REVISED SOIL VAPOR EXTRACTION PILOT TEST
WORK PLAN ADDENDUM

Former Loomis Chemical Warehouse Site
955 North Columbia Boulevard
Portland, Oregon

Submitted to:
Oregon Department of Environmental Quality
Northwest Region
1550 NW Eastman Parkway, Suite 290
Gresham, Oregon  97030-3850

Submitted by:
AMEC Earth & Environmental, Inc.
7376 SW Durham Road
Portland, Oregon  97224

On Behalf of:
Columbia Development, Inc.
1367 West Broadway #504
Vancouver, B.C.  V6H 4A7

6-61M-088974 Phase 6

November 2009
November 30, 2009

6-61M-088974 Phase 6

Mr. Paul Seidel
Project Manager
Oregon Department of Environmental Quality
Northwest Region
1550 NW Eastman Parkway, Suite 290
Gresham, Oregon 97030-3850

Dear Mr. Seidel:

Re: Revised Soil Vapor Extraction Pilot Test Work Plan Addendum
Former Loomis Chemical Warehouse
955 North Columbia Boulevard
Portland, Oregon

On behalf of Columbia Development, Inc. (CDI), AMEC Earth & Environmental, Inc. (AMEC) is pleased to provide this revised work plan for a soil vapor extraction (SVE) pilot test to evaluate the potential effectiveness of SVE to recover volatile organic compound (VOC) vapors from the vadose zone and to provide data necessary to design a full scale system at the Former Loomis Chemical Warehouse in Portland, Oregon (Site). The work plan originally was submitted to the Oregon Department of Environmental Quality (DEQ) on October 13, 2009. This revised work plan was prepared in response to DEQ comments provided on October 27, 2009.

The SVE Pilot Test Work Plan has been revised to address all DEQ comments except the following:

- DEQ requested indoor air sampling to assess baseline conditions in the Site building. This request is unrelated to the SVE pilot test and will be discussed with DEQ separately.

- DEQ suggested the use of larger diameter (2- or 4-inch) rather than the 1-inch wells described in the Work Plan. AMEC believes that 1-inch wells will be sufficient to: 1) assess the effect of the system on the subsurface during the pilot test; and 2) to adequately remove vapors during full-scale system implementation. If this opinion changes as a result of data collected during the pilot test, AMEC will consider the use of larger diameter wells in the full-scale SVE system design.
If you have any questions or need further information, please do not hesitate to contact the undersigned at (503) 639-3400.

Sincerely,

AMEC Earth & Environmental, Inc.

Carrie Rackey, CHMM    Leonard C. Farr, Jr., R.G.
Environmental Scientist    Senior Associate

Attachments

CR/cw

c: Nick Schmaling, Columbia Development, Inc.
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1.0 INTRODUCTION

This Revised Soil Vapor Extraction (SVE) Pilot test Work Plan (Pilot WP) has been prepared to support the installation of soil vapor extraction points that will be used to evaluate the potential effectiveness of SVE to recover volatile organic compound (VOC) vapors from the vadose zone and to provide data necessary to design a full scale system at the Former Loomis Chemical Warehouse property (Site) located at 955 North Columbia Boulevard in Portland, Oregon. The SVE Pilot WP was developed by AMEC Earth & Environmental, Inc. (AMEC) on behalf of Columbia Development, Inc. (CDI) based on Oregon Department of Environmental Quality (DEQ) comments dated February 17, 2009 on AMEC’s February 2009 Soil Gas Assessment Report, DEQ comments on the SVE Pilot test Work and October 27, 2009, and correspondence via telephone and email.

The purpose of this SVE Pilot WP is to outline the locations, depths, and methodologies associated with the installation of four new permanent SVE wells, and to provide the standard procedures that will be performed to complete the SVE pilot test.

2.0 NATURE AND EXTENT OF COI IMPACTS

No impacts to surface or subsurface soil have been confirmed by analyses performed on soil samples collected from explorations at the Site or on adjoining properties. The VOCs tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) have been detected in groundwater beneath the Site and are considered the Site-related constituents of interest (COIs). The greatest degree of groundwater impact has been encountered between 25 and 40 feet below ground surface (bgs).

Historical investigations have indicated that the dissolved-phase VOC plume originates near the center of the Site and potentially extends up to 750 feet beyond the Site’s western property boundary. Land use west of the Site includes a neighboring cemetery and a right-of-way easement next to Highway Interstate 5 (I-5).

Soil gas samples were collected in August 2007, September 2008, and August 2009 from sampling points located at 3 to 8 feet bgs and from 15 to 20 feet bgs. Soil gas sample analysis identified TCE at concentrations above the “no risk” site-specific risk-based concentration (RBC) of 100 micrograms per cubic meter (µg/m³) and the “potential risk exists” Site-specific RBC of 1,000 µg/m³ recommended by DEQ in multiple samples from both depth intervals during each sampling event. Detected PCE and cis-1,2-DCE concentrations were below soil gas screening values calculated for...
the Site in all soil gas samples. Vinyl chloride was not detected in any of the soil gas samples collected.

Figures 1 and 2 show TCE isoconcentrations for groundwater and soil gas. TCE concentrations in groundwater samples from shallow sampling intervals (ranging from 25 to 45 feet bgs) were consistently higher than in the deeper interval; therefore, the shallow groundwater results from the most recent sampling event (May 2007) were used to create the isoconcentration figures. Figure 1 also shows TCE isoconcentrations for soil gas samples collected from the shallow interval (3 to 8 feet bgs). Figure 2 shows TCE isoconcentrations for soil gas samples collected from the deeper interval (15 to 20 feet bgs). The figures also show the location of storm sewers and proposed SVE pilot test wells.

3.0 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) is a summary that describes all of the known or suspected sources of contamination; considers how and where the contaminants are likely to move and routes of exposure (pathways); and identifies who is likely to be exposed to site-related contaminants (receptors). The CSM considers not only the current conditions at the Site, but also reasonably likely future conditions. The CSM was developed in accordance with the DEQ guidance document, *Risk-Based Decision Making for Petroleum Contaminated Sites* (DEQ, 2003) and DEQ’s draft guidance document *Guidance for Assessing and Remediating Vapor Intrusion in Buildings* (DEQ, 2009). The CSM is depicted on Figure 3.

Source

Based on soil, groundwater, and soil gas investigations conducted at the Site, VOCs have been identified as COIs. Groundwater and soil gas sampling at the Site has demonstrated elevated concentrations of the VOCs TCE, PCE, cis-1,2-DCE, and VC.

Soil sampling has not identified the location of VOC impacts to Site soil. Given the volatile nature of the COIs historically used at the Site and the length of time since the potential releases would have occurred, it is likely that historical VOC impacts to surface and near surface soils have been significantly reduced by volatilization and natural attenuation. Based on these considerations, soil within 3 feet of the ground surface is not considered a potential source of risk at the Site. As a conservative assumption, soils deeper than 3 feet bgs are considered potentially impacted by COIs and have been retained as a potential source of risk in the CSM.
Receptors

The Site is located in an area of established commercial and industrial development. Based on the industrial zoning of the Site and surrounding area, the land use is not likely to change to more sensitive land use, such as residential, in the future; therefore, residential receptors are not included in the CSM.

A Beneficial Water Use Determination (BWUD) completed by AMEC in 2002 determined that there is no current or potential future use of groundwater for domestic purposes in the immediate Site vicinity. At the request of DEQ, AMEC conducted a door-to-door survey within the immediate vicinity of the Site to assess whether there is any current or future likely use of groundwater. Based on the results of the door-to-door survey, it is unlikely that there will be future use of groundwater for domestic purposes at properties within the immediate vicinity of the Site. The future use of groundwater by nearby properties for industrial purposes cannot be completely ruled out and subsequently has been considered in this CSM.

Based on the zoning for the Site and vicinity and the findings of the BWUD, potential current and future receptors at the Site are limited to indoor and outdoor occupational workers, and construction and excavation workers.

Pathways

The CSM depicted on Figure 3 shows the potentially complete exposure pathways at the Site.

Potential direct exposure to VOCs in soil greater than 3 feet bgs is limited to dust inhalation, ingestion, and dermal contact by construction and excavation workers. Indirect exposure routes to VOCs in soil could include inhalation of outdoor vapors by construction or excavation workers and outdoor and indoor vapor inhalation by occupational workers. The potential leaching of COIs from soil at depth to groundwater has been considered in the CSM, and the vapor inhalation pathway from the groundwater to occupational workers and construction or excavations workers is assumed to be potentially complete.

There are currently no groundwater supply wells in the Site vicinity. The potential for a well to be present on the Site in the future is considered in the CSM. Direct exposure to VOCs in groundwater could include dermal contact, incidental ingestion, and inhalation of vapors by a future occupational worker. Indirect exposure routes to VOCs in groundwater could include inhalation of vapors potentially migrating from groundwater to outdoor and indoor air by current and future occupational workers, and inhalation of vapors in outdoor air by occupational workers and construction and excavation workers. The upper portion of the water-bearing zone beneath the Site is
between 25 and 40 feet bgs; therefore, excavation or construction worker direct contact with groundwater in an excavation will not occur.

4.0 SELECTION OF SVE REMEDIATION METHOD

In telephone conversations with Mr. Seidel and Mr. Gilles of DEQ, AMEC proposed, on behalf of CDI, to implement an SVE system at the Site to reduce elevated VOC concentrations. Site conditions (i.e., volatile COIs, lithology/hydrogeology, and location of plume beneath building), suggest that an SVE system would be the most feasible and timely remedial option to effectively reduce the VOC concentrations in soil gas and groundwater. During telephone conversations in February 2009, DEQ agreed that implementation of an SVE system at the Site would be acceptable.

5.0 DATA QUALITY OBJECTIVES

The objective of the SVE pilot test is to evaluate the feasibility of SVE technology to reduce the concentrations of VOCs in soil gas at the Site. The immediate data quality objectives (DQOs) for the SVE pilot test include:

- Evaluating the radius of influence under a vacuum applied independently within the shallow vadose zone (3 to 8 feet bgs) and the deep vadose zone (between 15 and 20 feet bgs);
- Identifying variances in the subsurface lithology that may affect the full system design;
- Evaluating moisture content in the subsurface soil that may affect system performance;
- Calculating rates of air flow in order to estimate the time required to meet remedial objectives;
- Monitoring the concentrations of VOCs in the recovered air stream and the treated air discharge; and,
- Assessing the effectiveness and feasibility of the SVE pilot system for full-scale design.

These DQOs will provide information necessary for the design of a full scale SVE system.

6.0 SVE PILOT TEST

Upon approval of the SVE Pilot WP from both CDI and DEQ, AMEC will perform the SVE pilot test at the Site to evaluate the effectiveness of SVE recovery of VOC vapors
in the vadose zone. Figure 4 illustrates the proposed locations of four permanent SVE wells to be installed using a direct-push drill rig. The four wells, in addition to the existing well network, will be used to conduct and monitor the SVE pilot test.

The following subsections outline the SVE well locations and installation methods, SVE pilot test system specifications, and sampling procedures that will be implemented at the Site.

6.1 Location

Four SVE pilot test well locations are planned for installation at the Site (Figure 4). Permanent SVE wells will be angle-drilled and installed at the proposed locations, identified as SVE-1S/SVE-1D, SVE-2S/SVE-2D. The top of the angled borings will be located just outside the building in order to position the screened-sections beneath the building foundation. The boring locations are positioned in the area of the Site with the highest soil gas COI concentrations. These four SVE wells, in addition to several existing soil gas and groundwater monitoring wells, will be used to conduct the SVE pilot test. The proposed well are located at intervals that can be integrated with the final full-system design. The purpose of each well proposed for the SVE pilot test is outlined in Table 1.

6.2 SVE Well Installation and Development

Prior to the installation of any SVE well, each location will be surveyed for the presence of underground utilities. Two 3.5-inch angled borings will be advanced by licensed subcontractor Pacific Soil and Water, LLC using truck-mounted, direct-push drilling methods. The top of the angled borings will be located just outside the building in order to position the screened-sections beneath the building foundation. During drilling soil from the borings will be field screened for VOCs using a photoionization detector (PID), and measurements will be recorded in a field notebook.

Two wells will be constructed within each of the angled borings using pre-packed 1-inch diameter schedule 40 polyvinyl chloride (PVC) factory-slotted (0.010-inch) screens and flush-threaded riser. The use of 1-inch diameter wells for the pilot test will provide data that can be used to assess the need for larger diameter wells in the full-scale system design. In each boring, one SVE well will be installed with a shallow screened interval from 3 feet to 8 feet bgs, and one well will be installed with a deeper screened interval from 15 feet to 20 feet bgs. Soil gas sampling indicates detectable concentrations of COIs in both shallow and deep intervals in existing wells at the Site. Placement of SVE well screens at shallow and deep intervals will allow for an evaluation of the system’s ability to reduce COI concentrations in soil vapor in close proximity to the groundwater source and in soil gas beneath the building slab. The
nested wells screened intervals are proposed at depths similar to several of the previously installed nested wells. Several existing wells with screened intervals beneath the building slab and at depths of greater than 15 feet bgs also will be used in the pilot test.

A silica sand pack will extend 1 foot above the screened interval and a minimum of 6 inches below the screened interval. A 2-foot bentonite seal will be placed atop each of the sand packs to eliminate infiltration of ambient or non-sample zone air. This nested well configuration is illustrated in Figure 5.

All monitoring points will be completed with flush-mount highway-grade monuments. The bottom of the monument will be sealed using concrete. Well logs (Field Form B-1, Appendix B) will be completed for each of the wells installed. Ball valves to eliminate ambient air intrusion and hose barbs for attaching sample tubing will be installed at each monitoring point (see Photo 1 below).

![Photo 1: Ball value and hose barb (typ.)](image)

After installation, the wells will be developed by injecting pressurized air (up to 10 pounds per square inch [psi]) at varying flow rates (15 cubic feet per minute [cfm], 10 cfm, and 5 cfm) into the well for a total duration of less than 1 hour.

### 6.3 SVE Pilot Test

The SVE pilot test will be conducted after the SVE wells have been installed, developed, and measured relative to the existing coordinate system. The SVE test will be conducted in accordance with the standard operating procedure (SOP), SOP-1, included in Appendix A.
6.3.1 Baseline Field Parameters

Before beginning the SVE pilot test, baseline field parameters will be measured at each of the newly installed SVE wells and existing monitoring wells included in the study. Baseline field measurements will include depth-to-water (DTW), existing well pressures, and PID readings at each of the wells. Baseline field measurements will be recorded on Field Form B-2, Baseline Measurements (Appendix B).

6.3.2 SVE Pilot Test System Design

A schematic of the SVE pilot test system is presented in Figure 6. A rotron blower, capable of applying a vacuum of approximately 40 inches of water, will be connected to one of the two central test wells, SVE-1S or SVE-1D. A moisture knockout tank will be installed before the blower to remove moisture from the recovered vapors. The moisture knockout tank will be equipped with a valve at the bottom of the tank to recover moisture during the test, if needed. The discharge from the blower will be routed to a carbon treatment system. The carbon treatment system consists of a series of 55-gallon activated carbon air treatment vessels. Three sample ports will be installed along the carbon treatment system for air monitoring at the influent, the midpoint, and the effluent of the carbon treatment.

6.3.3 SVE Test Procedure

The SVE pilot test will be completed by conducting two vacuum tests, one in the shallow vadose zone, and one in the deep vadose zone. A vacuum will be applied at a central well (SVE-1) in each of the zones, and the influence of the pilot test system will be monitored by measuring the vacuum influence in the surrounding wells. The vacuum will be measured using vacuum gages, capable of measuring a change in vacuum of 0.01 inches of water. The vacuum gages will be connected to hose barb fittings situated on the top of the SVE observation wells, similar to that shown in Photo 1, during the SVE pilot test.

For the shallow vadose zone test the vacuum will be applied at SVE-1S. Vacuum will be measured at the extraction well every minute for the first 5 minutes of the test and every 15 minutes thereafter. The vacuum in the surrounding wells will be monitored and recorded every 15 minutes on the Field Form B-3, SVE Test Measurements (Appendix B) throughout the duration of the pilot test. The test will be conducted until the vacuum readings stabilize to within 0.05-inches of water for a 15-minute period, or a minimum of 15 minutes. The stabilization test will be conducted for a maximum of 24 hours. After the initial test period, the blower will be turned off and the wells will be allowed to equilibrate to atmospheric conditions. The vacuum recovery will be monitored within the vadose zone during this time period. The SVE pilot test
procedure will be repeated for the deep vadose zone test and the vacuum will be applied at SVE-1D, following a minimum delay of 1 hour.

Before the moisture knockout tank fills to 1/3 of its total capacity, or once at the end of the test, at a minimum, the volume of condensate in the tank will be measured, the duration of the collection time will be recorded, and the tank will be drained.

Three types of readings will be collected to monitor the performance of the extraction during the pilot test: vacuum, velocity, and VOCs. The measurements will be recorded on Field Form B-3. The readings will be collected concurrently with the measurements at the surrounding wells. The vacuum will be recorded from a vacuum gage situated at the moisture knockout tank. The velocity reading will be collected using anemometer and will be converted to flow rates based on the pipe diameter at the reading location. The VOC concentrations will be monitored using a PID at a sample location after the blower and before the carbon treatment system.

Air recovered from the subsurface during the SVE pilot test will be directed through the carbon treatment system. The recovered air stream VOC concentrations will be monitored using a PID at the influent, midpoint, and effluent sample ports of the carbon treatment system every 30 minutes throughout the duration of the test.

6.4 Sample Collection

A total of four air samples will be collected during the SVE pilot test to profile the SVE system in accordance with SOP-2 in Appendix A. Two air samples will be collected after the vacuum conditions within the shallow vadose zone have stabilized during the SVE test, and two air samples will be collected after the vacuum conditions within the deep vadose zone have stabilized. During each test, one sample will be collected from the SVE influent and one from the SVE effluent. The influent sample will be collected from a sample port located along the influent line (Figure 6) before the carbon treatment system and will represent the recoverable VOC concentrations from the SVE pilot system. The effluent sample will be collected from a sample port located along the treatment system discharge pipe (Figure 6), located after the carbon treatment system, and will represent the VOC concentrations that are discharged to ambient air, if any, during the SVE pilot test.

The air samples will be collected into 6-liter, evacuated, and internally-passivated stainless steel Summa® canisters. All Summa® canisters will be batch certified by the analytical laboratory, ensuring that any residual target analytes from prior canister usage are not present at levels greater than the method detection limits (MDLs).
The Summa® canister will be labeled with the time and date of sampling and the chain-of-custody (COC) will be attached to the Summa® canister.

Prior to collecting the air samples, Field Form B-4, Air Sample Collection Form (Appendix B) will be completed. Observations of meteorological conditions such as barometric pressure, outdoor temperature, humidity, and rainfall will be recorded. The record of the various meteorological parameters may be used to assess the influence that meteorological fluctuations may have on the analytical results.

6.5 Sample Analysis

Each SVE system sample will be analyzed by United States Environmental Protection Agency (EPA) Method TO-15 in Scan Mode for the following COIs: PCE, TCE, cis-1,2-DCE, and VC.

The chemical analysis will be performed off-Site at a fixed laboratory by Columbia Analytical Services (CAS) of Simi Valley, California using a standard 2-week turn-around time.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

All samples will be maintained under proper COC procedures while in the field, until received by the lab. Samples will be transported directly to the contract laboratory or back to the AMEC office at the end of the sampling day. Air samples will be stored at room temperature until shipped. COC forms will be retained with the respective samples at all times and signed and dated appropriately.

8.0 SCHEDULE

Implementation of the SVE pilot test is tentatively scheduled for early January 2010. The installation of the SVE pilot test wells will be conducted on a weekend to avoid disruption of business at the Site. The SVE pilot test will be conducted the weekend following the well installation activities, and will take 1 day.

The results of the SVE pilot test will be submitted to DEQ within 90 days of completion of the study.

9.0 REPORTING

Upon completion of the SVE pilot test, AMEC will prepare a brief feasibility testing report to document field activities, results, and conclusions. AMEC assumes the feasibility report on the SVE pilot test will be submitted to both CDI and DEQ, but no
significant revisions will be required. The report will include, at a minimum, the following:

- SVE well logs;
- Location map of final installation locations;
- Copies of the completed field forms;
- Discussion of any deviations from the procedures described in this SVE Pilot WP;
- Influent/effluent sample analytical results;
- Summary table of SVE pilot test field data; and
- Interpretation of results and findings relative to feasibility of the SVE technology at the Site and potential impacts to design of full-scale system.

REFERENCES

Oregon Department of Environmental Quality (DEQ), 2003. Risk Based Decision Making for the Remediation of Petroleum Contaminated Sites.

Oregon Department of Environmental Quality (DEQ) 2009. Guidance for Assessing and Remediating Vapor Intrusion in Buildings
LIMITATIONS

This work plan was prepared exclusively for Columbia Development, Inc. (CDI) by AMEC Earth & Environmental, Inc (AMEC). The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in AMEC services and based on: i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions and qualifications set forth in this work plan. This work plan is intended to be used by CDI for the 955 North Columbia Boulevard property and vicinity only, subject to the terms and conditions of its contract with AMEC. Any other use of, or reliance on, this report by any third party is at that party’s sole risk.
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Notes:
- **SVE** = Soil Vapor Extraction
- Feet bgs = Feet Below Ground Surface
FIGURES
Notes:
+ This exposure pathway is potentially complete.
- Exposure pathway is not complete.

1 Residential receptors not included due to current and anticipated future zoning/land use.
2 Based on age of potential releases, COI impacts to soil within 3 feet of the ground surface are not considered to pose a
APPENDIX A

Standard Operating Procedures
SOIL VAPOR EXTRACTION TESTING

The following section documents standard operating procedures for a basic in situ SVE feasibility test. Note that this general technology can be used by injecting a gas, extracting a gas, or injecting and extracting a gas. The procedures below detail a basic and often performed extraction type SVE test.

The procedures for a basic SVE feasibility test are as follows:

- **Test Equipment and Calibrate** - Test all equipment and battery charges before going into the field. Calibration of the volatile organic compound (VOC) meter or handheld photoionization detector (PID) is necessary. Though relative changes are important, the vacuum gauges must all respond equivalently and the VOC meter (or PID) must be accurate in order to estimate actual emission loads.

- **Traffic Control** - Set up traffic control systems as needed.

- **Measure Distances Between Wells and Depths of Wells** - Wells screened above the water table (unsaturated zone, monitoring, or pumping wells) are opened and allowed to equilibrate to atmospheric pressure. Measure distances between wells if there is any question these data were not recorded previously or the accuracy of the site map is in question. Water levels are then measured, if applicable at wells, to assure screens are above the water table.

Note that there are instances in fine soils where the screen may be only a couple feet or less above the water table and no vacuum is observed. During the test, the suction may draw the water over the remaining screen resulting in no or low air flow from the well. Also, capillary rise in the formation may inhibit air flow from a well.

- **Cap Monitoring Wells** - Monitoring wells are fitted with caps or union that allow attachment of a differential pressure gauges. A tubing port tapped into a PVC cap serves this purpose. Zero all differential pressure gauges. Be sure the atmospheric pressure ports on the differential pressure gauges do not get exposed to high or variable winds. One way to do this is to run a piece of tubing from the high pressure port into the well monument and out of the wind.

If there are more wells than differential pressure gauges, and vacuum readings are desired at those wells, then they should be fitted with a cap or union, and the hose barb port should be plugged when not used. Unmonitored wells should be capped off to prevent possible short circuiting. Wells not being monitored should be plugged.

- **Manifold the Blower and Moisture Separator to the Extraction Well** - The vacuum is commonly applied by connecting a blower to the SVE well. Flexible vacuum hose is much more useful than hard piping. The vacuum hose from the well should be connected to a knock-out tank to collect condensing water. This knock-out tank should have a vacuum gauge attached that reads up to 100 in. H2O (or the maximum vacuum capacity of the blower) for measuring the vacuum applied at the SVE well head. Another section of flexible
vacuum hose connects the knock-out tank to the blower. A bleed-in pipe equipped with a gate valve is installed off of a tee on the line between the vacuum end of the blower and the extraction well. The bleed-in line allows for control of the vacuum applied to the extraction well. Velocity measurement ports should be installed at three locations: on the pipe to the well, on the bleed-in pipe, and on the stack. The velocity measurement ports should be tapped ports for insertion of a pitot tube at proper distances from flow disturbances. Regulatory rules or health and safety issues may require the blower exhaust to be passed through a treatment system to remove VOCs or other contaminants from the gas stream.

- **Examine Possible Test Vacuums and Start SVE Testing** - With the bleed valve closed, briefly turn on the blower and measure the maximum possible vacuum that the blower can apply to the well. Also, measure the resulting flow from the well and collect a PID reading. Use the maximum vacuum data to determine at least two appropriate vacuums that may be applied during SVE testing. SVE tests using at least two extraction vacuums are recommended in order to obtain sufficient blower selection data. Typically, SVE testing is performed using the maximum vacuum and half of the maximum vacuum or at reasonable SVE design vacuums.

Start SVE testing by turning on the blower and immediately adjusting the bleed valve until the vacuum on the well is at the desired level.

- **Extraction Well Data Recording During the Test** - During the test, the following extraction well data is recorded on intervals as frequent as possible. Typically, extraction well data is recorded every 15 to 30 seconds for the first few minutes. As steady state conditions are approached, data recording intervals may be lengthened.

1. Time from start of the test
2. Vacuum at the extraction well
3. Air velocity from the well, air velocity out of the blower, and air velocity in the bleed-in pipe. Use an anemometer or pitot tube or both to monitor velocity.
4. Concentration of VOCs in the air coming out of the well as measured with a PID. (Due to the location of the SVE wells in relation to possible vadose zone impacts, the concentration of VOCs in the extracted air is expected to be high, however, the test is not designed to recover significant amounts of VOCs.)

- **Effluent Samples** - PID measurements should be collected every 15 minutes throughout the duration of the test. One influent and one effluent sample will be collected to determine the VOC concentrations in the air stream during the test. Summa vacuum canisters are preferred for sampling.

- **Monitoring Vacuum Influence During the Test** - Monitor the differential pressure gauges on the surrounding wells as frequently as possible during the start of the test. Each time a reading is taken, note the time and vacuum level, even if zero or if it has become negative (pressurized). Barometric pressure changes can have a large effect, especially when most of the ground surface is covered by asphalt, concrete, or building footers. Using a barometer, take an atmospheric pressure reading at the beginning and end of the test. Try
to record local barometric pressure data (consulting a website or newspaper) if a barometer is not available.

Vacuum should be applied at only one location at a time. If multiple wells are to be tested, then sufficient time must elapse between tests to allow subsurface pressures to return to background levels. The waiting period will likely be a function of soil permeability and surface coverage. During the SVE test, the technician in charge of the test should contact the project engineer immediately if there are any special problems or unexpected results.

- **Data Recording Notes** - Frequency of measurement priority should be given those to wells closest to the vacuum point. Frequency of measurement should also be adjusted in the field as the results are obtained. For instance, if a monitoring well 15 feet from the vacuum point has vacuum stabilized at some maximum value, then less frequent measurement is necessary. The time when frequent measurement is most useful is when the vacuums start to change. This will generally be later in the test for more distant wells. However, anisotropies have been known to result in more distant wells showing a response more quickly than closer wells.

- **SVE Testing at a Higher Vacuum** - Once it has been determined that the vacuum levels observed in monitoring wells have reached near-equilibrium conditions, start a second higher vacuum or maximum vacuum test without stopping the blower. The maximum vacuum at the well is simply applied by completely closing the bleed valve. Perform the higher vacuum test as described above. If the bleed valve is completely closed, then PID measurements and air samples may be gathered from the pressure side of the blower.

- **Upon Completion of the Test** - After vacuum, flow, and VOC concentration data have reached apparent steady state conditions, prepare to shut off the blower. Before shutting off the blower, station observers next to monitoring wells. When the blower is shut off, record the observed change in vacuum at each of the monitoring wells. A marked vacuum drop at a monitoring well following a drop in vacuum at the extraction well may provide another valuable indication of total vacuum influence.

During the SVE test, the technician in charge of the test should contact the project engineer immediately if there are any special problems or unexpected results.
SOP - 2

GRAB AIR SAMPLE COLLECTION

The following standard operating procedure (SOP) will be used by AMEC Earth & Environmental, Inc. (AMEC) during the soil vapor extraction (SVE) Pilot Test conducted at the Former Loomis Chemical Warehouse Site (Site).

Purpose

The purpose of this procedure is to collect a representative sample of the air extracted during the SVE pilot study, conducted within the shallow vadose zone and the deep vadose zone. Samples will be collected from two SVE Pilot test system locations, the air influent (untreated air being removed from the test well) and from the effluent (treated air being discharged from the SVE pilot test system).

Equipment List

1. Dedicated field logbook, field data collection form, and indelible pens.
2. Summa canister(s).
3. Pressure gauge (supplied by lab).
4. Site map and Site health and safety plan (HASP).
5. Personal protective equipment (PPE) appropriate for Site (see HASP).

Procedure

Prior to Collection of the Sample

1. Check that the valve on the Summa canister is closed. The green knob should be turned completely clockwise.
2. Using a 9/16-inch wrench, remove the brass cap above the valve on the top of the Summa canister.
3. Connect a pressure gauge to the Summa canister.
4. Check the pressure on the Summa canister. If the canister pressure reads less than 28.5 inches of mercury (in Hg), then do not use the canister.

Sample Collection

1. Connect the summa canister to the sample port, after doing the pressure check specified above.
2. When ready to sample, open the canister valve(s). Turn the green knob until there is no resistance (approximately 1¼ turns) counterclockwise, then turn clockwise slightly until resistance is detected. A hissing noise should be heard as the air flows into the evacuated Summa canister.

3. Once the hissing noise stops, let the canister sit another 20 seconds and then close the valve by turning the green knob clockwise. Do not over-tighten. Replace the brass cap.

4. Record the final pressure reading for the canister.

**Following Collection of the Sample**

1. Fill out the provided sample label using ink. Attach the completed sample label to the canister and record the sample on the chain of custody.

2. Record the date, time, location, serial number of the canister, and canister pressure on the field data sheet. Make any notes regarding sample location that will potentially influence the VOC sample collection.

3. Submit the Summa canister with the chain of custody to the laboratory for analysis per EPA Method TO-15. Follow shipping instructions provided by the lab.
<table>
<thead>
<tr>
<th>SAMPLING METHOD</th>
<th>SAMPLE NUMBER</th>
<th>BLOW COUNT</th>
<th>DEPTH SAMPLED</th>
<th>RECOVERY</th>
<th>DEPTH IN FEET</th>
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<td>SPT</td>
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**GROUNDWATER TABLE**

- **DATE BEGUN**
- **DATE COMPLETED**
- **LOCATION**
- **WEATHER**

**PROJECT NAME**

**PROJECT NUMBER**

**GEOLOGIST/ENGINEER**

**DRILLING CONTACTOR/CREW**

**METHOD USED**

**SAMPLING METHOD:** SPT = STANDARD PENETRATION TEST  T = TUBE  R = RING

**SOIL DESCRIPTION**

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**BORING LOG SUMMARY**

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AMEC Earth & Environmental, Inc. (Rev. 11/01)
B-2

Baseline Field Measurements
<table>
<thead>
<tr>
<th>Well</th>
<th>Date and Time</th>
<th>VOC Headspace (PPM)</th>
<th>Vacuum (Inches Water)</th>
<th>DTW (Feet Bgs)</th>
<th>Notes</th>
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Water Level Instrument:
Water Parameter Instrument Type & Number:
Vacuum Gage Type:
PID Instrument Type & Number:
Instrument Calibration Dates & Times:
Calibration Problems?

Notes:
PPM = Parts Per Million
Feet Bgs = Feet Below Ground Surface
DTW = Depth To Water
PID = Photoionization Detector
B-3

SVE Pilot Test Measurements
### Soil Vapor Extraction

#### Test Measurements

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<td>Barometric Pressure (in. H₂O)</td>
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<td>Influent Air PID Reading (PPM)</td>
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<td>Effluent Air PID Reading (PPM)</td>
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<td>Airstream Temperature (°C)</td>
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</table>

Barometric Pressure: 0.04 in. Hg = 0.54 in. H₂O
cfm = cubic feet per minute
NA = not applicable
in. = inches
Dia. = diameter
ft = feet
PPM = parts per million
bgs = below ground surface
NM = not measured

Columbia Development, Inc.
Former Loomis Chemical Warehouse, Portland, Oregon
Soil Vapor Extraction Pilot Test Work Plan Addendum
K:\8000\8800\8897\Work Plans\SVE Pilot Work Plan\Appendices\Appendix B - Field Forms\B-3 SVE Test Measurements.xls
Air Sample Collection Form
AIR SAMPLING FIELD FORM

Sample Location _____________________  Sample Name _____________________

Canister Number _____________________  Canister Height ________________ (in Feet)

Start Canister Pressure ____________ (in. Hg)  End Canister Pressure ____________ (in. Hg)

Date_______________ Sample Time_____________ Sampler Name____________________

<table>
<thead>
<tr>
<th>Weather Conditions:</th>
<th>Reading</th>
<th>Units</th>
<th>Time</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Barometric Pressure</td>
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<tr>
<td>Temperature</td>
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<tr>
<td>Relative Humidity</td>
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Submit the sample to CAS in Simi Valley, California for VOCs by TO-15.

Comments:________________________________________________________________________

_______________________________________________________________________________

_______________________________________________________________________________

Sketch of Sample Location: