SoundEarth Strategies, Inc.
2811 Fairview Avenue East, Suite 2000
Seattle, Washington 98102

WORK PLAN

IN SITU CHEMICAL OXIDATION PILOT TEST

Avtec Property
3400 Wallingford Avenue North
Seattle, Washington
PN: 0789-004

August 20, 2013

INTRODUCTION AND OBJECTIVE

SoundEarth Strategies Inc. (SoundEarth) has prepared this In Situ Chemical Oxidation Pilot Test Work Plan (the Work Plan) to evaluate in situ chemical oxidation by potassium permanganate as a potential cleanup action alternative.

The objective of the pilot test is to evaluate the effectiveness of injecting permanganate solution as an in situ remedy. Results of the pilot test will be used to optimize injection well spacing, rates of injection, and injectate concentrations needed to provide sufficient groundwater treatment. A site plan showing the locations of the monitoring wells that will be used for the pilot test is attached (Figure 1).

The test design rational and field program for the Work Plan include:

- Pilot test components and design.
- Short-term permanganate injection into the subsurface.
- Post-injection monitoring to evaluate the effectiveness of the chemical oxidation pilot test.

This Work Plan also includes:

- Waste disposal methods.
- Data analysis and documentation.
- Schedule of when the work will be performed.
- Project contact information and key personnel.

PILOT TEST COMPONENTS AND DESIGN

The pilot test is designed to evaluate the radius of influence of the permanganate solution and impact on groundwater quality. During the pilot test, a known volume and concentration of permanganate solution will be injected into four wells. Following the injection, contaminants of concern concentrations and groundwater quality parameters will be measured in each of the injection wells. Additionally, three observation wells (MW1, MW15 and MW07) will be monitored quarterly for manganese, pH and permanganate color (purple) to assess oxidant migration. If necessary Ferrous Ammonium Sulfate kits

may be employed to measure permanganate concentration. All post-injection monitoring data will be compared to pre-injection data to assess the efficacy of permanganate injections.

Monitoring wells MW03, MW04, MW12 and MW13 will be employed as the injection wells, and monitoring wells MW1, MW07 and MW15 will be used to monitor groundwater conditions before and after injections. The proposed injection wells vary in depth from 35 to 50.5 feet and are constructed of 2 inch diameter schedule 40 PVC. The injection wells are located on the North side of North 34th Street and the observation wells on the South side (Figure 1). Based on the results of a slug test, the horizontal hydraulic conductivity is approximately 9.5 x 10^{-3} centimeters per second.

PERMANGANATE INJECTION

A portable injection system will be used to inject the 4 percent permanganate solution. The portable injection system consists of a 150-gallon mixing tank where the solution will be mixed in batches, and injected into monitoring wells MW03, MW04, MW12 and MW13. The flow rate and pressure at which the solution is injected into each well will be documented. A maximum volume of 600 gallons (4 individual batches) will be used for the pilot test. An Underground Injection Control (UIC) registration was submitted to the Washington State Department of Ecology (Ecology) and approved on August 19, 2013. Ecology issued the site UIC number 32207 and a copy of the UIC registration approval is attached.

The permanganate solution will be injected into the injection wells at relatively low pressures (e.g., 5 pounds per square inch), and will not exceed a maximum pressure of 30 pounds per square inch.

Monitoring of groundwater conditions during injection will include the following elements:

- Wellhead pressures will be continuously monitored during injection to minimize the risk of failure of the well seal.
- A flow rate (in gallons per minute) will be periodically measured. If the flow rates appear to be changing or fluctuating during the injection, frequency of the flow rate measurements will be increased.
- Monitoring well water levels will be manually monitored on a periodic basis using a water level indicator.

Permanganate injections will continue until one of the following criteria is met:

- A total of 600 gallons is injected over a maximum period of 5 hours.
- After 3 hours of continuous injection at very low injection rates (less than 0.5 gallons per minute) if well construction or receptor soil hydraulic characteristics limit the rate of injection.
- The well seal fails.
- Injection solution comes to the surface.

POST-INJECTION MONITORING

Post-injection monitoring will occur three weeks after completion of the pilot test.

Post-injection monitoring will include the following elements:

- Measuring groundwater levels all observation (MW1, MW07 and MW15) and injection (MW03, MW04, MW12 and MW13) wells.
- Measuring field water quality parameters and documenting the presence of any color changes in the water in all observation and injection wells.
- Obtaining groundwater samples for analysis of chlorinated volatile organic compound (CVOCs), total and dissolved manganese.

Low-flow sampling techniques will be used to purge and sample the wells, and for measuring field water quality parameters. Water quality parameter measurements will include pH, temperature, specific conductivity, turbidity, dissolved oxygen, and redox potential. In addition, qualitative descriptions of the groundwater color will be documented in the field records.

The groundwater samples will be transported directly to the analytical laboratory under SoundEarth's chain of custody procedures for analysis of CVOCs using United States Environmental Protection Agency (EPA) Method 8260C and for total and dissolved manganese, by EPA Method 200.8. Quality control sampling will consist of one field duplicate sample.

All samples will be submitted for normal 2-week laboratory turnaround times. Analytical laboratory services will be provided by Friedman and Bruya, Inc., located in Seattle, Washington.

WASTE DISPOSAL

Well purge water and decontamination water will be drummed on site and disposed of properly.

Personal Protective Equipment and other non-hazardous investigation-derived waste will be disposed of in existing on-site waste containers (i.e., dumpsters).

DATA ANALYSIS AND DOCUMENTATION

Data compilation and analysis will include the following:

- Tables with field quality parameters, field observations, and laboratory analytical results.
- Tables with cumulative flow and flow rate.
- Water-level measurements.
- Copies of the data collection forms.
- Field measurements of permanganate concentrations and a plot of concentration versus gallons.
- Charts showing trends of field parameters and/or analytical results from the pilot test.
- Laboratory analytical reports.

- Preliminary analysis of pilot test results including summary of injection radius of influence, rates of injection, and injection solution concentrations.
- Comparison of pre- and post- injection groundwater quality.

The results of the pilot test will be included in a Pilot Test Report.

SCHEDULE

We anticipate initiating the pilot test September 2013. The pilot test will be completed in 4 working days. Post-injection monitoring of groundwater conditions and the seep discharge will be completed approximately 3 weeks after the completion of the pilot test.

Laboratory analytical results are anticipated to be received within 10 working days of submitting the samples to the laboratory. Data compilation and evaluation will be completed within 2 weeks after completing the post-injection monitoring. The results of the pilot test will be presented in a Pilot Test Report.

PROJECT CONTACT INFORMATION AND KEY PERSONNEL

Project Contact for Property Owner:

Jorge Valladares III
Avtec Tyee Inc.
6500 Merrill Creek Parkway
Everett, Washington 98203

kpb1951@hctc.com

The Senior Project Manager for SoundEarth is:

John Funderburk
SoundEarth Strategies, Inc.
2811 Fairview Avenue East, Suite 2000
Seattle, Washington 98102

(206) 306-1900

jfunderburk@soundearthinc.com

The Project Manager for SoundEarth is:

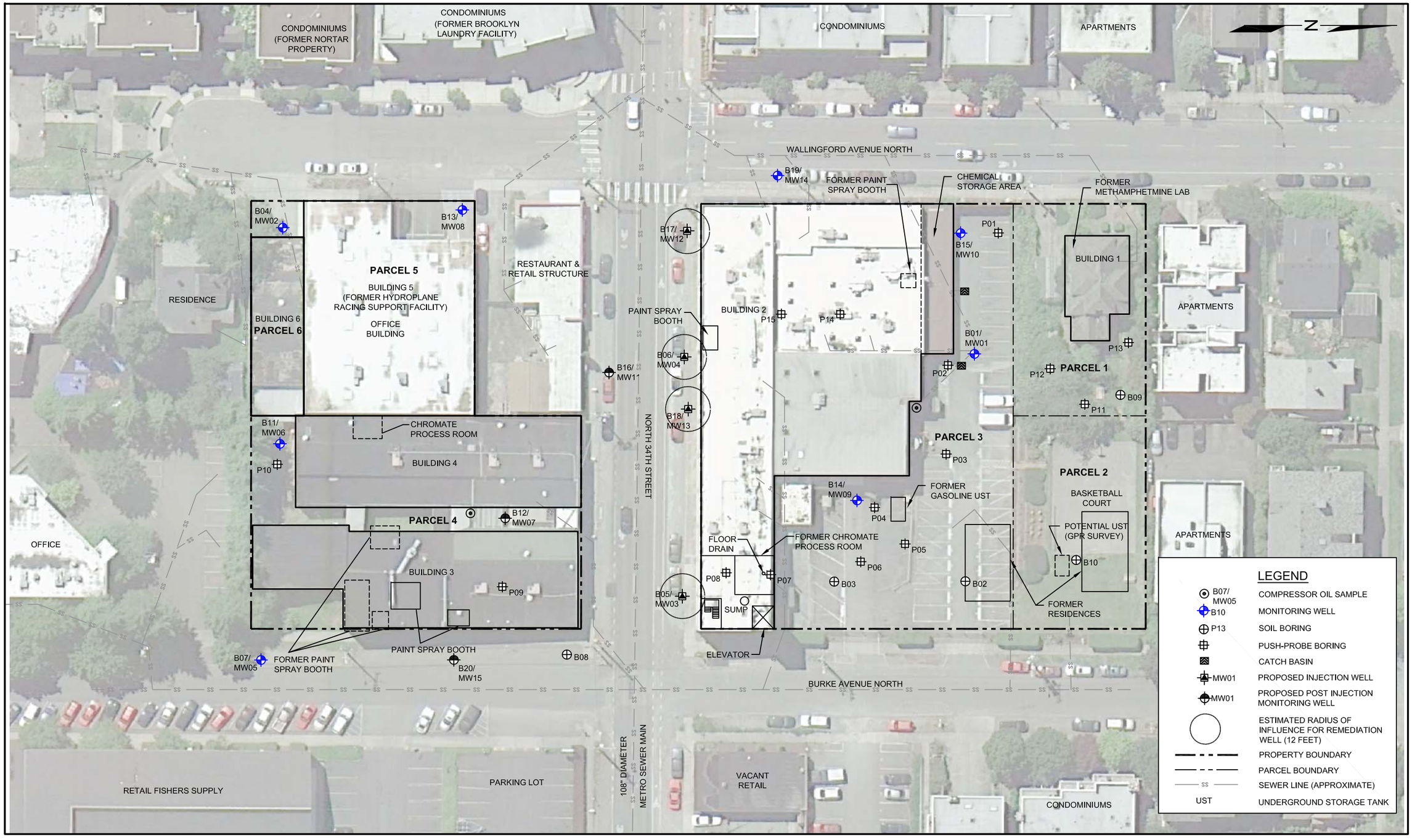
Rob Roberts
SoundEarth Strategies, Inc.
2811 Fairview Avenue East, Suite 2000
Seattle, Washington 98102

(206) 306-1900

rroberts@soundearthinc.com

ATTACHMENTS

Figure 1, Chemical Oxidation Pilot Test Potassium Permanganate Injection
Field Form
UIC Registration Authorization No. 32207



SoundEarth Strategies
WWW.SOUNDEARTHINC.COM

DATE: 07/25/13
DRAWN BY: NAC/BLR
CHECKED BY: RMT/WMC
CAD FILE: 0789-004_2013_UIC_PCI

PROJECT NAME: AVTECH PROPERTY
PROJECT NUMBER: 0789-004-02
STREET ADDRESS: 3400 WALLINGFORD AVENUE NORTH
CITY, STATE: SEATTLE, WASHINGTON

REGION:

0 25 50 100
APPROXIMATE SCALE IN FEET

FIGURE 1
CHEMICAL OXIDATION PILOT TEST
POTASSIUM PERMANGANATE INJECTION

7/29/2013
P:\0789 AMLI RESIDENTIAL\0789-004 AMLI AVTECH\TECHNICAL\GRAPHICS\20132013 ISCO PT\0789-004-2012_UIC_F.DWG
SOUNDEARTHINC.COM

SoundEarth Strategies

In Situ Chemical Oxidation Pilot Test
Injection Field Data Sheet

Avtec Property
3400 Wallingford Avenue North
Seattle, Washington
SoundEarth PN: 0789-004

Date: _____

Well ID	Batch Characteristics			Injection Start Time	Injection Stop Time	Total Volume Injected (gal)	Estimated Flow Rate (gpm)	Injection Wellhead Pressure (psi)	Notes/Comments
	Mass $KMnO_4$ (lb)	Total Volume (gal)	Permangante Concentration (%)						

Notes: _____

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47600 • Olympia, WA 98504-7600 • 360-407-6000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

August 19, 2013

Jorge Valladares III
Avtech Tyee Inc.
6500 Merrill Creek Parkway
Everett, WA 98203

RE: Registration with the Underground Injection Control (UIC) Program, Avtech Corporation, 3400 Wallingford Ave. N., Seattle, WA

Dear Mr. Valladares:

This letter is to acknowledge receipt of your registration form received July 30, 2013 to register the above-mentioned site with the UIC Program. The project will include:

- A one- time injection of 600 gallons of potassium permanganate mixed with water, four percent solution, into each of the following UIC wells, MW-03, MW-04, MW-12, and MW-13.
- Monitoring results will determine if subsequent injection concentrations are needed but Ecology notification is required prior to the additional injections.
- The project will begin in August 2013 and can continue through August 2014 if needed.
- Down gradient groundwater monitoring for manganese will occur in MW-07, MW-11, and MW-15. If manganese sampling results exceed the Water Quality Criteria for Ground water of the State of Washington, chapter 173-200 WAC (GWQS) at monitoring wells located close to the property or plume boundary than future injections must stop till the levels drop below the criteria.

Clean up actions/sites that are not approved by WA State Department of Ecology under the Model Toxics Control Act (MTCA), chapter 70.105D RCW or approved by the United States Environmental Protection Agency under the Comprehensive Environmental Response Compensation and Liability Act, 42 U.S.C. 9601 et seq are required to meet the GWQS. The injected compounds are intended to improve groundwater quality. There are inherent environmental risks associated with injecting compounds into groundwater. Carefully characterize, manage, and monitor the site to minimize risk and prevent unforeseen degradation of groundwater quality. Mobilized metals or other substances, injected chemicals or hazardous bi-products, are not allowed to migrate beyond the site property boundary. A thorough discussion of risk and management options is provided in the following document: *Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater,* June 2005, prepared by Interstate Technology and Regulatory Cooperation Work Group. This document is available on the internet at: http://www.itrcweb.org/Documents/ISCO-2.pdf.

The two UIC Program requirements for rule authorization are, registration of UIC wells (prior to use) and the discharge from the well must meet the nonendangerment standard, of WAC 173-218-080. The UIC site is number 32207. Listed below are the minimum requirements to meet the nonendangerment standard. Your site is conditionally rule authorized when the following have been met:

- Meet the groundwater quality standards, chapter 173-200-WAC;
- Complete a thorough site characterization including: geologic investigation, concentration and extent of contaminant plume, aquifer characteristics, and location of preferential migration pathways (natural and manmade);
- A groundwater monitoring program that includes: well location and sampling sufficient to characterize the background groundwater quality, the water quality at the point of compliance, and identify any changes in groundwater quality resulting from the injected compounds;
- Develop a conceptual site model that balances the injection rate, concentration, and total mass of injected compound with that of the subsurface oxidizable material. The model should predict the expected changes in groundwater chemistry over time, final groundwater quality at the point of compliance, and predicted restoration timeframe;
- Hydrologically contain within the site property boundaries, the injected compounds and any regulated substances mobilized by the injected products;
- Prepare a written contingency plan that describes, in detail, the actions to be taken in case of spills, failures, equipment breakdowns and/or unforeseen environmental degradation caused by the cleanup activities; and,
- Retain all plans, modeling, monitoring results, interim and final reports. Upon request, provide these documents to the Department of Ecology.

If ground water quality does not meet the Ground Water Quality Standards at the point of compliance, you must notify the Department of Ecology within 24 hours of discovery.

At any time, the Department of Ecology may require you to apply for and obtain a Waste Discharge Permit for the continued use of these compounds to promote In Situ Chemical Oxidation.

A formal approval for this project may be obtained through the departments' State Waste Discharge Permit Program or the MTCA Program.

Please call me at (360) 407-6143 if you have any questions. Additional information on the UIC Program can also be found at our website http://www.ecy.wa.gov/programs/wq/grndwtr/uic/index.html

Sincerely,

MSHansen

Mary Shaleen-Hansen
UIC Coordinator
Water Quality Program

Cc: Ashley Elliott, SoundEarth Strategies Inc.