Tier II Commercial Vapor Intrusion Assessment Work Plan
Winter 2015
Boeing Auburn Facility
Auburn, Washington

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Prepared for

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1.0 INTRODUCTION

This work plan presents an investigation approach to complete additional sub-slab soil vapor and indoor air sampling investigation activities near The Boeing Company's (Boeing) Auburn Fabrication Division facility (facility), located at 700 15th Street Southwest in Auburn, Washington. The investigations described in this work plan are part of the ongoing remedial investigation (RI) for the facility. Boeing is currently conducting corrective action at the facility. Corrective action requirements are documented in an Agreed Order (Order; No. DE 01HWTRNR-3345) dated August 14, 2002 and the First Amended Agreed Order dated February 21, 2006, both with the Washington State Department of Ecology (Ecology). The Order includes a requirement to conduct an RI of facility contamination impacts both within the facility (on Boeing property) and at downgradient properties (off Boeing property). This work plan includes sub-slab and indoor air sampling for vapor intrusion assessment at a commercial building off Boeing property in Auburn and at one building on Boeing property. The location of the facility and its immediate vicinity are shown on Figure 1.

1.1 SCOPE OF WORK AND OBJECTIVE

The proposed scope of work presented in this work plan includes collection of sub-slab soil vapor and indoor air samples. The objective of the work is to assess indoor air and soil vapor at two commercial buildings to determine if vapor intrusion is occurring.

1.2 BACKGROUND

Boeing has been implementing RI activities to characterize the nature and extent of two groundwater plumes: the Area 1 plume (Plume 1) and the western plume (Plume 2), which occur beneath the northern portion of the facility and extend off Boeing property to the north and northwest. These plumes are made up of the volatile organic compound (VOC) trichloroethene (TCE) and its breakdown components cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). The plumes have affected shallow groundwater both on and off Boeing property. VOCs in shallow groundwater have the potential to impact indoor air via the vapor intrusion pathway. Boeing prepared the *2nd Revised Agency Review Draft Vapor Intrusion Evaluation and Assessment Approach* (Vapor Intrusion Assessment report; Landau Associates 2014a) to guide vapor intrusion assessment during the RI.

The Vapor Intrusion Assessment report documents the site-wide approach to assessing vapor intrusion risk in the vicinity of the shallow groundwater TCE and VC plumes both on and off of Boeing property. Assessment of vapor intrusion is based on the tiered approach presented in Ecology's draft vapor intrusion guidance document (Ecology 2009). The assessment process consists of two[1] stages:

1. Tier I assessment – Focuses on determining whether there is a potential vapor intrusion risk based on groundwater and soil vapor concentrations and which buildings may potentially be at risk for vapor intrusion. A Tier I assessment does not evaluate individual buildings.
2. Tier II assessment – If a potential vapor intrusion risk is identified in an area with overlying structures, a Tier II assessment focuses on evaluating individual structures using additional building-specific sampling such as indoor air (which may include crawlspace or basement air), ambient air, and sub-slab soil vapor.

The Tier I assessment evaluates whether VOCs in shallow groundwater or soil vapor occur at concentrations that could pose a vapor intrusion threat to indoor air quality. Groundwater and soil vapor screening levels (SLs) are used to evaluate Tier I data. The Tier II assessment evaluates specific buildings to determine if VOCs of potential concern are present in indoor air above Model Toxic Control Act (MTCA) cleanup levels (CULs) and if the VOCs are related to vapor intrusion or background sources (Ecology 2009).

An initial Tier I assessment for commercial areas of the site using existing shallow groundwater data was completed and presented in the Vapor Intrusion Assessment report. The results of the initial Tier I assessment indicated that groundwater in limited commercial areas exceeds the commercial groundwater vapor intrusion SLs (commercial groundwater SLs). Additional Tier I assessments were recommended in commercial areas in Algona and Auburn and are presented in a separate work Plan (Landau Associates 2014b). However, two buildings (The Outlet Collection in Auburn and Building 17-70 on Boeing property) were identified to proceed directly to Tier II evaluation. Although Boeing property is considered industrial, Building 17-70 is primarily an office building, where industrial manufacturing does not take place; therefore, groundwater near Building 17-10 was evaluated using commercial groundwater SLs. The Outlet Collection and Building 17-70 are shown with relevant nearby groundwater data on Figures 2 and 3, respectively.

At The Outlet Collection, the size of the building and potential business interference make additional Tier I assessments difficult and inefficient. At this building, Tier II evaluation is proposed primarily for efficiency and to minimize business disruption. Building 17-70 is located directly north of buildings 17-07 and 17-12 where indoor air and sub-slab vapor sampling have already been completed (Landau Associates 2012a)[2]. The south end of Building 17-70 is at the edge of the 100-foot (ft) boundary

[1] Ecology's guidance presents an additional stage of assessment called a "preliminary assessment." The preliminary assessment for the RI was completed in 2012 and therefore, is not discussed in this document.

[2] Indoor air results were below reporting limits for all constituents at Building 17-07 and 17-12.

line of the area where groundwater exceeds the commercial groundwater SLs[3] (Figure 3); therefore, Building 17-70 has been identified as needing a Tier II assessment.

[3] Ecology vapor intrusion guidance contains a "100 ft rule," which requires that areas within 100 ft of groundwater exceeding vapor intrusion SLs should be included in a vapor intrusion assessment.

2.0 INVESTIGATION APPROACH

The investigation approach presented below addresses the Tier II vapor intrusion assessment for two commercial buildings: The Outlet Collection and Building 17-70. The need for Tier II assessments was determined based on exceedances of the commercial groundwater SLs, which were presented in the Vapor Intrusion Assessment report (Landau Associates 2014a). Commercial groundwater SLs and the investigation approach for Tier II assessments at The Outlet Collection and Building 17-70 are described below.

2.1 COMMERCIAL SCREENING LEVELS

Commercial groundwater SLs were calculated for constituents of concern for use in vapor intrusion assessments. TCE and VC are the primary chemicals being evaluated as constituents of concern because of their concentrations in groundwater relative to their toxicity and CULs. Although there are presently no MTCA air CULs (and, thus, no vapor intrusion groundwater or soil vapor SLs) for cis-1,2-DCE, this constituent will continue to be included as an analyte in future vapor intrusion work if it is detected in shallow groundwater or soil vapor.

Commercial SLs were developed for TCE and VC in shallow groundwater and soil vapor based on MTCA Modified Method B values for indoor air[4]. Both carcinogenic (excess cancer risk) and non-carcinogenic effects (hazard index) were evaluated when developing indoor air SLs; carcinogenic values were the most conservative for a commercial setting. Commercial TCE and VC indoor air SLs based on a 1 in 1,000,000 (1×10^{-6}) excess cancer risk are 1.9 micrograms per cubic meter (µg/m^3) and 0.85 µg/m^3, respectively. Commercial TCE and VC shallow groundwater SLs protective of indoor air are 7.9 micrograms per liter (µg/L) and 1.0 µg/L, respectively. Commercial TCE and VC soil vapor SLs protective of indoor air are 63 µg/m^3 and 28 µg/ m^3, respectively.

Indoor Air Action Levels (IAALs)[5] were also developed for TCE and VC. There are two types of IAALs: short-term exposure, which are concentration-based IAALs, and long-term exposure, which are risk-based IAALs. A short-term exposure IAAL was developed for only one compound, TCE, based on an EPA Region 10 publication (EPA 2012) that identified potential non-carcinogenic risk to a developing fetus; short-term exposure IAALs are not derived from MTCA. The short-term exposure IAAL for TCE is 8.4 µg/m^3 and is applicable to commercial buildings where women of child-bearing age work or visit

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[4] Indoor air values calculated using Modified MTCA Method B formulas for commercial areas are considered SLs rather than CULs because MTCA does not contain a provision for use of commercial CULs.

[5] The IAAL value is a sub-chronic non-carcinogenic indoor air action level from the U.S. Environmental Protection Agency (EPA) Region 10 (EPA 2012). VC does not have an IAAL.

for extended time periods[6]. A long term risk-based IAAL was established based on chronic exposure and a cumulative potential cancer risk of 1 in 100,000 (1×10^{-5}) for both TCE and VC. Table 1 presents groundwater, soil gas, indoor air SLs, and IAALs for both carcinogenic and non-carcinogenic effects. A discussion of how SL and IAALs will be used to evaluate data is presented in Section 4.0.

2.2 PROPOSED ADDITIONAL TIER II ASSESSMENT APPROACH

The investigation approach for The Outlet Collection and Building 17-70 consists of collecting additional Tier II data including: sub-slab soil vapor samples, indoor air samples, and ambient air samples. Building surveys were conducted at both buildings to collect information about the following features and identify sampling locations:

- Heating, ventilation, and air conditioning (HVAC) system
- Spaces occupied by employees for the majority of the work day (e.g., office space)
- Slab penetrations (e.g., sumps, elevators, utility trenches)
- Foundation construction (e.g., slab thickness, footing locations, and other construction details)
- Underground spaces (e.g., crawlspace and subfloor spaces)
- Potential indoor air VOC sources.

Plan view figures showing applicable building features and proposed sampling locations are provided for The Outlet Collection and Building 17-70 on Figures 4 and 5, respectively. Relevant building features are depicted on each plan view. Additional details describing the proposed sampling approach for each building are presented in the following sections.

2.2.1 THE OUTLET COLLECTION

The Outlet Collection is located in an area where VC groundwater data exceed commercial vapor intrusion SLs[7]. Additional Tier I assessments would be inefficient due to the size of the building; therefore, assessment activities will proceed directly to Tier II assessments. A building survey of The Outlet Collection was conducted on November 13, 2014 by Ecology and Landau Associates (on behalf of Boeing).

The Outlet Collection is a privately owned mall with approximately 130 leased spaces. The building is serviced by multiple HVAC systems. Many of the leased spaces either have a dedicated HVAC system or share systems with a small number of neighboring leased spaces. There is office space

[6] The short term exposure IAAL is based on an 8-hour work day, 260 days per year, which eliminates the assumption that there is a 2-week absence during the year (EPA 2012).
[7] TCE does not exceed commercial vapor intrusion groundwater SLs at boreholes collected from the water table near The Outlet Collection.

for The Outlet Collection employees in the center of the building, and tenant employees occupy the leased spaces during each tenant's business hours. The building is reportedly under positive pressure during the mall's operating hours.

The entire building is slab-on-grade. Slab penetrations by utilities were identified in electrical and sprinkler riser rooms. Two underground delivery and emergency egress tunnels were identified, and there are two sumps containing sump pumps in each tunnel (four sumps total); the sumps extend below the concrete floor slab. The sump pumps reportedly run frequently during the wet season, but the tunnels do not have groundwater intrusion issues. There are elevators at both ends of each tunnel connecting the tunnels to the main level; the sumps are located at the ends of the tunnels near the elevators. As-built drawings of the sumps were not available to verify the sump depths in relationship to groundwater; however, water in the sumps appears to be groundwater since there did not appear to be an aboveground source of water flowing into the sumps. Tunnel, sump, and elevator locations are shown on Figure 4.

Areas of chemical storage were observed and documented during the building survey, but an exhaustive chemical inventory was not conducted due to the volume and variety of chemicals stored within the mall. In general, samples will not be located near chemical storage areas. However, if background sources are a suspected source of detections, a more thorough chemical inventory may need to be conducted.

The building underwent a major renovation within the last year. Smaller-scale renovations of leased spaces are also typical and occur throughout the year as desired by the tenants. New materials associated with building renovations have the potential to off gas chemicals that may interfere with indoor air sampling. Therefore, it was important to identify sample locations away from the renovated areas. Additionally, access to leased tenant spaces is difficult due to the conditions in the lease agreements. Leased spaces are shown on Figure 4.

Suitable sampling locations within the buildings included areas with characteristics including: bare concrete floors, areas with controlled access away from public areas of the building, areas without chemical storage, and areas with floor penetrations (i.e., cracks or drains). During the building survey sprinkler rooms, storage areas, and hallways with these characteristics were identified. The following bullets expand on the characteristics of suitable sampling locations.

- Areas with bare concrete flooring are suitable for sub-slab samples because the sample points, which must be drilled through the entire thickness of the concrete slab, can be placed without risk of damaging floor coverings.
- Controlled access to the sampling areas is important to ensure that equipment is not tampered with and to avoid excess air exchange. The main mall area, leased spaces, and many hallways are not suitable for sampling because they experience frequent air exchanges with outdoor air due to customers and other persons entering and exiting the building and operation of the HVAC system. According to mall personnel, hallway doors are frequently open for hours at a

time as deliveries are made, which creates a “wind tunnel” effect. The sprinkler rooms, storage rooms, and north hallway (between LS-007 and LS-008) are controlled by the business owner and generally access can be controlled during sampling.

- Sampling locations away from chemical storage and retail areas are preferred in order to reduce the potential for sampling interference from background sources. A large variety of chemicals are used and sold throughout the mall, either explicitly as chemicals or associated with other products. The sprinkler and storage rooms and north hallway are expected to be suitable sampling locations because they are separate from chemical storage and retail areas and, therefore, are expected to have less exposure to potential background sources.
- Floor penetrations or cracks in the slab could potentially provide a conduit for subsurface vapors to enter the building. Although these conditions are not necessarily typical throughout the mall, they represent worst-case conditions; areas with these features are suitable for evaluating vapor intrusion potential. The sprinkler rooms contain both floor drains and other floor penetrations. The slab in the north hallway between LS-007 and LS-008 has numerous cracks as do the slabs in both tunnels.

Indoor air samples and co-located sub-slab soil vapor samples will be collected in two sprinkler rooms and a hallway (Figure 4) that provide geographic coverage on the north, south, and west sides of The Outlet Collection. The groundwater plume extends under much of The Outlet Collection, with the exception of the eastern end of the mall. Therefore, these locations were chosen to capture conditions throughout the area above the plume. These locations are also expected to represent worst-case conditions due to the floor penetrations, floor drains, and cracks in the slab, which all provide preferential pathways.

Indoor air samples are also proposed in the two underground delivery and emergency egress tunnels. Sub-slab samples are not proposed in the tunnels due to the likelihood that the water table is at or near the bottom of the slab. Sumps and elevator shafts, because they penetrate beneath the concrete slab, create potential preferential pathways for vapor intrusion within the tunnels and provide an opportunity to evaluate vapor intrusion potential. Indoor air samples in the tunnels will be collected adjacent to the sumps and elevators with the air intake tubing directed toward the sump opening. One indoor air sample will be located in each tunnel, at the sump closest to the center of the mall (Figure 4).

As noted previously, there are numerous HVAC systems employed at The Outlet Collection as many leased spaces have separate systems or only share a system with neighboring leased spaces. However, all HVAC systems serving The Outlet Collection have inlets on the roof. Therefore, one ambient air sample will be collected on the roof from the up-wind side of the building (based on wind direction at the time of sampling). See Section 3.0 for additional sampling details and procedures.

2.2.2 BUILDING 17-70

Tier II assessment is recommended at Building 17-70 because the south end of the building is at the 100 ft boundary line where TCE or VC concentrations exceed commercial groundwater SLs. The building survey conducted on November 12, 2014 by Landau Associates (on behalf of Boeing) focused on identifying sample locations in the south end of the building nearest to the well with groundwater concentrations exceeding commercial groundwater SLs. Building 17-70 consists of office space throughout the building. The building is serviced by HVAC systems, all with air intakes on the roof. The building is reportedly under slightly positive pressure.

A chemical inventory was conducted during the building survey, which primarily identified common commercial cleaning chemicals and some drummed chemicals associated with the mechanical room. The chemicals observed did not appear to contain constituents of concern; however, a more thorough chemical inventory may need to be conducted if background source interference is suspected.

The entire building is slab-on-grade. However, there are multiple varieties of slab-on-grade flooring. According to drawings provided by Boeing prior to the building survey, and confirmed during the building survey, the southeastern quarter of the building rests on a sandwich slab; the sandwich slab consists of 5 inches of concrete slab over 13 inches of polystyrene foam which rests on a mud slab. This slab type is not conducive to sub-slab sampling procedures. However, the western side of the building is closer to the 100 ft boundary than the eastern side and the groundwater flow direction is northwest, away from the southeastern quarter; therefore, sampling locations were not identified in the southeastern quarter.

The southwestern quarter of the building is primarily slab-on-grade. Many areas within the southwestern quarter are either carpeted[8] or contain extensive electrical systems[9] and are therefore not suitable sampling locations. One room (identified as room W-6 on Figure 5) with an exposed slab-on-grade floor does not contain electrical systems, and was identified as a location for co-located indoor air and sub-slab samples. Access to this room can be controlled and the room has utility penetrations and two floor drains; therefore, this room may represent a worst-case scenario for the building. A dedicated HVAC system services room W-6.

Some rooms in the southwestern quarter have a "raised floor" with removable panels which reveal the underlying slab. A second co-located indoor air and sub-slab soil vapor sampling location was identified in a combined office/storage room with the raised flooring (identified as room 13A11 on Figure 5). This room shares an HVAC system with the south half of the building.

The air intakes for both HVAC systems are on the roof. Therefore, one ambient air sample will be collected from the roof upwind of the two HVAC system intakes (based on wind direction at the time

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[8] New furniture and carpet were installed in the "Training Room 12A11" within the last 6 months.

[9] Electrical rooms are problematic for sub-slab sampling because dust from concrete drilling can damage electrical infrastructure and use of wet methods for drilling sample ports is generally not allowed.

of sampling). The sampling locations are presented on Figure 5. See Section 3.0 for additional sampling details and procedures.

3.0 FIELD ACTIVITES

This section describes the field activities and provides sampling procedures and analytical procedures for sub-slab soil vapor, indoor air, and ambient air sampling. The use of Summa canisters [for time-weighted average (TWA) samples] is proposed for application in this work plan. TWA samples collected using Summa canisters are the primary type of air and soil vapor samples collected for the project; the sampling and laboratory procedures for using Summa canisters are presented in Section 3.2 of this work plan and in the current draft sampling and analysis plan (Landau Associates 2013a) and quality assurance project plan (Landau Associates 2013b). Field activities will be performed in accordance with the site Health and Safety Plan (Appendix A).

3.1 PERMITS

The proposed sample locations in Auburn will be located on The Outlet Collection property owned by Glimcher. Boeing will obtain an access agreement from Glimcher for sampling occurring within The Outlet Collection. No field investigation activities will be initiated until the access agreement is approved. An access agreement is not necessary for work conducted on Boeing property.

3.2 SUMMA CANISTER FIELD PROCEDURES

The following three sub-sections present sample collection procedures, laboratory procedures, and sample labeling procedures when using summa canisters. Based on a discussion with Ecology during a meeting on May 29, 2013, field duplicates will not be collected.

3.2.1 SAMPLE COLLECTION PROCEDURES

This section provides information regarding the collection of sub-slab soil vapor, indoor air, and ambient air samples. Two methods are provided for sub-slab soil vapor sampling. The chosen method will depend on site conditions and slab thickness at a given location.

3.2.1.1 Sub-slab Soil Vapor Sampling

Sub-slab soil vapor sampling is accomplished by drilling a hole through the slab, inserting a sample collection device, and sealing the hole around the sample collection device so that ambient air cannot enter the subsurface. Sample points may be constructed two ways, either by inserting a Cox-Colvin Vapor Pin™ (Vapor Pin) of approximately 3 inches in length into each core or by placing a vapor implant and sealing the hole with hydrated bentonite. The sections below describe the installation process for both the Vapor Pin and the vapor implant. The installation sections are followed by a description of the sampling protocol, which is the same for both installation types.

During sub-slab sampling activities, Boeing will make best efforts to minimize the introduction of soil vapors into the commercial space. Sub-slab soil vapor samples will be collected from just beneath a slab from a 5/8-inch to 1-inch diameter core. The core will be drilled with a handheld rotary hammer style drill[10]. Immediately following coring, field staff will insert a photoionization detector (PID) into the drilled hole to quickly check for VOCs, and will proceed with installing the sample point to minimize the introduction of soil vapor into indoor air.

Cox-Colvin Vapor Pin

Vapor Pins are comprised of a barbed, stainless steel sample point fitted with an inert, compressible, silicon sleeve. Each Vapor Pin will be installed using a hammer and specialized installation tool to drive the Vapor Pin into a ⅝-inch-diameter vertical core within the slab. Driving the Vapor Pin into the core compresses the sleeve, creating a seal between the sample point and slab surface. Typically slabs are thicker than 3 inches, so the bottom of the Vapor Pin will rest within the slab core, above underlying soil. After the Vapor Pin is installed, the end with a hose barb is exposed at the ground surface. A fitted cap will be attached to the barb to allow the sub-slab soil vapor to equilibrate without exposure to ambient air. The manufacturer's standard operating procedures for installation, sampling, and removal are provided in Appendix B.

Vapor Implant

Vapor implants are typically installed in a 1-inch diameter vertical core within the slab; larger cores may be used, but are not anticipated for this sampling event. Vapor implants comprise a porous sampling tip and sample tubing placed in the core. Teflon or Nylaflow® tubing may be used as sample tubing. The porous sampling tip should extend 1 to 2 inches below the slab. The void space around the sampling tip will be backfilled with drilling grade silica sand up to the bottom of the slab.

Granular bentonite (bentonite) will be used to seal the annular space between the sample tubing and the slab within the core. Two to three inches of dry bentonite will be placed on top of the silica sand. Tap water will be used to hydrate the top 1 inch of bentonite. Care will be taken to avoid getting water into the silica sand layer. Once the top layer of bentonite is hydrated, additional bentonite will be added and hydrated in 1 to 2 inch lifts until the bentonite is within a ½ inch of the top of the slab.

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[10] Some coring debris will remain at the bottom of the boring; therefore, drilling should extend beneath the bottom of the slab by approximately 4 to 6 inches to expose the soil before installing the Vapor Pin. A broom and dust pan will used to collect coring debris deposits on the ground surface; a shop vacuum will not be used.

Sample Collection

The sample point will be left undisturbed for a minimum of 2 hours (Cal EPA 2012) to allow for the soil vapor to equilibrate. To prevent the sample point from being tampered with or damaged, a small safety cone will be placed over the sampling assembly during the equilibration period[11].

Each sub-slab sample will be collected in a 1-liter (L) Summa (vacuum) canister fitted with a flow controller. The flow controller will be calibrated by the laboratory to a flow rate not to exceed 200 milliliters per minute.

After the equilibration period is complete:

a. Turn on the helium detector and zero-out the instrument to read a helium concentration of 0 parts per million (ppm).

b. Attach sample tubing to the Summa canister. Teflon or Nylaflow tubing is acceptable. If using a vapor pin, install new connection tubing (Masterflex® or other acceptable connection tubing) on the barb of the Vapor Pin and connect it to the sample tubing. If using the vapor implant, the sample tubing connected to the porous implant should be long enough to connect it directly to the Summa canister.

c. Place the shroud over the sample point, tubing, and Summa canister.

d. Connect the helium tank to the shroud from the exterior of the shroud and ensure that all connections are tight. Place the helium detector inside the shroud. Only ultra-pure helium should be used. Balloon grade helium can contain other contaminants and is not acceptable for use in sampling.

e. Attach the shroud lid to the shroud. Release one burst of helium into the shroud.

f. Concentrations should be at least two orders of magnitude above the lower detection limit of the helium detector (for example: if the lower detection limit is 25 ppm, the concentration in the shroud should be at least 2500 ppm). It is expected that helium concentrations will peak and begin to fall. Maintain concentrations inside the shroud at least two orders of magnitude above the lower detection limit. If concentrations fall near or below that concentration, add another short-burst of helium to maintain the minimum concentration.

g. Using the attached gloves, open the Summa canister valve to begin collecting the sample.

h. Record helium concentration and time at the start of sampling and at the end of sampling. If the sampling period is longer than 5 minutes, record one additional reading approximately halfway through the sample period. Record the lowest concentration of helium during sample period.

i. Once the vacuum gauge on the Summa canister reaches 0 inches of mercury (in. Hg), remove the shroud lid and close the valve on the Summa canister itself. Ensure the Summa canister valve is closed prior to disconnecting it from the well to prevent accidental entrance of remnant low-level helium from the shroud into the Summa canister.

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[11] Applicable field sampling procedures for sub-slab vapor sampling are presented in *Vapor Intrusion Pathway: A Practical Guideline* (ITRC 2007), and *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology 2009). Procedures in this work plan are generally consistent with these two guidance documents, except where the Cal EPA 2012 document is followed.

j. After collecting the required samples at each location, the sample point assembly will be removed and the core hole patched with quick-set concrete to reseal the concrete slab.

Where sub-slab soil vapor samples are co-located with indoor air samples, potential impacts to the indoor air samples related to sub-slab soil vapor must be considered. The sub-slab sample must be collected either at least 1 day before the indoor air sample is set up or after the indoor air sampling is completed. In the case where samples will be collected with a Summa canister coupled with a 21-day passive diffusive sampler (i.e., Radiello®), the sub-slab soil vapor sample point will not be installed, purged, or disassembled less than 1 day prior to indoor air sampling.

3.2.1.2 Indoor Air Sampling

Commercial indoor air samples will be 10-hour, TWA samples. The TWA samples will be collected using integrated passive air samplers consisting of a 6-L laboratory-certified evacuated Summa canister. Each Summa canister will be equipped with a pressure gauge and a calibrated critical orifice air flow controller.

Canister inlet valve heights will be about 3 to 3½ ft to approximate a sitting receptor in a commercial space. The Summa canister inlets for the samples located in The Outlet Collection tunnels will be fitted with tubing and directed at the floor near the sump. Canisters will be clearly labeled with signs indicating the purpose of the canisters and that the canisters are not to be interfered with or moved.

The TWA Summa canisters will be evacuated to a vacuum pressure of 25 to 30 in. Hg by the laboratory. A final vacuum pressure reading greater than ambient (i.e., 0 in. Hg) indicates a valid sample; however, canister closure will be targeted for a vacuum pressure of 5 in. Hg to provide a margin of safety. Canister pressures will be checked within 1 to 2 hours after beginning sampling to evaluate whether air flow controllers are functioning properly. Observed hourly pressure losses greater than one-tenth of the initial pressure will be considered indicative of a faulty flow controller. Any canisters observed to have a faulty flow controller will be replaced with a backup canister and flow controller.

3.2.1.3 Ambient Air Sampling

Ambient air sample locations will be 10-hour, TWA samples. The sample will be collected using a 6-L laboratory-certified evacuated Summa canister. The Summa canister will be equipped with a pressure gauge and a calibrated critical orifice air flow controller for collection of the TWA samples. Canister inlet valves will be placed on the roof of the building, near HVAC inlets where feasible.

The background sample Summa canisters will be evacuated to a vacuum pressure of 25 to 30 in. Hg by the laboratory. A final vacuum pressure reading greater than ambient (i.e., 0 in. Hg) indicates a valid sample; however, canister closure will be targeted for a vacuum pressure of 5 in. Hg to provide a safety margin. Canister pressure will be checked within 1 to 2 hours after beginning sampling to evaluate whether the air flow controller is functioning properly. Observed hourly pressure losses greater than one-tenth of the initial pressure will be considered indicative of a faulty flow controller. If the canister is observed to have a faulty flow controller, it will be replaced with a backup canister and flow controller:

Atmospheric conditions during the sampling period, including temperature; barometric pressure; wind direction; wind speed; and precipitation totals, will be recorded using a combination of publicly available meteorological data from a weather station[12] (located within about ½ mile from the commercial building where sampling will occur). Observations will be recorded both at the beginning and at the end of the sample period.

3.2.2 SAMPLE HANDLING AND ANALYSIS

Summa canisters will be shipped using the original shipping packaging under chain-of-custody procedures to Boeing's contracted laboratory. Samples will be analyzed for total concentrations of select VOCs, TCE, cis-1,2-DCE, and VC. Indoor and ambient air samples will be analyzed by EPA Method TO-15 low-level; sub-slab samples will be analyzed by standard EPA Method TO-15. Samples will be analyzed on a standard turnaround time.

Final data packages will be validated. Validated results will be entered in the site-wide database for inclusion in supplemental reports. The limits of quantitation for EPA Method TO-15 and TO-15 low-level are presented in Table 2.

3.2.3 SAMPLE LABELING

This section describes the creation of the sample identification (ID) number, which will be used for sub-slab soil vapor, indoor air and ambient air samples. Sample ID will be as follows:

- Location type: sub-slab soil vapor (SSV), indoor air (IA), or ambient air (AA)
- The sample number will be a three digit consecutive number
- Date of sample collection by year, month, and day (e.g., 20150401).

Thus, an indoor air sample collected at sample location 003 on April 1, 2015, would be assigned the following sample ID number:

IA003-20150401		
IA	**003**	**20150401**
Location type (indoor air)	Sample number	Date– (yyyymmdd)

[12] Data will be primarily obtained from the Celery Avenue meteorological station; station identification is KWAALGON3.

An example sample ID number for a sub-slab soil vapor sample and an ambient air sample collected on the same day would be:

- SSV055-20150401 would represent the 55th sub-slab soil vapor sample collected during the RI to date, collected on the same day as the above indoor air sample.
- AA015-20150401 would represent the 15th ambient air sample collected during the RI to date, collected on the same day as the above indoor air sample.

4.0 DATA ANALYSIS AND MITIGATION ASSESSMENT

The vapor intrusion pathway is best evaluated using multiple lines of evidence. The data obtained from sub-slab soil vapor, indoor air, and ambient air samples at commercial buildings are considered Tier II data[13]. In the context of this work plan, sub-slab soil vapor samples will be treated as secondary lines of evidence; indoor air samples are primary lines of evidence. The commercial Tier II data will be evaluated using the SLs identified in Section 2.1. Depending on maximum concentration in the samples from a given building, more sampling or mitigation planning may be conducted. Planned actions will be discussed with Ecology. The evaluation of results will be conducted as described below:

4.1 COMPARISON OF INDOOR AIR CONCENTRATIONS TO INDOOR AIR SCREENING LEVELS

- If the maximum detected concentrations from the cold weather season (October 2014 through April 2015) sampling event are less than the indoor air SLs, no further indoor air sampling will be conducted unless average groundwater concentrations underlying the building double (average for the previous four sampling events) and are greater than the groundwater SL, thereby increasing the potential for vapor intrusion.
- If the maximum detected concentration of one or more constituents is equal to or greater than the indoor air SL, the concentrations in ambient air will be subtracted from the reported results prior to further evaluation. The calculated results will be compared to the indoor air SLs.
    - If the maximum calculated concentrations from the cold weather season sampling event are all less than the indoor air SLs, no further indoor air sampling will be conducted unless groundwater concentrations underlying the building change according the criteria above, thereby increasing the potential for vapor intrusion.
    - If a maximum calculated concentration is equal to or greater than the indoor air SL, the cumulative carcinogenic risk and hazard index (HI) for that sample will be calculated and compared to the indoor air action level as described in the following bullet.

4.2 COMPARISON OF INDOOR AIR CUMULATIVE CARCINOGENIC RISK AND HAZARD INDEX TO THE INDOOR AIR ACTION LEVEL

- If the cumulative carcinogenic risk and HI from the cold weather season sampling event are less than or equal to the IAAL, VOC concentrations in groundwater will continue to be evaluated. No further indoor air sampling will be conducted unless groundwater concentrations underlying the building change according to the criteria described above, thereby, increasing the potential for vapor intrusion.
- If the cumulative carcinogenic risk or HI exceeds the IAAL during the cold weather sampling event, the potential for the results to have been impacted by background sources or data quality problems will be considered. The evaluation will also consider the sample location

[13] Ambient air samples often accompany collection of indoor air samples to verify background conditions. When ambient air is sampled during indoor air sampling, the indoor air concentration is commonly estimated to be the [max measured indoor concentration] – [representative measured, same-day, ambient air concentration] (Ecology 2009).

and the potential for exposure at the location. Most proposed sample locations are in areas that are not regular work areas and therefore, do not pose the same risk as an areas where workers are present for a full 40 hours per week.

- If there is no reason to suspect that air sample results were impacted by background sources or data quality problems, Boeing will evaluate the potential worker exposure at the sample location, evaluate whether additional sampling at other locations within the building is warranted, and, if needed, evaluate mitigation options.
- If there is reason to suspect that background sources of VOCs influenced the air sample results or if data is not of adequate quality for decision making, a second round of sampling will be conducted within about 1 month to verify the results. In addition, a background source evaluation will be completed at the time of the second sampling event to assist in distinguishing between concentrations from background sources and concentrations related to vapor intrusion of VOCs present in groundwater near the building.

4.3 COMPARISON OF INDOOR AIR TCE CONCENTRATION TO TCE SHORT-TERM SCREENING LEVEL

If, after subtraction of ambient air results, the maximum calculated concentration of TCE in an indoor air sample exceeds the short-term indoor air SL (8.4 $\mu g/m^3$), Boeing will notify the business owner and provide a warning notification for distribution at the building[14].

Results from the 10-hour TWA indoor air samples will be compared with the co-located sub-slab samples. The comparison will be considered in the evaluation of whether detected concentrations of VOCs in indoor air are likely to be a result of vapor intrusion. The sub-slab results are less likely to be impacted by background sources than indoor air samples. If the results of the 10-hour TWA and the sub-slab samples are not consistent, Boeing will discuss with Ecology the potential reasons for the differences and appropriate further actions.

Depending on the sample results, the next steps may include: 1) conduct prompt repeat sampling to evaluate suspected background sources and confirm results; 2) evaluate worker exposure; or 3) evaluate the need for mitigation. If the decision is made to mitigate a building, the VOC data from the building and the building survey documentation can be used to assess conceptually what vapor intrusion mitigation technique is most feasible. If needed, appropriate mitigation options will be evaluated at that time and presented in a separate work plan.

[14] It will be assumed that there is a female employee of child bearing age working in the building.

5.0 SCHEDULE AND REPORTING

Field work is tentatively scheduled for April/early May of 2015, pending Ecology approval of this work plan, and obtaining the required access agreement. Results from the indoor air and sub-slab soil vapor sampling will be shared with Ecology within 4 weeks of receipt of the final data package. A draft supplemental report about the data collected will be submitted to Ecology approximately 10 weeks after receipt of the final data package. A detailed schedule for the field activities is as follows:

- Public and private utility locates will occur at least 3 business days before initiation of field activities.
- Sub-slab soil vapor and indoor air sampling will begin within 2 weeks after approval of the work plan or access agreement, whichever is later.

RMM/SEF/JWW/jrc

6.0 REFERENCES

Cal EPA. 2012. *Advisory – Active Soil Gas Investigations*. Department of Toxic Substances Control, Los Angeles Regional Water Quality Control Board, San Francisco Regional Water Quality Control Board. California Environmental Protection Agency. April.

EPA. 2012. Memorandum: *OEA Recommendations Regarding Trichloroethylene Toxicity in Human Health Risk Assessments.* From Joyce C. Kelly, Office of Environmental Assessment, U.S. Environmental Protection Agency, to Rick Albright, Office of Environmental Cleanup, U.S. Environmental Protection Agency. December 13.

Ecology. 2009. *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action, Review DRAFT.* Toxics Cleanup Program, Washington State Department of Ecology. Publication No. 09-09-047. October.

ITRC. 2007. *Vapor Intrusion Pathway: A Practical Guideline*. Interstate Technology and Regulatory Council. January.

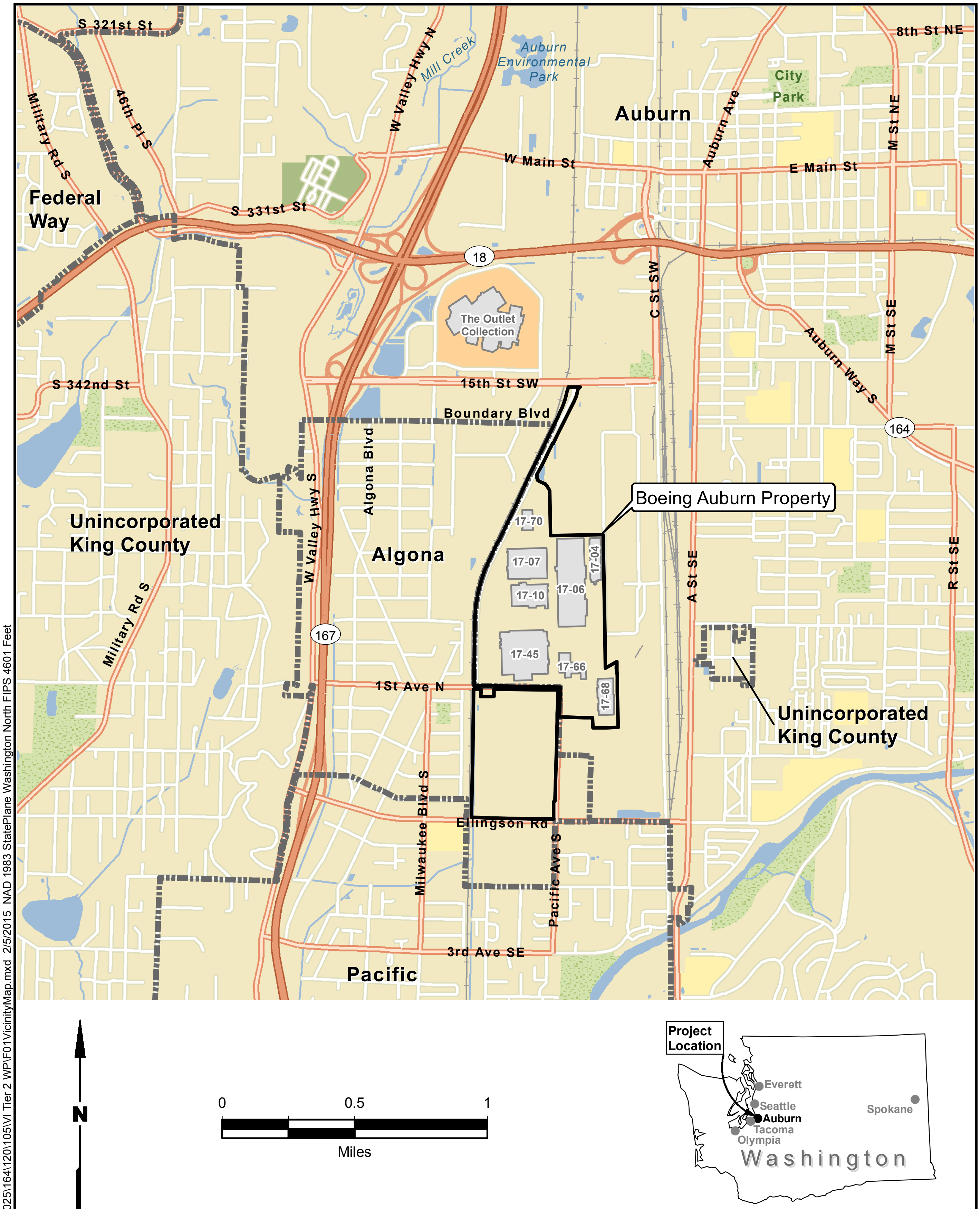
Landau Associates. 2014a. Draft Report: 2nd Revised Agency Review Draft, Vapor Intrusion Evaluation and Assessment Approach, Boeing Auburn Facility, Auburn, Washington.

Landau Associates. 2014b. Report: *Additional Tier I Commercial Vapor Intrusion Assessment Work Plan Winter 2014/2015, Boeing Auburn Facility, Auburn, Washington*. Prepared for The Boeing Company. December 10.

Landau Associates. 2013a. *Draft Sampling and Analysis Plan, Boeing Auburn Facility, Auburn, Washington.* Prepared for The Boeing Company. May 10.

Landau Associates. 2013b. Draft Report: *Quality Assurance Project Plan Remedial Investigation Boeing Auburn Facility, Auburn, Washington*. Prepared for The Boeing Company. May 9.

Landau Associates. 2012a. Draft Report*: Draft Spring 2011 Remedial Investigation Data Summary Report, Boeing Auburn Facility, Auburn, Washington*. Prepared for The Boeing Company. March 1.

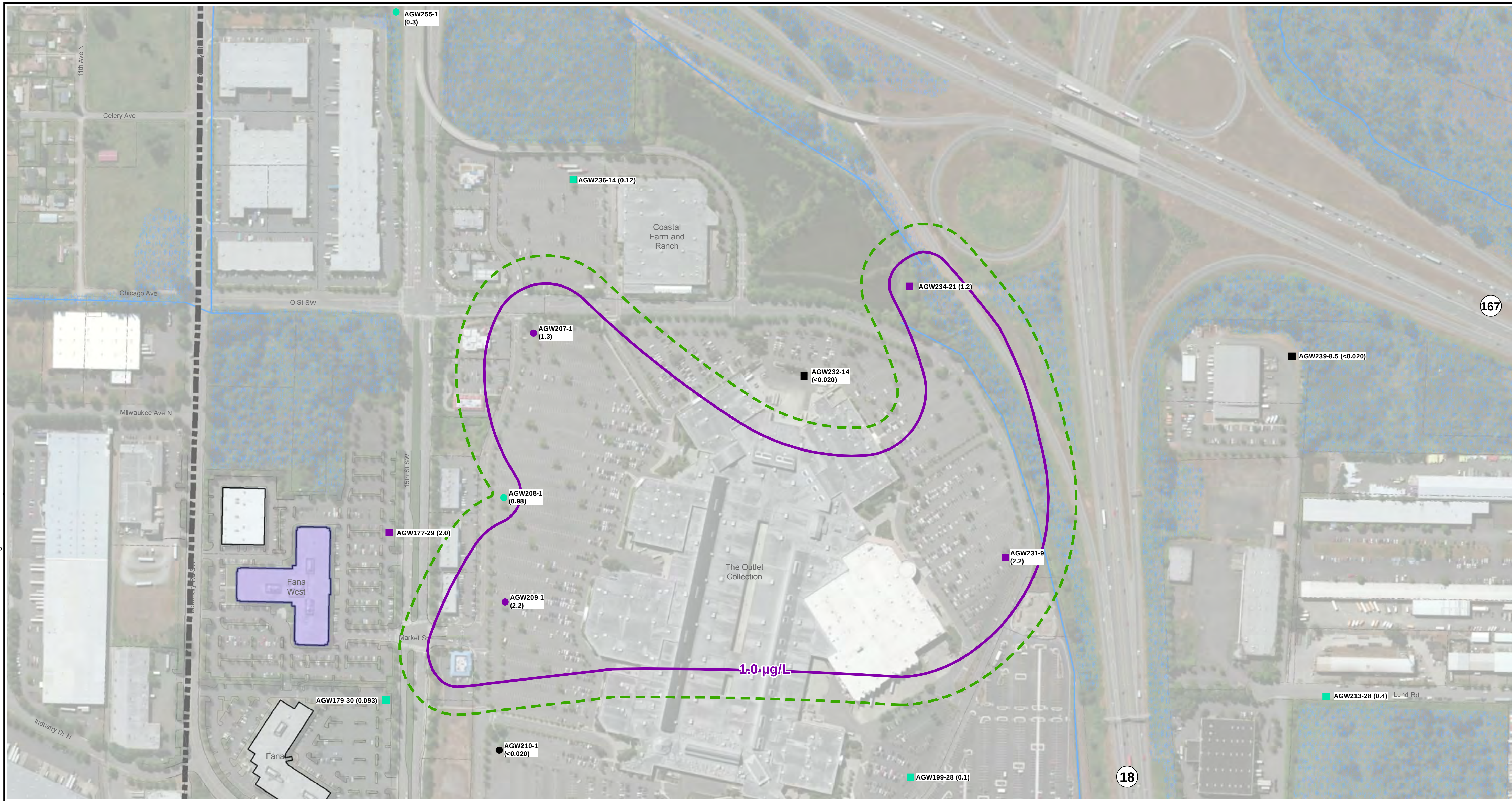


Data Source: Esri 2012

G:\Projects\025\164\120\105\VI Tier 2 WP\F01VicinityMap.mxd 2/5/2015 NAD 1983 StatePlane Washington North FIPS 4601 Feet

LANDAU ASSOCIATES

Boeing Auburn Auburn, Washington	**Vicinity Map**	Figure 1



Notes

1. Vinyl chloride (VC) concentrations are shown in µg/L and represent the most recent as of December 2014 shallow zone results. TCE data is not shown, but TCE exceedances of the commercial screening level contour are contained within the VC contour.
2. The applicable VC commercial screening level for shallow groundwater protective of indoor air is 1.0 µg/L.
3. The VC concentration data from channel 1 of the multi-level wells were used to develop the 1.0 µg/L contour since it is the shallowest screen.
4. Multi-level wells have multiple channels. Channel designations are included in the well ID (ex: AGW208-1). Channel 1 is the shallowest channel.
5. Borehole sample naming designations include the location name (e.g., AGW213) followed by the depth below ground surface in feet at which the sample was collected at time of drilling (e.g., 29).
6. Area around AGW177-29 previously investigated; no further investigation required.
7. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- Shallow Well
- Borehole Grab Sample
- Last VC Detection = < 1.0 µg/L
- Last VC Detection = ≥ 1.0 µg/L
- Non-Detect
- 100 ft Boundary
- VC Screening Level Contour = 1.0 µg/L
- Commercial Building Where Vapor Intrusion Assessments Have Been Conducted
- City Limits
- Waterways
- Wetland Areas

N

0 350 700

Scale in Feet

Base map source: Geometrix 2003; Aerial Photo Source: Esri World Imagery; Parcel Data Source: King County GIS 2013

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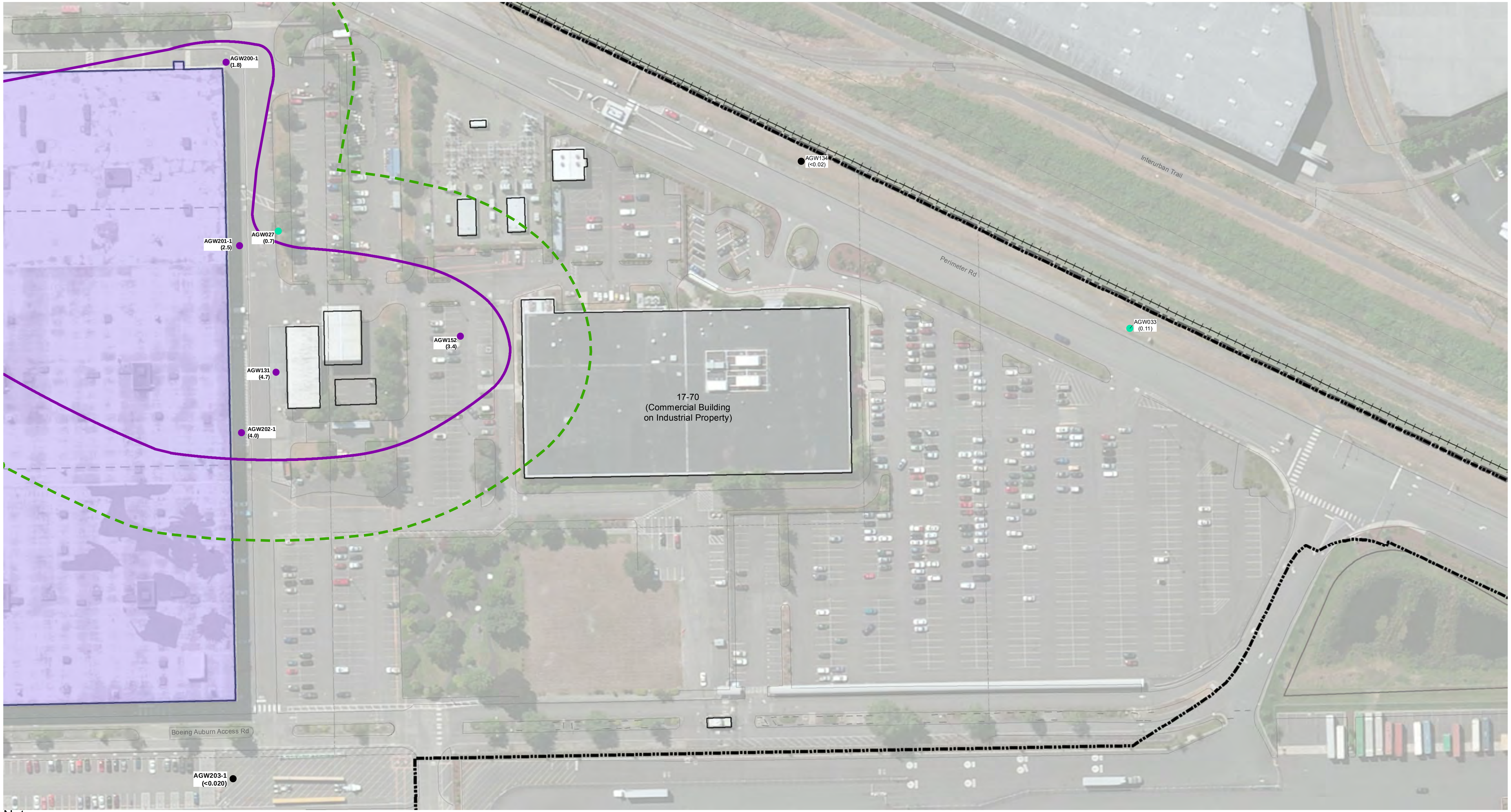
LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

Shallow Groundwater Vinyl Chloride Concentrations Commercial Auburn

Figure 2



G:\Projects\025\164\120\105\Vi Tier 2 WP\F03ShallowGWVC17-70.mxd 4/20/2015 NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes

1. Vinyl chloride (VC) concentrations are shown in µg/L and represent the most recent as of December 2014 shallow zone results. TCE data is not shown because TCE concentrations do not exceed the TCE commercial screening level within this area.
2. The applicable VC commercial screening level for shallow groundwater protective of indoor air is 1.0 µg/L.
3. The VC concentration data from channel 1 of the multi-level wells AGW200 through AGW203 were used to develop the 1.0 µg/L contour since it is the shallowest screen.
4. Multilevel wells have multiple channels, channel designations are included in the well ID (ex: AGW208-5). Channel 1 is the shallowest channel.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- Shallow Well
- Last VC Detection = < 1.0 µg/L
- Last VC Detection = ≥ 1.0 µg/L
- Non-Detect
- VC Screening Level Contour = 1.0 µg/L
- 100 ft Boundary
- Industrial Building Where Vapor Intrusion Assessments Have Been Conducted
- Boeing Property
- City Limits

N

0 120 240

Scale in Feet

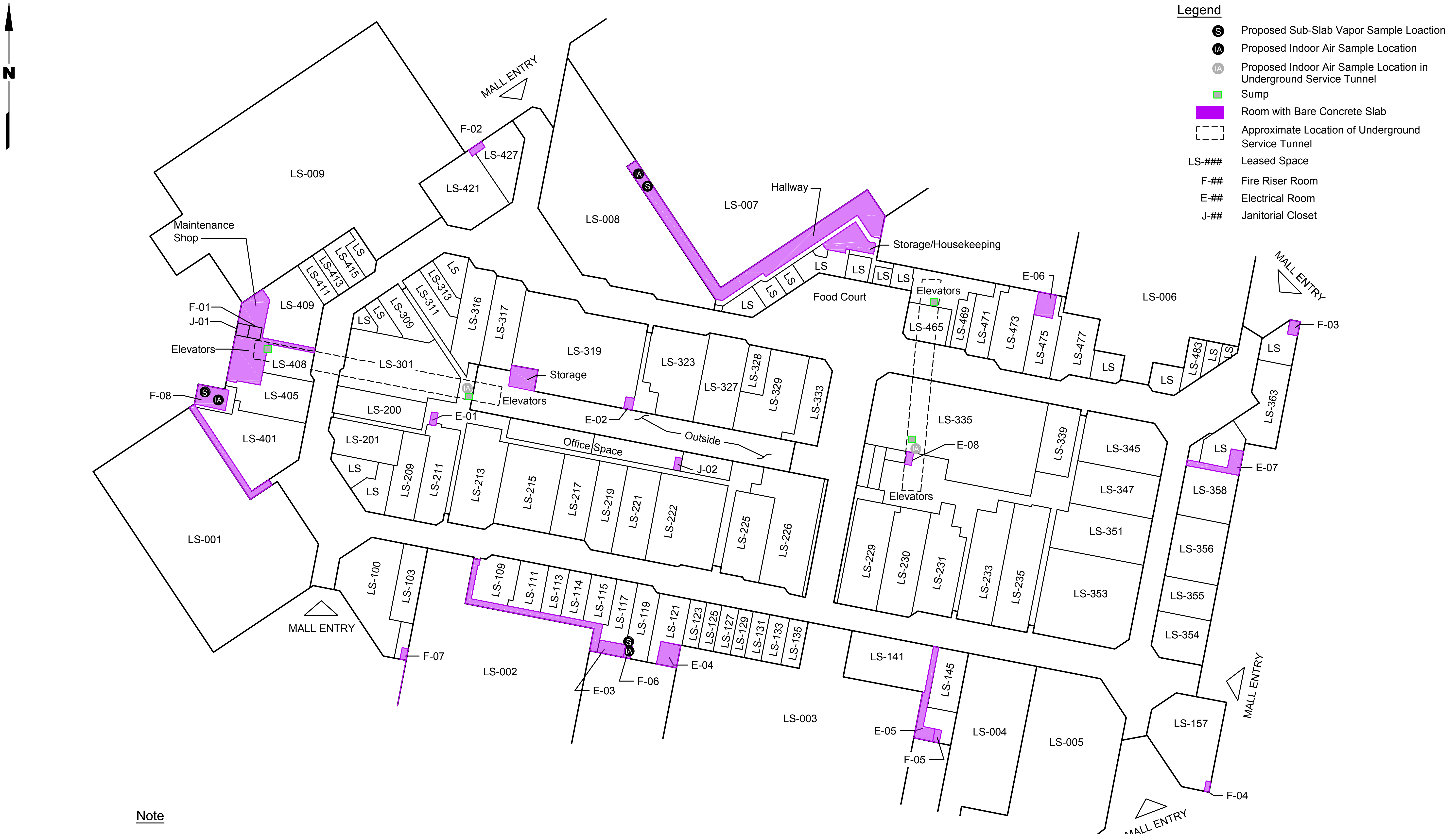
Base map source: Geometrix 2003; Aerial Photo Source: Esri World Imagery; Parcel Data Source: King County GIS 2013

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

**Shallow Groundwater
Vinyl Chloride Concentrations
Building 17-70**

Figure 3



Source: Glimcher, 2014;

0 120 240
Scale in Feet

Note

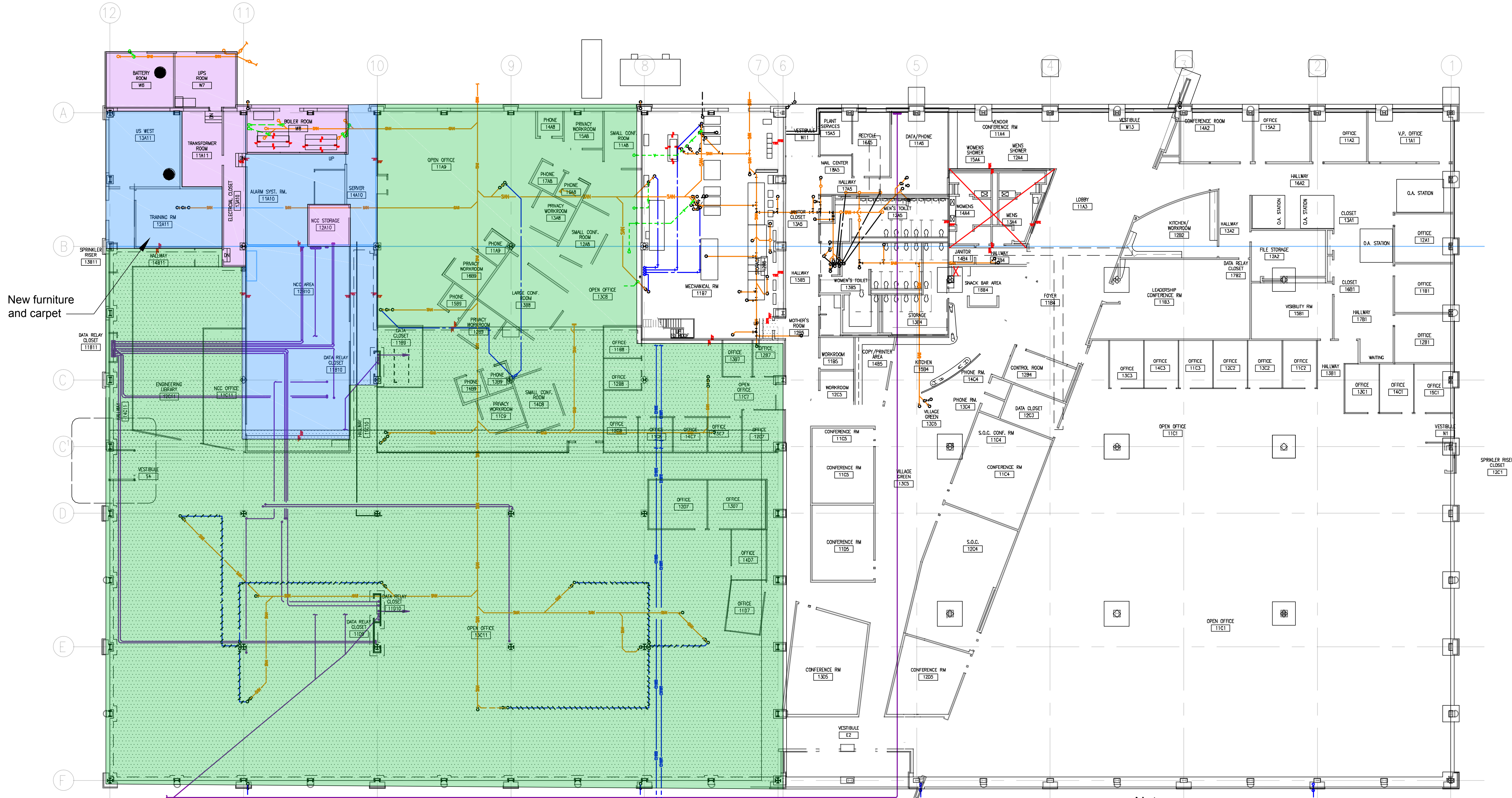
1. An ambient air sample will be collected from the roof. The actual sample location will be determined on the day of sampling and placed on the upwind side of the building.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

The Outlet Collection
Indoor Air and Sub-Slab Vapor Sampling Locations

Exhibit
4



Legend

- ● Co-located sub-slab soil vapor and indoor air sample location
- Top concrete slab rests on polystyrene foam which rests on slab-on-grade base.
- Raised floor with removable panels above slab-on-grade base.
- Slab-on-grade
- SAN Sanitary
- V Vent
- Fiber Optic Cable
- CHWS Cold Water Supply

N

0 30 60

SCALE IN FEET

Note

1. An ambient air sample will be collected from the roof. The actual sample location will be determined on the day of sampling and placed on the upwind side of the building.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Boeing Auburn Auburn, Washington	**Commercial Boeing Building 17-70 Indoor Air and Sub-Slab Soil Vapor Sampling Locations**	Figure 5

LANDAU ASSOCIATES

TABLE 1
COMMERCIAL VAPOR INTRUSION SCREENING AND INDOOR AIR ACTION LEVEL CRITERIA
BOEING AUBURN

	Air (µg/m³) (a)				Screening Levels Protective of Modified MTCA Method B Air SLs			
	Modified MTCA Method B (b)		EPA Region 10 Value	MTCA	Soil Gas (µg/m3)		Groundwater (µg/L) (d)	
Constituent of Concern	SL (Carc.)	SL (Non-Carc.)	IAAL Sub-Chronic (Non-Carc)(c)	IAAL Chronic Exposure Cumulative Excess Cancer Risk	SL (Carc.)	SL (Non-Carc.)	SL (Carc.)	SL (Non-Carc.)
TCE	1.9	6.0	8.4	1×10^{-5}	63	200	7.9	25
VC	0.85	300	--		28	10000	1.0	370

Carc. = Carcinogenic
EPA = U.S. Environmental Protection Agency
IAAL = Indoor Air Action Level
µg/m³ = Micrograms per Cubic Meter
µg/L = Micrograms per Liter
MTCA = Model Toxics Control Act
Non-Carc = Non-carcinogenic
SL = Screening Level
TCE = Trichloroethene
VC = Vinyl Chloride

Note:
Shaded = Most Conservative SL

(a) Air screening criteria will be applied to indoor air samples, crawl space, and basement air samples, and ambient air samples.
(b) Method for calculating modified MTCA Method B air SLs for commercial land use was defined by Washington State Department of Ecology (Ecology) in their comments to the draft vapor intrusion data report.
(c) The sub-chronic non-carcinogenic indoor air action level comes from the EPA Region 10 (EPA 2012). Ecology has requested that Boeing apply this value as an IAAL when air sampling is conducted where a woman of child bearing age works or visits regularly. Once EPA Office of Solid Waste and Emergency Response determines an official value, the EPA Region 10 sub-chronic value will be replaced.
(d) The Henry's Law constant used to calculate the shallow groundwater screening level assumes a temperature of 13 degrees Celsius per the U.S. temperature map provided by the EPA. Online Tools for Site Assessment Calculation for Henry's Law Constants.

TABLE 2
LABORATORY ANALYTICAL METHODS AND
TARGET LIMITS OF QUANTITATION FOR AIR SAMPLES
BOEING AUBURN

Analyte	Target LOQs - Air Toxics (a,b,e) 1-Liter Canister TO-15 Standard (f)	Target LOQs - Air Toxics (a,b,e) 6-Liter Canister TO-15 Low Level (g)	Soil Vapor SLs (c)	Indoor Air SLs
VOCs	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**
TCE	7.10	0.94	63	1.9
cis-1,2-DCE	5.30	0.69	--- (d)	--- (d)
VC	3.40	0.46	28	0.85

cis-1,2-DCE = cis-1,2-Dichloroethene
LOQ = Limit of Quantitation
µg/m³ = micrograms per cubic meter
SL = Screening Level
TO = Toxic Organic
TCE = Trichloroethene
VC = Vinyl Chloride
VOC = Volatile Organic Compound
--- = Preliminary screening level not established

(a) Target LOQs are based on current laboratory data and may be modified during the investigation process as methodology is refined.
(b) The Eurofins-Lancaster California Air Toxics branch is the proposed primary air lab.
(c) Soil gas SLs have been developed in accordance with methods recommended by Ecology (Ecology 2012a; Jones, E. 2012). Soil gas SLs have been calculated by applying a vapor attenuation factor of 0.03 to standard MTCA Method B air cleanup levels from the CLARC database, which is applicable to shallow soil gas samples.
(d) Air cleanup levels, the basis for calculating soil gas SLs, are not calculated under MTCA for cis-1,2-DCE due to insufficient data (Ecology 2010). Analysis of cis-1,2-DCE is conducted to provide information regarding the distribution of chlorinated solvent degradation products, per a recent Ecology comment letter (Ecology 2012b).
(e) LOQs assume a post-sample canister vacuum of 7 in. Hg and no analytical dilution. A lower post-sample canister vacuum would result in a slightly lower LOQ. The target post-sample canister vacuum is typically 5 in. Hg.
(f) TO-15 standard analysis is proposed for use on soil gas samples.
(g) TO-15 low-level analysis is proposed for use on indoor air sample.

APPENDIX A

Health and Safety Plan

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

**WORK LOCATION PERSONNEL PROTECTION
AND SAFETY EVALUATION FORM**

**Attach Pertinent Documents/Data
Fill in Blanks <u>As Appropriate</u>**

Job No.:	025164.110.105	Revised:	
Prepared by:	Sierra Mott	Reviewed by:	Christine Kimmel
Date:	August 13, 2014	Date:	August 13, 2014

A. WORK LOCATIONS DESCRIPTION

1. **Project Name:** Boeing Auburn, Site-wide Corrective Action
2. **Location:** Auburn, Washington
3. **Anticipated Activities:** Advancement of approximately 50 direct-push probes, groundwater sampling and soil gas sampling. Locations in immediate vicinity of The Outlet Collection. Up to 2 weeks of night work.
4. **Size:** Approximately 42 acres
5. **Surrounding Population:** Mixed industrial, commercial, and residential
6. **Buildings/Homes/Industry:** Industrial buildings, roadways, parking areas, commercial stores, residential areas
7. **Topography:** Flat pavement or unpaved surface, short and steep slopes, nearby ponds, ditches, and wetlands
8. **Anticipated Weather:** 25 to 70 degrees Fahrenheit, chance of rain and freezing conditions
9. **Unusual Features:** Working in the roadway and parking lots in commercial areas.
10. **Site History:** Various areas of the Boeing Auburn facility were designated Areas of Concern or Solid Waste Management Units during the 1998 Resource Conservation Recovery Act facilities assessment conducted by the U.S. Environmental Protection Agency. Remedial investigation will be conducted on site and off site to address volatile organic compounds present in soil and groundwater.

B. HAZARD DESCRIPTION

1. Background Review: ☒ Complete ☐ Partial

If partial, why?

2. Hazardous Level: ☐ B ☐ C ☒ D ☐ Unknown

Justification: Existing data regarding site conditions

3. Types of Hazards: (Attach additional sheets as necessary)

A. ☒ Chemical ☒ Inhalation ☐ Explosive
☐ Biological ☒ Ingestion ☐ O2 Def. ☒ Skin Contact

Describe: sampling of soil and groundwater potentially impacted by VOCs;

B. ☒ Physical ☒ Cold Stress ☒ Noise ☐ Heat Stress ☐ Other

Describe: Noise and physical hazards associated with working around a drill rig, pumps and hoses, and other heavy equipment at the Site. Potential for cold, wet weather.

C. ☐ Radiation

Describe:

4. Nature of Hazards:

☒ Air	Describe: Potential for volatile constituents to be released from contaminated soil or groundwater.
☒ Soil	Describe: Potential for contact with or ingestion of contaminated soil.
☐ Surface Water	Describe:
☒ Groundwater	Describe: Potential for contact with or ingestion of contaminated groundwater.
☐ Other	Describe:

5. Chemical Contaminants of Concern ☐ N/A

The primary chemical contaminants of concern are VOCs. The table below lists information for these primary compounds and other potential contaminants.

Contaminant	PEL (ppm)	I.D.L.H. (ppm)	Source/Quantity Characteristics	Route of Exposure	Symptoms of Acute Exposure	Instruments Used to Monitor Contaminant
Trichloroethene	50 ppm	1,000 ppm	Present in groundwater	Inhalation, ingestion, dermal contact,	Eye, nose, and throat irritation; headache; nausea	PID
Vinyl Chloride	1 ppm	Unknown (carcinogen)	Present in groundwater	Inhalation, ingestion, dermal contact	Weakness, abdominal pain	Colorimetric tubes
cis-1,2-Dichloroethene	200 ppm	1,000 ppm	Present in groundwater	Inhalation, ingestion, dermal contact	Dizziness, nausea, dermatitis, irritation of mucous membranes	PID
Tetrachloroethene	25 ppm	150 ppm	Present in groundwater	Inhalation, ingestion, dermal contact	Eye, nose, skin and throat irritation; nausea; flushed face and neck; dizziness, incoherent; drowsy	PID

Notes:

ppm: parts per million
PID: Photoionization Detector
PEL: Personal Exposure Limit
IDLH: Immediately Dangerous to Life and Health
STEL: Short-Term Exposure Limit

6. Physical Hazards of Concern ☐ N/A

Hazard	Description	Location	Procedures Used to Monitor Hazard
Moving parts of drill rig, falling and flying objects		Near drill rig for monitoring well installation	Alert observation of surroundings; minimize time spent near drill rig and get drillers attention before approaching drill head; no loose clothing; use of safety glasses, hard hat, and steel-toed boots.
Road hazards from working along roadways		Monitoring well locations that are in public right-of-way	Use of flaggers and traffic control, alert observation of surroundings, wear brightly colored safety vest.
Weather Stress	Exposure to hot or cold temperatures, wind, and or rain.	All areas of the site	Have drinking water accessible, wear appropriate clothing (light for heat, warm for cold), wear sunscreen protection, avoid caffeine, and take short breaks as needed.
Slips, Trips, and Falls	Uneven terrain and drilling equipment	Around work area	Visual observations of terrain and hazards. Keep work area clear of debris.
Overhead and Underground Utilities	Damage to utilities through drilling and excavations	In work area	Client to provide utility maps and a public and private utility locating service will be utilized. No raised towers within 20 ft of overhead power lines.
Travel to and from site	Operating motor vehicle in traffic on highways and rural roads.	Route to and from site from Landau Associates office.	Operate motor vehicle while well rested and physically able to drive safely. Conduct pre-trip vehicle inspection, all vehicles to be maintained and in good working order. Obey all traffic laws including no cell phone use while driving. Secure all cargo properly to avoid shifting. Allow sufficient time for travel to site at safe speeds. Engage emergency brake when parking vehicles. Establish a planned route prior to departure.
Working at Night	Approximately 75% of the work included in this HASP will take place at night.	Drilling locations on The Outlet Collection (Glimcher) property.	Drillers will implement a light plan. Stay well rested. Communicate throughout shift as to everyone's ability to complete the job in a safe manner. If a team member appears fatigued or verbally expresses extreme tiredness, stop work immediately.

7. Work Location Instrument Readings ☐ N/A

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

8. Hazards Expected In Preparation For Work Assignment ☒ N/A

Describe:

C. PERSONAL PROTECTIVE EQUIPMENT

1. Level of Protection

☐ A ☐ B ☐ C ☒ D

Location/Activity: All

☐ A ☐ B ☒ C ☐ D

Location/Activity: Upgrade to Level C PPE if ambient air conditions meet target monitoring level in Attachment A

2. Protective Equipment (specify probable quantity required)

Respirator ☐ N/A

☐ SCBA, Airline
☐ Full-Face Respirator
☒ Half-Face Respirator (Cart. organic vapor) (Only if upgrade to Level C)
☐ Escape mask
☐ None
☐ Other:
☐ Other:

Clothing ☐ N/A

☐ Fully Encapsulating Suit
☐ Chemically Resistant Splash Suit
☒ Safety Vests
☒ Tyvek Coverall (only if upgrade to Level C)
☐ Saranex Coverall
☐ Coverall, Specify
☐ Other:

Head & Eye ☐ N/A

☒ Hard Hat
☐ Goggles
☐ Face Shield
☒ Safety Eyeglasses
☒ Other: Hearing protection

Hand Protection ☐ N/A

☐ Undergloves; Type:
☒ Gloves; Type: Nitrile
☐ Overgloves; Type:
☐ None
☐ Other:

Foot Protection ☐ N/A

☐ Neoprene Safety Boots with Steel Toe/Shank
☐ Disposable Overboots
☒ Other: Steel-toed work boots

3. Monitoring Equipment ☐ N/A

☐ CGI ☒ PID

☐ O^2 Meter ☐ FID

☐ Rad Survey ☐ Other

☒ Detector Tubes (Attachment A)

Type:

D. PERSONNEL DECONTAMINATION (ATTACH DIAGRAM)

☒ Required ☐ Not Required

Avoid hand to mouth contact, no eating/drinking in exclusion zone. Wash hand and face after work shift and prior to breaks.

EQUIPMENT DECONTAMINATION (ATTACH DIAGRAM)

☒ Required ☐ Not Required

If required, describe and list equipment:

Decontamination of non-dedicated sampling equipment with Alconox/tap water solution followed by tap water rinse and deionized water rinse. Drill rig tooling will be decontaminated between borings by steam cleaning methods. All drill rig tooling will be decontaminated before leaving the job site.

E. PERSONNEL

	Name	Work Location Title/Task	Medical Current	Fit Test Current
1.	Kristin Hooper	Site Geologist	☒	☒
2.	Sarah Fees	Site Hydrogeologist	☒	☒
3.	Jennifer Wynkoop	Project Manager	☒	☒
4.	Ben Lee	Site Engineer	☒	☒
5.	Sierra Mott	Site Scientist	☒	☒
6.	Jamie Sloan	Site Scientist	☒	☒
7.			☐	☐
8.			☐	☐
9.			☐	☐
10.			☐	☐

Site Safety Coordinator: **Sierra Mott**

F. ACTIVITIES COVERED UNDER THIS PLAN

Task No.	Description	Preliminary Schedule
1	Direct-push probe drilling; groundwater sampling; soil gas sampling	Fourth Quarter 2014

EMERGENCY FACILITIES AND NUMBERS

Off Site

Hospital:
Auburn Regional Medical Center
202 N Division Street
Auburn WA 98001

Directions: Attachment B

Telephone: 253-833-7711

Emergency Transportation Systems (Fire, Police, Ambulance) – 911

Emergency Routes – Map (Attachment B)

Emergency Contacts:

	Offsite
Landau Associates	
Christine Kimmel	206-786-3801
Jennifer Wynkoop	206-617-3117
Boeing	
Jim Bet	206-679-0433
Fred Wallace	206-930-0461
Jennifer Parsons	206-715-7981

In the event of an emergency, do the following:

1. Call for help as soon as possible. Call Boeing dispatch and 911. Give the following information:
   - WHERE the emergency is – use cross streets or landmarks
   - PHONE NUMBER you are calling from
   - WHAT HAPPENED – type of injury
   - WHAT is being done for the victim(s)
   - YOU HANG UP LAST – let the person you called hang up first.

2. If the victim can be moved, paramedics will transport to the hospital. If the injury or exposure is not life threatening, decontaminate the individual first. If decontamination is not feasible, wrap the individual in a blanket or sheet of plastic prior to transport.

HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Sierra Mott Site Safety Coordinator	Signature	Date
Christine Kimmel Landau Associates' Health and Safety Manager	Signature	Date
Jennifer Wynkoop Project Manager	Signature	Date

Personnel Health and Safety Briefing Conducted By:

Name	Signature	Date

ATTACHMENT A

PROCEDURES AND ACTION LEVELS
FOR RESPIRATORY PROTECTION

PROCEDURES

During drilling, exposure monitoring for volatile organic compounds (VOCs) will be conducted in the workers' breathing zone before beginning work and periodically, thereafter, using a calibrated photoionization detector (PID) equipped with a 10.6 electron volt (eV) detector lamp. Monitoring of the breathing zone will consist of collecting PID readings from the approximate elevation and position of the most exposed workers' faces. While PID readings above background are not expected at this Site, action levels and safety steps are presented below in the event that VOCs are detected in the worker breathing zone. All PID readings will be recorded in a field notebook.

All air monitoring equipment used at this Site must be calibrated daily and operated by trained personnel. The PID will be calibrated using and a 100 parts per million (ppm) concentration of isobutylene gas. A contaminant-specific correction factor will not be entered into the PID during calibration, as these correction factors are accounted for in the action levels. The calibration of the equipment should be recorded on a calibration log.

ACTION LEVELS

Due to the low permissible exposure limit (PEL) for vinyl chloride (VC; 1 ppm), if PID readings for VOCs in the breathing zone are more than 1 ppm above background VOC concentrations (e.g., upwind, rig exhaust, ambient levels) for 1 minute, workers will be required to leave the area until the situation is adequately characterized using chemical-specific colorimetric detector tubes for VC. [Note: The lower detection limit of colorimetric gas detection tube to be used for VC must be below the VC action level of 1 ppm. The recommended colorimetric tube for this application is Dräeger No. 810721 (Vinyl Chloride 0.5/b 0.5 to 30 ppm)

ACTION LEVELS FOR RESPIRATORY PROTECTION		
Monitoring Parameter	**Reading**	**Level of Protection**
VOC ACTION LEVEL #1		
PID Screening		
VOCs	PID reading 0.3 to 0.9 ppm in breathing zone for more than 1 minute	Employ fans or engineering controls to reduce VOCs in work area if possible. Collect colorimetric tube VC readings and refer to action levels below.
Colorimetric Tubes		
VC	VC reading 0.1 to 1 ppm	Establish 25-ft-diameter exclusion zone around work area and upgrade to Level C-half face respirator with organic vapor/HEPA cartridge.
VC	VC reading > 1 ppm	Evacuate area and move upwind. Establish 50-ft-diameter exclusion zone around work area. Notify onsite contact and Landau Associates Project manager. Do not return to area of detection until VC < 1 ppm.
VOC ACTION LEVEL #2		
PID Screening		
VOCs	PID reading >1 ppm in breathing zone for more than 1 minute	Establish 25-ft-diameter exclusion zone around work area and upgrade to Level C-half face respirator with organic vapor/HEPA cartridge. Collect colorimetric tube VC and PCE readings and refer to action levels below.
Colorimetric Tubes		
VC	Follow ACTION LEVEL #1	Follow ACTION LEVEL #1
PCE	PCE reading 1 to 15 ppm	Establish 25-ft-diameter exclusion zone around work area and upgrade to Level C-half face respirator with organic vapor/HEPA cartridge.
PCE	PCE reading >15 ppm	Evacuate area and move upwind. Establish 50-ft-diameter exclusion zone around work area. Notify onsite contact and Landau Associates Project manager. Do not return to area of detection until PCE <15 ppm.
VOC ACTION LEVEL #3		
VOCs (PID)	PID reading >25 ppm **instantaneous** reading	Evacuate area and move upwind. Establish 50-ft-diameter exclusion zone around work area. Notify onsite contact and Landau Associates Project manager. Do not return to area of detection until VOCs <25 ppm.

ATTACHMENT B
OFF SITE WORK - ROUTE TO HOSPITAL

Start	Head NORTH on CELERY AVE toward BOUNDARY BLVD, From **Start Point (Celery Ave and 11th Ave N, Algona, WA)**
1	Go **0.1** miles and then TURN LEFT onto O ST
2	Go **0.1** miles and then TURN RIGHT onto 15th ST SW
3	Go **0.8** miles and then TURN LEFT onto C ST SW
4	Go **1.0** mile and then TURN RIGHT onto 3rd ST NW
5	Go **0.2** miles and then TURN RIGHT onto N DIVISION ST
End	Go **115** ft to **End Point on RIGHT (202 N Division St, Auburn, WA)**

APPENDIX B

Standard Operating Procedure Installation and Extraction of the Vapor Pin

Standard Operating Procedure
Installation and Extraction of the Vapor Pin™

May 20, 2011

Scope:

This standard operating procedure describes the installation and extraction of the Vapor Pin™[1] for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin™ for the collection of sub-slab soil-gas samples.

Equipment Needed:

- Assembled Vapor Pin™ [Vapor Pin™ and silicone sleeve (Figure 1)];
- Hammer drill;
- 5/8-inch diameter hammer bit (Hilti™ TE-YX 5/8" x 22" #00206514 or equivalent);
- 1½-inch diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch diameter bottle brush;
- Wet/dry vacuum with HEPA filter (optional);
- Vapor Pin™ installation/extraction tool;
- Dead blow hammer;
- Vapor Pin™ flush mount cover, as necessary;
- Vapor Pin™ protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel.

[1]Cox-Colvin & Associates, Inc., designed and developed the Vapor Pin™; a patent is pending.

Figure 1. Assembled Vapor Pin™.

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch diameter hole at least 1¾-inches into the slab.

4) Drill a 5/8-inch diameter hole through the slab and approximately 1-inch into the underlying soil to form a void.

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of Vapor Pin™ assembly into the drilled hole. Place the small hole located in the handle of the extraction/installation tool over the Vapor Pin™ to protect the barb fitting and cap, and tap the Vapor Pin™ into place using a

dead blow hammer (Figure 2). Make sure the extraction/installation tool is aligned parallel to the Vapor Pin™ to avoid damaging the barb fitting.

Figure 2. Installing the Vapor Pin™.

For flush mount installations, unscrew the threaded coupling from the installation/extraction handle and use the hole in the end of the tool to assist with the installation (Figure 3).

Figure 3. Flush-mount installation.

During installation, the silicone sleeve will form a slight bulge between the slab and the Vapor Pin™ shoulder. Place the protective cap on Vapor Pin™ to prevent vapor loss prior to sampling (Figure 4).

Figure 4. Installed Vapor Pin™.

7) For flush mount installations, cover the Vapor Pin™ with a flush mount cover.

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the Vapor Pin™ (Figure 5).

Figure 5. Vapor Pin™ sample connection.

10) Conduct leak tests [(e.g., real-time monitoring of oxygen levels on extracted sub-slab soil gas, or placement of a water

dam around the Vapor Pin™) Figure 6]. Consult your local guidance for possible tests.

Figure 6. Water dam used for leak detection.

11) Collect sub-slab soil gas sample. When finished sampling, replace the protective cap and flush mount cover until the next sampling event. If the sampling is complete, extract the Vapor Pin™.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the Vapor Pin™ (Figure 7). Continue

Figure 7. Removing the Vapor Pin™.

turning the tool to assist in extraction, then pull the Vapor Pin™ from the hole (Figure 8).

Figure 8. Extracted Vapor Pin™.

2) Fill the void with hydraulic cement and smooth with the trowel or putty knife.

3) Prior to reuse, remove the silicone sleeve and discard. Decontaminate the Vapor Pin™ in a hot water and Alconox® wash, then heat in an oven to a temperature of 130° C.

The Vapor Pin™ to designed be used repeatedly; however, replacement parts and supplies will be required periodically. These parts are available on-line at www.CoxColvin.com.

Replacement Parts:

Vapor Pin™ Kit Case - VPC001
Vapor Pins™ - VPIN0522
Silicone Sleeves - VPTS077
Installation/Extraction Tool - VPIE023
Protective Caps - VPPC010
Flush Mount Covers - VPFM050
Water Dam - VPWD004
Brush - VPB026