FINAL PLAN

Remedial Investigation/Feasibility Study Work Plan - Landfill and Groundwater

Dewey Loeffel Landfill Superfund Site
Nassau, New York

Index No. CERCLA-02-2013-2008

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Index No. CERCLA-02-2013-2008

General Electric Company/SI Group, Inc.
Albany, New York

DOUGLAS M. CRAWFORD, P.E., PROJECT OFFICER
O'Brien & Gere Engineers, Inc.

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ACRONYMS

Settlement Agreement	Administrative Settlement Agreement and Order on Consent for Remedial Investigation and Feasibility Study of Landfill and Groundwater (Index No. CERCLA-02-2013-2008)
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	ASTM International
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
BBL	Blasland, Bouck & Lee, Inc.
°C	Degrees Centigrade
C.T. Male	C. T. Male & Associates
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	Centimeters per Second
cis-1,2-DCE	cis-1,2-Dichloroethene
CVOCs	Chlorinated Volatile Organic Compounds
CSIA	Compound-Specific Stable Isotope Analysis
CSM	Conceptual Site Model
CLP	Contract Laboratory Program
DHC	*Dehalococcoides*
DNAPL	Dense Non-Aqueous Phase Liquid
DNA	Deoxyribonucleic Acid
DOT	Department of Transportation
DR/IP	Design Report/Implementation Plan
Site	Dewey Loeffel Landfill Superfund Site
DPT	Direct Push Technology
DO	Dissolved Oxygen
2-D	2-Dimensional
3-D	3-Dimensional

EC	Electrical Conductivity
EM	Electromagnetic
Enviroscan	Enviroscan, Inc.
Eurofins Lancaster	Eurofins Lancaster Laboratories Environmental, LLC
FS	Feasibility Study
FID	Flame Ionization Detector
FLUTe™	Flexible Liner Underground Technologies, LLC
FFD	Fuel Fluorescent Detector
GE	General Electric Company
GRAs	General Response Actions
Geoprobe	Geoprobe Systems®
GeoTrans	GeoTrans, Inc.
GPS	Global Positioning System
Golder	Golder Associates Ltd.
GPR	Ground-Penetrating Radar
GW	Groundwater
XSD	Halogen-Specific Detector
Hartgen	Hartgen Archeological Associates, Inc.
HAZWOPER	Hazardous Waste Operations and Emergency Response
HASP	Health and Safety Plan
HTL	Heated Trunkline
HSA	Hollow Stem Auger
HPT	Hydraulic Profiling Tool
IDM	Investigation-Derived Materials
ID	Inside Diameter
ISSI	Initial Supplemental Site Investigation
LF	Landfill
LIF	Laser-Induced Fluorescence
LCT	Leachate Collection Tank

LNAPL	Light Non-Aqueous Phase Liquid
Loeffel Companies	Loeffel's Waste Oil and Removal Service Company, Inc., and Marcar Oil, Inc.
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MIP	Membrane Interface Probe
µV	Micro Volts
µg/L	Micrograms per Liter
MI	Microbial Insights
Microseeps	Microseeps, Inc.
mL	Milliliter
mV	Millivolts
NELAP	National Environmental Laboratory Accreditation Program
NGVD 29	National Geodetic Vertical Datum of 1929
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NAVD 88	North American Vertical Datum of 1988
O'Brien & Gere	O'Brien & Gere Engineers, Inc.
O&M	Operation and Maintenance
OM&M	Operation, Maintenance and Monitoring
OSWER	Office of Solid Waste and Emergency Response
ORP	Oxidation Reduction Potential
PAES	Pace Analytical Energy Services, LLC
ppb	Parts per Billion
ppm	Parts per Million
PDBs	Passive Diffusion Bags
PAR	Pathway Analysis Report
%	Percent
PMP	Performance Monitoring Plan

PPE	Personnel Protective Equipment
PID	Photoionization Detector
PMTs	Photomultiplier Tubes
POU	Point of Use
PCBs	Polychlorinated Biphenyls
PVC	Polyvinyl Chloride
PRGs	Preliminary Remediation Goals
PTS	PTS Laboratories, Inc.
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCDOH	Rensselaer County Department of Health
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RI/FS SOW	Statement of Work for Remedial Investigation and Feasibility Study of the Landfill and the Groundwater
ROD	Record of Decision
RAOs	Remedial Action Objectives
RAGS	*Risk Assessment Guidance for Superfund*
RQD	Rock Quality Designation
SLERA	Screening Level Ecological Risk Assessment
SVOCs	Semi-Volatile Organic Compounds
SI Group	SI Group, Inc.
SCSR	Site Characterization Summary Report
SVI	Soil Vapor Intrusion
SD	Southern Drainageway
SOP	Standard Operating Procedure
SU	Standard Units
SOW	Statement of Work
Stone Environmental	Stone Environmental, Inc.
SARA	Superfund Amendments and Reauthorization Act

S2C2	S2C2, Inc.
TAL	Target Analyte List
TCL	Target Compound List
TOC	Total Organic Carbon
TCE	Trichloroethene
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
USEPA	United States Environmental Protection Agency
UCL	Upper Control Limit
Kv	Vertical Permeability
VCR	Vinyl Chloride Reductase
VOCs	Volatile Organic Compounds
WD	Western Drainageway

1. INTRODUCTION

1.1. GENERAL

This Remedial Investigation/Feasibility Study (RI/FS) Work Plan has been developed by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) on behalf of the General Electric Company (GE) and SI Group, Inc. (SI Group) (GE and SI Group are referred to collectively herein as the Respondents) for the Dewey Loeffel Landfill Superfund Site (Site) located in the Town of Nassau, Rensselaer County, New York (see Figure 1-1). The RI/FS Work Plan was prepared in accordance with the requirements of the Statement of Work (RI/FS SOW) included as Appendix 2 of the Administrative Settlement Agreement and Order on Consent for Remedial Investigation and Feasibility Study of Landfill and Groundwater (Index No. CERCLA-02-2013-2008) (Settlement Agreement) executed between the United States Environmental Protection Agency (USEPA) and the Respondents, effective October 7, 2013.

The Dewey Loeffel Landfill is listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 site (Site No. 442006). The New York State Department of Environmental Conservation (NYSDEC) referred the Dewey Loeffel Landfill to USEPA and issued a letter of support for placing the Site on the federal National Priorities List (NPL). USEPA proposed the Site for inclusion on the NPL on March 4, 2010, and the Site was subsequently added to the NPL on March 10, 2011.

1.2. PROJECT SCOPE AND PURPOSE

This RI/FS Work Plan presents the activities proposed to complete the Remedial Investigation (RI) and perform a Feasibility Study (FS) for the Landfill and Groundwater components of the Site. Additional information (*i.e.,* treatability testing) may also be needed to complete the FS. However, in accordance with the RI/FS SOW, the need for any treatability testing will be decided during the FS.

As described in the RI/FS SOW, the Site consists of the following four components:

- Landfill (LF) - Defined as the Dewey Loeffel Landfill proper, including contaminated soils associated with prior landfill operations and leachate and any other areas where contaminants may have migrated, but not including the Groundwater, Southern Drainageway and Western Drainageway, as defined below.
- Groundwater (GW) - Defined as the groundwater contamination at the Site and any other areas where contaminants may have migrated, but not including the Landfill, Southern Drainageway and Western Drainageway.
- Southern Drainageway (SD) - Defined as the Southern Drainage Ditch, Valley Stream, Smith Pond, and any other areas where contaminants may have migrated, but not including the Groundwater, Landfill and Western Drainageway.
- Western Drainageway (WD) - Defined as the Northwestern Drainage Ditch, former Mead Road Pond, Tributary T11A, Valatie Kill, Nassau Lake, and any other area where contaminants have migrated, but not including the Landfill, Groundwater and Southern Drainageway.

The RI/FS SOW outlines requirements to investigate the nature and extent of contamination for the Landfill and Groundwater components of the Site. The Southern and Western Drainageway components of the Site are being addressed through a separate Administrative Settlement Agreement and Order on Consent for Remedial Investigation and Feasibility Study for the Surface Drainageways (*i.e.*, a separate RI/FS is being performed for the Drainageways component of the Site under a different Settlement Agreement).

This RI/FS Work Plan contains eleven sections. Section 1 presents a discussion of background information for the Site. Section 2 presents the proposed RI activities. Sections 3 through 5 present a discussion of laboratory analyses and data validation, access requirements and permit requirements. Section 6 provides a summary of and reference to the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP), which is separate from but associated with this RI/FS Work Plan. Section 7 provides a summary of and reference to the Health and Safety Plan (HASP), which is also separate from but associated with this RI/FS Work Plan. Section 8 presents the process for conducting a Baseline Risk Assessment, including a Baseline Human Health Risk Assessment (BHHRA) and a Screening Level Ecological Risk Assessment (SLERA); per the RI/FS SOW, a Baseline Ecological Risk Assessment (BERA) will only be performed for the Landfill and/or Groundwater components of the Site if determined to be necessary based on the SLERA. Section 9 provides a summary of the Feasibility Study activities, excluding any treatability testing that USEPA may determine to be necessary. Section 10 presents a summary of planned reporting activities, Section 11 presents the project schedule and references are provided in Section 12.

As required by the RI/FS SOW, a Phase IA Archeological Sensitivity Assessment, conducted in accordance with the *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections* (New York Archaeological Council, 1994) has been completed. This work was performed by Hartgen Archeological Associates, Inc. (Hartgen) under subcontract to O'Brien & Gere, and the associated report is included as Exhibit A.

1.3. BACKGROUND INFORMATION

This section presents background information for the Site, including Site history, Site setting, the Site geology and hydrogeology, ongoing response actions, and the Settlement Agreement and RI/FS SOW.

1.3.1. Site Description

The Dewey Loeffel Landfill proper is located approximately three and a half miles northeast of the village of Nassau in Rensselaer County, New York. It is located in a low-lying area between two large hills, bounded to the north by Mead Road and surrounded to the south, west, and east by undeveloped forested land (Figure 1-1). The Landfill occupies approximately 19.6 acres on the south side of Mead Road. The area in the vicinity of the Landfill is predominantly rural residential with scattered homes along Mead Road and Central Nassau Road. A bowhunters club lodge is also located on Central Nassau Road south of the Landfill.

The topography generally slopes from east to west with higher elevations present on the eastern side of the Landfill and lower elevations present south-southwest of the Landfill near the intersection of Central Nassau and Curtis Hill Roads and to the west along Nassau Averill Park Road.

1.3.2. Site History

From approximately 1952 to 1968, a waste handling facility was operated by Richard Loeffel (until his death in 1959), his son Dewey Loeffel, and companies owned by the Loeffels, including, but not limited to, Loeffel's Waste Oil and Removal Service Company, Inc., and Marcar Oil, Inc. (hereinafter referred to as the "Loeffel Companies"). The facility was used to manage liquid wastes. Prior to 1952, the property was a natural area that included a swampy area of approximately four to six acres.

During facility operations, liquid waste materials containing a variety of contaminants were reportedly transported to the property in 55-gallon drums. The contents of reusable drums were dumped either into an oil pit or into the eastern portion of the former swampy area (hereinafter referred to as the "lagoon"), which later became the upper lagoon. Unusable drums were dumped either along the perimeter of the lagoon or in a drum disposal area and were later covered with soil. The oil pit was used to store and/or separate recyclable oily wastes. The non-recyclable liquid waste materials were pumped into the eastern portion of the lagoon or onto the ground surface.

As shown on Figure 1-2, the facilities operated by the Loeffel Companies at the disposal site included (C. T. Male & Associates [C.T. Male], 1970; O'Brien & Gere, 1981):

- An approximate four to six -acre lagoon (later divided into an approximate one-acre lagoon, referred to as the lower lagoon and an approximate five-acre lagoon referred to as the upper lagoon) located in the western and central portion of the facility;
- An approximate 25-foot by 150-foot by 6-foot deep oil pit located in the southeastern portion of the facility;
- Four 30,000 gallon aboveground oil tanks and a storage shed located in the northeastern portion of the facility; and

- A drum disposal area located adjacent to the oil pit in the eastern portion of the facility.

NYSDEC estimated that approximately 46,320 tons of industrial and/or hazardous waste were transported to and disposed of at the Site by the Loeffel Companies. The waste included chlorinated solvents, non-chlorinated solvents, waste oils, polychlorinated biphenyls (PCBs), acids, bases, and scrap materials including resins, paint solids and liquids, sludge, phenols, xylol residue and various other wastes (O'Brien & Gere, 1981; Blasland, Bouck & Lee, Inc. [BBL], 1992; NYSDEC, 1980, 1981). The disposal of these liquid wastes represents the primary and only known source of contamination at the Site.

In 1966, the State of New York initiated legal action against the Loeffel Waste Oil Removal and Service Company, Inc., which led to a 1968 Order and Judgment by the New York State Supreme Court against the company to cease discharges from the facility and to perform remedial activities. In response to the Order and Judgment, the company subsequently filled in the lagoon and covered and graded the drum disposal area and oil pit. A system of drainage ditches was also constructed around the facility to control surface water from flowing onto the facility from surrounding areas. These remedial actions were reportedly completed by 1974. Subsequent to these remedial actions, the facility was reportedly used as a transfer station for waste oils, utilizing the four 30,000-gallon above-ground storage tanks, until about 1980 (BBL, 1992).

Since 1979, investigations and remedial activities have been conducted at the Dewey Loeffel Landfill by NYSDEC, the New York State Department of Health (NYSDOH), GE and their respective consultants/contractors. On September 23, 1980, GE and NYSDEC entered into a consent order which required GE to perform field investigations to assess the environmental conditions at the Dewey Loeffel Landfill. Following these field investigations, GE submitted an Engineering Report (O'Brien & Gere, 1981) which included the data collected, identified remedial alternatives, and recommended a remedial alternative. The Engineering Report recommended, and NYSDEC approved, an in-place containment remedy consisting of installation of a soil-bentonite cutoff wall around the facility, construction of a low-permeability cap over the area enclosed by the cutoff wall, and a landfill leachate collection system below the cap within the cutoff wall, and construction of surface drainage swales on the cap.

The remedy was constructed by NYSDEC from September 1983 to November 1984 using funding obtained from GE, Schenectady International, Inc. (now SI Group) and Bendix Corporation (now part of Honeywell International, Inc.). Regularly scheduled post-closure maintenance, monitoring and site inspections began in the Fall of 1985 after the construction of the containment system was completed.

Beginning in 1983, NYSDEC and GE performed numerous response actions at the Site, some of which were performed in accordance with Records of Decision (RODs) issued by NYSDEC in January 2001 and January 2002. Response actions conducted at the Site included the following:

- Periodic residential well monitoring;
- Periodic collection and removal of leachate from the leachate collection system located in the western portion of the containment system;
- Installation and operations of a groundwater extraction system consisting of three bedrock extraction wells located south of the containment system;
- Evaluation of the cutoff wall;
- Installation, operation, maintenance and monitoring of point of use (POU) treatment systems for five residential wells, located on four properties, to remove volatile organic compounds (VOCs);
- Completion of a soil vapor intrusion assessment at two residential properties with residential POU treatment systems; and
- Routine groundwater monitoring at overburden and bedrock monitoring wells.

As described in Section 1.1 the Site was added to the NPL on March 10, 2011. USEPA prepared a plan for an Initial Supplemental Site Investigation (ISSI) in April 2011, immediately following the Site's listing on the NPL. The scope of the ISSI included the following:

- Surface geophysical surveys (magnetic and electromagnetic terrain conductivity) at the containment system to assess the presence and location of residual subsurface metallic debris (*e.g.*, drum fragments);
- Soil borings at twenty locations on the cap of the containment system with soil sampling and geotechnical analyses to evaluate the physical characteristics (*e.g.*, type of material, thickness) and condition of the cap; and
- Drilling and testing of five additional deep bedrock boreholes to the south of the containment system to gather additional geologic and hydrogeologic information and further define the extent of the bedrock VOC plume.

An estimated 3,200 pounds of VOCs[1] have been removed from within the containment system using the leachate collection system. Leachate has been removed every year since 1991, with the exception of 1994, and transported off-site for proper treatment/disposal; the leachate removed from the system is now being treated on-site in the new leachate and groundwater treatment system that was constructed in 2013.

Recent investigation activities, as described in Appendix F and G of the *Design Report/Implementation Plan* (DR/IP) submitted by Respondents to USEPA pursuant to the Administrative Settlement Agreement and Order on Consent for a Removal Action (Index No. CERCLA-02-2012-2005) (Removal Order), have included the installation of the five additional extraction wells closer to the Landfill and additional testing conducted in the five open deep bedrock boreholes (*i.e.,* EPA-1, EPA-2, EPA-3, EPA-4 and EPA-5) installed by USEPA during its ISSI. Investigation activities associated with the installation and operation of the five additional extraction wells closer to the Landfill included the performance of rock coring, borehole geophysics (including vertical flow meter testing under ambient and pumping conditions), and packer testing (for both hydraulic and groundwater quality data). In addition, bedrock samples were collected at some of the new extraction well locations for laboratory analysis of various chemical and physical parameters, and detailed hydraulic conductivity profiling has been performed at two locations. The data associated with these activities were compiled and presented in the Appendix F Summary Report submitted to USEPA on June 22, 2015.

Investigation activities associated with the additional testing conducted in the five open bedrock boreholes previously installed by USEPA have been completed. Specifically, groundwater samples have been collected from multiple depth intervals using passive diffusion bag (PDB) samplers set within each of the five boreholes. The purpose of this sampling was to evaluate groundwater quality below the deepest interval that was packer tested previously and to compare these results to the results of the borehole flow meter and packer testing performed by USEPA. In addition, water-level monitoring of packer isolated intervals in open deep bedrock boreholes EPA-1, EPA-2, EPA-3 and EPA-4 and concurrent water-level monitoring in select monitoring wells at the Site were performed to evaluate hydraulic head relationships both vertically and horizontally in the western portion of the bedrock plume. Discrete groundwater samples were also collected for laboratory analysis of VOCs and 1,4-dioxane in open deep bedrock boreholes EPA-4 and EPA-5 to confirm the results of the groundwater samples collected from multiple intervals using PDBs in these boreholes. Additionally, detailed hydraulic conductivity profiling was performed in each of the five open deep bedrock boreholes. These data were compiled and presented in the Appendix G Summary Report submitted to USEPA on February 27, 2015.

1.3.3. Site Geology and Hydrogeology

Site Geology

The Site is located in the Hudson River Valley portion of the northern Appalachian physiographic province. The geology of the area is characterized by unconsolidated glacial deposits underlain by shale, argillite and graywacke bedrock. The unconsolidated deposits at the Site generally consists of glacial till which is described

[1] The historic analytical results for and volumes of leachate removed from the leachate collection tank (LCT) were used to estimate the mass of VOCs removed from the Dewey Loeffel Landfill. The estimated mass removed through time reported herein is for the nine dominant VOCs detected in the leachate samples, including BTEX compounds (*i.e.*, benzene, toluene, ethylbenzene and m&p-xylenes) and chlorinated volatile organic compounds (CVOCs) (*i.e.*, TCE, cis-1,2-DCE, vinyl chloride) and chlorobenzene. Due to the relatively low concentrations of the remaining VOCs detected in samples from the LCT, they have been omitted from the mass removal evaluation.

as a dry to moist, grayish-red to reddish-brown, very dense heterogeneous mixture of sand, silt, clay, gravel, cobbles and boulders. A few sand and gravel lenses are reportedly present within the till in some locations. The sand and gravel deposits consist of moist to wet, green to brown, fine to medium sand and coarse gravel with some boulders and were generally observed north and northwest of the Landfill along Mead Road.

At the Landfill, the native materials are overlain by fill materials, including Loeffels' filling of the lagoons and the subsequently constructed cap which consists of compacted locally-derived low-permeability till and loam. The overburden thickness in the vicinity of the Landfill ranges from approximately 2.5 feet to 106 feet. The overburden is thinnest east of the Landfill and increases in thickness to the west and to the south (Figures 1-3 and 1-4).

The bedrock underlying the Site consists of the Lower Cambrian Nassau Formation, which is comprised primarily of shale with interbedded graywackes and argillite. Similar to the overburden thickness, the bedrock surface varies across the Site. The highest bedrock surface elevations occur east and northeast of the Landfill, where two bedrock outcrops have been observed (Figure 1-3). The Bedrock surface becomes deeper to the south and west of the Landfill. A topographic low in the bedrock surface occurs along Central Nassau Road between borehole EPA-2 and residential well 191-05-21B.

Bedrock in the region has been folded, faulted and fractured as a result of the Taconic Orogeny. Evidence of thrust faulting was noted by GeoTrans, Inc. (GeoTrans) in rock cores and seismic reflection data which suggest the eastern portion of the Site near the Landfill consists of relatively unfractured bedrock thrust over more highly fractured rock (GeoTrans, 1996). In the area west of the Landfill, the bedrock appears to be highly folded and faulted with extensive fracturing. The folding and faulting created a multitude of fractures, some of which now serve as channels for the movement of groundwater.

Fracture trace analyses were performed in 1992 and 2012 using aerial photographs, topographic maps and outcrop measurements (Blasland & Bouck Engineers, 1993; USEPA, 2012). Results indicate that the dominant trend of the linear features is northwest-southeast; a few northeast-southwest linear features were also identified. One lineament was noted south of the Landfill along the Southeast Drainage Ditch. This orientation is consistent with the surface water drainage in this portion of the Site.

Site Hydrogeology

A conceptual model of the hydrogeologic system at the Landfill and in the area of the VOC groundwater plume has been developed based on information obtained during various investigations performed at the Site. The conceptual hydrogeologic system at the Landfill is shown in Figure 1-3 and the conceptual hydrogeologic system for the area south of the Landfill is shown in Figure 1-4. The conceptual model of the hydrogeologic system at the Landfill includes two hydrogeologic units: the overburden materials, and the bedrock unit.

The natural hydrogeology in the vicinity of the Landfill was altered by the construction of the containment system. The Landfill consists of three distinct features: the cap, the cutoff wall, and overburden materials within the containment system which consist of fill and glacial deposits. The cap was designed and constructed in a manner to reduce infiltration into the containment system, including the placement of a low permeability cap and construction of drainage swales to direct surface water runoff off and away from the Landfill. Because the local borrow sources met the specifications for the cap material, those sources were used for general fill/grading and the designed cap, resulting in a thickness of cap material much greater than specified in the actual design. The cutoff wall was constructed around the facility to reduce the lateral inflow of groundwater from upgradient and reduce the lateral migration of contaminated groundwater downgradient from the Landfill. The cutoff wall was reportedly constructed to the shale bedrock surface but was not keyed into the bedrock. The reported permeability of the cut-off wall ranged from 7.8×10^{-9} to 3.15×10^{-7} cm/sec with an overall arithmetic average of 9.51×10^{-8} cm/sec, which met the design permeability of 1×10^{-7} cm/sec for the soil-bentonite wall.

Due to the low permeability of the overburden materials and the Landfill cap, most of the precipitation at and in the vicinity of the Landfill ends up as overland surface water flow which is directed towards drainage ditches and adjacent topographic low areas. Horizontal groundwater flow in the overburden is quite slow due to the low permeability of this unit, and is directed laterally toward very local discharge zones. Within the containment system, overburden groundwater flow in the Landfill is generally directed westward, toward the leachate collection system. Over most of the Landfill, there is also a downward component of flow from the overburden hydrogeologic unit into the underlying bedrock hydrogeologic unit owing to the downward hydraulic gradient. However, an upward component of groundwater flow exists in the northeastern portion of the Landfill, where there is an upward hydraulic gradient.

Outside of the Landfill, overburden groundwater flow is directed laterally towards streams and wetland areas. However, given the generally shallow water table, a portion of the overburden groundwater is also seasonally removed by evapotranspiration. There is also a downward component of flow from the overburden hydrogeologic unit into the underlying bedrock hydrogeologic unit owing to the downward hydraulic gradient, which is locally augmented by the effects of pumping in the bedrock unit (via groundwater extraction wells and, farther away from the Landfill, by residential supply wells). For all of these reasons, horizontal groundwater flow within the overburden unit is quite limited, especially within the containment system, and the extent of contaminants in the overburden groundwater is limited to within the Landfill and a few, relatively small, localized areas immediately adjacent to the Landfill.

The bedrock hydrogeologic unit at the Site has historically been divided into shallow bedrock and deep bedrock. The shallow bedrock hydrogeologic unit consists of the more weathered portion of the Nassau Formation and comprises the upper 100 feet of the bedrock. This uppermost portion occasionally includes clay from the in-place weathering of the bedrock. The deep bedrock hydrogeologic unit includes the more competent portion of the Nassau Formation. While there appears to be no geologic basis to distinguish between the shallow and deep bedrock units, there may be hydraulic differences.

Groundwater within the bedrock is transmitted within secondary porosity features such as bedding plane partings and fractures. Very little flow of groundwater is expected to occur in the primary porosity (*i.e.,* in the matrix between the partings/fractures). In the deeper portions of the bedrock hydrogeologic unit, hydraulically active secondary porosity features are less common indicating low groundwater flow conditions at depth. Heat pulse vertical flow meter data generated during the DR/IP Appendix F investigations and USEPA's ISSI, indicates very little flow in the deeper portions of the new extraction wells or the boreholes installed by USEPA, respectively, owing to the low hydraulic conductivity of the bedrock and/or little vertical variation in hydraulic head.

The potentiometric surface for the bedrock generally occurs in the overlying overburden hydrogeologic unit, and the bedrock appears to act as a confined or semi-confined aquifer. Recharge to the bedrock unit is diffuse via leakage from the overlying overburden hydrogeologic unit where hydraulic gradients are downward. Where upward hydraulic gradients exist, such as in the eastern part of the Landfill, bedrock groundwater discharges to the overburden. This is also expected to occur in the southern part of the bedrock VOC plume, near Valley Stream, which is expected to be a primary groundwater discharge zone. Groundwater flow within the bedrock south of the Landfill is also influenced by groundwater pumping from extraction wells EW-1, EW-2 and EW-3, and to a lesser extent by residential water supply wells.

In the vicinity of the Landfill, the potentiometric surface in the bedrock unit slopes from east to west indicating that groundwater flow, under isotropic conditions, would flow to the west. In the area west of the Landfill, the potentiometric surface in the bedrock unit is believed to slope eastward, and thus groundwater flow would, under isotropic conditions, flow to the east. This results in a southward-sloping trough in the bedrock potentiometric surface south of the Landfill and flow towards Central Nassau Road (Figure 1-5). Fracturing and faulting in the bedrock is also believed to create anisotropic conditions, where groundwater can flow at angles oblique to the direction under isotropic conditions. As discussed above, the dominant trend of fracture traces is northwest-southeast. Based on the distribution of VOCs in the bedrock groundwater south of the Landfill, anisotropic conditions are also believed to influence the direction of bedrock groundwater flow and contaminant migration.

1.3.4. Groundwater Use

Property owners located in the vicinity of the Site currently obtain water from residential wells. As summarized in the RI/FS Work Plan, the SCSR, and Appendix J of the DR/IP, the residential well monitoring program currently performed by Respondents is an expanded version of the program that was initiated in November

1979 by the Rensselaer County Department of Health (RCDOH), then continued and expanded by NYSDOH and, beginning in 1998 under a work plan approved by the NYSDEC, continued and expanded by GE.

Currently the monitoring program consists of 22 residential wells that do not have POU treatment systems plus five residential wells (located on four properties) with POU treatment systems for a total of 27 wells. The residential wells without POU treatment systems consist of the 20 wells that were included in the monitoring program implemented by GE before preparation of the DR/IP, plus two additional residential wells that were installed at new residences in 2012 and 2014 (one near the intersection of Curtis Hill and Central Nassau Roads, and the other near the eastern end of Mead Road). Bottled water is also being provided to the residences with POU treatment systems and to residences without POU treatment systems that are being sampled semi-annually.

1.3.5. Conceptual Site Model

A preliminary conceptual site model (CSM) which integrates the conceptual hydrogeologic system and chemistry results for the Landfill and Groundwater components of the Site has been developed. The CSM was developed to understand the contaminants of concern, affected media, contaminant source, contaminant fate and transport, and exposure pathways that could potentially impact human receptors and any ecological receptors.

Nature and Extent of Contamination

During facility operations, liquid waste materials containing a variety of contaminants were reportedly transported to the property in 55-gallon drums. The disposal of these liquid wastes represents the primary and only known source of contamination at the Site. The wastes reportedly included chlorinated solvents, non-chlorinated solvents, waste oils, PCBs, acids, bases, and scrap materials including resins, paint solids and liquids, sludge, phenols, and xylol residue.

The oil pit and lagoons were subsequently filled in, and the containment system was constructed in the early 1980s. The containment system consists of a soil-bentonite slurry (*i.e.,* cutoff) wall around the perimeter of the facility and extending down to bedrock, an overlying low permeability cap, and a leachate collection system. The containment system was constructed to physically isolate the waste materials and reduce contaminant migration.

Prior to the Loeffels' operations, the area where the Landfill is now located was a low lying swampy area between two hills in the area of a surface water drainage divide. Some of the liquid waste material from Loeffels' operations drained to the northwest, into Tributary T11A (a 1900-feet long ravine) and then into the Valatie Kill. A component of the surface water flow drained to the southeast, into a broad, low wet trough that slopes downward to the south, crosses under Central Nassau Road and then joins Valley Stream. The Southern Drainageway and Western Drainageway components of the Site are being addressed through a separate Settlement Agreement between USEPA and GE.

Some of the liquid wastes placed at the facility during Loeffels' operations seeped downward into the overburden materials. Light non-aqueous phase liquid (LNAPL) (or weathered LNAPL) still exists within the containment system, as evidenced by field observations during monitoring activities at wells DB-1S through DB-5S located near the center of the containment system. Based on the nature of the wastes and Loeffels' operations, dense non-aqueous phase liquid (DNAPL) may also be present in the overburden materials at some locations within the containment system, although no direct observations have been made to support this.

The extent of contaminants in the overburden groundwater is limited to within the containment system and two, relatively small, localized areas immediately adjacent to the northern and southwestern edges of the containment system. Characterization of the horizontal and vertical extent of contamination within the containment system, including the potential presence of "hot spots" with higher concentrations of contaminants in the overburden groundwater and the potential presence of areas/depths within the containment system with much lower concentrations is incomplete and represents a data gap in the CSM. These data are necessary to evaluate natural attenuation processes within the containment system and potential enhancements to the existing remedial action.

Specific contaminants detected in soil, groundwater and/or leachate within the containment system include the most commonly detected VOCs at the Site (*i.e.,* BTEX constituents [including benzene, toluene, ethlybenzene, m&p-xylenes and o-xylene], chlorinated volatile organic compounds [CVOCs] including trichloroethene [TCE], cis-1,2-dichloroethene [cis-1,2-DCE] and vinyl chloride), chlorobenzene, phenolic compounds, PCBs, and 1,4-dioxane.

Contaminants in the wastes also adsorbed to the overburden materials and dissolved into overburden groundwater. Due to a downward hydraulic gradient from the overburden to the underlying bedrock, contaminants also migrated downward in the overburden groundwater to the bedrock, where the existing data demonstrate flow within the fractures and/or faults is to the south (Figure 1-6).

Construction of the containment system in 1983 and 1984 has significantly reduced the potential for off-site transport of contaminants via the surface water migration pathway. The low-permeability cap reduces infiltration into the Landfill, and thus reduces the production of impacted leachate and overburden groundwater. The cut-off wall around the facility reduces the lateral inflow to the containment system from upgradient areas (*i.e.,* to the northeast and east) and also the lateral outflow from the containment system to downgradient areas (*i.e.,* to the west, southwest and south). The primary route of migration of contaminants from the containment system is downward, via groundwater flow from the overburden materials into the bedrock (but not in the eastern and northeastern third of the containment system where an upward hydraulic gradient exists). Previous investigations to evaluate the cutoff wall have been conducted; however, further evaluation is needed to gain a better understanding of the hydraulic connection between the inside and outside of the cutoff wall.

Inside the containment system, the biotic degradation of certain VOCs (*e.g.*, BTEX, acetone) and perhaps oily wastes have changed the geochemical conditions, which are now anaerobic and reducing. Many of the contaminants in the containment system are degraded biologically and abiotically via several different pathways. Due to the depletion of oxygen in the containment system, anaerobic biotic processes are probably dominant (GE Global Research Center, 1997). However, abiotic degradation processes are probably also occurring. Further, there may be areas within the containment system that are not anaerobic and reducing, and different biotic processes may be occurring in these areas.

Based on the *Assessment of Natural Attenuation at the Loeffel Site and Environs Report* (GE Global Research Center, 1997), high levels of methane and alkalinity coincident with the presence of BTEX indicate that these compounds are undergoing substantial anaerobic oxidation. High levels of ethane, ethene, and chloride relative to the levels of TCE and its daughter products suggest that reductive dehalogenation of chlorinated aliphatics is also a significant degradation process in the containment system, fueled primarily by the biodegradation of the BTEX compounds (via cometabolism). There is strong evidence that some of the TCE is being completely dehalogenated to ethane/ethene in the Landfill. The net effect of these and other natural attenuation processes is to reduce the mass and change the relative proportions and distribution of the VOCs potentially migrating from the Landfill. The natural attenuation processes occurring within the containment system will be further characterized during the RI.

Contaminants detected in bedrock groundwater include the nine most commonly detected VOCs at the Site (*i.e.,* BTEX compounds [including benzene, toluene, ethlybenzene, m&p-xylenes and o-xylene], CVOCs [TCE, cis-1,2-DCE and vinyl chloride] and chlorobenzene), phenolic compounds, and (as detected most recently) 1,4-dioxane; PCBs are not migrating from the Landfill in groundwater. Figure 1-6 shows the distribution of VOCs detected in bedrock wells at the Site. Contaminant migration in the bedrock is primarily with groundwater in the secondary porosity features, such as fractures, faults and bedding planes, and is directed south-southwestward and southward from the Landfill. The shallow bedrock plume extends in a southerly direction approximately 500 feet from the Landfill and is approximately 1,000 feet wide. The deep bedrock plume extends approximately 3,000 feet in a north-south direction (to the area of Central Nassau Road) and is approximately 800 feet wide in an east-west direction. Semi-volatile organic compounds (SVOCs [specifically, phenolic compounds]) in the bedrock groundwater are confined to the area between the southern limits of the Landfill and extraction well EW-1, probably due to the higher retardation of these compounds. VOC concentrations decrease by more than three orders of magnitude from the area south of the Landfill to the residential wells located near Central Nassau Road, suggesting that substantial attenuation occurs downgradient from the Landfill due to one or more natural processes (Figure 1-6). Further characterization of the natural attenuation of VOCs in the bedrock groundwater, and the extent of groundwater impacts in the bedrock to the west of deep bedrock borehole EPA-3 and at the suspected toe of the bedrock VOC plume near Valley Stream, will be performed during the RI.

In addition to natural attenuation processes, contaminant mass has also been removed from the bedrock hydrogeologic unit through operation of the three extraction wells (EW-1, EW-2 and EW-3) south of the Landfill. An estimated 1,500 pounds of VOCs have been removed since operation of the groundwater extraction system began in early 2008[2]. While the extraction wells were installed with the intent of removing contaminant mass from the centerline of the bedrock VOC plume (to augment natural attenuation), increasing VOC concentrations in some monitoring wells in the vicinity of the extraction wells suggest the possibility that more contaminant migration from the Landfill toward the extraction wells may have been induced by the pumping, although the effects appear to have been short lived. The installation and operation of the five additional extraction wells closer to the Landfill should minimize the potential for contaminants to be pulled a significant distance from the Landfill toward extraction wells EW-2 and EW-1, and should set the stage for declines in contaminant concentrations in EW-2, similar to those observed in EW-1.

Potential Exposure Pathways

Potentially contaminated media resulting from the historical disposal of waste materials at the facility include soil[3], soil vapor, air, groundwater (overburden and bedrock) and surface water[4]. Ingestion and direct contact with soil are not expected to be significant contaminant exposure pathways for the Landfill due to construction of the low-permeability cap, which ranges from 6 to 16 feet thick. Contaminant concentrations in soils outside of the containment system west and southwest of the Landfill were either non-detected or very low. However, some additional characterization of soil both inside and outside of the containment system is needed. As described in Sections 2.4 and 2.5, respectively, a direct-sensing investigation and discrete-interval soil sampling and associated laboratory analysis will be performed to characterize subsurface soil both inside and outside of the containment system. Overall, it is estimated that a total of between 21 and 28 subsurface soil samples will be collected at 16 locations for laboratory analysis of VOCs. The actual number of subsurface soil samples collected and sampling depths will be determined based on the direct-sensing investigation. Additionally, as described in Section 2.5.4, surface soil sampling both within and outside of the Landfill will be performed. Subject to refinement in the *Memorandum on Exposure Scenarios and Assumptions*, it is estimated that 12 surface soil samples will be collected from within the Landfill, and nine surface soil samples will be collected outside of the Landfill. These surface soil samples will be submitted for laboratory analysis of Target Compound List (TCL)/Target Analyte List (TAL) constituents.

At the request of NYSDEC, the potential for soil vapor intrusion (SVI) was evaluated by GeoTrans at two of the four properties with impacted bedrock supply wells (and associated POU treatment systems); access was not obtained from the owner of the other two properties to perform the assessment. Because no Site-related VOCs were detected in any of the overburden groundwater samples from the two properties, GeoTrans concluded that there is no risk of vapor intrusion of Site-related VOCs into the structures at these two properties (refer to Section 2.1.6 for additional details regarding the assessment process used to evaluate potential risk from the vapor intrusion pathway).

An investigation of potential vapors (for Site-related VOCs) emanating from the Landfill was completed prior to the construction of the cap and reported in the Engineering Report submitted to and approved by NYSDEC (O'Brien & Gere, 1981). It was concluded that inhalation of vapors from the landfill is not expected to represent a

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[2] . The mass removed through time has been estimated and is reported herein for the nine primary VOCs detected in the groundwater samples, including BTEX compounds (*i.e.*, benzene, toluene, ethylbenzene, m&p-xylenes and o-xylene) and chlorinated VOCs (*i.e.*, TCE and its degradation products, cis-1,2-DCE and vinyl chloride) and chlorobenzene. Due to the relatively low concentrations of the remaining VOCs detected in groundwater, they have been omitted from the mass removal evaluation.

[3] Soil associated with the Drainageways component of the Site is being addressed under a separate Settlement Agreement specific to the Drainageways.

[4] Surface water associated with the Drainageways component of the Site is being addressed under a separate Settlement Agreement Specific to the Drainageways.

significant exposure pathway for potential human receptors based on this prior assessment and construction of the containment system by NYSDEC in 1983 and 1984. The vapor intrusion pathway will be discussed further in RAGS Part D Table 1, where a determination will be made whether the pathway will be evaluated quantitatively, qualitatively, or not at all.

Both overburden and bedrock groundwater represent contaminant migration pathways. Groundwater in overburden outside of the landfill flows laterally towards streams and wetland areas. Bedrock groundwater flows in a southerly direction towards Valley Stream, which is expected to be a primary groundwater discharge zone. The discharge potential of groundwater to surface water, and the overall groundwater and surface water interaction at Valley Stream, is not adequately characterized and represents a data gap in the CSM. Surface water and sediment associated with the Drainageways component of the Site are being addressed under a separate Settlement Agreement specific to the Drainageways. Potential exposure pathways for groundwater include ingestion and direct contact in the absence of treatment systems. Current groundwater use by property owners located in the vicinity of the Site is discussed in Section 1.3.4. The human ingestion exposure pathway for bedrock groundwater has thus far been eliminated by the operation, maintenance and monitoring of POU treatment systems installed at residential properties with supply wells impacted by Site-related VOCs, the provision of bottled water to those and several other nearby properties, and the routine monitoring of other residential supply wells. Exposure scenarios and exposure assumptions will be discussed in the *Memorandum on Exposure Scenarios and Assumptions*.

2. REMEDIAL INVESTIGATION

In accordance with the requirements of the RI/FS SOW, this section details the proposed activities to further investigate the nature and extent of contamination for the Landfill and Groundwater components of the Site; however, it is recognized that data collected during the activities discussed herein may demonstrate that some additional investigation work is warranted, and in that event a phased approach is necessary. The areas where further investigation is proposed are shown on Figure 2-1 and are identified in Section 2.1; the investigation activities specific to each area are then detailed in subsequent sections.

2.1. IDENTIFICATION OF REMEDIAL INVESTIGATION AREAS

As presented in the revised Site Characterization Summary Report (SCSR) (O'Brien & Gere, 2014) and discussed with USEPA, data gaps requiring additional investigation were identified with respect to the nature and extent of contamination associated with the Landfill and Groundwater components of the Site. The data gaps and the recommendations presented in the SCSR for further evaluation were identified and developed as part of a review of the data generated during the historical investigative and remedial activities performed at the Site, as well as the data from more recent investigation and remedial activities performed under the Removal Order. The data gaps identified in the SCSR were based on the compilation, review and evaluation of the data available at the time of the preparation of the SCSR, in addition to the data collected under the Removal Order including the routine sampling of extraction wells EW-1 through EW-3 and LCT, and the DR/IP Appendix F, Appendix G and Appendix J activities, and are focused on the following areas:

- Bedrock groundwater to overburden groundwater to surface water pathway in the vicinity of Valley Stream;
- Overburden groundwater to surface water pathway southeast of the Landfill (in the vicinity of the Southern Drainage Ditch) and northwest of the Landfill (in the vicinity of the Northwest Drainage Ditch, former Mead Road Pond and upper portion of Tributary T11A);
- Overburden soil and groundwater inside and immediately adjacent to the Landfill;
- Overburden groundwater north of the Landfill in the vicinity of well location GMW-11;
- Overburden groundwater southwest of the Landfill;
- Bedrock groundwater in the central and western portions of the bedrock VOC plume; and
- Vapor intrusion.

In addition, an assessment of the Landfill perimeter and cut-off wall integrity is proposed.

The areas for further investigation are briefly described below.

2.1.1. Bedrock Groundwater/Overburden Groundwater/Surface Water Interaction

An evaluation of the bedrock groundwater to overburden groundwater to surface water pathway in the vicinity of Valley Stream at the suspected toe of the bedrock VOC plume will be performed to confirm the connection between the bedrock groundwater, overburden groundwater and surface water at Valley Stream (the expected groundwater discharge zone), and estimate the approximate width of the plume in this area of the Site. This area is shown on Figure 2-2, and is identified as "Groundwater/Surface Water Interaction Evaluation." To perform the evaluation, the installation of overburden and shallow bedrock monitoring wells and surface water staff gages at and in the vicinity of Valley Stream is proposed. The collection of monthly synoptic groundwater and surface water elevation measurements at the new and select existing wells and the new staff gages is proposed for a one-year period to collect information from which hydraulic gradients can be calculated. These data will be supplemented with near-continuous hydraulic monitoring using pressure transducers and associated data loggers. Groundwater elevation data would be used to evaluate the hydraulic interaction between groundwater and Valley Stream, including hydraulic gradients and groundwater discharge potential to Valley Stream.

2.1.2. Overburden Groundwater/Surface Water Interaction

Additional evaluation of the overburden groundwater to surface water pathway southeast of the Landfill (in the vicinity of the Southern Drainage Ditch), northwest of the Landfill (in the vicinity of the Northwest Drainage Ditch, former Mead Road Pond and upper portion of Tributary T11A), and the three ponds located on Property 191-05-21 will be performed. These areas are shown on Figure 2-2. The data generated as part of the RI activities will be used to help evaluate whether overburden groundwater discharges to surface water in these areas of the Site.

2.1.3. Overburden Soil and Groundwater Inside and Immediately Adjacent to the Landfill

The remedy selected and constructed by NYSDEC in the early 1980s for the Landfill consisted of a soil-bentonite cut-off wall (often referred to as a "slurry wall") around the facility and an overlying low-permeability cap. Additional investigation will be performed at the Landfill to: identify the horizontal and vertical extent of contamination within the containment system, including the potential presence of "hot spots" with higher concentrations of contaminants in the overburden groundwater and the potential presence of areas/depths within the containment system with much lower concentrations; evaluate natural attenuation processes within the containment system; refine the understanding of the hydraulic relationship between the overburden and bedrock units at the Landfill; evaluate the effectiveness of the cut-off wall; and, refine the existing water budget for the containment system. These objectives will be achieved using a multidisciplinary approach, including the use of direct-sensing investigative methods, confirmatory and supplemental discrete-interval soil and groundwater sampling, the installation of overburden monitoring wells, groundwater sampling of new and select existing wells for analysis of groundwater quality and degradation-related parameters, and hydraulic testing/monitoring. These areas are shown on Figures 2-1 and 2-3, and are identified as "Overburden Soil and Groundwater Inside Landfill" and "Cut-Off Wall Evaluation/Landfill Perimeter Assessment."

2.1.4. Overburden Groundwater Outside of the Landfill

Further investigation will be performed in two areas located outside of, but adjacent to the containment system. These areas are shown on Figures 2-1 and 2-3, and identified as, "North Overburden Groundwater Evaluation," and "Southwest Overburden Groundwater Evaluation." As presented in the SCSR, within the area identified as the "North Overburden Groundwater Evaluation," dissolved phase contaminant concentrations are elevated in overburden monitoring well GMW-11, located outside of the cut-off wall on the north side of the Landfill, relative to nearby monitoring wells. Similarly, dissolved phase contaminant concentrations are elevated in overburden monitoring well OMW-211, located outside of the cut-off wall on the southwest side of the Landfill, relative to nearby monitoring wells.

2.1.5. Bedrock Groundwater Evaluation

Bedrock groundwater in the central and western portions of the bedrock VOC plume will be evaluated in the areas shown on Figure 2-1, identified as "Bedrock Groundwater Evaluation." As presented in the SCSR, the need for some additional delineation in these areas is suggested based on the results of packer isolated testing performed by USEPA during its ISSI, and the work performed in accordance with Appendix G of the DR/IP, namely the PDB samplers set within each of the five deep open bedrock boreholes and the results of packer isolated testing in deep open bedrock boreholes EPA-2 and EPA-3 (within the axis of the bedrock VOC plume and on the western side of the bedrock VOC plume, respectively). The bedrock groundwater evaluation will help refine the vertical and lateral extent of the VOCs in bedrock groundwater and evaluate the horizontal and vertical hydraulic gradients in these areas of the Site.

2.1.6. Vapor Intrusion

At the request of NYSDEC, the potential for vapor intrusion was evaluated by GeoTrans at two of the four properties with impacted bedrock supply wells (and associated POU treatment systems). Access was not obtained from the owner of the other two properties to perform the assessment. The assessment process used to evaluate potential risk from the vapor intrusion pathway consisted of the installation and groundwater sampling of overburden groundwater monitoring wells to determine if Site-related VOCs were present in shallow groundwater. In accordance with a NYSDEC-approved work plan, one overburden well (designated SVWG-1) was installed near the structure at Property 191-05-22.1 (aka Property A), and three overburden wells (designated SVWM-1 through SVWM-3) were installed near the structures at Property 191-05-21A (aka Property B). These water-table wells were sampled on two occasions and analyzed for VOCs. Because no Site-related VOCs were detected in any of the overburden groundwater samples from the two properties, GeoTrans concluded that there is no risk of vapor intrusion of Site-related VOCs into the structures at Properties A or B. If access is obtained from the property owner, the assessment described in the NYSDEC-approved work plan will also be completed at Property 192-01-3B (aka Property C) and Property 191-05-15 (aka Property D) as part of the RI. If access is obtained, and Site-related VOCs are detected as part of the vapor intrusion investigation at sufficient concentrations, then additional investigation activities may be warranted and will be evaluated in accordance with the November 10, 2009 *Soil Vapor Intrusion Evaluation Work Plan* prepared by GeoTrans.

2.2. GROUNDWATER/SURFACE WATER INTERACTION

As discussed in Section 2.1.1 above, the bedrock groundwater to overburden groundwater to surface water pathway in the vicinity of Valley Stream at the suspected toe of the bedrock VOC plume will be evaluated as part of the RI to confirm the connection between the bedrock groundwater, overburden groundwater and surface water at Valley Stream (the expected groundwater discharge zone), and estimate the approximate width of the plume in this area of the Site. In addition, as discussed in Section 2.1.2, an evaluation of the overburden groundwater to surface water pathway southeast of the Landfill (in the vicinity of the Southern Drainage Ditch), northwest of the Landfill (in the vicinity of the Northwest Drainage Ditch, former Mead Road Pond and upper portion of Tributary T11A), and the three ponds located on Property 191-05-21 will be performed.

Although the bedrock and overburden groundwater to surface water interactions are discussed separately in Section 2.1.1 and 2.1.2 above, the activities that will be performed to complete these evaluations are similar and will therefore be discussed together below.

The initial activities proposed as part of the groundwater to surface water interaction evaluation include the installation of staff gages and performance of surface water sampling. The scope of work is described in the following sections. Additional bedrock groundwater to surface water interaction activities, which include the installation of monitoring wells and hydraulic monitoring, are discussed in subsequent sections.

2.2.1. Staff Gage Installation

A total of three surface water staff gages will be installed in Valley Stream at the approximate locations shown on Figure 2-2. Each staff gage will be constructed of either a fiberglass, porcelain enameled iron or steel plating affixed to a stable structure (*e.g.*, steel post manually driven into the stream bed). The staff gages will include graduation marks to allow for measurements to the nearest hundredth of a foot. Periodic monitoring of the staff gages is discussed in Section 2.13.

2.2.2. Surface Water Sampling

A total of 19 surface water samples will be collected from the approximate sampling locations shown on Figure 2-2. As shown on Figure 2-2, three surface water samples will be collected from the Southern Drainage Ditch, eight surface water samples will be collected from Valley Stream, five surface water samples will be collected in the area northwest of the Landfill in the vicinity of the Northwest Drainage Ditch, former Mead Road Pond and upper portion of Tributary T11A, and three surface water samples will be collected from the ponds located on Property 191-05-21.

In advance of the surface water sampling activities, a reconnaissance of Valley Stream will be performed to identify locations where potential variations in water quality parameters suggest that groundwater discharge to Valley Stream may be occurring. Water quality parameters (temperature, pH, oxidation reduction potential [ORP], dissolved oxygen [DO], and specific conductivity) will be measured with a properly calibrated water quality meter. Surface water sampling locations along Valley Stream will be biased towards locations exhibiting variations in water quality parameters that suggest groundwater discharge. The water quality parameters will be recorded in a field log book in accordance with Standard Operating Procedure (SOP) 001 (Field Log Book Entries), which along with the other SOPs referenced herein, is provided in the Quality Assurance Project Plan (QAPP).

Surface water samples will be collected a minimum of six inches below the top of the water column, unless the total depth of the water column is less than six inches. If the depth of the water column is less than six inches, the sample will be collected such that the distance from the sampling depth to the surface of the water column is maximized. The collection of water at the immediate surface will be avoided. Based on prior observations of the water bodies where surface water samples will be collected, the water columns at these locations are generally less than 12 inches, with the exception of the ponds located on Property 191-05-21. Samples of the ponds will be collected near the outlets; the same sampling depth as the other surface water sampling locations (*i.e.*, minimum of six inches below the top of the water column) will be employed.

Surface water samples will be collected in accordance with SOP 002 (Surface Water Sampling Procedure) and sent via chain-of-custody to Eurofins Lancaster Laboratories Environmental, LLC (Eurofins Lancaster) for laboratory analysis of VOCs using USEPA SW-846 Method 8260C, and 1,4-dioxane using USEPA SW-846 Method 8270D. Quality assurance/quality control (QA/QC) samples will be collected in accordance with the QAPP at a frequency of one per 20 environmental samples. QA/QC samples include blind duplicate samples and matrix spike/matrix spike duplicate (MS/MSD) sample pairs and trip blanks. Trip blanks will be included with each sample cooler containing VOC samples. These data will be validated in accordance with the QAPP.

Surface water sample locations will be marked in the field using wooden stakes and survey flagging. The surface water sample locations will be surveyed by a Professional Land Surveyor for horizontal and vertical control, as discussed in Section 2.14, and incorporated into the existing Site base map. In addition, a preliminary set of horizontal coordinates will be obtained during the sampling event using a hand-held Global Positioning System (GPS) device capable of sub-meter accuracy. The depth of the water column at each sample location will also be measured using a measuring tape or fiberglass survey tape with a weighted bottom.

2.2.3. Pore Water Sampling

A total of six pore water samples will be collected from Valley Stream at the approximate locations shown on Figure 2-2. Pore water sampling locations along Valley Stream will be biased towards locations exhibiting variations in water quality parameters (see Section 2.2.2 above). Further, hydraulic head measurements will be collected to refine each sampling location using a device similar to the one described in United States Geological Survey (USGS) Fact Sheet 0077-00 (USGS, 2000) to qualitatively assess head differentials, if any, between the stream stage at Valley Stream and within the streambed at each pore water sampling location. Pore water sampling will be performed at areas where upwelling is suggested based on these measurements. If an upward hydraulic gradient does not occur at a proposed pore water sampling location, up to four additional head measurements on 15-foot centers (*i.e.*, two upstream and two downstream) will be performed near that proposed pore water sample location to identify if/where upwelling conditions exist. The pore water sampling will be performed at the first location where upwelling conditions are measured. If no appreciable head difference is discernible at any of the five locations where measurements are made, the pore water sampling will be performed at the initial proposed sampling location.

PDB samplers will be placed inside sections of 2-inch diameter schedule 40 polyvinyl chloride (PVC) well screen for protection and buried beneath streambed sediments by hand excavation to a depth of at least 12 inches. Each sampler will be covered with sediment and then large rocks to help prevent washout, and left in place for a minimum of 14 days to equilibrate. Alternatively, sections of protective PVC well screen containing the PDB samplers will be advanced either manually or mechanically at least 12 inches into the streambed sediments.

Pore water sample locations will be marked in the field using wooden stakes and survey flagging for future recovery. A preliminary set of horizontal coordinates will be obtained during installation of the PDBs using a hand-held GPS-device capable of sub-meter accuracy. In addition, the pore water sample locations will be surveyed by a licensed Professional Land Surveyor for horizontal and vertical control, as discussed in Section 2.14, and incorporated into the existing Site base map.

Following the equilibration period, the PDB samplers will be retrieved and used to fill pre-preserved 40 milliliter (mL) vials for VOC analysis in accordance with SOP 003 (Sampling Procedure using Passive Diffusion Bag Technique). The pore water samples will be sent via chain-of-custody to Eurofins Lancaster for laboratory analysis of VOCs using USEPA SW-846 Method 8260C. QA/QC samples will be collected at a frequency of one per 20 environmental samples. QA/QC samples include a blind duplicate sample, a MS/MSD sample pair and a trip blank. Trip blanks will be included with each sample cooler containing aqueous VOC samples. The laboratory data will be validated in accordance with the QAPP.

2.3. UTILITY MARK-OUT/SURFACE GEOPHYSICAL SURVEY

Prior to commencing subsurface work at the proposed drilling locations, DigSafe NY will be contacted by the drilling subcontractor to clear utilities in the vicinity of the drilling locations. A private utility mark-out utilizing surface geophysical techniques to locate underground utilities and structures may be performed at select proposed drilling locations located on private property if there is a concern that privately owned subsurface utilities/structures are proximal to a proposed drilling location. The actual drilling locations will be modified as necessary based on the utility mark-out. The purpose of the utility mark-out task is to protect the health and safety of the investigation team, and reduce the potential for damage to underground utilities/structures.

Prior to the completion of the Landfill Perimeter Assessment/Cut-off Wall Evaluation activities proposed herein, the location of the cut-off wall will be verified using ground-penetrating radar (GPR). The GPR survey will be performed in traverses across the expected cut-off wall alignment at approximately 50-foot intervals. The interpreted edges of the cut-off wall at each transect will be marked in the field using wooden stakes and survey flagging and surveyed with a GPS device. Additional GPR traverses may be performed at the proposed drilling locations to provide higher resolution to minimize the potential that drilling activities intersect the cut-off wall. Final surveying will be performed by a licensed Professional Land Surveyor for horizontal and vertical control, as described in Section 2.14.

In the event the GPR survey is inconclusive at any of the traverses, an electromagnetic (EM) terrain conductivity survey may be performed to identify and confirm the location of the cut-off wall as determined during the GPR survey. If necessary, the EM terrain conductivity survey will be performed using a Geonics EM-38 MK2 terrain conductivity meter along parallel profiles spaced approximately 10 feet apart and covering an approximate 200-foot swath over the presumed location of the cut-off wall. Measurement locations will be recorded using a GPS device.

The private utility mark-out, GPR survey and EM terrain conductivity survey (if performed) will be performed under the direction of O'Brien & Gere by Enviroscan, Inc. (Enviroscan) of Lancaster, Pennsylvania. The results of the geophysical survey(s) will be summarized by Enviroscan and presented in a report which will be included as an exhibit to the RI Report to be prepared as presented in Section 10.

2.4. DIRECT-SENSING INVESTIGATION

A direct-sensing survey will be performed to develop a 3-dimensional (3-D), semi-quantitative characterization of subsurface conditions in real time. Data generated as part of the direct-sensing investigation will be used to more optimally identify locations and depths for soil and groundwater sampling for various analyses. The proposed direct-sensing methods include the use of Geoprobe Systems® (Geoprobe) membrane interface probe (MIP) and integrated electrical conductivity (EC) sensor, hydraulic profiling tool (HPT), and optical screening tool (*e.g.*, fuel fluorescence detector [FFD], laser-induced fluorescence [LIF]) at targeted locations. The direct-sensing investigation will be designed to meet the following objectives:

- Identify the horizontal and vertical extent of areas impacted by VOCs and/or NAPL within the containment system;
- Identify subsurface zones not impacted by high concentrations of VOCs and/or NAPL (*i.e.*, relatively "clean" zones);
- At each survey location, provide a continuous log of the contaminant profile, lithology and estimated hydraulic conductivity of the subsurface materials; and
- Collect the data needed to develop a cost-effective overburden soil and groundwater sampling plan (*i.e.*, to determine optimal locations and depths for soil borings, monitoring wells and related sampling).

Each of the direct sensing methods are described below.

The MIP provides continuous semi-quantitative concentrations of VOCs in unconsolidated materials. At each location, the probe will be advanced from ground surface through the underlying overburden materials using direct push technology (DPT). A heater block on the probe increases the volatility of VOCs in the subsurface (both saturated and unsaturated), which diffuse across a semi-permeable membrane into an inert gas loop. The vapors are swept to equipment at the surface and analyzed in real time, generally by a flame ionization detector (FID), photoionization detector (PID), and halogen-specific detector (XSD). The detectors output responses in micro volts (µV). The FID and PID detect total VOCs with the PID more sensitive to aromatic compounds. The XSD detects only chlorinated hydrocarbons. Detection limits for typical MIP configurations are generally between 200 parts per billion (ppb) and 2 parts per million (ppm).

As part of the MIP system used during the direct sensing investigation at the Site, either the traditional trunkline or heated trunkline (HTL) will be utilized depending on the subsurface conditions encountered. Unlike traditional MIP setups where the MIP probe is the only portion of the system that is heated, Geoprobe's HTL will be used to heat the trunkline to approximately 100 degrees Centigrade (^{o}C) along its entire length. The heated trunkline moves the contaminant through the trunkline quicker than a traditional trunkline. This reduces the typical slurred baseline drop seen when dealing with high concentrations of contaminants.

An array of EC sensors is integrated into the MIP probe and provides a continuous log of soil conductivity with depth to identify variations in subsurface lithology. In general, EC response is inversely proportional to grain size; that is, high EC values generally correspond with small grain sizes (*e.g.*, silt and clay), and slow EC values generally correspond with coarse grain sizes (*e.g.*, sand and gravel). Mineralogy and pore water chemistry (brines, pH and contaminants) can also affect EC.

The HPT system continuously measures the pressure response of the formation to the constant injection of water as the probe is advanced through the subsurface, creating a detailed hydrostratigraphic log at each location. Injection pressure and flow rate are monitored and plotted with depth. In general, low pressure responses are indicative of higher subsurface permeability while high pressure responses indicate a lower permeability. Below the water table, dissipation tests can be performed to determine static water levels and used as inputs to calculate hydraulic conductivity estimates. HPT profiling will be performed at approximately 50 percent (%) of the locations profiled with MIP.

An optical screening tool (*e.g.*, FFD, LIF) allows enhanced in-situ detection of free and residual product for a wide range of product types containing aromatic hydrocarbons. In general, the optical screening tool emits monochromatic ultraviolet light through a protective sapphire window in the probe and excites aromatic hydrocarbons in the subsurface, causing them to fluoresce. This variable wavelength fluorescence is delivered as a signal to an optical detection system where it is quantified using a dual photomultiplier tubes (PMTs) to detect the different wavelengths. These responses can be used to generate real-time signal versus depth plots, and allows for differentiation of hydrocarbon fuel types.

The proposed direct-sensing investigation areas are shown on Figure 2-3, and include the "Overburden Soil and Groundwater Inside Landfill" area, the "Landfill Perimeter Assessment/Cut-off Wall Evaluation" area, and the "Overburden Groundwater Outside of the Landfill" areas (including both north and southwest of the Landfill). The details of the direct-sensing investigation are further described in Sections 2.4.1 and 2.4.2, below.

Upon completion, the direct-sensing borings will be tremie grouted and/or backfilled to grade using bentonite, which will be tamped into placed. Direct-sensing locations will be flagged in the field and surveyed with a GPS device. Additionally, the boring locations will be surveyed for horizontal and vertical control by a licensed Professional Land Surveyor, as described in Section 2.14. The management of investigation-derived materials (IDM) produced during the direct-sensing investigation activities is described in Section 2.15.

The direct-sensing investigation will be performed by S2C2, Inc. (S2C2) of Raritan, New Jersey, under the direction of O'Brien & Gere. The direct-sensing information obtained from each borehole will be digitally recorded. The results of the direct-sensing investigation will be summarized by S2C2 and presented in a report which will be included as an exhibit to the RI Report. Additionally, interpolation of the data generated as part of the direct-sensing investigation will be presented as 2-dimensional (2-D) and/or 3-D visualization of the results.

2.4.1. Overburden Soil and Groundwater Inside and Immediately Adjacent to the Landfill

Insufficient soil and groundwater characterization data exist for quantifying the horizontal and vertical distribution of contaminants within the Landfill. Initial field assessment of the overburden soil and groundwater inside of the Landfill will include the performance of five optical screening tool profile borings at locations biased towards areas with known or suspected NAPL (or weathered NAPL), specifically in the vicinity of wells DB-1S through DB-5S. Delineation of the subsurface within the Landfill impacted by NAPL (or weathered NAPL) will be attempted in advance of MIP/HPT activities to minimize MIP exposure to NAPL. Figures 2-1 and 2-3 show the area where the optical screening tool investigation within the containment system, identified as the "Overburden Soil and Groundwater Inside Landfill" area, will occur. At each location the optical screening tool will be advanced from the ground surface to the top of the bedrock interface, or refusal if shallower. Optical screening tool refusal will be considered obtained when the probe either stops advancing or slows to a push rate of less than one foot/minute, or DPT rig operator judgment. If significantly shallower than expected refusal is reached, up to two additional optical screening tool profiling attempts will be made per location to attempt to bypass the refusal surface. Pending the results of the initial optical screening tool profiling at the five locations, up to four additional contingency locations will be profiled with the optical screening tool if it is determined that further delineation within the Landfill is warranted.

Additional field assessment of the overburden soil and groundwater inside of the Landfill will include the performance of MIP/HPT profiling at the 20 locations previously evaluated during USEPA's cap evaluation (as part of its ISSI) resulting in a relatively uniform distribution across the cap. At each location the MIP/HPT probe will be advanced from the ground surface to the top of bedrock interface, or refusal if shallower. MIP/HPT refusal will be considered obtained when the probe either stops advancing or slows to a push rate of less than one foot/minute over an interval of a few inches. If shallower than expected refusal is reached, up to two additional profiling attempts will be made per location to attempt to bypass the refusal surface. Pending the results of the initial MIP/HPT profiling at the 20 locations, up to ten additional contingency locations may be profiled with the MIP if it is determined that further delineation within the Landfill is warranted.

At the completion of the MIP investigation, if additional areas of NAPL (or weathered NAPL) are suspected based on the MIP results outside of the area of initial optical screening tool investigation, additional optical screening tool profiling will be performed to confirm the results and delineate the NAPL (or weathered NAPL), if warranted.

2.4.1.1. Landfill Perimeter Assessment/Cut-Off Wall Evaluation

MIP/HPT profiling will be used to evaluate the integrity of the cut-off wall by logging 15 paired borings (one inside the cut-off wall and the others outside [three outside borings are paired with a single inside boring in the western end of the Landfill]) at locations along the perimeter of the cut-off wall, as shown in Figure 2-3 identified as "Cut-Off Wall Evaluation/Landfill Perimeter Assessment." Where feasible, MIP/HPT locations advanced to evaluate the interior of the Landfill (See Section 2.4.1) will be paired with MIP/HPT locations advanced outside of the cut-off wall. The data generated from the MIP will be used to determine optimal soil and groundwater sampling locations, and evaluate the distribution of contaminants along the interior and exterior portions of the cut-off wall. The data generated using the HPT will be used to compare groundwater elevations along the interior and exterior edge of the cut-off wall. The resulting data will be used in conjunction with the soil and groundwater quality data and the hydraulic monitoring data described in subsequent sections to evaluate the cut-off wall integrity.

2.4.2. Overburden Groundwater Outside of the Landfill

A direct-sensing investigation of overburden groundwater will be performed in two areas located adjacent to the containment system. As shown on Figure 2-3, these two areas are:

- North of the Landfill in the vicinity of well location GMW-11 to evaluate the nature and extent of VOCs in overburden groundwater (identified on Figure 2-3 as the "North Overburden Groundwater Evaluation" area); and,
- Southwest of the Landfill to evaluate the nature and extent of VOCs in overburden groundwater in the vicinity of monitoring well OMW-211 (identified on Figure 2-3 as the "Southwest Overburden Groundwater Evaluation" area).

2.4.2.1. North of Landfill

Dissolved phase contaminant concentrations are elevated in overburden monitoring well GMW-11, located outside of the cut-off wall on the north side of the Landfill (see the area identified on Figure 2-3 as "North Overburden Groundwater Evaluation"), relative to nearby monitoring wells. Direct sensing techniques, specifically MIP and HPT, will be used to further evaluate overburden groundwater quality in the vicinity of GMW-11. Additionally, HPT will be used to evaluate the presence and extent of the purported sand/gravel zone in this area of the Site. MIP/HPT profiling will be performed at three locations as shown on Figure 2-3. At each location the MIP/HPT probe will be advanced from ground surface to the top of the bedrock interface, or refusal if shallower. MIP/HPT refusal will be considered obtained when the probe either stops advancing or slows to a push rate of less than one foot/minute over an interval of a few inches. If shallower than expected refusal is reached, up to two additional profiling attempts will be made per location to attempt to bypass the refusal surface. Pending the results of the initial MIP/HPT profiling at the three proposed locations, up to three additional contingency locations will be profiled with the MIP/HPT if it is determined that further delineation within the "North Overburden Groundwater Evaluation" area is warranted.

2.4.2.2. Southwest of Landfill

Dissolved phase contaminant concentrations are elevated in overburden monitoring well OMW-211, located outside of the cut-off wall on the southwest side of the Landfill (see the area identified on Figure 2-3 as "Southwest Overburden Groundwater Evaluation"), relative to nearby monitoring wells. Direct sensing techniques, specifically MIP and HPT, will be used to further evaluate overburden conditions in the vicinity of OMW-211. MIP will be used as a field screening method to evaluate VOC concentrations in this area. MIP/HPT profiling in this area will be performed at the five approximate locations shown on Figure 2-3. At each location the MIP/HPT probe will be advanced from the ground surface to the top of the bedrock interface, or refusal if shallower. MIP/HPT refusal will be considered obtained when the probe either stops advancing or slows to a push rate of less than one foot/minute over an interval of a few inches. If shallower than expected refusal is reached, up to two additional profiling attempts will be made per location to attempt to bypass the refusal surface. Pending the results of the initial MIP/HPT profiling at the five locations, up to three additional contingency locations may be profiled with the MIP/HPT if it is determined that further delineation within the "Southeast Overburden Groundwater Evaluation" area is warranted.

2.5. DISCRETE-INTERVAL SOIL SAMPLING

The MIP survey will be augmented with soil sampling for laboratory analysis at select locations to correlate and interpret MIP results, and to characterize soil conditions not amenable to MIP characterization. In general, soil samples will be collected at boring locations and depth intervals indicative of low, medium and high contaminant concentrations based on the MIP responses and results of field screening. To avoid collecting soil that may have been affected by the MIP investigation process, the borings will be advanced in close proximity to, but not through, the MIP borings. Additionally, soil borings will be completed in areas not believed to have been impacted by historical Site activities to characterize background soil conditions. Soil sampling will be performed at the locations described in Sections 2.5.1 and 2.5.2, which include the "Overburden Soil Inside the Landfill" evaluation area, the "Landfill Perimeter Assessment/Cut-off Wall Evaluation" area. Background soil sample collection and analysis are described in Section 2.5.3.

Continuous soil cores will be collected using a dual tube sampling system lined with an acetate sleeve advanced with a vehicle or track-mounted DPT unit. Continuous soil cores will be collected from ground surface to the top of bedrock or refusal, if shallower. If shallower than expected refusal is reached, up to two additional attempts will be made per location to attempt to bypass the refusal surface. Alternatively, continuous soil cores may be collected using an acetate lined Macro-core® sampler advanced within a hollow stem auger (HSA) if shallower than anticipated refusal occurs, or drilling conditions warrant the use of HSA.

Soil samples will be collected and classified in the field in accordance with SOP 004 (Soil Sampling Procedure) by an O'Brien & Gere geologist using the Modified Burmeister and Unified Classification Systems. In addition to logging the geologic descriptions, observations including soil texture, composition, color, consistency, moisture content, recovery, and the observance of noticeable odors or stains will be recorded on the boring log by the on-site geologist. Portions of the split-barrel samples will also be collected for headspace analysis screening using a hand-held PID. Additional NAPL screening techniques will be performed on soil cores collected from inside of the Landfill as described in Section 2.5.1 below. Soil samples will be collected for laboratory analysis as described in Sections 2.5.1 through 2.5.3. For the soil sampling program, QA/QC samples will be collected in accordance with the QAPP at a frequency of one per 20 environmental samples. QA/QC samples include blind duplicate samples and MS/MSD sample pairs. The laboratory data will be validated in accordance with the QAPP.

Upon completion, soil borings will be tremie grouted and/or backfilled to grade using granular bentonite, which will be tamped into placed. Soil boring locations will be marked in the field using wooden stakes and survey flagging and surveyed for horizontal and vertical control by a licensed Professional Land Surveyor as described in Section 2.14. The management of IDM produced during soil boring activities is described in Section 2.15.

The soil borings will be advanced by S2C2 under the direction of O'Brien & Gere. A sub-set of the soil sampling laboratory results will be provided to S2C2 and incorporated into the direct-sensing report discussed in Section 2.4, if appropriate. Interpolation of the data generated as part of the soil sampling program will be presented as 2-D and/or 3-D visualization of the results to supplement the direct-sensing results.

2.5.1. Overburden Soil Inside the Landfill

Four continuously sampled soil borings will be advanced within the containment system from ground surface to the top of bedrock, or refusal (if shallower). The actual boring locations inside of the containment system will be determined based on the results of the MIP investigation. The soil cores will be classified and screened as described in Section 2.5 above. In addition, NAPL field screening will be performed in accordance with SOP 005 (NAPL Field Screening Procedure), and will include an examination of the ultraviolet fluorescence of the soil samples and the use of a hydrophobic dye soil-water shake test.

Soil samples will be collected for laboratory analysis at depths based on the field screening performed during the soil boring program, or based upon MIP results in the absence of visual impacts, PID instrument response, or NAPL screening response. An attempt will be made to collect at least one soil sample at the top of the bedrock interface, if drilling conditions permit.

Soil samples will be collected for laboratory analysis as follows:

- One to two samples will be collected from each of the four soil borings (total of between four and eight soil samples) and analyzed for VOCs using USEPA SW-846 Method 8260C;
- One sample will be collected from each of the four soil borings (total of four soil samples) and submitted for TCL/TAL analyses (including 1,4-dioxane using USEPA SW-846 Method 8270D);
- One sample will be collected from each of the four soil borings (total of four soil samples) and analyzed for physical property parameters including vertical permeability (Kv) and dry bulk density (a Shelby Tube sampler will be used to collect relatively undisturbed soil samples as necessary); and,

- One sample will be collected from each of the four soil borings (total of four soil samples) and analyzed for total organic carbon (TOC).

With the exception of the soil samples collected for physical property parameters, soil samples will be collected in accordance with SOP 004 (Soil Sampling Procedure) and sent via chain-of-custody to Eurofins Lancaster for laboratory analysis. Soil samples collected for analyses of physical properties parameters will be sent via chain-of-custody to PTS Laboratories, Inc. (PTS) in Santa Fe Springs, California.

2.5.2. Landfill Perimeter Assessment/Cut-Off Wall Evaluation

Three continuously sampled soil borings will be advanced at locations adjacent to, but outside the cut-off wall from ground surface to the top of bedrock, or refusal (if shallower). The actual boring locations will be determined based on the results of the MIP investigation; two of the borings will be advanced between the cut-off wall and the "North Overburden Groundwater Evaluation" area and the "Southwest Overburden Groundwater Evaluation" area (refer to Figure 2-3). The soil cores will be classified and screened as described in Section 2.5. The data generated from the soil sampling will be used to evaluate the distribution of contaminants along the interior and exterior portions of the cut-off wall.

Soil samples will be collected for laboratory analysis at depths based on the field screening performed during the soil boring program, or based upon MIP results in the absence of visual impacts, or PID instrument response. At least one unconsolidated soil sample will attempt to be collected at the suspected top of bedrock surface.

Soil samples will be collected for laboratory analysis as follows:

- Two to three samples will be collected from each of the three soil borings (total of between six and nine soil samples) and analyzed for VOCs using USEPA SW-846 Method 8260C;
- One sample will be collected from two of the three soil borings (total of two soil samples) and analyzed for TCL/ TAL (including 1,4-dioxane using USEPA SW-846 Method 8270D);
- One sample will be collected from two of the three soil borings (total of two soil samples) and analyzed for physical property parameters including Kv and dry bulk density (a Shelby Tube sampler will be used to collect relatively undisturbed soil samples as necessary); and,
- One sample will be collected from two of the three soil borings (total of two soil samples) and analyzed for TOC.

With the exception of the soil samples collected for physical property parameters, soil samples will be collected in accordance with SOP 004 (Soil Sampling Procedure) and sent via chain-of-custody to Eurofins Lancaster for laboratory analysis. Soil samples collected for analyses of physical properties parameters will be sent via chain-of-custody to PTS.

2.5.3. Background Evaluation

To assess background soil conditions (*i.e.*, characterize native soil not believed to be impacted by historical Site activities), five soil samples will be collected from up to three continuously sampled soil borings. Each soil boring will be advanced from ground surface to approximately 15 feet below grade, or refusal (if shallower). The soil cores will be classified and screened as described in Section 2.5.

Soil samples will be collected for laboratory analysis at depths based on the field screening results. Each of the five soil samples will be analyzed for TCL/ TAL (including 1,4-dioxane using USEPA SW-846 Method 8270D) and TOC.

Soil samples will be collected in accordance with SOP 004 (Soil Sampling Procedure) and sent via chain-of-custody to Eurofins Lancaster for laboratory analysis.

2.5.4. Other Soil and Surface Water Sampling

Surface soil and water samples will be collected in the vicinity of the Landfill and evaluated in the Human Health Risk Assessment (HHRA). Subject to refinement in the *Memorandum on Exposure Scenarios and Assumptions*, it is estimated that a total of 21 surface soil samples and two surface water samples will be collected as part of this evaluation. Twelve surface soil samples will be collected at the locations shown on Figure 2-4 within the Landfill.

Specifically, two surface soil samples will be collected from drainage swales; five surface soil samples will be collected from ridges between drainage swales; one surface soil sample will be collected at each of the southwestern, northern and eastern sides of the Landfill (outside of the cut-off wall); and one soil sample will be collected at each of the northwestern and southern drainage ditches below the surface of the water corresponding with the surface water sampling locations. Each of the surface soil samples will be collected from 0-6 inches below grade in accordance with SOP 004 and analyzed for TCL/TAL (including 1,4-dioxane using USEPA SW-846 Method 8270D).

One surface water sample will be collected at each of the northwestern and southern drainage ditches within the Landfill shown on Figure 2. Surface water samples will be collected a minimum of six inches below the top of the water column, unless the total depth of the water column is less than six inches. If the depth of the water column is less than six inches, the sample will be collected such that the distance from the sampling depth to the surface of the water column is maximized. The collection of water at the immediate surface will be avoided. Surface water samples will be collected in accordance with SOP 002 and analyzed for TCL/TAL (total and dissolved) constituents (including 1,4-dioxane using USEPA SW-846 method 8270D).

Nine surface soil samples will be collected outside of the Landfill at the locations shown on Figure 2-5. Specifically, three surface soil samples will be collected from Property 191-05-15 located north of the Landfill; two surface soil samples will be collected from Property 191-05-16.2 located southwest of the Landfill; and four surface soil samples will be collected from Property 191-05-16.1 (two samples each east of the Landfill and west of the Landfill). Each of the surface soil samples collected outside of the Landfill will be collected from 0-12 inches below grade in accordance with SOP 004 and analyzed for TCL/TAL (including 1,4-dioxane using USEPA SW-846 Method 8270D).

2.6. DISCRETE-INTERVAL GROUNDWATER SAMPLING

The MIP survey will be augmented with overburden groundwater sampling for laboratory analysis at select locations to correlate and interpret MIP results, and to characterize groundwater conditions not amenable to MIP characterization. In general, groundwater samples will be collected in areas and various depth intervals that are indicative of low, medium and high contaminant concentrations based on the MIP responses. To avoid collecting groundwater that may have been affected by the MIP/HPT investigation process, the groundwater borings will be advanced in close proximity to, but not through, the MIP borings. Groundwater sampling will be performed at the locations described in Sections 2.6.1, 2.6.2 and 2.6.3, which include the “Overburden Soil Inside the Landfill” evaluation area, the “Landfill Perimeter Assessment/Cut-off Wall Evaluation” area, the “Overburden Groundwater Outside of the Landfill” evaluation areas (including both north and southwest of the Landfill).

Discrete-interval groundwater samples will be collected using a dual tube groundwater sampling system equipped with either a disposable small-diameter slotted PVC screen or properly decontaminated slotted stainless steel screen (*i.e.*, sealed-screen sampling system) advanced with a vehicle or track-mounted DPT unit. At the desired depth, the outer drilling rods will be retracted to expose the small-diameter screen to the groundwater. If shallower than expected refusal is reached, up to two additional attempts will be made per location to attempt to bypass the refusal surface.

The discrete-interval groundwater sampling method will depend on the type of laboratory analysis that will be performed, and may include one or a combination of the following: narrow-diameter stainless steel bailer; disposable polyethylene tubing equipped with a check valve at the bottom of the tubing; a peristaltic pump; and/or a bladder pump. Groundwater samples will be collected for laboratory analysis as described in Sections 2.6.1 through 2.6.4. For the discrete-interval groundwater sampling program, QA/QC samples will be collected in accordance with the QAPP at a frequency of one per 20 environmental samples. QA/QC samples include blind duplicate samples, MS/MSD sample pairs and trip blanks. Trip blanks will be included with each sample cooler containing aqueous VOC samples. The laboratory data will be validated in accordance with the QAPP.

Upon completion, groundwater borings will be tremie grouted and/or backfilled to grade using granular bentonite, which will be tamped into placed. Groundwater boring locations will be marked in the field using wooden stakes and survey flagging and will be surveyed for horizontal and vertical control by a licensed Professional Land Surveyor, as described in Section 2.14. The management of IDM produced during the discrete-interval groundwater sampling activities is described in Section 2.15.

The groundwater borings will be advanced by S2C2 under the direction of O'Brien & Gere. A sub-set of the discrete-interval groundwater sampling laboratory results will be provided to S2C2 and incorporated the direct-sensing report discussed in Section 2.4, if appropriate. Interpolation of the data generated as part of the discrete-interval groundwater sampling program will be presented as 2-D and/or 3-D visualization of the results to supplement the direct-sensing results.

2.6.1. Overburden Groundwater Inside the Landfill

A total of 16 discrete-interval groundwater samples will be collected from four groundwater borings advanced within the containment system (four samples per location). The actual groundwater boring locations will be determined based on the results of the MIP investigation.

Discrete-interval groundwater samples will be collected for laboratory analysis at depths based on the results of the MIP investigation. An attempt will be made to collect at least one groundwater sample at the top of bedrock, if drilling conditions permit. The groundwater samples will be collected as described above in Section 2.6 and sent via chain-of-custody to Eurofins Lancaster for analysis of VOCs using USEPA SW-846 Method 8260C and 1,4-dioxane using USEPA SW-846 Method 8270D.

In addition, up to three samples of NAPL (or weathered NAPL) will be collected and sent via chain-of-custody to Eurofins Lancaster for analysis of the following: VOCs using USEPA SW-846 Method 8260C; SVOCs (including 1,4-dioxane) using USEPA SW-846 Method 8270D; PCBs using USEPA SW-846 Method 8082; and Hydrocarbon Fingerprinting using USEPA SW-846 8015C. Samples of the NAPL (or weathered NAPL) will also be sent via chain-of-custody to PTS for analysis of the following physical parameters: viscosity using ASTM Method D-445; fluid density using ASTM Method D-1481; and interfacial tension using ASTM Method D-971.

2.6.2. Landfill Perimeter Assessment/Cut-Off Wall Evaluation

A total of 24 discrete-interval groundwater samples will be collected from six groundwater borings advanced at locations adjacent to, but outside the cut-off wall (four samples per location). The actual groundwater boring locations will be determined based on the results of the MIP investigation; however, at least three of the groundwater borings will be advanced in the western end of the Landfill.

Discrete-interval groundwater samples will be collected for laboratory analysis at depths based on the results of the MIP investigation. An attempt will be made to collect at least one groundwater sample at the top of bedrock, if drilling conditions permit. The groundwater samples will be collected as described above in Section 2.6 and sent via chain-of-custody to Eurofins Lancaster for analysis of VOCs using USEPA SW-846 Method 8260C and 1,4-dioxane using USEPA SW-846 Method 8270D.

2.6.3. Overburden Groundwater Outside of the Landfill

2.6.3.1. North of Landfill

A total of four discrete-interval groundwater samples will be collected from one groundwater boring advanced at the "North Overburden Groundwater Evaluation" area shown on Figures 2-1 and 2-3. The actual groundwater boring location will be determined based on the results of the MIP investigation.

Discrete-interval groundwater samples will be collected for laboratory analysis at depths based on the results of the MIP investigation. An attempt will be made to collect at least one groundwater sample at the top of bedrock, if drilling conditions permit. The groundwater samples will be collected as described above in Section 2.6 and sent via chain-of-custody to Eurofins Lancaster for analysis of VOCs using USEPA SW-846 Method 8260C and 1,4-dioxane using USEPA SW-846 Method 8270D.

2.6.3.2. Southwest of Landfill

A total of eight discrete-interval groundwater samples will be collected from two groundwater borings advanced at the "Southwest Overburden Groundwater Evaluation" area shown on Figures 2-1 and 2-3 (four samples per location). The actual groundwater boring locations will be determined based on the results of the MIP investigation.

Discrete-interval groundwater samples will be collected for laboratory analysis at depths based on the results of the MIP investigation. An attempt will be made to collect at least one groundwater sample at the top of bedrock, if drilling conditions permit. The groundwater samples will be collected as described above in Section 2.6 and sent via chain-of-custody to Eurofins Lancaster for analysis of VOCs using USEPA SW-846 Method 8260C and 1,4-dioxane using USEPA SW-846 Method 8270D.

2.7. CHARACTERIZATION OF BEDROCK CONDITIONS

As presented in the SCSR, the installation of bedrock monitoring wells south of the Landfill is recommended, specifically in the center axis and on the western flank of the bedrock VOC plume, as shown on Figure 2-1 and identified as the “Bedrock Groundwater Evaluation” areas. The need for some additional delineation in these areas is suggested based on the results of packer isolated testing performed by USEPA during its ISSI, and the work performed in accordance with Appendix G of the DR/IP, namely the PDB samplers set within each of the five deep open bedrock boreholes and the results of packer isolated testing in deep open bedrock boreholes EPA-2 and EPA-3 (within the axis of the bedrock VOC plume and on the western side of the bedrock VOC plume, respectively). The addition of three bedrock monitoring wells is recommended in these two areas to refine the vertical and lateral extent of VOCs in bedrock groundwater.

At each new bedrock borehole location, the hydrogeologic conditions in the bedrock will be characterized using a multidisciplinary approach, including the use of rock coring, borehole geophysics (including vertical flow meter testing under ambient and pumping conditions), and packer testing (for both hydraulic and water quality data). In addition, bedrock samples are proposed to be collected at some of the new bedrock boreholes for laboratory analysis of various chemical and physical parameters, and additional detailed hydraulic conductivity profiling will also be performed. Following completion of the hydrogeologic investigation activities, each borehole will be converted into a discrete interval permanent monitoring well based on the data collected. These activities are presented in the following sections.

2.7.1. Borehole Advancement Methods

As indicated previously, three deep bedrock boreholes will be advanced in the areas shown on Figure 2-1 and identified as “Bedrock Groundwater Evaluation” to further refine the vertical and lateral extent of VOCs in bedrock groundwater.

At each bedrock drilling location, the overburden unit will be isolated using steel casing prior to further advancing the borehole into competent bedrock. Overburden drilling will be accomplished utilizing one or more drilling methods including: sonic; HSA; and/or rotary techniques. Once bedrock is encountered, the borehole will be advanced approximately 3 feet into competent bedrock.

The overburden unit will be sealed off by grouting a 4-inch inside diameter (ID) steel casing into the rock socket prior to bedrock drilling. A cement-bentonite grout will be tremied into the lower portion of the borehole and the casing will be lowered into the borehole to the top of bedrock and tapped into place with a mallet or light weight. The remainder of the annulus will be grouted to ground surface and some, but not all, of the grout inside the casing will be pumped out and the remaining grout will be allowed to set overnight before further bedrock drilling is initiated. The grout material will consist of Type I Portland cement mixed with either a powdered or granular bentonite. The grout will be prepared in accordance with ASTM International (ASTM) Method D5092, such that approximately 3 to 5 pounds of bentonite will be mixed with 6½ to 7 gallons of water per 94-pound sack of cement.

After the grout cures, the borehole will be advanced to its terminal depth using a nominal 4-inch (HQ3) outside diameter diamond core bit. Continuous bedrock cores will be collected in 5-foot intervals from the base of the isolation casing to a depth of 350 feet below grade at each of the three locations. Clean water will be used to cool the diamond core bit and circulate bedrock cuttings to ground surface during the bedrock coring process. Clean water, obtained from a local water provider, such as Scaccia, Inc. or from the Town of Schodack’s water supply system, will be used for all rock coring activities.

Following extraction of the rock core from the borehole, each core section will be described by an O'Brien & Gere geologist in a manner consistent with SOP 006 (Bedrock Core Logging and Sample Preparation Method), which is provided in the QAPP. The core description will be recorded on a core log along with related depth, and will include identification of visible fractures, percent recovery and rock quality designation (RQD) information. As described in Section 2.7.2 below, bedrock core subsamples will be obtained from two of the boreholes located along the center axis of the VOC plume for laboratory analysis of VOCs (identified on Figure 2-1). The rock core from each core hole will be placed in labeled core boxes for storage at the Site. Rock core will be stored on pallets at the Landfill at a location near the pole barn. Alternatively, the rock core may be stored at a location inside the security fence associated with the treatment building.

The management of IDM produced during bedrock drilling activities is described in Section 2.15.

2.7.2. Analysis of Bedrock Chemical Properties

Bedrock core subsamples will be collected during the drilling program at the two boreholes located along the axis of the VOC plume for laboratory analysis of VOCs in the rock matrix. Bedrock core subsamples will be collected both adjacent to major fractures[5] and in the rock matrix between the major fractures for laboratory analysis of VOCs by EPA SW-846 Method 8260C. Sample locations within the rock core will be based on the presence of fractures, lithology, weathering and evidence of fluid movement with a minimum sample spacing of one foot and an average sample frequency along the length of the borehole of one sample every two feet. Between 120 and 150 bedrock core subsamples will be collected from each of the two boreholes.

Rock core subsampling and sample processing (*i.e.*, crushing and sample preservation in methanol) will be performed by Stone Environmental, Inc. (Stone Environmental) under subcontract to O'Brien & Gere. Laboratory analysis of the rock core subsamples will also be performed by Stone Environmental at its National Environmental Laboratory Accreditation Program (NELAP) certified laboratory located in Montpelier, Vermont.

2.7.3. Analysis of Bedrock Physical Properties

Bedrock core samples will be collected in accordance with SOP 006 (Bedrock Core Logging and Sample Preparation Method) during the bedrock borehole drilling program for laboratory analysis of various physical properties of the bedrock at the Site. A total of six to 12 bedrock core samples (*i.e.*, two sets of between three and six samples) will be obtained for possible testing. The bedrock core samples obtained for laboratory analysis will be collected from various depth intervals at the two boreholes proposed in the axis of the VOC plume and will be representative of each of the predominant lithologic units (*i.e.*, argillite beds and greywacke beds).

Three to six bedrock core samples will be submitted to Golder Associates Ltd. (Golder) in Mississauga, Ontario to evaluate the bedrock matrix diffusion coefficient for chloride and the corresponding tortuosity factor. Specific gravity, hydraulic conductivity, rock density, TOC, and total porosity analyses will also be conducted.

Three to six additional bedrock core samples will be submitted to PTS for physical properties testing. These bedrock samples will be analyzed by mercury injection porosimetry for total porosity and pore throat distribution by ASTM Method D4404, and for TOC by the Walkley-Black method.

The results of the bedrock physical properties testing will be included as an appendix to the RI Report.

2.7.4. Borehole Development

Following the completion of the drilling activities, each bedrock borehole will be developed prior to performing the additional hydrogeologic investigation activities described in the following sections. The bedrock borehole will be developed to:

- Remove fine-grained particulates from the borehole walls and formation;
- Reduce the turbidity within the water column; and,

[5] For purposes of the RI, major fractures are defined as continuous open fractures with a ranking of 2 or greater based on the Paillet Ranking System developed by the United States Geological Survey (USGS), Water Resources Division, Borehole Geophysics Research Project.

- Enhance the hydraulic connection between each borehole and the surrounding formation.

Borehole development will be completed in accordance with SOP 007 (Borehole Development), which is provided in the QAPP. Development of each bedrock borehole will be performed by the drilling subcontractor and will be accomplished by mechanical surging using a surge block device and pumping utilizing an air lift method. Development shall continue until the development fluid is relatively clear and sediment free, as determined by the on-site geologist.

Non-disposable borehole development equipment will be decontaminated prior to and following use in each borehole. The management of IDM produced during the well development activities is described in Section 2.15.

2.7.5. Detailed Hydraulic Conductivity Profiling

To obtain a detailed profile of the variability of hydraulic conductivity with depth, Flexible Liner Underground Technologies, LLC (FLUTe™) will test each of the new deep bedrock boreholes using its Hydraulic Conductivity Profiler method. During this process, a blank liner is installed into the borehole while monitoring the rate of decent, or velocity, that the liner everts down the borehole. Those data are then used to prepare a detailed vertical profile of hydraulic conductivity in the borehole.

Completing hydraulic conductivity profiling along the full length of the borehole is contingent on the bedrock formation having adequate transmissivity so that the everting liner reaches the bottom of the borehole in a reasonable amount of time (*i.e.*, within ten hours of the start of the test). As the liner descends sealing the flow zones, it is not uncommon to have the liner descent rate decrease until the liner is moving so slowly that deeper flow paths will not be sealed in a reasonable time. The test will be stopped and considered completed when the descent rate of the everting liner is between approximately 0.004 and 0.005 feet per second or less.

2.7.6. Borehole Geophysical Logging

Each of the three new deep bedrock boreholes will be logged using a suite of downhole geophysical methods. Changes in borehole diameter, fluid characteristics, rock type and vertical flow (including direction [*i.e.*, upward or downward] and magnitude) will be used to assist with identifying potential water-transmitting fractures within the open borehole for subsequent packer testing (see Section 2.7.7 below).

The suite of geophysical methods performed at each borehole will include:

- Borehole caliper (borehole diameter);
- Fluid resistivity (conductivity);
- Fluid temperature;
- Normal resistivity;
- Natural gamma radioactivity (rock type);
- Heat pulse flow meter, under ambient and pumping conditions (the latter with the pump set at the base of the well casing, or the top of the water column if the static water level is below the casing);
- Borehole video;
- Optical televiewer; and,
- Acoustic televiewer (including subsequent processing to generate an acoustic caliper log).

Borehole geophysical logging will be conducted in accordance with SOP 008 (Borehole Logging Equipment and Methodology), which is provided in the QAPP. Borehole geophysical logging services will be provided by Enviroscan. The geophysical information obtained from each borehole will be digitally recorded. The results of the borehole geophysical logging will be summarized by Enviroscan and presented in a report which will be included as an exhibit to the RI Report.

2.7.7. Packer Testing

Packer testing will be performed for the potential water-transmitting fractures identified within the open section of each of the three bedrock boreholes. The packer testing will be scheduled to begin after completion of the borehole geophysical work to allow evaluation of the geophysical data and coordination for mobilization of the packer testing subcontractor. A downhole, dual-straddle, inflatable packer system will be utilized to perform this testing. The number of zones that will be tested during packer testing in each of the new deep bedrock boreholes will be different due to the expected varying length of the open section of each borehole. It is anticipated that the number of zone tested will be as follows:

- Up to 13 zones will be tested in the westernmost bedrock borehole located southwest of EPA-3;
- Up to 15 zones will be tested in the centrally located bedrock borehole near EPA-1; and
- Up to 17 zones will be tested in the southern bedrock borehole near Valley Stream.

Packer testing and groundwater sampling will be performed in accordance with SOP 009 (Groundwater Sampling Procedure using the Packer Technique), which is provided in the QAPP. In general, the packer sampling will be conducted using a wire-line straddle packer assembly fitted with an appropriate electric or gas-driven piston pump. The assembly will include dual-straddle, inflatable packers to isolate each test zone for sample collection. The pipe separating the upper and lower packers will have at least 3 feet of perforations above the bottom portion of packer assembly. The dual-straddle packers will be separated by no more than 10 feet, and the length of the packer interval will remain constant throughout the testing of each of the boreholes. The packers will be inflated with nitrogen to isolate the test interval. During pumping from within the packer assembly, water levels will be collected at one-minute intervals from within the test interval and also within the open borehole above the test interval using pressure transducers and associated data logger(s).

Water quality parameters (temperature, pH, ORP, DO, and specific conductivity) will be measured during purging of each packer interval using low-flow sampling techniques. An In-Situ® TROLL® 9500 (or equivalent) set up in a flow-through cell will be used to measure water quality parameters while purging the test interval prior to groundwater sample collection. The water quality parameters will be recorded in a field log book in accordance with SOP 001 (Field Log Book Entries).

Groundwater field indicator parameters will be monitored and recorded until stabilization within the interval is achieved. The interval will be considered stabilized when the parameters have stabilized for three consecutive readings as follows:

- ±0.1 Standard Units (SU) for pH;
- ±3% for specific conductivity;
- ±10 millivolts (mV) for ORP; and,
- ±10% for DO and turbidity.

Once stabilization has been achieved, a groundwater grab sample will be collected directly from the discharge tubing. In the event stabilization does not occur within 120 minutes, then the test interval will be purged to dryness for a minimum of one packer interval volume prior to groundwater sample collection. If a test interval does not recover sufficiently to collect a sample within 60 minutes, then no sample will be collected from that interval.

The collected groundwater samples will be sent via chain-of-custody to Eurofins Lancaster for laboratory analysis of VOCs using USEPA SW-846 Method 8260C and 1,4-dioxane using USEPA SW-846 Method 8270D. QA/QC samples will be collected in accordance with the QAPP at a frequency of one per 20 environmental samples. QA/QC samples include blind duplicate samples, MS/MSD sample pairs and trip blanks. Trip blanks will be included with each sample cooler containing VOC samples. The analytical results will be validated in accordance with the requirements provided in the QAPP.

Other SOPs provided in the QAPP that apply to the packer testing and associated sampling and analyses include:

- SOP 010 (Chain-of-Custody, Handling, Packing, and Shipping)

- SOP 011 (Field Equipment Decontamination)
- SOP 012 (Water Level Measurement)

2.7.8. Completion of Bedrock Boreholes into Multi-Level Monitoring Wells

Following completion of the hydrogeologic investigation activities, each of the three new deep bedrock boreholes are proposed to be converted to groundwater monitoring wells by installing a FLUTe™ multi-level monitoring device (*i.e.*, Water FLUTe™) in each borehole. The Water FLUTe™ system (Figure 2-6) is comprised primarily of a polyurethane coated nylon fabric outfitted with a permeable surround (*i.e.*, spacer) that defines a monitoring interval and appurtenant tubing and pumping hardware. Up to six monitoring intervals will be established at each new deep bedrock borehole; this represents the maximum number of ports that can be installed in a liner for a 4-inch diameter borehole. The actual number and depths of the sampling intervals will be determined based on the results of the hydrogeologic investigation activities. The final completion approach of each well will be presented to USEPA for approval prior to borehole completion. Use of FLUTe™ multi-level monitoring devices appears to be appropriate for this application because of the ability to monitor multiple zones in a single borehole while sealing the borehole in the non-monitored zones.

Pending USEPA approval, each FLUTe™ multi-level monitoring device will be fabricated off-site, specific to the borehole and monitoring intervals. The length of the liner for each device will be as long as the length of the borehole such that the end of the liner is supported by the bottom of the borehole. A similar process is used to install a Water FLUTe™ as is used to perform the transmissivity profiling. During the installation of each FLUTe™ multi-level monitoring device, clean water is inserted into the liner to evert the liner down the borehole. During the eversion process, the water from within the borehole is displaced into the bedrock (or pumped from beneath the liner using a pump tube emplaced in the borehole before installation) allowing the liner to descend down the borehole. The spacer, port, tubing, and pumping hardware are lowered to the bottom of the borehole as the liner descends to the bottom.

As shown on Figure 2-6, each monitoring device draws water from the formation through a spacer that defines the monitoring interval. During sampling, groundwater is drawn through the spacer and into a port in the liner that is fitted to a tube. The water flows via the tube to the bottom of the liner, and then back upward through the first of two Teflon™ ball check valves into a "U" shaped tube. The larger of the "U" shaped tubes, or pump tube, is utilized for collecting water-level measurements, and also for applying an inert gas pressure to push the sample water through the second Teflon™ ball check valve, and into the sample tube. Once in the sample tube, water can be purged for sample collection.

2.8. MONITORING WELL INSTALLATION

As discussed in Section 2.1, new overburden and bedrock monitoring wells will be installed in the vicinity of Valley Stream, the Landfill and near the western flank of the bedrock VOC plume. As shown on Figure 2-2, three overburden and shallow bedrock monitoring well pairs are proposed to be installed in the vicinity of Valley Stream as part of the bedrock groundwater/surface water interaction evaluation. In addition, one overburden monitoring well will be installed southwest of open deep bedrock borehole EPA-3, in conjunction with the new deep bedrock borehole at that location. As shown on Figure 2-7, and discussed in Section 2.8.1.1, up to 33 new overburden monitoring wells are proposed to be installed at 20 locations at the Landfill, and as discussed in Section 2.8.1.3, new shallow bedrock monitoring wells are proposed to be installed at four locations just outside the cut-off wall in the vicinity of the Landfill. In addition, to complete the vapor intrusion evaluation, new overburden monitoring wells are proposed to be installed at Property C and Property D, if access is granted by the property owner. The installation of these overburden and bedrock monitoring wells are detailed in the following sections.

2.8.1. Overburden Monitoring Wells

Under the oversight of an O'Brien & Gere geologist or hydrogeologist, overburden monitoring wells will be installed at several locations inside and immediately adjacent to the Landfill, in the vicinity of Valley Stream, near the western flank of the bedrock VOC plume and at residential Properties C and D. Overburden drilling and monitoring well installation activities will be accomplished utilizing one or more drilling methods including sonic, HSA, or DPT techniques. Soil samples/soil cores will be obtained from the deepest soil boring at each location and will be logged in accordance with the procedures presented in Section 2.5.

Typical construction of each overburden monitoring well will include a length of 2-inch ID schedule 40 PVC riser pipe connected to a length of 0.010 or 0.020-inch slot schedule 40 PVC well screen of between 10 and 20 feet in length. The base of each well will be equipped with threaded bottom plugs and the top of each well will be equipped with a vented cap. In addition, a designated measuring point will be notched into the top of the PVC riser pipe to provide a permanent reference point for subsequent total depth and depth to water measurements.

After setting the well, sand will be introduced into the annular space between the screen and the borehole adjacent to the screen. The sand pack will extend from the bottom of the boring to approximately two feet above the screen. The sand pack will consist of a clean, graded, silica sand with grain size distribution matched to the slot size of the screen. A Morie No. 1 or No. 2 or equivalent sand is deemed appropriate. A bentonite pellet seal will be placed above the sand pack to form a seal at least three feet thick. A cement-bentonite grout will extend from the top of the bentonite pellet seal to the ground surface. The grout material will consist of Type I Portland cement mixed with either a powdered or granular bentonite. The grout will be prepared in accordance with ASTM Method D5092, such that approximately 3 to 5 pounds of bentonite was mixed with 6½ to 7 gallons of water per 94-pound sack of cement. The grout will be introduced via a tremie pipe lowered to just above the top of the bentonite pellet seal. As the grout is pumped into the borehole, the tremie pipe will be removed in sections so that the grout is pumped into the borehole at a level below the top of the grout seal as it is emplaced.

Alternatively, if DPT methods are used to install the overburden monitoring wells, the wells may be constructed with a 2-inch diameter pre-packed (No. 1 or No. 2 size sand) well screen with an appropriate length of 2-inch diameter schedule 40 PVC riser pipe. The pre-packed wells will be constructed using 0.010-inch slotted schedule 40 PVC well screens between 10 and 20 feet in length.

Each new monitoring well will have a steel casing equipped with a locking cap placed over the monitoring well. The protective casing will extend at least two feet below ground surface and will be cemented in place. In some areas it may be necessary to complete the wells with flush-mounted, bolt-down steel manholes set within approximately 2-foot square protective concrete pads.

The installation of the overburden monitoring wells at select investigation areas is described in the following sections.

2.8.1.1. Inside and Immediately Adjacent to the Landfill

Permanent overburden monitoring wells will be installed at locations inside of the Landfill where it is likely that confirmatory groundwater samples are desired and to establish a monitoring well network for longer term monitoring and to allow for the collection of chemical and degradation-related samples. The new monitoring wells will also be used for hydraulic monitoring. Up to 33 overburden monitoring wells consisting of shallow (*i.e.*, intercepting the water table [but not screened more than two feet above the base of the engineered cap]), intermediate and deep (*i.e.*, just above the top of the weathered bedrock surface) depth intervals will be installed inside of the containment system depending on the thickness of the overburden materials at the selected locations. Based on the saturated overburden thickness at each well location the following well groups will be installed:

- Single well (for shallow depth intervals – saturated overburden thickness of 30 feet or less);
- Couplet well (shallow and deep depth intervals – saturated overburden thickness greater than 30 feet up to 50 feet); or
- Triplet (shallow, intermediate and deep depth intervals – saturated overburden thickness greater than 60 feet).

The conceptual well locations are shown on Figure 2-7. The results of the direct-sensing and discrete-interval soil and groundwater sampling will be used to guide the actual well installation locations. Based on the conceptual well locations and depth to bedrock, it is anticipated that up to 20 shallow, 11 intermediate, and 2 deep overburden monitoring wells will be installed inside and immediately adjacent to the Landfill.

If sonic drilling techniques are used to install the overburden monitoring wells, soil cores may be recovered as part of the monitoring well installation and will be screened for NAPL following the procedures presented in Section 2.5.1.

2.8.1.2. Western Flank of VOC Plume

A single, overburden monitoring well/piezometer will be installed in the vicinity of the deep bedrock borehole installed in the westernmost "Bedrock Groundwater Evaluation" area shown on Figure 2-1. The overburden monitoring well/piezometer will be installed for hydraulic monitoring purposes. The well will be installed as a "water table well", therefore, the depth of the well will be determined based on the depth at which groundwater is first encountered in the overburden at this location.

2.8.1.3. Bedrock Groundwater/Overburden Groundwater/Surface Water Interaction

A total of three new overburden monitoring wells will be installed at the approximate locations shown on Figures 2-1 and 2-2 in the area identified as "Groundwater/Surface Water Interaction Evaluation." These wells will be paired with the proposed shallow bedrock monitoring wells presented in Section 2.8.2. The installation of overburden groundwater monitoring wells will facilitate the collection of chemical and degradation-related groundwater samples and hydraulic monitoring in this area. The wells will be installed as "water table wells", therefore, the depths of the wells will be determined based on the depth at which groundwater is first encountered in the overburden at each location.

2.8.1.4. Vapor Intrusion

Pending access, the vapor intrusion assessment will be completed at the two properties (Property C and Property D) where the owner did not previously provide access. The vapor intrusion activities will be performed consistent with the previously performed assessment, as described in the NYSDEC-approved work plan (refer to Section 2.1.6 for additional details regarding the assessment process used to evaluate potential risk from the vapor intrusion pathway). A total of three overburden wells (one at Property D, two at Property C) will be installed, and constructed such that the screened portion of the wells intersect the water table within the unconsolidated deposits to allow the collection of groundwater samples from the uppermost portion of the saturated zone.

Groundwater samples will be collected from these three wells and submitted for laboratory analysis as described in Section 2.12.3. If Site-related VOCs are detected as part of the vapor intrusion investigation at sufficient concentrations, then additional investigation activities may be warranted and will be evaluated in accordance with the November 10, 2009 *Soil Vapor Intrusion Evaluation Work Plan* prepared by GeoTrans.

2.8.2. Shallow Bedrock Monitoring Wells

As discussed previously, shallow bedrock monitoring wells will be installed at four locations immediately adjacent to the Landfill and at three locations in the vicinity of Valley Stream. The new shallow bedrock wells located in the vicinity of Valley Stream will be paired with the new overburden monitoring wells discussed in Section 2.8.1.3 above. The location of the new shallow bedrock wells are shown conceptually on Figures 2-1 and 2-7.

Borehole advancement methods, including overburden drilling procedures, installation of overburden isolation casing and bedrock coring techniques will be performed as described in Section 2.7.1. Each shallow bedrock monitoring well will have 20 feet of well screen set from approximately 5 to 25 feet below the top of competent bedrock and will be installed using the procedures described in Section 2.8.1.

2.8.3. Monitoring Well Development

Following installation of the overburden and bedrock monitoring wells, each monitoring well will be developed to:

- Remove fine-grained particulates from the filter pack and formation;
- Reduce the turbidity within the water column; and,
- Enhance the hydraulic connection between each monitoring well and the surrounding formation.

Monitoring well development will be conducted in accordance with SOP 013 (Monitoring Well Development), which is provided in the QAPP. Each newly-constructed monitoring well will be developed as soon as practicable, but no sooner than 24 hours after installation. Non-dedicated, non-disposable equipment used in the development process will be decontaminated before and after each use in accordance with SOP 011 (Field Equipment Decontamination), which is provided in the QAPP.

The management of IDM groundwater and solids produced during the well development activities is further described in Section 2.15.

2.9. MONITORING WELL DECOMMISSIONING

As approved by USEPA on May 19, 2015, the three shallow overburden monitoring wells (designated SVWM-1 through SVWM-3) installed as part of the prior vapor intrusion assessment at Property 191-05-21 (Property B) were properly decommissioned on July 8 and 9, 2015. As approved by USEPA on June 22, 2015, the shallow overburden monitoring well (designated SVWG-1) installed as part of the prior vapor intrusion assessment at Property 191-05-22.1 (Property A) was properly decommissioned on July 8 and 9, 2015. These wells were no longer needed as part of the continued Site investigation and the owner of Property B had requested the wells be removed. The monitoring wells were decommissioned in accordance with Commissioner Polity CP-43 (*Groundwater Monitoring Well Decommissioning Policy)* (NYSDEC, November 2009). Specifically, the shallow overburden wells were decommissioned by grouting the well screen and riser pipe in-place. A cement-bentonite grout was introduced via a tremie pipe lowered to just above the bottom of the well. The well screen and riser pipe were filled with grout to a level of approximately 3 feet below grade and allowed to set for approximately 24 hours. A ferrous metal marker was embedded in the top of the grout to identify the location of each decommissioned well.

After the grout had been allowed to cure, an excavation was completed around each well to a depth of approximately 3 feet below ground surface. Excavated material was staged on plastic sheeting adjacent to each excavation. The riser pipe was cut at a depth of approximately 3 feet below ground surface and removed from the ground at each well. The excavation was then backfilled with the staged materials and the surface restored to its preexisting condition (*i.e.*, before decommissioning activities were initiated). The man-made materials removed from each well location (*e.g.*, riser pipe, concrete, steel protective casing and manway cover) were disposed off-Site as non-hazardous solid waste in a permitted landfill; steel material was recycled.

2.10. MONITORING WELL RECOMPLETION

A monitoring well inspection of 24 monitoring wells included in the *Ground Water Monitoring Plan* (GWMP) was performed on November 19 and 20, 2013 by a two-person O'Brien & Gere field team. The inspection was performed in accordance with the GWMP presented in Attachment B of the *Performance Monitoring Plan* (PMP) included as Appendix J of the DR/IP. The following observations were made during the monitoring well inspection:

- Based on a comparison of the measured total depths and as-built total depths, it is suspected that bedrock monitoring wells OMW-204 and OMW-214 have experienced formation collapse at or above the open bedrock interval; and,
- Based on a comparison of the measured total depth and as-built total depth, bedrock monitoring well OMW-219 is damaged, including a broken riser pipe at approximately 44.5 feet below its measuring point.

The following activities will be completed during the RI based on the results of the monitoring well inspection:

- Recomplete monitoring wells OMW-204 and OMW-214. Wells OMW-204 and OMW-214 were constructed as open bedrock boreholes; therefore, at each location, a roller bit will be advanced through the suspected formation collapse to the borehole's original total depth. To minimize future well integrity issues, each well be recompleted as a screened monitoring well using 2-inch ID, flush joint, schedule 40 PVC riser pipe with a 20 foot length of 0.020-inch slot PVC well screen; and,
- Recomplete monitoring well OMW-219. Well OMW-219 is 265.2 feet in depth and is constructed of 1-inch ID PVC riser pipe with a 40 foot length of PVC well screen. The annular space above the bentonite seal is grouted

to surface. Re-drilling will be accomplished using a 3-7/8-inch roller bit. The well will be recompleted as a screened monitoring well using 2-inch ID, flush joint, schedule 40 PVC riser pipe with a 40 foot length of 0.020-inch slot PVC well screen.

The management of IDM produced during well recompletion activities will be performed as described in Section 2.15.

2.11. AQUIFER PROPERTIES TESTING

Subsequent to well development, hydraulic conductivity testing will be performed in each of the newly-installed overburden and bedrock monitoring wells to estimate the hydraulic conductivity of the geologic materials immediately surrounding each well. Hydraulic conductivity tests will be performed using either conventional or pneumatic testing methods as described in SOP 014 (*In Situ* Hydraulic Conductivity Testing), which is provided in the QAPP.

A data logger will be installed into each monitoring well approximately 5 to 10 feet below the static water level and secured to the well casing. Following the installation of the data logger, the water level in each well will be allowed to equilibrate to static conditions prior to starting the test.

Following equilibration, the data logger will be programmed to record the water level relative to the top of well casing reference. Each test will be initiated using either physical or pneumatic testing methods as described in SOP 014 (*In Situ* Hydraulic Conductivity Testing), which is provided in the QAPP. Each hydraulic conductivity test will continue until water levels recover to approximately 95% of the static water level.

Before and after use, the data logger and cable will be decontaminated using a phosphate-free detergent wash and distilled water rinse, and wiped dry using paper towels. Decontamination fluids and other IDM will be managed as described in Section 2.15.

2.12. GROUNDWATER SAMPLING AND ANALYSIS

Each monitoring well installed pursuant to this RI/FS Work Plan will be sampled as part of the synoptic groundwater sampling events for VOCs and 1,4-dioxane on at least two occasions using low-flow sampling techniques, with the exception of the three deep bedrock boreholes. As discussed in Section 2.7.7 and below, groundwater samples will be obtained from the three deep bedrock boreholes during packer testing and again during the second synoptic sampling event following installation of the Water FLUTe™ systems. In addition, an initial sampling event will be performed for each well or group of wells located along Valley Stream, as discussed below in Section 2.12.1. This initial sampling event will be completed shortly after monitoring well installation activities are completed at this area.

Two synoptic groundwater sampling events and will be completed as discussed in Sections 2.12.2 and 2.12.3 and will include all of the new monitoring wells and several of the existing monitoring wells to provide a relatively comprehensive snapshot of VOC and 1,4-dioxane concentrations. In conjunction with the second synoptic sampling event, groundwater samples will also be collected from the three Water FLUTe™ systems, the new monitoring wells and several of the existing monitoring wells for analysis of degradation-related parameters as discussed in Section 2.12.2.2 below. Samples will also be collected from select wells for microbiological analysis and TCL/TAL (total and dissolved) analysis as discussed further below.

2.12.1 Initial Sampling Event at Valley Stream

One round of groundwater samples will be collected from each of the newly-installed overburden and bedrock monitoring wells located along Valley Stream shortly after monitoring well installation activities are completed to establish baseline conditions and to help determine the location of the deep bedrock borehole that is to be installed near Valley Stream. The groundwater samples will be collected no less than two weeks after the completion of well development activities.

Non-dedicated, non-disposable sampling equipment will be decontaminated before and after sampling at each monitoring well in accordance with the methods described in SOP 011 (Field Equipment Decontamination) provided in the QAPP. Groundwater samples will be obtained using low-flow sampling techniques (see SOP 015 [Groundwater Sampling Procedure using Low Flow Sampling Technique] provided in the QAPP) for analysis of

VOCs and 1,4-dioxane. In addition, to provide additional information on the general groundwater conditions along Valley Stream, water quality parameters will be measured using a flow-through cell during low-flow sampling. Measurements of DO, ORP, temperature, pH, specific conductivity and turbidity will be obtained for each monitoring well sampled.

The groundwater samples will be sent to Eurofins Lancaster under chain-of-custody procedures as described in SOP 010 (Chain-of-Custody, Handling, Packing, and Shipping) provided in the QAPP. QA/QC samples will be collected in accordance with the QAPP at a frequency of one set per 20 environmental samples. QA/QC samples include blind duplicate samples, equipment blanks, MS/MSD sample pairs, and trip blanks. Trip blanks will be included with each sample cooler containing aqueous VOC samples. The analytical results from this sampling event will be validated in accordance with the requirements provided in the QAPP.

During the sampling event, water level measurements will be collected in accordance with the procedures described in SOP 012 (Water Level Measurement) provided in the QAPP.

2.12.2 Synoptic Groundwater Sampling Events

Groundwater samples will be collected from the newly installed and select monitoring wells during two synoptic groundwater sampling events for VOC and 1,4-dioxane analyses as described below. Unless otherwise specified, groundwater sampling will be completed using low-flow sampling techniques in accordance with SOP 015 (Groundwater Sampling Procedure using Low Flow Sampling Technique). Groundwater samples will be obtained from the three deep bedrock wells in accordance with SOP 017 (Water FLUTe™ Multi-Level System Monitoring and Groundwater Sampling).

The groundwater samples will be sent to the relevant laboratories, as discussed below, or as presented in the QAPP, under chain-of-custody procedures as described in SOP 010 (Chain-of-Custody, Handling, Packing, and Shipping). QA/QC samples will be collected in accordance with the QAPP at a frequency of one set per 20 environmental samples. QA/QC samples include blind duplicate samples, equipment blanks, MS/MSD sample pairs, and trip blanks. Trip blanks will be included with each sample cooler containing VOC samples. Data validation will be performed in accordance with the procedures detailed in the QAPP as discussed in Section 3.

2.12.2.1 First Synoptic Groundwater Sampling Event

Subsequent to the completion of well installation activities at all of the investigation areas, the first of two synoptic groundwater sampling events will be performed either during the wet season (likely April/May) or dry season (likely September/October), and will coincide with the semi-annual groundwater program as presented in Attachment B of Appendix J of the DR/IP. If necessary, the schedule of the semi-annual groundwater event will be adjusted by up to two months (forward or backward) in order to minimize schedule impacts.

Groundwater samples will be collected from each of the newly-installed monitoring wells (excluding the wells installed as part of the vapor intrusion assessment and the three new deep bedrock boreholes) in addition to the monitoring wells routinely sampled as part of the semi-annual groundwater monitoring program as presented in Attachment B of Appendix J of the DR/IP. Several non-routine supplemental wells will also be sampled during the synoptic event to provide a relatively comprehensive snapshot of VOC and 1,4-dioxane concentrations. The non-routine supplemental wells that will be sampled during this event include the following:

- Overburden monitoring wells: DB-1S, DB-7S, DB-8S, GMW-1C, GMW-11, GMW-11B, OMW-106, PO-2, PO-3, PO-5, PO-6, PTW-2, PW-1, PW-3, 14C, 14F; and
- Bedrock monitoring wells: DB-1I, DB-7I, DB-8I, GMW-9B, GMW-11A, PB-1, PB-2.

In conjunction with the synoptic groundwater sampling event, groundwater samples will also be collected for analysis of the following degradation-related parameters: dissolved gases (*i.e.*, ethene, ethane, methane and acetylene); bicarbonate alkalinity; carbonate alkalinity; total alkalinity; chloride; nitrate; nitrite; sulfate; sulfide; dissolved organic carbon; dissolved calcium; iron; magnesium; manganese; potassium; and, dissolved sodium. Water quality parameters (DO, ORP, temperature, pH, specific conductivity and turbidity) will also be measured at each well during the sampling event.

2.12.2.2 Second Synoptic Groundwater Sampling Event

Subsequent to the completion of the three deep bedrock boreholes with Water FLUTe™ systems and receipt and evaluation of the results of the first synoptic sampling events, a second synoptic groundwater sampling event will be performed during the other season (*i.e.*, wet season if sampling already performed during the dry season, or dry season if sampling already performed during the wet season). Similar to the first synoptic sampling event, the performance of the second synoptic groundwater sampling event will coincide with the semi-annual groundwater program as presented in Attachment B of Appendix J of the DR/IP. If necessary, the schedule of the semi-annual groundwater event will be adjusted by up to two months (forward or backward) in order to minimize schedule impacts.

Groundwater samples will be collected from the wells identified in Section 2.12.2.1 in addition to the three new bedrock boreholes equipped with the Water FLUTe™ systems for VOC and 1,4-dioxane analysis. Additionally, groundwater samples will be collected for analysis of the following degradation-related parameters: dissolved gases (*i.e.*, ethene, ethane, methane and acetylene); bicarbonate alkalinity; carbonate alkalinity; total alkalinity; chloride; nitrate; nitrite; sulfate; sulfide; dissolved organic carbon; dissolved calcium; iron; magnesium; manganese; potassium; and, dissolved sodium. Water quality parameters (DO, ORP, temperature, pH, specific conductivity and turbidity) will also be measured at each well during the sampling event.

Up to ten samples will also be collected for microbiological analysis from wells located both inside and outside of the containment system with total chlorinated VOC concentrations greater than 1,000 micrograms per liter (µg/L). Currently it is envisioned that five samples will be collected from wells within the containment system and five samples will be collected from wells location outside of the containment system. Microbiological samples will be tested for *Dehalococcoides* (DHC) 16s and vinyl chloride reductase (VCR) genes. Two samples will be collected from each well. One sample will be collected by passing 3 liters of groundwater pumped from the mid-point of the well through a 0.2 micron filter. If less than 3 liters of ground water plugs the filter, the amount of groundwater passed through the filter will be recorded and reported to the laboratory. The second sample will be obtained by passing 3 liters of ground water pumped from at or near the bottom of the well through a 0.2 micron filter. If less than 3 liters of ground water plugs the filter, the amount of groundwater passed through the filter will be recorded and reported to the laboratory.

As part of the RI up to eight samples will be analyzed for compound-specific stable isotope analysis (CSIA) by Microseeps, Inc. (Microseeps). These samples will be analyzed for the carbon isotopes (13C, 12C) associated with TCE, cis-1,2-DCE and vinyl chloride and the results will be used as a secondary measure of the extent of biotic and/or abiotic degradation of these compounds. Up to three CSIA samples will be collected from monitoring wells located inside the Landfill, and up to five additional CSIA samples will be collected from wells located within the northern, central, and southern areas of the bedrock VOC plume south of the Landfill.

QuantArray® analyses will also be conducted to evaluate the presence of microbes responsible for reductive dechlorination and aerobic cometabolism processes in the Landfill groundwater. The sampling event will include the use of a matrix spike with a known target, such as the luciferase gene, or equivalent, to verify that deoxyribonucleic acid (DNA) amplification is not inhibited, The QuantArray® analyses will be performed by Microbial Insights (MI). The objective of the QuantArray® analyses is to evaluate if groundwater inside the Landfill contains the requisite microbes that could potentially degrade VOCs under the ambient geochemical conditions. Groundwater samples for QuantArray® analyses will be collected from up to five monitoring wells located inside the Landfill, and up to three locations within the bedrock VOC plume south of the Landfill.

Additional samples will be collected from a sub-set of the overburden and bedrock monitoring wells sampled during this event and sent via chain-of-custody to Eurofins Lancaster for TCL and TAL (total and dissolved) analyses. Samples will be collected from up to three overburden monitoring wells located inside of the Landfill, up to three overburden and three bedrock monitoring wells located outside of the Landfill within the VOC plume (total of up to six samples), and up to three overburden and three bedrock monitoring wells (total of up to six samples) located in areas not believed to have been impacted by historical Site activities.

2.12.3 Vapor Intrusion

If access is obtained from the property owner, two rounds of groundwater samples (an initial event and one confirmatory event) will be collected from each of the three new overburden monitoring wells installed as part of the vapor intrusion assessment. The groundwater samples will be collected no less than two weeks after the completion of well development activities.

Non-dedicated, non-disposable sampling equipment will be decontaminated before and after sampling at each monitoring well in accordance with the methods described in SOP 011 (Field Equipment Decontamination) provided in the QAPP. Groundwater samples will be obtained using low-flow sampling techniques (see SOP 015 [Groundwater Sampling Procedure using Low Flow Sampling Technique] provided in the QAPP) for analysis of VOCs.

The groundwater samples will be sent to Eurofins Lancaster under chain-of-custody procedures as described in SOP 011 (Chain-of-Custody, Handling, Packing, and Shipping) provided in the QAPP. QA/QC samples will be collected in accordance with the QAPP at a frequency of one set per 20 environmental samples. QA/QC samples include blind duplicate samples, equipment blanks, MS/MSD sample pairs, and trip blanks. Trip blanks will be included with each sample cooler containing VOC samples. The analytical results from this sampling event will be validated in accordance with the requirements provided in the QAPP.

2.13. HYDRAULIC MONITORING

2.13.1 Collection of Synoptic Water Level Measurements

Hydraulic monitoring both inside and outside of the cut-off wall at the Landfill, the western flank of the VOC plume, and near Valley Stream will be performed to further understand horizontal and vertical hydraulic gradients. The resulting data will be used to establish horizontal and vertical hydraulic gradients over time, assist in assessing contaminant fate and transport, and to help evaluate the effectiveness of the cut-off wall. The performance of hydraulic monitoring includes the collection of monthly, synoptic water levels for a one-year period from new and accessible/usable existing monitoring wells located inside and outside of the cut-off wall at the Landfill, the western flank of the VOC plume, and Valley Stream, and the three new surface water staff gages installed in Valley Stream. Water level measurements will be collected in accordance with SOP 012 (Water Level Measurement) provided in the QAPP.

2.13.2 Near-Continuous Water Level Monitoring

Near-continuous water level monitoring will be performed at select new and accessible/usable existing monitoring wells located inside and outside the cut-off wall and near Valley Stream using pressure transducers and associated data loggers to evaluate the response of the hydrogeologic system at these areas to various stressors (*e.g.*, precipitation and/or snow melt events, seasonal changes, barometric pressure changes, etc.). Climatic data (*i.e.*, precipitation, temperature and barometric pressure) will also be obtained during the near-continuous water level monitoring. Precipitation data will be obtained from a nearby climate monitoring station, such as the Albany International Airport. Barometric pressure and temperature data will also be obtained at the Landfill using a barometric pressure transducer and associated data logger.

2.14. PROFESSIONAL LAND SURVEY

2.14.1 Topographic Survey

A topographic survey has recently been performed and includes the Landfill and Groundwater components of the Site. This updated topographic survey was completed to document and geo-reference current Site features and was performed by a licensed Professional Land Surveyor.

2.14.2 Monitoring Wells and Other Drilling Locations

The following locations associated with the RI activities will be surveyed for horizontal and vertical control by a licensed Professional Land Surveyor:

- Surface water samples;
- Sediment pore water samples;

- Surface water gages;
- Locations of the cut-off wall flagged as part of the geophysical survey;
- Direct-sensing profiles;
- Soil borings;
- Groundwater borings;
- New overburden monitoring wells/piezometers; and
- New bedrock monitoring wells.

Additionally, each of the existing monitoring wells installed as part of previous investigations at the Site will be re-surveyed by a licensed Professional Land Surveyor for horizontal and vertical control, if not recently surveyed during activities performed pursuant to the DR/IP. Based on a review of survey data during preparation of the SCSR, many of the existing wells were surveyed in the National Geodetic Vertical Datum of 1929 (NGVD 29) vertical coordinate system. Some of the newer monitoring wells installed by NYSDEC and USEPA were surveyed in the North American Vertical Datum of 1988 (NAVD 88) vertical coordinate system. The purpose of re-surveying all of the existing wells is to confirm that all wells at the Site are referenced to a common vertical coordinate system so that historical and new data generated during the RI can be appropriately evaluated. It is anticipated that the surveying will be performed over several separate mobilizations at the completion of individual field events.

Horizontal coordinates will be obtained to the nearest 0.1 feet. Elevation data will be obtained from the top of the steel casing, the top of the riser pipe, and top of the staff gage to the nearest 0.01 feet, and ground surface to the nearest 0.1 feet. The survey information will be incorporated into the updated Site base map.

2.15. HANDLING OF INVESTIGATION-DERIVED MATERIALS

IDM resulting from the various RI activities will require appropriate management. The IDM includes the following:

- Soil and bedrock cuttings;
- Groundwater resulting from the drilling and development of the overburden and bedrock boreholes;
- Groundwater resulting from the vertical heat pulse flow meter testing, packer testing and related sampling, detailed hydraulic conductivity profiling, and purge water from discrete-interval and well sampling;
- Decontamination fluids;
- Solids (if any) which settle out of groundwater and/or decontamination fluids; and
- Personnel protective equipment (PPE) and associated debris resulting from the execution of the various field activities (*e.g.*, polyethylene sheeting, sample tubing, disposable equipment, etc.).

The management of these materials is discussed below.

2.15.1 Soil and Bedrock Cuttings

Based on the analytical data for the overburden cuttings associated with the installation of the five new extraction wells under Appendix F of the DR/IP, the overburden cuttings from borings located outside of the Landfill beyond the five new extraction wells will, with property owner approval, be spread on the ground surface in the vicinity of the boring and stabilized (*e.g.*, biodegradable netless seed mats). If approval from the property owner is not obtained, the overburden cuttings from these locations will be transported to the Landfill and either (a) used beneficially at the Landfill in a manner approved by USEPA or (b) placed into a roll-off container temporarily stored at the Landfill and subsequently transported off-site for disposal at a local, permitted sanitary landfill determined by USEPA to be acceptable under the Off-Site Rule.

The overburden cuttings from borings located inside or immediately adjacent to the Landfill (*i.e.*, not beyond the five new extraction wells) will be placed in 55-gallon drums and transported to a central location at the Landfill proper. Regardless of location, all bedrock cuttings will be placed in 55-gallon drums and transported to a central location at the Landfill proper. The drummed cuttings will be temporarily stored adjacent to the gravel turnaround in a manner that does not impede truck traffic, and will be labeled with the appropriate borehole identification(s), the dates on which the cuttings were containerized, and a description of the type of material (*i.e.*, overburden or bedrock drill cuttings).

Following the completion of the drilling and monitoring well installation program, representative samples of the drummed overburden and bedrock drill cuttings will be submitted to Eurofins Lancaster for laboratory analysis for VOCs by USEPA SW-846 Method 8260C and 1,4-dioxane by USEPA Method 8270D. Samples of the drummed overburden and bedrock drill cuttings from select borings located inside and immediately adjacent to the Landfill will also be analyzed for PCBs by USEPA SW-846 Method 8082. The final disposition of the drummed cuttings will be determined based on the results of the laboratory analysis. After receiving the necessary approval(s), the drill cuttings will be either (a) used beneficially at the Landfill in a manner approved by USEPA based on the analytical results or (b) transported for off-site disposal at a permitted facility in accordance with the *Transportation and Disposal Plan* conditionally approved by USEPA under the Removal Order.

2.15.2 Groundwater

Groundwater produced during the drilling, development, vertical flow meter testing, packer testing, detailed hydraulic conductivity profiling, discrete-interval sampling and well sampling will be containerized in polyethylene storage tanks and/or 55-gallon drums and transported to the Landfill where it will be transferred to one of the two frac tanks located in the pole barn. This groundwater will subsequently be treated using the treatment system located immediately west of the Landfill and discharged in accordance with the substantive requirements determined by NYSDEC.

2.15.3 Decontamination Fluids and Settled Solids

To the extent possible, non-disposable equipment will be decontaminated at the Landfill prior to and after use at the Site. Liquid/solid mixtures generated during equipment decontamination will be temporarily stored in polyethylene storage tanks and/or 55-gallon drums to allow solids to settle. Decontamination fluids containing non-indigenous materials (*e.g.*, alconox solution, methanol) generated during the RI/FS will be containerized in 55-gallon drums and temporarily stored at a central location at the Landfill. Pending approval from USEPA, the decontamination fluid will be transported for off-site disposal as discussed above in Section 2.15.1. Alternatively, the decontamination fluids may be treated using the treatment system located immediately west of the Landfill and discharged in accordance with the substantive requirements determined by NYSDEC.

Decontamination fluids free of non-indigenous materials (*e.g.*, alconox solution, methanol) generated during the various RI activities will be containerized in polyethylene storage tanks and/or 55-gallon drums and transported to the Landfill where it will be transferred to one of the two frac tanks located in the pole barn. Solids will be allowed to settle and the decontamination fluid will subsequently be treated using the treatment system located immediately west of the Landfill and discharged in accordance with the substantive requirements determined by NYSDEC.

Settled solids (*e.g.*, sediment) will be transferred into drums and labeled with the dates on which the sediments were containerized and a description of the type of material (*e.g.*, sediment). Alternatively, sediment from cleaning of the frac tanks will be placed into lined roll-off containers. Representative samples of the containerized sediment will be submitted to Eurofins Lancaster for laboratory analysis for VOCs by USEPA SW-846 Method 8260C and 1,4-dioxane by USEPA SW-846 Method 8270D. Samples of the drummed settled solids (*e.g.*, sediment) collected of material generated during investigations performed inside and immediately adjacent to the Landfill will also be analyzed for PCBs by USEPA SW-846 Method 8082. The final disposition of the sediment will be determined based on the results of the laboratory analysis. After receiving the necessary approval(s), the sediment will be transported for off-site disposal at a permitted facility in accordance with the *Transportation and Disposal Plan* conditionally approved by USEPA under the Removal Order.

2.15.4 Personal Protective Equipment and Associated Debris

PPE generated during non-intrusive, non-sampling activities (*e.g.,* Tyvek® coveralls used during site visits or reconnaissance activities for protection against aggressive fauna and flora [*e.g.*, ticks and poison ivy]) will be transported off-site for disposal at a local, permitted sanitary landfill. PPE and associated debris (*e.g.*, polyethylene sheeting, etc.) from the overburden drilling near Valley Stream (for the overburden and shallow bedrock wells and the one deep bedrock well) and two other deep bedrock wells will be managed similarly. All other PPE and all associated debris (*e.g.*, polyethylene sheeting, sample tubing, disposable equipment, etc.), will be containerized in 55-gallon drums and transported to the Landfill, including the PPE and associated debris from the bedrock drilling near Valley Stream and two other deep bedrock wells. These drums will be temporarily stored in the pole barn or, if there is insufficient space in the pole barn, then adjacent to the gravel turnaround in a manner that does not impede truck traffic. These materials will be characterized as necessary for profile approval, and will then be transported off-site for disposal at a permitted facility in accordance with the *Transportation and Disposal Plan* conditionally approved by USEPA under the Removal Order.

3. LABORATORY ANALYSIS AND DATA VALIDATION

As discussed in Section 2.0, aqueous samples (including groundwater, pore water and surface water), NAPL samples, and soil samples will be collected for laboratory analysis during implementation of the RI/FS. A summary of these samples are provided on Table 3-1.

Third-party, fully validatable Contract Laboratory Program (CLP) equivalent data packages will be obtained from Eurofins Lancaster for the following analyses:

- VOCs for the pore water samples;
- VOCs and 1,4-dioxane for surface water samples and select groundwater and soil samples;
- TCL/TAL for select groundwater and soil samples;
- Laboratory degradation-related parameters (with the exception of acetylene) for select groundwater samples; and,
- VOCs, SVOCs (including 1,4-dioxane), PCBs and hydrocarbon fingerprinting for NAPL samples.

Third-party, fully validatable CLP equivalent data packages will be obtained from Stone Environmental for the bedrock core subsamples analyzed for VOCs.

Data validation will be performed in accordance with the procedures detailed in the QAPP for the above referenced analytical data. Full validation of the analytical data will be performed in accordance with the procedures detailed in the QAPP.

In addition, it is anticipated that full, validatable data will be obtained during at least one sampling event (probably closest to a synoptic sampling event) of the LCT, extraction wells, POU and non-POU residential wells and existing monitoring wells performed under the Removal Order. These data will be validated in accordance with the procedures detailed in the QAPP.

Abbreviated data packages will be obtained from Eurofins Lancaster for the soil samples submitted for TOC analysis and from Pace Analytical Energy Services, LLC (PAES) for the groundwater samples submitted for CSIA, microbiological, and acetylene analyses. Abbreviated data packages will also be obtained from Microbial Insights for the groundwater samples submitted for QuantArray® analyses. These data packages will consist of a case narrative, analytical results, data qualifications, and field chain-of-custody forms.

Abbreviated data packages will be obtained from Golder and PTS for the physical parameters (vertical hydraulic conductivity and dry bulk density) for select soil samples, the physical parameters (including viscosity, fluid density, and interfacial tension) for NAPL samples, and the bedrock core samples submitted for laboratory analysis of bedrock physical properties. These data packages will consist of a case narrative, analytical results, data qualifications, and field chain-of-custody forms.

Abbreviated data packages will be obtained from Eurofins Lancaster for the waste characterization samples that may be collected of IDM as discussed in Section 2.15.

4. ACCESS REQUIREMENTS

Access agreements will be required with the four property owners associated with six private properties and the Tri-Village Bowhunters Club where RI/FS Work Plan activities are planned. In addition, an access agreement with the County of Rensselaer will be required for work performed on the Landfill parcel and access from the Town of Nassau may be required for work performed along Mead Road. Existing access agreements associated with work previously performed by Respondents will be reviewed, and if necessary, amended to include the RI/FS scope of work. New access agreement may be required for several of the private property owners.

As required by the Settlement Agreement, Respondents will use best efforts to obtain all access required to implement the field activities described in this RI/FS Work Plan within 45 days of obtaining USEPA's approval of the work plan. Thereafter Respondents will immediately notify USEPA if after using best efforts they are unable to obtain the required access.

5. PERMITS OR ASSOCIATED SUBSTANTIVE REQUIREMENTS

In accordance with Section XIV of the Settlement Agreement, no local, state, or federal permits are required for any action (including studies) conducted at the Site (which is broadly defined to include all impacted areas [the source area{s} and all areas into which contaminants from the source area{s} have migrated] and the immediately adjacent portions of non-impacted areas) if the action is selected and carried out in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Based on USEPA's Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03 (February 1992), permits should not be necessary for the performance and execution of the field activities described in this RI/FS Work Plan. Notwithstanding the lack of need for permits to implement the RI/FS Work Plan, the work needs to comply with any substantive requirements. Valley Stream and Tributary T11A are Class C surface water bodies, and as such the substantive requirements of a Protection of Waters Permit are not applicable. Additionally, none of the proposed drilling/boring locations are within wetlands or "wetland check zones" based on NYSDEC's Environmental Resource Mapper.

Temporary Traffic Control Procedures associated with work that may occur near or on road shoulders will be implemented in a manner consistent with Department of Transportation (DOT) guidelines in Section 6 (Temporary Traffic Control) of the Manual of Uniform Traffic Control Devices. Adjustments may be made at specific work locations to accommodate obstructions, limited driver sight distances or other location-specific conditions.

6. QUALITY ASSURANCE PROJECT PLAN

In accordance with the RI/FS SOW, a QAPP is being prepared for this project and will be provided under separate cover. The QAPP is being prepared in accordance with the Uniform Federal Policy for Quality Assurance Project Plans, Parts 1, 2 and 3, USEPA-505-B-04-900A, B and C, March 2005 or newer (*e.g.*, Part 2A revised March 2012).

7. HEALTH AND SAFETY PLAN

In accordance with the RI/FS SOW, a HASP has been prepared for this project and is provided under separate cover. The HASP was prepared in conformance with 29 CFR 1910.120, which is OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) regulation, and USEPA's guidance document, "Standard Operating Safety Guidelines" (OSWER, 1988).

8. BASELINE RISK ASSESSMENT

A Baseline Risk Assessment will be prepared for the Landfill and Groundwater components of the Site and will be incorporated into the RI Report. Data available for use as part of the Baseline Risk Assessment include the data collected during the RI as discussed in Section 2, in addition to the data collected during the Appendix F and G activities and the validatable data that will be obtained during at least one sampling event (probably closest to a synoptic sampling event) of the LCT, extraction wells, POU and non-POU residential wells and existing monitoring wells performed under the Removal Order as discussed in Section 3.

8.1. BASELINE HUMAN HEALTH RISK ASSESSMENT

The BHHRA will identify and characterize the potential current and future cancer risks and non-cancer hazards to human health under current and reasonably anticipated future land uses in accordance with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and USEPA guidance documents including the RI/FS Guidance, "*Land Use in the CERCLA Remedy Selection Process*" (OSWER Directive No. 9355.7-04), "*Reuse Assessments: A Tool to Implement the Superfund Land Use Directive*" (OSWER 9355.7-06P, June 2001), and the definitions and provisions of "*Risk Assessment Guidance for Superfund*“ (RAGS), Volume 1 ("*Human Health Evaluation Manual*") (USEPA/540/1-89/002, December 1989) and associated updates (RAGS Parts B, C, D, E, F and Part III). The risk assessment will follow relevant USEPA guidance documents, including RAGS: Volume III - Part A, *Process for Conducting Probabilistic Risk Assessment* (USEPA 2001).

8.1.1. Memorandum on Exposure Scenarios and Assumptions

As required by the RI/FS SOW, a Memorandum on Exposure Scenarios and Assumptions will be prepared submitted to USEPA as an interim BHHRA deliverable. This memorandum will describe the exposure scenarios and assumptions for the BHHRA, taking into account the current and reasonably anticipated future use of the Landfill and groundwater at the Site. The memorandum will describe the CSM and exposure routes of concern for the Landfill and Groundwater components of the Site, and include a completed RAGS Part D Table 1. This table will describe the pathways that will be evaluated in the BHHRA and the rationale for their selection, and will also include a description of those pathways that will not be evaluated in the BHHRA and the rationale for excluding those pathways. The memorandum will also include a completed RAGS Part D Table 4 describing the exposure pathway parameters with appropriate references to USEPA's 1991 *Standard Default Assumptions*, the 2002 *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* and the 2014 update of standard default exposure factors (OSWER Directive No. 9200 1-120), or, where other, site-specific exposure assumptions are proposed, a detailed rationale and supporting basis for those assumptions. In the event that chemicals with a mutagenic mode of action are identified, specific exposure assumptions for age groups 1 to younger than 16 will be developed. If these chemicals are identified, the memorandum will clarify the references that will be used to develop the age-specific exposure assumptions for these age groups.

8.1.2. Pathway Analysis Report

Upon USEPA approval of the above-referenced memorandum, the Pathway Analysis Report (PAR) will be developed as a second interim BHHRA deliverable to build on the Memorandum on Exposure Scenarios and Assumptions and will describe the risk assessment process and how the risk assessment will be performed. Updates to the *Memorandum of Exposure Scenarios and Assumptions* and RAGS Party D Tables 1 and 4, based on USEPA comments following submission of the former interim deliverables, will be included in the PAR. The PAR will be developed in accordance with "*Risk Assessment Guidelines for Superfund Part D*" (OSWER Directive 9285.7-01D, January 1998) and other appropriate guidance. The PAR will contain information for a reviewer to understand how the risks due to the Landfill and Groundwater components of the Site will be assessed. This will include completed RAGS Part D Tables 2, 3, 5, and 6, detailing the selection of chemicals of potential concern, media specific exposure point concentrations, and toxicological information. ProUCL version 5.0, or the most current version available at the time of the preparation of the PAR, will be used to calculate the exposure point concentrations. The toxicity hierarchy will be used to assist in the selection of toxicity values. For those chemicals lacking toxicity values, the chemicals will be submitted to USEPA so that USEPA can coordinate with the Superfund Technical Support Center to provide input on the toxicity values that should be used for these chemicals.

8.1.3. Baseline Human Health Risk Assessment Report

The BHHRA Report will be prepared and submitted to USEPA for inclusion in the RI Report. The submittal will include the risk characterization with a discussion of uncertainties and critical assumptions and completed RAGS Part D Tables 7 through 10 summarizing the calculated cancer risks and non-cancer hazards. The BHHRA will be performed in accordance with the approach and parameters described in the USEPA-approved Memorandum of Exposure Scenarios and Assumptions and the USEPA-approved PAR, as described above, including a discussion of uncertainties and other qualifications.

8.2. BASELINE ECOLOGICAL RISK ASSESSMENT

8.2.1. Screening Level Ecological Risk Assessment Report

A SLERA will be performed in accordance with current Superfund ecological risk assessment guidance. The SLERA Report will include a comparison of the 95% upper control limit (UCL) and maximum contaminant concentrations in each medium of concern for the Landfill and Groundwater components of the Site to appropriate, conservative ecotoxicity screening values for such medium (if any), and will use conservative exposure estimates for the ecological receptors, considering site-specific conditions. The SLERA Report will also include a recommendation as to whether a full Baseline Ecological Assessment (BERA) is warranted for the Landfill and/or Groundwater components of the Site.

8.2.2. Baseline Ecological Risk Assessment Report

If the USEPA determines that a BERA is necessary, a Scope of Work (SOW) will be prepared that outlines the steps and data necessary to perform the BERA. The BERA Scope of Work will identify any RI/FS Work Plan amendments or addenda, including establishment of a schedule for review and approval additional field work, which will be subject to USEPA's approval as per the Settlement Agreement. Upon completion of any needed field activities and receipt of BERA-related validated data, a BERA Report will be prepared. Actual and potential ecological risks will be identified and characterized in accordance with CERCLA, the NCP, and USEPA guidance. The BERA report will address the following:

- Hazard identification (sources);
- Dose-response assessment;
- Characterization of site and potential receptors;
- Select chemicals, indicator species, and endpoints;
- Exposure assessment;
- Toxicity assessment/ecological effects assessment;
- Risk characterization;
- Identification of limitations/uncertainties; and
- Site conceptual model.

9. FEASIBILITY STUDY

The purpose of the FS is to develop, screen and evaluate remedial actions for the Landfill and Groundwater components of the Site. Accordingly, the FS will be conducted to develop, screen, and evaluate alternative remedial actions based on RI results. The FS tasks to be performed include preparation of the Identification of Candidate Technologies Memorandum, conducting treatability studies as needed, development and screening of remedial alternatives, detailed analysis of remedial alternatives, and preparation of the FS. The FS tasks are consistent with CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA) and the NCP. The FS tasks are also consistent with the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988) and *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA, 2000). Each of the tasks is described below. The schedule for FS activities is included in Figure 11-1.

9.1. IDENTIFICATION OF CANDIDATE TECHNOLOGIES MEMORANDUM

An Identification of Candidate Technologies Memorandum will be prepared and submitted to identify candidate technologies and provide an initial screening of remedial technology types and process options potentially applicable for the Landfill and Groundwater components of the Site. The initial identification of and screening of remedial technologies is the first step in generating the FS. Innovative treatment technologies will be identified where appropriate. Representative technology types and process options will be evaluated based on implementability, effectiveness and cost criteria. The listing of candidate technologies will cover the range of technologies required for alternatives analysis. A literature survey will be conducted to gather information on performance, relative costs, applicability, removal efficiencies, operation and maintenance (O&M) requirements, and implementability of candidate technologies for the Landfill and Groundwater components of the Site. Preliminary remediation goals (PRGs) and Remedial Action Objectives (RAOs) will be developed, and General Response Actions (GRAs) to address Site contamination for the Landfill and Groundwater components of the Site will be identified (see Section 9.3). The memorandum will conclude with a preliminary screening of candidate technologies that will be used to assemble remedial alternatives for a more detailed evaluation in the FS. The preliminary screening will be subject to revision based on further investigation findings, results of treatability studies, or advancement in alternative remedial technologies, as applicable.

9.2. TREATABILITY STUDY(IES)

If determined to be necessary, treatability testing will be conducted as part of the FS to assist with the detailed analysis of alternatives. In accordance with the RI/FS SOW, if treatability testing is needed, a Treatability Testing Work Plan will be prepared and submitted to USEPA, along with an amended QAPP and HASP. After completion of the treatability testing and receipt of all laboratory analytical results, a Treatability Testing Evaluation Report will be prepared and submitted to interpret and evaluate the results with respect to technology effectiveness, implementability and cost.

9.3. DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

As part of the FS, remedial alternatives for the Landfill and Groundwater components of the Site will be developed and screened. The objective of this part of the FS is to identify a range of remedial alternatives which are protective of human health and the environment. The following activities will be performed during the development and screening of remedial alternatives.

9.3.1 Remedial Action Objectives

RAOs are medium-specific goals for protecting human health or the environment. The initial step in the development of remedial alternatives for the Landfill and Groundwater components of the Site will be to identify RAOs based on the contaminants and media of interest, pathways of exposure, and preliminary remediation goals (PRGs). The RAOs will be based on human health and environmental concerns identified during the RI and on applicable or relevant and appropriate requirements (ARARs).

ARARs are identified as chemical-specific, location-specific, or action-specific. Chemical-specific ARARs are usually health- or risk-based values, or methodologies which when applied to Site-specific conditions result in the establishment of numerical values, that represent the acceptable constituent amount or concentration that may be found in, or discharged to the ambient environment. Location-specific ARARs set restrictions on activities based on the characteristics of the Site. Although they are not used in the development of RAOs, action-specific ARARs set controls or restrictions on particular types of actions related to management of hazardous substances, pollutants, or contaminants. Accordingly, action-specific ARARs are identified later (when remedial alternatives are identified) than chemical- and location-specific ARARs.

9.3.2 General Response Actions

GRAs will be developed for each medium of interest for the Landfill and Groundwater components of the Site and included in the Identification of Candidate Technologies Memorandum (see Section 9.1). The GRAs will include containment, treatment, excavation, pumping, and other actions, either singly or in combination, that could satisfy the RAOs. GRAs will be refined, if necessary, during the development and screening of remedial alternatives.

9.3.3 Areas and/or Volumes of Media

The areas and/or volumes impacted media to which the GRAs may apply will be identified based on the nature and extent of constituents and RAOs for the Landfill and Groundwater components of the Site.

9.3.4 Assembly of Remedial Alternatives

The first step in development of remedial alternatives is to identify technology types and process options and screen them on the basis of technical implementability. Site constituent information and physical characteristics will be used to evaluate the technical implementability of identified process options. Technologies or process options that are not technically implementable will be screened out at this stage of the FS. Technologies and process options that are considered technically implementable will then be screened further based on the following criteria:

Effectiveness - Technology processes (or process options) will be evaluated with respect to their effectiveness in handling the estimated areas and/or volumes of impacted media and meeting the pertinent RAOs. The effectiveness at protecting human health and the environment during construction and implementation will also be considered. Each of the process options will also be evaluated based on how proven and reliable the process is with respect to the specific conditions for the Landfill and Groundwater components of the Site.

Implementability - Each process option will be evaluated with respect to its technical and administrative feasibility. This will include evaluating constraints such as the availability of treatment facilities, storage facilities, disposal services, special permitting requirements, and the need for and availability of equipment and skilled workers.

Cost - Capital costs and O&M costs will be compared relative to other process options.

Once the process options have been evaluated with respect to these three criteria, at least one representative process option will be selected for each technology type.

The next step is to assemble a range of remedial alternatives by combining GRAs and representative process options into alternatives that address the RAOs. Selected representative process options will be assembled into remedial alternatives for the Landfill and Groundwater components of the Site. Alternatives will be assembled to represent a range of treatment and containment alternatives including the following:

- Treatment to reduce the toxicity, mobility, or volume of wastes, including, the principal threats posed by the Site, but may vary in the types of treatment, the amount treated, and the manner in which long-term residuals or untreated wastes are managed;
- Containment with little or no treatment;
- Both treatment and containment;
- Removal or destruction of the waste;
- Innovative technologies to the extent practicable; and
- No-action.

The remedial alternatives for the Landfill and Groundwater components of the Site will be refined to identify the contaminant volume addressed by the proposed process and sizing of critical unit operations as necessary. Sufficient information will be collected for an adequate comparison of the remedial alternatives. PRGs will also be modified as necessary to incorporate the results of the risk assessment performed as part of the RI. Additionally, the action-specific ARARs for each remedial alternative will be updated as the alternatives are refined.

A final screening of remedial alternatives based on short- and long-term effectiveness, implementability and relative cost may be conducted if there are numerous feasible alternatives remaining for detailed analysis. The screening will be conducted to retain those alternatives with the most favorable composite evaluation of these factors, while preserving the range of treatment and containment alternatives that were initially developed.

9.3.5. Development and Screening of Alternatives Technical Memorandum

A Development and Screening of Remedial Alternatives Technical Memorandum will be prepared and submitted summarizing the work performed and the results of each task above, including an alternatives array summary and the reasoning employed in screening, arraying alternatives that remain after screening, and the identification of action-specific ARARs for the alternatives that remain after screening. The memorandum will also provide an explanation for choosing institutional or engineering controls as part of remedial alternatives, and the level of effort that will be required to secure, maintain, and enforce the control.

9.4. DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The objective of the detailed analysis of remedial alternatives is to provide the basis for selection of a remedy for the Landfill and Groundwater components of the Site. A detailed description will be developed for each of the alternatives that outlines the remedial strategy and identifies the key ARARs. Each alternative will then be evaluated against the specific evaluation criteria set forth in the NCP (40 CFR. Section 300.430(e)(9)(iii)), as described below.

The following two primary criteria will be used to evaluate each remedial alternative and also compare the alternatives:

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

The following five balancing criteria will be used to evaluate each remedial alternative and also compare the alternatives:

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

After completing the detailed analysis of each remedial alternative, a comparative analysis of the remedial alternatives will be conducted to compare the alternatives to each other based on the seven criteria listed above. The results of the detailed and comparative analysis of remedial alternatives will be presented in the FS Report, which will include a recommended remedial alternative for the Landfill and Groundwater components of the Site.

In addition to the seven criteria above, USEPA will evaluate the following two criteria after completion of the FS and issuance of a Proposed Plan:

- Community acceptance; and
- State (or support agency) acceptance.

9.5. FEASIBILITY STUDY REPORT

The development and detailed analysis of alternatives will be documented in a FS Report and submitted to USEPA for review and approval. The FS Report will be prepared in accordance with the NCP as well as the most recent guidance and will include the following:

- Site background description;
- Description of ARARs;
- Baseline risk assessment summary;
- Summary of FS objectives;
- Summary of remedial action objectives;

- Articulation of general response actions;
- Identification and screening of remedial technologies;
- Description of remedial alternatives
- Detailed analysis of remedial alternatives; and
- Summary, conclusions and recommendations.

10. REPORTING

This section describes the reports, notices and other documents required to be submitted to USEPA under the Settlement Agreement and the RI/FS SOW included as Appendix 2 of the Settlement Agreement.

10.1 MONTHLY PROGRESS REPORTS

Written monthly progress reports will be prepared and submitted to USEPA by the 15th day of each month following the Effective Date of the Settlement Agreement and continue until USEPA gives written notice of completion of the work. The monthly progress reports will include the elements specified in Section X of the Settlement Agreement. A summary data table showing detections will be developed for each sampling event and included in the Monthly Progress Report submitted to USEPA

10.2 DATA VALIDATION REPORTS

As discussed in Section 3, data validation will be performed on select soil and groundwater samples in accordance with the procedures detailed in the QAPP. In accordance with Section V of the RI/FS SOW, validated analytical data will be submitted to USEPA within 75 days after each sampling activity.

10.3 SITE CHARACTERIZATION SUMMARY REPORT ADDENDUM

An addendum to the SCSR will be prepared and submitted to USEPA within 60 days after the submittal of the final set of validated data, or such longer time as specified or agreed to by USEPA. Upon USEPA's approval, the SCSR Addendum will be incorporated into the RI Report as an appendix, once the required risk assessments have been completed.

10.4 IDENTIFICATION OF CANDIDATE TECHNOLOGIES MEMORANDUM

As discussed in Section 9.1, an Identification of Candidate Technologies Memorandum will be prepared and submitted to USEPA within 45 days after the submittal of the last set of final validated analytical data.

10.5 BASELINE RISK ASSESSMENT

10.5.1 Memorandum on Exposure Scenarios and Assumptions

As discussed in Section 8.1.1, a Memorandum on Exposure Scenarios and Assumptions will be prepared and submitted to USEPA as an interim BHHRA deliverable within 120 days after approval or modification of the RI/FS Work Plan, or such longer time as specified or agreed to by USEPA.

10.5.2 Pathway Analysis Report

As discussed in Section 8.1.2, a PAR will be prepared and submitted to USEPA within 60 days after the submittal of the last set of validated data, or USEPA's approval of the Memorandum on Exposure Scenarios and Assumptions, whichever is later.

10.5.3 Baseline Human Health Risk Assessment Report

As discussed in Section 8.1.3, a BHHRA Report will be prepared and submitted to USEPA within 75 days after approval of the PAR. Upon completion and approval, the BHHRA Report will be included in the RI Report.

10.5.4 Screening Level Ecological Risk Assessment Report

As discussed in Section 8.2.1, a SLERA Report will be prepared and submitted to USEPA after the submission of the last set of final validated analytical data, or upon agreement of the parties that sufficient data exists, or at such other time as is specified or agreed to by USEPA. Upon completion and approval, the SLERA Report will be included in the RI Report.

10.5.5 Baseline Ecological Risk Assessment Report

As discussed in Section 8.2.2, if the USEPA determines that a BERA is necessary, USEPA will notify Respondents in writing and a SOW will be prepared and submitted to USEPA within 60 days, or such longer time as specified or agreed to by USEPA. The SOW will outline the steps and data necessary to perform the BERA, including any amendments to the RI/FS Work Plan, QAPP and HASP, required to collect additional relevant data. Upon completion of any needed field activities and receipt of BERA-related validated data, a BERA Report will be prepared and submitted to USEPA within 60 days after submittal of the final set of BERA-related validated data, or such longer time as specified or agreed to by USEPA. Upon USEPA's approval, the BERA Report will be incorporated into the RI Report as an appendix.

10.6 REMEDIAL INVESTIGATION REPORT

A RI Report will be prepared and submitted to USEPA within 60 days after USEPA approval of the BHHRA Report, the SLERA Report, or (if required) the BERA Report, whichever is latest. The RI Report will be prepared in accordance with the "*Guidance for Conducting Remedial Investigations/Feasibility Studies under CERCLA*" (OSWER Directive 9355.3-01, October 1988, Interim Final) and the "*Guidance for Data Usability in Risk Assessment*" (USEPA/540/G-90/008, September 1990).

10.7 FEASIBILITY STUDY

10.7.1 Identification of Candidate Technologies Memorandum

An Identification of Candidate Technologies Memorandum will be prepared and submitted to USEPA within 45 days after submittal to USEPA of the last set of final validated analytical data; provided, however, that if USEPA and Respondents agree, Respondents may submit a portion of that memorandum at an earlier time.

10.7.2 Treatability Studies

Based on USEPA's review of the Candidate Technologies Memorandum, USEPA may require that treatability testing be conducted. Once a decision has been made to perform treatability studies, the USEPA, with input from Respondents, will decide on the type of treatability testing to use (*e.g.*, bench versus pilot). Following USEPA's written determination that treatability testing is necessary and the decision on the type of treatability testing to be used is made, a Treatability Testing Work Plan will be submitted to USEPA within 90 days. The work plan will include a Field Sampling and Analysis Plan and a schedule for completion of the treatability testing. In addition, if the original RI/FS QAPP is not adequate for defining the activities to be performed during the treatability testing, a separate Treatability Testing QAPP, or amendment to the original QAPP will be prepared and submitted to USEPA at the same time as the Treatability Testing Work Plan. Additionally, if the original HASP is not adequate for defining the activities to be performed during the treatment tests, a separate or amended HASP will be prepared and submitted to USEPA.

Within 45 days after completion (including field work and receipt of all laboratory results, including validated laboratory results if data validation is required) of any treatability testing or such longer time as specified or agreed to by USEPA, a Treatability Testing Evaluation Report will be submitted to USEPA.

10.7.3 Development and Screening of Remedial Alternatives Technical Memorandum

As discussed in Section 9.3.5, a Development and Screening of Remedial Alternatives Technical Memorandum will be prepared and submitted to USEPA within 60 days after approval of the BHHRA Report, the SLERA Report, the BERA Report (if required), whichever is latest, or USEPAs approval of the Treatability Testing Evaluation Report (if treatability testing is performed), or such longer time as is specified or agreed by USEPA.

10.7.4 Feasibility Study Report

As discussed in Section 9.5, a FS Report will be prepared and submitted to USEPA within 60 days after approval of the Development and Screening of Remedial Alternatives Technical Memorandum or the RI Report, whichever is later, or such time as specified or agreed by USEPA. The FS Report will be prepared in accordance with the NCP as well as the most recent guidance.

11. SCHEDULE

A schedule for implementation of the RI/FS is provided as Figure 11-1 and is based on the process outlined in the RI/FS SOW attached to the Settlement Agreement. This schedule begins with submission of this RI/FS Work Plan and progresses through approval of the FS Report. A USEPA review time of 60 calendar days has been assumed for each initial submittal, and 21 calendar days has been assumed for review and approval or approval with modifications for each re-submittal. Other assumptions/clarifications associated with the schedule presented on Figure 11-1 include the following:

- A fate and transport model is determined to be unnecessary (however, if a fate and transport model is determined to be needed, the RI/FS schedule will be adjusted accordingly);
- A reuse assessment is not required (however, if a reuse assessment is determined to be needed, the RI/FS schedule will be adjusted accordingly);
- The schedule for implementing the RI field work is as presented in Figure 11-2;
- Treatability testing is determined to be warranted, and the decision to perform treatability testing is made at the same time USEPA provides comments on the Candidate Technologies Memorandum;
- Implementation of the treatability testing takes 365 days (including all field work, laboratory analyses and data validation) from the time the associated work plan is approved or approved with modification;
- The submittal dates for the PAR and SLERA Report are triggered by Respondents' submission to USEPA of the validated data associated with the synoptic/comprehensive groundwater sampling event;
- USEPA determines that a BERA is not required for the Landfill and Groundwater components of the Site;
- The submittal date for the RI Report is based on USEPA approval or approval with modifications of the BHHRA Report;
- The submittal date for the Development & Screening of Remedial Alternatives Technical Memorandum is based on USEPA approval of Treatability Testing Evaluation Report; and
- The submittal date for the FS Report is based on USEPA approval of the Development & Screening of Remedial Alternatives Technical Memorandum.

A schedule for implementation of the RI field work associated with this RI/FS Work Plan is provided as Figure 11-2. This schedule begins with USEPA approval of the RI/FS Work Plan and its associated QAPP and progresses through approval of the SCSR Addendum. A USEPA review time of 60 calendar days has been assumed for each initial submittal, and 21 calendar days has been assumed for review and approval or approval with modifications for each re-submittal. If additional RI activities are required, then the schedules shown in Figures 11-1 and 11-2 will need to be modified. Other assumptions/clarifications associated with the schedule presented on Figure 11-2 for the RI field work include the following:

- Access required for the RI field work is obtained within 45 days of RI/FS Work Plan approval; and
- The decision on the location of the deep bedrock borehole near Valley Stream is made within 14 days of receipt of the last analytical data package associated with the sampling of surface water, pore water, overburden monitoring wells and shallow bedrock monitoring wells in and near Valley Steam.

12. REFERENCES

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Tables

Table 3-1

Remedial Investigation Sampling Summary
Dewey Loeffel Landfill Superfund Site
Nassau, New York

Well or Sampling Location	Number of Locations/Samples per Location (if more than one sample per location)	Matrix	Sample Description	Laboratory Analysis	Field Analysis	Total Number of Environmental Samples
Groundwater / Surface Water Interaction						
Surface Water Sampling (Valley Stream and 191-05-21 Property Ponds)						
SW-VS-01 to SW-VS-08	8 locations	Surface Water	Surface water samples from Valley Stream	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	8
SW-PND-01 to SW-PND-03	3 locations	Surface Water	Surface water samples from 191-05-21 Property Ponds	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	3
Surface Water Sampling (Southern Drainage Ditch and Northwest of Landfill)						
SW-NWDD-01 to SW-NWDD-05	5 locations	Surface Water	Surface water samples from Northwest Drainage Ditch and Tributary T11A	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	5
SW-SEDD-01 to SW-SEDD-03	3 locations	Surface Water	Surface water samples from Southeast Drainage Ditch	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	3
Pore Water Sampling at Valley Stream						
PW-VS-01 to PW-VS-06	6 locations	Pore Water	Pore water samples from Valley Stream	**VOCs by 8260C**	NA	6
Initial Groundwater Sampling Event (newly-installed overburden and shallow bedrock monitoring wells at Valley Stream)						
MW-OVB-VS-WELL-01 to OVB-VS-WELL-03	3 locations	Groundwater	Initial groundwater event from 3 new overburden monitoring wells at Valley Stream	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	3
MW-SHB-VS-WELL-01 to SHB-VS-WELL-03	3 locations	Groundwater	Initial groundwater event from 3 new shallow bedrock monitoring wells at Valley Stream	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	3
Surface Water/Surface Soil Sampling for Risk Assessment						
Surface Soil Sampling at and in the Vicinityof the Landfill						
SSS-01 to SSS-21	21 locations	Surface Soil	Total of 21 locations: 2 surface soil samples (0-6") from Landfill drainage swales; 5 surface soil samples (0-6") from Landfill ridges between swales; 1 surface soil sample (0-6") on southwestern side of Landfill (outside the cut-off wall); 1 surface soil sample (0-6") on north side of Landfill (outside the cut-off wall); 1 surface soil sample (0-6") on eastern side of Landfill (outside the cut-off wall); 2 soil samples (0-6" below surface water) at drainage ditches inside Landfill perimeter fence; 3 surface soil samples (0-12") from private property north of Landfill (191-05-15); 2 surface soil samples (0-12") from private property southwst of Landfill (191-05-16.2); 2 surface soil samples (0-12") from county property east of Landfill (191-05-16.1); 2 surface soil samples (0-12") from county property west of Landfill (191-05-16.1)	**TCL/TAL: VOCs by 8260C, SVOCs by 8270D, 1,4-dioxane by 8270D SIM, pesticides by 8081B, PCBs by 8082A, metals by 6010C, mercury by 7471B and total cyanide by 9012B**	NA	21
Surface Water Sampling at the Landfill						
SW-LF-01 and SW-LF-02	2 locations	Surface Water	Surface water samples from locations inside the Landfill perimeter fence at the northwestern and southern drainage ditches.	**TCL/TAL: VOCs by 8260C, SVOCs by 8270D, 1,4-dioxane by 8270D SIM, pesticides by 8081B, PCBs by 8082A, total and dissolved metals by 6010C, mercury by 7471B and total cyanide by 9012B**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	2

Table 3-1

Remedial Investigation Sampling Summary
Dewey Loeffel Landfill Superfund Site
Nassau, New York

Well or Sampling Location	Number of Locations/Samples per Location (if more than one sample per location)	Matrix	Sample Description	Laboratory Analysis	Field Analysis	Total Number of Environmental Samples
Overburden Soil and Groundwater Evaluation Inside and Immediately Adjacent to the Landfill/ Containment System						
Discrete-Interval Soil Sampling						
SB-LF-01-DPTH to SB-LF-04-DPTH	1-2 samples from 4 locations (total of 4-8 samples)	Soil	Soil Borings from within the containment system (locations based on MIP results)	**VOCs by 8260C**	NA	4 - 8
SB-LF-01-DPTH to SB-LF-04-DPTH	1 sample from 4 locations (total of 4 samples)	Soil	Soil Borings from within the containment system (locations based on MIP results)	**TCL/TAL: VOCs by 8260C, SVOCs by 8270D, 1,4-dioxane by 8270D SIM, pesticides by 8081B, PCBs by 8082A,metals by 6010C, mercury by 7471B and total cyanide by 9012B**	NA	4
SB-LF-01-DPTH to SB-LF-04-DPTH	1 sample from 4 locations (total of 4 samples)	Soil	Soil Borings from within the containment system (locations based on MIP results)- for physical properties	**Physical properties including vertical permeability and dry bulk density**	NA	4
SB-LF-01-DPTH to SB-LF-04-DPTH	1 sample from 4 locations (total of 4 samples)	Soil	Soil Borings from within the containment system (locations based on MIP results)	**TOC by Lloyd Kahn**	NA	4
SB-P-01-DPTH to SB-P-03-DPTH	2-3 samples from 3 locations (total of 6-9 samples)	Soil	Soil Borings from locations adjacent to, but outside the cut-off wall (locations based on MIP results)	**VOCs by 8260C**	NA	6 - 9
SB-P-01-DPTH to SB-P-03-DPTH	1 sample from 2 locations (total of 2 samples)	Soil	Soil Borings from locations adjacent to, but outside the cut-off wall (locations based on MIP results)	**TCL/TAL: VOCs by 8260C, 1,4-dioxane by 8270D SIM, pesticides by 8081B, PCBs by 8082A, metals by 6010C, mercury by 7471B and total cyanide by 9012B**	NA	2
SB-P-01-DPTH to SB-P-03-DPTH	1 sample from 2 locations (total of 2 samples)	Soil	Soil Borings from locations adjacent to, but outside the cut-off wall (locations based on MIP results) for physical properties	**Physical properties including vertical permeability and dry bulk density**	NA	2
SB-P-01-DPTH to SB-P-03-DPTH	1 sample from 2 locations (total of 2 samples)	Soil	Soil Borings from locations adjacent to, but outside the cut-off wall (locations based on MIP results) for physical properties	**TOC by Lloyd Kahn**	NA	2
Discrete-Interval Groundwater Sampling						
GW-LF-01-DPTH to GW-LF-04-DPTH	4 samples from 4 locations (total of 16 samples)	Groundwater	Groundwater within the containment system (locations based on MIP results)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	NA	16
NAPL-LF-01-DPTH to NAPL-LF-03-DPTH	3 sample locations	NAPL	NAPL within the containment system (locations based on direct sensing results)	**VOCs by 8260C, SVOCs by 8270D, 1,4-dioxane by 8270D SIM, PCBs by 8082A**	NA	3
NAPL-LF-01-DPTH to NAPL-LF-03-DPTH	3 sample locations	NAPL	NAPL within the containment system (locations based on direct sensing results)	**Hydrocarbon fingerprinting using USEPA Method 8015C**	NA	3
NAPL-LF-01-DPTH to NAPL-LF-03-DPTH	3 sample locations	NAPL	NAPL within the containment system (locations based on MIP results) for physical properties	**Physical properties including viscosity, fluid density and interfacial tension**	NA	3
GW-P-01-DPTH to GW-P-06-DPTH	4 samples from 6 locations (total of 24 samples)	Groundwater	Groundwater from locations adjacent to, but outside the cut-off wall (locations based on MIP results)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	NA	24
Overburden Groundwater Evaluation Outside of the Landfill						
Discrete-Interval Groundwater Sampling						
GW-N-01-DPTH	4 samples from 1 location (total of 4 samples)	Groundwater	Groundwater in the vicinity of well location GMW-11 outside of the cut-off wall on the north side of the Landfill (location based on MIP results)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	NA	4
GW-SW-01-DPTH to GW-SW-02-DPTH	4 samples from 2 locations (total of 8 samples)	Groundwater	Groundwater in the vicinity of OMW-211 on the southwest side of the Landfill (location based on MIP results)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	NA	8
Background Evaluation						
Discrete-Interval Soil Sampling						
SB-BKGD-01-DPTH to SB-BKGD-03-DPTH	5 samples from 3 locations (total of 5 samples)	Soil	Background conditions soil sampling (native material) - 3 locations corresponding with proposed drilling locations (total of five samples)	**TCL/TAL: VOCs by 8260C, SVOCs by 8270D, 1,4-dioxane by 8270D SIM, pesticides by 8081B, PCBs by 8082A, metals by 6010C, mercury by 7471B and total cyanide by 9012B, TOC by Lloyd Kahn.**	NA	5

Table 3-1

Remedial Investigation Sampling Summary
Dewey Loeffel Landfill Superfund Site
Nassau, New York

Well or Sampling Location	Number of Locations/Samples per Location (if more than one sample per location)	Matrix	Sample Description	Laboratory Analysis	Field Analysis	Total Number of Environmental Samples
Characterization of Bedrock Conditions - Bedrock groundwater in the central and western portions of VOC plume						
Bedrock Core Sampling and Bedrock Core Subsampling						
BH-01-DPTH to BH-02-DPTH	120 to 150 samples from 2 locations (total of 240 - 300 samples)	Bedrock Core Subsample	Bedrock core subsamples from two bedrock boreholes along the axis of the VOC plume (120-150 samples per location)	**VOCs by 8260C/ Stone Environmental Sample Preparation**	NA	240 - 300
BH-01-DPTH to BH-02-DPTH	3 to 6 samples from 2 locations collected (total of 3 to 6 samples analyzed)	Bedrock Core	Bedrock core samples from two bedrock boreholes along the axis of the VOC plume	**Bedrock matrix diffusion coefficient for chloride and the corresponding tortuosity factor, specific gravity, hydraulic conductivity, dry density, TOC, and total porosity analyses**	NA	3 - 6
BH-01-DPTH to BH-02-DPTH	3 to 6 samples from 2 locations collected (total of 3 to 6 samples analyzed)	Bedrock Core	Bedrock core samples from two bedrock boreholes along the axis of the VOC plume	**Physical properties including total porosity and pore throat distribution and TOC.**	NA	3 - 6
Packer Testing						
BH-01-DPTH to BH-03-DPTH	13 samples from the westernmost bedrock borehole, 15 samples from the centrally located bedrock borehole, 17 samples from the southern bedrock borehole (total of 45 samples analyzed)	Groundwater	Packer testing for potential water-transmitting fractures in open section of three bedrock boreholes	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	45
Synoptic Groundwater Sampling Events						
First Synoptic Groundwater Sampling Event						
MW-OVB-LF-WELL-01 to MW-OVB-LF-WELL-33; MW-SHB-LF-WELL-01 to MW-SHB-LF-WELL-04; MW-OVB-VS-WELL-01 to MW-OVB-VS-WELL-03; MW-SHB-VS-WELL-01 to MW-SHB-VS-WELL-03	43 locations	Groundwater	Synoptic groundwater sampling event including all newly installed overburden and shallow bedrock monitoring wells (40)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	43
MW-OVB-OMW-101, MW-B-OMW-102, MW-B-OMW-103, MW-OVB-OMW-107, MW-B-OMW-108, MW-B-OMW-201, MW-B-OMW-202, MW-B-OMW-204, MW-B-OMW-205, MW-B-OMW-206, MW-OVB-OMW-211, MW-B-OMW-212, MW-B-OMW-213, MW-B-OMW-214, MW-B-OMW-215, MW-B-OMW-216, MW-B-OMW-218, MW-B-OMW-219, MW-B-OMW-220, MW-B-OMW-221, MW-B-OMW-222, MW-B-OMW-223, MW-B-OPZ-207, MW-B-OPZ-217	24 locations	Groundwater	Synoptic groundwater sampling event including existing monitoring wells sampled in the semi-annual groundwater monitoring program (24)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	24
MW-OVB-DB-1S, MW-OVB-DB-7S, MW-OVB-DB-8S, MW-OVB-GMW-1C, MW-OVB-GMW-11, MW-OVB-GMW-11B, MW-OVB-OMW-106, MW-OVB-PO-2, MW-OVB-PO-3, MW-OVB-PO-5, MW-OVB-PO-6, MW-OVB-PTW-2, MW-OVB-PW-1, MW-OVB-PW-3, MW-OVB-14C, MW-OVB-14F, MW-B-DB-1I, MW-B-DB-7I, MW-B-DB-8I, MW-B-GMW-9B, MW-B-GMW-11A, MW-B-PB-1, MW-B-PB-2	23 locations	Groundwater	Synoptic groundwater sampling event including non-routine supplemental monitoring wells- overburden monitoring wells and bedrock monitoring wells (23)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	23
MW-OVB-LF-WELL-01 to MW-OVB-LF-WELL-33; MW-SHB-LF-WELL-01 to MW-SHB-LF-WELL-04; MW-OVB-VS-WELL-01 to MW-OVB-VS-WELL-03; MW-SHB-VS-WELL-01 to MW-SHB-VS-WELL-03; MW-OVB-OMW-101, MW-B-OMW-102, MW-B-OMW-103, MW-OVB-OMW-107, MW-B-OMW-108, MW-B-OMW-102, MW-B-OMW-201, MW-B-OMW-202, MW-B-OMW-204, MW-B-OMW-205, MW-B-OMW-206, MW-OVB-OMW-211, MW-B-OMW-212, MW-B-OMW-213, MW-B-OMW-214, MW-B-OMW-215, MW-B-OMW-216, MW-B-OMW-218, MW-B-OMW-219, MW-B-OMW-220, MW-B-OMW-221, MW-B-OMW-222, MW-B-OMW-223, MW-B-OPZ-207, MW-B-OPZ-217, MW-OVB-DB-1S, MW-OVB-DB-7S, MW-OVB-DB-8S, MW-OVB-GMW-1C, MW-OVB-GMW-11, MW-OVB-GMW-11B, MW-OVB-OMW-106, MW-OVB-PO-2, MW-OVB-PO-3, MW-OVB-PO-5, MW-OVB-PO-6, MW-OVB-PTW-2, MW-OVB-PW-1, MW-OVB-PW-3, MW-OVB-14C, MW-OVB-14F, MW-B-DB-1I, MW-B-DB-7I, MW-B-DB-8I, MW-B-GMW-9B, MW-B-GMW-11A, MW-B-PB-1, MW-B-PB-2	90 Locations	Groundwater	Synoptic groundwater samples for degradation-related parameters	**Dissolved gases (i.e., ethene, ethane, methane) by RSK-175; bicarbonate, carbonate and total alkalinity by SM20 2320B; chloride, nitrate, nitrite and sulfate by USEPA Method 300.0; sulfide by SM20 4500-S2D, dissolved organic carbon (DOC) by SM20 5310C; dissolved calcium, iron, magnesium, manganese, potassium and dissolved sodium by 6010C**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	90
Second Synoptic Groundwater Sampling Event						
MW-OVB-LF-WELL-01 to MW-OVB-LF-WELL-33; MW-SHB-LF-WELL-01 to MW-SHB-LF-WELL-04; MW-OVB-VS-WELL-01 to MW-OVB-VS-WELL-03; MW-SHB-VS-WELL-01 to MW-SHB-VS-WELL-03	43 locations	Groundwater	Synoptic groundwater sampling event including all newly installed overburden and shallow bedrock monitoring wells (43)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	43
BH-FLUTe-01-DPTH to BH-FLUTe-03-DPTH	3 locations (up to 6 sampling zones/6 samples per location)	Groundwater	Synoptic groundwater sampling event following conversion of the open deep bedrock boreholes to FLUTe multi-level monitoring devices	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	18

Table 3-1

Remedial Investigation Sampling Summary
Dewey Loeffel Landfill Superfund Site
Nassau, New York

Well or Sampling Location	Number of Locations/Samples per Location (if more than one sample per location)	Matrix	Sample Description	Laboratory Analysis	Field Analysis	Total Number of Environmental Samples
Second Synoptic Groundwater Sampling Event (continued)						
MW-OVB-OMW-101, MW-B-OMW-102, MW-B-OMW-103, MW-OVB-OMW-107, MW-B-OMW-108, MW-B-OMW-201, MW-B-OMW-202, MW-B-OMW-204, MW-B-OMW-205, MW-B-OMW-206, MW-OVB-OMW-211, MW-B-OMW-212, MW-B-OMW-213, MW-B-OMW-214, MW-B-OMW-215, MW-B-OMW-216, MW-B-OMW-218, MW-B-OMW-219, MW-B-OMW-220, MW-B-OMW-221, MW-B-OMW-222, MW-B-OMW-223, MW-B-OPZ-207, MW-B-OPZ-217	24 locations	Groundwater	Synoptic groundwater sampling event including existing monitoring wells sampled in the semi-annual groundwater monitoring program (24)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	24
MW-OVB-DB-1S, MW-OVB-DB-7S, MW-OVB-DB-8S, MW-OVB-GMW-1C, MW-OVB-GMW-11, MW-OVB-GMW-11B, MW-OVB-OMW-106, MW-OVB-PO-2, MW-OVB-PO-3, MW-OVB-PO-5, MW-OVB-PO-6, MW-OVB-PTW-2, MW-OVB-PW-1, MW-OVB-PW-3, MW-OVB-14C, MW-OVB-14F, MW-B-DB-1I, MW-B-DB-7I, MW-B-DB-8I, MW-B-GMW-9B, MW-B-GMW-11A, MW-B-PB-1, MW-B-PB-2	23 locations	Groundwater	Synoptic groundwater sampling event including non-routine supplemental monitoring wells- overburden monitoring wells and bedrock monitoring wells (23)	**VOCs by 8260C, 1,4-dioxane by 8270D SIM**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	23
15 locations - To be determined from a sub-set of the overburden and bedrock monitoring wells sampled during the synoptic groundwater sampling event, including: up to 3 overburden monitoring wells located inside of the Landfill (total of up to 3 samples); up to 3 overburden and three bedrock monitoring wells located outside of the Landfill within the VOC plume (total of up to 6 samples); and up to 3 overburden and 3 bedrock monitoring wells (total of up to 6 samples) located in areas not believed to have been impacted by historical Site activities	15 locations	Groundwater	Synoptic groundwater samples from a sub-set of the overburden and bedrock monitoring wells sampled during this event	**TCL/TAL: SVOCs by 8270D, pesticides by 8081B, PCBs by 8082A, total and dissolved metals by 6010C, mercury by 7470A and total cyanide by 9012B**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	15
MW-OVB-LF-WELL-01 to MW-OVB-LF-WELL-33; MW-SHB-LF-WELL-01 to MW-SHB-LF-WELL-04; MW-OVB-VS-WELL-01 to MW-OVB-VS-WELL-03; MW-SHB-VS-WELL-01 to MW-SHB-VS-WELL-03; BH-FLUTe-01-DPTH to BH-FLUTe-03-DPTH, MW-OVB-OMW-101, MW-B-OMW-102, MW-B-OMW-103, MW-OVB-OMW-107, MW-B-OMW-108, MW-B-OMW-201, MW-B-OMW-202, MW-B-OMW-204, MW-B-OMW-205, MW-B-OMW-206, MW-OVB-OMW-211, MW-B-OMW-212, MW-B-OMW-213, MW-B-OMW-214, MW-B-OMW-215, MW-B-OMW-216, MW-B-OMW-218, MW-B-OMW-219, MW-B-OMW-220, MW-B-OMW-221, MW-B-OMW-222, MW-B-OMW-223, MW-B-OPZ-207, MW-B-OPZ-217, MW-OVB-DB-1S, MW-OVB-DB-7S, MW-OVB-DB-8S, MW-OVB-GMW-1C, MW-OVB-GMW-11, MW-OVB-GMW-11B, MW-OVB-OMW-106, MW-OVB-PO-2, MW-OVB-PO-3, MW-OVB-PO-5, MW-OVB-PO-6, MW-OVB-PTW-2, MW-OVB-PW-1, MW-OVB-PW-3, MW-OVB-14C, MW-OVB-14F, MW-B-DB-1I, MW-B-DB-7I, MW-B-DB-8I, MW-B-GMW-9B, MW-B-GMW-11A, MW-B-PB-1, MW-B-PB-2	Up to 108 Samples from 93 Locations	Groundwater	Synoptic groundwater samples for degradation-related parameters	**Dissolved gases (i.e., ethene, ethane, methane) by RSK-175; bicarbonate, carbonate and total alkalinity by SM20 2320B; chloride, nitrate, nitrite and sulfate by USEPA Method 300.0; sulfide by SM20 4500-S2D, dissolved organic carbon (DOC) by SM20 5310C; dissolved calcium, iron, magnesium, manganese, potassium and dissolved sodium by 6010C**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	108
10 locations - To be determined from a sub-set of the wells sampled during the synoptic groundwater sampling event, up to 10 samples will be collected from wells located both inside and outside of the containment system with total chlorinated VOC concentrations greater than 1,000 micrograms per liter (µg/L). Five samples will be collected from wells within the containment system and five samples will be collected from wells located outside of the containment system.	10 locations	Groundwater	Synoptic groundwater microbiological samples from wells with total VOC concentrations greater than 1,000 ug/L, up to a maximum of 10 samples (5 inside the containment system, 5 outside the containment system)	**Microbiological analysis for Dehalococcoides (DHC) bacteria and vinyl chloride reductase (vcr-A)**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	10
8 locations - To be determined from a sub-set of the wells sampled during the synoptic groundwater sampling event, three samples collected from monitoring wells located inside the Landfill and up to five additional CSIA samples will be collected from wells located within the northern, central, and southern areas of the bedrock VOC plume south of the Landfill.	8 locations	Groundwater	Synoptic groundwater samples; three CSIA samples collected from monitoring wells located inside the Landfill and up to five additional CSIA samples will be collected from wells located within the northern, central, and southern areas of the bedrock VOC plume south of the Landfill	**Compound-specific stable isotope analysis (CSIA) and acetylene analysis**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	8
8 locations - To be determined from a sub-set of the wells sampled during the synoptic groundwater sampling event, samples to be collected from up to five monitoring wells located inside the Landfill and up to three locations within the bedrock VOC plume south of the Landfill	8 locations	Groundwater	Synoptic groundwater microbiological samples; collected from up to five monitoring wells located inside the Landfill and up to three locations within the bedrock VOC plume south of the Landfill	**Microbiological analysis using QuantArray®**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	8

Table 3-1

Remedial Investigation Sampling Summary
Dewey Loeffel Landfill Superfund Site
Nassau, New York

Well or Sampling Location	Number of Locations/Samples per Location (if more than one sample per location)	Matrix	Sample Description	Laboratory Analysis	Field Analysis	Total Number of Environmental Samples
Overburden Groundwater Sampling as Part of Vapor Intrusion Assessment						
First Groundwater Sampling Event						
MWVI-PRD-Well-01, MWVI-PRC-Well-01 and MWVI-PRC-Well-02	3 locations	Groundwater	Initial Sampling Event - Vapor Intrusion assessment groundwater from three new overburden monitoring wells (one at Property D, two at Property C)	**VOCs by 8260C**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	3
Second Groundwater Sampling Event						
MWVI-PRD-Well-01, MWVI-PRC-Well-01 and MWVI-PRC-Well-02	3 locations	Groundwater	Confirmatory Sampling Event - Vapor Intrusion QC sample from three new overburden monitoring wells (one at Property D, two at Property C)	**VOCs by 8260C**	pH, Temperature, Specific Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	3

Notes:
FLUTe = Flexible Liner Underground Technologies
NA = not applicable
TBD = to be determined
TCL = target compound list
TAL = target analyte list
VOCs = volatile organic compounds

Project Sample Designation:
Sample location designations will be as follows: A-B-C where:

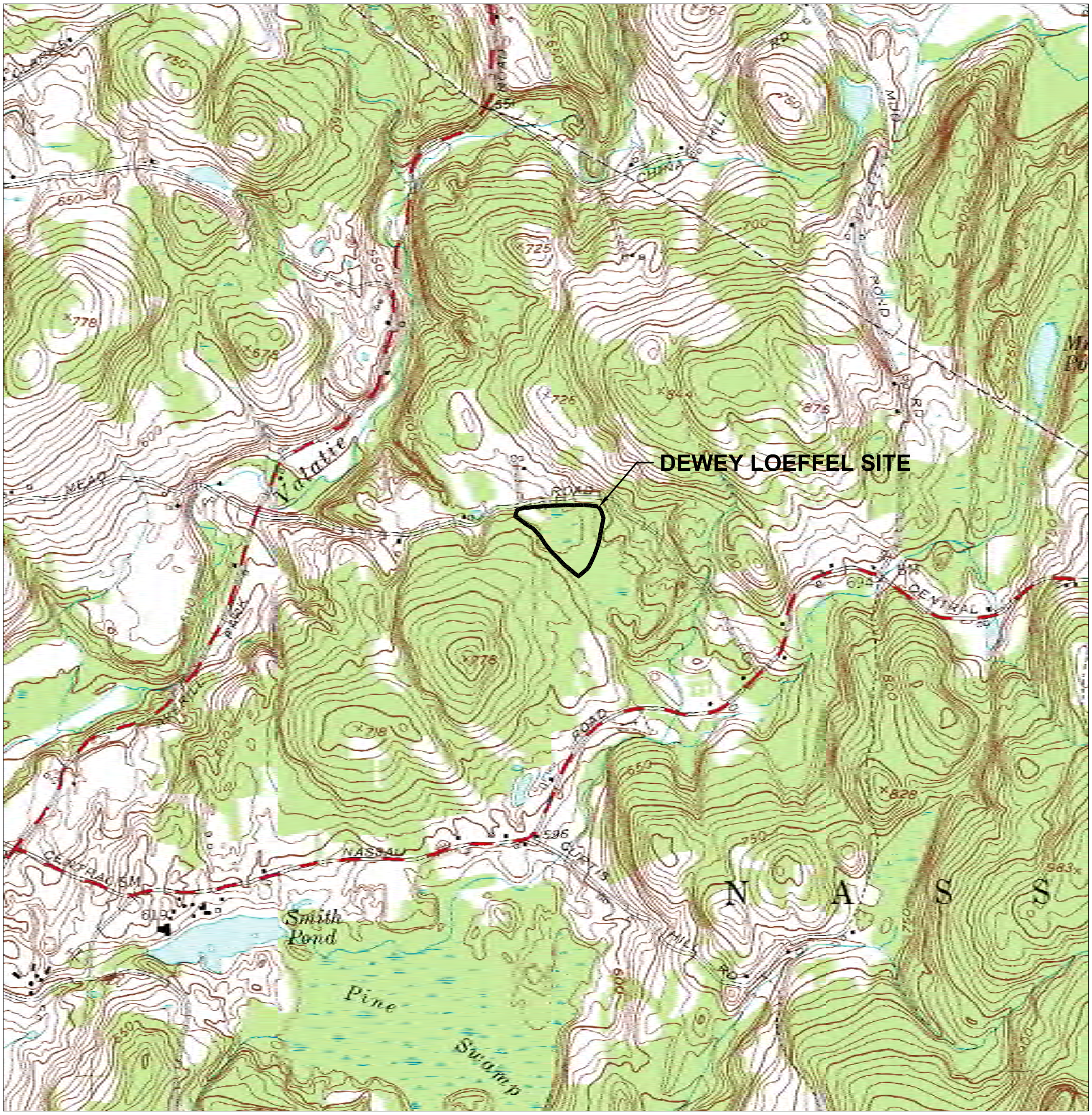
A = sample type; Examples:
GW = Groundwater
SW = Surface Water
PW = Pore Water
SB = Soil Boring
SSS = Surface Soil Sample
NAPL = Non-aqueous Phase Liquid Sample
BH = Bedrock Borehole
MW-OVB-VS = Overburden Monitoring Well at Valley Stream
MW-SHB-LF = Shallow Bedrock Monitoring Well in the Landfill
MW-SHB-VS = Shallow Bedrock Monitoring Well at Valley Stream
MW-OVB = Monitoring Well Existing Overburden
MW-B = Monitoring Well Existing Bedrock
MWVI = Vapor Intrusion Assessment Monitoring Well

B = sample field location; Examples:
NWDD = Northwest Drainage Ditch
SEDD = Southeast Drainage Ditch
VS = Valley Stream
PND = 191-05-21 Property Ponds
LF = Landfill
P = Perimeter/Cut-off well evaluation
BKGD = Background
N = North Side of Landfill
SW = Southwest of Landfill
PRC = Property C
PRD = Property D

C = sample well location number, sample number, sample depth
WELL-01 = Well number 01 (new well)
FLUTe-01 = Water FLUTe multi-level sampling system number 01
01 = Sample number 01
DPTH = Sample depth value

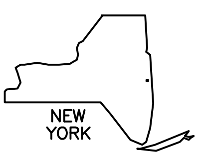
Figures

FIGURE 1–1



ADAPTED FROM: NASSAU, NEW YORK U.S.G.S. 7.5 MIN. QUAD

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE



QUADRANGLE LOCATION

SITE LOCATION MAP

1 ½ 0 1 MILE

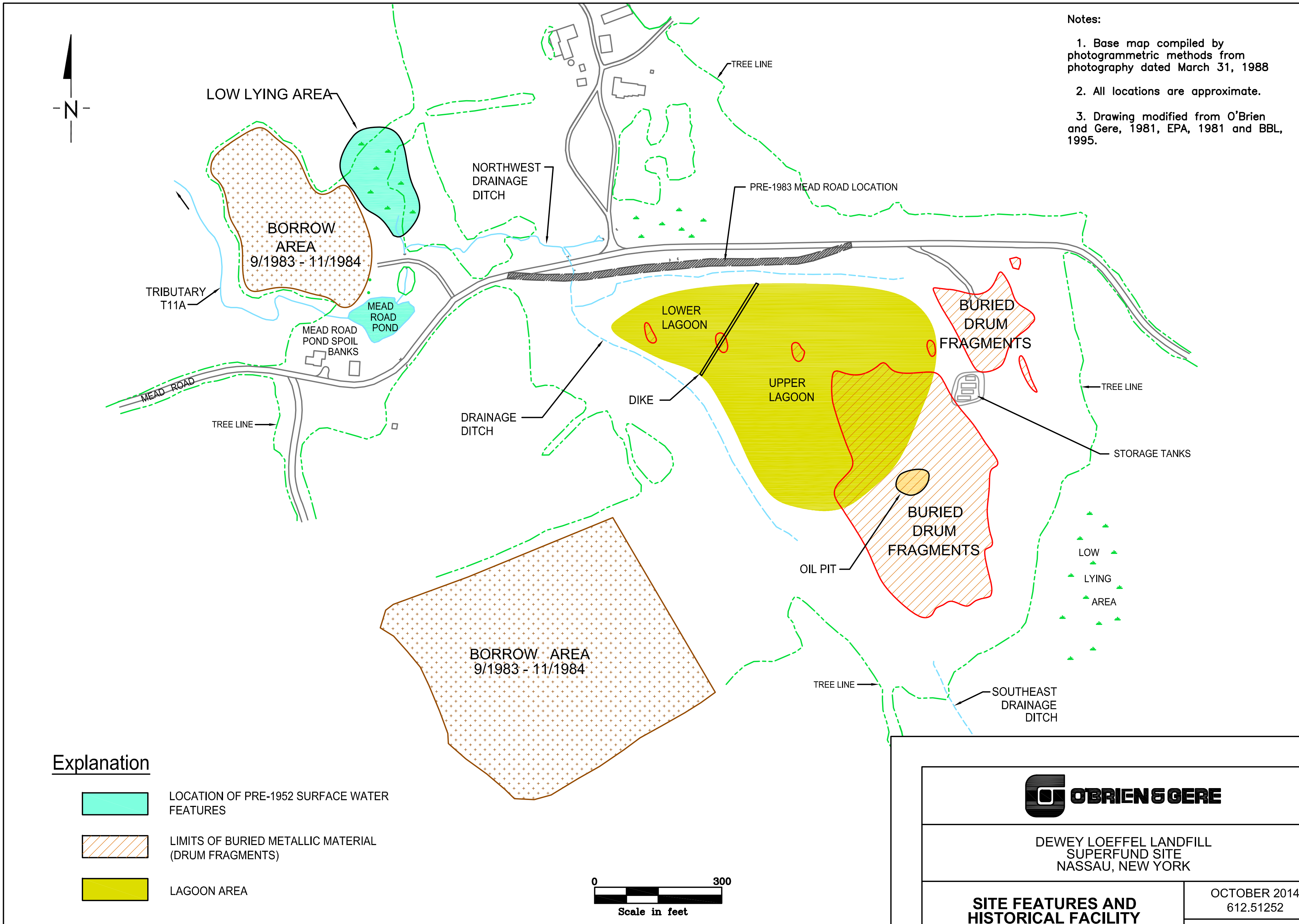
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

SCALE: 1:24000

612.51252
OCTOBER 2014

O'BRIEN & GERE



Notes:

1. Base map compiled by photogrammetric methods from photography dated March 31, 1988
2. All locations are approximate.
3. Drawing modified from O'Brien and Gere, 1981, EPA, 1981 and BBL, 1995.

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DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

SITE FEATURES AND HISTORICAL FACILITY LAYOUT

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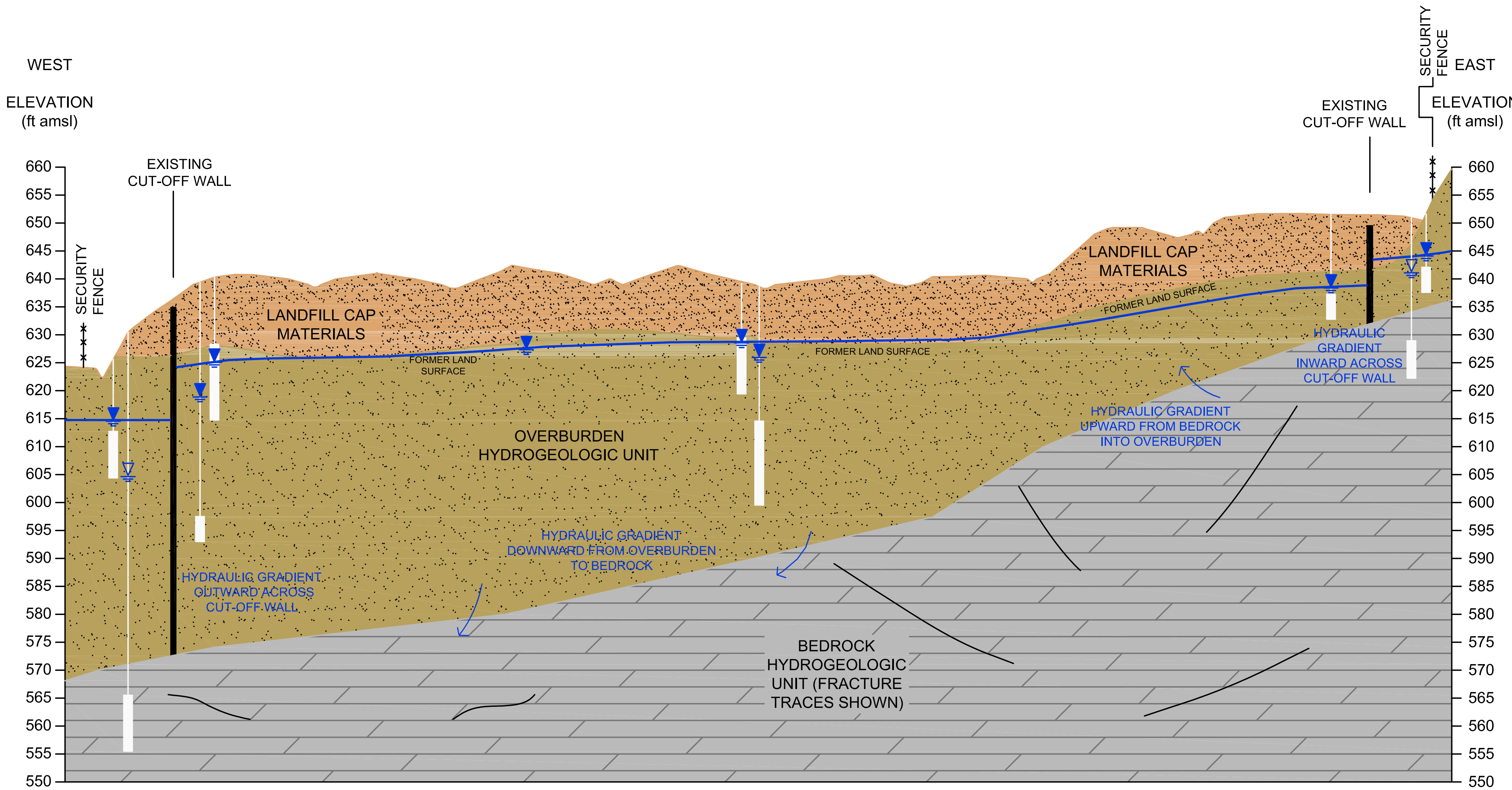
FIGURE 1-2

FIGURE 1-3



NOTES:
1. "ft amsl" designates feet above mean sea level.

LEGEND

OVERBURDEN WATER TABLE ELEVATION

BEDROCK WELL GROUNDWATER ELEVATION

CONCEPTUAL GROUNDWATER FLOW DIRECTION

CONCEPTUAL MONITORING WELL

CASED SECTION OF BOREHOLE

OPEN/SCREENED SECTION OF BOREHOLE

24

120

0

0

SCALE IN FEET

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

CONCEPTUAL HYDROGEOLOGIC SYSTEM AT LANDFILL

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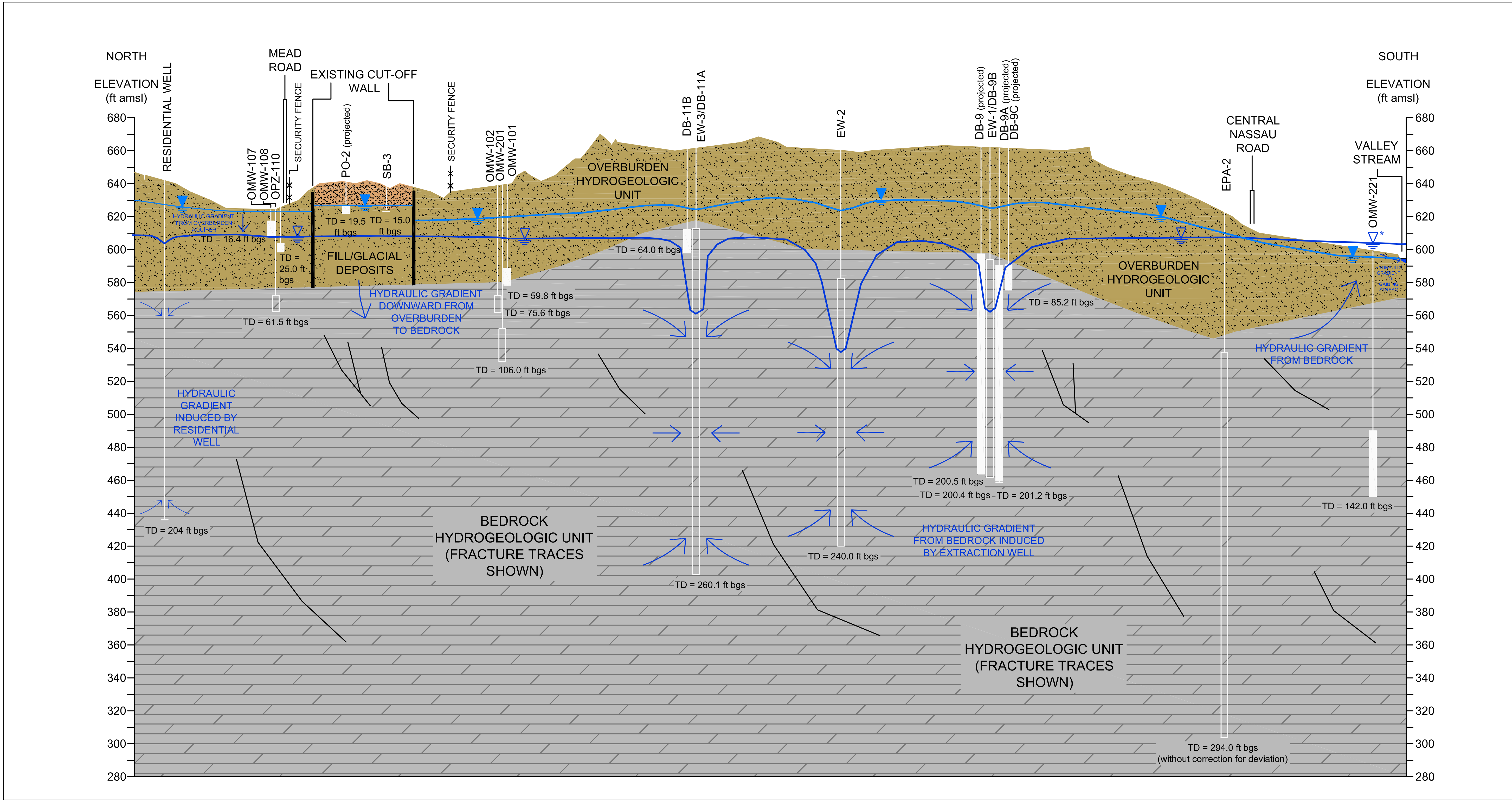
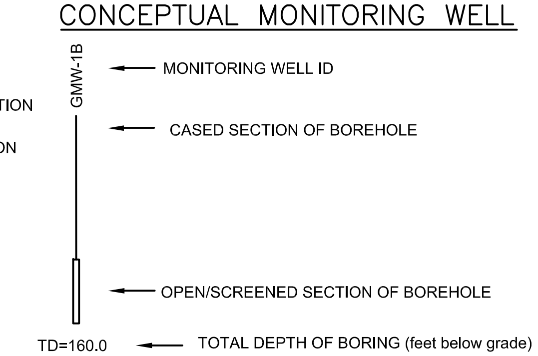
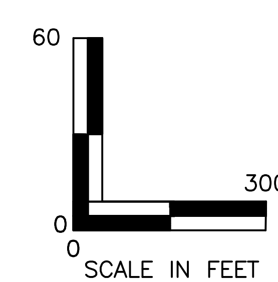


LEGEND

- OVERBURDEN WATER TABLE ELEVATION
- BEDROCK POTENTIOMETRIC SURFACE ELEVATION
- CONCEPTUAL GROUNDWATER FLOW DIRECTION

CONCEPTUAL MONITORING WELL





NOTES:
1. "ft amsl" designates feet above mean sea level.
2. Groundwater elevations measured on December 2, 2013.
3. "*" designates flowing artesian well.

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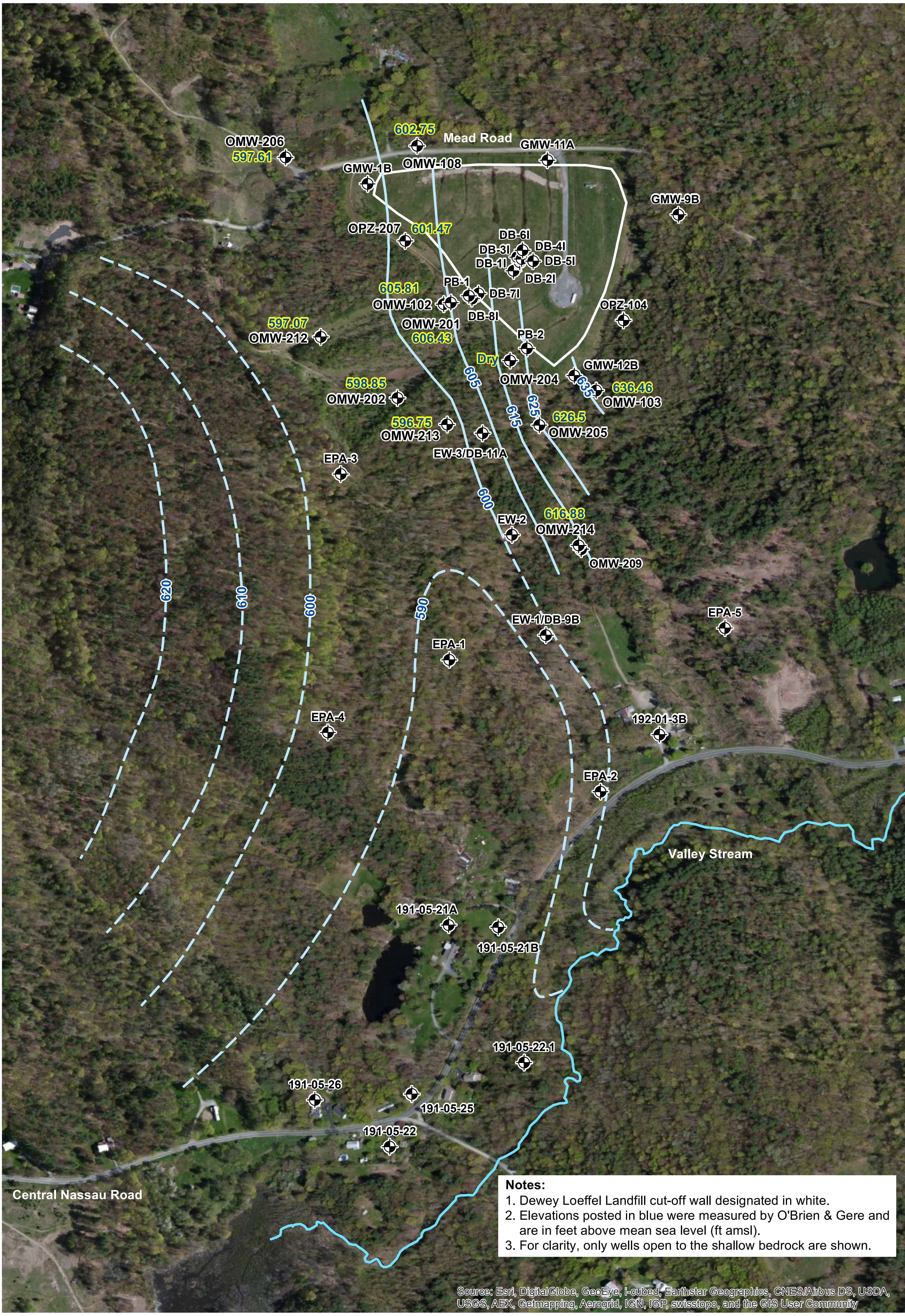
DEWEY LOEFFEL LANDFILL SUPERFUND SITE
NASSAU, NEW YORK

CONCEPTUAL HYDROGEOLOGIC SYSTEM

OCTOBER 2014
612.51252

FIGURE 1-4



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Legend

- Monitoring Well Location
- Shallow Bedrock Contour Line
- Shallow Bedrock Contour Line (Inferred)

SHALLOW BEDROCK GROUNDWATER CONTOUR MAP - DECEMBER 2, 2013

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

N

0 200 400 800
Feet

FIGURE 1-5

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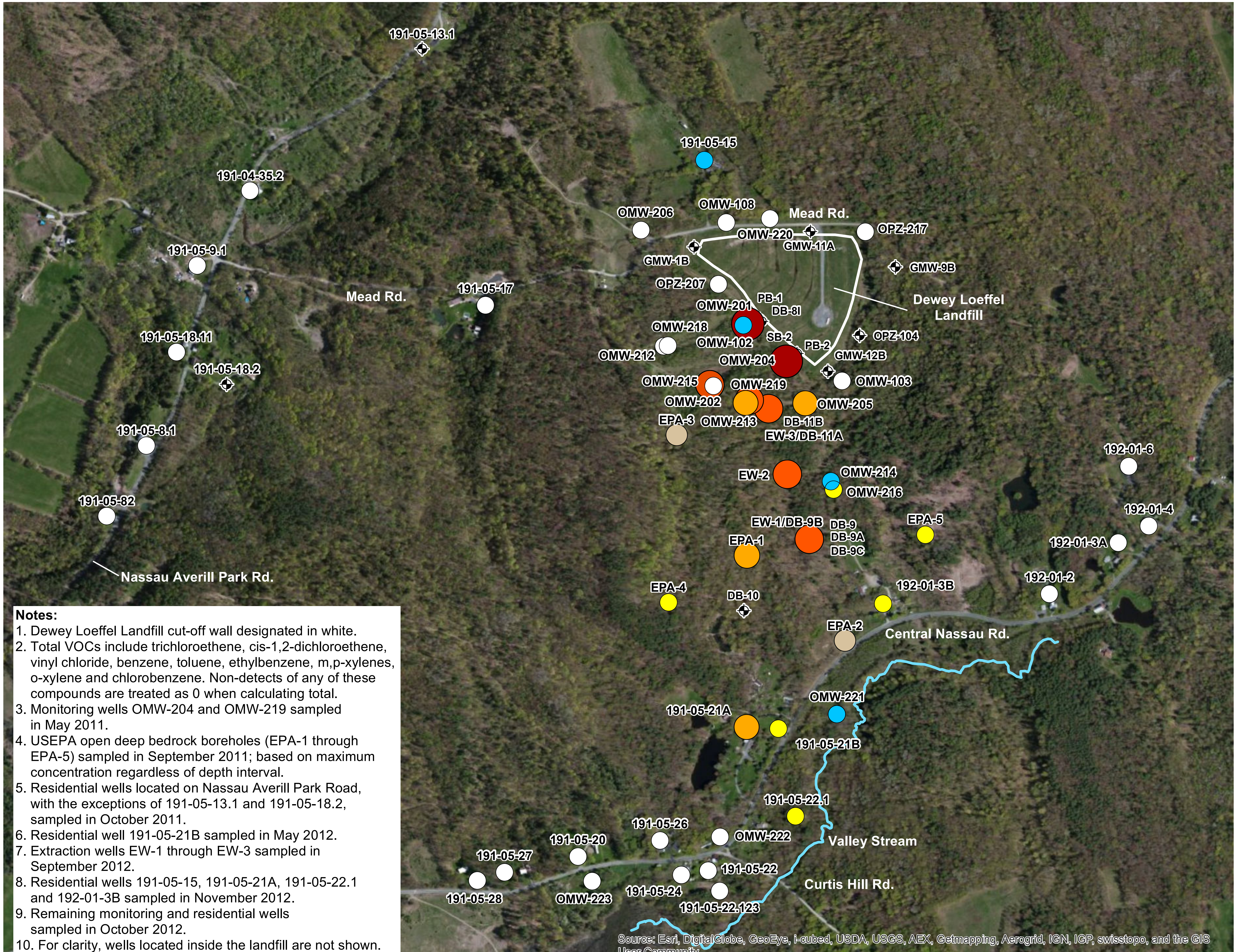
I:\Ge-Cep.612\51252.Dewey-Npl-Site\Docs\Reports\RI_FS Work Plan\Figures\Section 1\Figure 1-6 BR Total VOCs 2011-2012.mxd

FIGURE 1-6



Notes:
1. Dewey Loeffel Landfill cut-off wall designated in white.
2. Total VOCs include trichloroethene, cis-1,2-dichloroethene, vinyl chloride, benzene, toluene, ethylbenzene, m,p-xylenes, o-xylene and chlorobenzene. Non-detects of any of these compounds are treated as 0 when calculating total.
3. Monitoring wells OMW-204 and OMW-219 sampled in May 2011.
4. USEPA open deep bedrock boreholes (EPA-1 through EPA-5) sampled in September 2011; based on maximum concentration regardless of depth interval.
5. Residential wells located on Nassau Averill Park Road, with the exceptions of 191-05-13.1 and 191-05-18.2, sampled in October 2011.
6. Residential well 191-05-21B sampled in May 2012.
7. Extraction wells EW-1 through EW-3 sampled in September 2012.
8. Residential wells 191-05-15, 191-05-21A, 191-05-22.1 and 192-01-3B sampled in November 2012.
9. Remaining monitoring and residential wells sampled in October 2012.
10. For clarity, wells located inside the landfill are not shown.

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N

Legend

- Total VOC Conc. ND
- Total VOC Conc. ≤5 ug/L
- Total VOC Conc. >5 ug/L and ≤50 ug/L
- Total VOC Conc. >50 ug/L and ≤500 ug/L
- Total VOC Conc. >500 ug/L and ≤5,000 ug/L
- Total VOC Conc. >5,000 ug/L and ≤50,000 ug/L
- Total VOC Conc. >50,000 ug/L
- Existing Well Not Sampled

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

TOTAL VOCs IN BEDROCK GROUNDWATER - 2011-2012

0 325 650 1,300
Feet

OCTOBER 2014
612.51252

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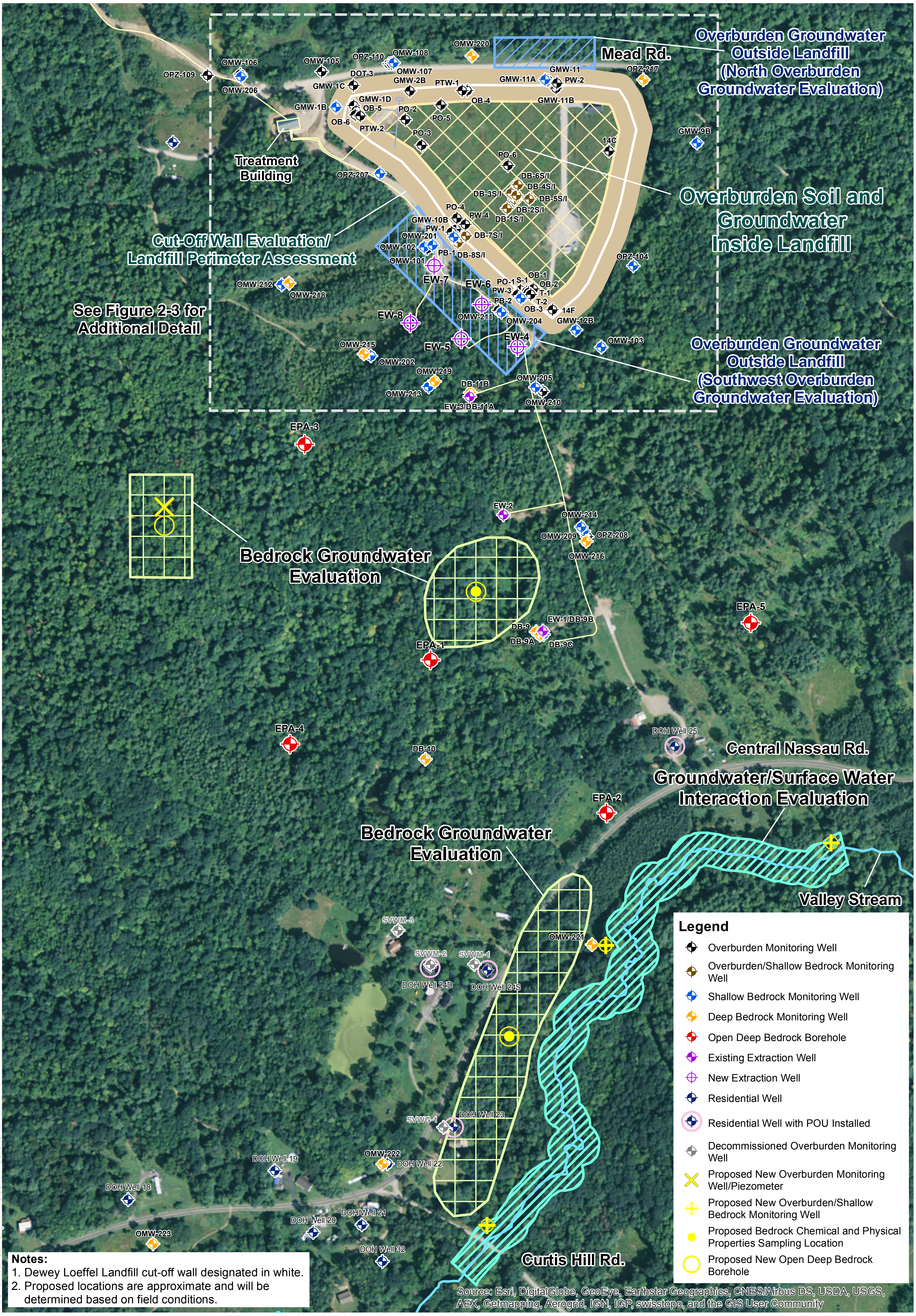

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AREAS FOR ADDITIONAL EVALUATION AND PROPOSED REMEDIAL INVESTIGATION ACTIVITIES

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

0 175 350 700
Feet

N

FIGURE 2-1

JULY 2015
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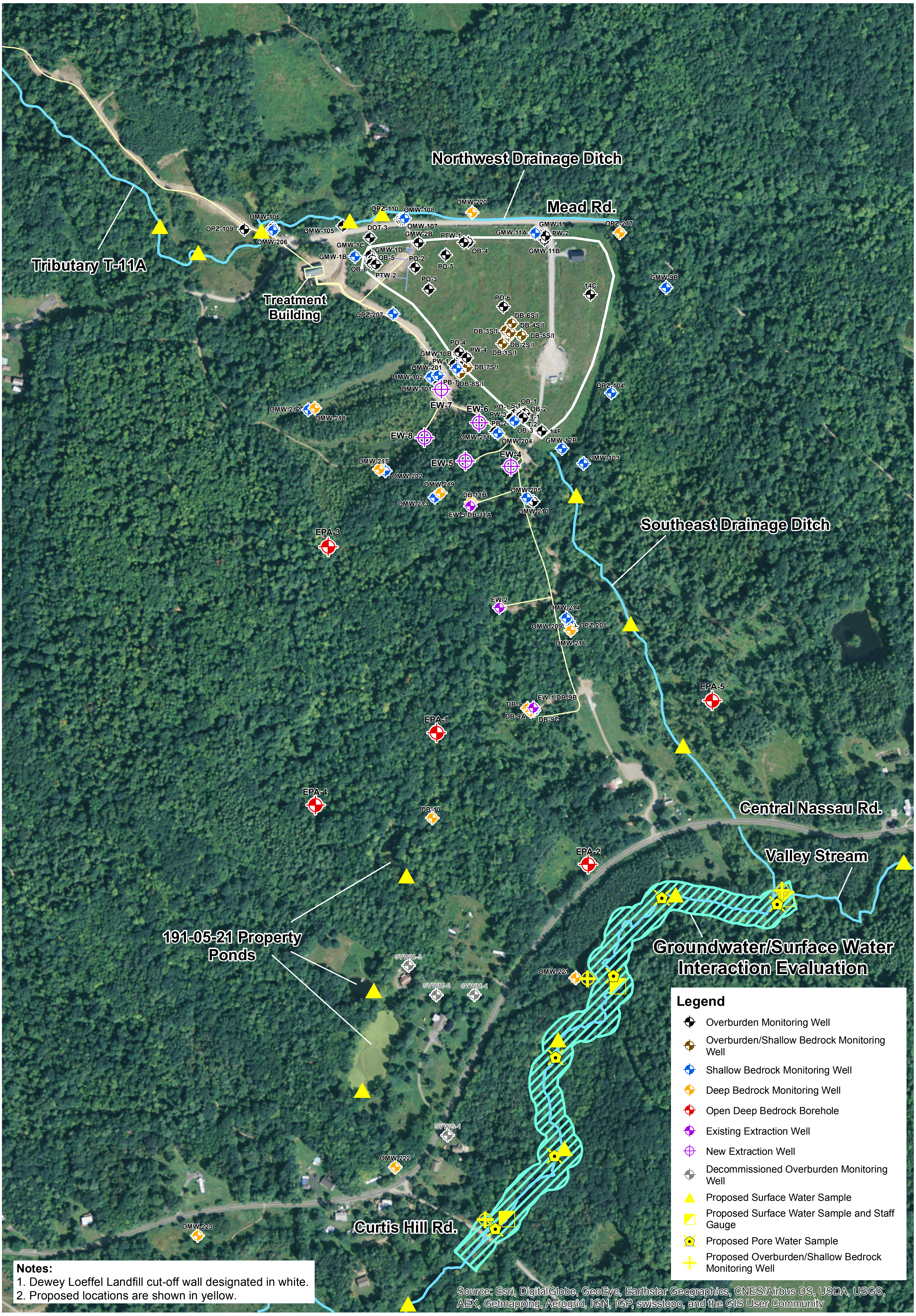
I:\Ge-Cep.612\51252.Dewey-Npl-Site\Docs\Reports\RI_FS Work Plan\RI_FS Work Plan_V2\Figures\Section 2\Figure 2-2 SW Sampling Locs.mxd



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PROPOSED SURFACE WATER-GROUNDWATER INTERACTION EVALUATION AREAS

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

0 200 400 800
Feet

N

FIGURE 2-2

JULY 2015
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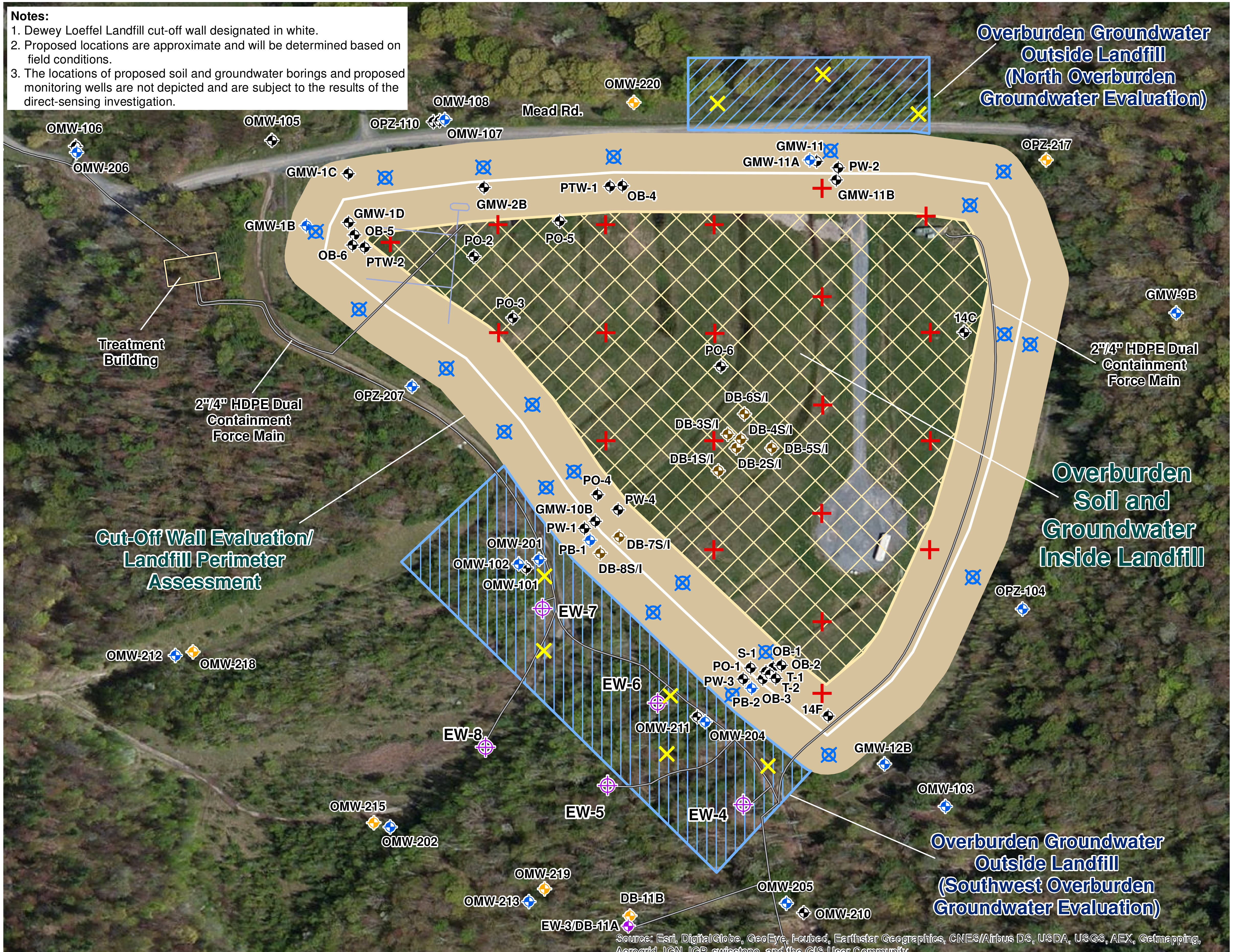
FIGURE 2-3



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N

Legend

- Overburden Monitoring Well
- Overburden/Shallow Bedrock Monitoring Well
- Shallow Bedrock Monitoring Well
- Deep Bedrock Monitoring Well
- Existing Extraction Well
- New Extraction Well
- Proposed Direct Sensing Boring Location (Cut-Off Wall Evaluation/Landfill Perimeter Assessment)
- Proposed Direct Sensing Boring Location (North and Southwest Overburden Groundwater Evaluation)
- Proposed Direct Sensing Boring Location (Soil and Groundwater Inside Landfill)

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

PROPOSED OVERBURDEN, SOIL AND GROUNDWATER EVALUATION AT LANDFILL AND ADJACENT AREAS

0 75 150 300
Feet

MARCH 2015
612.51252

O'BRIEN & GERE

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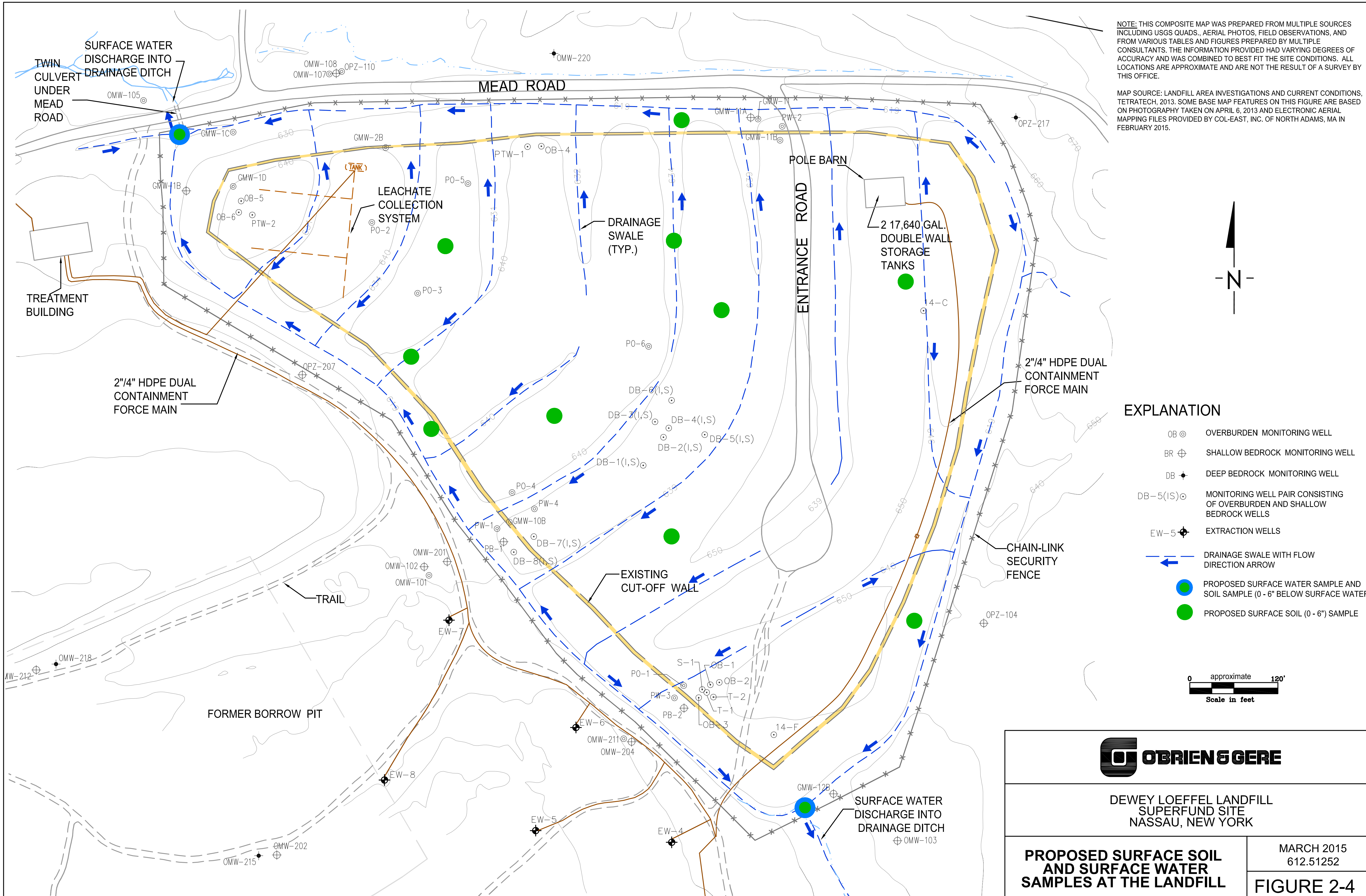
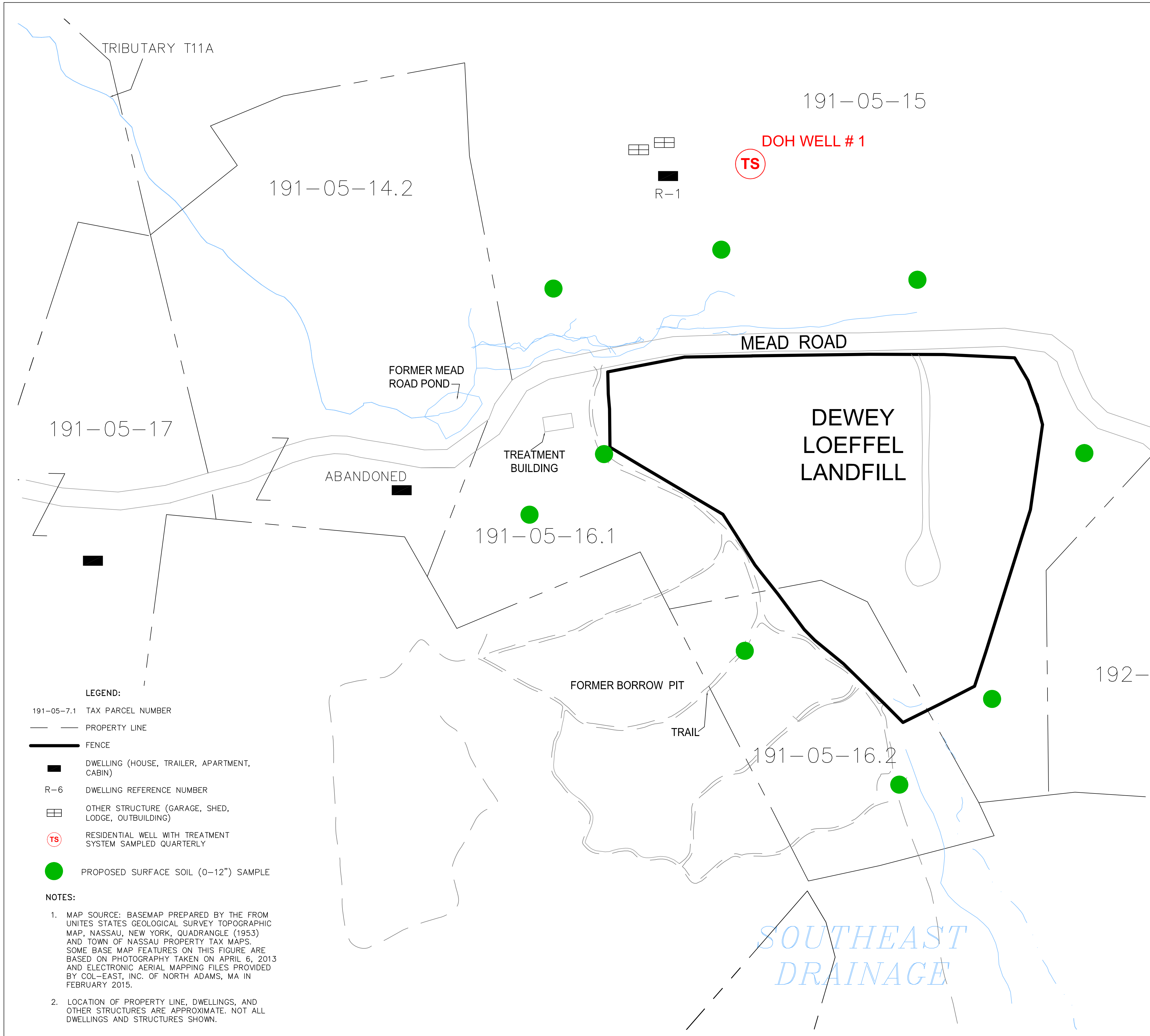


NOTE: THIS COMPOSITE MAP WAS PREPARED FROM MULTIPLE SOURCES INCLUDING USGS QUADS., AERIAL PHOTOS, FIELD OBSERVATIONS, AND FROM VARIOUS TABLES AND FIGURES PREPARED BY MULTIPLE CONSULTANTS. THE INFORMATION PROVIDED HAD VARYING DEGREES OF ACCURACY AND WAS COMBINED TO BEST FIT THE SITE CONDITIONS. ALL LOCATIONS ARE APPROXIMATE AND ARE NOT THE RESULT OF A SURVEY BY THIS OFFICE.
MAP SOURCE: LANDFILL AREA INVESTIGATIONS AND CURRENT CONDITIONS, TETRATECH, 2013. SOME BASE MAP FEATURES ON THIS FIGURE ARE BASED ON PHOTOGRAPHY TAKEN ON APRIL 6, 2013 AND ELECTRONIC AERIAL MAPPING FILES PROVIDED BY COL-EAST, INC. OF NORTH ADAMS, MA IN FEBRUARY 2015.
SURFACE WATER DISCHARGE INTO DRAINAGE DITCH
TWIN CULVERT UNDER MEAD ROAD
MEAD ROAD
TREATMENT BUILDING
LEACHATE COLLECTION SYSTEM
TANK
DRAINAGE SWALE (TYP.)
POLE BARN
2 17,640 GAL. DOUBLE WALL STORAGE TANKS
ENTRANCE ROAD
2"/4" HDPE DUAL CONTAINMENT FORCE MAIN
2"/4" HDPE DUAL CONTAINMENT FORCE MAIN
CHAIN-LINK SECURITY FENCE
EXISTING CUT-OFF WALL
TRAIL
FORMER BORROW PIT
SURFACE WATER DISCHARGE INTO DRAINAGE DITCH
OMW-105
OMW-108
OMW-107
OPZ-110
OMW-220
OPZ-217
GMW-1C
GMW-2B
GMW-1D
GMW-1B
OB-5
OB-6
PTW-2
PO-2
PO-5
PTW-1
OB-4
GMW-11A
GMW-11B
PW-2
14-C
PO-3
PO-6
OPZ-207
DB-6(I,S)
DB-3(I,S)
DB-4(I,S)
DB-5(I,S)
DB-2(I,S)
DB-1(I,S)
PO-4
PW-4
PW-1
GMW-10B
PB-1
DB-7(I,S)
DB-8(I,S)
OMW-201
OMW-102
OMW-101
EW-7
OMW-218
OMW-212
OPZ-104
S-1
OB-1
OB-2
T-2
T-1
OB-3
PO-1
PW-3
PB-2
14-F
EW-6
OMW-211
OMW-204
EW-8
EW-5
EW-4
GMW-12B
OMW-103
OMW-202
OMW-215
N
EXPLANATION
OB OVERBURDEN MONITORING WELL
BR SHALLOW BEDROCK MONITORING WELL
DB DEEP BEDROCK MONITORING WELL
DB-5(IS) MONITORING WELL PAIR CONSISTING OF OVERBURDEN AND SHALLOW BEDROCK WELLS
EW-5 EXTRACTION WELLS
DRAINAGE SWALE WITH FLOW DIRECTION ARROW
PROPOSED SURFACE WATER SAMPLE AND SOIL SAMPLE (0 - 6" BELOW SURFACE WATER)
PROPOSED SURFACE SOIL (0 - 6") SAMPLE
0 approximate 120'
Scale in feet
O'BRIEN & GERE
DEWEY LOEFFEL LANDFILL SUPERFUND SITE NASSAU, NEW YORK
PROPOSED SURFACE SOIL AND SURFACE WATER SAMPLES AT THE LANDFILL
MARCH 2015
612.51252
FIGURE 2-4



O'BRIEN & GERE

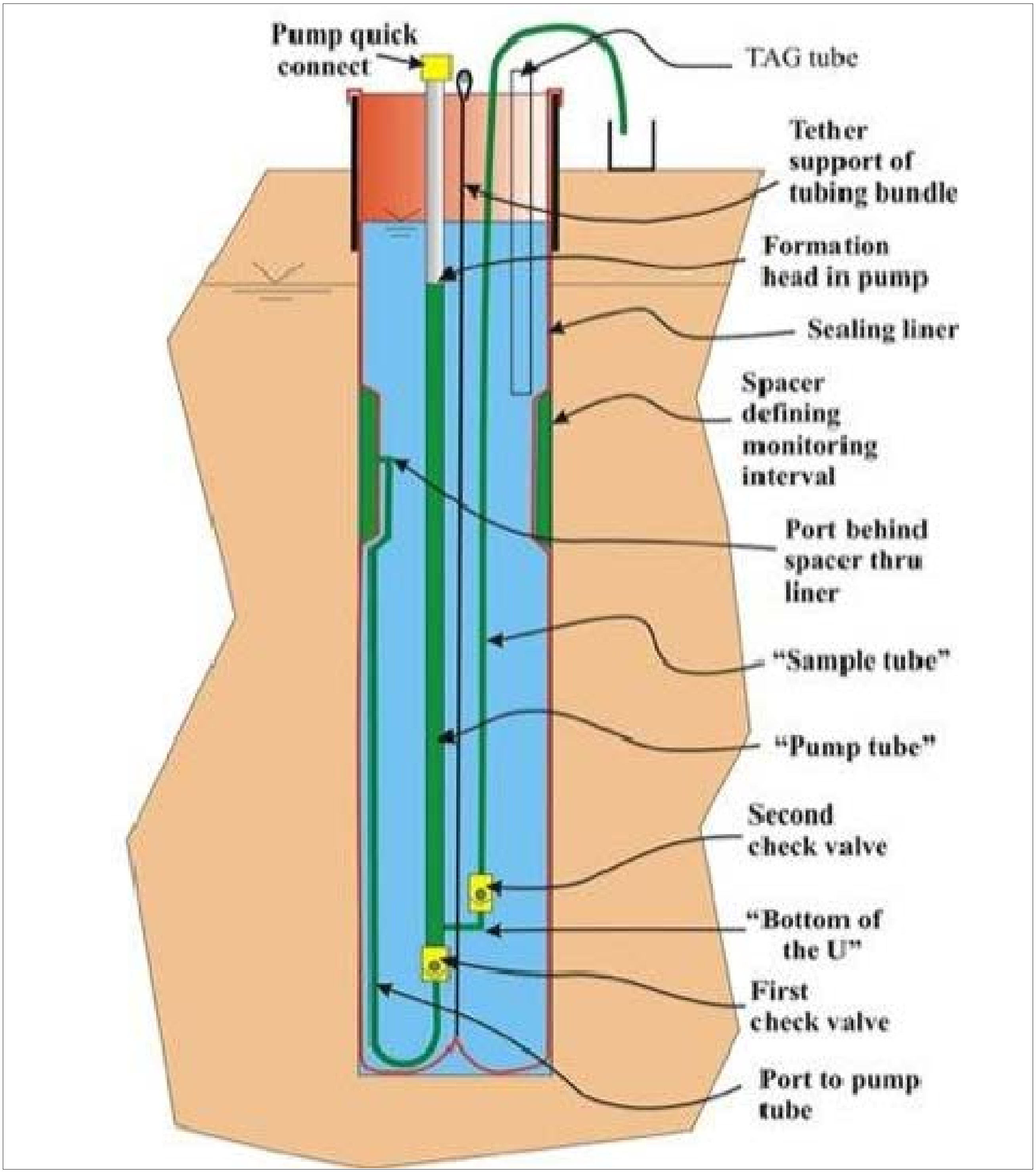
DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

PROPOSED SURFACE SOIL SAMPLES IN THE VICINITY OF THE LANDFILL

MARCH 2015
612.51252

FIGURE 2-5

FIGURE 2-6



Source: Flexible Liner Underground Technologies, LLC (http://www.flut.com/WaterFLUTe/water_method.html)
Note: Single port system shown for clarity.

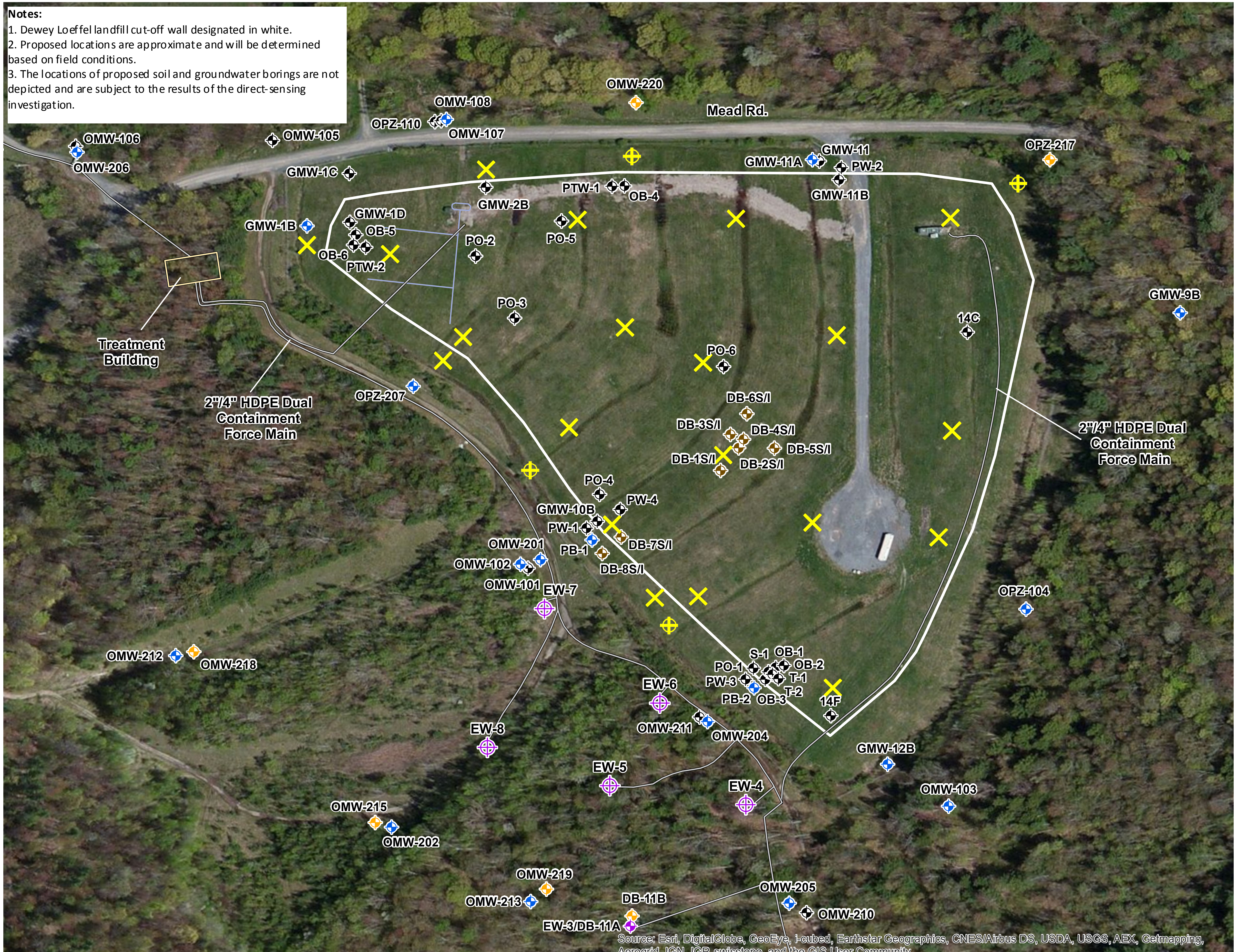
DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

WATER FLUTE™ SYSTEM

O'BRIEN & GERE

MAY 2015
612.51252

Notes:
1. Dewey Loeffel landfill cut-off wall designated in white.
2. Proposed locations are approximate and will be determined based on field conditions.
3. The locations of proposed soil and groundwater borings are not depicted and are subject to the results of the direct-sensing investigation.



This document was developed in color. Reproduction in B/W may not represent the data as intended.

I:\Ge-Cep.612\51252.Dewey-Npl-Site\Docs\Reports\RI_FS Work Plan\RI_FS Work Plan_V2\Figures\Section 2\Figure 2-7 Proposed MWs - Landfill.mxd

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FIGURE 2-7

N

Legend
- Overburden Monitoring Well
- Overburden/Shallow Bedrock Monitoring Well
- Shallow Bedrock Monitoring Well
- Deep Bedrock Monitoring Well
- Existing Extraction Well
- New Extraction Well
- Proposed New Overburden Monitoring Well Location
- Proposed New Shallow Bedrock Monitoring Well

DEWEY LOEFFEL LANDFILL
SUPERFUND SITE
NASSAU, NEW YORK

PROPOSED ADDITIONAL OVERBURDEN AND SHALLOW BEDROCK MONITORING WELL LOCATIONS

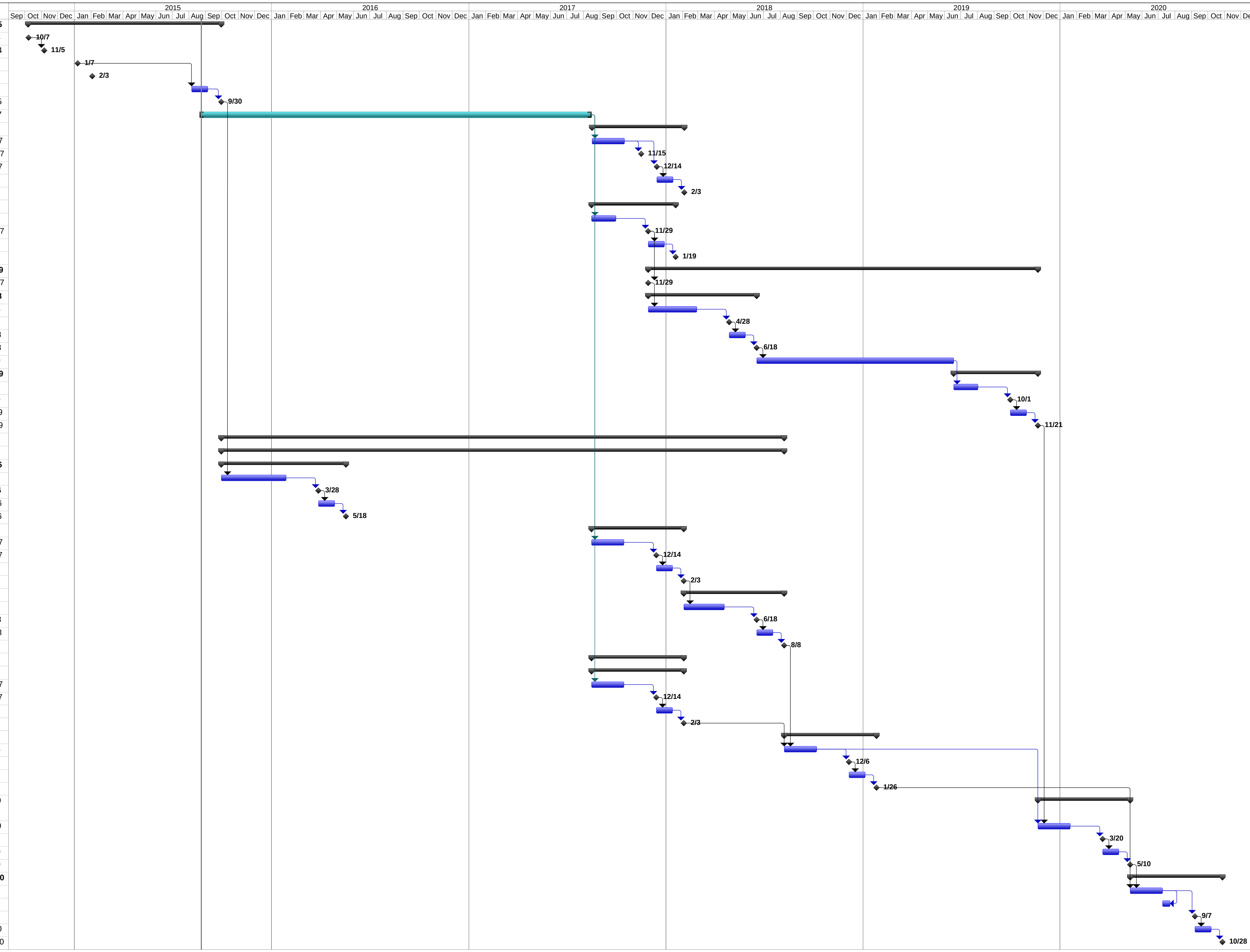
0 75 150 300
Feet

MARCH 2015
612.51252

O'BRIEN & GERE

FIGURE 11-1
Remedial Investigation/Feasibility Study Process Schedule
Dewey Loeffel Landfill Superfund Site
Nassau, Rensselaer County, New York

ID	Task Name	Duration	Start	Finish
1	**Task 2 - RI/FS Work Plan**	**256 days**	**Tue 10/7/14**	**Wed 9/30/15**
2	Submittal of RI/FS Work Plan & HASP to USEPA	1 day	Tue 10/7/14	Tue 10/7/14
3	Submittal of QAPP to USEPA	1 day	Wed 11/5/14	Wed 11/5/14
4	Receipt of USEPA comments on HASP & QAPP	0 edays	Wed 1/7/15	Wed 1/7/15
5	Receipt of USEPA comments on RI/FS Work Plan	0 edays	Tue 2/3/15	Tue 2/3/15
6	Modification/re-submittal	30 edays	Thu 8/6/15	Sat 9/5/15
7	USEPA approval or approval w/ modifications	0 edays	Wed 9/30/15	Wed 9/30/15
8	**Task 4 - RI Implementation (See Figure 11-2)**	726 edays	Fri 8/21/15	Wed 8/16/17
9	**SCSR Addendum**	**122 days**	**Wed 8/16/17**	**Sat 2/3/18**
10	Preparation/submittal	60 edays	Wed 8/16/17	Sun 10/15/17
11	Meeting to present SCSR finding	1 day	Wed 11/15/17	Wed 11/15/17
12	Receipt of USEPA comments	60 edays	Sun 10/15/17	Thu 12/14/17
13	Modification/re-submittal	30 edays	Thu 12/14/17	Sat 1/13/18
14	USEPA approval or approval w/ modifications	21 edays	Sat 1/13/18	Sat 2/3/18
15	**Task 5 - Candidate Technologies Memo**	**112 days**	**Wed 8/16/17**	**Fri 1/19/18**
16	Preparation/submittal	45 edays	Wed 8/16/17	Sat 9/30/17
17	Receipt of USEPA comments	60 edays	Sat 9/30/17	Wed 11/29/17
18	Modification/re-submittal	30 edays	Wed 11/29/17	Fri 12/29/17
19	USEPA approval or approval w/ modifications	21 edays	Fri 12/29/17	Fri 1/19/18
20	**Task 6 - Treatability Studies**	**516 days**	**Wed 11/29/17**	**Thu 11/21/19**
21	**USEPA determination**	0 days	Wed 11/29/17	Wed 11/29/17
22	**Treatability Testing Work Plan**	**143 days**	**Wed 11/29/17**	**Mon 6/18/18**
23	Preparation/submittal	90 edays	Wed 11/29/17	Tue 2/27/18
24	Receipt of USEPA comment	60 edays	Tue 2/27/18	Sat 4/28/18
25	Modification/re-submittal	30 edays	Sat 4/28/18	Mon 5/28/18
26	USEPA approval or approval w/ modifications	21 edays	Mon 5/28/18	Mon 6/18/18
27	**Treatability Testing**	365 edays	Mon 6/18/18	Tue 6/18/19
28	**Treatability Testing Evaluation Report**	**112 days**	**Tue 6/18/19**	**Thu 11/21/19**
29	Preparation/submittal	45 edays	Tue 6/18/19	Fri 8/2/19
30	Receipt of USEPA comments	60 edays	Fri 8/2/19	Tue 10/1/19
31	Modification/re-submittal	30 edays	Tue 10/1/19	Thu 10/31/19
32	USEPA approval or approval w/ modifications	21 edays	Thu 10/31/19	Thu 11/21/19
33	**Task 7 - Baseline Risk Assessment**	**745 days**	**Wed 9/30/15**	**Wed 8/8/18**
34	**Task 7A - Baseline Human Health Risk Assessment (BHHRA)**	**745 days**	**Wed 9/30/15**	**Wed 8/8/18**
35	**Memo on Exposure Scenarios & Assumption**	**165 days**	**Wed 9/30/15**	**Wed 5/18/16**
36	Preparation/submittal	120 edays	Wed 9/30/15	Thu 1/28/16
37	Receipt of USEPA comments	60 edays	Thu 1/28/16	Mon 3/28/16
38	Modification/re-submittal	30 edays	Mon 3/28/16	Wed 4/27/16
39	USEPA approval or approval w/ modifications	21 edays	Wed 4/27/16	Wed 5/18/16
40	**Pathway Analysis Report**	**123 days**	**Wed 8/16/17**	**Sat 2/3/18**
41	Preparation/submittal	60 edays	Wed 8/16/17	Sun 10/15/17
42	Receipt of USEPA comments	60 edays	Sun 10/15/17	Thu 12/14/17
43	Modification/re-submittal	30 edays	Thu 12/14/17	Sat 1/13/18
44	USEPA approval or approval w/ modifications	21 edays	Sat 1/13/18	Sat 2/3/18
45	**BHHRA Report**	**132 days**	**Sat 2/3/18**	**Wed 8/8/18**
46	Preparation/submittal	75 edays	Sat 2/3/18	Thu 4/19/18
47	Receipt of USEPA comments	60 edays	Thu 4/19/18	Mon 6/18/18
48	Modification/re-submittal	30 edays	Mon 6/18/18	Wed 7/18/18
49	USEPA approval or approval w/ modifications	21 edays	Wed 7/18/18	Wed 8/8/18
50	**Task 7B - Baseline Ecological Risk Assessment**	**123 days**	**Wed 8/16/17**	**Sat 2/3/18**
51	**Screening Level Ecological Risk Assessment Report**	**123 days**	**Wed 8/16/17**	**Sat 2/3/18**
52	Preparation/submittal	60 edays	Wed 8/16/17	Sun 10/15/17
53	Receipt of USEPA comments	60 edays	Sun 10/15/17	Thu 12/14/17
54	Modification/re-submittal	30 edays	Thu 12/14/17	Sat 1/13/18
55	USEPA approval or approval w/ modifications	21 edays	Sat 1/13/18	Sat 2/3/18
56	**Task 8 - RI Report**	**123 days**	**Wed 8/8/18**	**Sat 1/26/19**
57	Preparation/submittal	60 edays	Wed 8/8/18	Sun 10/7/18
58	Receipt of USEPA comments	60 edays	Sun 10/7/18	Thu 12/6/18
59	Modification/re-submittal	30 edays	Thu 12/6/18	Sat 1/5/19
60	USEPA approval or approval w/ modifications	21 edays	Sat 1/5/19	Sat 1/26/19
61	**Task 9 - Development & Screening of Remedial Alternatives Technical Memo**	**122 days**	**Thu 11/21/19**	**Sun 5/10/20**
62	Preparation/submittal	60 edays	Thu 11/21/19	Mon 1/20/20
63	Receipt of USEPA comments	60 edays	Mon 1/20/20	Fri 3/20/20
64	Modification/re-submittal	30 edays	Fri 3/20/20	Sun 4/19/20
65	USEPA approval or approval w/ modifications	21 edays	Sun 4/19/20	Sun 5/10/20
66	**Task 10 - FS Report**	**122 days**	**Sun 5/10/20**	**Wed 10/28/20**
67	Preparation/submittal	60 edays	Sun 5/10/20	Thu 7/9/20
68	Meeting to present FS findings	14 edays	Thu 7/9/20	Thu 7/23/20
69	Receipt of USEPA comments	60 edays	Thu 7/9/20	Mon 9/7/20
70	Modification/re-submittal	30 edays	Mon 9/7/20	Wed 10/7/20
71	USEPA approval or approval w/ modifications	21 edays	Wed 10/7/20	Wed 10/28/20

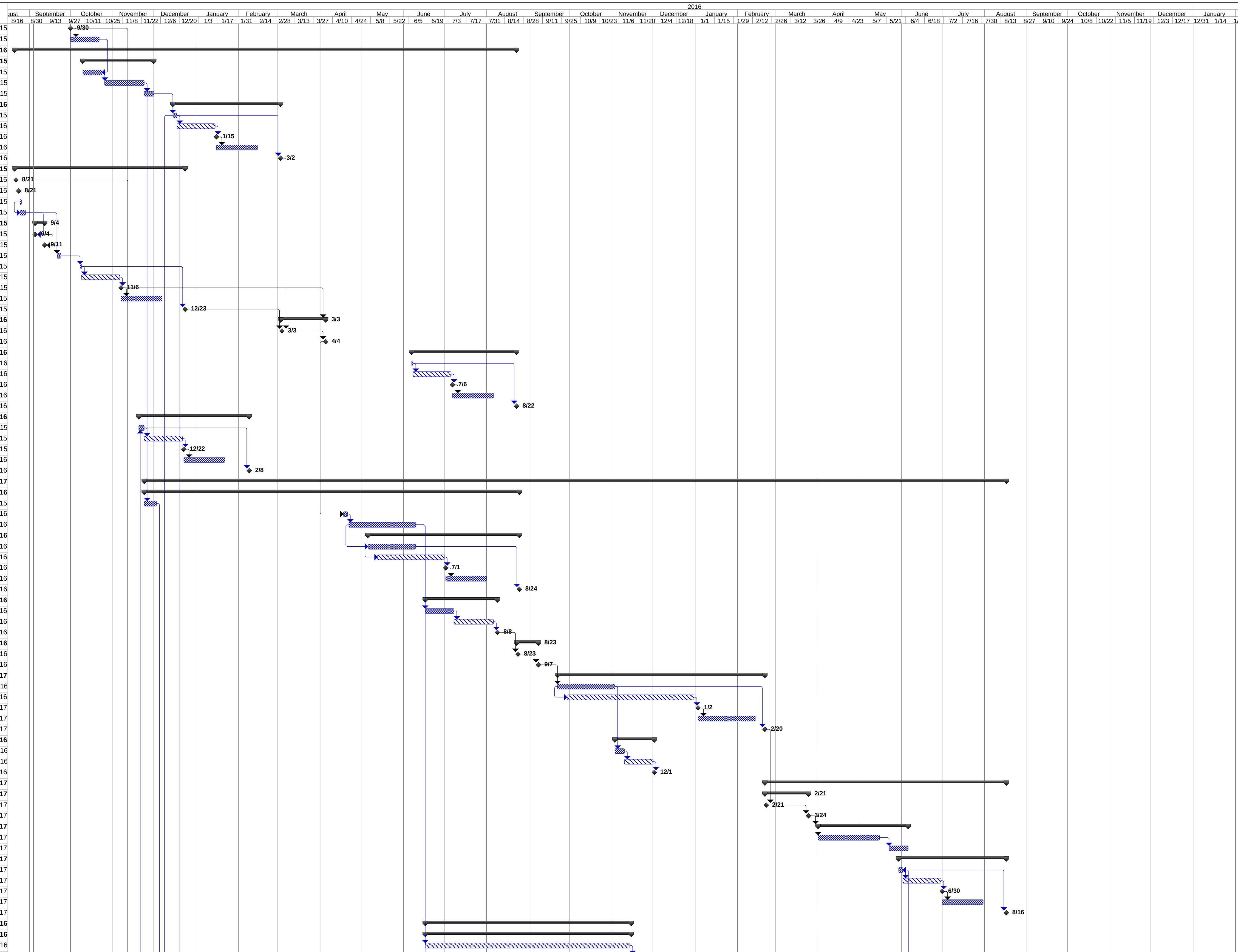


Project: Dewey RIFS Process per mark
Date: Mon 8/24/15

Task		Milestone		Project Summary		External Milestone		Inactive Milestone		Manual Task		Manual Summary Rollup		Start-only		Progress	
Split		Summary		External Tasks		Inactive Task		Inactive Summary		Duration-only		Manual Summary		Finish-only		Deadline	

FIGURE 11-2
Remedial Investigation Implementation Schedule
Dewey Loeffel Landfill Superfund Site
Nassau, Rensselaer County, New York

ID	Task Name	Duration	Start	Finish
1	**USEPA Approval or Approval w/ Modifications of RI/FS Work Plan & QAPP**	1 day	Wed 9/30/15	Wed 9/30/15
2	**Obtain Access**	21 edays	Wed 9/30/15	Wed 10/21/15
3	**Groundwater/Surface Water Interaction**	**252 days**	**Fri 8/21/15**	**Mon 8/22/16**
4	**Monitoring Well Installation at Valley Stream**	**34 days**	**Fri 10/9/15**	**Mon 11/30/15**
5	Subcontractor Mobilization	14 edays	Fri 10/9/15	Fri 10/23/15
6	Well Drilling and Installation	21 days	Mon 10/26/15	Mon 11/23/15
7	Well Development	3 days	Tue 11/24/15	Mon 11/30/15
8	**Initial Groundwater Sampling Event at Valley Stream**	**53 days**	**Tue 12/15/15**	**Wed 3/2/16**
9	Groundwater Sample Collection	3 days	Tue 12/15/15	Thu 12/17/15
10	Groundwater Sample Laboratory Analysis	28 edays	Thu 12/17/15	Thu 1/14/16
11	Receive Final Data Package	1 day	Fri 1/15/16	Fri 1/15/16
12	Data Validation	30 edays	Fri 1/15/16	Sun 2/14/16
13	Submittal of Validated Data to USEPA	1 day	Wed 3/2/16	Wed 3/2/16
14	**Surface Water/Pore Water/Staff Gage at Valley Stream**	**85 days**	**Fri 8/21/15**	**Wed 12/23/15**
15	**USEPA Conditional Approval**	1 day	Fri 8/21/15	Fri 8/21/15
16	**Obtain Access**	3 edays	Fri 8/21/15	Mon 8/24/15
17	Staff Gage Installation	1 day	Tue 8/25/15	Tue 8/25/15
18	Surface Water Reconnaissance of Valley Stream	4 days	Tue 8/25/15	Fri 8/28/15
19	**Decision on Pore Water Sample Locations**	**4 days**	**Fri 9/4/15**	**Fri 9/11/15**
20	Data Submittal to USEPA	0 days	Fri 9/4/15	Fri 9/4/15
21	Receipt of USEPA Concurrence	1 day	Fri 9/11/15	Fri 9/11/15
22	Hydraulic Head Evaluation and Pore Water PDB Installation	3 days	Mon 9/21/15	Wed 9/23/15
23	Surface Water & Pore Water Sample Collection	1 day	Thu 10/8/15	Thu 10/8/15
24	Surface/Pore Water Sample Laboratory Analysis	28 edays	Thu 10/8/15	Thu 11/5/15
25	Receive Final Data Package	1 day	Fri 11/6/15	Fri 11/6/15
26	Data Validation	30 edays	Fri 11/6/15	Sun 12/6/15
27	Submittal of Validated Data to USEPA	1 day	Wed 12/23/15	Wed 12/23/15
28	**Decision on Valley Stream Deep Bedrock Borehole Location**	**23 days**	**Thu 3/3/16**	**Mon 4/4/16**
29	Data Submittal to USEPA	1 day	Thu 3/3/16	Thu 3/3/16
30	Reciept of USEPA Concurrence	1 day	Mon 4/4/16	Mon 4/4/16
31	**Surface Water Sampling at Southern Drainage Ditch and NW of Landfill**	**54 days**	**Tue 6/7/16**	**Mon 8/22/16**
32	Surface Water Sample Collection	1 day	Tue 6/7/16	Tue 6/7/16
33	Surface Water Sample Laboratory Analysis	28 edays	Tue 6/7/16	Tue 7/5/16
34	Receive Final Data Package	1 day	Wed 7/6/16	Wed 7/6/16
35	Data Validation	30 edays	Wed 7/6/16	Fri 8/5/16
36	Submittal of Validated Data to USEPA	1 day	Mon 8/22/16	Mon 8/22/16
37	**Surface Water/Surface Soil Sampling for Risk Assessment**	**51 days**	**Fri 11/20/15**	**Mon 2/8/16**
38	Surface Water/Soil Sample Collection	2 days	Fri 11/20/15	Mon 11/23/15
39	Surface Water/Soil Sample Laboratory Analysis	28 edays	Mon 11/23/15	Mon 12/21/15
40	Receive Final Data Package	1 day	Tue 12/22/15	Tue 12/22/15
41	Data Validation	30 edays	Tue 12/22/15	Thu 1/21/16
42	Submittal of Validated Data to USEPA	1 day	Mon 2/8/16	Mon 2/8/16
43	**Characterization of Bedrock Conditions**	**442 days**	**Tue 11/24/15**	**Wed 8/16/17**
44	**Borehole Advancement**	**189 days**	**Tue 11/24/15**	**Wed 8/24/16**
45	Overburden Casing Installation at 2 Locations	5 days	Tue 11/24/15	Wed 12/2/15
46	Overburden Casing Installation at Valley Stream Location	3 days	Mon 4/18/16	Wed 4/20/16
47	Bedrock Borehole Drilling and Development	7 ewks	Thu 4/21/16	Thu 6/9/16
48	**Bedrock Chemical Testing**	**77 days**	**Thu 5/5/16**	**Wed 8/24/16**
49	Bedrock Subcore Sample Collection	35 edays	Thu 5/5/16	Thu 6/9/16
50	Bedrock Subcore Sample Laboratory Analysis	49 edays	Thu 5/12/16	Thu 6/30/16
51	Receive Final Data Package	1 day	Fri 7/1/16	Fri 7/1/16
52	Data Validation	30 edays	Fri 7/1/16	Sun 7/31/16
53	Submittal of Validated Data to USEPA	1 day	Wed 8/24/16	Wed 8/24/16
54	**Borehole Geophysical Logging**	**36 days**	**Fri 6/17/16**	**Mon 8/8/16**
55	Field Testing Program	14 days	Fri 6/17/16	Thu 7/7/16
56	Subcontractor Data Analysis & Report Preparation	21 days	Fri 7/8/16	Fri 8/5/16
57	Receive Geophysical Logging Report(s)	1 day	Mon 8/8/16	Mon 8/8/16
58	**Decision on Packer Testing Sample Intervals**	**12 days**	**Tue 8/23/16**	**Wed 9/7/16**
59	Data Submittal to USEPA	1 day	Tue 8/23/16	Tue 8/23/16
60	Reciept of USEPA Concurrence	1 day	Wed 9/7/16	Wed 9/7/16
61	**Packer Testing & Groundwater Sampling**	**106 days**	**Thu 9/22/16**	**Mon 2/20/17**
62	Packer Testing & Groundwater Sample Collection	30 days	Thu 9/22/16	Wed 11/2/16
63	Groundwater Sample Laboratory Analysis	65 days	Thu 9/29/16	Fri 12/30/16
64	Receive Final Data Package	1 day	Mon 1/2/17	Mon 1/2/17
65	Data Validation	30 edays	Tue 1/3/17	Mon 2/13/17
66	Submittal of Validated Data to USEPA	1 day	Mon 2/20/17	Mon 2/20/17
67	**Detailed Hydraulic Conductivity Profiling**	**19 days**	**Thu 11/3/16**	**Thu 12/1/16**
68	Field Testing Program	5 days	Thu 11/3/16	Wed 11/9/16
69	Subcontractor Data Analysis & Report Preparation	21 edays	Wed 11/9/16	Wed 11/30/16
70	Receive Hydraulic Conductivity Profiling Report	1 day	Thu 12/1/16	Thu 12/1/16
71	**Bedrock Well Completions**	**127 days**	**Tue 2/21/17**	**Wed 8/16/17**
72	**Decision on Deep Bedrock Borehole Monitoring Intervals**	**24 days**	**Tue 2/21/17**	**Fri 3/24/17**
73	Data Submittal to USEPA	1 day	Tue 2/21/17	Tue 2/21/17
74	Receipt of USEPA Comments/Concurrence	1 day	Fri 3/24/17	Fri 3/24/17
75	**Installation of Bedrock Monitoring Wells (as approved)**	**46 days**	**Fri 3/31/17**	**Mon 6/5/17**
76	Finalize Design & Procure Water Flutes	45 edays	Fri 3/31/17	Mon 5/15/17
77	Water Flute Installation and Development	10 days	Tue 5/23/17	Mon 6/5/17
78	**Deep Bedrock Monitoring Well Groundwater Sampling**	**57 days**	**Tue 5/30/17**	**Wed 8/16/17**
79	Groundwater Sample Collection	3 days	Tue 5/30/17	Thu 6/1/17
80	Groundwater Sample Laboratory Analysis	28 edays	Thu 6/1/17	Thu 6/29/17
81	Receive Final Data Package	1 day	Fri 6/30/17	Fri 6/30/17
82	Data Validation	30 edays	Fri 6/30/17	Sun 7/30/17
83	Submittal of Validated Data to USEPA	1 day	Wed 8/16/17	Wed 8/16/17
84	**Bedrock Physical Properties Testing**	**106 days**	**Thu 6/16/16**	**Mon 11/14/16**
85	**Bedrock Matrix Diffusion**	**106 days**	**Thu 6/16/16**	**Mon 11/14/16**
86	Bedrock Matrix Diffusion Laboratory Analysis	150 edays	Thu 6/16/16	Sun 11/13/16
87	Receive Bedrock Matrix Diffusion Test Report(s)	1 day	Mon 11/14/16	Mon 11/14/16

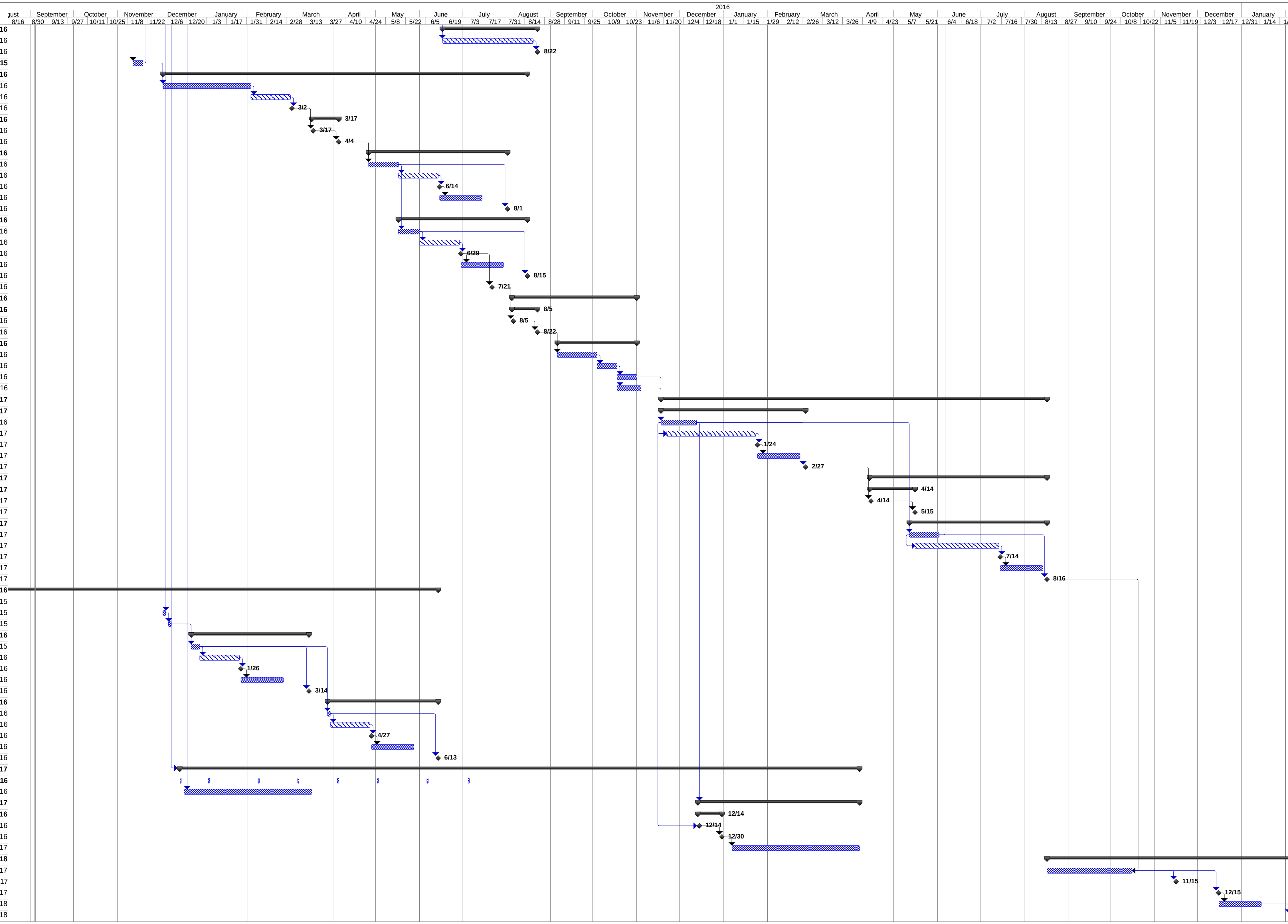


Project: DL_RI F11-2_v2
Date: Fri 9/4/15

Task	Milestone	Project Summary	External Milestone	Inactive Milestone	Manual Task	Manual Summary Rollup	Start-only	Progress
Split	Summary	External Tasks	Inactive Task	Inactive Summary	Duration-only	Manual Summary	Finish-only	Deadline

FIGURE 11-2
Remedial Investigation Implementation Schedule
Dewey Loeffel Landfill Superfund Site
Nassau, Rensselaer County, New York

ID	Task Name	Duration	Start	Finish
88	**Bedrock Physical Properties**	**46 days**	**Fri 6/17/16**	**Mon 8/22/16**
89	Bedrock Physical Properties Laboratory Analysis	45 days	Fri 6/17/16	Fri 8/19/16
90	Receive Bedrock Physical Properties Test Report(s)	1 day	Mon 8/22/16	Mon 8/22/16
91	**Utility Mark-Out/Surface Geophysical Survey**	**5 days**	**Thu 11/12/15**	**Wed 11/18/15**
92	**Direct-Sensing Investigation**	**177 days**	**Thu 12/3/15**	**Mon 8/15/16**
93	Field Testing Program	8 wks	Thu 12/3/15	Tue 2/2/16
94	Subcontractor Data Analysis & Preliminary Report Preparation	4 wks	Wed 2/3/16	Tue 3/1/16
95	Receive Preliminary Direct-Sensing Report	1 day	Wed 3/2/16	Wed 3/2/16
96	**Decision on Discrete-Interval Soil & GW Sample Intervals/Locations**	**13 days**	**Thu 3/17/16**	**Mon 4/4/16**
97	Data Submittal to USEPA	1 day	Thu 3/17/16	Thu 3/17/16
98	Reciept of USEPA Concurrence	1 day	Mon 4/4/16	Mon 4/4/16
99	**Discrete-Interval Soil Sampling**	**68 days**	**Tue 4/26/16**	**Mon 8/1/16**
100	Soil Sample Collection	15 days	Tue 4/26/16	Mon 5/16/16
101	Soil Sample Laboratory Analysis	28 edays	Mon 5/16/16	Mon 6/13/16
102	Receive Final Data Package	1 day	Tue 6/14/16	Tue 6/14/16
103	Data Validation	30 edays	Tue 6/14/16	Thu 7/14/16
104	Submittal of Validated Data to USEPA	1 day	Mon 8/1/16	Mon 8/1/16
105	**Discrete-Interval Groundwater Sampling**	**63 days**	**Tue 5/17/16**	**Mon 8/15/16**
106	Groundwater Sample Collection	10 days	Tue 5/17/16	Tue 5/31/16
107	Groundwater Sample Laboratory Analysis	28 edays	Tue 5/31/16	Tue 6/28/16
108	Receive Final Data Package	1 day	Wed 6/29/16	Wed 6/29/16
109	Data Validation	30 edays	Wed 6/29/16	Fri 7/29/16
110	Submittal of Validated Data to USEPA	1 day	Mon 8/15/16	Mon 8/15/16
111	Receive Direct-Sensing Report	1 day	Thu 7/21/16	Thu 7/21/16
112	**Monitoring Well Installation Inside and Immediately Adjacent to Landfill**	**62 days**	**Fri 8/5/16**	**Mon 10/31/16**
113	**Decision on Monitoring Well Locations and Screened Depths**	**12 days**	**Fri 8/5/16**	**Mon 8/22/16**
114	Data Submittal to USEPA	1 day	Fri 8/5/16	Fri 8/5/16
115	Reciept of USEPA Concurrence	1 day	Mon 8/22/16	Mon 8/22/16
116	**Well Drilling and Installation**	**40 days**	**Tue 9/6/16**	**Mon 10/31/16**
117	Overburden Wells Inside Landfill	20 days	Tue 9/6/16	Mon 10/3/16
118	Shallow Bedrock Wells Adjacent to Landfill	10 days	Tue 10/4/16	Mon 10/17/16
119	Well Development	10 days	Tue 10/18/16	Mon 10/31/16
120	**Monitoring Well Recompletion and Development**	13 days	Tue 10/18/16	Thu 11/3/16
121	**Synoptic/Comprehensive Groundwater Sampling Events**	**192 days**	**Fri 11/18/16**	**Wed 8/16/17**
122	**1st Groundwater Sample Collection Event (april/may or sept/oct)**	**70 days**	**Fri 11/18/16**	**Mon 2/27/17**
123	Groundwater Sample Collection	15 days	Fri 11/18/16	Mon 12/12/16
124	Groundwater Sample Laboratory Analysis	43 days	Tue 11/22/16	Mon 1/23/17
125	Receive Final Data Package	1 day	Tue 1/24/17	Tue 1/24/17
126	Data Validation	30 edays	Tue 1/24/17	Thu 2/23/17
127	Submittal of Validated Data to USEPA	1 day	Mon 2/27/17	Mon 2/27/17
128	**2nd Groundwater Sample Collection Event (april/may or sept/oct)**	**89 days**	**Fri 4/14/17**	**Wed 8/16/17**
129	**Decision on Additional Parameter Sample Collection Locations**	**22 days**	**Fri 4/14/17**	**Mon 5/15/17**
130	Data Submittal to USEPA	1 day	Fri 4/14/17	Fri 4/14/17
131	Reciept of USEPA Concurrence	1 day	Mon 5/15/17	Mon 5/15/17
132	**Implementation of Groundwater Sampling Event**	**69 days**	**Fri 5/12/17**	**Wed 8/16/17**
133	Groundwater Sample Collection	15 days	Fri 5/12/17	Thu 6/1/17
134	Groundwater Sample Laboratory Analysis	43 days	Tue 5/16/17	Thu 7/13/17
135	Receive Final Data Package	1 day	Fri 7/14/17	Fri 7/14/17
136	Data Validation	30 edays	Fri 7/14/17	Sun 8/13/17
137	Submittal of Validated Data to USEPA	1 day	Wed 8/16/17	Wed 8/16/17
138	**Vapor Intrusion**	**235 days**	**Wed 7/8/15**	**Mon 6/13/16**
139	Decommissioning of 4 Existing Wells (Completed July 9, 2015)	2 days	Wed 7/8/15	Thu 7/9/15
140	Well Drilling and Installation	2 days	Thu 12/3/15	Fri 12/4/15
141	Well Development	2 days	Mon 12/7/15	Tue 12/8/15
142	**Initial Groundwater Sampling Event**	**55 days**	**Wed 12/23/15**	**Mon 3/14/16**
143	Groundwater Sample Collection	2 days	Wed 12/23/15	Mon 12/28/15
144	Groundwater Sample Laboratory Analysis	28 edays	Mon 12/28/15	Mon 1/25/16
145	Receive Final Data Package	1 day	Tue 1/26/16	Tue 1/26/16
146	Data Validation	30 edays	Tue 1/26/16	Thu 2/25/16
147	Submittal of Validated Data to USEPA	1 day	Mon 3/14/16	Mon 3/14/16
148	**Second Groundwater Sampling Event**	**55 days**	**Mon 3/28/16**	**Mon 6/13/16**
149	Groundwater Sample Collection	2 days	Mon 3/28/16	Tue 3/29/16
150	Groundwater Sample Laboratory Analysis	28 edays	Tue 3/29/16	Tue 4/26/16
151	Receive Final Data Package	1 day	Wed 4/27/16	Wed 4/27/16
152	Data Validation	30 edays	Wed 4/27/16	Fri 5/27/16
153	Submittal of Validated Data to USEPA	1 day	Mon 6/13/16	Mon 6/13/16
154	**Hydraulic Monitoring**	**335 days**	**Tue 12/15/15**	**Thu 4/6/17**
155	Monthly Synoptic Water Level Measurements	**140 days**	**Tue 12/15/15**	**Tue 7/5/16**
168	Near Continuous Water Level Monitoring In Vicinity of Valley Stream	90 edays	Thu 12/17/15	Wed 3/16/16
169	**Near Continuous Water Level Monitoring In Vicinity of Landfill**	**82 days**	**Wed 12/14/16**	**Thu 4/6/17**
170	**Decision on Wells to be used for Hydraulic Monitoring Program**	**13 days**	**Wed 12/14/16**	**Fri 12/30/16**
171	Data Submittal to USEPA	1 day	Wed 12/14/16	Wed 12/14/16
172	Reciept of USEPA Concurrence	1 day	Fri 12/30/16	Fri 12/30/16
173	Implementation of Hydraulic Monitoring Program	90 edays	Fri 1/6/17	Thu 4/6/17
174	**SCSR Addendum**	**122 days**	**Wed 8/16/17**	**Sun 2/4/18**
175	Preparation/Submittal	60 edays	Wed 8/16/17	Sun 10/15/17
176	Meeting to Present SCSR Findings	1 day	Wed 11/15/17	Wed 11/15/17
177	Reciept of USEPA Comments	1 day	Fri 12/15/17	Fri 12/15/17
178	Modification/Resumittal	30 edays	Fri 12/15/17	Sun 1/14/18
179	USEPA approval or approval w/ modifications	21 edays	Sun 1/14/18	Sun 2/4/18



Project: DL_RI F11-2_v2
Date: Fri 9/4/15

Task · Split · Milestone · Summary · Project Summary · External Tasks · External Milestone · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · Progress · Deadline

Exhibit

Phase IA Archeological Sensitivity Assessment

HARTGEN
archeological associates inc

PHASE IA ARCHEOLOGICAL SENSITIVITY ASSESSMENT

Dewey Loeffel Landfill Superfund Site
Remedial Investigation and Feasibility Study

Mead Road
Town of Nassau
Rensselaer County, New York

HAA # 4706-11

Submitted to:
O'Brien & Gere Engineers, Inc.
94 New Karner Road, Suite 106
Albany, New York 12203

Prepared by:
Hartgen Archeological Associates, Inc.

1744 Washington Avenue Ext.
Rensselaer, New York 12144
p +1 518 283 0534
f +1 518 283 6276
e hartgen@hartgen.com

www.hartgen.com

An ACRA Member Firm
www.acra-crm.org

October 2014, revised August 2015

MANAGEMENT SUMMARY

SHPO Project Review Number: n/a
Involved State and Federal Agencies: United States Environmental Protection Agency (USEPA)
Phase of Survey: IA

LOCATION INFORMATION

Location: Mead Road
Minor Civil Division: Town of Nassau (08306)
County: Rensselaer

SURVEY AREA

Length: approximately 5,300 ft (1,615 m)
Width: approximately 4,100 ft (1,250 m)
Number of Acres Surveyed: 364 (147 ha)
7.5 Minute Quadrangle Map: Nassau

RESULTS OF RESEARCH

Sites within one mile: two historic sites over one-half mile away
Surveys in vicinity: none
NR/NRE sites in or adjacent: none
OPRHP inventoried structures in or adjacent: none
Precontact Sensitivity: moderate in more level, better drained areas; low in sloping or wet areas.
Historic Sensitivity: low in most areas, moderate to high near map-documented structures along Central Nassau Road

RECOMMENDATIONS

The Phase IA was prepared as part on the on-going Remedial Investigation/Feasibility Study being conducted for the study area. At the time this report was prepared, only investigative activities limited to soil borings and ground monitoring wells are proposed although no specific locations were identified. These are minor undertakings and no archeological investigation is recommended. Once the locations and extent of remediation measures are identified, it is recommended that subsurface testing be conducted if the proposed remediation involves ground disturbance. Testing can be limited to the more level, better drained areas and/or in proximity to map-documented structures to determine the presence or absence of archeological deposits. No testing is recommended for areas of excessive slope, standing water and prior disturbance or for areas where remedial activities do not involve ground disturbance.

Report Authors: Lori J. Blair, MA
Date of Report: October 6, 2014; revised August 21, 2015

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PHASE IA LITERATURE REVIEW AND ARCHEOLOGICAL SENSITIVITY ASSESSMENT

INTRODUCTION

Hartgen Archeological Associates, Inc. (Hartgen) was retained by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) to conduct a Phase IA archeological sensitivity investigation for the Dewey Loeffel Landfill Superfund Site (Site) located on Mead Road in the Town of Nassau, Rensselaer County, New York. The Site is a United States Environmental Protection Agency (USEPA) Region 2 Superfund Site. A Remedial Investigation/Feasibility Study (RI/FS) is currently being undertaken for the Landfill and Groundwater components of the Site. The cultural resources investigation was completed pursuant to the requirements of the Statement of Work (RI/FS SOW) included as Appendix 2 of the Administrative Settlement Agreement and Order on Consent for Remedial Investigation and Feasibility Study of Landfill and Groundwater (Index No. CERCLA-02-2013-2008) (Settlement Agreement) executed between the USEPA and the General Electric Company (GE) and SI Group, Inc. (SI Group) (GE and SI Group are referred to collectively herein as the Respondents), effective October 7, 2013. This investigation was conducted to comply with Section 106 of the National Historic Preservation Act. The investigation was conducted according to the New York Archaeological Council's *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections* (1994), which are endorsed by the New York State Office of Parks, Recreation and Historic Preservation (OPRHP). This report has been prepared according to OPRHP's *State Historic Preservation Office (SHPO) Phase I Archaeological Report Format Requirements* (2005).

PROJECT INFORMATION

A site visit was conducted by Lori J. Blair on August 4, 2014 to observe and photograph general conditions within the study area. Ms. Blair was escorted by Paul D'Annibale of O'Brien & Gere. The site visit focused on areas identified as proposed disturbance areas although observations were made of areas within the overall study area. The information gathered during the site visit is included in the relevant sections of the report.

Project Location

The Dewey Loeffel Landfill proper is located in the Town of Nassau approximately 4 miles northeast of the Village of Nassau in southern Rensselaer County, New York. The Landfill is on the south side of Mead Road, a small gravel roadway that extends between Nassau Averill Park Road and Central Nassau Road (Map 1).

Description of the Project Area

The Landfill occupies approximately 19.6 acres on the south side of Mead Road. From 1952 to 1968 the Landfill was used as a disposal facility by the Loeffel Waste Oil Removal and Service Company and received hazardous waste materials from several Capital District businesses. The Landfill was covered and graded in the 1970s and a containment system consisting of a cap and subsurface cut-off wall was constructed from 1983-1984.

The surrounding area is predominantly rural, residential with scattered homes along Mead Road and Central Nassau Road. For the purposes of this Phase IA, an area encompassing approximately 364 acres surrounding the Landfill was identified as the cultural resources study area. Within the study area, O'Brien & Gere identified several proposed disturbance areas (Map 2). These areas represent the most likely location for investigative activities, but are preliminary and may change.

Description of the Area of Potential Effects (APE)

The area of potential effects (APE) includes all portions of the property that will be directly or indirectly altered by the proposed undertaking. The Phase IA was prepared as part of the RI/FS currently being undertaken for the Landfill and Groundwater components of the Site. The goals of the RI/FS include determining the nature and extent of contamination in order to identify clean-up actions to eliminate, reduce or control risks to human health and the environment. Currently, continuing investigative activities limited to soil borings and groundwater monitoring wells are planned. Although no specific locations were identified, the general areas identified by the client as proposed disturbance areas represent the most likely locations for proposed investigative activities. The locations and extent of remediation measures will be identified following completion of investigative activities.

The background research included the overall 364-acre study area; the site visit focused on the Landfill with surrounding potential disturbance area (approximately 40 acres) and the proposed disturbance areas to the south of the Landfill (about 78 acres combined).

ENVIRONMENTAL BACKGROUND

The environment of an area is significant for determining the sensitivity of the project area for archeological resources. Precontact and historic groups often favored level, well-drained areas near wetlands and waterways. Therefore, topography, proximity to wetlands, and soils are examined to determine if there are landforms in the project area that are more likely to contain archeological resources. In addition, bedrock formations may contain chert or other resources that may have been quarried by precontact groups. Soil conditions can provide a clue to past climatic conditions, as well as changes in local hydrology.

Present Land Use and Current Conditions

The Landfill has been graded and capped. It is currently grassed except for gravel access roads and facilities that have been constructed as part of the on-going environmental work (Photo 1 and 2). Numerous dirt trails traverse the area (Photo 3). Off the trails, the study area and proposed disturbance areas are heavily wooded. The topography varies from extensively sloping to moderately sloping with some small terraces (Photos 4, 5 and 6). Small drainages and wetland areas were noted. Rocks and small boulders on the surface suggest shallow, rocky soils. A small stream is located along the southern portion of the study area (Photos 7, 8, and 9).

Soils

Soil surveys provide a general characterization of the types and depths of soils that are found in an area. This information is an important factor in determining the appropriate methodology if and when a field study is recommended. The soil type also informs the degree of artifact visibility and likely recovery rates. For example, artifacts are more visible and more easily recovered in sand than in stiff glacial clay, which will not pass through a screen easily.

Several soils are located within the study area (Map 3 and Table 1). Large areas are described as gravelly silt loams and gravelly sandy loams, characterized as well drained to somewhat excessively drained. These soils are predominant in most of the proposed disturbance areas. Exceptions include some areas along the stream south of Central Nassau Road where soils are poorly drained components of the Fluvaquents, Udifluvents complex.

Table 1. Soils in the Study Area

Symbol	Name	Depth	Textures	Slope	Drainage	Landform
BeC	Bernardston gravelly silt loam	0-20 cm (0-8 in)	Gra si lo	8-15%	Well drained	Drumlinoid ridges, hills, till plains
		20-76 cm (8-30 in)	Channery Si lo, Gra lo, Si lo			
		76-152 cm (30-60 in)	Channery Si lo, Gra lo, Lo			
BfC	Bernardston very stony silt loam	0-20 cm (0-8 in)	Gra si lo	3-15%	Well drained	Drumlinoid ridges, hills, till plains
		20-76 cm (8-30 in)	Channery Si lo, Gra lo, Si lo			

Symbol	Name	Depth	Textures	Slope	Drainage	Landform
		76-152 cm (30-60 in)	Channery Si lo, Gra lo, Lo			
BfD	Bernardston very stony silt loam	0-20 cm (0-8 in)	Gra si lo	15-40%	Well drained	Drumlinoid ridges, hills, till plains
		20-76 cm (8-30 in)	Channery Si lo, Gra lo, Si lo			
		76-152 cm (30-60 in)	Channery Si lo, Gra lo, Lo			
CaA	Carlisle muck	0-157 cm (0-62 in)	Muck	0-1%	Very poorly drained	Swamps, marshes
FlA	Fluvaquents-Udifluvents complex	0-15 cm (0-6 in)	Si lo	0-3%	Poorly drained	Flood plains
		15-152 cm (6-60 in)	Coarse Sa, Gra si lo, very Gra sa lo, Si cl lo			
HoC	Hoosic gravelly sandy loam, rolling	0-25 cm (0-10 in)	Gra sa lo	8-15%	Somewhat excessively drained	Deltas, outwash plains, terraces
		25-76 cm (10-30 in)	Gra lo, Gra sa lo, very Gra sa lo			
		76-152 cm (30-60 in)	Very Gra lo sa, very Gra sa			
HoD	Hoosic gravelly sandy loam, hilly	0-25 cm (0-10 in)	Gra sa lo	15-25%	Somewhat excessively drained	Deltas, outwash plains, terraces
		25-76 cm (10-30 in)	Gra lo, Gra sa lo, very Gra sa lo			
		76-152 cm (30-60 in)	Very Gra lo sa, very Gra sa			

Key: Texture: Co-Coarse, Fi-Fine, Gv-Gravel(ly, Lo-Loam, Sa-Sand, Si-Silt, Vy-Very

Bedrock Geology

The vicinity of the study area is underlain by Cambrian age slate, shale and quartzite of the Nassau Formation (Fisher, et al. 1970). No bedrock outcrops were noted in the study area during the site visit.

Physiography and Hydrology

Steeply sloped areas are considered largely unsuitable for human occupation. As such, the standards for archeological fieldwork in New York State generally exclude areas with a slope in excess of 12% from archeological testing (NYAC 1994). Exceptions to this rule include steep areas with bedrock outcrops, overhangs, and large boulders that may have been used by precontact people as quarries or rock-shelters. Such areas may still warrant a systematic field examination.

The study area is characterized by varying topography with many areas of moderate to steep slopes. Elevations generally sloped downward to the south. While some small boulders and large rocks were noted in areas during the site visit, no large rock overhangs or bedrock outcrops were noted. Small drainages and wetlands were observed in sections of the study area, including Valley Stream, which is located south of Central Nassau Road and eventually empties into Nassau Lake southwest of the study area. The Valatie Kill is located northwest of the study area.

DOCUMENTARY RESEARCH

Archeological Sites

Previously reported archeological sites provide an overview of both the types of sites that may be present in the study area and relation of sites throughout the surrounding region. The presence of few reported sites, however, may result from a lack of previous systematic survey and does not necessarily indicate a decreased archeological sensitivity within the project area.

No known sites are located within or immediately adjacent to the Landfill or study area. However, an examination of the archeological site files at the OPRHP and the New York State Museum (NYSM) identified two reported historic archeological sites within a one mile (1.6 km) radius of the study area (Table 2). No precontact sites were identified within one mile.

Table 2. OPRHP/NYSM Archeological Sites within One Mile (1.6 km) of the Study Area*

OPRHP Site No.	NYSM Site No.	Site Identifier	Description	Proximity to Project Area
08306.000022		Devereaux Mill	Historic: late-19th-century mill remains	2,400 ft west of study area
08306.000013		Casey Homestead Foundation	Historic: Fireplace base and foundation. Late-18th-century ceramics found.	3,500 ft northeast of study area

*****Not for Public Distribution

State and National Register

The computer files at OPRHP were searched for properties located within the vicinity of the study area that have been listed on the State/National Registers of Historic Places (NR), determined eligible (NRE) for listing on the registers, or merely inventoried (meaning they are included in the database but either have been determined ineligible for the National Register or their status has yet to be determined). The search did not identify any NR properties in or adjacent to the study area. The search identified on NRE and two inventoried properties on Mud Pond Road to the northeast. Brief descriptions of the three properties are provided below in Table 3.

Table 3. NRE Properties and Inventoried Buildings within Vicinity of the Study Area

OPRHP Number	Property Name	Status	Description	Location and Proximity to Project Area
08306.000073	Binck-Casey Wagon Shed	NRE	97 Mud Pond Rd, part of a district; no form.	About 3,500 ft northeast
08306.000037	Carpentier Residence		Mud Pond Road, west side between China Hill Road and Central Nassau Road.	About 3,500 ft northeast
08306.000071	Carriage Barn/ Blacksmith shop		Mud Pond Road; no form.	About 3,500 ft northeast

Previous Surveys

There are no previous surveys within one mile of the project area based on an examination of the OPRHP database and library.

HISTORICAL MAP REVIEW

Several historical maps that depict the general vicinity of the project were reviewed for this report. These include several 19th-century landowner maps, and early to mid-20th-century topographic maps. Select maps are presented in this report (Maps 1, 4-9). The maps are georeferenced and the study area has been superimposed on each of the maps.

The earliest map examined dates to 1829 (Burr 1829). The map shows the village of Nassau to the south but nothing is depicted in the vicinity of the study area. Map 4 is the earliest map examined that shows the vicinity of the study with some detail (Rogerson 1854). The map shows that by the mid-19th century, the major road patterns in the vicinity of the study area are developed much as they are today. These include what are now Mead Road, Central Nassau Road and Curtis Hill Road. Several structures are shown along these roadways in and adjacent to the study area. Names associated with these structures include Mead, Waterbury, Ambler, Hall and Bink (see Table 4). Except for at the intersection of Curtis Hill Road and Central Nassau

Road where a structure associated with E Ambler (MDS 7) is shown, no structures are indicated within the proposed disturbance areas or within the Landfill.

Maps 5 and 6 (Beers 1876; Lake and Beers 1861) do not indicate significant changes within the immediate vicinity of the study area except for the addition of a structure along Central Nassau Road just west of Mead Road (Structure 13). This house still stands within the study area (Photo 10).

Maps 7, 8 and 9 are sections of topographic quadrangles (United States Geological Survey (USGS) 1893, 1928, 1950).The maps are similar to the 19th-century maps in terms of general characteristics of the study area. No structures are shown within the Landfill or the potential planned disturbance areas in the central part of the study area. Structures are indicated along Mead Road and Central Nassau Road.

Although not identified by name, the Central Nassau Cemetery is located within the study area on the south side of Central Nassau Road (Map 9). The cemetery's sign indicates a date of c.1876. A cursory examination of the cemetery indicated that many of those buried here were members of the Waterbury family. Other surnames noted include Burlington, Marten, Pangburn, Williams, Sharp, Malagodi and Wood. Many burial dates were from the late 19th century with several from the early 20th century. The most recent date noted was 2007. The cemetery does not lie within a potential area of disturbance.

Map-Documented and Existing Structures

Each past or current structure within the study area is assigned a unique structure number. Map-documented structures—those structures that are depicted on one or more maps but no longer standing—are distinguished using the abbreviation "MDS" after the structure number (e.g. Structure 3 (MDS)).

The examination of historical maps shows several structures along Central Nassau Road and Mead Road in the vicinity of the study area by the mid-19th century (Table 4; Map 10). The number of structures decreased by the late 19th century and by the mid-20th century only six are shown on a map (Map 9). Only one of the MDSs shown on the earlier maps is located within one of the potential planned disturbance areas. A structure shown associated with the name Ambler is located at southeast corner of Central Nassau Road and Curtis Hill Road (Structure 7 mds). This structure is not shown after 1928 and currently this area is occupied by a 20th century house and garage. The structures located north of Mead Road were not visible from the roadway. While the easternmost structure apparently still exists it is not known if the other is extant. While a house currently stands in the vicinity of Structure 4, shown on the maps along the north side of Central Nassau Road (west of the Tri-Village Bowhunters Club); it was not clearly visible from the roadway to confirm whether the house dates from the 19th century or if it is later.

Table 4. Summary of Map-Documented and Existing Structures within the Study Area

Str #	Map 4 (1854)	Map 5 (1861	Map 6 (1876)	Map 7 (1893)	Map 8 (1928)	Map 9 (1950)	1978/ Photorevised 1992	Extant (2014)
1 mds n CN Rd	S. Waterbury store	Store	S. Waterbury store					
2 mds n CN Rd	S. Waterbury	D.S. Waterbury	D. Waterbury					
3 mds n CN Rd	D. Waterbury	D.S. Waterbury	D. Waterbury					
4 possibly still standing on north side of Central Nassau Rd.	A Bedell	E.Ambler	E Ambler	?	?	?	?	x not clearly visible from road
5 mds n CN Rd	E. Ambler	A. Ambler						
6 mds n CN Rd	L H Haynes	Dr. J. Haynes	C Waterbury	x	x			
7 mds s CN Rd	E. Ambler	A. Ambler	A. Ambler	x	x			
8 s CN Rd	J. Bink	J. Binck (sic)	J.H. Binck	x	x	x	x	x
9 mds n CN Rd	Waterbury	S. Waterbury	Wm. Hall					

Str #	**Map 4 (1854)**	**Map 5 (1861**	**Map 6 (1876)**	**Map 7 (1893)**	**Map 8 (1928)**	**Map 9 (1950)**	**1978/ Photorevised 1992**	**Extant (2014)**
10 mds CH Rd	B.S.S. (blacksmith)		R. E. Casey		x	x		
11 n Mead Rd	G.W. Meade	J. Mead	G. W. Mead	x	x	x	x	x
12 n Mead Rd	GW. Meade	G.W. Mead	G. W. Mead	x	x	x	x	
13 cor CN & MR		S. Waterbury	S, Waterbury	x	x	x	x	#385
14 mds n CN Rd					x			
15 vic of MDS 9					x	x	x	
16 cor MR CN Rd							x	x
17 vic. of MDS 7							x	x

- **CN Rd = Central Nassau Road**
- **MR = Mead Road**
- **CH Rd = Curtis Hill Road**
- **N = north side; s = south side; vic = vicinity; cor= corner**

ARCHEOLOGICAL SENSITIVITY ASSESSMENT

The New York Archaeological Council provides the following description of archeological sensitivity:

> Archaeologically sensitive areas contain one or more variables that make them likely locations for evidence of past human activities. Sensitive areas can include places near known prehistoric sites that share the same valley or that occupy a similar landform (e.g., terrace above a river), areas where historic maps or photographs show that a building once stood but is now gone as well as the areas within the former yards around such structures, an environmental setting similar to settings that tend to contain cultural resources, and locations where Native Americans and published sources note sacred places, such as cemeteries or spots of spiritual importance (NYAC 1994:9).

The archeological potential of an area consists of its sensitivity modified by modern disturbance. Recommendations for additional investigation are based on the project area's archeological sensitivity and potential, and are discussed below.

Precontact Archeological Sensitivity

The study area is not located within an area designated on the OPRHP website as a known archeologically sensitive area. Generally, this designation is based on the proximity of reported archeological sites. No known sites are located within or immediately adjacent to the study area. This may reflect the lack of previous surveys in the area rather than reflect a low sensitivity. Areas of known archeological sensitivity are indicated to the north, east, southeast and west along streams and swamps. Generally, areas in the vicinity of streams and wetlands suggest a potential for occupation or use by Native Americans who may have occupied the area. These areas represent potential food and water sources.

Based on the study area's physiographic characteristics, the more level and better drained areas near streams or wetlands are considered to have a moderate sensitivity for precontact resources. A lower sensitivity is assigned to areas of slope or standing water.

Historic Archeological Sensitivity

The historic sensitivity of an area is based largely on the examination of historical maps as well as the presence of documented archeological sites in the vicinity. The 19th-century property maps indicate development in the immediate vicinity of the study area as early as the mid-19th century, including several structures along Central Nassau Road in the southern portion of the study area. Several of the structures shown on the historic map within the study area are no longer standing. The vicinity of the map-documented structures is considered to have a high sensitivity for historic structural remains as well as associated archeological deposits. Most of the study area, particularly the proposed disturbance areas are far enough away from the historic road network that they are considered to have a low archeological sensitivity for historic resources.

ARCHEOLOGICAL POTENTIAL

The archeological potential is the likelihood of locating intact archeological remains within the study area. The combined site file and environmental data suggest the project area has a low to moderate sensitivity for precontact cultural resources and a low to high sensitivity for historic deposits depending on the proximity to map documented structures. The Landfill has undergone substantial prior disturbance associated with its operation as a disposal area as well as subsequent grading, debris removal, capping and environmental testing. Some small, localized areas of disturbance were noted in the study area, including the proposed disturbance areas. These disturbances include the areas around the residences and bowhunters club along Central Nassau Road; recent house construction along Mead Road; the trails that traverse the area; and areas where environmental work has entailed the construction of such facilities as extraction wells and ground water monitoring wells, etc. However, much of the study area appears relatively undisturbed.

RECOMMENDATIONS

The Phase IA was prepared as part on the on-going RI/FS being conducted for the study area. At the time this report was prepared, only investigative activities limited to soil borings and ground monitoring wells are proposed although no specific locations were identified. These are minor undertakings and no archeological investigation is recommended. Once the locations and extent of remediation measures are identified, it is recommended that an assessment of the need for and scope of additional cultural resource investigations be conducted subsequent to the issuance of a Record of Decision (ROD) and prior to commencement of the remedial action. Subsurface archeological testing can be limited to the more level, better drained areas and/or in proximity to map-documented structures to determine the presence or absence of archeological deposits. No testing is recommended for areas of excessive slope, standing water or prior disturbance or for areas where post-ROD remedial activities do not involve ground disturbance.

BIBLIOGRAPHY

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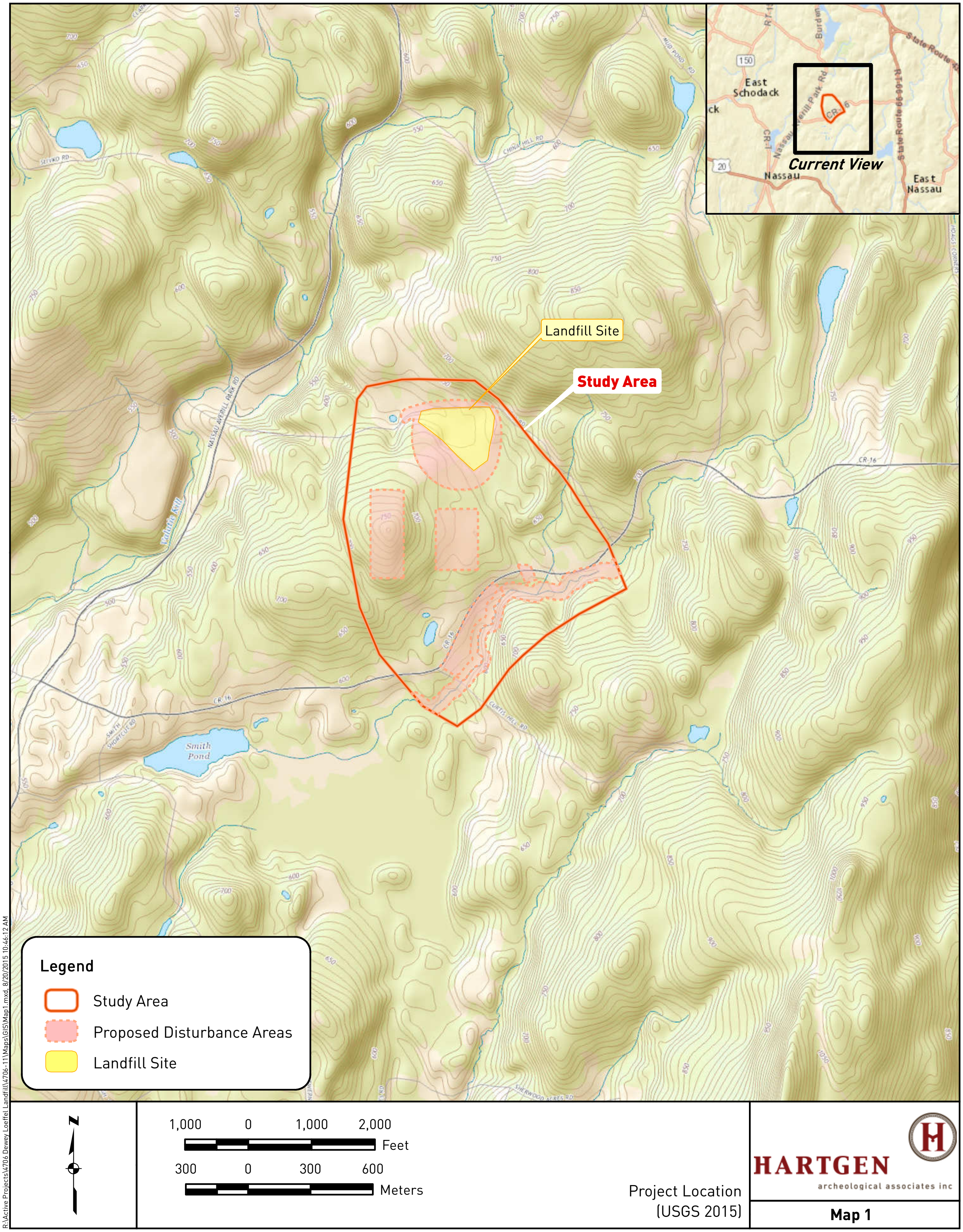
2015 USGS The National Map Topo Base Map - Large Scale. USGSTopo (MapServer), The National Map Seamless Server, USGS, Sioux Falls, South Dakota, http://services.nationalmap.gov/arcgis/rest/services/USGSTopoLarge/MapServer.

MAPS



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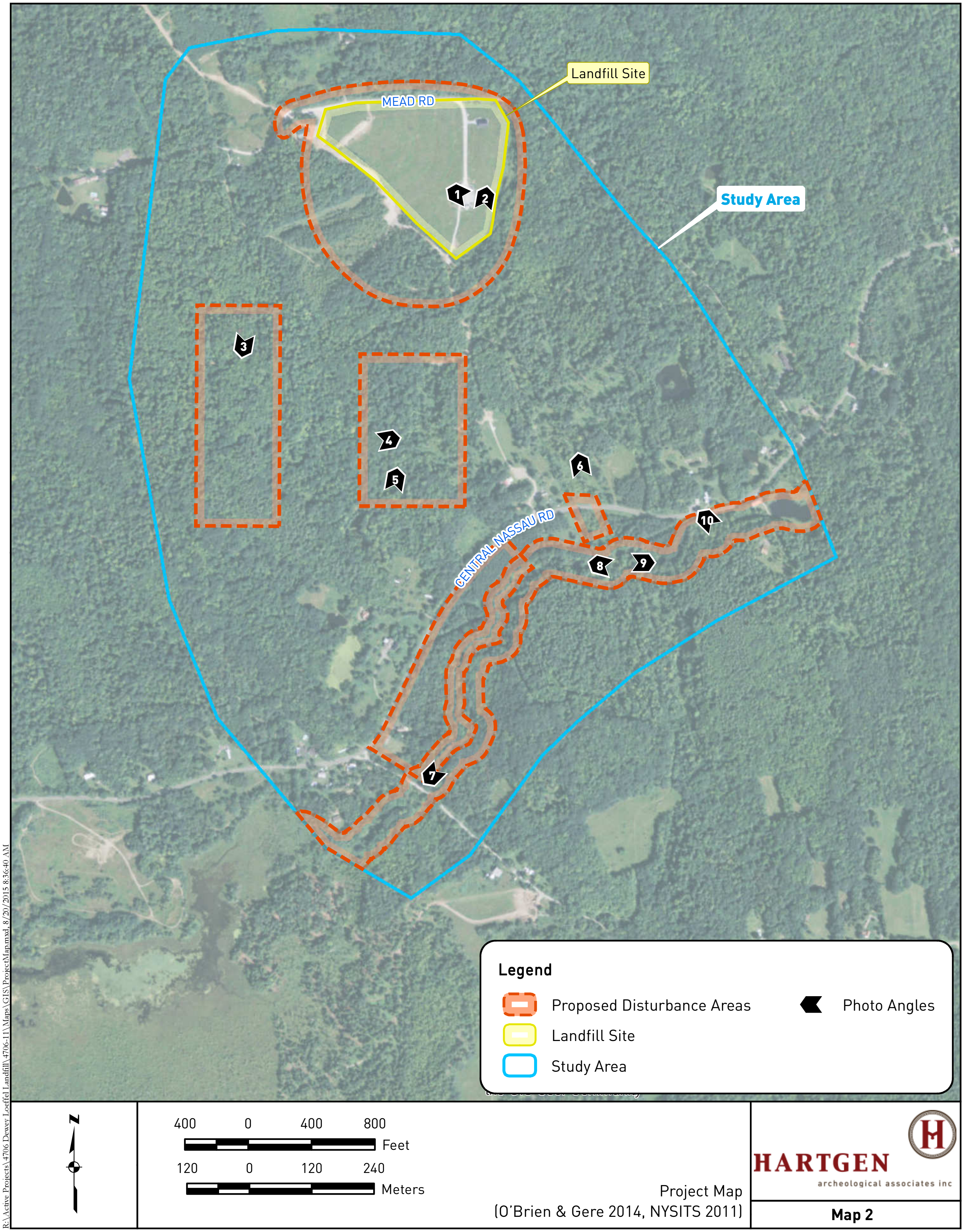

Project Map
(O'Brien & Gere 2014, NYSITS 2011)

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Map 2

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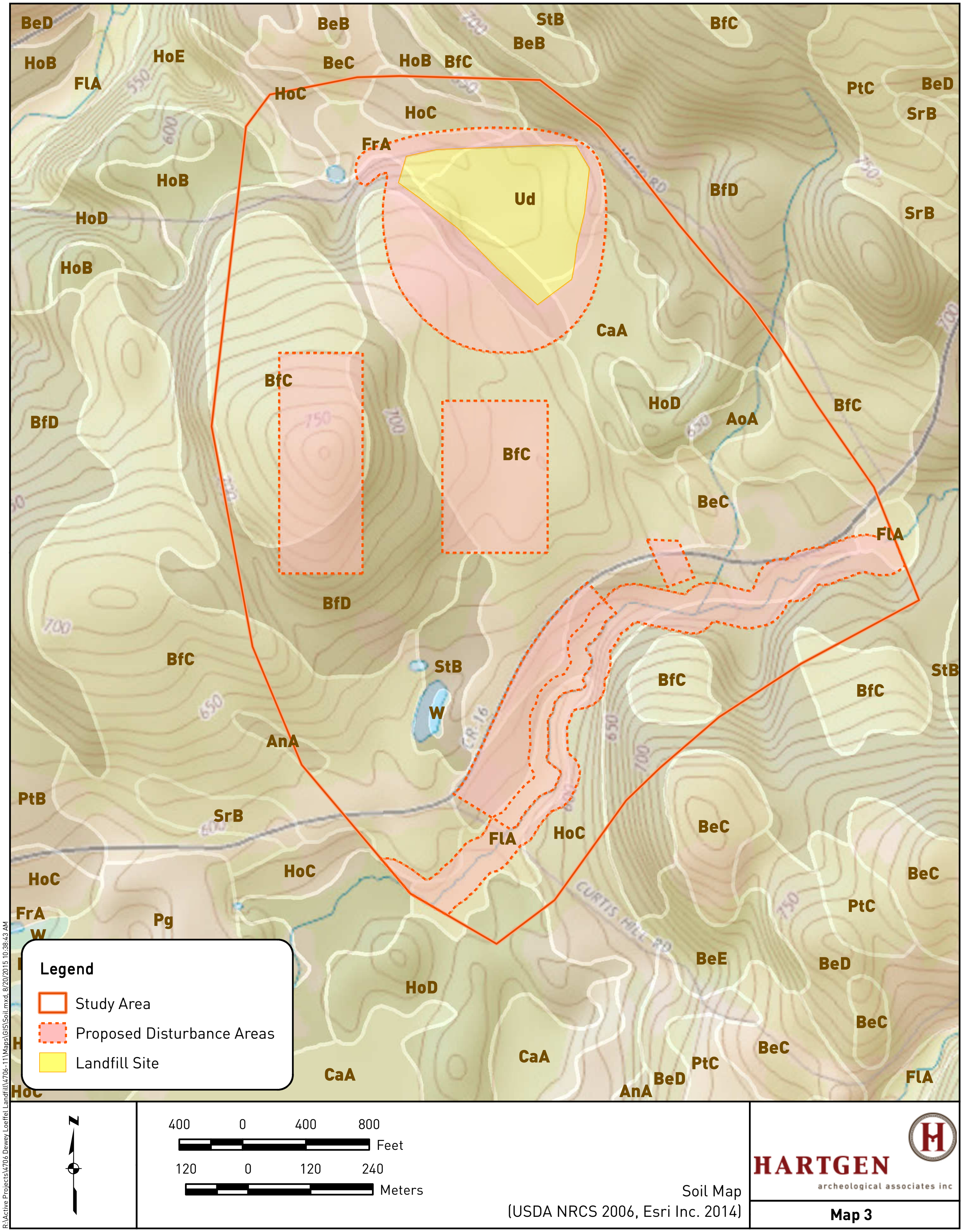

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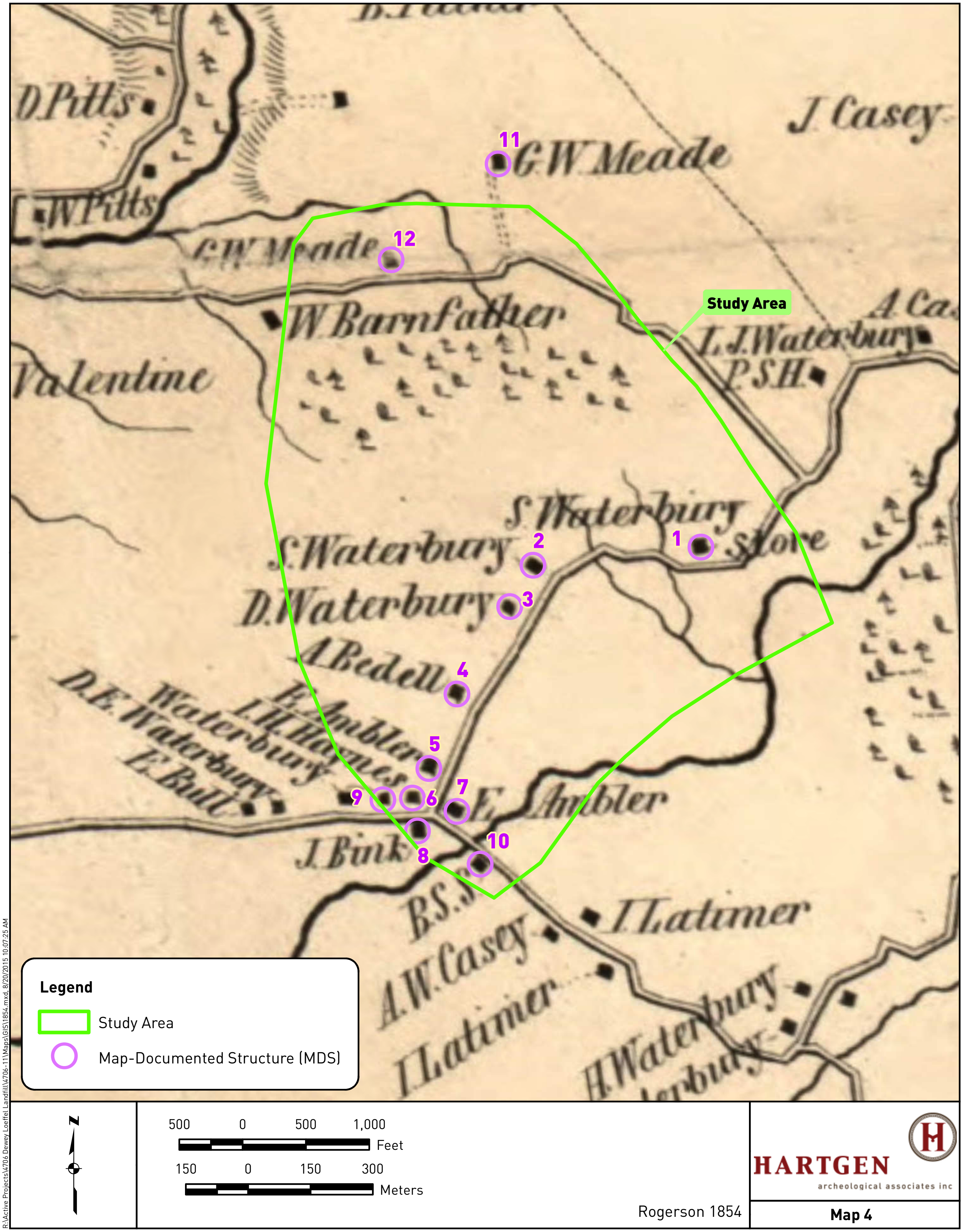

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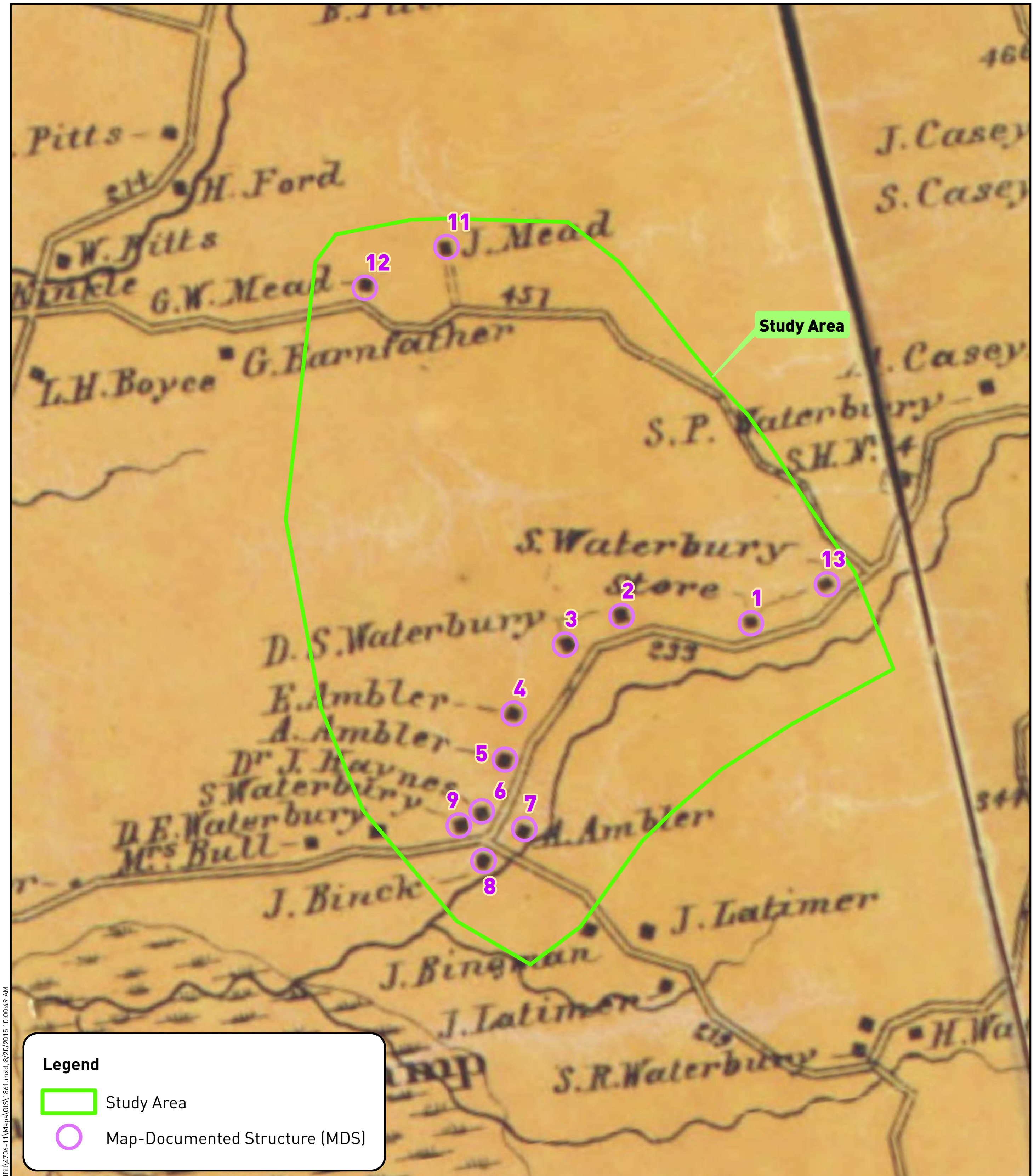

N

500 0 500 1,000 Feet

150 0 150 300 Meters

Lake and Beers 1861

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Map 5

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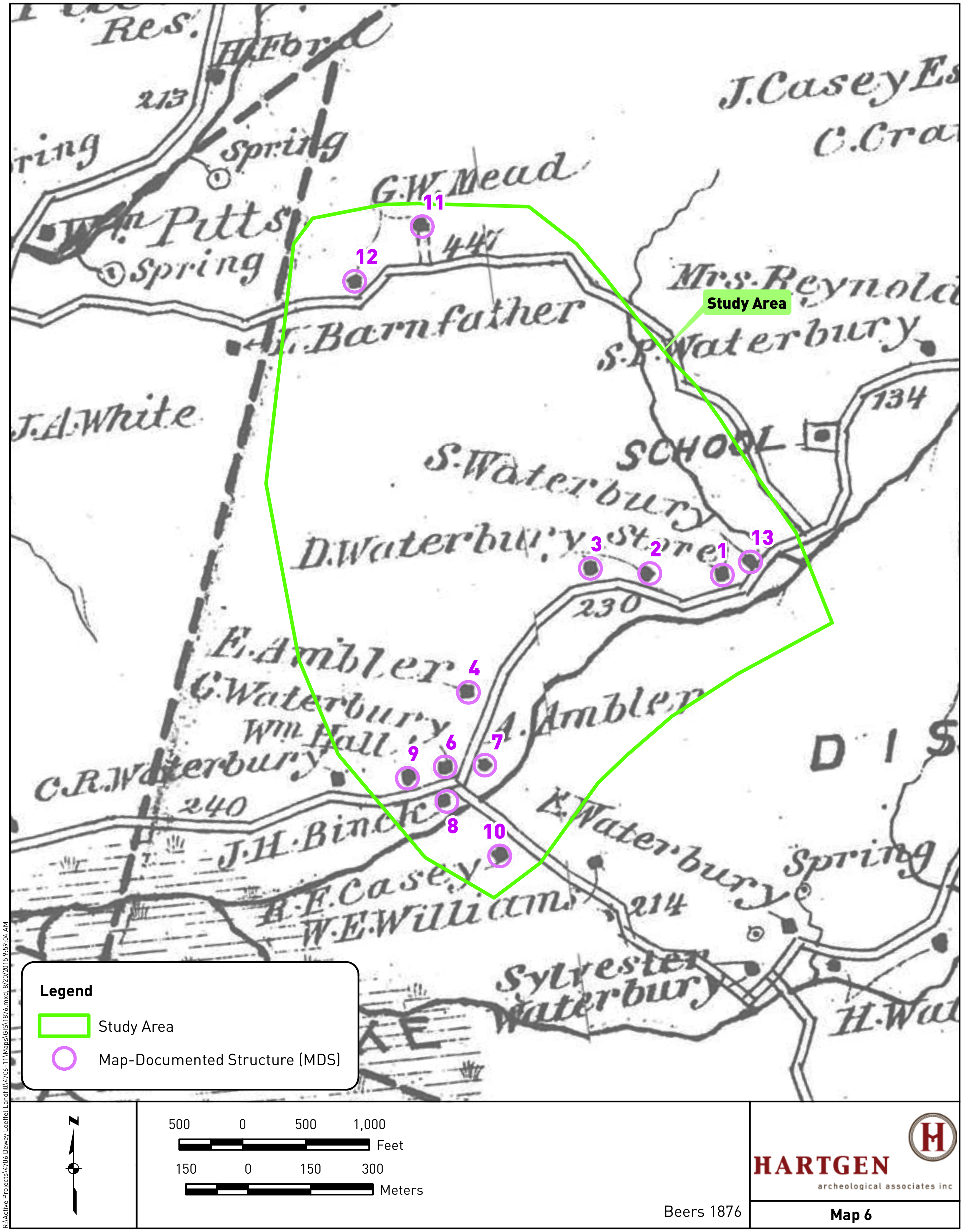
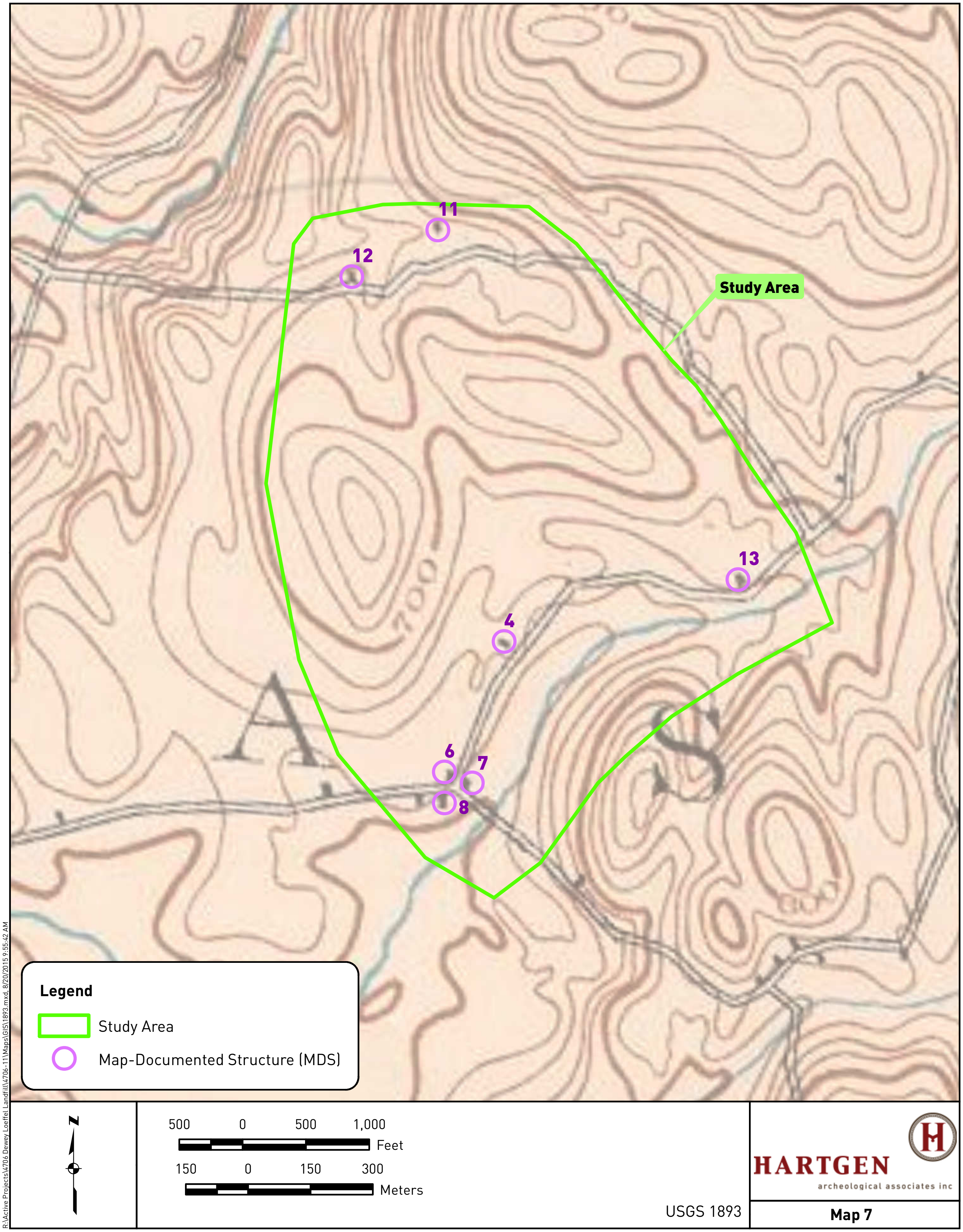

Res.
H.Ford
213
Spring
J.Casey Es
C.Cra
G.W.Mead
Wm Pitts
Spring
447
Mrs.Reynold
Study Area
A.Barnfather
S.P.Waterbury
134
J.A.White
SCHOOL
S.Waterbury
D.Waterbury
Store
230
E.Ambler
C.Waterbury
Wm Hall
A.Ambler
DIS
C.R.Waterbury
240
J.H.Binck
E.Waterbury
Spring
R.F.Casey
W.E.Williams
214
Sylvester Waterbury
H.Wat
1 2 3 4 6 7 8 9 10 11 12 13
Legend
Study Area
Map-Documented Structure (MDS)
N
500 0 500 1,000 Feet
150 0 150 300 Meters
Beers 1876
HARTGEN
archeological associates inc
Map 6



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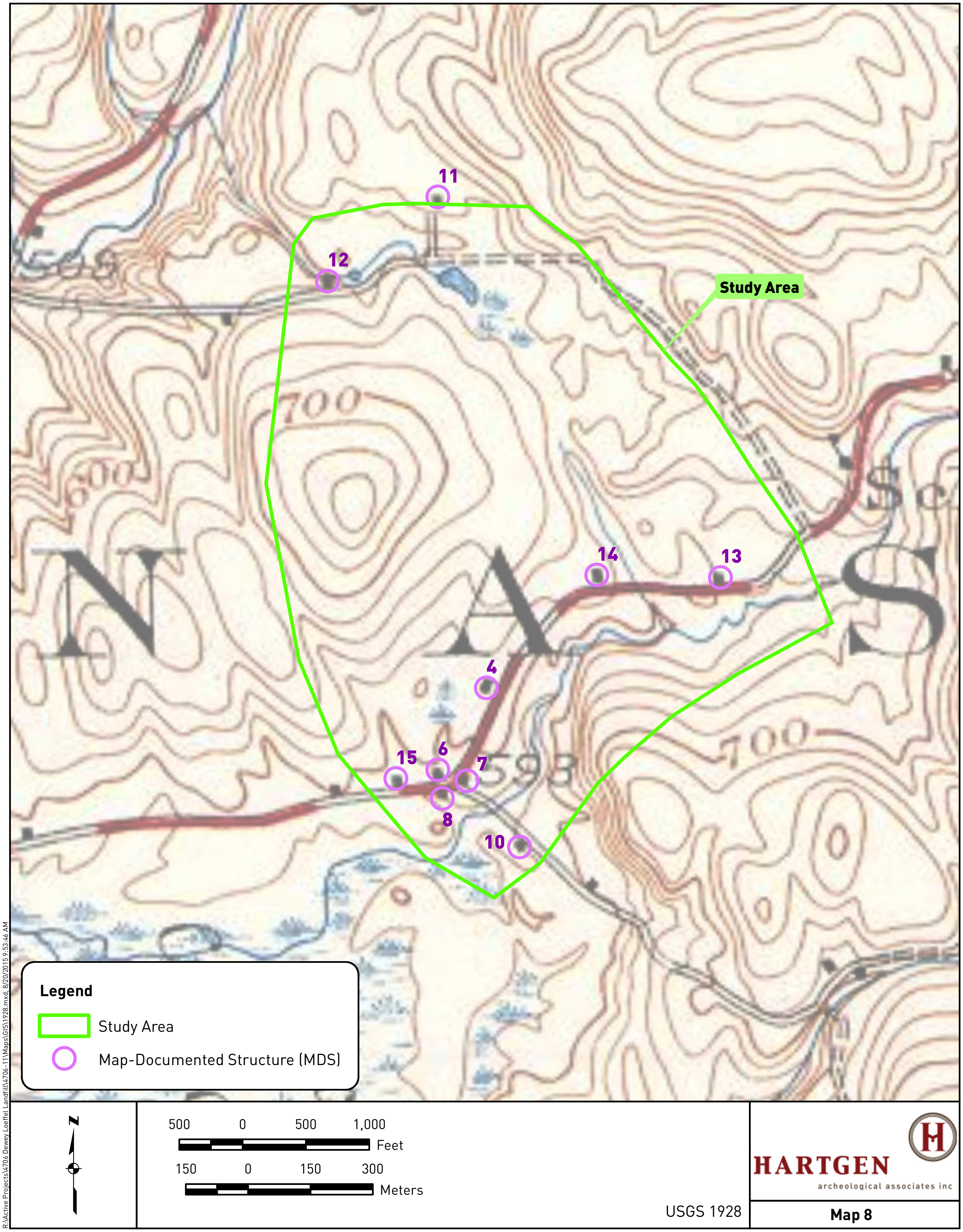
11
12
Study Area
14
13
4
15
6
7
8
10
700
700
Legend
Study Area
Map-Documented Structure (MDS)
N
500 0 500 1,000
Feet
150 0 150 300
Meters
USGS 1928
HARTGEN
archeological associates inc
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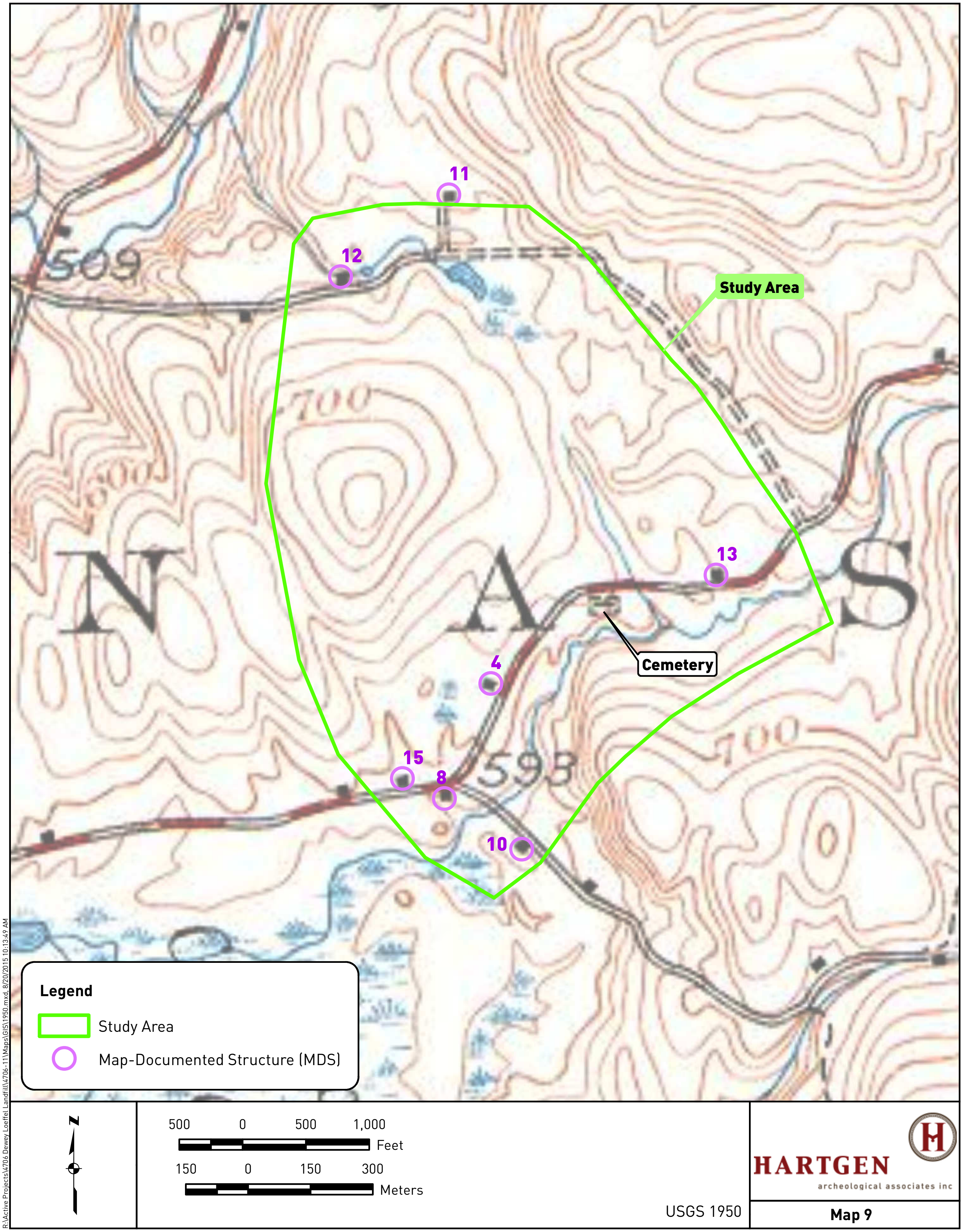
Map 8


11
12
13
4
15
8
10
Study Area
Cemetery
509
700
593
N
A
S
Legend
Study Area
Map-Documented Structure (MDS)
N
500 0 500 1,000
Feet
150 0 150 300
Meters
USGS 1950
HARTGEN
archeological associates inc
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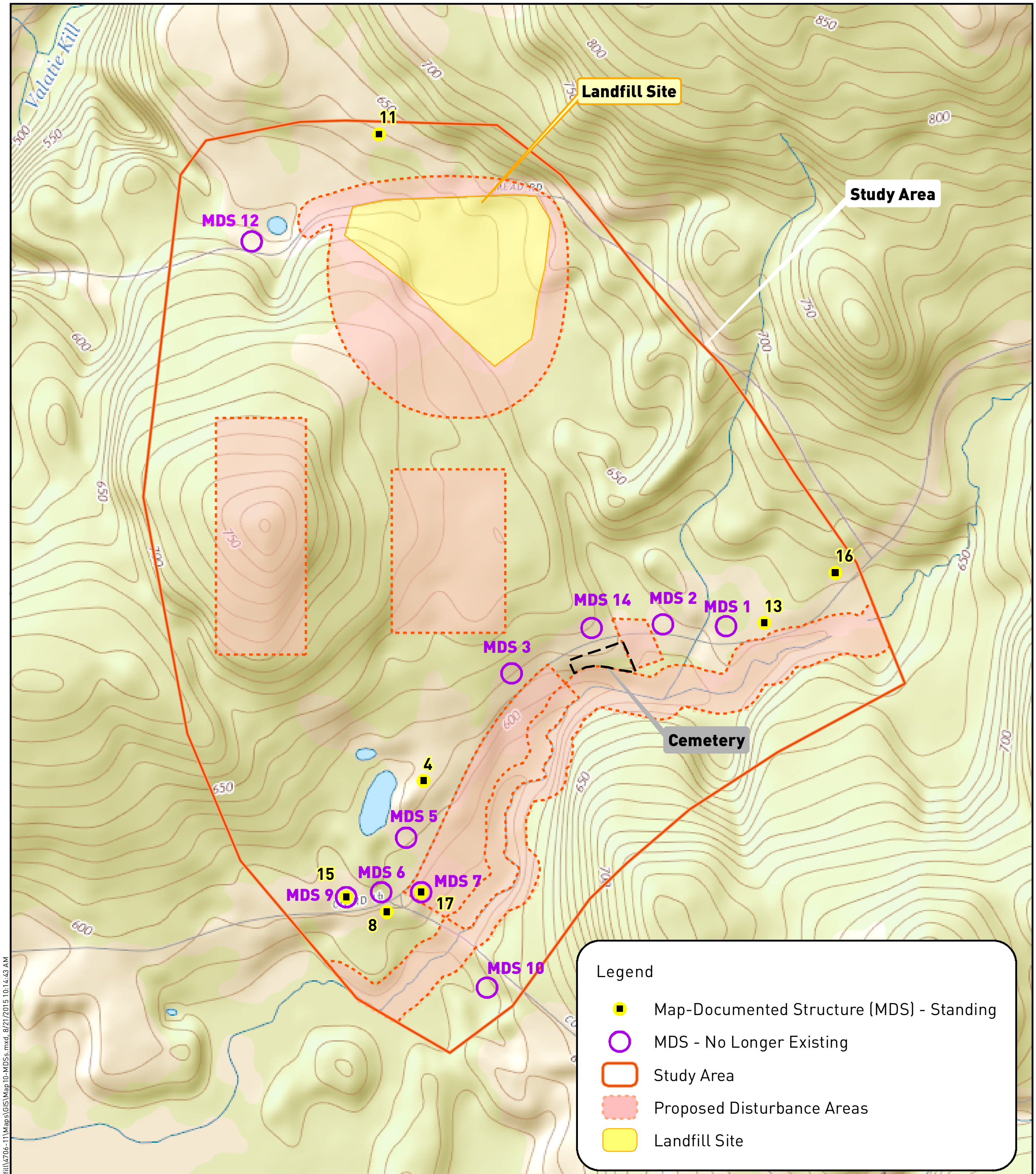
Map 9



N

400 0 400 800
Feet

120 0 120 240
Meters

Map-Documented and
Standing Historic Structures
(Hartgen 2015; O'Brien & Gere 2014;
USGS 2015)

HARTGEN
archeological associates inc

Map 10

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PHOTOGRAPHS

Photo 1. View northwest across capped Landfill.

Photo 2. View north across Landfill toward Mead Road.

Photo 3.View south along one of trails that traverses the study area. This one is located in the westernmost potential planned disturbance area.

Photo 4.View northeast in the central potential planned disturbance area showing typical conditions.

Photo 5. View northeast in the central potential planned disturbance area. The topography in this vicinity ranges from somewhat level to sloping. Note the downward slope to a small drainage-way in the right of the photo.

Photo 6. View north within the eastern portion of the study area. The photo shows the typical ground cover. The topography varies from relatively level to somewhat sloping.

Photo 7. View southwest from Curtis Hill Road along the stream in the southern part of study area.

Photo 8. View west along stream (base of slope in left of photo) located south of Central Nassau Road. The c. 1876 Central Nassau Cemetery is located to the north (to the right of the photo).

Photo 9. View east along stream (in right of photo) south of Central Nassau Road.

Photo 10. View northwest across Central Nassau Road toward one of the few remaining 19th-century structures noted in the study area. It is not within a potential disturbance area. The house is shown associated with the name Waterbury on the historical maps.