 16,000	From any trenching or saw cut work
	Sub-Total				**$ 169,111**	
6	**Treatment System**					
6.1	Sodium Hypochlorite Addition System	1	LS	$ -	$ -	Existing system to be used.
6.2	Green Sand Filtration System	1	LS	$ -	$ -	Existing system is unused due to low inorganics concentrations
6.3	Bag Filter Skid System	1	LS	$ 2,500	$ 2,500	Expansion of existing system only
6.4	Air Stripper	1	LS	$ 25,000	$ 25,000	Additional air stripper as expansion of current system only
6.5	Liquid GAC	1	LS	$ 77,500	$ 77,500	2 - 5,000 lb GAC vessels
6.6	Vapor GAC	1	LS	$ 45,000	$ 45,000	2 - 5,000 lb GAC vessels
6.7	Interconnecting pipes and valves	1	LS	$ 5,000	$ 5,000	Expansion of existing system only
6.8	PLC Controller and instrumentation	1	LS	$ -	$ -	Assumes use of existing system controller.
6.9	Electrical Components	1	LS	$ 5,000	$ 5,000	Expansion of existing system only
6.10	Discharge Pump	1	LS	$ 5,000	$ 5,000	Expansion of existing system only
	Sub-Total				**$ 165,000**	
7	**Solar System Installation**	1	LS	$868,000	**$ 868,000**	Lump sum cost provided by solar vendor for a >400,000 kw-hr system
8	**Treatment Plant Building**					
8.1	Concrete Foundation with 6" slab	1	LS	$ -	$ -	Assumes existing building may be used.
8.2	Concrete and Soil Testing	1	LS	$ -	$ -	
8.3	Site Preparation	1	LS	$ -	$ -	
8.4	Steel Building	1	LS	$ -	$ -	
8.5	HVAC System	1	LS	$ -	$ -	
8.6	Windows and Doors	1	LS	$ -	$ -	
8.7	Electrical Power and Lighting	1	LS	$ -	$ -	
	Sub-Total				**$ -**	
9	**System Start-up Testing**					
9.1	System Start-up	1	LS	$ 70,000	$ 70,000	includes intitial testing period and sampling
	Sub-Total				**$ 70,000**	
10	**Re-injection System**					
10.1	Dry Wells	10	EA	$ 10,000	$ 100,000	8-ft diameter
10.2	Disposal Costs	10	EA	$ 1,800	$ 18,000	
	Sub-Total				**$ 118,000**	
11	**Reporting and Institutional Controls**					
11.1	Remedial Action Report	1	LS	$ 50,000	$ 50,000	Environmental easement/deed restriction, legal fees.
11.2	Institutional Control & Site Management Plan	1	LS	$ 15,000	$ 15,000	Environmental easement/deed restriction, legal fees.
11.3	Site Information Database	1	LS	$ 25,000	$ 25,000	Setup data management system.
11.4	Fate and Transport Modeling/Calculation	1	LS	$ 10,000	$ 10,000	
	Sub-Total				**$ 100,000**	
	Sub-Total				**$ 2,344,791**	Sub-Total All Construction Costs.
	Contingency	25%			$ 586,000	10% scope + 15% bid.
	Sub-Total				**$ 2,930,791**	
	Project Management				$ 50,000	
	Remedial Design				$ 250,000	
	Permitting				$ 30,000	
	Construction Management				$ 30,000	
	Construction Oversight				$ 100,000	
	TOTAL CAPITAL COST				**$ 3,391,000**	

Appendix A4 - Cost Estimate for Alternative G4

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
ANNUAL O&M COSTS:						
1	**Operation Cost - Years 1 to 30**					
1.1	Electrical Usage	500,000	KW-Hr	$ -	$ -	The proposed solar system provides 100% of necessary electricity.
1.2	Vapor Carbon Usage	10,000	LB	$ 2.10	$ 21,000	Carbon change out 1x / year
1.3	Carbon characterization testing	1	EA	$ 385	$ 385	
1.4	Liquid Carbon Usage	1,666	LB	$ 2.10	$ 3,499	Change out lead Carbon unit every 3 years
1.5	Chemical Usage	2,072	gal	$ 2.00	$ 4,144	Additional chemical use.
1.6	Plant Operator	2,080	HR	$ -	$ -	Assumes existing operators can continue to maintain plant.
1.7	Reporting	12	Month	$ 5,000	$ 60,000	Monthly reports for 1 year.
1.8	Yearly backwash wastewater disposal	1	yearly	$ 8,200	$ 8,200	Yearly cost for offsite disposal of backwash wastewater.
	Sub-Total				**$ 97,228**	
2	**SSDS O&M Cost - Years 1 to 30**					
2.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
2.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
2.3	Annual Report	1	LS	$ 3,000	$ 3,000	
2.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
2.5	Repair and Maintenance	1	LS	$ 250	$ 250	SSDS - 1 system
	Sub-Total				**$ 23,510**	
3	**Treatment System Performance Sampling - Years 1 to 30**					
3.1	Performance Sampling and Analysis	115	EA	$ 1,500	$ 172,800	2 extraction wells + combined influent + effluent + 2 samples between Liquid phase GAC, VOCs analysis only, monthly from year 0-30, sewer discharge (VOC+TSS), 20% QC samples.
3.2	Air Sampling and Analysis (TO-15 Analysis)	48	EA	$ 1,500	$ 72,000	1 influent, 2 between lead/lag, 1 effluent, monthly, VOCs analysis only
3.3	Data Reduction, Evaluation, Reporting	1	LS	$ 25,000	$ 25,000	
	Sub-Total				**$ 269,800**	
4	**LTM and Institutional Controls (Years 1 & 2)**					
4.1	Maintain Institutional Controls	1	LS	$ 5,000	$ 5,000	Site Management Plan
4.2	Groundwater Sampling	84	EA	$ 950	$ 79,800	Quarterly sampling of 21 wells
4.3	Groundwater Sample Laboratory Analysis	101	EA	$ 550	$ 55,440	Sampling 21 wells quarterly for Total VOCs analysis + 20% QC samples.
4.4	Data Reduction, Evaluation and Reporting	4	EA	$ 10,000	$ 40,000	Four reports per year.
4.5	Quarterly Reports	4	EA	$ 24,000	$ 96,000	
4.6	Periodic Report	1	EA	$ 8,000	$ 8,000	Annually
	Sub-Total				**$ 284,240**	
	Sub-Total				**$ 674,778**	
	Contingency	15%			$ 101,000	
	Sub-Total				**$ 775,778**	
	Project Management				$ 15,000	
	Technical Support				$ 15,000	
	TOTAL ANNUAL O&M COST (Years 1&2)				**$ 805,778**	
5	**LTM and Institutional Controls - Years 3 to 30**					
5.1	Maintain Institutional Controls	1	LS	$ 6,000	$ 6,000	Site Management Plan
5.2	Groundwater Sampling	21	EA	$ 950	$ 19,950	Annually sampling of 21 wells
5.3	Groundwater Sample Laboratory Analysis	25	EA	$ 550	$ 13,860	Sampling 21 wells annually for Total VOCs analysis + 20% QC samples.
5.4	Data Reduction, Evaluation and Reporting	1	EA	$ 10,000	$ 10,000	One report per year.
5.5	Annual Report	1	EA	$ 24,000	$ 24,000	Includes periodic report
	Sub-Total				**$ 73,810**	
	Sub-Total				**$ 464,348**	
	Contingency	15%			$ 70,000	
	Sub-Total				**$ 534,348**	
	Project Management				$ 15,000	
	Technical Support				$ 15,000	
	TOTAL ANNUAL O&M COST (Years 3 to 30)				**$ 564,348**	

Appendix A4 - Cost Estimate for Alternative G4

PERIODIC COSTS:

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**Periodic Maintenance**						
1.1	Equipment Replacement/Repair	5	1	LS	$ 15,000	$ 15,000	Every 5 years through year 30
	Sub-Total					**$ 15,000**	
2	**System Decommissioning**						
2.1	Demobilize Treatment System	30	1	LS	$ 130,000	$ 130,000	
2.2	Well Abandonment	30	12	LS	$ 1,500	$ 18,000	Abandon extraction wells, and drywells
2.3	Treatment System Piping	30	1	LS	$ 20,000	$ 20,000	
2.4	Permitting and Reporting	30	1	LS	$ 20,000	$ 20,000	
	Sub-Total					**$ 188,000**	
3	**Site Close Out**						
3.1	Monitoring Well Abandonment	30	21	EA	$ 1,500	$ 31,500	Drilling subcontractor, abandonment of monitoring and performance wells.
3.2	Decommission SSDS- one system	30	1	LS	$ 5,000	$ 5,000	
3.3	Final Closure Report	30	1	LS	$ 50,000	$ 50,000	
	Sub-Total					**$ 86,500**	

PRESENT VALUE ANALYSIS: Rate of Return: 5% Inflation Rate: 3%

Item No.		Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0		**$ 3,391,000**	
2	**Annual O&M Cost**				
2.1	Years 1 to 2	1 to 2	$ 805,778	$ 1,565,803	
2.2	Years 3 to 30	3 to 30	$ 564,348	$ 12,838,129	
	Sub-Total (Rounded up to $1K)		$ 1,370,125	**$ 14,404,000**	
3	**Periodic Costs**				
3.1	Year 5	5	$ 15,000	$ 13,625	
3.2	Year 10	10	$ 15,000	$ 12,376	
3.3	Year 15	15	$ 15,000	$ 11,241	
3.4	Year 20	20	$ 15,000	$ 10,211	
3.5	Year 25	25	$ 15,000	$ 9,274	
3.6	Year 30	30	$ 274,500	$ 154,163	
	Sub-Total (Rounded up to $1K)			**$ 211,000**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 18,006,000**	

Alternative G5

Pump and Treat at a new GWTF and SSDS with LTM

COST ESTIMATE SUMMARY

Site: Former Aluminum Louvre Site (#130195)
Location: Old Bethpage, Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2016
Date: December 18, 2016

Description: Alternative G5 consists of extracting groundwater to remove mass from high concentration areas of the aquifer and to establish hydraulic control of the aquifer to minimize off-Site migration of the groundwater plume. Extracted groundwater will be treated via air stripping and carbon polishing in a new treatment facility to be constructed near the existing Claremont Treatment Plant. Long-term monitoring will be implemented outside the area of active remediation. Includes installation of a SSDS for the 303 Winding Road Building.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Sub-Slab Depressurization System Installation**					
1.1	Connectivity Testing	1	LS	$ 15,000	$ 15,000	Pilot Study to optimize extraction points
1.2	Mobilization	1	LS	$ 2,000	$ 2,000	
1.3	Transmission Piping	250	LF	$ 15	$ 3,750	Includes pipe, grout, pipe supports, valves etc.
1.4	Blowers and Accessories	1	EA	$ 15,000	$ 15,000	Includes 10-hp blower, moisture separator, filters, muffler, valves, manual pump drain.
1.5	Equipment Enclosures	1	EA	$ 12,000	$ 12,000	includes 72"x96" fiberglass shelter, delivery to site and construction of concrete pad
1.6	Power Service	1	LS	$ 10,500	$ 10,500	
1.7	Electrical Controls	1	LS	$ 5,000	$ 5,000	
1.8	System Installation	1	LS	$ 15,000	$ 15,000	labor to install the system including 4 extraction points, enclosure, piping, etc.
1.9	System Startup	1	LS	$ 10,000	$ 10,000	
1.10	Permits	1	LS	$ 10,000	$ 10,000	
1.11	Reporting, Documentation and Surveying	1	LS	$ 15,000	$ 15,000	
1.12	IDW - Drum Disposal	2	EA	$ 250	$ 500	Assumes disposal of 2 drums, nonhazardous, includes delivery of clean drums to site
	Sub-Total				**$ 113,750**	
2	**Pre-Design Investigation**					
2.1	Investigation Work Plan	1	LS	$ 45,000	$ 45,000	Sampling Plan, QAPP, HASP
2.2	Well Driller Mob/Demob	1	LS	$ 6,000	$ 6,000	
2.3	Performance Monitoring Well Installation - Shallow	5	EA	$ 7,600	$ 38,000	Drilling, construction and development. 2-inch diameter; 95 ft depth
2.4	Performance Monitoring Well Installation - Deep	5	EA	$ 9,200	$ 46,000	Drilling, construction and development. 2-inch diameter; 240 ft depth
2.5	Flush-mount curb box with inner locking cap	10	EA	$ 275	$ 2,750	
2.6	IDW- performance wells	1	LS	$ 8,000	$ 8,000	
2.7	Aquifer Pump Test	1	LS	$ 75,000	$ 75,000	Includes the performance of a two-week step drawdown pumping test on an existing monitoring well.
2.8	Water Level Measurements/Transducers	1	LS	$ 5,000	$ 5,000	
2.9	Groundwater Sampling (Baseline) and data evaluation	12	EA	$ 1,500	$ 18,000	Sampling 10 MWs; 20% QC samples; includes sampling and VOC analysis,and water chemistry
2.10	Permits	1	LS	$ 5,000	$ 5,000	Street closure/traffic control permits
2.11	Pre-Design Report	1	LS	$ 60,000	$ 60,000	
	Sub-Total				**$ 308,750**	
3	**EW Drilling and Installation - Pump and Treat**					
3.1	Well Driller Mob/Demob	1	LS	$ 18,000	$ 18,000	Hollow stem auger rig, water truck, decon pad
3.2	Extraction Well Installation - Shallow	1	EA	$ 75,000	$ 75,000	6-inch diameter to 65 ft bgs, stainless steel casing & 20 ft stainless steel screen
3.3	Extraction Well Installation - Deep	1	EA	$ 100,000	$ 100,000	6-inch diameter to 200 ft bgs, stainless steel casing & 20 ft stainless steel screen
3.4	Decon/ well development	2	EA	$ 15,000	$ 30,000	
3.5	Pump Installation and Testing	2	EA	$ 6,300	$ 12,600	includes drawdown testing
3.6	Extraction Well Pump, and Transducer	2	EA	$ 6,000	$ 12,000	
3.7	Well Vault	2	EA	$ 2,500	$ 5,000	For extraction wells, 4'x4'x4'
3.8	IDW-extraction wells	1	LS	$ 15,000	$ 15,000	Soil cuttings and wastewater from well installations, steam cleaning and well development.
3.9	Surface Repair- Asphalt	1	SY	$ 40.00	$ 40	9 sf area per well installation
3.1	Water Level Measurements/Transducers	1	LS	$ 5,000	$ 5,000	For pump test
	Sub-Total				**$ 272,640**	

Appendix A5 - Cost Estimate for Alternative G5

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
4	**Conveyance Piping**						
	4.1	EW Trenching, Bedding, Pipe	1,000	LF	$ 50	$ 50,000	3-inch HDPE double walled pipe.
	4.2	Surface Restoration	444	SY	$ 40	$ 17,778	
	4.3	Effluent Discharge Pipe	1,000	LF	$ 50	$ 50,000	
	4.4	Backfill	370	CY	$ 30	$ 11,111	includes placement and compaction
	4.5	Electrical	1,000	LF	$ 2	$ 2,000	from EW to PLC
	4.6	Soil Disposal	222	Tons	$ 100	$ 22,222	1 foot x 2 foot wide by total length x 1.5 tons/CY.
	4.7	Asphalt and concrete disposal	1,000	LF	$ 16	$ 16,000	From any trenching or saw cut work
		Sub-Total				**$ 169,111**	
5	**Treatment System**						
	5.1	Sodium Hypochlorite Addition System	1	LS	$ 15,000	$ 15,000	
	5.2	Green Sand Filtration System	1	LS	$ 330,000	$ 330,000	Skid mounted green sand filtration system 140-250 gpm
	5.3	Bag Filter Skid System	1	LS	$ 14,000	$ 14,000	
	5.4	Air Stripper	1	LS	$ 95,000	$ 95,000	6 trays, low profile stripper, blower, piping, sump, alarms
	5.5	Liquid GAC	1	LS	$ 77,500	$ 77,500	2 - 5,000 lb GAC vessels
	5.6	Vapor GAC	1	LS	$ 45,000	$ 45,000	2 - 5,000 lb GAC vessels
	5.7	Interconnecting pipes and valves	1	LS	$ 10,000	$ 10,000	
	5.8	PLC Controller and instrumentation	1	LS	$ 100,000	$ 100,000	Skid mounted green sand filtration system 140-250 gpm
	5.9	Electrical Components	1	LS	$ 10,000	$ 10,000	
	5.10	Discharge Pump	1	LS	$ 10,000	$ 10,000	
		Sub-Total				**$ 706,500**	
6	**Solar System Installation**		1	LS	$868,000	**$ 868,000**	Lump sum cost provided by solar vendor for a >400,000 kw-hr system
7	**Treatment Plant Building**						
	7.1	Concrete Foundation with 6" slab	1	LS	$ 30,000	$ 30,000	
	7.2	Concrete and Soil Testing	1	LS	$ 5,000	$ 5,000	
	7.3	Site Preparation	1	LS	$ 5,000	$ 5,000	Includes silt fence and temporary fence around building footprint
	7.4	Steel Building	1	LS	$ 60,000	$ 60,000	
	7.5	HVAC System	1	LS	$ 30,000	$ 30,000	
	7.6	Windows and Doors	1	LS	$ 20,000	$ 20,000	
	7.7	Electrical Power and Lighting	1	LS	$ 25,000	$ 25,000	
		Sub-Total				**$ 175,000**	
8	**System Start-up Testing**						
	8.1	System Start-up	1	LS	$ 70,000	$ 70,000	includes intitial testing period and sampling
		Sub-Total				**$ 70,000**	
9	**Re-injection System**						
	9.1	Dry Wells	10	EA	$ 10,000	$ 100,000	8-ft diameter
	9.2	Disposal Costs	10	EA	$ 1,800	$ 18,000	
		Sub-Total				**$ 118,000**	
10	**Reporting and Institutional Controls**						
	10.1	Remedial Action Report	1	LS	$ 50,000	$ 50,000	
	10.2	Institutional Control & Site Management Plan	1	LS	$ 15,000	$ 15,000	Environmental easement/deed restriction, legal fees.
	10.3	Site Information Database	1	LS	$ 25,000	$ 25,000	Setup data management system.
	10.4	Fate and Transport Modeling/Calculation	1	LS	$ 10,000	$ 10,000	
		Sub-Total				**$ 100,000**	
	Sub-Total					**$ 2,901,751**	Sub-Total All Construction Costs.
		Contingency	25%			$ 725,000	10% scope + 15% bid.
	Sub-Total					**$ 3,626,751**	
	Project Management					$ 50,000	
	Remedial Design					$ 250,000	
	Permitting					$ 30,000	
	Construction Management					$ 30,000	
	Construction Oversight					$ 100,000	
	TOTAL CAPITAL COST (Rounded up to $1K)					**$ 4,087,000**	

ANNUAL O&M COSTS:

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
1	**Operation**						
	1.1	Electrical Usage	500,000	KW-Hr	$ -	$ -	The proposed solar system provides 100% of necessary electricity.
	1.2	Vapor Carbon Usage	10,000	LB	$ 2.10	$ 21,000	Carbon change out once / year
	1.3	Carbon characterization testing	1	EA	$ 385	$ 385	
	1.4	Liquid Carbon Usage	1,666	LB	$ 2.10	$ 3,499	Change out lead Carbon unit every 3 years
	1.5	Chemical Usage	2,072	gal	$ 2.00	$ 4,144	Additional chemical use.
	1.6	Plant Operator	2,080	HR	$ 100.00	$ 208,000	Loaded rate for a full-time operator for 1 year.
	1.7	Reporting	12	Month	$ 5,000	$ 60,000	Monthly reports for 1 year.
	1.8	Yearly backwash wastewater disposal	1	yearly	$ 8,200	$ 8,200	Yearly cost for offsite disposal of backwash wastewater.
		Sub-Total				**$ 305,228**	
2	**SSDS O&M**						
	2.1	Quarterly Inspections	4	LS	$ 3,000	$ 12,000	
	2.2	Annual Sampling Event	1	LS	$ 2,500	$ 2,500	
	2.3	Annual Report	1	LS	$ 3,000	$ 3,000	
	2.4	Electrical Usage	32,000	kW-hr	$ 0.18	$ 5,760	
	2.5	Repair and Maintenance	1	LS	$ 250	$ 250	SSDS - 1 system
		Sub-Total				**$ 23,510**	

Appendix A5 - Cost Estimate for Alternative G5

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
3	**Performance Sampling**					
3.1	Performance Sampling and Analysis	130	EA	$ 1,500	$ 194,400	4 extraction wells + combined influent + effluent + 2 samples between Liquid phase GAC, VOCs analysis only, monthly from year 0-30, sewer discharge (VOC+TSS). 20% QC samples.
3.2	Air Sampling and Analysis (TO-15 Analysis)	48	EA	$ 1,500	$ 72,000	1 influent, 2 between lead/lag, 1 effluent, monthly, VOCs analysis only
3.3	Data Reduction, Evaluation, Reporting	1	LS	$ 30,000	$ 30,000	
	Sub-Total				**$ 296,400**	
4	**LTM and Institutional Controls (Years 1 & 2)**					
4.1	Maintain Institutional Controls	1	LS	$ 5,000	$ 5,000	Site Management Plan
4.2	Groundwater Sampling	84	EA	$ 950	$ 79,800	Quarterly sampling of 21 wells
4.3	Groundwater Sample Laboratory Analysis	101	EA	$ 550	$ 55,440	Sampling 21 wells quarterly for Total VOCs analysis + 20% QC samples.
4.4	Data Reduction, Evaluation and Reporting	4	EA	$ 10,000	$ 40,000	Four reports per year.
4.5	Quarterly Reports	4	EA	$ 24,000	$ 96,000	
4.6	Periodic Report	1	EA	$ 8,000	$ 8,000	Annually
	Sub-Total				**$ 284,240**	
	Sub-Total				**$ 909,378**	
	Contingency	15%			$ 136,000	
	Sub-Total				**$ 1,045,378**	
	Project Management				$ 15,000	
	Technical Support				$ 15,000	
	TOTAL ANNUAL O&M COST (Years 1&2)				**$ 1,075,378**	
5	**LTM and Institutional Controls - Years 3 to 30**					
5.1	Maintain Institutional Controls	1	LS	$ 6,000	$ 6,000	Site Management Plan
5.2	Groundwater Sampling	21	EA	$ 950	$ 19,950	Annually sampling of 21 wells
5.3	Groundwater Sample Laboratory Analysis	25	EA	$ 550	$ 13,860	Sampling 21 wells annually for Total VOCs analysis + 20% QC samples.
5.4	Data Reduction, Evaluation and Reporting	1	EA	$ 10,000	$ 10,000	One report per year.
5.5	Annual Report	1	EA	$ 24,000	$ 24,000	Includes periodic report
	Sub-Total				**$ 73,810**	
	Sub-Total				**$ 698,948**	
	Contingency	15%			$ 105,000	
	Sub-Total				**$ 803,948**	
	Project Management				$ 15,000	
	Technical Support				$ 15,000	
	TOTAL ANNUAL O&M COST (Years 3 to 30)				**$ 833,948**	

PERIODIC COSTS:

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**Periodic Maintenance**						
1.1	Equipment Replacement/Repair	5	1	LS	$ 15,000	$ 15,000	Every 5 years through year 30
	Sub-Total					**$ 15,000**	
2	**System Decommissioning**						
2.1	Demobilize Treatment System	30	1	LS	$ 130,000	$ 130,000	
2.2	Well Abandonment	30	12	LS	$ 1,500	$ 18,000	Abandon extraction wells, and drywells
2.3	Treatment System Piping	30	1	LS	$ 20,000	$ 20,000	
2.4	Permitting and Reporting	30	1	LS	$ 20,000	$ 20,000	
	Sub-Total					**$ 188,000**	
3	**Site Close Out**						
3.1	Monitoring Well Abandonment	30	21	EA	$ 1,500	$ 31,500	Drilling subcontractor, abandonment of monitoring wells.
3.2	Decommission SSDS- one system	30	1	LS	$ 5,000	$ 5,000	
3.3	Final Closure Report	30	1	LS	$ 50,000	$ 50,000	
	Sub-Total					**$ 86,500**	

PRESENT VALUE ANALYSIS: Rate of Return: 5% Inflation Rate: 3%

Item No.	Description	Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0		**$ 4,087,000**	
2	**Annual O&M Cost**				
2.1	Years 1 to 2	1 to 2	$ 1,075,378	$ 2,089,695	
2.2	Years 3 to 30	3 to 30	$ 833,948	$ 18,971,158	
	Sub-Total (Rounded up to $1k)		$ 1,909,325	**$ 21,061,000**	
3	**Periodic Costs**				
3.1	Year 5	5	$ 15,000	$ 13,625	
3.2	Year 10	10	$ 15,000	$ 12,376	
3.3	Year 15	15	$ 15,000	$ 11,241	
3.4	Year 20	20	$ 15,000	$ 10,211	
3.5	Year 25	25	$ 15,000	$ 9,274	
3.6	Year 30	30	$ 274,500	$ 154,163	
	Sub-Total (Rounded up to $1k)			**$ 211,000**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 25,359,000**	

Backwash

Flow Rate	Filter Area	# of Filters	Backwash Time	Backwash Flow	Backwashes/ Day	Flow/Day	Flow/Year	Cost per Gallon	Cost per Year
gpm/sf	sf		min	gallons		gallons	gallons		
12.00	28.26	3.00	15.00	15260.40	3.00	45781.20	16,710,138	$0.049000	**$8,187.97**

Appendix B

Memo to File

Date:	Thursday, September 14, 2017
Project:	D006129 Work Assignment #10 Former Aluminum Louvre Corporation RI|FS
To:	File
From:	HDR
Subject:	Additional Scope of Work - Methanotroph Analysis of Groundwater Samples

HDR subcontracted with Microbial Insights to analyze groundwater samples obtained from the Aluminum Louvre site for the presence of methane-oxidizing bacteria (methanotrophs) capable of metabolising chlorinated organic compounds. Microbial Insights offered several methods for differentiating methanotrophic bacteria at the site; however, only the CENSUS approach allowed the rapid quantification and differentiation of bacterial species necessary to evaluate the viability of bioremediation at the site and expedite revisions to the FS. Samples were obtained from monitoring wells MW-301-1-SI and EW-7C at the site on 05/28/2015 and analyzed by Microbial Insights using their CENSUS technology on 05/29/2015.

Results of laboratory analyses are provided on the attachment to this memorandum and summarized below. As indicated on the attached, results of CENSUS analyses indicated that the following methanotrophic bacteria were present in groundwater:

	MW-301-1-SI	**EW-7C**
Total Eubacteria:	1.16E+05 cells/ml	4.42E+05 cells/ml
Methane Oxidizing Bacteria	1.37E+03 cells/ml	1.43E+04 cells/ml
Soluble Methane Monooxygenase	5.48E+01 cell/ml	2.03E+02 cells/ml

As indicated above, the population of methanotrophs appears relatively high in relation to the overall bacterial population (between 1% and 10% or the total Eubacteria count). The presence of soluble methane monooxygenase is also a good general indicator that methanotrophic bacteria are present since methanotrophs produce methane monooxygenase in a methane-rich environment. The monooxygenase oxidizes methane to methanol (a food source for bacteria) and also co-oxidizes chlorinated compounds such as trichloroethene.

HDR contacted Professor Jeremy D. Semrau, PhD at the University of Michigan and requested if he could provide further insite on whether the results of CENSUS analyses were an indication that bioremediation of TCE in groundwater at the site were feasible using indigenous bacteria. While not being able to comment directly on the results as he was not involved in the analyses, Professor Semrau indicated that, in his opinion, the data collectively suggested that indigenous bacteria could be used for bioremediation of groundwater. Professor Semrau also recommended further testing to confirm the efficacy of bioremediation at the site.Email correspondence between HDR and Professor Semrau is also attached to this memorandum for reference.

10515 Research Drive
Knoxville, TN 37932
Phone: (865) 573-8188
Fax: (865) 573-8133

Client:	Agnes Huntley Spectrum Analytical, Inc. 646 Camp Avenue North Kingstown, RI 02852	**Phone:** **Fax:**	

Identifier: 093ME **Date Rec:** 05/29/2015 **Report Date:** 06/03/2015

Client Project #: **Client Project Name:** Aluminum Louvre

Purchase Order #: P0976

Analysis Requested: CENSUS

Reviewed By:

Casey Brown

MICROBIAL INSIGHTS, INC.

10515 Research Dr., Knoxville, TN 37932
Tel. (865) 573-8188 Fax. (865) 573-8133

CENSUS

Client: **Spectrum Analytical, Inc.**
Project: Aluminum Louvre

MI Project Number: **093ME**
Date Received: 05/29/2015

Sample Information

Client Sample ID:		**MW-301-1-S-20 150528**	**EW-7C-2015022 8**
Sample Date:		05/28/2015	05/28/2015
Units:		cells/mL	cells/mL
Analyst:		CB	CB

Functional Genes

Soluble Methane Monooxygenase	SMMO	**5.48E+01**	**2.03E+02**

Phylogenetic Group

Total Eubacteria	EBAC	**1.16E+05**	**4.42E+05**
Methane Oxidizing Bacteria	MOB	**1.37E+03**	**1.43E+04**

Legend:

NA = Not Analyzed NS = Not Sampled J = Estimated gene copies below PQL but above LQL I = Inhibited
< = Result not detected

Parvis, Patricia A.

From:	Zimmerman, Erich
Sent:	Thursday, July 09, 2015 10:21 AM
To:	'jsemrau@umich.edu'
Subject:	Use of Methanotrophic Bacteria to Degrade TCE in Groundwater on Long Island - Review of Groundwater Sampling Results
Attachments:	Figure 4 New TCE Results.pdf; CENSUS-093ME_95909633 (2).pdf

Dear Mr. Semrau,

I read a 2011 article you authored entitled, "**Bioremediation via methanotrophy: overview of recent findings and suggestions for future research"** and was hoping you could provide clarification regarding what constitutes an acceptable starting population of methantrophic bacteria for the purposes of bioremediation in groundwater.

We have been asked by New York State to evaluate alternatives for remediating groundwater at a site in Long Island, NY that is impacted by elevated concentrations of trichloroethylene (TCE). Concentrations of TCE range from below detection at the fringes of the groundwater plume to ~2,500 ug/l in the former source areas. I've attached a figure for your review.

One of the alternatives I am evaluating is bioremediation, and we've taken two 1-liter groundwater samples for methotrophic plate count by Microbial Insights using their CENSUS methodology. The results of plate count and MMO analysis is also attached.

Based on my review of the results (and no expert), the population of methanotrophs appears high in relation to the overall bacterial population. I'm assuming this is at least partially a result of the presence of TCE and other chlorinated compounds in the groundwater. Does this indicate bioremediation could be viable at this site?

Thanks in advance for any information you could provide.

Regards,

Erich

Erich Zimmerman, P.E.
Senior Project Manager

HDR
1 International Boulevard, 10th Floor, Suite 1000
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and

1514 Davis Road
West Falls, NY 14170

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erich.zimmerman@hdrinc.com
hdrinc.com/follow-us

Parvis, Patricia A.

From:	Jeremy Semrau <jsemrau@umich.edu>
Sent:	Thursday, July 09, 2015 3:09 PM
To:	Zimmerman, Erich
Subject:	Re: Use of Methanotrophic Bacteria to Degrade TCE in Groundwater on Long Island - Review of Groundwater Sampling Results

Dear Erich,

I can't comment directly on the numbers you provide as I don't know how they were generated (CFUs? MPN? 16 rRNA copies?) but on the face of it, you do have methanotrophs present (whether they are active or not I can't say) but collectively the data you show suggest that you could utilize indigenous methanotrophs for bioremediation. I'd recommend some simple batch tests to confirm but that's easy enough. And I'd also suggest screening for pMMO in addition to sMMO.

Hope this helps. If you have any other questions I can try and answer them.

Best,

Jeremy

Jeremy D. Semrau, PhD
Arthur F. Thurnau Professor
Professor, Civil and Environmental Engineering *and* Program in the Environment
The University of Michigan
Phone: 734-764-6487
Fax: 734-763-2275

On Thu, Jul 9, 2015 at 10:21 AM, Zimmerman, Erich <Erich.Zimmerman@hdrinc.com> wrote:

> Dear Mr. Semrau,
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> I read a 2011 article you authored entitled, "**Bioremediation via methanotrophy: overview of recent findings and suggestions for future research"** and was hoping you could provide clarification regarding what constitutes an acceptable starting population of methantrophic bacteria for the purposes of bioremediation in groundwater.
>
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