RECORD OF DECISION

Fort Drum - Waste Disposal Areas
Operable Unit Number 02: 3800 PCE Site
State Superfund Project
Fort Drum, Jefferson County
Site No. 623008
March 2016

Prepared by
Division of Environmental Remediation
New York State Department of Environmental Conservation

DECLARATION STATEMENT - RECORD OF DECISION

Fort Drum - Waste Disposal Areas
Operable Unit Number: 02
State Superfund Project
Fort Drum, Jefferson County
Site No. 623008
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Statement of Purpose and Basis

This document presents the remedy for Operable Unit Number: 02: 3800 PCE Site of the Fort Drum - Waste Disposal Areas site, a Class 2 inactive hazardous waste disposal site. The remedial program was chosen in accordance with the New York State Environmental Conservation Law and Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (6 NYCRR) Part 375, and is not inconsistent with the National Oil and Hazardous Substances Pollution Contingency Plan of March 8, 1990 (40CFR300), as amended.

This decision is based on the Administrative Record of the New York State Department of Environmental Conservation (the Department) for Operable Unit Number: 02 of the Fort Drum - Waste Disposal Areas site and the public's input to the proposed remedy presented by the Department. A listing of the documents included as a part of the Administrative Record is included in Appendix B of the ROD.

Description of Selected Remedy

The elements of the selected remedy are as follows:

1. In-Situ Chemical Oxidation- In-situ chemical oxidation (ISCO) injections initiated as an IRM will be continued utilizing the existing IRM injection well network with refinement as needed to treat contaminants in groundwater. Sodium permanganate will continue to be injected into the subsurface to destroy the contaminants in the PCE contamination area under Building 1885 and Oneida Avenue.

2. Institutional Control- Imposition of an institutional control in the initial form of Army Land Use Controls by the incorporation of the controls into the Ft. Drum base management plan. An environmental easement will be recorded at such time as the property is transferred from federal ownership to private ownership for the controlled property, which will:
•require the remedial party or site owner to complete and submit to the Department a periodic certification of institutional controls in accordance with Part 375-1.8 (h)(3);
•restrict the use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the NYSDOH or County DOH; and
•require compliance with the Department approved Site Management Plan.

3. Site Management Plan- A Site Management Plan is required, which includes the following:

a. an Institutional Control Plan that identifies all use restrictions for the site and details the steps and media-specific requirements necessary to ensure the institutional controls remain in place and effective. This includes but may not be limited to:
• the Army Land Use Controls and Environmental Easement discussed in Paragraph 3 above;
• the groundwater use restriction discussed in Paragraph 3 above;
• maintaining site access controls and Department notification;
• the steps necessary for the periodic reviews and certification of the institutional controls;
• if the source area becomes accessible before the site is fully remediated, an alternative treatment of the source area may be used in place or in combination with the groundwater treatment remediation; and
• evaluation of the potential for soil vapor intrusion for future buildings developed in the area of the groundwater plume including provision for implementing actions recommended to address exposures related to soil vapor intrusion.

b. a Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but may not be limited to:
•monitoring of groundwater to assess the performance and effectiveness of the remedy;
•monitoring of the sub-slab soil vapor in the maintenance pit area of building 1885;
•monitoring for vapor intrusion for any new buildings developed on the site, as may be required by the Institutional and Engineering Control Plan discussed above; and
•a schedule of monitoring and frequency of submittals to the Department.

c. an Operation and Maintenance (O&M) Plan to ensure continued operation, maintenance, optimization, monitoring, inspection, and reporting of any mechanical or physical components of the remedy. The plan includes, but is not limited to:
•procedures for operating and maintaining the remedy;
•compliance monitoring of treatment systems to ensure proper O&M as well as providing the data for any necessary permit or permit equivalent reporting;
•maintaining site access controls and Department notification; and
•providing the Department access to the site and O&M records.

Green remediation principals and techniques will be implemented to the extent feasible in the site management of the remedy as per DER-31. The major green remediation components are as follows;
•Considering the environmental impacts of treatment technologies and remedy stewardship over the long term;
•Reducing direct and indirect greenhouse gas and other emissions;
•Increasing energy efficiency and minimizing use of non-renewable energy;
•Conserving and efficiently managing resources and materials;
•Reducing waste, increasing recycling and increasing reuse of materials which would otherwise be considered a waste.

New York State Department of Health Acceptance

The New York State Department of Health (NYSDOH) concurs that the remedy for this site is protective of human health.

Declaration

The selected remedy is protective of human health and the environment, complies with State and Federal requirements that are legally applicable or relevant and appropriate to the remedial action to the extent practicable, and is cost effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies, to the maximum extent practicable, and satisfies the preference for remedies that reduce toxicity, mobility, or volume as a principal element.

March 30, 2016	
Date	Robert W. Schick, P.E., Director Division of Environmental Remediation

RECORD OF DECISION

Fort Drum - Waste Disposal Areas
Fort Drum, Jefferson County
Site No. 623008
March 2016

SECTION 1: SUMMARY AND PURPOSE

The New York State Department of Environmental Conservation (the Department), in consultation with the New York State Department of Health (NYSDOH), has selected a remedy for the above referenced site. The disposal of hazardous wastes at the site has resulted in threats to public health and the environment that would be addressed by the remedy. The disposal or release of hazardous wastes at this site, as more fully described in this document, has contaminated various environmental media. The remedy is intended to attain the remedial action objectives identified for this site for the protection of public health and the environment. This Record of Decision (ROD) identifies the selected remedy, summarizes the other alternatives considered, and discusses the reasons for selecting the remedy.

The New York State Inactive Hazardous Waste Disposal Site Remedial Program (also known as the State Superfund Program) is an enforcement program, the mission of which is to identify and characterize suspected inactive hazardous waste disposal sites and to investigate and remediate those sites found to pose a significant threat to public health and environment.

The Department has issued this document in accordance with the requirements of New York State Environmental Conservation Law and 6 NYCRR Part 375. This document is a summary of the information that can be found in the site-related reports and documents.

SECTION 2: CITIZEN PARTICIPATION

The Department seeks input from the community on all remedies. A public comment period was held, during which the public was encouraged to submit comment on the proposed remedy. All comments on the remedy received during the comment period were considered by the Department in selecting a remedy for the site. Site-related reports and documents were made available for review by the public at the following document repository:

NYS Department of Environmental Conservation Region 6
Attn: Peter Taylor
Dulles State Office Building
317 Washington Street
Watertown, NY 13601
Phone: (315)785-2511

A public meeting was also conducted. At the meeting, the findings of the remedial investigation (RI) and the feasibility study (FS) were presented along with a summary of the proposed remedy. After the presentation, a question-and-answer period was held, during which verbal or written comments were accepted on the proposed remedy.

Comments on the remedy received during the comment period are summarized and addressed in the responsiveness summary section of the ROD.

Receive Site Citizen Participation Information By Email

Please note that the Department's Division of Environmental Remediation (DER) is "going paperless" relative to citizen participation information. The ultimate goal is to distribute citizen participation information about contaminated sites electronically by way of county email listservs. Information will be distributed for all sites that are being investigated and cleaned up in a particular county under the State Superfund Program, Environmental Restoration Program, Brownfield Cleanup Program, Voluntary Cleanup Program, and Resource Conservation and Recovery Act Program. We encourage the public to sign up for one or more county listservs at http://www.dec.ny.gov/chemical/61092.html

SECTION 3: SITE DESCRIPTION AND HISTORY

Location: Fort Drum is located about 10 miles northeast of the City of Watertown, New York and is approximately 107,265 acres in area, making Fort Drum the largest Army training installation in the northeast. Two Areas of Concern comprise the property listed on the Registry of Inactive Hazardous Waste Disposal Sites: the 40 acre Old Sanitary Landfill and the overlapping 190 acre 3800 PCE Site. The 3800 PCE Site is located at the eastern end of Oneida Avenue, near the intersection with New York State Route 26.

Site Features: The 3800 PCE Site includes portions of base areas 1700, 1800, 1900, and 3800; associated buildings; portions of the Fort Drum Old Sanitary Landfill (OSL); and the streams north and northeast of the OSL. The site is 203 acres in size. In 2010, Buildings 1880 and 1885 (located in the 1800 area) were each constructed on a 5-inch reinforced slab-on-grade foundation. In 2012, the concrete slab was expanded as part of a facilities upgrade project. Building 1885 and the new concrete slab cover areas with the highest chlorinated volatile organic compound (CVOC) detections in groundwater. Building 1885 is currently used for troop support operations.

Current Zoning/Use(s): Fort Drum is utilized by the Army for training Army and Army National Guard troops. Approximately 31,000 military personnel, their dependents, and civilian employees reside and/or work at the base on a daily basis. The 3800 Area PCE Site is in a commercial/industrial area of Fort Drum. The suspected source area is located beneath a large vehicle staging/parking area covered by a concrete slab. The remainder of the groundwater plume passes beneath roads and currently unoccupied portions of the base. Seven small towns border the installation.

Historic Use(s): Fort Drum was established in 1906 as a National Guard training facility. During World War II, Fort Drum functioned as an operations base and firing range and provided combat skills training facilities for the 45th Infantry Division and the 4th and 5th Armored Divisions. The historic land use of the 3800 Area PCE Site has been predominantly industrial since the installation was established. Historically, the 3800 Area PCE Site was primarily used for vehicle and equipment storage, maintenance, and refueling purposes according to aerial photography and records. There was documented historic use and storage of hazardous materials, including chlorinated solvents, south of Oneida Avenue. The Old Sanitary Landfill (OSL) operated from 1940 until 1973 and was used for the disposal of general refuse, empty containers from paint, solvents and pesticides, and for oil and lubricant-saturated solid waste.

Operable Units: The portion of Fort Drum which is listed on the Registry was divided into two operable units. An operable unit represents a portion of a remedial program for a site that for technical or administrative reasons can be addressed separately to investigate, eliminate or mitigate a release, threat of release or exposure pathway resulting from the site contamination.

Operable Unit 01 (OU01) consists of the Old Sanitary Landfill (OSL), an inactive landfill used from 1940-1973. The OSL was capped with a 20-mil polyvinyl chloride (PVC) cap in 1981, and the surface was covered with topsoil and grass. The landfill is fenced and is subject to a long-term monitoring and maintenance program. Operable Unit 02 (OU02) consists of the source area, plume area, and surrounding buffer area associated with tetrachloroethene (PCE) contamination in an area referred to as the 3800 PCE Site.

Site Geology and Hydrogeology: Subsurface soils at the site are composed of deltaic sand and silty sand, which grade to clay, which forms the base of the surficial aquifer and confining unit for the deeper bedrock aquifer. The depth of the water table varies from 20 feet below ground surface (bgs) at the source area to 40 feet bgs beneath the OSL. The depth to the clay confining layer varies from 56 to 97 feet bgs. Groundwater flows to the north toward the unnamed streams in the vicinity of the Old Sanitary Landfill.

Operable Unit (OU) Number 02 is the subject of this document.

Landfill closure was completed previously for OU01.

A site location map is attached as Figure 1.

SECTION 4: LAND USE AND PHYSICAL SETTING

The Department may consider the current, intended, and reasonably anticipated future land use of the site and its surroundings when evaluating a remedy for soil remediation. For this site, alternatives (or an alternative) that restrict(s) the use of the site to commercial use (which allows for industrial use) as described in Part 375-1.8(g) were/was evaluated in addition to an alternative which would allow for unrestricted use of the site.

A comparison of the results of the RI to the appropriate standards, criteria and guidance values

(SCGs) for the identified land use and the unrestricted use SCGs for the site contaminants is included in the Tables for the media being evaluated in Exhibit A.

SECTION 5: ENFORCEMENT STATUS

Potentially Responsible Parties (PRPs) are those who may be legally liable for contamination at a site. This may include past or present owners and operators, waste generators, and haulers.

The PRPs for the site, documented to date, include:

United States Army (Fort Drum Military Installation)

The United States Army (Fort Drum) has assumed responsibility for investigation and remediation of the site under a voluntary Order on Consent (Index # A6-0797-12-10) with the NYSDEC dated 12 February 2014.

SECTION 6: SITE CONTAMINATION

6.1: Summary of the Remedial Investigation

A Remedial Investigation (RI) has been conducted. The purpose of the RI was to define the nature and extent of any contamination resulting from previous activities at the site. The field activities and findings of the investigation are described in the RI Report.

The following general activities are conducted during an RI:

- Research of historical information,
- Geophysical survey to determine the lateral extent of wastes,
- Test pits, soil borings, and monitoring well installations,
- Sampling of waste, surface and subsurface soils, groundwater, and soil vapor,
- Sampling of surface water and sediment,
- Ecological and Human Health Exposure Assessments.

The analytical data collected on this site includes data for:

- groundwater
- soil
- soil vapor
- indoor air
- sub-slab vapor

6.1.1: Standards, Criteria, and Guidance (SCGs)

The remedy must conform to promulgated standards and criteria that are directly applicable or that are relevant and appropriate. The selection of a remedy must also take into consideration guidance, as appropriate. Standards, Criteria and Guidance are hereafter called SCGs.

To determine whether the contaminants identified in various media are present at levels of concern, the data from the RI were compared to media-specific SCGs. The Department has developed SCGs for groundwater, surface water, sediments, and soil. The NYSDOH has developed SCGs for drinking water and soil vapor intrusion. The tables found in Exhibit A list the applicable SCGs in the footnotes. For a full listing of all SCGs see: http://www.dec.ny.gov/regulations/61794.html

6.1.2: RI Results

The data have identified contaminants of concern. A "contaminant of concern" is a hazardous waste that is sufficiently present in frequency and concentration in the environment to require evaluation for remedial action. Not all contaminants identified on the property are contaminants of concern. The nature and extent of contamination and environmental media requiring action are summarized in Exhibit A. Additionally, the RI Report contains a full discussion of the data. The contaminant(s) of concern identified for this Operable Unit at this site is/are:

tetrachloroethene (PCE) trichloroethene (TCE)

As illustrated in Exhibit A, the contaminant(s) of concern exceed the applicable SCGs for:

-Groundwater

6.2: Interim Remedial Measures

An interim remedial measure (IRM) is conducted at a site when a source of contamination or exposure pathway can be effectively addressed before issuance of the Record of Decision.

The following IRM has been completed at this site based on conditions observed during the RI.

ISCO Injection for Source Area

The IRM consisted of two in-situ chemical oxidation (ISCO) treatment events utilizing the injection of sodium permanganate into the subsurface at the source area. The goal of the IRM was to reduce source concentrations of the contaminants of concern to facilitate remediation of the site through natural remediation. The first ISCO treatment event was conducted from November 12 through 21, 2012 and involved the injection of approximately 20,000 gallons of a 10 percent sodium permanganate into 40 injection wells. The second ISCO treatment event was performed from June 24 through July 15, 2015 and involved the injection of approximately 98,400 gallons of a 2.6 percent sodium permanganate solution into 35 new injection wells. The

results of the IRMs showed that PCE concentrations in portions of the source area were reduced. The details of the IRM are presented in the Feasibility Study (FS) Report, dated December 2015.

6.3: Summary of Environmental Assessment

This section summarizes the assessment of existing and potential future environmental impacts presented by the site. Environmental impacts may include existing and potential future exposure pathways to fish and wildlife receptors, wetlands, groundwater resources, and surface water.

Based upon the resources and pathways identified and the toxicity of the contaminants of ecological concern at this site, a Fish and Wildlife Resources Impact Analysis (FWRIA) was deemed not necessary for OU 02.

Nature and Extent of Contamination:

Based upon investigations conducted to date, the primary contaminants of concern for the site are tetrachloroethene (PCE) and trichloroethene (TCE).

Soil – A total of 279 discrete soil samples were collected from various depth intervals and analyzed for volatile organic compounds (VOCs) during the RI. Soil samples were collected from vadose and saturated zones. The VOC soil data from the saturated zone was used to inform decisions for monitoring well screen depths. Vadose zone samples were collected for site characterization and to locate potential chlorinated VOC (CVOC) source areas. PCE and TCE were not detected in vadose zone soil samples. The highest PCE concentration in a saturated soil sample was 0.350 parts per million (ppm) from a sample collected at a depth of 63 feet below ground surface (bgs). All of the detected soil concentrations were at least an order of magnitude less than the protection of groundwater soil cleanup objective for PCE of 1.3 ppm (6 NYCRR Part 375, Table 375-6.8 (a)).

Soil Vapor - Eight soil vapor samples were collected from the perimeter of Building 1885 at a depth interval of 3 to 5 feet bgs. The highest concentration of PCE in soil gas was detected near the southeast portion of Building 1885 (171 micrograms per cubic meter [µg/m3]). Subsequently, a vapor intrusion survey was implemented to assess CVOCs in sub-slab vapor and indoor air at both Building 1885 and Building 1880. CVOCs were not detected in indoor air samples collected at Buildings 1880 and 1885. Levels of CVOCs were not significantly elevated beneath building 1880. Results of the survey did not indicate a potential for soil vapor intrusion outside of the plume area.

Groundwater:

Groundwater sampling data obtained from 75 monitoring wells was used to characterize dissolved-phase CVOCs in groundwater. Groundwater samples were collected from each of the unconfined surficial aquifer hydrostratigraphic zones as follows:

- 22 wells in the shallow zone

- 26 wells in the intermediate zone
- 26 wells in the deep zone
- 1 well in the bedrock unit (PCERI-MW01D)

The CVOC analytical data were compared to the NYCRR Part 703.5 Groundwater Quality Standards (GWQS). The only CVOCs detected above the GWQS were PCE and TCE.

In the shallow zone, PCE concentrations are highest in the upgradient portions of the Site near building 1885. The highest concentration of PCE was detected during the RI at 906 parts per billion in well PCERI-MW19S (screened at 30 to 40 feet bgs), which is located at the northern end of the paved area adjacent to Ontario Avenue. There is a potential source area in the saturated zone beneath Building 1885. The lateral extent of dissolved-phase PCE in the shallow zone is confined to the area south of Oneida Avenue. The absence of the PCE dissolved-phase plume in the shallow zone north of Oneida Avenue is attributed to the downward vertical gradients in this portion of the Site.

The highest PCE concentrations in the intermediate zone were detected in the upgradient portion of the Site. The highest concentration of PCE was detected at (599 ppb in well PCERI-MW25I, which is screened at 35 to 45 feet bgs and located adjacent to the north side of Building 1885). The lateral extent of the dissolved-phase PCE plume extends to the groundwater discharge point at the unnamed creek between Old Sanitary Landfill (OSL) Cells 1 and 2. Surface water in the creek is sampled as part of the OSL O&M program. The Army has an ongoing stream sampling program associated with OU1 (the OSL closed landfill) which includes the OU2 contaminants of concern. The PCE plume is predominantly located in the intermediate zone across the Site to the discharge point at the creek. The width of the plume is narrow in proportion to the length.

The highest concentration of PCE in the deep zone was detected at 218 ppb in a well PCERI-MW20D, which is screened at 62 to 72 ft bgs, and located in the middle of the paved area north of Building 1885. PCE detections in the deep zone of the surficial aquifer are confined to the upgradient portion of the Site. The absence of the PCE plume in the deep zone of the aquifer down-gradient of the source area is consistent with the observed upward vertical gradients between the deep and intermediate aquifer zones.

CVOCs were not detected in sample collected from the bedrock aquifer beneath the site.

6.4: Summary of Human Exposure Pathways

This human exposure assessment identifies ways in which people may be exposed to site-related contaminants. Chemicals can enter the body through three major pathways (breathing, touching or swallowing). This is referred to as *exposure.*

The landfill was properly capped when it was closed; therefore people are not likely to contact contaminated soils. People are not drinking the contaminated groundwater at the site because the area is served by a public water supply that obtains water from areas not affected by this

contamination. Volatile organic compounds in the groundwater may move into the soil vapor (air spaces within the soil), which in turn may move into overlying buildings and affect the indoor air quality. This process, which is similar to the movement of radon gas from the subsurface into the indoor air of buildings, is referred to as soil vapor intrusion. The potential exists for the inhalation of site contaminants due to soil vapor intrusion for any future on-site redevelopment and occupancy.

6.5: Summary of the Remediation Objectives

The objectives for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375. The goal for the remedial program is to restore the site to pre-disposal conditions to the extent feasible. At a minimum, the remedy shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at the site through the proper application of scientific and engineering principles.

The remedial action objectives for this site are:

Groundwater

RAOs for Public Health Protection

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

RAOs for Environmental Protection

- Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to surface water.
- Remove the source of ground or surface water contamination.

Soil Vapor

RAOs for Public Health Protection

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

SECTION 7: SUMMARY OF THE SELECTED REMEDY

To be selected the remedy must be protective of human health and the environment, be cost-effective, comply with other statutory requirements, and utilize permanent solutions, alternative technologies or resource recovery technologies to the maximum extent practicable. The remedy must also attain the remedial action objectives identified for the site, which are presented in Section 6.5. Potential remedial alternatives for the Site were identified, screened and evaluated in the feasibility study (FS) report.

A summary of the remedial alternatives that were considered for this site is presented in Exhibit B. Cost information is presented in the form of present worth, which represents the amount of money invested in the current year that would be sufficient to cover all present and future costs

associated with the alternative. This enables the costs of remedial alternatives to be compared on a common basis. As a convention, a time frame of 30 years is used to evaluate present worth costs for alternatives with an indefinite duration. This does not imply that operation, maintenance, or monitoring would cease after 30 years if remediation goals are not achieved. A summary of the Remedial Alternatives Costs is included as Exhibit C.

The basis for the Department's remedy is set forth at Exhibit D.

The selected remedy is referred to as the In-situ Chemical Oxidation with Groundwater Monitoring remedy.

The estimated present worth cost to implement the remedy is $1,480,100. The cost to construct the remedy is estimated to be $940,500 and the estimated average annual cost is $500,700.

The elements of the selected remedy are as follows:

1. In-Situ Chemical Oxidation- In-situ chemical oxidation (ISCO) injections initiated as an IRM will be continued utilizing the existing IRM injection well network with refinement as needed to treat contaminants in groundwater. Sodium permanganate will continue to be injected into the subsurface to destroy the contaminants in the PCE contamination area under Building 1885 and Oneida Avenue.

2. Institutional Control- Imposition of an institutional control in the initial form of Army Land Use Controls by the incorporation of the controls into the Ft. Drum base management plan. An environmental easement will be recorded at such time as the property is transferred from federal ownership to private ownership for the controlled property, which will:
•require the remedial party or site owner to complete and submit to the Department a periodic certification of institutional controls in accordance with Part 375-1.8 (h)(3);
•restrict the use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the NYSDOH or County DOH; and
•require compliance with the Department approved Site Management Plan.

3. Site Management Plan- A Site Management Plan is required, which includes the following:

a. an Institutional Control Plan that identifies all use restrictions for the site and details the steps and media-specific requirements necessary to ensure the institutional controls remain in place and effective. This includes but may not be limited to:
• the Army Land Use Controls and Environmental Easement discussed in Paragraph 3 above;
• the groundwater use restriction discussed in Paragraph 3 above;
• maintaining site access controls and Department notification;
• the steps necessary for the periodic reviews and certification of the institutional controls;
• if the source area becomes accessible before the site is fully remediated, an alternative treatment of the source area may be used in place or in combination with the groundwater treatment remediation; and

• evaluation of the potential for soil vapor intrusion for future buildings developed within OU-2 including provision for implementing actions recommended to address exposures related to soil vapor intrusion.

b. a Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but may not be limited to:
•monitoring of groundwater to assess the performance and effectiveness of the remedy;
•monitoring of the sub-slab soil vapor in the maintenance pit area of building 1885;
•monitoring for vapor intrusion for any new buildings developed on the site, as may be required by the Institutional and Engineering Control Plan discussed above; and
•a schedule of monitoring and frequency of submittals to the Department.

c. an Operation and Maintenance (O&M) Plan to ensure continued operation, maintenance, optimization, monitoring, inspection, and reporting of any mechanical or physical components of the remedy. The plan includes, but is not limited to:
•procedures for operating and maintaining the remedy;
•compliance monitoring of treatment systems to ensure proper O&M as well as providing the data for any necessary permit or permit equivalent reporting;
•maintaining site access controls and Department notification; and
•providing the Department access to the site and O&M records.

Green remediation principals and techniques will be implemented to the extent feasible in the site management of the remedy as per DER-31. The major green remediation components are as follows;
•Considering the environmental impacts of treatment technologies and remedy stewardship over the long term;
•Reducing direct and indirect greenhouse gas and other emissions;
•Increasing energy efficiency and minimizing use of non-renewable energy;
•Conserving and efficiently managing resources and materials;
•Reducing waste, increasing recycling and increasing reuse of materials which would otherwise be considered a waste.

Exhibit A

Nature and Extent of Contamination

This section describes the findings of the Remedial Investigation for Operable Unit 02 (OU02) for all environmental media that were evaluated. As described in Section 6.1, samples were collected from various environmental media to characterize the nature and extent of contamination.

For each medium for which contamination was identified, a table summarizes the findings of the investigation. The tables present the range of contamination found at the site in the media and compares the data with the applicable SCGs for the site. The contaminants are arranged into one category; volatile organic compounds (VOCs) since they are the only identified contaminant emanating from the Site. Even though there are other classes of contaminants found in the groundwater, all the other contaminants have been identified as coming from other sources. For comparison purposes, the SCGs are provided for each medium that allows for unrestricted use.

Groundwater

Groundwater samples were collected from 75 monitoring wells during two monitoring events as follows:

- 22 wells in the shallow zone (see Figure 4)
- 26 wells in the intermediate zone (see Figure 5)
- 26 wells in the deep zone (see Figure 6)
- 1 well in the bedrock unit

Table 1A - Groundwater (Shallow Zone)

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
Tetrachloroethene (PCE)	ND - 906	5	21/64
Trichloroethene (TCE)	ND – 36.8	5	11/64

Table 1B - Groundwater (Intermediate Zone)

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
Tetrachloroethene (PCE)	ND - 599	5	44/65
Trichloroethene (TCE)	ND – 14.6	5	29/65

Table 1C - Groundwater (Deep Zone)

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
Tetrachloroethene (PCE)	ND - 319	5	11/62

Table Notes:
ND – not detected
a - ppb: parts per billion, which is equivalent to micrograms per liter, ug/L, in water.
b - SCG: Standard Criteria or Guidance - Ambient Water Quality Standards and Guidance Values (TOGs 1.1.1), 6 NYCRR Part 703, Surface water and Groundwater Quality Standards, and Part 5 of the New York State Sanitary Code (10 NYCRR Part 5).

The primary groundwater contaminants are tetrachloroethene (PCE) and its daughter product trichloroethene (TCE). Based on the findings of the RI, the presence of PCE has resulted in the contamination of groundwater and was therefore considered to be the primary contaminant of concern which will drive the remediation of groundwater to be addressed by the remedy selection process.

Soil

A total of 279 discrete soil samples were collected from various depth intervals and analyzed for VOCs during the RI. Soil samples were collected from vadose and saturated zones. The VOC soil data from the saturated zone was used to inform decisions for monitoring well screen depths. Vadose zone samples were collected for site characterization and to locate potential chlorinated VOC (CVOC) source areas. PCE and trichloroethene (TCE) were not detected in vadose zone soil samples. The highest PCE concentration in a saturated soil sample was 0.350 parts per million (ppm) from a sample collected at a depth of 63 feet below ground surface (bgs). All of the detected soil concentrations were at least an order of magnitude less than the protection of groundwater soil cleanup objective for PCE of 1.3 ppm (6 NYCRR Part 375, Table 375-6.8 (a)). See Figure 3.

No site-related soil contamination of concern was identified during the RI. Therefore, no remedial alternatives need to be evaluated for soil.

Soil Vapor

The evaluation of the potential for soil vapor intrusion resulting from the presence of site related soil or groundwater contamination was evaluated by the sampling of soil vapor, sub-slab soil vapor under structures, and indoor air inside structures. At this site due to the presence of buildings in the impacted area a full suite of samples were collected to evaluate whether soil vapor intrusion was occurring.

A vapor intrusion survey was implemented to assess chlorinated volatile organic compounds (CVOCs) in sub-slab vapor and indoor air at both Building 1885 and Building 1880 (see figures 8, 9, and 10).

Eight soil vapor samples were collected from the perimeter of Building 1885 at a depth interval of 3 to 5 feet bgs. The highest concentration of PCE in soil gas was detected near the southeast portion of Building 1885 (171 micrograms per cubic meter [$\mu g/m^3$]). Soil vapor sampling was not conduced elsewhere in the plume area.

Table X - Soil Gas

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
Tetrachloroethene (PCE)	3.9 - 171	NA	---
Trichloroethene (TCE)	ND - 2.1	NA	---

Notes:
a) ug/m^3
b) There are no standards/guidance values for soil vapor in NYS.

Sub-slab Vapor and Indoor Air - Based on the results of the soil vapor sampling, a vapor intrusion investigation was implemented to assess the presence and magnitude of CVOCs in sub-slab vapor and indoor air at both Building 1885 and Building 1880. CVOCs were detected in the sub-slab soil vapor samples collected beneath the buildings, but were not detected in indoor air samples. The maximum CVOC concentration detected in the in the sub-slab soil vapor samples was PCE at 151 µg/m^3 in a sample from beneath Building 1885. Based on comparison of sub-slab and indoor air contaminant levels to the NYSDOH Decision Matrix 2, monitoring is necessary at this location.

Table Y – Sub-slab Vapor

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
Tetrachloroethene (PCE)	4.7 - 151	1,000	0 / 6
Trichloroethene (TCE)	1.7 – 1.8	250	0 / 6
Benzene	2.7 – 52.1	NA	---

Notes:
a) ug/m^3
b) Mitigate action level when constituent not detected in indoor air.

Based on the concentrations detected, and in comparison with the NYSDOH Soil Vapor Intrusion Guidance, no site-related soil vapor contamination requiring mitigation was identified during the RI. Therefore, no remedial alternatives need to be evaluated for soil vapor. Sub-slab soil vapor monitoring will be performed at Building 1885 under the site management plan. Any future construction near the groundwater plume area will be evaluated for potential soil vapor intrusion concerns.

Exhibit B

Description of Remedial Alternatives

The following alternatives were considered based on the remedial action objectives (see Section 6.5) to address the contaminated media identified at the site as described in Exhibit A.

Alternative 1: No Action

The No Action Alternative is evaluated as a procedural requirement and as a basis for comparison. This alternative leaves the site in its present condition and does not provide any additional protection to public health and the environment.

Alternative 2: In-Situ Chemical Oxidation with Groundwater Monitoring

Alternative 2 utilizes the existing injection well network with optimization, via installation of additional injection wells or refinement to the injection strategy, to inject chemical oxidant in the presumed PCE source area between Building 1885 and Oneida Avenue. See Figure 7. Alternative 2 would rapidly eliminate source concentrations of PCE currently migrating downgradient and thus allow transition to a long-term groundwater monitoring program within the shortest timeframe. In addition, Alternative 2 provides the ability to remediate a suspected source area under Building 1885 as the reaction kinetics of the selected oxidant provide months of active treatment allowing the injected solution to migrate downgradient and remediate CVOCs outside the ROI of the injection well network. Institutional controls, including LUCs and an environmental easement, would be established to prevent the use of groundwater in the affected portions of the aquifer.

The long-term groundwater monitoring program will include sample collection from existing monitoring wells in the source area and the down-gradient plume. Approximately 30 monitoring wells will be included in the monitoring plan. The timeframe for long-term monitoring was estimated based on the number of pore flushes required to reach the 5 ppb water quality standard for PCE at the location with the maximum measured PCE concentration during the most recent sampling event. Based on these calculations, monitoring will be conducted for approximately 16 years. Groundwater monitoring will be performed periodically on a schedule to be developed during the development of the site management plan.

Present Worth: *$1,480,100*
Capital Cost: *$174,500*
Annual Costs: *$1,337,100*

Alternative 3: In-Situ Enhanced Bioremediation with Bioaugmentation and Groundwater Monitoring

Alternative 3 utilizes the existing injection well network with optimization via installation of additional injection wells or refinement to the injection strategy, to inject organic carbon and bacterial dechlorinating cultures in the presumed PCE source area between Building 1885 and Oneida Avenue.

The current aquifer environment is not conducive to biological degradation of PCE; therefore, to more rapidly create the appropriate environment, a soluble donor (sodium lactate), would be injected initially at all of the injection wells. Following an initial injection of soluble donor, an insoluble donor (e.g. Emulsified Vegetable Oil (EVO)) would be utilized. The EVO injection in the wells down-gradient of Building 1885 will be conducted within 6 months of completing the initial sodium lactate injection. EVO injections will be completed annually for three additional years. Sodium lactate will be injected semi-annually for 4 years in the injection wells upgradient of Building 1885. Alternative 3 will effectively prevent migration of PCE downgradient of the treatment area once the In-situ Reactive Zone (IRZ) in the farthest downgradient barrier is established. Alternative 3 would require maintenance injections until the impacted water between each barrier has attenuated to concentrations that will support long-term monitoring. It is estimated this will take up to four years of active injections. Institutional controls, including LUCs and an environmental easement, would be established to prevent the use of groundwater in the affected portions of the aquifer.

The monitoring program will consist of performance monitoring during active remediation followed by long-term monitoring. Performance monitoring will be completed quarterly at 10 monitoring wells. The long-term monitoring program will include sample collection from existing monitoring wells in the source area and the down-gradient plume. Approximately 30 monitoring wells will be included in the long-term plan. Based on pore flushing calculations, long-term monitoring will be conducted for approximately 19 years. Groundwater monitoring will be performed semi-annually for 5 years with subsequent sampling annually.

Present Worth: ..... *$ 1,620,100*
Capital Cost: *$259,500*
Annual Costs: *$1,423,400*

Alternative 4: Air Sparge / Soil Vapor Extraction with Groundwater Monitoring

Alternative 4 requires the installation of new well infrastructure to inject ambient air into the target treatment interval (i.e., via air sparging (AS)) and to recover volatilized CVOCs from the vadose zone soils (i.e., via soil vapor extraction (SVE)). The AS system will inject ambient air into the presumed PCE source area between Building 1885 and Oneida Avenue. The AS/SVE system would focus treatment on the silty sands in the intermediate zone, where the bulk of the PCE mass is located. Implementation of Alternative 4 would involve the installation of a new well network for both the AS and SVE systems as the existing well network is not designed appropriately for either type of system. AS and SVE pilot tests, as well as a combined AS/SVE test, would be completed to confirm design parameters and appropriately size equipment.

The AS/SVE system would operate approximately two years to reduce source concentrations enough to support system shutdown and implementation of long-term monitoring. The AS system would operate in zones, while the SVE system would operate continuously. The AS system would be pulsed using motorized valves and a programmable logic controller to prevent the creation of preferential flow paths. To operate year round, all the instrumentation and controls would be located inside an insulated and heated equipment building and all piping would be buried. Institutional controls, including LUCs and an environmental easement, would be established to prevent the use of groundwater in the affected portions of the aquifer.

The long-term monitoring program will include sample collection from existing monitoring wells in the source area and the down-gradient plume. Approximately 30 monitoring wells will be included in the monitoring plan. Based on pore flushing calculations, long-term monitoring will be conducted for approximately 17 years. Groundwater monitoring will be performed semi-annually for 5 years with subsequent sampling annually.

Present Worth: *$3,066,000*
Capital Cost: *$2,123,900*
Annual Costs: *$987,900*

Exhibit C

Remedial Alternative Costs

Remedial Alternative	Capital Cost ($)	Periodic and Annual Costs ($)	Total Present Worth ($)
No Action	0	0	0
Alt 2. In-Situ Chemical Oxidation with Groundwater Monitoring	174,500	1,337,100	1,480,100
Alt 3. In-Situ Enhanced Bioremediation with Bioaugmentation and Groundwater Monitoring	259,500	1,423,400	1,620,100
Alt 4. Air Sparge / Soil Vapor Extraction with Groundwater Monitoring	2,123,900	987,900	3,066,000

Exhibit D

SUMMARY OF THE SELECTED REMEDY

The Department has selected Alternative 2, In-Situ Chemical Oxidation with Groundwater Monitoring as the remedy for this site. Alternative 2 would achieve the remediation goals for the site by remediating the groundwater in the source area through continued injection of a chemical oxidant (sodium permanganate). Reduction in mass flux from the source area would enhance the natural attenuation of the CVOC plume by removing a continuing source. Institutional controls (LUCs) would be put in place to prevent use of the groundwater within this aquifer. These institutional controls would be maintained by the incorporation of the of the LUCs into the Ft. Drum base management plan and through the preparation of an environmental easement for the area of the groundwater plume consistent with Section 27-1318(b) and Article 71, Title 36 of ECL, in favor of the State of New York and the Army, which will be recorded at the time of the property's transfer from federal ownership. The easement will require the owner and/or any person responsible for implementing the LUCs set forth in this PRAP to periodically certify that such institutional controls are in place. Long-term groundwater monitoring would demonstrate natural attenuation of the plume after source removal and that the impacted area does not fall beyond the institutional control boundaries established in the LUCs and environmental easement. The elements of this remedy are described in Section 7. The selected remedy is depicted in Figure 7.

Basis for Selection

The selected remedy is based on the results of the RI and the evaluation of alternatives. The criteria to which potential remedial alternatives are compared are defined in 6 NYCRR Part 375. A detailed discussion of the evaluation criteria and comparative analysis is included in the FS report.

The first two evaluation criteria are termed "threshold criteria" and must be satisfied in order for an alternative to be considered for selection.

1. Protection of Human Health and the Environment. This criterion is an overall evaluation of each alternative's ability to protect public health and the environment.

   The selected remedy (Alternative 2) would satisfy this criterion by reducing PCE concentrations in the source area via chemical oxidation and natural attenuation processes along with institutional controls to limit exposures. Remediation of the continuing source would result in natural attenuation of the CVOC plume. Alternative 1 (No Action) does not provide any protection to public health and the environment and will not be evaluated further. Alternative 3 and 4 would both provide similar protection, but would take longer to reach the remedial goals.

2. Compliance with New York State Standards, Criteria, and Guidance (SCGs). Compliance with SCGs addresses whether a remedy will meet environmental laws, regulations, and other standards and criteria. In addition, this criterion includes the consideration of guidance which the Department has determined to be applicable on a case-specific basis.

   Alternatives 2, 3, 4 will all eventually comply with SCGs. All three alternatives reduce the amount of contaminants in the groundwater to meet SCGs through source treatment and natural attenuation. Alternative

3 will most likely take the longest time to achieve the SCGs since the rate of reductive dechlorination is indirectly dependent on other external environmental factors such as soil chemistry and microbial activities which are difficult to control. Alternative 4 will achieve the SCGs more reliably compared to Alternative 3, but would take slightly longer than Alternative 2.

The next six "primary balancing criteria" are used to compare the positive and negative aspects of each of the remedial strategies.

3. Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of the remedial alternatives after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the engineering and/or institutional controls intended to limit the risk, and 3) the reliability of these controls.

   All three remaining alternatives utilize technologies that can readily treat the contaminants in the source area, Alternatives 2 and 4 will have low risks and good reliability in the long-term. Alternative 3 will be marginally effective in the long-term since remediation of the untreated portions of the plume and the completeness of the remediation process relies on the continued microbial activities to transform the contaminants from a hazardous waste to non-hazardous byproducts.

4. Reduction of Toxicity, Mobility or Volume. Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

   Alternatives 2, 3, and 4 treat the contaminated groundwater in-situ with chemical, biological amendment, or physical treatment, thereby reducing the toxicity, mobility and volume of contamination within the treatment area.

5. Short-term Impacts and Effectiveness. The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and/or implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared against the other alternatives.

   Implementation of Alternative 2 or 3 would result in minimal exposure risks to the community, workers, and the environment through the installation of monitoring wells and injection of reagents. Alternative 4 would subject the community and the environment to minimal risk through the installation of AS and SVE wells. There are no known impacts to shallow soil; however, the increased number of well installations and complexity of the construction activities (trenching, pipe installation, equipment installation) pose an increased risk to workers. Alternative 2 meets the remedial response objectives the quickest (within 6 months). The remedial response objective for Alternative 4 should be met within 2 years and Alternative 3 within 4 years.

6. Implementability. The technical and administrative feasibility of implementing each alternative are evaluated. Technical feasibility includes the difficulties associated with the construction of the remedy and the ability to monitor its effectiveness. For administrative feasibility, the availability of the necessary personnel and materials is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, institutional controls, and so forth.

Alternatives 2, 3, and 4 are technically and administratively feasible with Alternative 4 being the most difficult to implement both technically and administratively. Alternatives 2 and 3 are more implementable due to the ability to utilize existing infrastructure, minimal installation of new wells, and no permanent above ground or below ground infrastructure (other than the injection wells). Alternatives 2 and 3 are comparable and would not interfere or would minimally interfere with ongoing operations. The air sparge wells for Alternative 4 require installation into a deeper interval that may be less amenable to injection and would either limit treatment, or would require a denser well network to achieve treatment. Installation of the infrastructure associated with Alternative 4 would create the most disruption to the ongoing operations in and around the nearby buildings.

7. Cost-Effectiveness. Capital costs and annual operation, maintenance, and monitoring costs are estimated for each alternative and compared on a present worth basis. Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision.

   The costs associated with Alternatives 2, 3, and 4 are provided in Exhibit C. Alternative 2 has the lowest present value cost of $1,511,600 and Alternative 4 has the highest present value cost of $3,111,800. A comparative sustainability analysis of Alternatives 2, 3, and 4 indicates that Alternative 2 is the most sustainable of the alternatives considered. Alternative 2 has both the lowest energy use and the lowest air emissions. Alternative 2 also has the lowest material consumption and waste generation of the alternatives considered. Because of the extra three years of injections, Alternative 3 is less sustainable than Alternative 2 in all categories evaluated. Due to the continuous remedial system operations, Alternative 4 is the most energy-intensive of all the alternatives. Alternative 2 presents the lowest energy, air emission, and waste generation, as a result of the reduced equipment operation and the use of the existing remedy infrastructure.

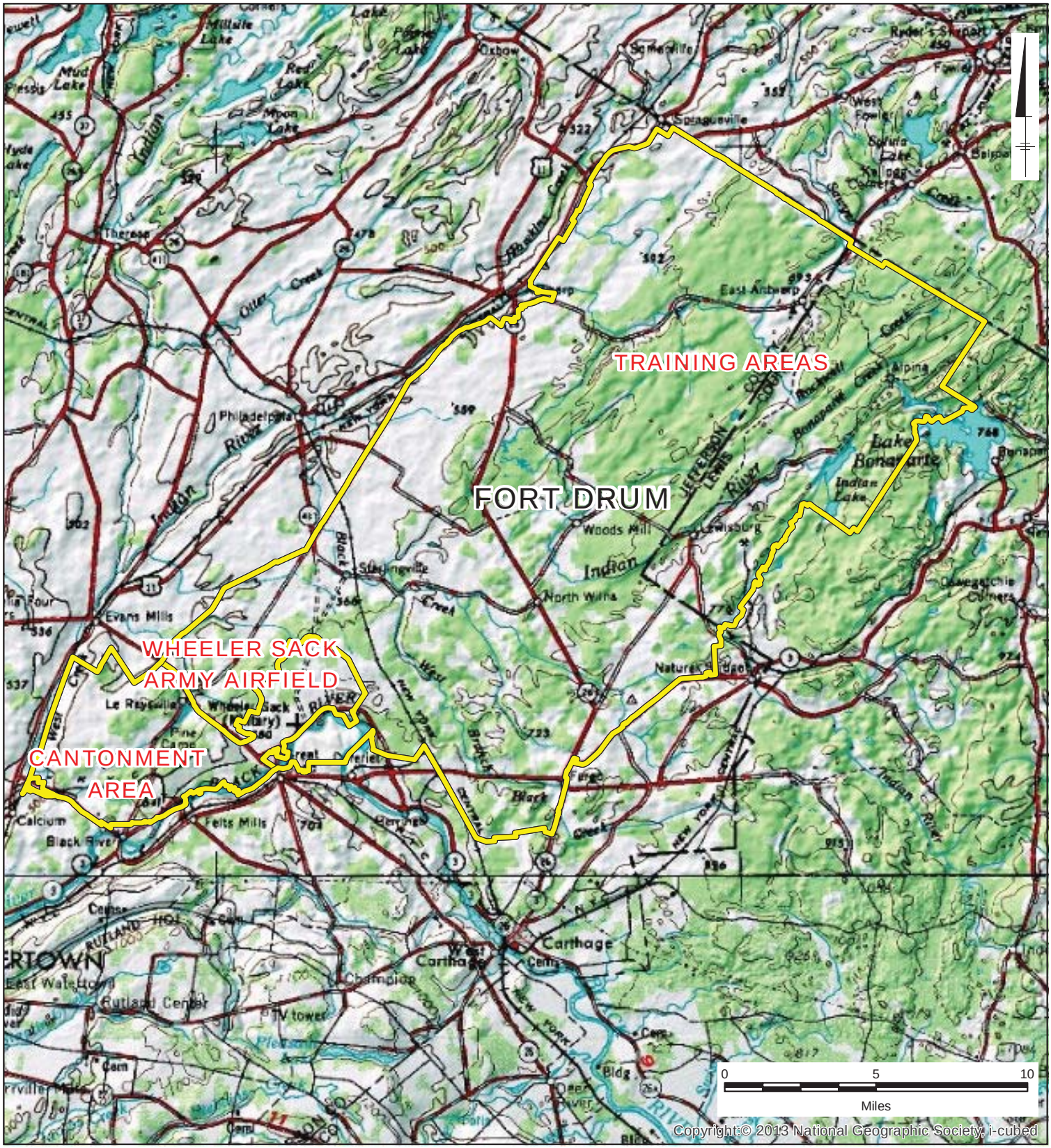
8. Land Use. When cleanup to pre-disposal conditions is determined to be infeasible, the Department may consider the current, intended, and reasonable anticipated future land use of the site and its surroundings in the selection of the soil remedy.

   This criterion is not applicable to groundwater remedies.

   The final criterion, Community Acceptance, is considered a "modifying criterion" and is taken into account after evaluating those above. It is evaluated after public comments on the Proposed Remedial Action Plan have been received.

9. Community Acceptance. Concerns of the community regarding the investigation, the evaluation of alternatives, and the PRAP were evaluated. A responsiveness summary has been prepared that documents the public meeting and public comment period. No comments or questions were received.

   Alternative 2 has been selected because, as described above, it satisfies the threshold criteria and provides the best balance of the balancing criterion.



FORT DRUM
FORT DRUM, NEW YORK

3800 AREA PCE SITE

SITE LOCATION MAP

NEW YORK STATE OF OPPORTUNITY. | Department of Environmental Conservation

FIGURE
1

CITY: MPLS DIV/GROUP: IM DB: MG LD: CK MADISON-KIPP
Z:\GISPROJECTS_ENV\ENV_FORTDRUM_IRP\MXD\PCE Site Feasibility Study\F2-1 SITE_LOCATION.mxd

LEGEND

Approximate 3800 Area PCE Site Boundary

0 400 800

GRAPHIC SCALE

FORT DRUM
FORT DRUM, NEW YORK

3800 AREA PCE SITE

3800 AREA PCE SITE AND VICINITY

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

FIGURE 2

CITY:(CHARLOTTE) DIV/GROUP:(ENV/GIS) DB: ssutton LD: S.SUTTON PIC: PM: TM:
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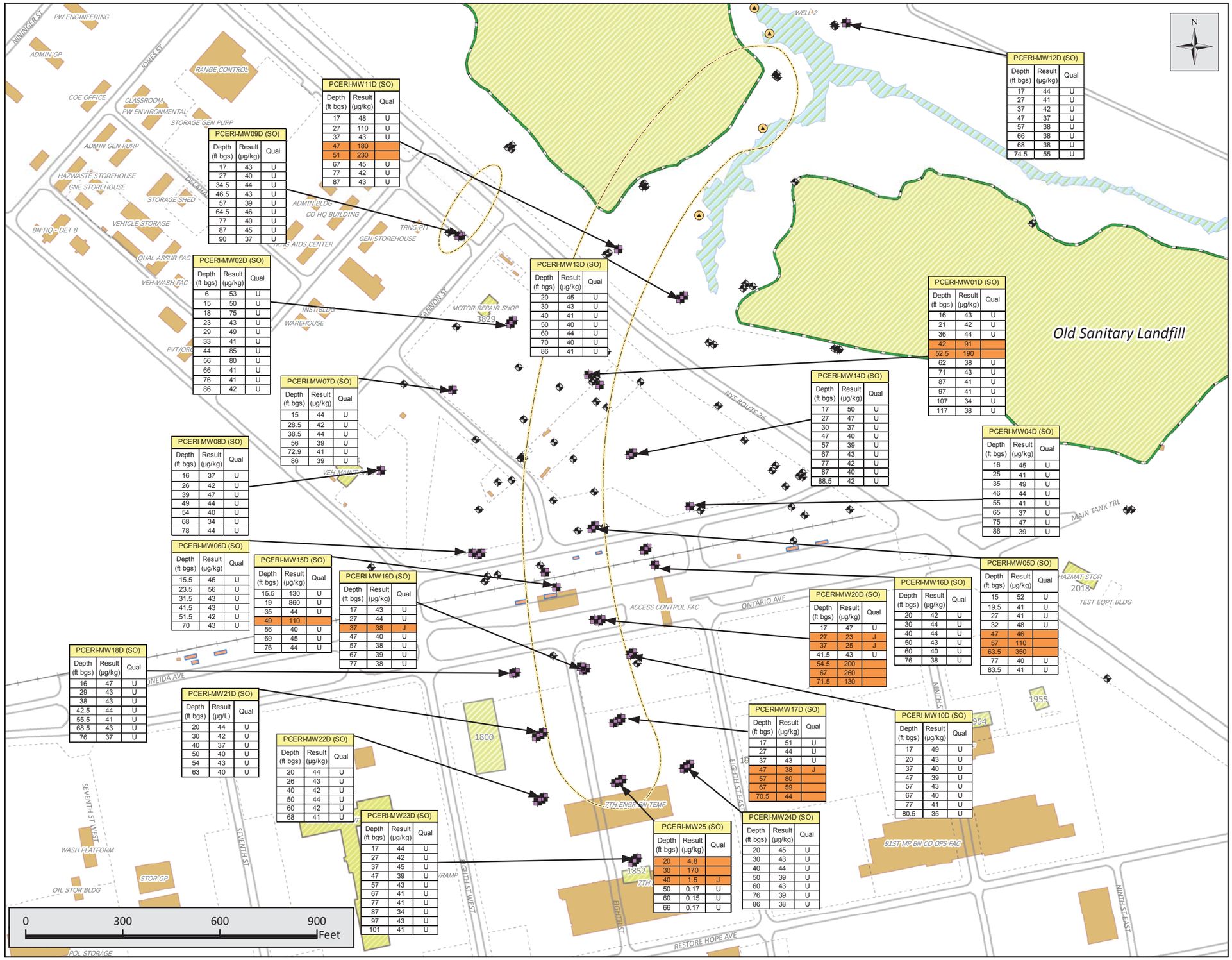

PCERI-MW12D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	44	U
27	41	U
37	42	U
47	37	U
57	38	U
66	38	U
68	38	U
74.5	55	U

PCERI-MW11D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	48	U
27	110	U
37	43	U
47	180	
51	230	
67	45	U
77	42	U
87	43	U

PCERI-MW09D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	43	U
27	40	U
34.5	44	U
46.5	43	U
57	39	U
64.5	46	U
77	40	U
87	45	U
90	37	U

PCERI-MW02D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
6	53	U
15	50	U
18	75	U
23	43	U
29	49	U
33	41	U
44	85	U
56	80	U
66	41	U
76	41	U
86	42	U

PCERI-MW13D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
20	45	U
30	43	U
40	41	U
50	40	U
60	44	U
70	40	U
86	41	U

PCERI-MW01D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
16	43	U
21	42	U
36	44	U
42	91	
52.5	190	
62	38	U
71	43	U
87	41	U
97	41	U
107	34	U
117	38	U

PCERI-MW07D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
15	44	U
28.5	42	U
38.5	44	U
56	39	U
72.9	41	U
86	39	U

PCERI-MW14D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	50	U
27	47	U
30	37	U
47	40	U
57	39	U
67	43	U
77	42	U
87	40	U
88.5	42	U

PCERI-MW08D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
16	37	U
26	42	U
39	47	U
49	44	U
54	40	U
68	34	U
78	44	U

PCERI-MW04D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
16	45	U
25	41	U
35	49	U
46	44	U
55	41	U
65	37	U
75	47	U
86	39	U

PCERI-MW06D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
15.5	46	U
23.5	56	U
31.5	43	U
41.5	43	U
51.5	42	U
70	43	U

PCERI-MW15D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
15.5	130	U
19	860	U
35	44	U
49	110	
56	40	U
69	45	U
76	44	U

PCERI-MW19D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	43	U
27	44	U
37	38	J
47	40	U
57	38	U
67	39	U
77	38	U

PCERI-MW05D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
15	52	U
19.5	41	U
27	41	U
32	48	U
47	46	
57	110	
63.5	350	
77	40	U
83.5	41	U

PCERI-MW20D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	47	U
27	23	J
37	25	J
41.5	43	U
54.5	200	
67	260	
71.5	130	

PCERI-MW16D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
20	42	U
30	44	U
40	44	U
50	43	U
60	40	U
76	38	U

PCERI-MW18D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
16	47	U
29	43	U
38	43	U
42.5	44	U
55.5	41	U
68.5	43	U
76	37	U

PCERI-MW21D (SO)

Depth (ft bgs)	Result (µg/L)	Qual
20	44	U
30	42	U
40	37	U
50	40	U
54	43	U
63	40	U

PCERI-MW22D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
20	44	U
26	43	U
40	42	U
50	44	U
60	42	U
68	41	U

PCERI-MW17D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	51	U
27	44	U
37	43	U
47	38	J
57	80	
67	59	
70.5	44	

PCERI-MW10D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	49	U
20	43	U
37	40	U
47	39	U
57	43	U
67	40	U
77	41	U
80.5	35	U

PCERI-MW23D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
17	44	U
27	42	U
37	45	U
47	39	U
57	43	U
67	41	U
77	41	U
87	34	U
97	43	U
101	41	U

PCERI-MW25 (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
20	4.8	
30	170	
40	1.5	J
50	0.17	U
60	0.15	U
66	0.17	U

PCERI-MW24D (SO)

Depth (ft bgs)	Result (µg/kg)	Qual
20	45	U
30	43	U
40	44	U
50	39	U
60	43	U
76	39	U
86	38	U

Legend

- PCERI Monitoring Wells
- Preliminary PCE Plume Outline
- Monitoring Well Locations
- Seep Sample Location
- Landfill
- Potential Hazardous Waste Sources
- Former UST
- Fence Line
- Rail Road
- Paved Road
- Wetlands
- Building

Highlight indicates a PCE detection

Acronym Key:
UST: Underground Storage Tank
MW: Monitoring Well
ft bgs: Feet Below Ground Surface
µg/L: Microgram per Liter
µg/kg: Microgram per Kilogram

Qualifier Key:
U: Non-detect
J: Result has been estimated
D: Sample has been diluted

FORT DRUM
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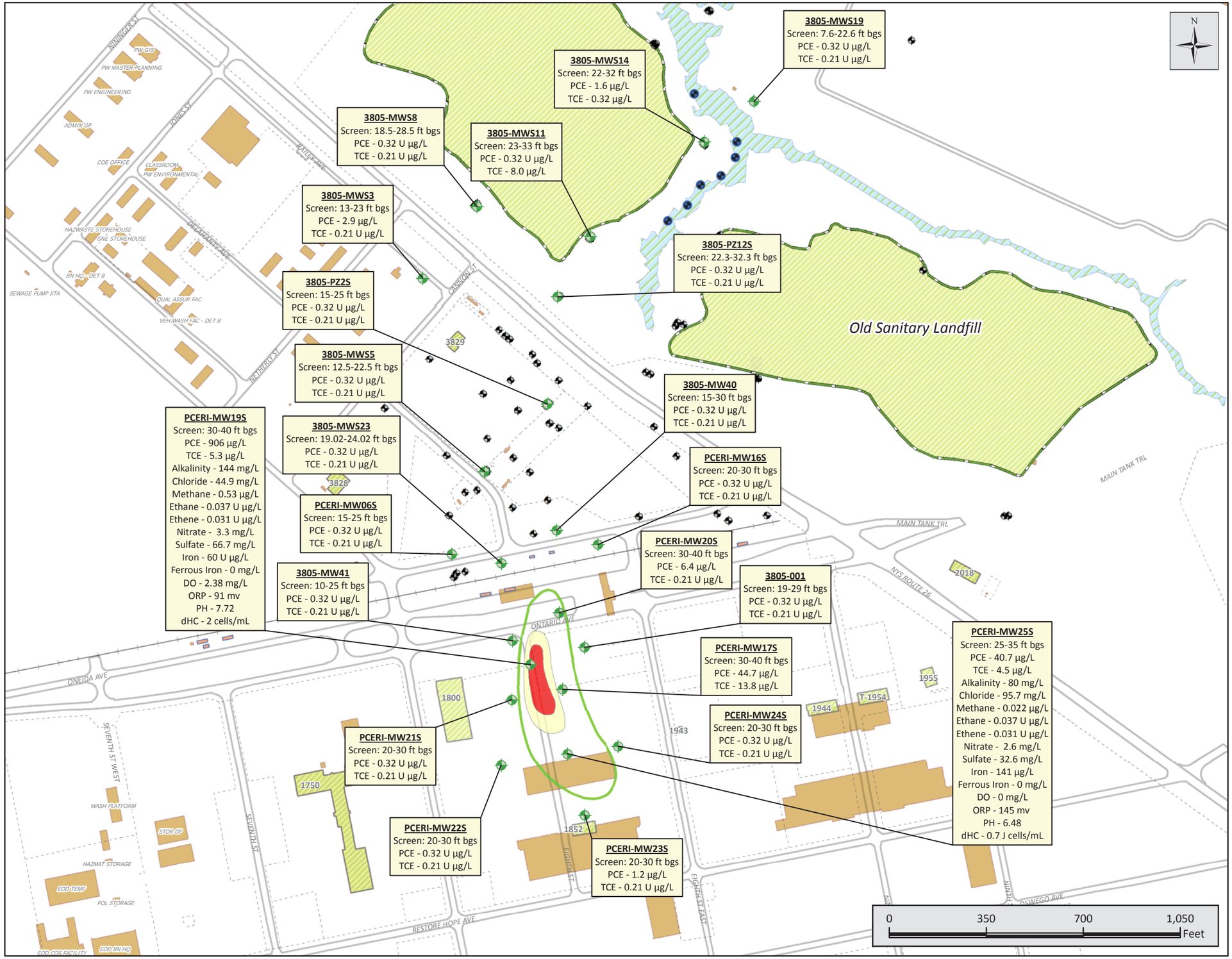
REMEDIAL INVESTIGATION SOIL SAMPLING

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

FIGURE
3



Legend

- Shallow Monitoring Wells
- SWIM/SD/SW Locations
- Monitoring Well Locations
- Landfill
- Potential Hazardous Waste Sources
- Former UST
- Fence Line
- Rail Road
- Paved Road
- Wetlands
- Building

Shallow PCE Plume (µg/L)

- 5-99
- 100-500
- >500

Acornym Key:
PCE - Tetrachloroethene
TCE - Trichloroethene
µg/L - micrograms per Liter
mg/L - miligrams per Liter
ft bgs - Feet Below Ground Surface
cells/mL - Cells per mililiter
DO - Dissolved Oxygen
ORP - Oxygen-Reduction Potential
dHC - Dehalococcoides
SWIM - Surface Water Interface Monitoring

Qualifier Key:
U - Non detect
J - Result has been Estimated
<0.5 cells/mL is a Non-detect

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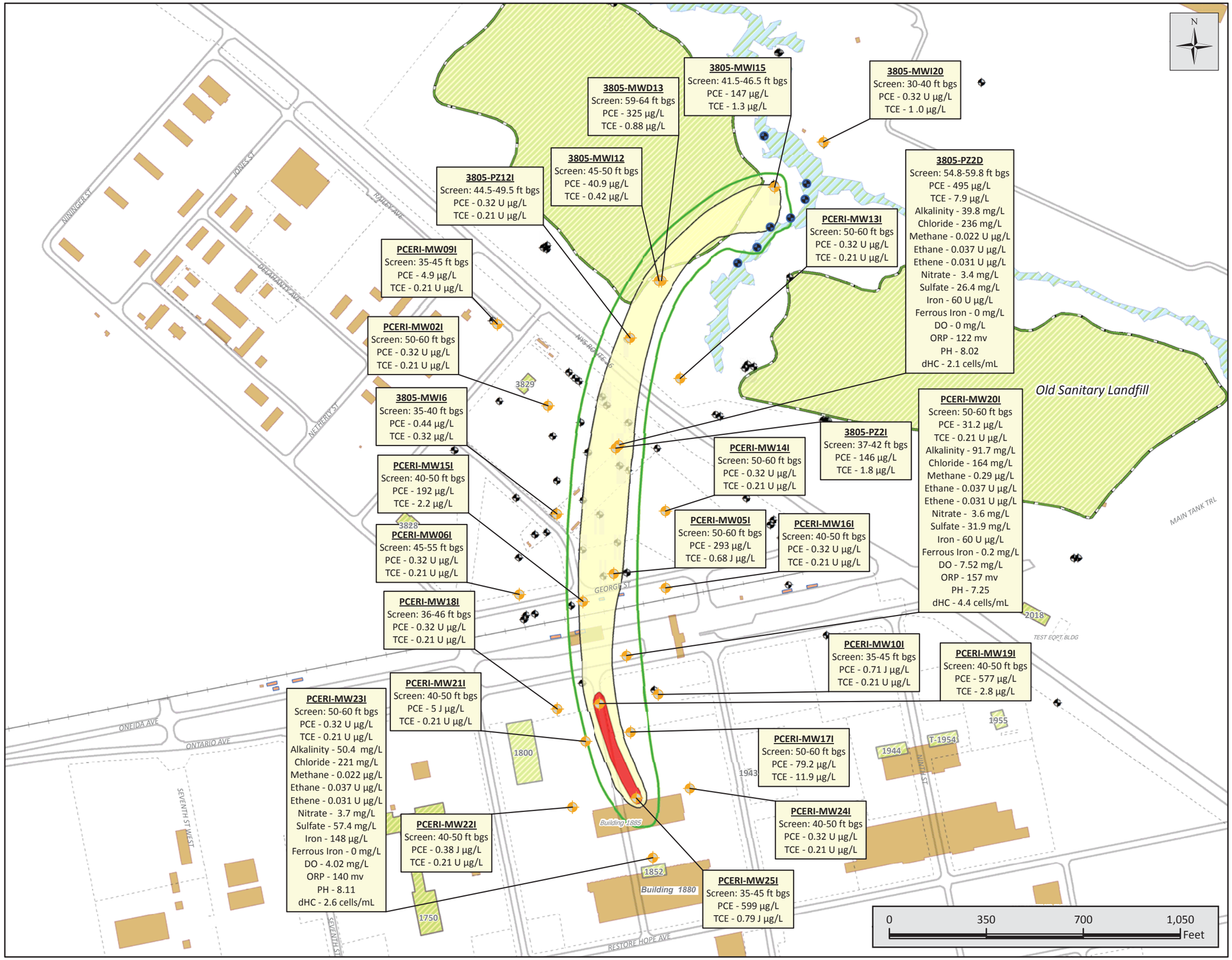
REMEDIAL INVESTIGATION SHALLOW GROUNDWATER

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

FIGURE
4



Legend

- Intermediate Monitoring Wells
- SWIM/SD/SW Locations
- Monitoring Well Locations

Intermediate PCE Plume (µg/L)

- 5-99
- 100-500
- >500
- Landfill
- Potential Hazardous Waste Sources
- Former UST
- Fence Line
- Rail Road
- Paved Road
- Wetlands
- Building

Acornym Key:
PCE - Tetrachloroethene
TCE - Trichloroethene
µg/L - micrograms per Liter
mg/L - miligrams per Liter
ft bgs - Feet Below Ground Surface
cells/mL - Cells per mililiter
DO - Dissolved Oxygen
ORP - Oxygen-Reduction Potential
dHC - Dehalococcoides
SWIM - Surface Water Interface Monitoring

Qualifier Key:
U - Non detect
J - Result has been Estimated
<0.5 cells/mL is a Non-detect

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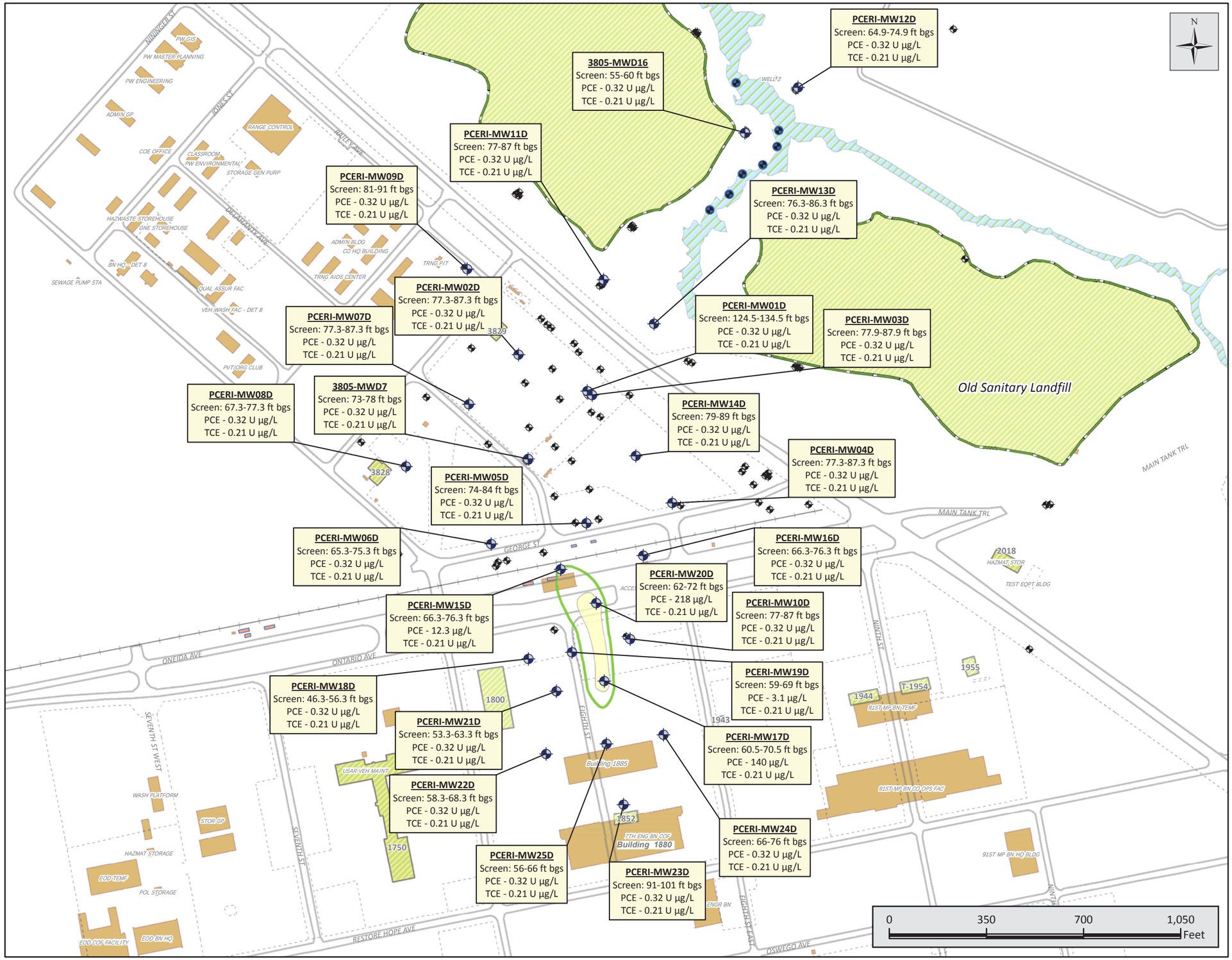
3800 AREA PCE SITE

REMEDIAL INVESTIGATION INTERMEDIATE GROUNDWATER

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

FIGURE
5



Legend

- Deep Monitoring Wells
- SWIM/SD/SW Locations
- Monitoring Well Locations

Deep PCE Plume (µg/L)

- 5-99
- 100-500
- Landfill
- Potential Hazardous Waste Sources
- Former UST
- Fence Line
- Rail Road
- Paved Road
- Wetlands
- Building

Acornym Key:
PCE - Tetrachloroethene
TCE - Trichloroethene
µg/L - micrograms per Liter
ft bgs - Feet Below Ground Surface
SWIM - Surface Water Interface Monitoring

Qualifier Key:
U - Non detect

FORT DRUM
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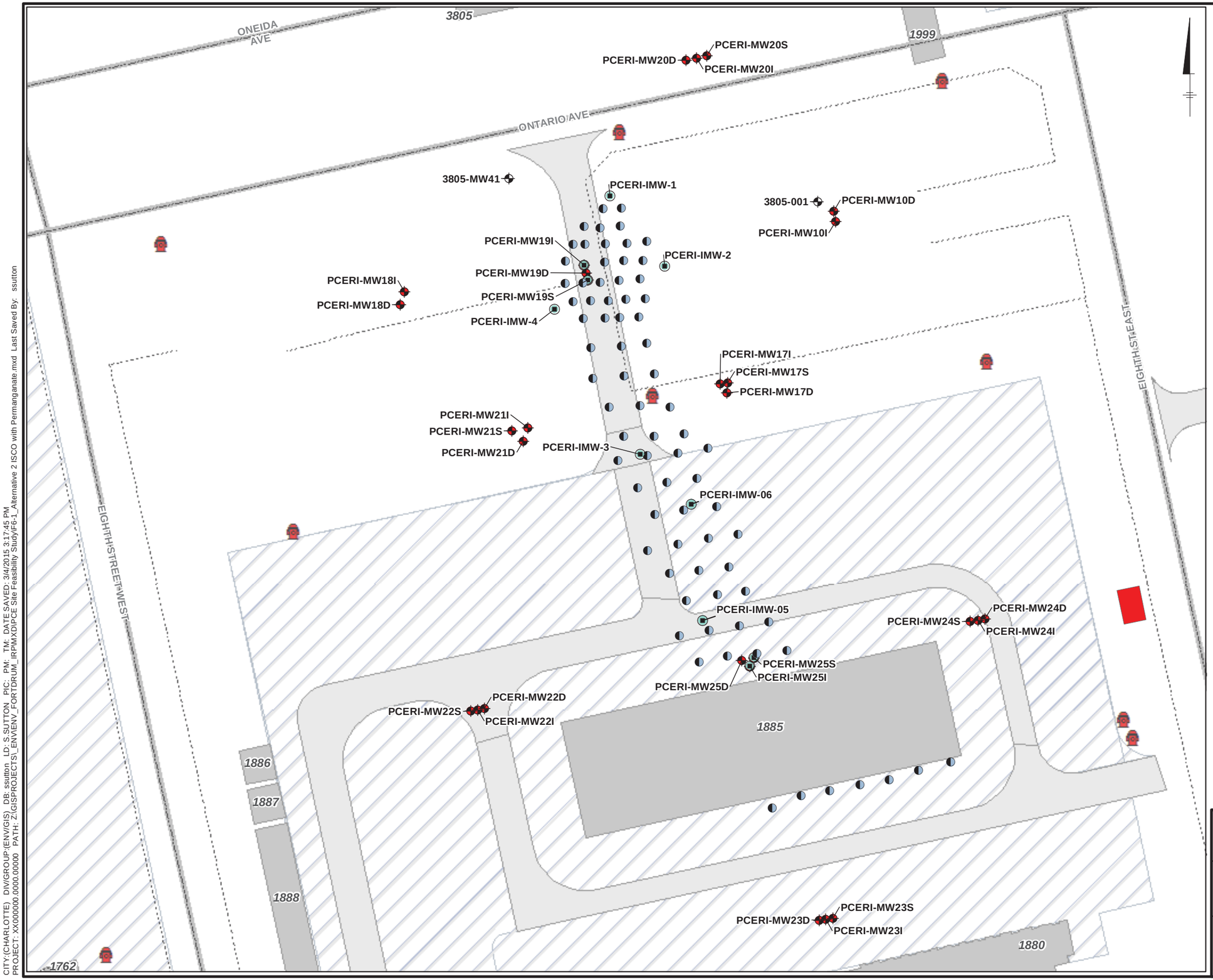
3800 AREA PCE SITE

REMEDIAL INVESTIGATION
DEEP GROUNDWATER

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

FIGURE
6



LEGEND

- ISCO DOSE-RESPONSE WELLS
- ISCO INJECTION WELLS
- MONITORING WELL
- PCE SITE RI MONITORING WELL
- PROPOSED INJECTION MIXING EQUIPMENT LOCATION
- HYDRANT
- FENCE LINE
- ROAD CENTERLINE
- BUILDING
- PARKING AREA

NOTE:
Up to 15 new ISCO injection wells would be installed to optimize oxidant distribution, if needed, based on the results of the planned ISCO pilot study.

0 80 160
GRAPHIC SCALE

FORT DRUM
FORT DRUM, NEW YORK
3800 AREA PCE SITE

ALTERNATIVE 2
ISCO WITH PERMANGANATE

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

FIGURE
7

CITY:(CHARLOTTE) DIV/GROUP:(ENV/GIS) DB: ssutton LD: S.SUTTON PIC: PM: TM: DATE SAVED: 3/4/2015 3:17:45 PM
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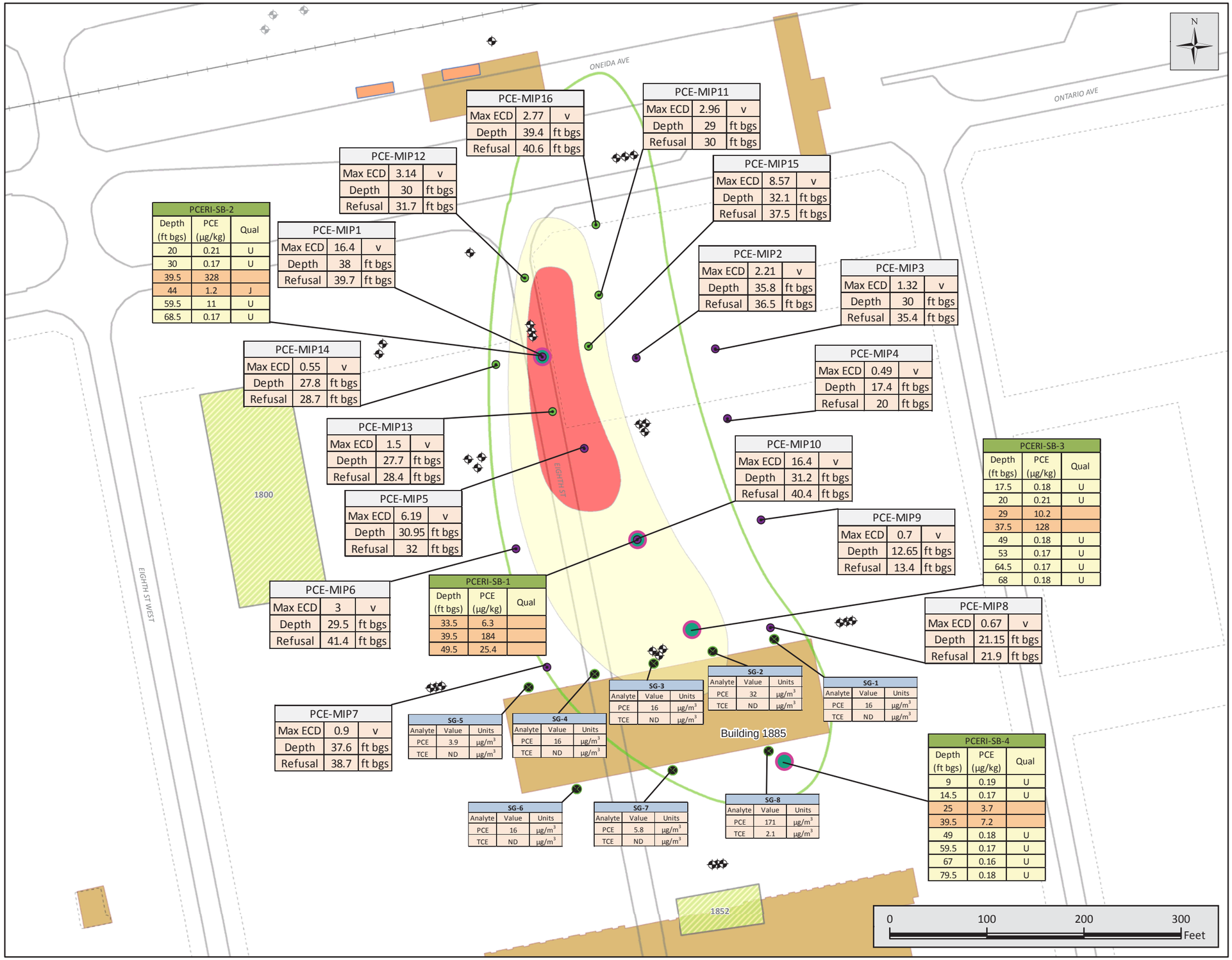


PCE-MIP16		
Max ECD	2.77	v
Depth	39.4	ft bgs
Refusal	40.6	ft bgs

PCE-MIP11		
Max ECD	2.96	v
Depth	29	ft bgs
Refusal	30	ft bgs

PCE-MIP12		
Max ECD	3.14	v
Depth	30	ft bgs
Refusal	31.7	ft bgs

PCE-MIP15		
Max ECD	8.57	v
Depth	32.1	ft bgs
Refusal	37.5	ft bgs

PCERI-SB-2		
Depth (ft bgs)	PCE (µg/kg)	Qual
20	0.21	U
30	0.17	U
39.5	328	
44	1.2	J
59.5	11	U
68.5	0.17	U

PCE-MIP1		
Max ECD	16.4	v
Depth	38	ft bgs
Refusal	39.7	ft bgs

PCE-MIP2		
Max ECD	2.21	v
Depth	35.8	ft bgs
Refusal	36.5	ft bgs

PCE-MIP3		
Max ECD	1.32	v
Depth	30	ft bgs
Refusal	35.4	ft bgs

PCE-MIP14		
Max ECD	0.55	v
Depth	27.8	ft bgs
Refusal	28.7	ft bgs

PCE-MIP4		
Max ECD	0.49	v
Depth	17.4	ft bgs
Refusal	20	ft bgs

PCE-MIP13		
Max ECD	1.5	v
Depth	27.7	ft bgs
Refusal	28.4	ft bgs

PCE-MIP10		
Max ECD	16.4	v
Depth	31.2	ft bgs
Refusal	40.4	ft bgs

PCERI-SB-3		
Depth (ft bgs)	PCE (µg/kg)	Qual
17.5	0.18	U
20	0.21	U
29	10.2	
37.5	128	
49	0.18	U
53	0.17	U
64.5	0.17	U
68	0.18	U

PCE-MIP5		
Max ECD	6.19	v
Depth	30.95	ft bgs
Refusal	32	ft bgs

PCE-MIP9		
Max ECD	0.7	v
Depth	12.65	ft bgs
Refusal	13.4	ft bgs

PCE-MIP6		
Max ECD	3	v
Depth	29.5	ft bgs
Refusal	41.4	ft bgs

PCERI-SB-1		
Depth (ft bgs)	PCE (µg/kg)	Qual
33.5	6.3	
39.5	184	
49.5	25.4	

PCE-MIP8		
Max ECD	0.67	v
Depth	21.15	ft bgs
Refusal	21.9	ft bgs

PCE-MIP7		
Max ECD	0.9	v
Depth	37.6	ft bgs
Refusal	38.7	ft bgs

SG-1		
Analyte	Value	Units
PCE	16	µg/m³
TCE	ND	µg/m³

SG-2		
Analyte	Value	Units
PCE	32	µg/m³
TCE	ND	µg/m³

SG-3		
Analyte	Value	Units
PCE	16	µg/m³
TCE	ND	µg/m³

SG-4		
Analyte	Value	Units
PCE	16	µg/m³
TCE	ND	µg/m³

SG-5		
Analyte	Value	Units
PCE	3.9	µg/m³
TCE	ND	µg/m³

SG-6		
Analyte	Value	Units
PCE	16	µg/m³
TCE	ND	µg/m³

SG-7		
Analyte	Value	Units
PCE	5.8	µg/m³
TCE	ND	µg/m³

SG-8		
Analyte	Value	Units
PCE	171	µg/m³
TCE	2.1	µg/m³

PCERI-SB-4		
Depth (ft bgs)	PCE (µg/kg)	Qual
9	0.19	U
14.5	0.17	U
25	3.7	
39.5	7.2	
49	0.18	U
59.5	0.17	U
67	0.16	U
79.5	0.18	U

Legend

- Soil Gas Locations
- Initial MIP Points
- Step Out MIP Points
- Soil Borings
- PCE RI Monitoring Wells
- IRP Monitoring Wells

Shallow PCE Plume (µg/L)

- 5
- 100-500
- >500
- Potential Hazardous Waste Sources
- Former UST
- Fence Line
- Rail Road
- Paved Road
- Building

Acronym Key:
MIP - Membrane Interface Probe
ECD - Electron Capture Detector
PID - Photoionization Detector
SG - Soil Gas Location
PCE - Tetrachloroethylene
TCE - Trichloroethylene
ft bgs - feet below ground surface
v - volts
µg/m³ - micrograms per cubic meter
µg/kg - micrograms per kilogram
µg/L - micrograms per Liter

Qualifier Key:
U - Non detect

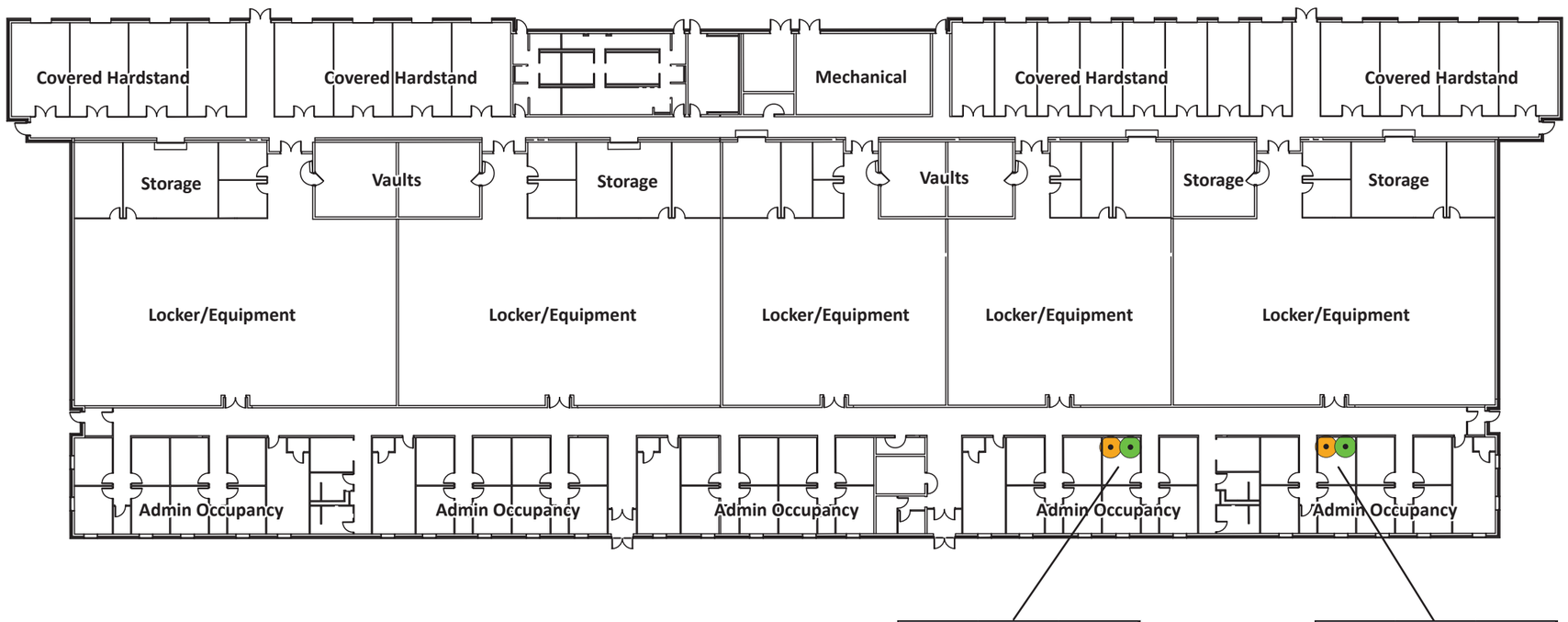
NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

Created By: JRC
Date: May 2012

FIGURE 8

Source Area Investigation Results

Remedial Investigation Report
For Chlorinated Solvent Contaminants
Fort Drum, NY



Sample Pair 5		
Sub-Slab Sample		
Analyte	Value	Units
PCE	4.7	µg/m³
TCE	0.13 U	µg/m³
Benzene	2.7	µg/m³
Ambient Air Sample		
Analyte	Value	Units
PCE	0.19 U	µg/m³
TCE	0.18 U	µg/m³
Benzene	0.19 J	µg/m³

Sample Pair 6		
Sub-Slab Sample		
Analyte	Value	Units
PCE	4.7	µg/m³
TCE	0.13 U	µg/m³
Benzene	6.1	µg/m³
Ambient Air Sample		
Analyte	Value	Units
PCE	0.19 U	µg/m³
TCE	0.18 U	µg/m³
Benzene	0.70	µg/m³

0 40 80 120 Feet

Legend

Vapor Intrusion Sample Locations

- Indoor Air Sample Location
- Sub-Slab Soil Vapor Sample Location

Acronym Key:
PCE - Tetrachloroethene
TCE - Trichloroethene
µg/m³ - micrograms per cubic meter

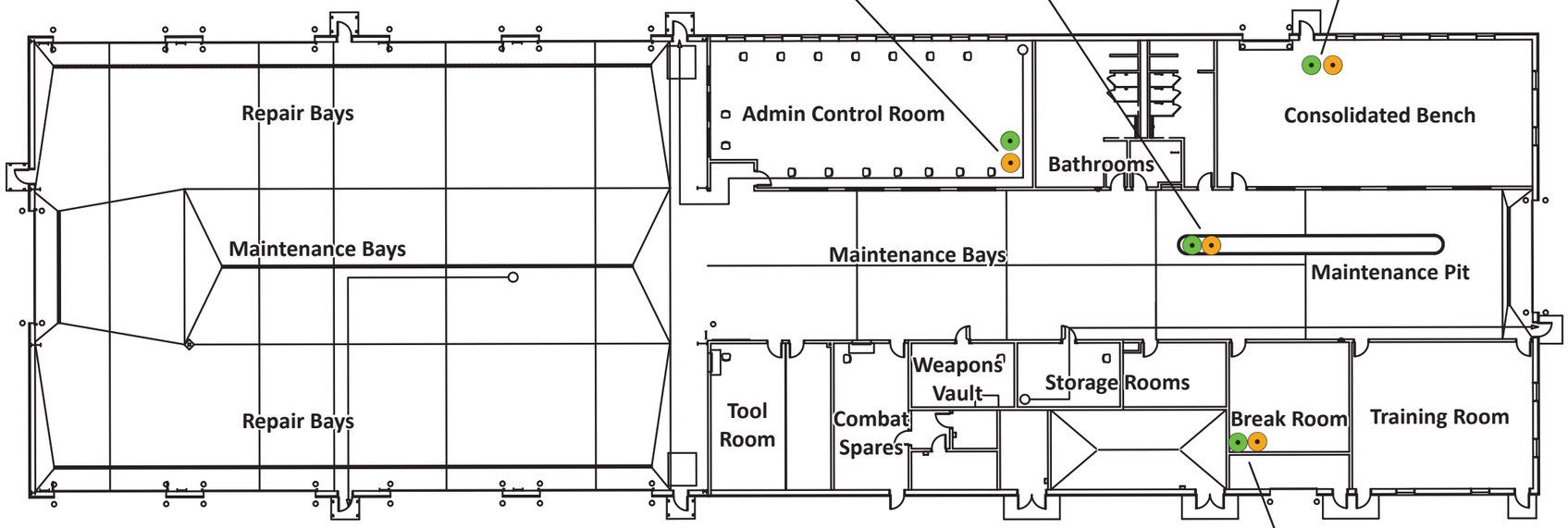
NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

Created By: JRC
Date: May 2012

FIGURE 9

Building 1880 Indoor Air Sampling Results February 2012

Remedial Investigation Report For Chlorinated Solvent Contaminants Fort Drum, NY



Sample Pair 1		
Sub-Slab Sample		
Analyte	Value	Units
PCE	9.5	µg/m³
TCE	0.70 U	µg/m³
Benzene	26	µg/m³
Ambient Air Sample		
Analyte	Value	Units
PCE	0.19 U	µg/m³
TCE	0.18 U	µg/m³
Benzene	4.2	µg/m³

Sample Pair 3		
Sub-Slab Sample		
Analyte	Value	Units
PCE	151	µg/m³
TCE	1.7	µg/m³
Benzene	2.9	µg/m³
Ambient Air Sample		
Analyte	Value	Units
PCE	0.19 U	µg/m³
TCE	0.18 U	µg/m³
Benzene	8.9	µg/m³

Sample Pair 2		
Sub-Slab Sample		
Analyte	Value	Units
PCE	8.8	µg/m³
TCE	0.70 U	µg/m³
Benzene	3.1	µg/m³
Ambient Air Sample		
Analyte	Value	Units
PCE	0.19 U	µg/m³
TCE	0.18 U	µg/m³
Benzene	5.1	µg/m³

Sample Pair 4		
Sub-Slab Sample		
Analyte	Value	Units
PCE	8.8	µg/m³
TCE	1.8	µg/m³
Benzene	52.1	µg/m³
Ambient Air Sample		
Analyte	Value	Units
PCE	0.19 U	µg/m³
TCE	0.18 U	µg/m³
Benzene	7.3	µg/m³

0 30 60 90 Feet

Legend

1885 Floorplan

Vapor Intrusion Sample Locations

- Indoor Air Sample Location
- Sub-Slab Vapor Sample Location

Acronym Key:
PCE - Tetrachloroethene
TCE - Trichloroethene
µg/m³ - micrograms per cubic meter

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

Created By: JRC
Date: May 2012

FIGURE 10

Building 1885 Indoor Air Sampling Results February 2012

Remedial Investigation Report For Chlorinated Solvent Contaminants Fort Drum, NY

APPENDIX A

Responsiveness Summary

RESPONSIVENESS SUMMARY

Fort Drum Site
PCE Groundwater Plume
Watertown, Jefferson County, New York
Site No. 623008

The Proposed Remedial Action Plan (PRAP) for the Fort Drum PCE plume was prepared by the New York State Department of Environmental Conservation (the Department) in consultation with the New York State Department of Health (NYSDOH) and was issued to the document repositories on February 25, 2016. The PRAP outlined the remedial measure proposed for the contaminated groundwater plume at the Fort Drum site.

The release of the PRAP was announced by sending a notice to the public contact list, informing the public of the opportunity to comment on the proposed remedy.

A public meeting was held on March 09, 2016, which included a presentation of the remedial investigation for the Fort Drum PCE Plume site as well as a discussion of the proposed remedy. The meeting provided an opportunity for citizens to discuss their concerns, ask questions and comment on the proposed remedy. The public comment period for the PRAP ended on March 25, 2016.

There were no questions or comments raised regarding the proposed PRAP during the public comment period.

APPENDIX B

Administrative Record

Administrative Record

Fort Drum Site
PCE Groundwater Plume

Watertown, Jefferson County, New York
Site No. 623008

1. Fort Drum, 3800 PCE Site PRAP, dated February 2016, prepared by the Department

2. PARS, 2012. Draft Work Plan – Pilot Testing of Permanganate Injection, Fort Drum, New York. September.

3. PARS, 2013a. Draft Final Remedial Investigation Report for Chlorinated Solvent Contaminants, Fort Drum, New York. February.

4. PARS, 2013b. Draft Final Remedial Investigation Report – Addendum. Pilot Testing of Permanganate Injection. Fort Drum PCE Remedial Investigation for Chlorinated Solvent Contaminants, Fort Drum, New York. August.

5. PIKA-MP JV. 2015. Work Plan, In-Situ Chemical Oxidation Pilot Study and Groundwater Monitoring Work Plan – 3800 PCE Site. Fort Drum Installation Restoration Program, Fort Drum, New York. February 2015.

6. PIKA-MP JV. 2015. Feasibility Study, 3800 PCE Site. Fort Drum Installation Restoration Program, Fort Drum, New York. December 2015.

7. Plexus Scientific. 2014. Draft 2014 Annual Basewide Monitoring Report at Fort Drum, New York. November.