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FINAL
REMEDIAL DESIGN WORK PLAN

for
Pre-Design and Remedial Design

at the
Peninsula Boulevard Groundwater Plume Superfund Site
Hempstead, New York

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LIST OF ACRONYMS

ANSETS	Analytical Services Tracking System
APP	Accident Prevention Plan
ARAR	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BOD	Biochemical Oxygen Demand
CLP	Contract Laboratory Program
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
CQCP	Contractor Quality Control Plan
DAR	Design Analysis Report
DCE	Dichloroethene
DER	Data Evaluation Report
DESA	Division of Environmental Science and Assessment
DO	Dissolved Oxygen
DPT	Direct Push Technology
DVI	Dual-valent Iron
EDD	Electronic Data Deliverable
EM	Electromagnetic
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
EVO	Emulsified Vegetable Oil
FAR	Federal Acquisition Regulation
FASTAC	Field and Analytical Services Technical Advisory Committee
FOL	Field Operations Lead
fpd	feet per day
FS	Feasibility Study
g/cm^3	grams per cubic centimeter
GIS	Geographic Information System
gpm	gallons per minute
GPR	Ground-penetrating Radar
HDR	Henningson, Durham & Richardson Architecture and Engineering, P.C.
hp	horsepower
HSA	Hollow Stem Auger
IDW	Investigation Derived Waste
ISCO	In-Situ Chemical Oxidation
ISCR	In-Situ Chemical Reduction
lb	pound
LDP	Locational Data Policy
LIAWC	Long Island American Water Company
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/L	milligram per liter
MII	Micro-Computer Aided Cost Engineering System
msl	mean sea level
NA	Natural Attenuation

LIST OF ACRONYMS (Cont'd)

NAD	North American Datum
NAVD	North American Vertical Datum
NCDH	Nassau County Department of Health
NPL	National Priorities List
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PDI	Pre-Design Investigation
PESM	Program Environmental Safety and Quality Manager
PID	Photoionization Detector
POTW	Publicly Owned Treatment Works
ppb	parts per billion
PQO	Project Quality Objective
PRB	Permeable Reactive Barrier
PRG	Preliminary Remediation Goal
psi	pounds per square inch
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
qPCR	Quantitative Real-time Polymerase Chain Reaction
RA	Remedial Action
RAO	Remedial Action Objective
RAS	Routine Analytical Services
RD	Remedial Design
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
ROD	Record of Decision
RSCC	Regional Sample Control Center
SAS	Specific Analytical Services
SOP	Standard Operating Procedure
SOW	Scope of Work
SSHP	Site Safety and Health Plan
STR	Sampling Trip Report
SVOC	Semi-Volatile Organic Compound
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristics Leaching Procedure
TDS	Total Dissolved Solids
Tetra Tech	Tetra Tech, EC, Inc.
TO	Task Order
TOC	Total Organic Carbon

LIST OF ACRONYMS (Cont'd)

UFGS	Unified Facilities Guide Specifications
UFP	Uniform Federal Policy
ug/L	micrograms per liter
UGA	Upper Glacial Aquifer
USACE	United States Army Corps of Engineers
USCS	United Soil Classification System
USDA	United States Department of Agriculture
VC	Vinyl Chloride
VOC	Volatile Organic Compound
WQ	Water Quality
ZVI	Zero-valent Iron

EXECUTIVE SUMMARY

This Executive Summary provides an introduction to, and an overview of, the Remedial Design Work Plan (RDWP) prepared in response to Task Order 0002 (TO 0002) issued by the Kansas City District of the United States Army Corps of Engineers (USACE) under Contract Number W912DQ-11-D-3011 for Pre-Design and Remedial Design at the Peninsula Boulevard Groundwater Plume Superfund Site, CERCLIS ID NYN000204407 (the Site). The Site, which consists of the area within and around a groundwater plume identified during a series of field investigations and limited interim removal activities, is located in a mixed residential and commercial area in the Village of Hewlett, Town of Hempstead, Nassau County, New York.

In March 1991, the Nassau County Department of Health (NCDH) cited Grove Cleaners (located at 1274 Peninsula Boulevard) for discharging hazardous waste into dry wells via a drain located north of the eastern building. Subsequently, the New York State Department of Environmental Conservation (NYSDEC) became involved with the Site, and from 1991 through October 2001, a series of investigations were performed on behalf of the property owner, and later on behalf of NYSDEC. In addition, removal actions were implemented at the Grove Cleaners site in 1994 and 1999. The results of these activities indicated an extensive plume of contaminated groundwater, primarily impacted by tetrachloroethene (PCE), located north and south of Peninsula Boulevard. The investigative work did not produce enough evidence to determine that Grove Cleaners was solely responsible for the contamination, and suggested the potential for additional source areas other than the former Grove Cleaners site.

The United States Environmental Protection Agency (EPA) assumed responsibility for the larger Peninsula Boulevard Groundwater Plume Site in September 2002. The Site was placed on the National Priorities List (NPL) on 23 August 2004. The Agency for Toxic Substances and Disease Registry (ATSDR), in cooperation with the New York State Department of Health (NYSDOH), prepared a Public Health Assessment for the Site in 2007, which concluded there was no present health risk, due to the treatment of water produced from the Long Island American Water Company (LIAWC) Plant #5 wells and engineering controls. Additional activities to evaluate vapor intrusion and reduce potential future exposures to groundwater and surface water were recommended.

Between March 2008 and March 2011, EPA performed vapor intrusion sampling at multiple residences in the vicinity of the Site, as well as at the North Woodmere Middle School. Based on volatile organic compound (VOC) concentrations at or above EPA Region 2 screening levels, a sub-slab depressurization system was installed at one residence in July 2009. EPA continues to investigate the soil vapor intrusion pathway at the Site by conducting future monitoring.

Tetra Tech EC, Inc. (Tetra Tech) conducted initial remedial investigation (RI) activities for EPA, including environmental sampling and hydrogeological analyses, in 2006 and 2007. Supplemental RI work was conducted in 2010 and 2011 by Henningson, Durham & Richardson Architecture and Engineering, P.C. in association with HDR Engineering, Inc. (HDR). The focus of the RI was characterization of the contamination in the Upper Glacial Aquifer (UGA). The identification of additional potential sources was also an objective of the supplemental effort. The results indicated:

- Chlorinated VOCs were detected in both the shallow and deep UGA groundwater at concentrations above screening criteria ("shallow" and "deep" indicate above and below the "20-foot clay" layer that bisects the UGA across the Site area [although it is not considered to be a confining layer]). Shallow UGA (0 to 30 feet below ground surface [bgs]) had PCE concentrations exceeding 1,000 micrograms per liter (ug/L), while three wells installed within the deep UGA (40 to 75 feet bgs) contained PCE at concentrations greater than 10,000 ug/L.

- The Jameco Aquifer, the source for the LIAWC Plant #5 raw water, is impacted by chlorinated VOCs.
- Source area(s) were not definitively identified, although plume characteristics (areal extent and relative concentrations) appeared to indicate a potential source at the intersection of Hewlett Parkway and West Broadway (formerly Choe's West Broadway Cleaners; presently Cedarwood Cleaners).

The Human Health Baseline Risk Assessment concluded, under current exposure scenarios, the risks to human health and the environment were largely controlled through engineering and institutional controls. In a future scenario assuming direct use of impacted groundwater, risks existed from groundwater (ingestion, dermal contact, and inhalation exposure routes) resulting from plume-related and other VOC contaminants of concern exceeding acceptable levels for carcinogenic and non-carcinogenic effects.

In September 2011, EPA published the Record of Decision (ROD) for Operable Unit One (OU-1) for the Site, documenting the selection of a remedy for the groundwater contamination. It noted that a second remedial phase or operable unit, including a subsequent decision document, would address the source of the groundwater contamination. The major components of the selected remedy for groundwater, as stated in the ROD, include the following:

- Extraction of the groundwater via pumping and ex-situ treatment prior to discharge to a publicly owned treatment works (POTW) or surface water, or reinjection to the aquifer (to be determined during design);
- In-situ chemical treatment of targeted high concentration contaminant areas, as appropriate;
- Monitored natural attenuation for those areas where active remediation is not performed;
- Institutional controls; and
- Long-term monitoring to ensure the effectiveness of the remedy.

The objectives of performing the RD activities are to:

- Fill data gaps required for preparation of a complete design package including identifying the current extent of groundwater affected by constituents at concentrations above applicable criteria through investigation and modeling activities;
- Develop the remedial design components and basis in accordance with the 2011 ROD to treat the groundwater contaminants via in-situ chemical treatment and a groundwater extraction and treatment system and meet applicable federal and state requirements;
- Perform the required testing of the remedial design components; and
- Prepare the required design documents to implement the remedies presented in the ROD.

The pre-design field investigation tasks include the following: installation of pumping and observation wells for the aquifer testing; installation of wells for injection and monitoring/observation purposes during the in-situ treatability study; performance of groundwater sampling from existing monitoring and new in-situ treatability study injection and monitoring/observation wells; installation of geotechnical borings; aquifer evaluation testing (pump tests) for the shallow and deep UGA; a topographic survey; and in-situ treatability testing. The estimated duration of the field activities is five (5) months.

RD activities will be initiated concurrent with the pre-design investigation field activities. The RD activities include: a bench-scale groundwater ex-situ treatment train treatability study; groundwater modeling;

development of the preliminary (30%), intermediate (60%), pre-final (95%), and final (100%) design documents and drawings for both the in-situ and ex-situ remedy components; and preparation of permit equivalency applications for the groundwater treatment plant. The overall estimated duration of the RD activities is 20 months.

1.0 INTRODUCTION

This Remedial Design Work Plan (RDWP) has been prepared by Tetra Tech EC, Inc. (Tetra Tech) in response to Task Order 0002 (TO 0002) issued by the Kansas City District of the United States Army Corps of Engineers (USACE) under Contract Number W912DQ-11-D-3011 for Pre-Design and Remedial Design at the Peninsula Boulevard Groundwater Plume Superfund Site, CERCLIS ID NYN000204407 (the Site). The purpose of this RDWP is to describe the pre-design investigation (PDI) activities and identify the remedial design (RD) elements and activities to be performed to address constituents affecting the groundwater. This RDWP is based on USACE's Request for Proposal dated 18 November 2011; negotiations conducted on 16 December 2011; Tetra Tech's Revised Technical Proposal dated 19 December 2011; the site visit performed on 30 January 2012; and the scoping meeting conducted on 31 January 2012. A Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) and Accident Prevention Plan (APP) are included as Appendices A and B, respectively, to this RDWP.

1.1 Site Description

The Site consists of the area within and around a groundwater plume identified during a series of site investigations and limited interim removal activities at the former Grove Cleaners site conducted between 1991 and 2001. The Site is located in the Village of Hewlett (Town of Hempstead, Nassau County, New York) with Valley Stream and Lynbrook, along the Route 27 corridor, located to the north; East Rockaway and Hewlett Harbor to the east; Woodsburgh and Hewlett Bay Park to the south; and Woodmere to the west. John F. Kennedy International Airport is located approximately three miles to the west of the Site. A map of the Site Location is provided as Figure 1.

The area consists of a mix of commercial and residential properties, with the majority of the commercial properties located along Mill Road, Peninsula Boulevard, Broadway, and West Broadway. Woodmere Middle School is located along the western Site boundary. The Long Island American Water Company (LIAWC) operates its Plant #5 Well Field on property located approximately 1,000 feet of north of the Site. LIAWC has been monitoring and treating groundwater pumped from this well field since 1991, and continues to maintain monitoring and treatment activities to address both iron fouling, a common and naturally-occurring problem for Long Island water suppliers, and volatile organic compound (VOC) contamination (EPA, 2004; HDR, 2011a).

During previous investigations, several former and existing area dry cleaners were identified as potential sources of tetrachloroethene (PCE) contamination in the Site area. An aerial view diagram of the Site, including existing and former dry cleaners, is provided as Figure 2 (Site Map).

1.2 Site History

The information provided in the following section is generally summarized from EPA, 2004; EPA, 2011; HDR, 2011a; HDR, 2011b; and Tetra Tech, 2008:

In March 1991, the Nassau County Department of Health (NCDH) cited Grove Cleaners (located at 1274 Peninsula Boulevard) for discharging hazardous waste into dry wells via a drain located north of the eastern building. PCE was detected in soil and sludge samples collected from dry wells at concentrations of 2,200 and 110 milligrams per kilogram (mg/kg), respectively.

In 1992, the New York State Department of Environmental Conservation (NYSDEC) became involved with the Site. The Grove Cleaners site was classified as a Class 2 Inactive Hazardous Waste Disposal Site in March 1993.

From 1991 through October 2001, a series of field investigations were performed on behalf of either the property owner or NYSDEC. In addition, in April 1994, a removal action was implemented at the Grove Cleaners site with thirteen (13) 55-gallon drums of sludge recovered from the drains and dry wells. Between January and February 1999, a second removal action was performed. Approximately 4,000 gallons of groundwater was pumped from a 4-inch recovery well. PCE was detected at 1,100 micrograms per liter (ug/L) at the completion of this purging event.

The results of these activities indicated an extensive plume of contaminated groundwater, primarily impacted by PCE, located north and south of Peninsula Boulevard. The results of the investigative work did not produce enough evidence to determine that Grove Cleaners was solely responsible for the contamination, and suggested the potential for additional source areas other than the former Grove Cleaners site. A “No Further Action” Record of Decision (ROD) was issued by NYSDEC for the Grove Cleaners site in March 2003.

The United States Environmental Protection Agency (EPA) assumed responsibility for the larger Peninsula Boulevard Groundwater Plume Site in September 2002. After preparation of a Hazard Ranking System Package in March 2004, the Peninsula Boulevard Groundwater Plume Superfund Site was proposed for placement on the National Priorities List (NPL) on 7 March 2004. The Site was placed on the NPL on 23 August 2004.

Between August 2006 and November 2007, Tetra Tech conducted initial remedial investigation (RI) field activities, including environmental sampling and hydrogeological analyses. A resulting Data Evaluation Report (DER) was submitted in October 2008.

The Agency for Toxic Substances and Disease Registry (ATSDR), in cooperation with the New York State Department of Health (NYSDOH) prepared a Public Health Assessment for the Site dated 24 April 2007. Based on the available data, ATSDR concluded there was no present health risk, due to the treatment of water produced from the LIAWC Plant #5 wells and engineering controls limiting access to the unnamed tributary. Additional sampling to evaluate vapor intrusion and actions to reduce potential future exposures to groundwater and surface water were recommended.

In March 2008, July 2008, February 2009, and March 2011, EPA performed vapor intrusion sampling at multiple residences in the Site vicinity. VOCs were found at concentrations at or above EPA Region 2 screening levels in sub-slab and/or indoor air in two residences. A sub-slab depressurization system was installed at one residence on 28 July 2009 to mitigate the impacts of soil vapor intrusion by reducing or eliminating vapor entry into the building. In addition, in 2004, EPA performed sampling at the North Woodmere Middle School. PCE was not detected in the basement, classrooms or the auditorium. Trace levels of PCE (0.15 to 0.35 parts per billion [ppb]) were observed in the art room and in the drains in a bathroom; these trace levels were determined not to pose any health concern. EPA will continue to investigate the soil vapor intrusion pathway at the Site by conducting future monitoring.

Henningson, Durham & Richardson Architecture and Engineering, P.C. in association with HDR Engineering, Inc. (HDR) conducted supplemental RI work in 2010 and 2011 to address data gaps from the initial effort. The focus of the supplemental RI was further characterization of the contamination in the Upper Glacial Aquifer (UGA), identified as being impacted with the VOC plume-related contaminants of concern. The identification of additional potential sources was also a goal of this supplemental effort, as were completion of human health and ecological risk evaluations. The RI Report, submitted as final in July 2011, indicated the following:

- Chlorinated compounds were detected in both the shallow and deep UGA groundwater (Figure 2). A “20-foot clay” layer bisects the UGA across the Site area. The shallow and deep portions of the UGA were identified as being above and below this layer (although not considered to be a fully confining layer), to facilitate identification and evaluation of remedial alternatives based on the nature and extent of contamination.
- The shallow UGA (0 to 30 feet below ground surface [bgs]) was characterized by an approximately 3,500-foot long VOC plume that is oriented in a north-south direction, with an area of PCE concentrations exceeding 1,000 ug/L, which appeared to extend approximately 2,000 feet from West Broadway to 200 feet north of Peninsula Boulevard. South of Peninsula Boulevard (upgradient) the plume was approximately 1,000 feet wide. North of Peninsula Boulevard (downgradient) the VOC plume was approximately 400 feet wide. The greater width of the plume south of Peninsula Boulevard may be the result of comingling of contaminant plumes from additional upgradient source area(s), subsurface disturbance due to infrastructure placement, or the relatively flat groundwater surface.
- The deep UGA (40 to 75 feet bgs) was characterized by a 1,100-foot long VOC plume oriented in a northeast-southwest direction. PCE was detected at concentrations greater than 10,000 ug/L at three locations: HW-038, HW-037, and MW-27D.
- The Jameco Aquifer, the source for the LIAWC Plant #5 raw water, is impacted by chlorinated VOCs.
- Surface water, sediment and, to a lesser degree, soils also had been impacted by the plume-related VOCs, specifically PCE and its breakdown products.
- Screening for the potential for anaerobic biodegradation and natural attenuation (NA) of chlorinated solvents in the area of the Site was performed. There was inadequate (score of “zero”) to adequate (score of “fifteen”) evidence of NA across the Site. Specific to biodegradation of PCE, the screening scored “zero” in all wells.
- The source area(s) of the plume were not identified during the RI, although the plume characteristics (areal extent and relative concentrations) appear to indicate one potential source property at the former Choe’s West Broadway Cleaners (presently Cedarwood Cleaners) at the intersection of Hewlett Parkway and West Broadway.

The Human Health Baseline Risk Assessment concluded, under current exposure scenarios, the risks to human health and the environment were largely controlled through engineering and institutional controls, i.e., the continued monitoring and treatment of groundwater extracted through the LIAWC Plant #5 Well Field; restrictions on the use of private wells in the county; fencing around surface water areas on-site; and EPA’s continuing investigation and mitigation of vapor intrusion impacts in the area of the plume. However, in a future scenario assuming direct use of impacted groundwater (i.e., assuming that the engineering control is not in place at LIAWC Plant #5), risks existed from groundwater (ingestion, dermal contact, and inhalation exposure routes) resulting from plume-related and other VOC contaminants of concern exceeding acceptable levels for carcinogenic and non-carcinogenic effects. The risk assessments indicated that concentrations of plume-related VOCs in other on-site media do not pose unacceptable risks to either human health or ecological resources.

In July 2011, a Final Feasibility Study (FS) was prepared by HDR. Preliminary Remedial Action Objectives (RAOs) and Remediation Goals (PRGs) were developed for the Site. The FS developed, screened, and evaluated potentially applicable remedial alternatives to provide sufficient data to select a feasible and cost-effective remedy that would protect public health and the environment from potential risks at the Site.

In September 2011, EPA published the ROD for Operable Unit One (OU-1) for the Site. The ROD documented the selection of a remedy for the groundwater contamination. It noted that a second remedial phase or operable unit, including a subsequent decision document, would address the source of the groundwater contamination. The major components of the selected remedy for groundwater, as stated in the ROD, include the following:

- Extraction of the groundwater via pumping and ex-situ treatment of the extracted groundwater prior to discharge to a publicly owned treatment works (POTW) or surface water, or reinjection to the aquifer (to be determined during design);
- In-situ chemical treatment of targeted high concentration contaminant areas, as appropriate;
- Monitored natural attenuation for those areas where active remediation is not performed;
- Institutional controls; and
- Long-term monitoring to ensure the effectiveness of the remedy.

1.3 Physical Setting

The following sections are summarized from EPA, 2004; HDR, 2011a; HDR, 2011b; and Tetra Tech, 2008:

1.3.1 Topography and Surface Features

Topographically, the Site slopes to the north and west toward Doxey Brook Drain and Motts Creek with surface elevations decreasing from approximately 20 feet above mean sea level (msl) near the southern border of the Site to approximately one foot above msl in the vicinity of Doxey Brook Drain and the nearby LIAWC property to the north.

Portions of Motts Creek, Doxey Brook Drain, and an unnamed tributary leading to Motts Creek are located within the Site area (Figure 2). The unnamed tributary and Doxey Brook Drain are classified by NYSDEC as Class C streams, which are waters supporting fisheries and suitable for non-contact activities. These features merge and eventually drain into Motts Creek (also a Class C stream) at the very northern portion of the Site boundary.

1.3.2 Soils

The soils in the Site area are predominantly of the urban type, i.e., reworked by man and frequently covered by structures or pavement. Classification by the United States Department of Agriculture (USDA) in the USDA Soil Conservation Service Soil Survey of Nassau County, New York (USDA, 1987) indicated the following:

- Proceeding south to north from Broadway to West Broadway, the Site area is largely classified as "Urban Land" (Ug). Urban Land is described as being 85% covered by structures or pavement. In this zone, which is prone to drainage problems, a few spots of sandy loam or loamy sand may occur.
- The zone that passes through the Site area from West Broadway northward beyond Oak Place and Westervelt Street is mapped as "Urban land – Riverhead complex," 3 to 8% slopes (UrB). The zone is about 60% urban land with much of the remaining "Riverhead," a well-drained sandy loam present to about 3 feet bgs, with sand at greater depth.

- Moving northward toward Peninsula Boulevard, the next zone is prevalently described as “Urban land – Sudbury complex” (Us). This type of soil exists in other areas of the Site as well. This zone is about 70% urban land. Much of the remainder is moderately well-drained Sudbury soils, which are generally sandy loam to about 2 feet bgs, then sand.
- North of Peninsula Boulevard, the area in the vicinity of the former Grove Cleaners site, the National Grid property, and the Woodmere Middle School is classified as “Urban land.”
- The residential area northeast of Doxey Drain is mapped as “Us.”
- The Woodmere Middle School and the southeastern and central portions of the LIAWC wooded property across Doxey Brook Drain/Motts Creek are mapped as Sudbury sandy loam (Su), a deep and moderately well-drained soil.
- The western portion of the LIAWC property is mapped as Atsion loamy sand (At), a deep, poorly-drained sandy loam with a few inches of leafy muck at the surface.

1.3.3 Geology

The Site is situated within the Atlantic Coastal Plain Physiographic Province in the southwestern corner of Long Island, New York. The geologic conditions of the island are primarily the result of cycles of advancement and retreat of continental glaciers through approximately 10,000 years before present. Sediments associated with the glacial periods include deposits of till, ice-contact stratified drift, outwash materials, and various other mixtures of sediment and related deposits.

The stratified drift and till deposits are concentrated from the terminal moraines in the center of the island and are present northward to the north shore of the island. Unconsolidated Pleistocene-age strata consisting mostly of outwash deposits are present between the moraine sand and the south shore of the island, where they overlie Cretaceous-age, marine-derived sediments and Pre-Cambrian bedrock. Cretaceous-age deposits range from the late Cretaceous Raritan Formation, composed of an upper clay member (Raritan clay) and a lower sand member (Lloyd aquifer), to the Magothy-Matawan group, which overlies the Raritan Formation. The Magothy is composed of deltaic quartzose sand of continental origin with some interbedded clay and silt. This formation represents one of the important water bearing units that comprise Long Island’s water supply aquifers.

Overlying the Magothy-Matawan group in portions of Long Island is the Jameco Gravel formation. The Jameco is the earliest of the Pleistocene deposits in the region, and has only been detected in Kings, southern Queens, and southwestern Nassau County. The thickness of this unit is highly variable owing to its origin as a channel fill deposit within a diversion pathway for the Hudson River. At one time, the course of the river was through what is now the southwestern end of Long Island.

Above the Jameco Gravel is a blue-grey clay layer, the Gardiners Clay, which forms a confining layer over the Jameco and Magothy-Matawan group in areas of the island. The Gardiners Clay was deposited in a marine environment during an interglacial period in the Pleistocene. This unit is the deepest encountered during previous investigations at the Site, with some of the deeper borings completed at the interface between the Gardiners Clay and the overlying unconsolidated Pleistocene deposits.

The sediments above the Gardiners Clay are Pleistocene deposits forming the Upper Glacial Aquifer, the shallowest aquifer on the island. The UGA consists primarily of meltwater-derived coalescing sheets of sand and gravel forming an outwash plain that extends southward from the terminal moraines to the Atlantic shore.

In the vicinity of the Site, the UGA includes a thin layer of marine clay (as indicated by the presence of marine shells and plant remains), locally referred to as the “20-foot clay”, which was deposited during a phase of warmer climate within the Pleistocene glaciations. The “20-foot clay” thickens southward on the Site. Over approximately the southern half of the Site, available data indicated that it forms a clay layer thick enough to interrupt the hydraulic connection between the shallow and deep portions of the UGA, and therefore it is thought to result, effectively, in semi-confined conditions for the deeper UGA in this localized area.

The 2006 through 2011 field investigation activities indicate that the “20-foot clay” is actually a clayey silt, and its competency increases southward across the Site. South of Peninsula Boulevard it appears to act as a confining unit and is encountered at depths ranging from 20 to 40 feet. The unit thins significantly to about a one-foot thickness in the northern portion of Site, based on analysis of geophysical logging of the re-drilled LIAWC wells at Plant #5, located just north of the Site. This unit may completely pinch out in the vicinity of the Plant #5 Well Field. This combination of discontinuity and a significant silt fraction, rather than pure clay, indicates that it is not a complete confining layer but is likely a semi-confining unit, with that level of confinement being lost in the vicinity of the LIAWC Well Field.

The surficial and shallow subsurface geology in the Site includes a combination of pavement, gravel subgrade, and reworked native soils covering the ground surface. Where present, fill materials typically extend to a depth of approximately one foot below grade. Below the fill layer, there are sporadic layers of peat, organic silts and fine sands, as noted at several subsurface locations near Peninsula Boulevard. Where present, these layers were encountered at a depth of approximately 4 to 8 feet bgs and exhibited a maximum thickness of approximately 4 feet. These layers of organic material may correlate with a former creek channel located in the vicinity of the Grove Cleaners site.

1.3.4 Hydrogeology

On a regional basis, the groundwater regime in this area of Long Island is dominated by a groundwater divide located approximately 2,000 feet south of Peninsula Boulevard, along a low ridge trending southwest to northeast. Groundwater in the UGA north of the divide exhibits flow with both northerly and westerly components. This depth-dependent variability in flow direction within the UGA is supported by water level data collected from wells completed in the shallow unconfined and deeper semi-confined intervals of the UGA. South of the divide, groundwater flow within the UGA appears to trend southward toward Macy Channel.

In this area of Long Island, the Jameco gravel, despite its limited extent, is a waterbearing zone of primary importance because of hydraulic conductivity values on the order of 200 feet per day (fpd). The LIAWC Plant #5 Well Field adjacent to the Site utilizes the Jameco as its source aquifer. North of the Site, the UGA directly overlies the Jameco. Given the similar hydraulic properties of the UGA and Jameco, there is the potential for significant hydraulic connection between the two units, with data from a broader area of Long Island indicating that to be the case. Data obtained as a result of supplemental RI activities indicate that the Gardiners Clay acts as a confining unit in the localized area of the Site and the LIAWC Well Field.

For the Site, drilling, sampling, and aquifer tests have focused on the characteristics of the UGA. In general, groundwater hydraulics are a function of the potentiometric (i.e., hydraulic head) gradient and physical parameters or hydraulic conductivity of the aquifer. At the Site, the UGA is divided into two regimes. These upper and lower sub-units are divided by the discontinuous “20-foot clay.” For wells completed in the upper portion of the UGA (denoted as “shallow”), groundwater elevations are indicative of a typical unconfined water table aquifer. In the deeper portions of the UGA, below the “20-foot clay,” groundwater elevation measurements are similar to or lower than shallower wells at the same location, suggesting that, as a result of areal discontinuity, the “20-foot clay” does not constitute a fully confining unit between the sub-units of the UGA.

Based on measurements conducted during drilling and testing at the Site, the depth to groundwater within the unconfined portion of the UGA ranges from approximately 3 to 15 feet bgs, while ranging from 6 to 17 feet bgs in the semi-confined portion of aquifer. Saturated thickness of the unconfined UGA above the “20-foot clay” layer ranges from 10 to 30 feet. Saturated thickness of the deeper portion of the UGA below the “20-foot clay,” including the pressure head component imparted by the semi-confined conditions, is approximately 55 to 65 feet.

Groundwater elevation data collected from monitoring well clusters installed during the RI suggest that a significant downward vertical gradient exists between the unconfined and semi-confined portions of the UGA, especially toward the southern end of the Site along Broadway and West Broadway, where vertical gradients on the order of -0.1 feet/feet were calculated.

In-situ hydraulic testing and pump tests indicate horizontal hydraulic conductivity values for the on-site UGA material in the unconfined portion of the aquifer on the order of 5 feet per day (fpd), with individual test results yielding values as high as 155 fpd. In the deeper portion of the UGA, horizontal hydraulic conductivity values of approximately 40 to 50 fpd were calculated, with individual test results up to 200 fpd. The interbedded nature of sediments in the UGA suggests significant vertical and horizontal variability in hydraulic conductivity values would be anticipated.

Monitoring of water levels from on-site wells does not indicate that tidal fluctuation of the water table occurs at the Site. No significant change was noted from manually collected water levels over a period encompassing at least one tidal cycle. Pressure transducer readings collected from other on-site wells likewise exhibited no tidal signature over the period of record.

2.0 TASK ORDER OBJECTIVES

The objectives of this Task Order (TO) are to perform the necessary pre-design and RD activities to develop the remedial design components required to perform the remedial action (RA) and meet the RAOs. The purpose of this TO is to:

- Fill data gaps required for preparation of a complete design package including identifying the current extent of groundwater affected by constituents at concentrations above applicable criteria through investigation and modeling activities;
- Develop the remedial design components and basis;
- Perform the required testing of the remedial design components; and
- Prepare the required design documents to implement the remedies presented in the ROD.

The following list provides a brief summary of some of the key scope of work (SOW) tasks Tetra Tech will perform to achieve the TO objectives:

- Install monitoring wells for pumping and observation purposes for completion of the pump test and injection and monitoring/observation wells for completion of the in-situ treatability study;
- Perform groundwater sampling from existing monitoring and new in-situ treatability injection and monitoring/observation wells;
- Advance geotechnical borings, with collection of soil samples, for the building foundation design;
- Conduct aquifer evaluation testing (pump tests);
- Perform a topographic survey collected at 2-foot contours of the Site in support of the RD, including site features, boundaries, easements, rights of way, and utilities;
- Conduct in-situ treatability testing to determine the implementability and optimal design of the selected remedy;
- Perform a bench-scale groundwater ex-situ treatment train treatability study to address data gaps associated with the conceptual process design;
- Develop a numerical groundwater flow model using the existing and newly acquired data to support design decisions; and
- Develop detailed designs for in-situ chemical treatment and groundwater extraction and treatment, in accordance with the requirements specified in the 2011 ROD.

2.1 Project Planning and Support (WAD 01)

The Project Planning and Support task includes project administration, review of existing data, conducting a site visit, preparing for and attending a technical scoping meeting, project meetings, and quality control (QC) audits. Each of the Work Orders included in this task is presented below.

2.1.1 Project Administration (Work Order 01.01)

The project administration activities in support of this TO include preparing the technical monthly reports, reviewing and updating the project schedule, providing technical resource management, responding to questions from the USACE and EPA, preparing and submitting monthly invoices, and monitoring the budget. This task includes the efforts for overall management to oversee the implementation of the PDI and RD tasks to be performed. This Work Order will be performed throughout the period of performance of the TO.

2.1.2 Review Existing Data (Work Order 01.02)

Review and evaluation of existing Site background documents and previously obtained data were performed prior to the site visit (Work Order 01.03), technical scoping meeting (Work Order 01.04), and preparation of this RDWP (Work Order 02.01). Documents reviewed included the Remedial Investigation Report including risk assessments (HDR, 2011a); the Feasibility Study (HDR, 2011b); the Public Health Assessment (ATSDR, 2007); and the Record of Decision (EPA, 2011).

2.1.3 Site Visit (Work Order 01.03)

USACE, EPA, and Tetra Tech representatives attended a one-day site visit on 30 January 2012 to develop a conceptual understanding of the Site and the RD scope and requirements. In addition, an assessment of potential locations for the field office, proposed new wells, and groundwater treatment system was performed.

2.1.4 Conduct a Technical Scoping Meeting (Work Order 01.04)

A technical scoping meeting attended by USACE, EPA, and Tetra Tech representatives was conducted on 31 January 2012 at the EPA Region 2 offices in New York, NY. During the meeting, the Project Team discussed:

- The ROD requirements;
- Existing data gaps;
- The proposed PDI, specifically the aquifer evaluation testing activities;
- The plan for the treatability studies, including pursuing the in-situ and ex-situ portions in parallel;
- The format for the design;
- Potential locations for the PDI staging area and the treatment plant;
- Community relations activities to be conducted by EPA; and
- The draft baseline project schedule.

2.1.5 Meetings (Work Order 01.05)

Tetra Tech will prepare for, attend and document face-to-face meetings, as well as prepare for, participate in, and document teleconferences. Tetra Tech will prepare agenda summarizing the proposed topics and discussion points. Following each meeting or teleconference, Tetra Tech will prepare meeting minutes summarizing the key discussion points and action items. The following meetings/teleconferences are anticipated:

- A kick-off meeting/site visit prior to the PDI;
- A data assessment teleconference to discuss the PDI, modeling and treatability study efforts and findings;
- Design Review Meetings to be held following 30%, 60%, and 95% design completion;
- Monthly project progress teleconferences; and
- Technical discipline teleconferences, as required.

2.1.6 QC Audits (Work Order 01.06)

Tetra Tech will conduct one internal systems audit during the course of the TO activities to assess adherence to the quality assurance (QA) and QC procedures outlined in this Work Plan, the Contractor Quality Control Plan (CQCP), and the UFP-QAPP in accordance with Tetra Tech's Quality Program. Tetra Tech will prepare an audit report for distribution to the audited group, Tetra Tech management, and USACE.

2.2 Field Investigation (WAD 02)

Tetra Tech will conduct a PDI field investigation to fill data gaps required for preparation of a complete design package. The field sampling program will consist of several components including: installation of wells for pumping and observation purposes during the aquifer evaluation testing (pump tests) and for injection and monitoring/observation purposes during the in-situ treatability study; performance of groundwater sampling; advancement of geotechnical borings, with collection of soil samples, for the building foundation design; performance of aquifer evaluation testing (pump tests); and performance of a detailed topographic survey.

Field work will not begin without [1] approval of project plans by USACE and EPA and [2] right of access to the properties where work will be performed. Site access will be obtained by EPA. Tetra Tech will support site access activities by obtaining tax maps and ownership information (Work Order 02.03).

2.2.1 Develop a Work Plan (Work Order 02.01)

This RDWP describes the activities to be performed by Tetra Tech during execution of the TO. Tetra Tech developed this RDWP to describe its technical approach and present the activities required to perform the SOW presented in the Scope of Services, dated 18 November 2011, and further discussed during the 16 December 2011 negotiations, 30 January 2012 site visit, and 31 January 2012 technical scoping meeting. This RDWP was prepared using existing background documents, to the extent possible, to minimize the amount of new work required during preparation. The RDWP includes the background of the Site, the technical approach for each task, a description of deliverables that will be submitted over the course of the TO, a project schedule, and a description of the project organization.

The following deliverables were also prepared under this Work Order:

- Contractor Quality Control Plan (CQCP);
- Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP); and
- Accident Prevention Plan (APP).

The CQCP was developed to describe Tetra Tech's systematic management approach for planning, implementing, controlling, and assessing work during the PDI and design tasks. Utilization of this plan will verify that the results of a task produce an end product that satisfies technical, administrative, and quality objectives for the project. The CQCP also provides details about the project's Independent Technical Review (ITR) program. The CQCP was submitted to the USACE on 9 March 2012 as a separate deliverable.

Appendix A to this RDWP is the UFP-QAPP, prepared in accordance with OSWER Directive 9272.0-17, which implements use of the Uniform Federal Policy for Quality Assurance Project Plans at hazardous waste sites under federal jurisdiction. The UFP-QAPP describes the site-specific project requirements for the field and laboratory activities related to the acquisition of chemical samples, measurements, and data. Standard operating procedures (SOPs) for proposed field activities are provided as an attachment to the UFP-QAPP.

Tetra Tech has prepared an APP in accordance with 29 Code of Federal Regulations 1910.120 and USACE EM 385-1-1 (September 2008 edition including errata/changes), submitted as Appendix B to this RDWP. The APP, including a Site Safety and Health Plan (SSHP), was developed to maintain a safe and healthy work environment during the performance of the covered project activities, instruct Project Team personnel on procedures to minimize the potential for injury or exposure to hazardous conditions; train Project Team personnel on proper actions to be taken during emergency response situations; and provide guidelines and actions to ensure compliance with applicable Occupational Safety and Health Administration (OSHA), United States Department of Labor, USACE, and state and local regulations or other requirements.

2.2.2 Conduct Field Work (Work Order 02.02)

The following provides a description of the various PDI tasks to be implemented at the Site. Additional details regarding the procedures and methods to be used during field activities are presented in the UFP-QAPP and APP (Appendices A and B to this RDWP). The field investigation will consist of the following primary activities:

- Well installation;
- Aquifer evaluation testing (pump tests);
- Groundwater sampling;
- Geotechnical borings; and
- Surveying.

Associated activities, including subcontract procurement/management, mobilization/demobilization, utility location/clearance, and IDW management, will also be conducted during the PDI.

Subcontract Procurement / Management

Tetra Tech anticipates procuring seven (7) subcontracts to perform the tasks required to implement the SOW, in addition to the services of the following two (2) Contract Team Members: YU & Associates and Environmental Compliance, Inc. The following subcontractors are expected to be contracted during implementation of the TO:

- Utility Location / Geophysics;
- Drilling;
- Analytical Laboratory;
- In-Situ Chemical Reagent Injection;
- Bench Scale Treatability Test Laboratory;
- Surveyor; and
- Investigation Derived Waste Management Services.

Subcontract procurement activities will be performed in accordance with Tetra Tech's Government Procurement Procedures. These procedures are based on the Federal Acquisition Regulations (FARs) and are the basis of Tetra Tech's Government-approved purchasing system.

This task also includes management, coordination, processing of invoices, and closeout of the seven field subcontracts.

Mobilization

Mobilization will be performed by Environmental Compliance, Inc. (a Contract Team Member), under the direction of Tetra Tech's Field Operations Lead (FOL), prior to the initiation of site activities. During mobilization, setup of temporary facilities (i.e., on-site office, phone, electric, bathroom facilities, etc.) will occur; rental and expendable equipment will be ordered; health and safety and field specific forms will be prepared; and setup of a temporary IDW storage area will be established. Mobilization activities will consist of the following:

Office tasks:

- Prepare list of required field equipment;
- Perform lease/purchase analyses, as necessary;
- Prepare requisitions, as necessary;
- Set up health and safety field files; and
- Arrange delivery and storage of equipment, as necessary.

Field tasks:

- Coordinate setup of temporary offices (i.e., utilities, etc.);
- Receive field activity and health and safety equipment;
- Arrange delivery, storage and set up of equipment (as necessary);
- Set up field computer equipment; and
- Conduct initial health and safety briefing for project personnel.

Underground Utility Location

The design and implementation of the field investigation and selected remedies will require detailed knowledge of underground utilities in the Site area. To this end, Tetra Tech will obtain utility drawings, perform subsurface geophysics, and excavate test pits.

First, personnel will contact local utility companies (including water, sewer, gas, and cable/telephone; electric is overhead) to obtain drawings of utility locations and specifications. As required, a Tetra Tech representative will visit a company's offices to perform copying, pay requested fees, etc.

A request for a utility mark-out of the Site area will also be performed. Tetra Tech will contact "Dig Safely New York" at 811 or 1-800-272-4480 at least two (2) working days (not counting the day of the call) but not more than ten (10) working days before the start of field work.

After assessment of the "as built" drawings, subsurface geophysics will be employed to provide information on utility configurations at four (4) key roadway intersections, as well as to confirm utility locations at other points along the roadway (six (6) transects). Multiple methodologies, including electromagnetic (EM) surveys and ground-penetrating radar (GPR), will be used in the field.

In addition, a 10-foot radius around each proposed boring and well location will be cleared using the subsurface geophysical equipment prior to beginning drilling activities. If subsurface utilities are identified within this radius that prevent borehole advancement/well installation (e.g., the location and number of utilities does not allow for a clear 3-foot by 3-foot area), the location will be moved, and the revised location will be checked again for subsurface utilities.

Test pits will then be excavated at a subset of the geophysical confirmation points (three (3) trenches) to verify the geophysical results. The locations and dimensions of the test pits will be determined based on the results of geophysical surveys with regard to any site-specific constraints (e.g., access). Prior to task initiation, the proposed locations/dimensions will be memorialized in a request for a field change to this RDWP, which will be submitted for review and approval following the procedures outlined in Worksheet #6 of the UFP-QAPP (Appendix A).

Well Installation

Installation of wells will be required for completion of the pre-design field investigation. The following types of wells are proposed:

- Pumping wells (shallow and deep) for the aquifer evaluation testing;
- Observation wells (shallow and deep) for the aquifer evaluation testing;
- Injection point wells (shallow and deep) for the in-situ treatability study; and
- Monitoring/observation wells (shallow and deep) for the in-situ treatability study.

The locations of the proposed aquifer evaluation testing wells are presented on Figure 3, with a diagram of the proposed well design provided as Figure 4. Figure 5 presents the proposed locations for the in-situ treatability study.

During installation, the subsurface lithology will be visually characterized and described by a Tetra Tech field geologist using the modified Burmeister method and assigned a Unified Soil Classification System (USCS) classification, as appropriate. Borings will be screened using a photoionization detector (PID).

As noted previously, a mark-out will be requested from the local utility companies. The area around each well (approximately 10-foot radius) will be screened by the subsurface geophysical subcontractor to clear the proposed location for utilities prior to beginning the drilling activities. In addition, each location will be "soft cleared" to 5 feet bgs using hand-clearing or vacuum methods to reduce the potential for encountering a subsurface utility.

Aquifer Evaluation Testing Wells

Installation of shallow and deep wells will be required for completion of the aquifer evaluation testing (pump tests), which will obtain data (for both the shallow and deep UGA) to be used in the hydrogeologic modeling and RD. The pumping wells (along with observation wells) will be designed for and constructed at strategic areas of the project Site (Figure 3). The Site has existing wells; however, the wells are not constructed appropriately to gather all of the needed hydrogeologic and geologic data required to obtain accurate aquifer testing data. Additional wells are proposed for installation as observation wells around pumping wells within the expected radius of influence.

Two new pumping wells and two new observation wells will be installed to determine sufficient aquifer response during the tests. One pumping well and one observation well will be constructed at specified depths to determine conditions in each of the two identified subsurface hydrogeologic units, i.e., the shallow UGA unit and the deep UGA unit, at the Site. Although not suitable for pumping, existing on-site wells will be used as additional observation wells, as applicable, based on their location (proximal to the aquifer testing and to the newly completed observation wells), construction, and depth of screened interval.

The utilization and siting of the wells (both new and existing) was determined based on optimized well location calculations and needs related to previously understood hydrogeologic conditions. The well installation effort will include the collection of soil for grain size analysis at specified intervals and depth to water measurements to better understand and refine the model of subsurface conditions around the Site. This will ensure that subsequent activities (i.e., aquifer testing) will provide accurate and beneficial data.

The proposed location of the wells (both pumping and observation) was considered based on site limitations, optimization of data to be analyzed, contaminant concentration for discharge, and future remedial treatment. A consideration for the construction of the well was the screened interval fully penetrating the aquifer(s), while the diameter of the pumping well(s) was based on discharge rate and possible well utilization following the pumping test(s). Sizing of observation wells was determined based on suitability to obtain information from water level indicator equipment.

Drilling locations were determined based on the following considerations (Figure 3):

- The best known favorable aquifer conditions for pumping well placement and extraction well potential success based on maximum specific capacities, transmissivity, and related hydrogeologic parameters.
- Areas of higher contaminant concentrations and, based on performance monitoring and groundwater modeling, locations capable of inducing stronger gradients on the plume area(s).
- Readily accessible to drilling, discharge, and, as relates to potential for extraction wells, piping and control facilities.
- Potential for conversion to extraction wells to minimize adjustments to the wells for performance monitoring and extraction.
- Hydrogeologic conditions and related calculations. Ideal placement will be considered based on Site boundaries, the lateral extent of the aquifer(s), and drilling access.

The drilling and borehole completion will be accomplished using hollow stem auger (HSA) drilling methodology. The subsequent well construction will take place within the auger stem, set at depth for proper well construction and filter pack addition. The boreholes will be of sufficient size to construct a 6-inch diameter well at each pumping well location and a 2-inch diameter well at each observation well location.

Soils will be collected continuously utilizing split spoons to finish depth, in conjunction with the HSA process. The steel split spoon collection process will determine standard penetration parameters per American Society for Testing and Materials (ASTM) Method 1586-85. During the process, the blow count (standard penetration measurements) will be recorded at 6-inch intervals. The collected soils will be visually evaluated and documented for gradation changes, composition, and other related lithologic characteristics, based on the USCS and modified Burmeister classifications. These descriptions of the borings will be prepared under the supervision of the on-site Tetra Tech geologist, based on visual and olfactory inspection and field instrument (e.g., PID) measurement of the retrieved split spoons. The logging will be necessary to determine placement (construction) of well screen interval(s).

Soil samples will be collected from the two new pumping test wells (but not from the two observation well locations) at a frequency of one (1) sample every 5 feet, for an approximate total of 24 samples. The soil samples will be submitted to an off-site laboratory for grain size analyses (ASTM D422D).

The approximate thicknesses of the aquifers are 30 feet for the shallow and 25 feet for the deep; however, the exact thickness of the aquifer at specific well locations will be confirmed during drilling activities (prior to installation/construction). The UGA units are separated by the "20-foot clay" unit, which is approximately 20 feet thick to the south and composed of silty clays.

The pumping wells will be constructed of 6-inch diameter, stainless steel well screen (0.01-inch slot size). Screen lengths are estimated at 10 feet for the shallow and 25 feet for the deep UGA wells (with final determination based on geologic/hydrogeologic characteristics of the aquifer formation at each well location). For the shallow UGA, the pumping well will be screened over a length of 10 feet, from the top of the "20-foot clay" upwards. Above the screen, each pumping well will be constructed with 6-inch diameter stainless steel casing, which may eventually serve as a pump chamber location.

An observation well will also be constructed in each UGA unit, with the screened interval for the shallow UGA observation well of sufficient length to straddle the water column (i.e., approximately 20 feet in length). The deep UGA observation well will have a screen length equivalent to the aquifer thickness. This is important for continuous measurements of the head within the screen intervals. The observation wells will be constructed of 2-inch diameter, Schedule 40 polyvinyl chloride (PVC) blank casing and 0.01-inch slot size well screen.

The lower UGA wells will be cased from the ground surface to the bottom of the "20-foot Clay" layer in order to isolate the deep UGA hydrologically during the pumping tests.

The actual depth of the well casing will be determined in the field. During advancement of the borehole, continuous split spoons will be collected. The soils will be visually evaluated and documented for gradation changes, composition, and other related lithologic characteristics, based on the USCS and modified Burmeister classifications. This characterization will determine the transition in lithology from the 20-foot clay to the underlying UGA. Based on prior activities and the CSM for the Site, the top of clay is approximately 30 feet bgs with a general thickness of 20 feet (i.e., the bottom of clay is approximately 50 feet bgs). During well installation, the casing will be installed from ground surface to the bottom of the clay unit. Centralizers will be placed on the riser to ensure that the well is positioned properly in the boring. A schematic of the proposed well design is provided as Figure 4.

A slurry of Morie 0.01 sand will be tremied down the annulus of the borehole to an elevation of 3 to 5 feet above the top of the screen interval to form a filter sand pack. The construction of the wells will be completed by setting a 1- to 2-foot thick choke sand seal and a 3- to 5-foot thick bentonite seal above the sand packs, then grouting with a cement-bentonite mix to the surface. The pumping wells will be completed with temporary flush-mounted surfaces, consisting of a manhole, apron and locking j-plug. The four newly installed wells will be pre-pumped (and developed) as a preliminary step-down test, and to remove sediment from the casing and settle the filter pack.

Detailed procedures for well installation and development, along with associated field forms, are provided in the UFP-QAPP (Appendix A).

Using the data obtained during the aquifer testing and as part of the RD efforts (see subsections below), the pumping wells will be assessed as to their suitability for conversion to extraction wells. The RD will detail this evaluation, including describing conversion requirements (e.g., flush mount finishing may be upgraded and converted to a below-grade utility vault of either concrete or steel) and provisions for connecting to the existing underground conveyance piping for the pump and treat system.

In-Situ Treatability Study Wells

Additional information on the approach for the in-situ treatment treatability study (Work Order 04.01) is presented in Section 2.4.1.

As shown in Figure 5, two (2) permanent wells (one shallow and one deep) will be located upgradient of cluster MW-27. The locations will be drilled using HSA techniques as described above for the aquifer evaluation testing wells. The wells will be installed with 6-inch stainless steel screen (between 10 and 20 feet in length depending on subsurface conditions) and casing, flush-mounted to the local grade.

Ten (10) temporary PVC points for simulating a permeable reactive barrier (PRB) will be advanced using direct push technology (DPT) at roughly 5 to 10 feet (an average spacing of 7 feet) over a distance of 70 feet. These locations are further described in the "Injections of ISCR Reagent as a Permeable Reactive Barrier" subsection of Section 2.4.1, as they will be advanced at the same time as the slurry injections are performed.

DPT equipment will also be used to install a suitable pattern of temporary 2-inch PVC wells for monitoring/observation purposes. All temporary wells will have an approximate screen length of 10 to 20 feet depending on subsurface conditions. Twelve (12) locations are proposed near well cluster MW-27 and the general area of the PRB (west-southwest of the MW-21 cluster), as shown in Figure 5. Eight (8) of these locations are paired shallow and deep wells (four (4) each) installed in a relatively straight line between the location of the injection wells and the existing downgradient wells and/or new aquifer evaluation testing (pump test) wells. The remaining four (4) points will be deep wells only, with two (2) points located along Sturlane Place (Figure 5).

For the shallow plume, the 2-inch temporary wells will be drilled to a depth just above the top of the clayey silt within the UGA (approximately 20 to 30 feet bgs). For the deep UGA plume, the wells will be installed just above the top of the Gardiner's Clay formation (approximately 65 to 75 feet bgs). Actual depths will be dependent on field conditions at the select location. To properly locate the shallow temporary PVC wells just above the "20-foot clay" layer (if present), it may be necessary to collect macro-core samples using DPT equipment to identify the clay layer and any discontinuities. This approach may not be needed for the deep temporary PVC wells since the Gardiners Clay appears to be present at elevations between 50 and 60 feet below mean sea level beneath Hewlett Parkway.

If 2-inch temporary wells cannot be easily installed through the glacial outwash materials within the UGA, smaller diameter wells (e.g., 1-inch) will be drilled.

Additional temporary PVC wells may be installed during the post-injection monitoring program to help determine the lateral distribution of the injected materials, if the evaluation of the in-situ treatability study data indicates data gaps in the distribution monitoring. For planning purposes, four (4) wells (2 shallow and 2 deep) would potentially be installed within two (2) months after the injections are completed. Potential locations for the two (2) pairs of additional PVC monitoring/observations points are shown on Figure 5.

Aquifer Testing

Tetra Tech will conduct aquifer testing to obtain hydrogeological data in support of the proposed remedy. The aquifer testing, in the form of pumping tests, will provide hydraulic parameters related to heterogeneity and anisotropy, along with an estimation of response to pumping and the relationships between aquifer zones. Results of the testing will be evaluated for association to design volumes and radius of influence in order to model potential remedial optimization and contamination removal/attenuation. The following subsection describes the proposed pumping tests to be performed as part of the PDI for the Site; more detailed procedures are provided in the UFP-QAPP (Appendix A). As required prior to implementation of the aquifer evaluation testing, additional discussions with USACE and EPA may be held and/or supplemental memorandum may be developed related to the pumping tests to provide updates or changes to the aquifer testing approach, locations, or limitations.

Tetra Tech will conduct an initial step-drawdown test on each of the pumping wells to determine test diagnostics to meet expectations for the pumping test. Initial hydraulic testing of the pumping wells will be conducted to determine the specific capacity of the well and potential for volume and duration capabilities, and to obtain preliminary information on the well's radius of influence. The pump type and related equipment will meet necessary criteria including lift capacity and sustainable pumping rates at the greatest depth encountered.

The initial aquifer testing will consist of the following per pumping well: at least three (3) step down volume tests and one (1) preliminary constant rate test with pumping rates of 50, 100 and 150 gallons per minute (gpm) for a duration of 30 minutes. During the 30 minute interval, the drawdown will be evaluated, and the test duration extended, if necessary, to achieve equilibrium and/or stressed local aquifer conditions. During the pre-tests, well yield and drawdown will be recorded, and following the tests, water levels will be allowed to recover to pre-test conditions or static levels. The constant rate test will be based on an optimal and sustainable rate (yield) to achieve a steady state condition in the anticipation that water levels will not fall unexpectedly during the longer duration aquifer testing.

During this initial testing, a groundwater sample will be collected from each of the two aquifer units, for a total of two (2) samples. These samples will be analyzed for Target Compound List (TCL) VOCs [trace level]. This data will be used to determine compliance with POTW standards and to design the pump test water treatment prior to discharge to the POTW.

Based on the results of the preliminary testing, each of the two pump tests (i.e., one for the shallow UGA and one for the deep UGA) will last a duration of at least 24 hours (with equivalent recovery time) and will include the pumping of one well and the observation of several existing monitoring and new observation wells located in or related to the aquifer unit being tested. The monitoring of hydrogeologic parameters in the pumping well and observation wells will be performed utilizing pressure transducers. Additional measurements will be collected including volumetric analysis, pump rates, and radius of influence. Manual groundwater elevation, flow and volume measurements will be collected during the duration of the aquifer tests. The list of wells to be utilized during the pump tests is provided in the UFP-QAPP.

Immediately prior to the completion of the aquifer evaluation testing, a groundwater sample will be collected from each of the two aquifer units to aid in the design of the treatment system. These two (2) samples will be analyzed for Target Compound List (TCL) VOCs [trace level] and Target Analyte List (TAL) metals.

Consistent flow rates will be maintained throughout the length of the testing period (to ensure accurate hydrogeologic calculations). Flow rates can be used to formulate presumptive measurements of anticipated discharge volumes. Preliminary analysis of the aquifer parameters will be conducted following appropriate methodologies (ASTM D6029 and D6034). Pumping test data will be further evaluated utilizing Aqtesolv™ to formulate an understanding of the hydrogeologic parameters necessary for inputs into the groundwater modeling and RD efforts (such as T, K, S, distance drawdown, etc.).

The pumped water will be conveyed and stored in frac tanks until appropriately disposed. Further information on disposal of aquifer evaluation testing water is provided in the "IDW Containerization and Disposal" subsection of this RDWP.

Groundwater Level Measurement / Sampling

Groundwater sampling of on-site wells will occur as follows:

- One round for 29 existing monitoring wells to obtain a current understanding of plume conditions across the Site (described below);
- One round for 21 wells (two new injection, twelve new temporary observation/monitoring wells, the deep pumping well from the aquifer evaluation test, the shallow observation well from the aquifer evaluation test, and five existing monitoring wells), prior to injection, as part of the in-situ treatability investigation;
- Four rounds of process monitoring for 21 wells (two new injection, twelve new temporary observation/monitoring wells, the deep pumping well from the aquifer evaluation test, the shallow observation well from the aquifer evaluation test, and five existing monitoring wells), done after injections as part of the in-situ treatability investigation; and
- Two rounds of performance monitoring for 21 wells (two new injection, twelve new temporary observation/monitoring wells, the deep pumping well from the aquifer evaluation test, the shallow observation well from the aquifer evaluation test, and five existing monitoring wells), done concurrently with two of the four process monitoring events.

Synoptic groundwater elevation measurements will be collected prior to each of these sampling rounds. The objectives of measuring groundwater elevations are to:

- Evaluate groundwater flow direction;
- Assess the potential for impacted groundwater discharge into surface water bodies;
- Further refine the identification of vertical gradients between the shallow and deep portions of the UGA; and
- Assist in the development of the hydrogeological model (described in Section 2.5).

Groundwater elevations will be measured from the surveyed inner casing measuring point using an electronic interface probe. All data will be recorded in a field logbook and/or on field forms (as described in the UFP-QAPP), and subsequently presented in tabular form.

Current Understanding Event

In order to obtain a current understanding of groundwater conditions at the Site, one round of groundwater samples will be collected from 29 of the existing Site monitoring wells; the list of wells is provided in the UFP-QAPP. Based on three (3) locations having multiple sampling channels, a total of 32 groundwater samples will be collected.

Groundwater purging operations and subsequent groundwater sample collection will be conducted in accordance with the EPA Region 2 Low Stress Method (EPA R2, 1998) and USACE Standard Operating Procedure for Groundwater Low-Flow Purging (USACE, 2002), using an adjustable-rate bladder pump or submersible pump equipped with dedicated Teflon-lined tubing, a water-quality meter, and a flow-through cell. The well's static water level measurement will be recorded using an electronic water level indicator prior to sampling. After the water level is recorded, groundwater will be purged from each monitoring well to begin the sample collection process. The purged groundwater and well headspace will also be field screened using a PID prior to and during sampling.

During the purging operations, the pump speed will be adjusted to achieve minimal stabilized drawdown, to the extent practical. If drawdown cannot be stabilized, the pumping rate will be reduced to the minimum rate the equipment can maintain and continue to pump groundwater. Groundwater quality indicator parameters will be recorded approximately every five minutes during the groundwater purging process. The groundwater quality indicator parameters to be recorded include pH, temperature, specific conductivity, dissolved oxygen (DO), turbidity, and oxidation-reduction potential (ORP).

Once the groundwater quality indicator parameters are considered to be stabilized within the limits specified in the applicable SOP (found in the UFP-QAPP, Appendix A), a groundwater sample will be collected directly from the Teflon tubing into sample bottles. The groundwater samples will be analyzed for TCL VOCs [trace level except wells MW18S, MW21D and MW27D due to historically high concentrations], TCL semi-volatile organic compounds (SVOCs) including 1,4-dioxane, TCL pesticides, TCL polychlorinated biphenyls (PCBs), TAL metals, and water quality (WQ) parameters. The WQ parameters will include: alkalinity, ammonia, biochemical oxygen demand (BOD), chloride, chemical oxygen demand (COD), nitrate, nitrite, total phosphorus, sulfate, sulfide, total organic carbon (TOC), and total dissolved solids (TDS). The groundwater sample results will be compared to the applicable federal (EPA Maximum Contaminant Levels [MCLs]) and state (NYSDEC Water Quality Standards/Guidance Values - Class GA) as outlined in the UFP-QAPP.

In-Situ Treatability Study Events

Multiple sampling rounds will be performed as part of the in-situ treatability study, including one (1) pre-injection event and four (4) post-injection events. Descriptions of the sample collection and analysis requirements are provided in Section 2.4. A list of the wells to be sampled as part of the in-situ treatability study events is provided in the UFP-QAPP.

Geotechnical Borings

Five geotechnical soil borings will be advanced to identify the subsurface soil conditions within the planned footprint of the groundwater treatment plant. The borings will be advanced to depths of approximately 25 feet bgs using HSA through the unconsolidated subsurface materials.

Soil samples will be collected continuously in 2-foot intervals from ground surface to approximately 25 feet bgs. The soil samples will be collected in a split-spoon barrel sampler, ball check design, with an inside length of 2 feet and outside diameter of 2 inches. The split-spoon sampler will be driven into the subsurface soils utilizing a 140-pound hammer falling 30 inches. Blow counts will be collected in accordance with the Standard Penetration Test (ASTM 1586) for each split-spoon sample.

Based on the site-specific stratigraphy identified during previous environmental investigations, undisturbed soil samples may be collected. The undisturbed soil sample will be collected using Shelby Tubes in accordance with ASTM D-1587. The number of undisturbed sample(s), as well as the depth at which these samples may be collected, will be identified in the field.

Tetra Tech’s field geotechnical engineer will perform visual soil classification on each recovered soil sample based on ASTM D-2488 and record the type of material, sample depth, blow counts, sample recovery, water level, and any other observations for each soil boring. Tetra Tech will collect soil samples for geotechnical laboratory analysis from each split-spoon sampler, visually classify the sample in the field, and maintain field boring logs.

Geotechnical analyses will be performed on five (5) soil samples, one (1) per boring. The analyses will include particle size/sieve analysis, specific gravity/hydrometer analysis, standard test for material finer than No. 200 (75-µm) sieve, Atterberg limits, moisture content, and direct shear.

Laboratory Services

Tetra Tech will follow the EPA Region 2 Field and Analytical Services Technical Advisory Committee (FASTAC) procedures when procuring analytical services. For all non-time critical data collection, EPA Region 2 requires that a sequential decision tree for procuring Superfund analytical services be followed, which include:

- Tier 1: EPA Region 2 Division of Environmental Science and Assessment (DESA) Laboratory (with Environmental Services Assistance Team [ESAT] support);
- Tier 2: National Analytical Services Contract laboratories (Contract Laboratory Program [CLP] Routine Analytical Service [RAS] and Non-RAS);
- Tier 3: Region Specific Analytical Services (SAS) Contract laboratories; and
- Tier 4: Subcontract laboratories.

Tetra Tech presumes that the TCL and TAL analyses will be performed by the DESA Laboratory or through the EPA CLP RAS program. The DESA Laboratory or a subcontracted laboratory will be utilized for non-routine analyses, such as the geotechnical and chemical water quality parameters. A subcontracted laboratory is anticipated to be utilized when non-standard turnaround times are required (i.e., 24-hour) and when analysis/methodology, capacity, or scheduling needs cannot be met by the DESA Laboratory (e.g., in-situ treatability study microbial analyses). Details on analytical services are provided in the UFP-QAPP.

Prepare and Ship Samples

Tetra Tech will prepare and ship field environmental samples, and associated field QC samples, collected for off-site laboratory analysis according to the procedures outlined in the UFP-QAPP and the EPA CLP Guidance for Field Samplers (EPA, 2007). Samples will be shipped to the applicable laboratory(ies) via priority overnight shipping.

- For samples to be analyzed by the DESA Laboratory and/or CLP laboratories, Tetra Tech will procure and provide the sample containers. Arrangements will be made for sample shipment and delivery schedules with the Regional Sample Control Center (RSCC).
- If a subcontractor laboratory is required during the field investigation, the sample containers will be provided by the off-site subcontractor laboratory. Arrangements for container delivery and shipment will be made directly with the subcontractor laboratory.

During the field sampling activities, EPA's Scribe program will be used to manage sample collection data, and provide sample label and custody documentation. Completed custody seals will be placed on all shipping containers (i.e., cooler). The Tetra Tech CLP Authorized Requestor will review the proper packing and shipping techniques with Tetra Tech field personnel prior to field operations.

Sample Management

Tetra Tech will provide sample management support, including review of chain of custody procedures, information management, and data storage/retention, in accordance with the procedures outlined in this RDWP and the UFP-QAPP. Communication will be maintained with the EPA RSCC office, the DESA Laboratory, and/or the subcontract laboratory(ies) regarding the scheduling, tracking, and oversight of the sample analyses and validation. Tetra Tech will submit the following to the RSCC within one week after sampling is completed for a delivery group: a Sample Trip Report (STR) for any analyses completed by the CLP program and/or an Analytical Services Tracking System (ANSETS) Report for any analyses completed by a subcontractor laboratory.

The UFP-QAPP provides descriptions of laboratory oversight activities, including periodic performance evaluation sample analyses, sample label documentation, chain of custody forms, operational audits, and corrective action procedures.

Topographic Survey of the Site

Tetra Tech will subcontract a surveyor to perform a topographic survey of this 50-acre Site in support of the RD. Recent aerial surveys will be overlain with a topographic survey, updated property ownership and tax map information, and survey/verification of key features such as roadways, curbing, and manholes. The updated survey will be used for design considerations, such as determination of treatment plant foundation location and elevation, layout and design of exterior piping and utilities, and other design and/or permit drawings, as required.

The Surveyor will complete a tax map review and deed search of the properties located within the Tax Map and Deed Search Limits of the Site. All legal boundaries and easements within the surveying limits will be determined and shown. Bearing, distances, metes, bounds and other relevant information required to properly describing the boundaries of the site or easements will be provided in accordance with applicable standards. The tax map of the area will then be used as the base map to show ground surveying data of the areas within the public rights of way.

A ground survey of approximately 10 acres of the roadways at the Site will be conducted to establish horizontal and vertical location (where reasonably possible) of all utilities located within the limits of the public rights of way. All elevations at location coordinates will be performed to an accuracy of 0.01 foot.

Locations will be based on visual field observations, as well as readily available municipal and utility company documentation. Utility information to be provided will include, but not be limited to: water mains (including service connections and valves), sanitary sewer mains (including service connections, manholes, and junction boxes), storm water piping (including structures, manholes, recharge basins, detention basins, or catch basins), miscellaneous structures or piping, gas mains (including service connections and valves), and conduits. The surveyor will supply the size and material of utilities encountered as well as the top, grate and invert elevations (entering and exiting) of structures associated with the utilities.

The ground survey will establish topographic contours at 2-foot intervals along the roadways, and will identify relevant surface features within the public rights of way, including but not limited to the following: limits of pavement/surfacing types, location and materials of curbs, sidewalks, and pads, limits of vegetated areas, wells (potable, monitoring, pumping, etc.), walls and structures, natural and manmade drainage ditches or channels, fencing, waterway features (i.e., top of bank, waterline, centerline, depth of water, etc.), and other relevant information.

The coordinate system utilized for the survey of the new pumping, observation, injection, and monitoring/observation wells will be New York State Plane North American Datum 83/92 (NAD 83/92) for horizontal control and North American Vertical Datum 88 (NAVD 88) for vertical elevations (to 0.01 foot vertical). The surveyor will obtain horizontal location and vertical elevations for all sample points installed as part of the pre-design program, as well as the proposed corner locations of the treatment building. Data for the wells will include the vertical elevation of the concrete pad, ground surface, outer casing, and innermost casing. The proposed corner locations will be used to establish the location of a planned building plot area. Proposed site features will be identified in the field by reference marker (i.e. stakes, hubs, nails, ribbons, etc.).

The surveyor will remobilize to survey and provide a legal description of the final planned building plot area to be shown in the field by Tetra Tech. The surveyor will also be responsible to establish a minimum of four bench mark monuments within the survey area that can be used during future site activities. The surveyor will prepare a Survey Control Report and the appropriate portion of the EPA Electronic Data Deliverable (EDD).

IDW Containerization and Disposal

Investigation-derived wastes (IDW) generated during the field investigation activities will be staged at a secure location for subsequent characterization, transport, and disposal by Tetra Tech's IDW subcontractor. Tetra Tech and its subcontractors will ensure that IDW is properly containerized and labeled, and periodically inspected. Waste profiles and manifests, for subsequent transportation and disposal of IDW from the Site, will be reviewed by Tetra Tech's FOL and Program Environmental Safety and Quality Manager (PESM) to ensure proper transport and disposal.

Consumable material not impacted by Site contaminants or hazardous materials will be disposed as conventional municipal solid waste. IDW will include the following waste streams:

- Aquifer evaluation testing water;
- Well purge/development water;
- Soil cuttings;
- Decontamination fluids containing wash/rinse water and decontamination chemicals; and
- Contaminated debris including but not limited to personal protective clothing, plastic sheeting, and consumable sampling equipment.

Tetra Tech anticipates disposing of the aquifer evaluation testing water through the Nassau County POTW. Tetra Tech will obtain approval from the county prior to any discharges. Tetra Tech will comply with discharge requirements regarding volume limits and maximum contaminant concentrations. It is anticipated that the requirements will restrict Total VOC concentrations to less than 1 milligram per liter (mg/L), with the maximum concentration of PCE not to exceed 0.1 mg/L.

Existing data may be used to verify the suitability of the water for either direct discharge to the local POTW or pre-treatment and then discharge, and Tetra Tech will discuss the requirements with the local POTW. If existing data cannot be used or does not indicate Total VOCs less than 1 mg/L and/or PCE less than 0.1 mg/L, then water will be collected as part of the initial step tests into frac tanks. Two (2) samples will be collected (one from each aquifer unit) and analyzed for TCL VOCs [trace levels] on a 24-hour turnaround timeframe, to determine acceptance by the POTW.

During the 24-hour pump tests, the water will be passed through a carbon vessel treatment system (if pre-treatment is necessary due to Total VOC and/or PCE results exceeding limits), conveyed to portable frac tanks, sampled, and subsequently discharged to the local POTW. The system will include filtration vessels prior to the carbon to prevent clogging by removing solids and metals. Residues and associated equipment/materials from stored water will be cleaned and also properly disposed. Two (2) samples for TCL VOCs [trace levels] on a 24-hour turnaround timeframe are estimated.

The other IDW generated during field operations will be analyzed as applicable to obtain transport and disposal approval. IDW will be transported by an approved, licensed transporter to an approved treatment, storage, and disposal facility for disposal, as appropriate for the classification of the IDW (i.e., non-hazardous or hazardous). Tetra Tech will verify whether the proposed facilities are currently approved by EPA Region 2, and only an EPA-approved disposal facility will be used for disposal of the IDW.

The IDW management procedures contained in the APP (Appendix B) provide additional guidance on how the IDW generated during the field investigation will be managed during the project. This includes details regarding the staging pad, fencing, tarping, marking, and inspection requirements.

Demobilization

Following implementation of the field investigation activities, Tetra Tech and its subcontractors will demobilize the temporary offices and close any utility agreements. Rental equipment will be returned and the related agreements will be closed. Demobilization will also consist of the following field tasks:

- Removal of temporary utilities and facilities;
- Clean out of Site office/storage, including removal of computer equipment;
- Demobilization of field equipment;
- Return of rental vehicles;
- Breakdown of sample and drilling equipment decontamination areas; and
- Return of non-expendable Tetra Tech equipment to inventory.

2.2.3 Access Support (Work Order 02.03)

Tetra Tech will provide access support to USACE and EPA, to include identification of properties to which access is required, tracking access agreements, and assisting in notification of property owners. Tetra Tech will also attend two meetings with property owners as requested by EPA to facilitate access.

2.3 Data Evaluation (WAD 03)

Activities performed during this WAD will include organizing and evaluating applicable data from the PDI for later use in the RD effort.

2.3.1 Data Usability Evaluation for Data (Work Order 03.01)

Tetra Tech will quantitatively and/or qualitatively evaluate the usability of the collected data by examining data validation summary reports (DESA Laboratory/CLP only; subcontract laboratory data are not scheduled for validation), verifying the sampling procedures and analytical results were obtained following the applicable protocols, are of sufficient quality to satisfy project quality objectives (PQOs), and can be relied upon for the subsequent RD activities. The results of the data usability evaluations will be presented in the Technical Memorandum (Work Order 03.02).

2.3.2 Data Reduction, Tabulation, and Evaluation (Work Order 03.02)

Data Reduction

Data assessed to be usable and relevant to the project will be compiled and summarized in tabular format. Independent quality control verification will be implemented at each step in the process to prevent transcription/typographical errors. The data will be entered into a data management/geographic information system (GIS) platform compatible with project objectives and design requirements. Locational data will conform to EPA's Locational Data Policy (LDP).

In addition to analytical data, information obtained about the physical characteristics of the Site may also be entered into the data management/GIS platform, as applicable. These data may include survey data, boring logs, well construction diagrams, and groundwater elevation measurements. Similar to the analytical data, an independent quality control verification review of the computerized entries will be performed. The data entered into the database will be used to create data tables and figures to assist with the Site evaluation.

Data Tabulation

Tables of analytical results will be organized by matrix (e.g., soil, groundwater), analytical fraction (e.g., VOCs, metals), specific intervals (e.g., shallow UGA and deep UGA), and/or segregated according to specific contaminant source area and/or other unique areas, if warranted. The analytical data tables will identify individual samples by a unique sample location/identification number corresponding to the sample location maps. The tables will include the sample collection dates, detection limits for parameters not detected, and laboratory and/or validation qualifiers. Standard units for reporting the analytical results (e.g., ug/L for water) will be used in the tables (as well as in the text and figures). Applicable screening criteria (i.e., EPA MCLs and NYSDEC Water Quality Standards/Guidance Values - Class GA) will be included in the tables for ease of comparison.

Geotechnical data from analysis of soil samples to support the design of the building foundation will be compared to engineering parameters necessary to make recommendations for the proposed design. The recommendations will account for soil attributes and requirements such as foundation type, depth, need for foundation pilings, allowable soil bearing pressure, foundation settlements, etc.

Graphical soil boring logs and well construction diagrams will be prepared during the data reduction phase to describe the subsurface conditions encountered at the new boring locations where intrusive field activities occurred.

An EPA Region 2 Electronic Data Deliverable (EDD) will be prepared for electronic submittal of field sampling and laboratory analytical results, geologic data, well installation specifications, and locational data in accordance with Region 2 policies, guidelines, and formats. In addition, Tetra Tech will format project data for submittal to NYSDEC's EQUIS-based EDD system.

Data Evaluation/Reporting

Tetra Tech will prepare a Technical Memorandum summarizing the applicable and usable results obtained during the PDI for submittal to USACE and EPA. This Memorandum will provide a summary of the data and findings of the conducted activities, including:

- A quantitative and qualitative determination of the usability of the data obtained during the field effort;
- An assessment of ability of the data to satisfy PQOs;
- An analysis of the data results;
- Graphical soil boring logs and well construction diagrams;
- Well development forms;
- Figures depicting the locations of new/existing wells and the refined estimated extent of contamination requiring treatment; and

- Tables of the analytical data obtained during this TO.

The protocol for eliminating field sampling analytical results based on laboratory/field blank contamination results will be clearly explained within the Technical Memorandum. The discussions of the sampling results will not be qualified by suggesting a particular chemical is a common laboratory contaminant or was detected in a laboratory blank. If the reported result has passed validation, the result will be considered valid. Field rinsate blank analyses will be discussed in detail in the Technical Memorandum if decontamination solvents are believed to have contaminated field samples.

2.4 Treatability Testing (WAD 04)

2.4.1 <u>In-Situ Treatment (Work Order 04.01)</u>

In-situ treatability testing includes performing a limited ISCO or ISCR injection program; performing pre- and post-injection monitoring; determining the implementability and optimal design of the in-situ groundwater treatment component; and performing data evaluation. The results of the treatability study and subsequent in-situ groundwater design will be used to complement and improve the effectiveness of the groundwater extraction, treatment, and discharge component.

The objectives of the treatability testing study are to evaluate the applicability of the ISCO/ISCR strategy, and to provide the data to aid in the design, installation, and operational parameters for the in-situ groundwater system at the Site. The study will involve selection of an appropriate chemical oxidant, permeable reactive barrier (PRB), or enhanced bioremediation activity to destroy groundwater VOCs on a permanent basis. ISCR may include a chemical reductant such as zero-valent iron (ZVI) as part of the PRB or the injection of a bioremediation substrate (e.g., emulsified vegetable oil, lactate, plant fiber, guar, lecithin). Conceptually, the portion of the contaminated plume having PCE concentrations equal to or higher than 3,000 ug/L will be treated in-situ (i.e., the treatment area). This study will help determine design parameters including the ISCO chemical or ISCR material to be used, dosage, injection point spacing, and frequency of injections.

Scope of Work

The SOW for the study includes the following major elements:

- A limited hydrogeologic investigation. New, permanent injection wells and temporary PVC wells for monitoring/observation will provide the groundwater analytical data needed to evaluate contaminant mass reduction within the source area.
- A static injection event, including appropriate monitoring. Periodic well sampling and analysis will be performed to monitor and record conditions within the aquifer, determine the optimal quantity and frequency of injected material, and to measure the performance of the ISCO/ISCR treatment process during the testing period.

The Revised Technical Proposal submitted by Tetra Tech in December 2011 assumed that the use of an oxidant solution (specifically sodium permanganate or $NaMnO_4$) was the leading candidate for the treatability study, but other ISCO and ISCR approaches could not be ruled out. ISCR approaches may be better suited to designing an in-situ remedy to enhance the remediation of those areas within the groundwater plume containing elevated PCE concentrations. For example, the design of a PRB treatment zone may be appropriate to intercept/remediate the plume and reduce mass flux. This zone may rely on using materials such as ZVI or dual valent iron (DVI), or on materials to promote microbial activity (e.g., adding carbon substrate and nutrients). In this way, treatment would occur through a combination of physical, chemical, and biological processes. Direct injections of a bioremediation substrate could also be a valid option.

Potential in-situ treatment options are discussed below.

Treatability Testing Options

Based on available information, the groundwater from existing monitoring wells MW-21S, MW-21D, and MW-27D contains elevated PCE concentrations greater than 2,500 ug/L. The VOC concentrations within these wells are targeted for ISCO/ISCR treatment in support of the RD, in addition to well MW-27S, which is the companion well for MW-27D.

Clusters MW-21 and MW-27 are assumed to be representative of the site-related contaminated plumes (both shallow and deep) at the Site. Both clusters are relatively close to the suspected sources of PCE and other VOC contamination, including Cedarwood Cleaners and Piermont Cleaners. One cluster is located along Westervelt Place (wells MW-21S and MW-21D), and one along Hewlett Parkway (wells MW-27S and MW-27D).

Based on a review of background information and the results of the January 2012 site visit, four options were evaluated for the treatability study. These options included:

- Option 1: Injection of a chemical oxidant as originally described in the Revised Technical Proposal;
- Option 2: Injection of an enhanced bioremediation material;
- Option 3: Injection of an ISCR reagent with a ZVI type of component; and
- Option 4: Injections of Enhanced Bioremediation Material and ISCR Reagent.

All options assume that a pilot injection program will be performed at locations that are most representative of site conditions.

Common features of these study options include the following:

- Installation of permanent wells (injection) and temporary PVC wells (monitoring/observation). For the shallow plume, the wells would be drilled to a depth just above the top of the clayey silt within the UGA (approximately 20 feet bgs). For the deep UGA plume, the wells would be installed just above the top of the Gardiner's Clay formation (approximately 65 to 75 feet bgs).
- Pre-injection and post-injection monitoring, sampling and analysis. Activities to be conducted include obtaining water-level measurements and collecting groundwater samples from new injection wells, new temporary PVC wells, and existing monitoring wells that may be part of the study.
- Sample management and coordination. Tetra Tech will coordinate laboratory services and prepare samples for shipment to the designated laboratory(ies) in accordance with the UFP-QAPP. Activities to be performed include completion of sample documentation (including labels, chains of custody, etc.) and proper packaging. Additional discussion on these activities is provided in Section 2.2.2.
- IDW management. IDW that are expected to be generated from the field investigation includes decontamination fluids, used personal protective clothing, and purge water. Specific IDW handling procedures are presented in Section 2.2.2 and in the APP.

Option 1 - Injection of Chemical Oxidant

The primary contaminant of concern (COC) in the groundwater at the Site is PCE; other COCs include trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC). The typical end products of ISCO are carbon dioxide and chloride ion. The goal of ISCO is to lower concentrations of individual VOCs through destruction. There are four groups of oxidants that are commercially available and used for ISCO: [1] permanganate; [2] activated persulfate (sodium persulfate activated by different methods); [3] hydrogen peroxide (including Fenton's reagent); and [4] ozone. All four groups are effective in treating PCE. Permanganate is available as sodium permanganate ($NaMnO_4$) or potassium permanganate ($KMnO_4$). There is no difference in reactivity of these two salts, the main difference is in their solubility.

Permanganate was selected as the ISCO reagent given limitations of using the other oxidants. For example, persulfate activation by alkaline pH has limitations, since this form of activation requires the delivery and injection of a significant quantity of caustic (NaOH) into the groundwater plume to maintain a pH of 11. Persulfate activation with heat or UV light was considered impractical for the Site because of its significant energy requirement. Major concerns with peroxide involved the handling of a large quantity of hazardous reactive chemicals, excessive heat, and pressure buildup. Moreover, an abundance of iron and manganese at the Site would lead to excessive non-productive decomposition of H_2O_2, and limit the persistence of peroxide to a short period (minutes to hours). Thus, H_2O_2 was not considered for ISCO injections at the Site.

Ozone has a half-life of about 30 minutes and cannot be transported via diffusion over long distances, making the radius of influence of the injection points very small compared to other oxidants. There are also concerns regarding the operation of equipment necessary to implement ozone injections at the Site. Given the residential setting and the large number of injection points necessary even for localized treatment, implementing Option 1 with ozone was deemed impractical.

As such, $NaMnO_4$ was assumed as the ISCO reagent for Option 1. This reagent is best suited for the Site conditions and objectives of the treatability testing, and requires simpler logistics. The pilot study would include a static injection event involving a 5% solution.

Near each cluster, DPT equipment would be used to install a suitable pattern of temporary PVC wells after accounting for utilities and physical structures such as homes. Approximately 20 2-inch temporary wells would be needed for this option, along with four new, permanent 6-inch wells that would serve as injection wells (two wells at each of the clusters). Additional existing monitoring wells would also serve to monitor the lateral distribution of the injected solution.

At least five (5) temporary PVC wells would be drilled with four (4) wells at each corner of the diamond pattern and one (1) well further downgradient of the diamond. The spacing of wells at each cluster would be 20 to 30 feet apart. The actual locations of the wells would be adjusted such that the dispersion of the oxidant can be evaluated. This information would help determine the spacing and depth of injection points or wells as part of the RD.

Under Option 1, each injection well would accept up to 15 gpm. A total of 5,000 gallons of the 5% $NaMnO_4$ solution would be injected into four wells (i.e., near MW-21S, MW-21D, MW-27S, and MW-27D). Each injection well would receive roughly 1,250 gallons of the solution. The actual number of gallons to be injected at each well would be adjusted based on pre-injection monitoring results. For example, wells containing higher VOC concentrations may receive a greater volume of oxidant solution. A manifold system would not be used to inject the solution into multiple wells at the same time. At each well cluster, the deep well would receive its injection first, to determine if deep injections affect the shallow wells at that location. A pre-mixed solution could be delivered to the Site, the solution could be mixed on-site, or the solution could be introduced using in-line mixing equipment. Tetra Tech would rely on the delivery of a pre-mixed solution in a single 5,000-gallon tanker.

The injections would be performed under low pressure gravity flow. Gravity injection would help ensure that the oxidant solution does not surface and would help streamline the setup of the ISCO injection equipment.

Prior to activities, one round of pre-injection (baseline) monitoring would be performed. After the $NaMnO_4$ solution was injected, post-injection monitoring would be conducted. Following ISCO injections, groundwater samples and water-level measurements from selected wells would be obtained on a periodic basis. The monitoring program would help determine the effectiveness of the injections and measure the spread of the solution (both laterally and vertically). The sampling and analysis requirements could include field test kit parameters (e.g., colorimeter to determine permanganate presence), fixed-base laboratory analyses (e.g., VOCs, metals, and chloride), and/or other screening methods.

Given current site characteristics, the implementation of an in-situ groundwater remedy using an oxidant solution has the potential to pose risks to human health and the environment and may be ultimately ineffective in meeting the RA objectives as specified in the ROD. Specifically, this option may adversely affect LIAWC Plant #5 Well Field; impact commercial and residential properties; and alter groundwater, soil vapor, and indoor/outdoor air quality. The presence of underground piping and utilities in the neighborhood, particularly for the shallow UGA, may result in preferential pathways for the oxidant solution or generate pockets of unacceptable vapors that could escape into homes. In addition, there is a potential for the solution to daylight or reach the ground surface after injections in the residential neighborhood, especially given the presence of the 20-foot clay layer beneath the Site. Depending on its presence beneath the Site, the 20-foot clay layer may act to pool injected ISCO solution in the shallow UGA. The injected solution may then surface at the ground, or it may flow back out of the top of the well itself. Field experience has demonstrated that there is often no way to predict these events from occurring, even by using water-level measuring devices. As such, adequate warning signs are often not practicable. The surfacing of the solution may not occur until several weeks have passed since the injections, in part due to precipitation events. In addition, the injections may also raise the water-table elevation, possibly putting buried utilities (e.g., pipelines, storm drains) in contact with the ISCO solution. The presence of storm drains could also impede the mixing of the solution prior to injection and/or the containment and cleanup of any spills involving the injection of the solution (if applicable). These factors may pose potential risks to human health and the environment during and after the ISCO injections.

A second concern of Option 1 is its compatibility with the pump-and-treat portion of the groundwater remedy. While the combination of both pump-and-treat and ISCO remedies can be applied concurrently or sequentially, at this time there is not enough information to determine if the eventual extraction wells (in terms of their locations , depths, and pumping rates) would impact the effectiveness of the ISCO portion of the remedy. For example, the extraction wells may capture permanganate-contaminated water or groundwater containing manganese dioxide (MnO2) solids. ISCO injections may mobilize metals within the treatment area, which may adversely affect the operation of the treatment plant. In addition, it is likely that multiple ISCO injection events will be required at the Site as part of the long-term remedial action. This is a relatively common occurrence, and several injection events over a considerable period of time may be required. Given current and future possible access restrictions on locating ideal injection wells at the Site, it may be difficult to achieve the RAOs within the areas targeted for ISCO treatment.

Option 2 - Injection of Enhanced Bioremediation Material

Option 2 would involve the injection of liquid bioremediation (emulsified vegetable oil or EVO) material into four permanent 6-inch wells (two shallow and two deep) at two locations followed by post-injection monitoring. Several products are available to stimulate biodegradation of VOC-contaminated groundwater. For Option 2, LactOil™ would be used for the injections since it is well suited for delivery into wells and is simple to emplace into the UGA.

The LactOil™ would be delivered as an undiluted, soy microemulsion formulation. The liquid would be provided in 55-gallon drums. The emulsion would contain approximately 45% food grade soy bean oil, 35% fast-release substrate (i.e., lactate, plus a small percentage of food additives, emulsifiers, and preservatives), and 20% water (JRW, 2012).

A total of 14 50-gallon (450-pound [lb]) drums of LactOil™ would be added to roughly 18,000 gallons of formation water in frac tanks (e.g., 21,000-gallon capacity) or the mixture would be delivered to the Site in tankers. The mixture would be circulated in the frac tanks or tanker prior to injections using pumps or a paddle device. The LactOil™ injections would be performed prior to the pre-design aquifer evaluation testing.

At each of the four permanent injection wells (two shallow and two deep), the LactOil™ mixture would be transferred from the frac tanks or tanker using readily available equipment. Pressure would not be used for the injections. Each 6-inch well would receive a portion of the EVO mixture.

For Opton 2, one pair of the injection wells would be slightly upgradient of existing well cluster MW-27 along Hewlett Parkway. Temporary PVC wells would be installed in a relatively straight line between the injection wells and existing downgradient wells (including wells installed for the aquifer evaluation testing). The well locations would be adjusted based on the presence of buried utilities and accessibility. A total of 12 new temporary wells (six shallow and six deep wells) would be emplaced near well cluster MW-27 and the pair of new injection wells in this general area.

The second set of permanent injection wells under Option 2 would be installed upgradient of existing well cluster MW-21 along Mill Road. If access is not available along Mill Road, this set would be located between cluster MW-21 and proposed pumping well PW-01S. Shallow and deep temporary PVC wells would be located along Westervelt Place and Sturlane Place, and for planning purposes, six (6) temporary wells (three shallow and three deep wells) would be installed.

Additional temporary PVC well points may be installed during the post-injection monitoring program to help determine the lateral distribution of the injected LactOil™ material.

Following the LactOil™ injections, groundwater samples and water-level measurements from selected wells would be obtained on a periodic basis. The monitoring program would help determine the effectiveness of the injections. The schedule for these events would be adjusted based on the results from previous monitoring events. One round of pre-injection (baseline) monitoring would also be conducted.

Samples would be collected from the wells for both chemical and physical parameter analyses. The sampling and analysis requirements would include field instrument readings (particularly for ORP), field screening test kits, and fix-based laboratory analyses (e.g., VOCs, volatile fatty acids, dissolved gases, and TOC). Selected samples would also be tested for dechlorinating bacteria, functional genes, and phylogenetic groups utilizing a laboratory technique referred to as qPCR (quantitative real time polymerase chain reaction).

The results would be evaluated to determine the subsequent frequency of bioremediation injections, any necessary modifications to the dosage of the reagents, and the design of the full-scale in-situ groundwater remedy.

Option 3 - Injection of ISCR Reagent With ZVI-Type Component

Option 3 would involve the injection of ISCR slurry into closely-spaced borings or injection points at one general area followed by post-injection monitoring. Option 3 would simulate a PRB for plume treatment and management. For planning, EHC™ would be used for the injections. The slurry would facilitate the chemical reduction of the primary groundwater COCs by creating low redox potential and producing hydrogen.

The area selected for Option 3 would be near the intersection of Hewlett Parkway and Westervelt Place. This area contains elevated PCE and other VOC concentrations in both the shallow (specifically to the west of the intersection) and deep UGA. The injection points would be spaced roughly 5 to 10 feet apart and lie roughly perpendicular to apparent shallow and deep groundwater flows associated with the UGA. The configuration of the points would be a T-shaped pattern with the short portion of the T placed across Westervelt Place and the long portion parallel to Westervelt Place and across Hewlett Parkway. The barrier would be emplaced prior to the pre-design aquifer evaluation testing.

The slurry would be prepared using a mechanical mixing system. After mixing, the slurry would be connected to an injection pump. The EHC™ slurry would be injected at pressures of up to 200 lbs per square inch (psi) and would be prepared continuously until the injections are completed.

A total of at least 15 injection points may be needed as part of the barrier. The injections would begin at the top of the boring and proceed downward. For each injection interval, the rods of the DPT equipment would be advanced to the top of the targeted depth interval and the selected slurry volume injected before advancing deeper. For the shallow portion of the UGA, the well may have up to five (5) intervals; for the deep UGA, the wells may involve up to seven (7) intervals depending on lithology. Each injection point interval would receive approximately 600 lbs of dry EHC™ powder blended with 175 gallons of water.

Temporary PVC wells would be installed downgradient and near the Option 3 injection points. Some temporary wells would be located along Sturlane Place. The actual locations of wells would be adjusted based on the presence of buried utilities and accessibility. A total of ten (10) new temporary wells (five shallow and five deep wells) would be emplaced. Additional temporary well points may be installed during the post-injection monitoring program to help determine the lateral distribution of the injected EHC™ slurry.

Following the EHC™ slurry injections, groundwater samples and water-level measurements from selected wells would be obtained on a periodic basis. One round of pre-injection (baseline) monitoring would also be conducted. The monitoring program would be similar to Option 2, and would help determine the effectiveness of the injections. The actual schedule for these events would be adjusted based on the results from previous monitoring events. Samples would be collected from the wells for chemical and physical parameter analyses, with all points analyzed for VOCs and selected ones tested for TOC, dissolved gases, volatile fatty acids, and qPCR.

Option 4 - Injections of Enhanced Bioremediation Material and ISCR Reagent

Option 4 combines aspects of Options 2 and 3 to form a dual approach for the treatability study. More specifically, LactOil™ would be injected through two permanent wells, installed just upgradient of existing well cluster MW-27 as described under Option 2. EHC™ slurry would be emplaced in a series of injection points near the intersection of Hewlett Parkway and Westervelt Place to simulate a PRB as discussed under Option 3. The spacing of the wells for emplacing the EHC™ slurry would remain at roughly 5 to 10 feet (an average spacing of 7 feet) but the length of the barrier would be reduced. In addition, the PRB wells would be installed only in the deep UGA. The intent of the injection point layout would be to minimize the co-mingled effects of injecting both LactOil™ and EHC™ slurry, and to intercept the more contaminated portion of the PCE plume in both the shallow and deep UGA.

The EHC™ slurry would be emplaced prior to the pre-design aquifer evaluation testing. The injections of LactOil™ would be also performed prior to the pump tests, or concurrent with the aquifer evaluation testing.

Other aspects of Options 2 and 3 would be included as part of Option 4, including the installation of new permanent and temporary wells, and pre-injection and post-injection monitoring.

Evaluation of ISCO/ISCR Options

Table 1 summarizes the comparison of treatability study options. Based on this evaluation, Option 4 was selected as the approach to best meet the objectives of the treatability testing and to support the design of the in-situ groundwater remedy. The use of enhanced bioremediation or ISCR reagents has a better probability of reducing VOC concentrations (including PCE levels) within these targeted areas by creating conditions favorable to stimulate biodegradation of VOC-contaminated groundwater. These processes are also more likely to be compatible with the pump-and-treat portion of the groundwater remedy. Option 4 is described in more detail below.

Proposed Treatability Testing Approach

The proposed testing approach is Option 4. This option includes the following components:

- Installation of two permanent injection wells and 12 temporary PVC observation/monitoring wells in the vicinity of well clusters MW-21 and MW-27;
- Pre-injection monitoring at new wells installed during the PDI (including new in-situ wells described above and two new wells installed as part of the aquifer evaluation testing) and selected existing wells;
- Injections of bioremediation emulsified vegetable oil (i.e., LactOil™) into two permanent wells (one shallow and one deep) upgradient of existing well cluster MW-27 along Hewlett Parkway. Only two wells will be used for injections compared to four wells as discussed for Option 2;
- Installation of a simulated PRB using DPT equipment and ISCR (i.e., EHC™ slurry) along Westervelt Place and its intersection with Hewlett Parkway. The PRB will be shorter than described for Option 3 and will be emplaced in the deep UGA only;
- Post-injection monitoring and, if necessary, installation of four (4) additional temporary PVC monitoring/observation wells; and
- Data evaluation and reporting.

The intent of Option 4 is to use two different testing approaches to evaluate the applicability of these in-situ groundwater strategies, and to provide the data to aid in the design, installation, and operational parameters for the in-situ groundwater remedy for the Site.

Well Installation

Two permanent wells (for the LactOil™ injections) will be drilled using HSA and installed upgradient of cluster MW-27 as described in Section 2.2.2. These injection points will be 6-inch stainless steel (for long-term use), flush-mounted wells with approximately 10 (shallow) and 25 foot (deep) screen lengths (depending on subsurface conditions). These wells will be installed in similar fashion to the pumping wells.

Ten (10) temporary PVC points for emplacing the EHC™ slurry will be advanced using DPT at roughly 5 to 10 feet (an average spacing of 7 feet) over a distance of 70 feet. These locations are further described in the "Injections of ISCR Reagent as a Permeable Reactive Barrier" subsection below, as they will be advanced at the same time as the EHC™ slurry injections are performed.

DPT equipment will be used to install a suitable pattern of temporary 2-inch PVC observation/monitoring wells, after accounting for utilities and physical structures such as homes. Twelve (12) locations are proposed in the vicinity of well cluster MW-27 and the general area of the PRB (west-southwest of the MW-21 cluster), as shown in Figure 5. Eight (8) of these locations are paired shallow and deep wells (four (4) each) installed in a relatively straight line between the location of the injection wells and existing downgradient wells and/or new aquifer evaluation testing wells. The remaining four (4) points will be deep wells only, with two (2) points located along Sturlane Place (Figure 5).

The groundwater contours for May 2010 around the MW-21 cluster show a depression in the water table. However, the overall flow appears to be to the north, or slightly northwest. Water levels will be measured during the initial round of groundwater sampling (the "current understanding" event) and the groundwater flow direction determined. A recommendation will be made at that time regarding the potential need for an additional temporary well point.

For the shallow plume, the 2-inch temporary PVC wells will be drilled to a depth just above the top of the clayey silt within the UGA. For the deep UGA plume, the wells will be installed just above the top of the Gardiner's Clay formation. As a general rule, the shallow and deep screened wells will be installed to a depth of 20 feet and 65 to 75 bgs, respectively. All of the temporary points will have an approximate screen length of 10 to 20 feet depending on subsurface conditions. To reduce the potential for cross-contamination using the DPT technology, separate temporary wells will be installed to individually monitor the shallow and deep aquifers. After the treatability testing is complete, the temporary PVC wells will be properly abandoned.

If deemed necessary during data evaluation, additional temporary PVC wells may be installed at the Site during the post-injection monitoring program to help determine the lateral distribution of the injected materials. Two (2) pairs of shallow and deep wells (for a total of four (4) locations) are proposed for planning purposes (Figure 5). Installation of these monitoring/observation points, if necessary, would occur within 2 months after the injections are completed. Data to be collected from the additional wells (if required) would be TCL VOCs and water quality measurements to assist in the development of remedial design requirements for the in-situ portion of the groundwater remedy (e.g., refinement of the spacing of RA injection wells and/or additional PRB injection points). Pre-injection data from other wells in the vicinity of the injection points can be used for comparison to the data collected from the additional wells, if they are installed.

Pre-Injection Monitoring

Once all permanent injection wells and temporary PVC wells are installed, one round of groundwater samples will be collected. One round of comprehensive water-levels will also be obtained in and around the study area, and the elevations will be compared to previous water-level results.

Groundwater sampling will occur at 21 locations, including the two (2) new injection wells, the 12 new temporary PVC observation/monitoring wells, the new deep pumping well from the aquifer evaluation testing [PW-01D], the new shallow observation well from the aquifer evaluation testing [OW-01S], and five (5) existing wells [to include MW-18S, MW-18D, MW-21S, MW-21D, and MW-27 (two channels)]. Low-flow groundwater sampling procedures will be employed with Redi-Flo™ pumps or similar equipment being used for wells of 2-inch or larger diameter. If any of the new temporary PVC wells are less than 2 inches in diameter, either peristaltic pumps, micro-bladder pumps, or Waterra® inertial pumps will be used to collect samples.

To provide information to aid in the RD, all of the baseline groundwater samples will be analyzed for TCL VOCs [trace levels except wells MW18S, MW21D and MW27D due to historically high concentrations]. Ten (10) selected wells (listed in the QAPP) would be tested for TOC, dissolved gases, and volatile fatty acids. Groundwater from the two injection wells would also undergo testing for dechlorinating bacteria, functional genes, and phylogenetic groups (i.e., qPCR). In addition, all samples will be tested in the field for pH, DO, ORP, turbidity, conductivity, and temperature. Field test kits will be used for total alkalinity, total soluble sulfide, and ferrous iron.

Laboratory service coordination, sample preparation and shipment, and sample management will occur as described in Section 2.2.2. Analytical method requirements are provided in the UFP-QAPP. Water generated during pre-injection monitoring will be managed in accordance with specific IDW handling procedures, also presented in Section 2.2.2.

The results will be evaluated to determine the subsequent frequency of bioremediation injections, any necessary modifications to the dosage of the reagents, and the design of the full-scale in-situ groundwater remedy. Once the well network is installed and the baseline groundwater results are evaluated, Tetra Tech will mobilize for the injection portions of the treatability study.

Injections of Enhanced Bioremediation Material

LactOil™ will be injected after the two permanent wells are installed upgradient of cluster MW-27. The can occur either just prior to the pre-design aquifer evaluation testing or concurrent with the pump tests. The LactOil™ will be delivered as an undiluted, soy microemulsion formulation. The liquid will be provided in 55-gallon drums. The emulsion will contain approximately 45% food grade soy bean oil, 35% fast release substrate (i.e., lactate, plus a small percentage of food additives, emulsifiers, and preservatives), and 20% water (JRW, 2012).

A total of seven (7) 50-gallon (450-lb) drums of LactOil™ will be added to roughly 9,000 gallons of formation water in frac tanks (e.g., 21,000-gallon capacity) or the mixture will be delivered to the Site in tankers. The mixture will be circulated in the frac tanks or tanker prior to injections using pumps or a paddle device. It will not be necessary to use a mechanical mixing system since a slurry-type of solution would not be made. The final injection solution will be about 1.5 v/v LactOil™ to water. Since the LactOil™ contains about 200 gallons of soy bean oil (450 gallons times 45% oil), the injection solution will consist of 0.5% soy bean oil.

It is preferable that the make-up water for the LactOil™ solution is actual groundwater from the Site since it is more representative of site-specific conditions. Untreated groundwater may be stored on-site for this purpose. If this approach is not practicable, groundwater will be pumped from available nearby wells (e.g., the two new permanent injection wells installed near cluster MW-27), stored nearby, and then re-injected after adding and mixing the LactOil™ material.

The calculated amount of LactOil™ required for injections was based on a number of inputs and reasonable assumptions. The calculations assumed total porosity of 20% for glacial outwash to estimate the amount of PCE in the targeted treatment areas. The thickness of the treatment area was based on the geologic cross-sections and the PCE contaminant contours for MW-27, which indicated that the shallower (unconfined) UGA aquifer was at least 20 feet thick, and the deep (semi-confined) UGA aquifer was at least 30 feet in thickness. The area of targeted treatment associated with each injection well was assumed to be an elliptical pattern 25 feet in width and 100 feet in length given aquifer characteristics such as horizontal hydraulic conductivity estimates of 5 feet/day for the shallow and 50 feet/day for the deep UGA. The average PCE concentration in groundwater was assumed to be 5,000 ug/L; however, PCE levels at MW-27D have been as high as 30,000 ug/L as reported in 2010.

The LactOil™ injections into the two new wells near well cluster MW-27 will consist of these requirements:

PARAMETER	VALUE AND UNIT
LactOil Injectate Volume (1.5%)	9,100 US gal
Delivered LactOil Product Volume (45%)	350 US gal
Number of Drums (50 USG)	7
Number of Injection Wells	2
Injection Volume per Well	Between 3,600-5,500 US gal

If another bioremediation product is selected for the study (e.g., EHC-L™, EAS™, or SRS®) after further evaluation, similar calculations will be made based on the product's characteristics and typical method of employment.

At each injection well (one shallow and one deep), the LactOil™ mixture will be transferred from the frac tanks or tankers using readily available equipment by Tetra Tech field staff. Pressure will not be used for the injections. The shallow 6-inch well will receive about 3,600 gallons of the LactOil™ mixture (two (2) drums of undiluted LactOil™ product), while the deep well will receive roughly 5,500 gallons (three (3) drums of undiluted LactOil™ product).

Injections of ISCR Reagent as a Permeable Reactive Barrier

This component consists of injecting ISCR slurry into closely-spaced points at one general area followed by post-injection monitoring. This portion of the in-situ treatability study would occur prior to the pre-design aquifer evaluation testing.

EHC™ will be used to establish a simulated PRB for plume treatment and management. The slurry will reduce PCE and other VOC groundwater concentrations by creating low redox potential and producing hydrogen. The length and size of the PRB will be smaller than described for Option 3 since it will partially complement the bioremediation injections, and still provide information to meet the treatability testing objectives. Only the deep UGA will be targeted for the PRB. The injection points will be located along Westervelt Place near the intersection of Hewlett Parkway and Westervelt Place. As shown in Figure 2, this entire area contained elevated PCE and other VOC concentrations in the deep (semi-confined) UGA. The length of the barrier to be emplaced with the EHC™ slurry will be approximately 70 feet.

The configuration of the points will be a relatively straight line along Westervelt Place after accounting for utilities. The injection points will be spaced roughly 5 to 10 feet apart (an average of 7 feet) and generally lie perpendicular to the 10,000 ug/L PCE isoconcentration contour for the deep UGA based on 2010 sample results (HDR, 2011a). A total of at least ten (10) injection points will be needed as part of the barrier. The spacing of points may vary depending on accessibility. Only one line of injection points will be used (i.e., the width of the PRB will be negligible).

To evaluate the PRB's effectiveness and performance, and as discussed previously, one (1) deep temporary PVC well will be installed just upgradient of the PRB injection points along Westervelt Place

(Figure 5). Two (2) deep temporary PVC wells will be located downgradient along Sturlane Place. A fourth deep location will be installed on Hewlett Parkway, near the proposed OW-01S well.

The EHC™ slurry (29% solids) will consist of solid organic carbon, micro ZVI, plant fiber, guar, and water. The dry powder will be delivered in 50-lb bags, which is the preferred method for ease of handling, or in 2,000-lb collapsible sacks. If sacks are used, they will require the use of a forklift or extended boom for material handling. When mixed with water, the wet density of the slurry will be approximately 1.15 grams per cubic centimeter (g/cm^3).

The EHC™ slurry will be prepared using a 2-bin mixing system (e.g., ChemGrout 500™). One bin will contain a paddle-mixer. After mixing in the first bin, the slurry will be transferred to the second tank (the feed tank), which will be connected to the injection pump. The pump will be connected to each injection point individually or through a manifold system. The pump will be capable of handling solids and generating at least 500 psi of pressure at a flow rate of 5 gpm. The EHC™ slurry will be continuously injected at pressures up to 200 psi until injections are completed.

If practicable based on Site logistics (e.g., sufficient space for placing frac tanks without potential interference with residential traffic), the water for the EHC™ slurry will be actual groundwater from the Site. Similar to the bioremediation injections, untreated groundwater will be obtained by pumping from available nearby wells (e.g., proposed pumping well PW-01S or proposed observation well OW-01S) after they are installed but prior to the pre-design aquifer evaluation testing. Site-related groundwater is preferred for the in-situ treatability testing since it is more representative of the quality of groundwater present at the Site. Water from off-site sources (such as municipal water supplies) may contain minerals, additives, and other general chemistry characteristics that could interfere with ISCR processes. At no time will groundwater containing more elevated levels of VOCs be injected into an area with lower VOC concentrations.

A subcontractor will perform the EHC™ slurry injections with direct oversight by Tetra Tech. The injections will begin just below the “20-foot clay” layer and proceed downward. Based on current geologic information, injections will begin at approximately 50 feet bgs and will advance to 80 feet bgs. Slurry will not be introduced into the “20-foot clay” layer beneath the Site if it is present.

For each injection interval, the rods of the DPT equipment will be advanced to the top of the targeted depth interval, and the selected slurry volume will be injected before advancing deeper. The depth to groundwater within the shallow UGA ranges from 3 to 15 feet bgs; the depth to groundwater within the deep UGA varies from 6 to 17 feet bgs. A pressure activated tip with multiple openings will direct the slurry horizontally. The injection intervals within a well will be evenly spaced every 4 feet. For the deep UGA, an individual injection point may have up to seven (7) intervals depending on lithology. If necessary, additional DPT rods and injection tips will be available to allow for the injection points to be capped at the end of each day to prevent overflow.

The estimated amount of EHC™ required for the injection points was estimated based on a number of inputs and reasonable assumptions. The ISCR reagent requirements for the slurry are as follows:

PARAMETER	VALUE AND UNIT
EHC™ Injectate Weight (1.5%)	2,100 US gals
Delivered EHC Product Weight	5,800 lbs
Groundwater	1,750 US gals
Number of Bags (50 lbs)	116

Number of Injection Points	10
Number of Injection Intervals	7 to 8
Injection Volume per Interval	28 US gals

Each interval will receive approximately 75 lbs of dry EHC™ powder (about 1.5 bags) blended with 25 gallons of water.

As the points will be likely be installed through existing roadways, after the injections are completed, the points will be resurfaced with an appropriate asphalt mix.

Post-Injection Monitoring

Following the LactOil™ and EHC™ slurry injections, groundwater samples and water-level measurements from selected wells will be obtained on a periodic basis. Samples will be collected from the wells for both chemical and physical parameter analyses. The monitoring program will help determine the effectiveness of the injections and measure the spread of the solutions (both laterally and vertically).

After the injection events/PRB installation are completed, the same list of wells as for the baseline pre-injection event will be evaluated to determine if they are affected by the LactOil™ material and EHC™ slurry. Two types of post-injection monitoring will be performed: process monitoring and performance monitoring.

<u>Process Monitoring</u>

Four rounds of post-injection process monitoring will be performed, with events occurring approximately one (1) week, two (2) weeks, four (4) weeks, and eight (8) weeks after the LactOil™ injections and EHC™ slurry emplacement. The schedule for these events may be adjusted based on the results from the previous process monitoring event. Process monitoring events will involve the use of field instruments (for water quality parameters such as pH, DO, ORP, turbidity, conductivity, and temperature) and test kits (total alkalinity, total soluble sulfide, and ferrous iron), and these results will be compared to pre-injection groundwater quality results. Sampling and analysis requirements are detailed in Section 2.2.2 and the UFP-QAPP (Appendix A).

<u>Performance Monitoring</u>

Two rounds of performance monitoring will be performed after the injections. These rounds will be conducted concurrent with the process monitoring events during Weeks 2 and 8. These results will be evaluated to determine the subsequent frequency of bioremediation and ISCR reagent injections, any necessary modifications to the dosage of oxidants, and the design of the full-scale in-situ groundwater remedy. The actual schedule may vary based on previous results, and additional rounds of post-injection monitoring may be needed if the frequency of monitoring is extended. If the frequency and/or scope of performance monitoring needs to be better refined based on the results of the injection events and the results from the first rounds of post-injection monitoring, a request for a field change to this RDWP will be prepared and approved following the procedures outlined in Worksheet #6 of the UFP-QAPP.

The monitoring program will generate information to evaluate changes in VOC and degradation/transformation products; ORP; and other physical parameters (e.g., pH, conductivity, temperature, dissolved oxygen, and turbidity). For each of the two (2) post-injection performance monitoring events, samples will be collected from 21 wells for laboratory analyses and general chemistry measurements. Groundwater will be analyzed for TCL VOCs [trace level except wells MW18S, MW21D and MW27D due to historically high concentrations], TOC, dissolved gases, and/or volatile fatty (metabolic) acids. Field test kits will be used to measure total alkalinity, total soluble sulfide, and ferrous iron levels so that these results can be compared to pre-injection groundwater quality results.

Groundwater will also be collected using four (4) Bio-Trap® devices placed in the two (2) injection wells, and then analyzed for PCR (dechlorinating bacteria), functional genes (TCE R-Dase, BAV1 VC R-Dase, and VC R-Dase), and phylogenetic groups (eubacteria and methanogens) using qPCR. Further details as to the list of wells and required analytical parameters are provided in the QAPP.

Data Compilation, Validation, and Reporting

After the post-injection monitoring for the treatability study is completed (including laboratory analyses), Tetra Tech will compile, evaluate, and report the results of the pilot testing. This task includes reducing, tabulating, and validating field investigation data for subsequent evaluation, interpretation, and presentation. Data subject to these activities include the hydraulic head data obtained during water-level measurements and the chemical/physical data obtained during monitoring activities, including well sampling. Formatting requirements will be as described in Section 2.3.2.

Specific activities will include the following work:

- Compile water-level data and water chemistry data from the in-situ treatability study task;
- Interpret hydraulic head data from the water-level measurements and prepare contour maps;
- Summarize and interpret data from pilot testing to determine the number of injection wells required for the in-situ groundwater remedy, and determine the rates, volumes, and concentrations of contaminated groundwater that would be treated in-situ;
- Compile chemical and physical data from the rounds of monitoring well sampling and prepare plume maps utilizing the field investigation results and treatability testing data; and
- Prepare a brief report that presents the integrated interpretations of the hydraulic head and chemical data, updates the present understanding of site conditions based on these data, and presents the recommendations and rationale for the RD. As required, recommendations for any follow-on work will also be provided.

Tetra Tech will submit a draft in-situ treatability study report to USACE, EPA, and NYSDEC for review. Upon receipt of comments and incorporation, the report will be finalized.

The results of treatability testing may indicate that some form of bioaugmentation is required to stimulate and support the in-situ portion of the groundwater remedy. Bioaugmentation may not be necessary if data trends indicate a clear reduction in PCE groundwater concentrations; the presence of elevated VC and ethene concentrations relatively shortly after field work; the presence of sufficient bacterial populations (i.e., *Dehalococcoides spp.*); or a combination of these trends. If it is determined that *Dehalococcoides spp.* are not active at the Site and/or no clear trend in reduction of chlorinated VOCs is observed, then bioaugmentation with *Dehalococcoides* cultures may be required. Bioaugmentation could be performed by injecting a volume of oxygen-free water (preferably site-related groundwater) with *Dehalococcoides* cultures (e.g., KB-1® or KB-1® Plus) as recommended by an appropriate culture supplier. The volume would likely be similar to that used for the enhanced bioremediation injections to ensure that cultures are distributed within the targeted study area. If this type of activity appears to be required for the Site, the further study work will be outlined in detail, submitted for review, and discussed with the appropriate stakeholders.

2.4.2 Ex-Situ Treatment Train (Work Order 04.02)

Based on the results of the pre-design current conditions groundwater sampling event, Tetra Tech will perform a bench-scale groundwater treatability study to address data gaps associated with the conceptual process design. The treatability study will assess:

- Groundwater influent chemistry (i.e. pH, temperature, BOD, COD, etc.)
- The necessity for metals removal;
- The necessity for biological fouling prevention within treatment process and effluent discharge options;
- Site-specific liquid phase carbon adsorption rates; and
- Specific adsorbents for removal of vinyl chloride will be evaluated if vinyl chloride is found to be a significant contaminant in the extracted groundwater.

The ex-situ treatability study subcontractor will be present at the Site during the aquifer evaluation testing (pump tests) described in Section 2.2.2, and will collect the volume of groundwater necessary to complete the study. The groundwater will be obtained during a period of constant flow, after field parameters have stabilized, to provide a sample representative of groundwater conditions under constant pumping conditions.

The subcontractor will provide a report, including tabulated data, to Tetra Tech, who will subsequently include the deliverable as part of the design. These results will be reviewed by the design team and form the basis for the treatment train.

2.5 Groundwater Modeling (WAD 05)

Tetra Tech will perform groundwater modeling using Groundwater Vistas in conjunction with MODFLOW/MODPATH platform extensions, to support the remedial design proposed for the Site. The modeling will include an assessment of contaminant fate and transport and aquifer hydraulics. The model will evaluate the two UGA layers, defined based on hydrogeologic and sediment characteristics identified at the Site. Figures prepared from the groundwater modeling calculations will depict graphic interpretations of hydrologic boundaries, aquifer properties groundwater/contaminant particle flow paths for groundwater containing elevated concentrations of chlorinated compounds found at the Site.

A summary of the modeling approach and results will be prepared during development of the groundwater model following the PDI (groundwater sampling and aquifer testing). Different capture zone scenarios will be evaluated to assess the optimum extraction well placement and pumping rate required to obtain hydraulic capture of the chlorinated plumes. A technical memorandum presenting the model results will be prepared and incorporated into the RD deliverables.

2.6 Remedial Design (WAD 06)

This task includes the completion of two detailed designs, one for in-situ chemical treatment and one for a groundwater extraction and treatment system, in accordance with the requirements specified in the 2011 ROD. Tetra Tech assumes that both the in-situ and extraction/treatment designs will proceed simultaneously, with completion of the in-situ design package anticipated to occur ahead of the extraction and treatment design package. The following subsections describe the deliverables that will be provided to USACE, EPA and NYSDEC for each of the two designs.

2.6.1 Preliminary (30%) Design (Work Order 06.01)

Tetra Tech will prepare a Preliminary Design that will include the development of the major elements of the design, including the extraction system design, contaminant influent levels, unit operations, equipment layout, and site plan. Tetra Tech will review the remedy as described in the ROD and make recommendations, if warranted, for enhancing the anticipated treatment process based on current engineering design practices and similar recent projects. The preliminary design will proceed until the design is approximately 30% complete, at which point the following deliverables will be submitted to USACE, EPA and NYSDEC for review:

- Preliminary Design Analysis Report (DAR) including the four engineering disciplines (civil, process, mechanical, and electrical);
- Conceptual design drawings, such as Title Sheet, General Site Plan, In-situ Chemical Treatment Area Site Plan, Treatment System Area Site Plan, Discharge Option Site Plan, and Process and Instrumentation Diagram;
- List of specifications and drawings;
- Identification of required permits; and
- Preliminary budgetary cost estimate. The preliminary cost estimate will be prepared using Means or other available construction cost data presenting the bottom line cost, including the cost estimate assumptions.

The Preliminary DAR will include the components of a Design Criteria Report and a Basis of Design Report. The report will provide justification of assumptions made in the development of the RD, and summarize plans for addressing regulatory, permitting, and environmental issues related to RA implementation. Elements that will be addressed in the DAR include:

- Project description (site description, nature and extent of VOCs, treatment area definition and characteristics, and brief summary of treatability study results);
- Remedy objectives and scope of design;
- Identification of substantive permitting requirements;
- Identification of applicable and relevant or appropriate requirements (ARARs), pertinent codes, and standards;
- Design requirements and basis;
- In-situ treatment strategy;
- Permits, easements and access requirements;
- Green remediation considerations and strategies;
- Waste minimization plan;
- Identification of long-term performance monitoring requirements;
- Remedial Action (RA) contingency plan; and
- Preliminary RA schedule.

2.6.2 Intermediate (60%) Design (Work Order 06.02)

The Intermediate Design package will include the basis of design, calculations, drawings, and specifications completed to approximately the 60% level. The package will incorporate comments received from USACE, EPA and/or NYSDEC on the Preliminary (30%) Design and the final comment resolution will be documented using Dr Checks. Items to be included in the 60%design are:

- A revised DAR containing design calculations, assumptions, design related decisions, and associated information;
- 60% developed design drawings;
- Design specifications and a draft bid schedule. The specifications will be prepared using the latest Unified Facilities Guide Specifications (UFGS) [available online at http://www.ccb.org/docs/ufgshome/UFGSToc.htm] and SpecsIntact software. Tetra Tech personnel will develop technical specifications for any items of work for which guide specifications are not available, using the same format as the guide specifications. Safety Specifications will be included in the package of specifications;
- Cost estimate. The 60% cost estimate will be prepared using Micro-Computer Aided Cost Engineering System (MII) software, in accordance with the requirements of Attachment 1 to the Scope of Services, "Cost Estimating Appendix for AE Designs," dated 11 January 2011. A construction narrative defining the parameters upon which the cost estimate has been prepared to support the project scope and schedule will be provided. The narrative will describe the project requirements and present a clear understanding of the scope of work. Site-specific construction conditions will be considered during preparation of the cost estimate. The updated cost estimate will include any cost estimate assumptions. Appropriate cost estimate backup material will be included in the cost estimate;
- Site-specific construction conditions will be considered during preparation of the cost estimate. Appropriate backup material (e.g., historical data or subcontractor quotes) will be included in the cost estimate. The bottom line cost will be provided along with any cost estimate assumptions. Major changes from the 30% estimate will be noted; and
- Intermediate permit equivalency applications.

2.6.3 Pre-Final (95%) Design (Work Order 06.03)

The 95% Design package will include the basis of design, calculations, drawings, and specifications completed to approximately the 95% level. Comments and recommendations received from USACE, EPA and/or NYSDEC on the 60% Design will be incorporated into the Pre-Final Design and the final comment resolution will be documented using Dr Checks. The 95% design will include a revised DAR (if necessary), drawings and specifications for the treatment system, and an updated cost estimate using MII.

The Pre-Final (95%) package will be prepared in accordance with the requirements/documents referenced above in Section 2.6.2.

2.6.4 Final Design (100%) Design (Work Order 06.04)

Upon acceptable resolution/incorporation of comments and recommendations from USACE, EPA and/or NYSDEC on the Pre-Final Design (via DrChecks), the Final (!00%) Design will be prepared and sealed by New York Registered Professional Engineers and submitted per the Document Submittal List provided in the Scope of Services. Tetra Tech will submit, along with this design package, the contractor QC certifications applicable to these documents. An electronic copy of the final design deliverables will also be provided.

Permit equivalencies (if available) will be provided within the 100% package. If the permit equivalencies are not available, copies of the submitted permit equivalency applications will be provided.

2.7 Community Relations Support (WAD 07)

Tetra Tech will provide community relations support to assist USACE and EPA with its efforts to work with the community and Site stakeholders. This includes, but is not limited to, the following items:

- Preparation of fact sheets/newsletters;
- Preparation of press releases/public notices;
- Arrangement of and attendance at public meetings as needed; and
- Update of the Site mailing list.

Tetra Tech will assist with preparing four (4) fact sheets/newsletters during the course of the TO to update the community with regard to project progress and milestones achieved. The fact sheets will include text accompanied by figures and drawings to illustrate Site activities. A draft fact sheet will be provided to USACE and EPA personnel for review and comment. Comments received from USACE and/or EPA will be incorporated into the final fact sheet, and 150 copies of the final fact sheet will be provided to USACE/EPA for distribution.

Tetra Tech will assist with preparing public notices to inform the public of a planned availability session/public meeting. One newspaper release will be developed for each public meeting/availability session. The notice will appear one time in both a large-distribution newspaper and a small-distribution newspaper.

Tetra Tech will provide support for public meetings and/or availability sessions. Arrangements will be made by Tetra Tech for these meetings/sessions, including the selection and reservation of meeting space. In addition, personnel will develop draft and final visual aids (e.g., presentation slides, illustrative figures/posters) to be utilized at the meetings/sessions; prepare meeting/session hand-out documents; arrange for recording and/or stenographic support (including reserving a court reporter) if requested; attend the meeting/session; and coordinate processing/submitting meeting notes electronically to the USACE and EPA. One full-page original and a four-on-one-page copy, along with one electronic copy on CD, of the transcript of the meeting will be provided.

Tetra Tech will update the mailing list two (2) times during the duration of the TO. An electronic file of the current mailing list will be provided to Tetra Tech. Following each update, Tetra Tech will provide USACE and/or EPA with a printed set of mailing labels and an electronic copy of the revised mailing list on CD. It is anticipated that USACE/EPA personnel will do the actual mailing of any information to the community.

2.8 Post RD Support (WAD 08)

Tetra Tech will support USACE during RA contracting efforts. Support during this phase of work may include, as appropriate, but is not limited to, the following: responding to contractor questions; providing design changes (by page) as needed for potential amendments to the contractor design solicitations; revising design drawings and specifications; and providing additional copies of documents/drawings.

3.0 PROJECT ORGANIZATION

An organization structure has been developed to identify the roles and responsibilities of the various personnel involved with the project. The structure for this project includes USACE Kansas City District, EPA Region 2, Tetra Tech, and various subcontractors and laboratory service providers. A project organization chart is presented as Figure 6.

Tetra Tech is providing support to the USACE Kansas City District for the Pre-Design and Remediation Design at the Site, and will receive technical and cost direction solely from USACE. Todd Daniels is the USACE Project Manager. USACE will be the direct liasion with EPA Region 2, and USACE will be copied on all correspondence with EPA personnel. Gloria Sosa is the Remedial Project Manager for EPA Region 2.

Tetra Tech will perform RD activities for the Peninsula Boulevard Superfund Site under the direction of the USACE Contract Program Manager, Lee Haymon, P.G. Management of the activities to ensure the quality of work associated with the TO (and the overall contract) is the responsibility of the Program QA/QC Manager, Jon Gabry, Ph.D. The Program Health and Safety Manager, Tami Froelich, CIH, provides support on health and safety issues. The PHSM oversees personnel training, medical surveillance, industrial hygiene concerns, and other safety related issues, as needed.

The TO Manager for Tetra Tech will be Robert Cantagallo, CHMM. He has the primary responsibility for implementation of the scope, management of the budget, and oversight of the proposed schedule of this TO, and is the main contact for all communication with USACE during the project. He also has primary oversight over the acquisition of scientific, engineering or additional specialized technical support and other aspects of the day-to-day activities associated with the project. The TO Manager identifies staff requirements, directs and monitors progress, ensures implementation of quality procedures and adherence to applicable codes and regulations, and is responsible for performance within the established budget and schedule.

Project task leads and key personnel from various technical disciplines will assist the TO Manager to perform the proposed scope of work. Tetra Tech leads/key personnel are as follows:

- Jeff Vandever, PG, Project Hydrogeologist;
- Alexander Valli, PG (Primary) / Christine Jobon, PG (Alternate), Field Operations Lead;
- Robert Chozick, Ph.D., P.E., Project Engineer;
- Neil Teamerson, In-Situ Treatability Study Lead; and
- Hal Scaff, Estimator.

Technical discipline leads will oversee activities related to their expertise and provide their input, as needed, to the TO Manager.

The services of subcontractors and laboratory service providers will also be necessary for the performance of the field investigation. The Tetra Tech TO Manager will be the primary liaison with the subcontractors, with assistance from the FOL, the Project Hydrogeologist, the Analytical Services Coordinator, and/or other personnel as necessary and appropriate. In addition to two (2) Contract Team Members, YU & Associates and Environmental Compliance, Inc., the following subcontractors are expected to be contracted during implementation of the TO:

- Utility Location / Geophysics;
- Drilling;
- Analytical Laboratory;
- ISCR Reagent Injection;
- Bench Scale Treatability Test Laboratory;
- Surveyor; and
- IDW Management Services.

In addition, Tetra Tech anticipates using the EPA Region 2 DESA Laboratory and/or laboratories within the EPA CLP RAS program.

4.0 PROJECT SCHEDULE

Figure 7 presents the overall baseline project schedule. The schedule provides a fixed time period for each deliverable. Tetra Tech will update the schedule on a monthly basis at a minimum.

5.0 REFERENCES

EPA, 2007. Contract Laboratory Program Guidance for Field Samples. OSWER 9240.0-44 / EPA 540-R-07-06. United States Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation. Final, July 2007.

ATSDR, 2007. Public Health Assessment for Peninsula Boulevard Groundwater Plume, Town of Hempstead, Nassau County, New York, EPA Facility ID: NYN000204407. Prepared by New York State Department of Health, Center for Environmental Health under a cooperative agreement with United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation, Superfund and Program Assessment Branch. 24 April 2007.

EPA, 2002. Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers. EPA 542-S-02-001. Technology Innovative Office, Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. May 2002.

EPA, 2004. Hazard Ranking System Documentation Package, Peninsula Boulevard Groundwater Plume, Hewlett, Nassau County, New York. CERCLIS ID No.: NYN000204407. United States Environmental Protection Agency. February 2004.

EPA, 2011. Record of Decision, Operable Unit One, Peninsula Boulevard Groundwater Plume Superfund Site, Village of Hewlett, Town of Hempstead, Nassau County, New York. United States Environmental Protection Agency, Region II. September 2011.

EPA R2, 1998. Ground Water Sampling Procedure, Low Stress (Low Flow) Purging and Sampling. GW Sampling SOP, Final. United States Environmental Protection Agency, Region II. 16 March 1998.

JRW, 2012. LactOil™ Soy Microemulsion Product Specs. JRW Bioremediation LLC. http://www.jrwtechnologies.com/pdf/LactOilCutSheet120108.pdf. Accessed online on February 15, 2012.

HDR, 2011a. Remedial Investigation Report for the Peninsula Boulevard Groundwater Plume Superfund Site, Village of Hewlett, Town of Hempstead, Nassau County, New York. Prepared by Henningson, Durham & Richardson Architecture and Engineering, P.C. in association with HDR Engineering, Inc. July 2011.

HDR, 2011b. Feasibility Study Report for the Peninsula Boulevard Groundwater Plume Superfund Site, Village of Hewlett, Town of Hempstead, Nassau County, New York. Prepared by Henningson, Durham & Richardson Architecture and Engineering, P.C. in association with HDR Engineering, Inc. July 2011.

Tetra Tech, 2008. Data Evaluation Report for the Peninsula Boulevard Groundwater Plume RI/FS, Town of Hempstead, Village of Hewlett, Nassau County, New York. Volume I and Volume II. Prepared by Tetra Tech EC, Inc. October 2008.

USACE, 2002. Standard Operating Procedure for Groundwater Low-Flow Purging. Revised SOP for Low-flow Groundwater Purging and Sampling, Version 1.3. United States Army Corps of Engineers, Kansas City District. August 2002.

USDA, 1987. U.S. Department of Agriculture Soil Survey of Nassau County, New York. United States Department of Agriculture, Soil Conservation Service; in cooperation with Cornell University Agricultural Experiment Station.

TABLES

TABLE 1
Evaluation of Treatability Testing Options

FACTOR	***OPTION 1***	***OPTION 2***	***OPTION 3***	***OPTION 4***
	ISCO	***ARD***	***PRB***	***ARD and PRB***
Implementability	Can be readily implemented over a short period of time for treatability study. Implementability of a full-scale remedy is uncertain. Simple injection strategy. Defensible monitoring program is difficult to design compared to other options.	Can be readily implemented over a short period of time for treatability study. Implementability of a full-scale remedy is uncertain. Several injection strategies of different complexities can be used. More complex monitoring program compared to Option 1. May require bioaugmentation using bacterial cultures.	Can be readily implemented over a short period of time for treatability study. Implementability of a full-scale remedy is uncertain. More difficult to implement compared to Options 1 and 2. Relatively simple injection strategy, but requires use of subcontractor. Multiple rows of injection points are generally preferred, but site access and logistics may preclude this approach. More complex monitoring program compared to Option 1. Does not require bioaugmentation.	Can be readily implemented over a short period of time depending for treatability study. Implementability of a full-scale remedy is uncertain. Relatively simple injection strategy, but requires use of subcontractor for PRB. Multiple rows of injection points are generally preferred. More complex monitoring program compared to Option 1. May require bioaugmentation for ARD component.
Effectiveness	Effectiveness in reducing PCE and other VOC concentrations is highly site-specific. Primary reactive time of <6 months depending on the quantity (mass) of oxidant used and volume of injected solution. Will likely require additional oxidant injection events to address contaminant rebound.	Likely to be effective in reducing PCE and other VOC concentrations as long as subsurface conditions (pH, dissolved oxygen, etc.) are favorable. Carries less confidence as far as performance is concerned give site characteristics. Will take more time to realize degradation of primary COCs as compared to Option 1. Primary reactive time of < 2 years.	Effective in reducing PCE and other VOC concentrations as long as subsurface conditions are favorable. Can create and sustain stronger ISCR conditions due to the presence of ZVI compared to Option 2. Will take more time to realize degradation of primary COCs as compared to Option 1. Primary reactive time of < 5 years.	Effective in reducing PCE and other VOC concentrations as long as subsurface conditions are favorable. Will take more time to realize degradation of primary COCs as compared to Option 1 Primary reactive time of 2 to 5 years.

TABLE 1
Evaluation of Treatability Testing Options

FACTOR	***OPTION 1***	***OPTION 2***	***OPTION 3***	***OPTION 4***
	ISCO	***ARD***	***PRB***	***ARD and PRB***
Health and Safety	Poses more risks to workers and community compared to other options. May result in oxidant solution appearing on the ground surface (daylighting).	Poses less risks to workers and community compared to Option 1. Involves injection of non-hazardous material Shallow UGA injections should be less likely to daylight due to relatively slower groundwater velocity. Environmentally friendly.	Poses less risks to workers and community compared to Option 1. Involves injection of non-hazardous material. Shallow UGA injections may daylight due to presence of “20-foot clay” layer near the surface. Environmentally friendly.	Poses less risks to workers and community compared to Option 1. Involves injections of non-hazardous material. Environmentally friendly.
Compatibility	May not be compatible with long-term pump-and-treat groundwater remedy since the solution will be diluted more quickly and MnO4- ion may appear in groundwater influent.	Should be fully compatible with long-term pump-and-treat groundwater remedy.	Should be fully compatible with long-term pump-and-treat groundwater remedy. Provides greater longevity and minimizes generation of vinyl chloride.	Should be fully compatible with long-term pump-and-treat groundwater remedy. Provides greater longevity and minimizes generation of vinyl chloride.
Material Costs	$20,000	$15,500	$22,000	$25,000
Conclusion	Eliminate from further consideration due to health and safety concerns and lack of compatibility with pump-and-treat remedy	As a stand-alone approach, not the preferred option at this time given site characteristics and accessibility to appropriate injection locations; may not be able to establish and sustain satisfactory ISCR conditions.	As a stand-alone approach, not the preferred option at this time since implementation concerns may preclude selection as a long-term groundwater remedy. Subcontractor costs for emplacing PRB may be off-set by reducing the number of temporary PVC wells required for monitoring purposes.	Preferred treatability testing approach since it involves two forms of in-situ groundwater remediation to meet goals of study. Will develop better information to proceed to a full-scale design. Subcontractor costs for emplacing PRB are less than Option 3.

Key:

ISCO - injections using permanganate.
ARD – anaerobic reductive dechlorination (injection of EVO substrate and possibly VOC-degrading cultures).
PRB – permeable reactive barrier (injection of ISCR slurry reagent with VVI component).

FIGURES

APPENDIX A

UNIFORM FEDERAL POLICY - QUALITY ASSURANCE PROJECT PLAN

APPENDIX B

ACCIDENT PREVENTION PLAN