REVISED REMEDIAL DESIGN DOCUMENT:

PHASE I - SOIL REMEDIATION

Wallkill Wellfield Site

20 Industrial Place
City of Middletown
Orange County, New York

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CERTIFICATION

I, Paul H. Ciminello, certify that I am currently a Qualified Environmental Professional and that this Remedial Design Document was prepared in accordance with all applicable statutes and regulations.

I certify that all information and statements in this certification are true. I understand that a false statement made herein is punishable as Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

Paul H. Ciminello 02/02/2018

Qualified Environmental Professional # Date Stamp

It is a violation of Article 145 of New York State Education Law for any person to alter this document in any way without the express written verification of adoption by any New York State licensed engineer in accordance with Section 7209(2), Article 145, New York State Education Law.

1.0 INTRODUCTION

1.1 Site Location and Description

The "Site" as defined in this Phase I Remedial Design Document (RDD) is an irregularly-shaped, approximately 4.3-acre parcel, occupied by an approximately 40,000-square foot industrial building to the north and undeveloped wooded land to the south. The industrial building is currently occupied by a furniture manufacturing operation. Site Location and Site Features Maps (Figures 1 and 2) are provided in Appendix A.

The Site has overall downward slopes to the south, with surface elevations that range from approximately 640 to 600 feet above mean sea level. Groundwater flows in a southerly direction from Highland Avenue towards Industrial Place Extension. Fill soils are likely to have been imported to level the northern portion of the property prior to construction of the on-site building. The lowest property elevation is near the southern property edge, adjacent to the northwestern side of Industrial Place Extension.

1.2 Background and Purpose

Ecosystems Strategies, Inc. (ESI) prepared a Draft Remedial Action Work Plan: Phase I – Soil Remediation (Phase I RAWP) to address chlorinated-solvent contamination previously identified in soils beneath the on-site building. Written, conditional approval of the Phase I RAWP was granted by the United States Environmental Protection Agency (USEPA) via letter dated April 28, 2017. This RDD, prepared by WCD Group, LLC (WCD) provides a detailed description of the proposed response actions.

Detailed application methodologies (including relevant figures) for in-situ treatment of contaminated soil are provided to USEPA in this RDD, which includes specific protocols to be utilized by the remedial subcontractor. Standard operating procedures (SOPs) for general fieldwork activities, including all monitoring and media sampling (soil, groundwater, sub-slab and soil vapor, and indoor and outdoor air) are provided in Appendix B.

This RDD describes relevant current conditions at the Site, provides a rationale and detailed methodology for proposed in-situ treatment of chlorinated-solvent contaminated soils, and presents criteria for evaluating the effectives of the remedial action. This RDD has been prepared in response to comments received from the USEPA as part of the conditional approval of the Phase I RAWP.

1.3 Known Contamination Conditions

Chlorinated solvents, including tetrachloroethylene (PCE) and trichloroethylene (TCE), were previously used at the Site during production of electrical components. Prior investigations indicated the presence

of chlorinated solvents in soil and groundwater as a result of historical on-site discharges (off-site groundwater contamination was identified in the 1980s and investigations conducted in the early 1990s identified PCE, and trace concentrations of TCE, in on-site soils and groundwater). Chemicals currently used on-site within the industrial building include those contained in products associated with wood furniture manufacturing/fabrication (e.g. glue, varnish, stain, paint). Ongoing environmental investigative and remedial work is being conducted in accordance with a 1989 Consent Decree (CD), which requires General Switch Corporation (site owner at the time of the release) to respond to these contamination conditions.

Environmental investigation and remediation activities conducted by ESI, beginning in the late 1990s, are summarized below (relevant report titles shown in italics). Data and observations pertinent to the design of the in-situ treatment of soils beneath the building are noted, including depths to groundwater and refusal, and soil concentrations of PCE, and soil and groundwater data are presented on Figures 3 and 4, respectively, in Appendix A.

Soil

Summary Report of Soil Remediation Activities (September 1999, revised June 2002)

Elevated PCE concentrations were documented in soil in the vicinity of the on-site building, at areas identified as the northern and southern "hot spots." Accessible soil at these areas was excavated and removed. PCE contamination above the site-specific action level remains in the vicinity of both areas in soils not accessible for excavation/removal.

Summary Report of Subsurface Investigation (May 2007)

Eighteen mechanized, direct-push sub-slab soil borings were extended throughout the on-site structure in November 2006 and March 2007. Elevated concentrations of PCE were limited to boring SB-8, located southwest of the northern hot spot, where PCE was documented at 460 parts per million (ppm) at 16 feet below surface grade (bsg; referencing the top of the concrete building slab). All other soil samples contained low to trace levels of PCE, only. PCE concentrations in samples collected in the vicinity of SB-8 (the proposed treatment area), from the soil interval exhibiting the greatest field indication of contamination, included SB-3 (0.080 ppm), SB-4 (0.026 ppm), SB-6 (0.24 ppm), SB-7 (0.3 ppm), SB-11 (0.089 ppm) and SB-12 (0.32 ppm), supporting the conclusion that the area of contamination is limited in extent.

Borings terminated from 16 to 17 feet bsg (SB-8, SB-11, and SB-12) near the treatment site (refusal was met at 9.5 feet bsg at SB-7 near the southern boundary of this area). Groundwater was encountered from 4 to 10 feet bsg, with the water table generally observed at approximately 10 feet bsg in the vicinity of the PCE hotspot.

Groundwater

Multiple Groundwater Sampling Reports (2001 through 2008)

Groundwater sampling events in 2000, 2003, 2005 and 2008 documented peak concentrations of PCE in overburden wells located southwest of the building (MW-3, MW-4 and MW-5), with decreased concentrations in bedrock wells and an overall decline in contamination at peripheral and downgradient areas (to the southwest). PCE concentrations generally decreased compared to available 1992 data, with lower peak concentrations and a reduction in the number of wells showing significant contamination. The most contaminated well, MW-5, located in close proximity to the southern hot spot area, exhibited decreasing PCE concentrations from 1992 to 2003 (41,000 to 9,800 µg/L) then rebounded in 2005 and 2008 (26,000 and 17,000 µg/L, respectfully). Peak PCE levels in bedrock wells were reported at MW-204 (680 µg/L in 2008).

Groundwater Sampling Letter Report (April 25, 2016)

Monitoring wells (a priority list identified by USEPA) were inspected and sampled in March 2016 to document current on-site and off-site groundwater conditions (see Appendix C). In general, PCE levels in both overburden and bedrock wells decreased in comparison to the 2008 (and prior) sampling events. PCE at levels ranging from 1,200 to 26,000 µg/L remain to the southwest of the building, within a region generally defined by MW-3, MW-4 and MW-5 (peak concentration), consistent with earlier data. Peak concentrations of PCE in bedrock wells continued to be reported at MW-204 (430 µg/L). The groundwater hot spot to the southwest of the building does not appear to have expanded and concentrations of dissolved PCE (and breakdown products) appear to be decreasing in perimeter wells, potentially due to natural bio-attenuation.

1.4 Remedial Action Objectives

The remedial action objectives (RAOs) of the proposed activities presented in this RDD are:

- To reduce PCE concentrations in on-site soils in a hot spot under the building to site-specific criteria;
- To minimize the potential for vapors to enter the structure from the identified hot spot during and after remediation; and,
- To contribute towards reductions in dissolved PCE concentrations in groundwater as measured in on-site monitoring wells.

2.0 PROPOSED REMEDIAL ACTION

The Consent Decree identifies General Switch (and hence its successor, Laurwal Holding Corporation) as the Potentially Responsible Party (PRP). For the purpose of the work detailed in this RDD, the PRP is defined as Laurwal Holding Corporation, which is proposed to contract with the environmental consultant and/or remediation firm (hereafter referred to as the On-site Coordinator [OSC]) to provide the services detailed below.

2.1 Rationale

Soils containing PCE at concentrations warranting active remediation are present beneath a portion of the building concrete slab. An in-situ chemical oxidation (ISCO) treatment, introducing oxidants into the source zone in order to reduce contaminants of concern, is proposed to address these contamination conditions. ISCO treatment of organic contaminants is a well-established technology widely used to both directly destroy target compounds in soil and groundwater, and to create conditions (e.g., mass reduction) that favor natural attenuation. ISCO treatment is appropriate for treatment of contaminants at the Site.

Excavation and off-site removal of PCE-impacted soil is not considered to be a practical or cost-effective response action at the Site, based on the presence of the building. ISCO treatment by direct subsurface injection/recirculation of an oxidant/water solution may be implemented at the Site safely without significantly disrupting ongoing commercial activities, and has a high likelihood of diminishing residual contamination (consistent with the RAOs).

2.2 Proposed ISCO Treatment

The proposed chemical oxidant is sodium persulfate ($Na_2S_2O_8$), the predominant persulfate compound used in ISCO applications. Persulfate is applied in the form of a salt, which dissociates in water to form the sulfate anion. Oxidation by persulfate is complex; known reactions include both direct oxidation reactions and oxidation pathways arising from the generation of free radicals.

Direct oxidation is thermodynamically favored, but may have a slow kinetic rate. Radicals produced by persulfate have increased kinetic rates and also propagate through a chain reaction that creates additional radicals. Generation of radicals is enhanced through use of an activator, including heating or the addition of alkalizing agents.

Common radicals include the sulfate radical and the hydroxyl radical:

$$S_2O_8^{2-} + \text{Activator} \rightarrow SO_4\text{-}\bullet, OH\bullet, O_2\text{-}\bullet$$

The proposed ISCO reagent is Klozur®, a proprietary sodium persulfate product supplied by PeroxyChem. Klozur has been demonstrated to be effective in treating soil and water impacted by chlorinated ethenes (PCE, TCE, DCE and vinyl chloride), chlorinated ethanes (TCA and DCA), and chlorinated methanes (carbon tetrachloride and methylene chloride).

Supporting documentation from PeroxyChem, including case uses and application instructions, is provided in Appendix I.

Primary ISCO methodologies consist of placement of oxidants onto exposed soils or introduction of reagents mixed with water into the subsurface via the techniques of either direct injection or extraction of groundwater and reinjection following exposure to oxidants. Extraction is frequently useful where COCs are present in groundwater, and aboveground mixing ensures thorough contact with reagents. Extraction and reinjection is therefore proposed for the Site.

The remedial process proposed for soil remediation is a solvent-enhanced in-situ chemical oxidation (SE-ISCO) recirculation system, utilizing a biodegradable solvent and a chemical oxidant recirculated throughout the defined hot spot. The application of the solvent is followed by the injection of Klozur alkaline-activated sodium persulfate (AASP). Two extraction wells and six injection wells will be installed in the treatment area. Proposed well locations are presented on Figure 5 - Chemical Oxidation Fieldwork Map and a schematic representation of the system is presented as Figure 6 – ISCO/Recirculation Process Schematic.

During the first step of the treatment process, water will be pumped from the two extraction wells into portable containers, mixed with the biodegradable solvent, and then syphoned to the injection wells for distribution throughout the treatment area. The solvent (d-limonene, derived from orange peels) will remove the sorbed mass from the soil without rendering the mass water-soluble. This approach allows for effective collection of the contaminant mass and minimizes mass migration. Extraction rates will be balanced in the field to ensure adequate residence time of the solvent.

The second step repeats the process as described above, with the solvent replaced by ISCO reagents (sodium hydroxide [NaOH] and Klozur, constituting the AASP), which will be mixed with the extracted water and then syphoned to the injection wells for distribution throughout the soils to be treated. The NaOH is used to precondition the environment by increasing pH (optimal oxidant activation is in the range of pH 10.5 to 11.5). Figure 6 shows the general recirculation process for the proposed in-situ treatment.

Product literature and relevant Safety Data Sheets (SDSs) are provided in Appendix I.

2.3 Overview of Proposed Remedial Action

Hot spot soils targeted for treatment are located inside the building in the vicinity of Boring SB-8 (see above). The in-situ treatment of soils will involve the installation of injection and extraction wells within the building, followed by recirculation of an in-situ chemical solution to treat the existing PCE contamination located beneath the slab. The treatment area and configuration of injection and extraction wells are provided on Figure 5.

The proposed remedial action, described in detail in subsequent sections of this RDD, will consist of the following:

1. A bench test of site media (soil and groundwater) to determine design criteria for the treatment process and subsequent modelling to develop a site-specific design;
2. Baseline soil and groundwater sampling;
3. Remediation of on-site soils beneath the existing building utilizing solvent-enhanced in-situ chemical oxidation (SE-ISCO);
4. Post-remedial sampling of soils and soil vapor from beneath the existing building;
5. Installation and operation of a Sub-slab Depressurization System (SSDS) in the treatment area;
6. Preparation of a Final Engineering Report (FER) for the Client and the USEPA; and,
7. Preparation of an Operations, Management and Maintenance Plan for any systems installed on the Site that provide remedial services after active remediation has ceased.

Prior to, or in conjunction with, the initiation of these actions, the administrative and fieldwork tasks detailed in Section 3.0, below, will also be conducted.

3.0 GENERAL METHODOLOGY

3.1 Administrative and Site Preparation Services

3.1.1 Agency Notification/Communication

The USEPA will be notified in writing at least fourteen (14) business days prior to the start of fieldwork. Notification of subsequent field activities will be in accordance with reasonable business practice, with verbal notification for immediate (within 48 hours) activities and written notification otherwise. Written notifications will be transmitted to the USEPA via facsimile or electronic mail.

Periodic communication with the USEPA will occur during the course of RDD implementation. Meaningful events (e.g., soil sampling) will warrant prior notification to permit the USEPA (or its representative) to be present.

3.1.2 Access Agreements

All work performed under this Phase I RDD will occur on the Site; therefore, no separate access agreements will be required. Private arrangements will be made with the current building tenant to permit the execution of work while minimizing disruptions to ongoing commercial activities.

3.1.3 Equipment and Laboratory Procedures

Prior to the initiation of fieldwork, all field equipment to be used during the work will be properly decontaminated in accordance with USEPA guidelines, and all field instruments will be properly calibrated in accordance with procedures set forth by the equipment manufacturer(s). Unless otherwise specified, a photo-ionization detector (PID) will be utilized for screening of organic vapors during soil remediation activities and any on-site ground intrusive fieldwork activities (e.g., post-remediation soil sampling activities). The PID is calibrated to read parts per million gas equivalents of isobutylene. Instrument calibration will be performed each day prior to the commencement of fieldwork and as appropriate during the day to ensure that accurate readings are being obtained. A written record of calibration results will be kept in the project files.

All samples will be collected in accordance with applicable USEPA guidelines and will be submitted to a NYSDOH ELAP-certified laboratory using appropriate chain of custody procedures. Dedicated, laboratory supplied glassware will be used for sample collection. Appropriate blanks (field duplicates, trip blanks, and equipment blanks) will be collected for each day of fieldwork involving sample collection. Field personnel will complete all chain of custody forms.

Laboratory reports will include Quality Assurance/Quality Control (QA/QC) analysis. Laboratory data packages will be submitted to an independent validator for review and assembly of Data Usability Summary Reports (DUSRs). DUSRs will be included in interim reports (as available) and in the final report prepared for USEPA (see Section 5.1).

Additional quality assurance/quality control measures are referenced in Section 3.2.3.

3.1.4 Clean-up Levels

PCE soil data from post-remediation samples will be compared to a risk based, site-specific clean-up level of 12 ppm. Further remediation will be pursued beyond this clean-up level if the OSC believes that continued reduction in PCE concentrations in soil can be achieved through continued chemical application and if such further reduction will have a meaningful impact on PCE (and metabolite) concentrations in groundwater. PCE concentrations will be used to evaluate the effectiveness of the proposed treatment; the expectation is that use of the specified SE-ISCO chemicals will have a meaningful impact on PCE breakdown compounds (i.e., TCE, DCE, and vinyl chloride). It is the intent of this RDD to achieve, to the extent practical, the USEPA specified clean-up level as represented by post-remediation soil sampling.

3.1.5 Site Remediation Coordination Activities

Prior to the initiation of fieldwork, all subcontractors will be notified of the components of the Health and Safety Plan (see Section 3.2.2, below). All necessary insurance certificates will be secured from subcontractors by the PRP and/or by the OSC.

An assessment of subsurface soil characteristics, including soil type, the presence of foreign materials, field indications of contamination (e.g., unusual coloration patterns, or odors), and instrument indications of contamination (i.e., PID readings) will be made by the OSC during all Site remediation work.

The OSC will be responsible for identifying any soils and/or groundwater which, in the opinion of the OSC, may contain elevated concentrations of contaminants and should, therefore, require special handling. Materials that will be generated during remediation, and might require special handling, include: soil and groundwater from collection of baseline, bench test and post-treatment samples; soil generated during installation of SSDS components; and excess soil cuttings from boreholes that will be converted to injection and recirculation wells. Specific field parameters to be used by the OSC to identify such materials include the presence of free product or other evidence of gross contamination, PID readings greater than 10 ppm above background, and/or the overt presence of regulated materials such as debris. Those soils and/or groundwater identified by the OSC will be containerized and/or

removed to a dedicated soil stockpiling area (soil only) for characterization and proper disposition. The OSC will monitor the removal of all contaminated soil, including monitoring the trucks and establishing the designated truck routes. The OSC will also ensure that any unforeseen environmental conditions are managed in accordance with applicable federal regulations.

Soils identified by the OSC as requiring special handling will be managed as follows:

- Soils will be containerized in 50 gallon drums and/or removed to a soil stockpiling area (depending on volume of soil generated).
- If utilized, an area appropriate for temporarily stockpiling the contaminated soil will be identified and prepared for the temporary storage of this soil, including the use of 6 mil plastic and hay bales to fully segregate this soil.
- Soil samples from a sufficient number and distribution of locations (or from the containers) will be collected, analyzed, and compared to applicable USEPA and NYSDEC guidance levels in order to determine the condition of the stockpiled soils relative to the suitability of the soil for on-site re-use or the necessity of off-site disposal.
- If the soil must be disposed of off-site, it will be analyzed as required by the approved disposal facility.
- Prior to off-site disposal, acceptance of the material by the disposal facility (e.g., acceptance letter) will be submitted to the USEPA for approval. All waste will be managed as a hazardous waste, unless determined otherwise.

3.2 Governing Documents

3.2.1 Approved Remedial Action Work Plan

All activities conducted during implementation of the remedial action will be conducted according to the protocols established in this RDD and the approved Phase I RAWP for the remediation of the Site. Protocols specific to the proposed remedial action are addressed in Section 4, below.

3.2.2 Health and Safety Plan

A site-specific Health and Safety Plan (HASP) is included in this RDD as Appendix H. This HASP will be reviewed with on-site personnel (including subcontractors) prior to the initiation of fieldwork. All proposed work will be performed in either “Level D” or modified “Level D” personal protective equipment (as specified in the HASP); however, all on-site field personnel will be prepared to continue services wearing more protective levels of equipment should field conditions warrant.

Air quality will be monitored during activities where dust and organic vapors have the potential to affect public health. Because work is proposed inside the building, dust beyond the envelope of the structure is not reasonably likely. Should there be evidence of dust exiting the building as a result of the remedial work, dust monitors will be placed on the property line abutting the nearest residential property. Consistent recorded levels of 0.15 $\mu g/m^3$ of air will be set as the level above which specific actions to reduce said dust will be implemented. Organic vapors will be measured using a PID at the edge of the work area. PID readings consistently 2.5 ppm above background or higher will be considered evidence of vapor concentration contribution from the Site work and specific actions to reduce vapors will be implemented. An indoor air monitoring program has been established to protect workers within the building during remedial activities, as described in Section 3.3, below.

3.2.3 Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPP), detailing procedures necessary to generate data of sufficient quality and quantity to represent successful performance of the Remedial Action, is provided as Appendix G. The QAPP describes all relevant Quality Assurance/Quality Control (QA/QC) elements, including project organization and data validation, and details the collection, handling and laboratory submission of samples.

3.2.4 Community Air Monitoring Plan

A Community Air Monitoring Plan (CAMP, attached to the HASP in Appendix H) will be initiated during all ground intrusive activities. The implementation of the CAMP will document the presence or absence of specific compounds in the air surrounding the work zone, which may migrate out of the work zone due to fieldwork activities. This plan provides guidance on the need for implementing more stringent dust and emission controls based on air quality data. Air monitoring will be conducted for VOCs (see Section 3.3, below) and for dust.

3.2.5 Standard Operating Procedures

Detailed Standard Operating Procedures (SOPs) for proposed fieldwork activities, including general fieldwork and the application of the ISCO reagent, are provided as Appendix B and the SOP for ISCO "bench testing" is provided in Appendix I. These procedures include specific protocols to be utilized by the ISCO subcontractor during treatment and all fieldwork personnel during required monitoring/sampling. The SOP for the injection/recirculation events will be modified (as warranted, with USEPA approval) based on the findings of the pre-treatment soil and groundwater testing and subsequent bench testing. Application instructions and SDSs from the ISCO supplier are found in Appendix I.

3.2.6 Approvals and Permits

The primary approval for implementation of this Remedial Action is sign-off on this RDD by the USEPA. Prior to the commencement of fieldwork, the OSC will work to make a determination as to the need for additional permits and/or approvals. Proper USEPA Class 5 UIC notifications pertaining to the subsurface injection process will be made to the Agency. All other permits and/or approvals will be secured, if needed.

3.3 Indoor Air Monitoring During Remedial Activities

3.3.1 Sample Locations and Protocol

The release of VOCs from remedial activities, including soil boring/soil disturbance activities, and operation of the SE-ISCO treatment system, will be monitored via a two tiered system using stationary PIDs within the proposed treatment area at the northwest portion of the General Switch Building (see Figure 5). In addition, real-time screening with a dust meter (i.e., Thermo Scientific PDR-1000AN) will be performed as part of indoor air monitoring prior to, during and after completion of dust disturbing and potential vapor generating project activities. Proposed screening criteria for VOCs is 2.5 parts per million (ppm) above normal factory (pre-screened) background levels – this criteria is based on 1/10th the value of the American Conference of Governmental Hygienists Threshold Limit Value (ACGIH TLV) of 25 ppm for PCE. Proposed screening criteria for dust is 0.15 µg/m^3.

As noted in Section 3.4.1, below, prior to initiation of SE-ISCO treatment, indoor air samples will be collected and analyzed for PCE and its breakdown products to establish pre-treatment baseline data. As part of that sampling event, a pre-sampling building survey/inspection will be conducted according to the Site Operating Procedure (SOP) for Indoor and Outdoor Air Sampling, provided in Appendix C.

The first tier of three (3) fixed-station PIDs will be at an approximate distance of 5-10 feet at the immediate perimeter of treatment area, as allowed by the work sequence, logistics, and physical configuration (i.e., walls, stored materials, etc.). A second tier of PID monitors will be situated approximately 30-50 feet from the perimeter of the proposed treatment area to document any migration of VOCs into surrounding occupied areas.

Efforts will be made to ensure that work staff/populations shall be moved a minimum of twenty (20) feet from project operations/work zone. Where feasible, planned site activities that might result in VOC or dust emissions will be implemented when potentially exposed populations are at a minimum, such as during weekends or evening hours. The initial building survey will include a separate ventilation assessment to ensure that there is no entrainment of dust and/or VOCs into the building area. The location of all outside air intakes, and return and dispersion vents, will be assessed in relation to worker

safety throughout the building, and the monitoring locations will be established accordingly. HVAC systems will be sealed, cut and/or capped based on the results. Additional entrainment pathways (i.e. unsealed wall, floor/ceiling penetrations) within the work zone and throughout the structure will be treated and appropriately sealed off to prevent transfer of dust or VOCs into and within the building.

All PIDs (RAE Systems Mini RAE 3000 or equivalent) will be calibrated as per manufacturer's recommendations with 100 ppm isobutylene and all instruments shall be bump tested daily/prior to each use.

It is anticipated that some low-level VOC emissions, which will be detected by the immediate perimeter monitors, may result from the investigation and remediation work, particularly the installation of the SE-ISCO well system, collection of baseline soil and groundwater samples and installation of the sub-slab components of the proposed SSDS. According to the SE-ISCO subcontractor, the recirculation/treatment process does not typically generate VOC emissions due to the closed-system design.

In the event that VOCs are detected above the baseline/background, instantaneous read out colorimetric detector tubes (Sensidyne AP20-S pump or equivalent) will be used to collect a short-term "grab" sample at the particular location(s) for confirmation. The detector tubes will be specific for PCE and/or VOCs used in the furniture manufacturing operation.

3.3.2 Site Response Criteria

VOCs at Immediate Perimeter of Treatment Area

PID alarms shall initially be set at 2.5 ppm greater than background, as determined by average from approximately 4 hour sampling conducted during normal operation prior to investigation/remediation activity. If sustained measured airborne VOCs exceed 2.5 ppm greater than background for at least 15 seconds (simultaneous with second tier monitors indicating no greater than background VOCs), confirmation sampling for PCE will be conducted using short term colorimetric detector tubes at the affected location.

Should detector tube sampling indicate an elevation in PCE, fieldwork shall temporarily be halted. The OSC shall: 1) make a determination of the likely cause of the PCE release; and 2) institute necessary changes in engineering controls and/or work practices to reduce VOC levels to less than 5 ppm greater than background.

VOCs at Second Tier Locations

PID alarms shall be set at 2.5 ppm above background. If sustained measured airborne VOCs exceed 2.5 ppm greater than background for at least 15 seconds (simultaneous with treatment area monitors

indicating VOCs exceeding 2.5 ppm above background), confirmation sampling for PCE will be conducted using short term colorimetric detector tubes at the affected location.

Should detector tube sampling indicate an elevation in PCE, the OSC shall: 1) make a determination of the likely cause of the PCE release; and 2) institute necessary changes in engineering controls and/or work practices to reduce VOCs at the second tier location to less than 2.5 ppm greater than background. Sustained elevation of VOCs exceeding background at least 15 seconds in the absence of elevated VOC at the treatment area will be assumed to be the result of facility operations unrelated to the investigatory and remediation work. Confirmation using short-term colorimetric detector tube sampling for target compounds other than PCE (i.e. acetone, methyl ethyl ketone) may be conducted at the direction of the OSC.

3.4 Sampling of Site Media

Implementation of the remedial action requires the collection of bench-testing media samples, both pre-treatment baseline and post-treatment confirmatory samples, as well as sub-slab vapor and air quality samples prior to and after the remedial action.

All media sampling, and well installation and development, will be conducted in accordance with the QAPP provided in Appendix G. Fieldwork SOPs for sampling soil vapor, air, soil and groundwater are provided in Appendix B. All soil and groundwater encountered during media sampling will be properly characterized and findings will be recorded in logbooks. Sampled material will be obtained in a manner consistent with USEPA and NYSDEC sample collection protocols, using dedicated sampling equipment and gloves, and laboratory-supplied glassware. Additional QA/QC samples will be collected as per the requirements of the QAPP.

3.4.1 Sub-slab Soil Vapor and Indoor Air

A SSDS has been proposed to minimize any potential soil vapor intrusion into the building (see Section 4.2, below). Prior to operation of the SSDS and initiation of ISCO treatment, sub-slab soil vapor and indoor air samples will be analyzed for PCE and its breakdown products to establish pre-treatment baseline data. The SSDS will be temporarily shut down and additional sub-slab vapor and indoor air samples will be collected following the final round of soil sampling that has confirmed that remediation objectives have been reached and at the onset of the next heating season. All samples will be analyzed for PCE, TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride using USEPA Method TO-15.

Soil vapor and air sampling will be conducted in accordance with the NYSDOH *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH Guidance).

Three (3) sub-slab soil vapor and up to nine (9) indoor air samples, including one (1) in each building HVAC zone and all occupied areas (locations to be determined during site mobilization),will be collected over a twenty-four (24) hour period using six-liter stainless steel, laboratory supplied, Summa canisters with 24-hour calibrated flow controllers. A tracer gas (e.g., helium) will be utilized during soil vapor sampling to document the effectiveness of the floor seal and the general sampling methodology. A pre-sampling building inspection will be conducted prior to air sampling to identify any on-site activities and/or materials that may interfere with the sampling, including the presence of materials that contain VOCs. A minimum of four (4) air samples will be collected. One sample will be collected from an exterior, upwind area to document existing ambient air conditions. Three samples will be collected within the building from zones likely to be impacted by vapor intrusion, in areas where human exposures have the greatest potential (see Figure 5 and Appendix F).

3.4.2 Baseline Soil and Groundwater Sampling

Soil and groundwater sampling will be conducted at the Site: 1) prior to the start of the remedial action to establish existing baseline contaminant conditions; and, subsequent to the SE-ISCO fieldwork events to document the effectiveness of the treatment. Boring and well locations are provided on Figure 4.

Soil samples will be collected from the bottom of the boring and at the depth interval with peak PID reading as measured in the field (only one sample will be collected when the peak PID reading occurs at the well bottom). All soil samples will be collected following USEPA 5035 methodology and analyzed for chlorinated VOCs (cVOCs; USEPA method 8260).

Subsequent to installation, all wells will be properly developed, and field data documenting concentrations of dissolved oxygen (DO), CO_2, oxygen release potential (ORP), pH, and conductivity will be documented. A groundwater sample will be collected using USEPA “low-flow” methodology and analyzed for cVOCs (USEPA Method 8260).

Resulting data will be provided to the USEPA in conjunction with routine reporting requirements for this Site. These data will be considered accurate representations of pre-treatment soil and groundwater concentrations of PCE within the hot spot.

4.0 REMEDIATION METHODOLOGY

4.1 Solvent-Enhanced In Situ Chemical Oxidation

4.1.1 System/Well Installation

The OSC will install six (6) chemical solution injection wells around two (2) extraction wells. The extraction wells will be located in the center of the contaminant plume/treatment area; injection wells will be located at the perimeter of the treatment area, equidistant from each other and the extraction wells. The proposed locations of the system wells are presented on Figure 5 – Chemical Oxidation Fieldwork Map. A detailed SOP for well installation and development is included in Appendix B.

Previous investigations generally documented groundwater at 10 feet below the building slab in the area proposed for treatment; wells will therefore be installed to approximately 20 feet below the slab, with 10 feet of screening from the invert of the boring followed by solid casing extended to the surface. Maximum well depth and screening interval will be adjusted, as warranted by conditions encountered in the field (e.g., depth of saturated soils), to ensure proper system operation.

Each well location will be properly marked within the structure and a determination of subgrade utilities will be made prior to intrusive activities. Borings will be extended using a track-mounted Geoprobe unit. All wells (injection and extraction) will be constructed of 2” PVC (Schedule 40) well casing with slotted screened casing extending throughout the target treatment zone (saturated soils from approximately 10 to 20 feet below grade). The largest slot size that is compatible with the texture of subsurface materials will be utilized. Clean, porous material (e.g., silica sand) will be placed in the annulus surrounding the screen and the first foot of the upper solid casing, and the remaining riser piping will be properly grouted in place. The wells will be finished just beneath the building floor and be protected by gripper caps and flush-mounted protective covers.

4.1.2 Design Parameter Evaluation Methodology

The ISCO subcontractor will conduct a design parameter evaluation (DPE, aka “bench test”) prior to the start of fieldwork, utilizing samples of Site soil and groundwater. The objectives of the DPE are to observe reactions that take place following the application of ISCO reagents to Site media (soil and groundwater) and develop a site-specific, optimized reagent formulation. DPE SOPs are provided in Appendix I.

The biodegradable solvent (d-limonene), dissolved a various concentrations of water, will be evaluated first to select a stable concentration that can be optimally applied without coagulation (maximum concentration 8%).

The ISCO subcontractor will then utilize an empirical Oxidation Estimating Tool (OET©) model (populated with site-specific geochemical, geophysical and contaminant mass information provided by the OSC) to predict both the optimum concentrations and total mass of reagents to be used for the treatment. Using the output from this model, reagents will be applied to groundwater and saturated soil from the Site (provided by the OSC) within four stainless steel and glass columns.

Treatment solutions will be introduced into three of the columns (one column will be untreated and serve as a control). Water from the site will be circulated from the bottom of each column at a rate to simulate the anticipated groundwater flow velocities based on a 1 gallon per minute (gpm) exfiltration rate at the well head. Once recirculation is achieved, the designed solvent concentration will be introduced into the system and recirculated for a period of 8 hours. Upon completion, recirculation will be discontinued for a minimum of 8 hours in order to simulate actual site conditions, and the columns will be inspected for visual evidence of polymerization or coagulation. If any adverse condition exists, the system will be retested using diluted concentrations, until coagulation is no longer observed. In the absence of any evidence of coagulation, the oxidation program will be commenced.

The oxidation program begins with NaOH titration of the recirculating water with dissolved solvent, maintaining a range of pH 10.5 to 11.5. Once the pH is stable, 0.5X, 1X and 2X the modeled concentration of sodium persulfate will be added to the three treatment columns, respectively. This solution will be recirculated through the columns for 8 hours each day for 5 days. Each day the solution will have the pH adjusted to maintain the range.

Following completion of the DPE, the ISCO subcontractor will submit four soil and four groundwater samples (3 test samples and 1 control sample) to the subcontracted laboratory for analysis of cVOCs (USEPA Method 8260). Laboratory results will be used to select the optimum concentration that can be efficiently applied, and to recalibrate the OET model for the total mass of reagents that will be required to achieve the treatment objectives.

Observations and results from the bench testing will be provided to USEPA; a re-evaluation of the Design Summary will be conducted to either confirm or support a modification of the design parameters and calculations. The ISCO subcontractor will prepare a final report, which will document the DPE procedures and observations, and will provide a revised ISCO reagent dosage for the field application.

4.1.3 ISCO Fieldwork Methodology

The following procedures are applicable to the methodology for in-situ treatment in saturated soils using biodegradable solvents and oxidants (see SOPs in Appendix I, including protocols for spill response and handling waste materials). Unless otherwise notes, all activities are to be performed by the ISCO subcontractor.

Pre-Application Activities

Prior to the initial mobilization to the field, a project team kick-off meeting will be conducted to review the scope of work, the pre-application checklist, the roles and responsibilities of project team members and schedule of events during the ISCO application program. The OSC will be responsible for: meeting relevant notification requirements; coordinating installation of 2"diameter PVC injection/extraction wells, screened through the targeted soil interval; and pre-treatment baseline soil and groundwater sampling (see Section 3.4.2).

Material Delivery

The design quantity of reagents will be delivered to the Site:

- D-limonene (100%): 55gal drums;
- Sodium hydroxide (25%; liquid): 55 gal drums or 330-gal totes;
- Sodium persulfate (granular): in 55 lb. bags or 2000 lb. "supersacks"

Chemical reagents will be off loaded using drum dollies, pallet-jacks and/or a forklift, and be staged near the treatment area and covered with plastic sheeting or other appropriate material.

In-situ Chemical Application and Recirculation

Groundwater will be extracted from two monitoring wells near the center of the hot spot using downhole stainless steel pumps at each targeted horizon. A sustainable pumping rate will be determined to minimize associated drawdown. Extracted groundwater will be used for makeup water to prepare reagent solutions. During extraction activities, the OSC will provide field support in monitoring the drawdown and rate of recovery to assist the ISCO subcontractor in the determination of extraction and application rates for treatment.

The following activities will occur:

- Placement of application wellheads in the injection wells, and connection of extraction wellheads to the reagent distribution manifold and pumps at the reagent mixing area (wellhead assemblies consist of a stainless steel riser pipe fitted with a ball valve and a pressure gauge, with a connection to the distribution manifold and to a vent relief tube);
- Mixing of reagents (using extracted groundwater) in chemical resistant mixing tanks;
- Application of ISCO reagents using recirculation by continuous extraction of groundwater from extraction wells and simultaneous application of reagents through the SE-ISCO application wells (flow rate of 1-2 gpm per application well) - design quantities of SE-ISCO reagents will be applied in the following sequence:

1. D-limonene distributed during the first day;
2. Sodium hydroxide (25%; liquid) applied during the subsequent day until the extracted water achieves the design pH of 10.5;
3. Sodium persulfate (granular): applied at the design concentration and recirculated until the extracted water achieves targeted concentration; and,

- Monitoring of field conditions during the application process.

In-Situ Concentrations

The target ranges for in-situ conditions from the treatment (pre-bench testing values) are expected to be in the following ranges:

D-limonene - 4% to 8%	*Increased conductivity*
Persulfate - 0.5% to 2.0%;	*No substantial temperature increases*
ORP 100 to 500 millivolt (mV)	*DO may be increased*

Field Documentation

The ISCO subcontractor will maintain a field activity logbook during the SE-ISCO application program. Entries will be made in waterproof ink. In the case of an error, corrections will be made by crossing a single line through the incorrect information, entering the correct information, and initialing and dating all entries. Information to be documented includes: site name and project number; date and weather; phase of work; name of personnel on-site; daily planned scope of work; description and quantities of fluids added; and observations of activities.

4.1.4 Assessment of System Effectiveness

The effectiveness of the proposed remedial action will be assessed by the collection and analysis of post-treatment soil and groundwater samples for cVOCs using USEPA Method 8260. Post-treatment soil and groundwater data will be evaluated to determine whether a second application round is necessary. Fieldwork SOPs for soil and groundwater sampling are provided in Appendix B.

Post-treatment Soil Sampling

Weekly evaluation of the presence of sodium persulfate in the wells will occur after the initial application. Once the oxidant is inactive (i.e. not detected through use of field chemical kits), post-treatment soil and groundwater sampling can be conducted. After completion of the ISCO treatment, a minimum of ten (10) sub-surface soil samples (five within and five outside the treatment area) will be collected to document concentrations of PCE and other chlorinated VOCs. The goal of the soil sampling

is to collect post-treatment data that can usefully be compared to baseline, pre-treatment soil data (collected during installation of the wells). Proposed, potential sampling locations are shown on Figure 5, Appendix A. Boring locations were chosen to fully characterize post-remedial soil conditions both inside of the treatment area (nearest the hotspot) and outside of the treatment area.

Soil borings will be extended to depths equivalent to corresponding to pre-treatment sampling locations. Sampling will be based on the assessment of each interval, with samples collected from the interval(s) with the greatest field indications of contamination. In the absence of significant overt contamination, samples will be collected from the interval(s) matching the depth of pre-treatment sampling conducted at the nearest well location.

Sampling results will be provided to USEPA for review and evaluation. At this time it is anticipated that if concentrations of PCE and other chlorinated VOCs are detected at or below the site-specific clean-up objectives, additional ISCO applications will not be performed. If PCE and other chlorinated VOC concentrations are detected at concentrations in excess of the site-specific clean-up objectives, an additional round of ISCO treatment may be performed four to five weeks after the initial application, with confirmatory sampling (minimum of four samples) to be conducted after confirming through field testing that the oxidant is inactive.

Post-treatment Groundwater Sampling

Groundwater samples will be collected using low-flow methodology from the on-site extraction and injection wells that were previously used for the collection of baseline, pre-treatment samples. Final sampling locations will be confirmed in the field.

4.2 Soil Vapor Management

Proposed remedial activities include the installation and operation of a Sub-slab Depressurization System (SSDS). The system was designed and will be tested per the NYSDOH Guidance and the USEPA *Indoor Air Vapor Intrusion Mitigation Approaches*, October 2008, before the initiation of remediation activities. The primary purpose of the SSDS is to prevent sub-slab soil vapors (generated within the treatment area) from entering the interior of the building. The locations of potential permanent vacuum pressure/soil vapor monitoring points are shown on Figure 5 (and Figure 2 of the SSDS design report), and the SSDS design report and equipment specifications are provided in Appendix D.

4.2.1 SSDS Specifications

One SSDS is anticipated within the treatment area. The final design of the SSDS includes the following components: concrete building slab, sub-slab penetration points, a vertical riser and chaser pipes to connect the penetration points and piping to an above-grade fan, and sub-slab monitoring points to

periodically test vacuum pressure beneath the slab and monitor soil vapor to assess effectiveness of the SE-ISCO treatment system. Sub-slab conductivity testing, including sub-slab pressure flow, will aid in confirming the number and location of penetration points, pipe layout and other components, fan size, and permanent vacuum pressure/soil vapor monitoring points. All floor penetration points will connect to an above-grade vertical riser for the system.

The proposed final design for the system was determined based on a building survey; initial sub-slab conductivity testing results will be used to confirm and/or modify the design as warranted. The SSDS for the treatment area will consist of the following:

Four (4) floor penetrations will be extended beneath the building slab in the treatment area (see Appendix D, Figure 2). The concrete floor will be cut and a hole will be extended beneath the slab base with final dimensions of 12” deep, 12” wide and 12” long (the SSDS Design Document, Appendix D, allows for 12” minimum diameter by 8” minimum depth suction pits). All original soils will be excavated, containerized and tested for volatile organic compounds (VOCs) prior to final disposition.

One 4” PVC pipe will be inserted into the floor penetration and surrounded by a porous medium (minimum ½” stone). The concrete floor will be restored and properly sealed around the pipe to prevent infiltration of vapors into the building as well as movement of air from the building into the sub-slab. The 4” PVC pipe will be plumbed to the exterior of the building and connected to a fan with sufficient draw to establish vacuum throughout the treatment area.

With the fan operational, a minimum of two permanent vacuum pressure/soil vapor monitoring points will be established to periodically assess vacuum pressure beneath the slab in the treatment area. Implants will be mounted in accordance with the manufacture’s recommendations, and be located such that vapors will be collected at approximately 2” below the bottom of the building slab. The selected sampling technology and installation methodology will be reviewed with USEPA prior to installation. Vacuum levels between 0.025 to 0.035 inches of water at the perimeter of the system will be considered sufficient evidence of effective vacuum throughout the treatment area. Perimeter vacuum pressure will be measured with both the HVAC system on and off to ensure that its operation does not have a negative impact on the vacuum pressure and reduce the effectiveness of the SSDS. The fan(s) will be hard-wired to a dedicated breaker and a visual pressure indicator will be installed in each vertical riser to alert site personnel of system failure.

4.2.2 Sub-slab Depressurization System

Post-treatment sub-slab soil vapor samples will be collected, in order to document that vapor concentrations have been reduced to a level that would not impact indoor air at unacceptable levels, with the initial round conducted during the first heating season. Results of this initial sampling will be

reviewed with USEPA to determine the need for additional rounds of sampling. Once sampling results do not exceed EPA risk-based screening levels for PCE and its breakdown products, then operation of the SSDS system will be evaluated for transition from an active to a passive system and a monitoring program will be instituted. If, however, the sub-slab soil gas and indoor air concentrations are higher than the screening criteria cited, the systems will be re-started and a long-term monitoring plan be developed (e.g., leaving the SSDS in place as a passive system).

5.0 DOCUMENTATION OF SITE REMEDIATION

The OSC will provide periodic Interim Remedial Monitoring Reports documenting the in-situ treatment of soil beneath the existing building. These reports will include, as applicable for the reporting period: documentation of the installation of the SSDS system; monitoring of sub-slab soil vapor; in-situ treatment events; post-treatment soil results; documentation of the effectiveness of the treatment; and, recommendations regarding the SSDS system and any future actions needed to address this portion of the Site. Interim monitoring reports will be submitted semi-annually for the first three years and annually thereafter. A report will be submitted within 30 days after installation of the soil treatment system and upon completion of baseline soil and groundwater sampling; a separate report will be submitted within 30 days after post-treatment soil and groundwater sampling occurs for each application.

5.1 Final Engineering Report

A Final Engineering Report (FER), stamped by a NYS registered and licensed engineer, will be prepared at the completion of all in-situ soil treatment in order to document Site remediation. This FER will document the proper handling, removal, and off-site disposal of any wastes requiring special handling, and will include applicable laboratory reports and maps illustrating Site closure activities.

5.2 Operations, Management and Maintenance Plan

Since the northern and southern hot spots (addressed through previous remedial action for surface soils) contained contaminated soils above the clean-up objectives, and contaminated groundwater will remain beneath the Site after completion of the Remedial Action, engineering controls (ECs) and institutional controls (ICs) will be required to protect human health and the environment. An Operations, Management and Maintenance (OMM) Plan, providing detailed procedures for the long-term management of EC/ICs and any remaining contamination at the Site after completion of the Remedial Action, will be prepared for review and approval by USEPA.

6.0 SCHEDULE

WCD is prepared to implement the Phase I RAWP within thirty days of approval from the USEPA. The following preliminary project schedule is presented:

WALLKILL WELLFIELD: PHASE I – SOIL REMEDIATION IMPLEMENTATION SCHEDULE		
MONTH	**ITEM / TASK**	**BY WHOM**
0	USEPA Approval of RAWP/RDD	USEPA
1	ISCO Contractor Notification and Mobilization	OSC
1-2	Set Up Indoor Air Monitoring System	OSC
2	Design Parameter Evaluation	ISCO Subcontractor
2	Sample Baseline Media* (soil vapor, air, soil and groundwater)	OSC
3	Installation of Soil Treatment System	ISCO Subcontractor/OSC
3	Indoor Air Quality Monitoring – Initial Invasive Activities	OSC
TBD	Installation of SSDS	OSC
3	Evaluate Baseline Data	OSC/USEPA
3	Finalize Design Parameters	ISCO Subcontractor
4	First Chemical Solution Injection/Application	ISCO Subcontractor
8	Post-injection Sampling* (soil vapor, soil and groundwater)	OSC
8	Post-Injection Soil Vapor Sampling*	OSC
9	Second Round of ISCO Treatment, if required	ISCO Subcontractor
12	Post-injection Soil Sampling (If necessary)#	OSC
Ongoing	Soil Vapor and Indoor Air Monitoring	OSC
TBD	Decommissioning of Sub-slab Depressurization System	ISCO Subcontractor
Ongoing	Submission of Interim Remedial Monitoring Reports	OSC

Notes: TBD – to be determined; # –laboratory results to be provided to USEPA within 3 days of receipt