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LIST OF ABBREVIATIONS AND ACRONYMS

°C .... degrees Celsius
µS/cm .... microsiemens per centimeter
AOC .... Area of Concern
ATD .... at time of drilling
bgs .... below ground surface
Boeing .... The Boeing Company
COC .... contaminant of concern
DC .... Developmental Center
DO .... dissolved oxygen
Ecology .... Washington State Department of Ecology
EIM .... Environmental Information Management
EPA .... US Environmental Protection Agency
ft .... feet, foot
GPS .... Global Positioning System
IDW .... investigation-derived waste
L/min .... liters per minute
LAI .... Landau Associates, Inc.
LDW .... Lower Duwamish Waterway
LDPE .... low-density polyethylene
mL .... milliliter
mL/min .... milliliters per minute
mV .... millivolts
NTU .... nephelometric turbidity units
OAR .... Boeing Onsite Activities Representative
ORP .... oxidation reduction potential
PAH .... polycyclic aromatic hydrocarbon
PCB .... polychlorinated biphenyl
PID .... photoionization detector
ppm .... parts per million
PVC .... polyvinyl chloride
QA/QC .... quality assurance/quality control
QAPP .... quality assurance project plan
RI .... remedial investigation
RI work plan .... Boeing DC Remedial Investigation Work Plan
SAP .... sampling and analysis plan
SWMU .... Solid Waste Management Unit
TPH .... total petroleum hydrocarbons
TPH-D .... diesel-range total petroleum hydrocarbons

LIST OF ABBREVIATIONS AND ACRONYMS (CONT'D)

TPH-G .... gasoline range total petroleum hydrocarbons
TPH-O .... oil-range total petroleum hydrocarbons
USCS .... Unified Soil Classification System
UST .... underground storage tank
VOC .... volatile organic compound
WAC .... Washington Administrative Code

1.0 INTRODUCTION

Landau Associates, Inc. (LAI) prepared this sampling and analysis plan (SAP), which describes the procedures for conducting field activities during the remedial investigation (RI) at The Boeing Company's (Boeing's) Developmental Center (DC) in Tukwila, Washington (Figure A-1). This SAP is an appendix to the Boeing DC Remedial Investigation Work Plan (RI work plan). The primary objective of this SAP is to provide sampling and analysis procedures and methodologies consistent with accepted procedures such that the data collected will be adequate for use in characterizing environmental conditions at the site. This SAP was prepared in accordance with the requirements of Washington Administrative Code (WAC) 173-340-820.

This SAP addresses RI field work, during which samples of soil and groundwater will be collected at Areas of Concern (AOCs), Solid Waste Management Units (SWMUs), and other areas of interest at the DC facility. The anticipated number of samples and analyses for each medium are summarized in Table A-1, which also describes the anticipated sampling activities for each of the following investigation areas:

- AOC-01/02: former fuel underground storage tanks (USTs)
- AOC-03/04: former No. 5 oil USTs
- AOC-05: former unleaded gasoline UST
- SWMU-16: former regulated materials storage area
- SWMU-17: former sump and UST
- SWMU-20: former degreaser pit
- SWMU-43: stormwater sewer system
- Gate J-28/Museum of Flight
- Groundwater Seeps
- Bank Erosion.

The following sections describe the field procedures to be employed for the planned sampling activities.

2.0 SOIL AND GROUNDWATER SAMPLING

Continuous soil samples will be collected from borings drilled using a direct-push drill rig. Borings will be advanced to the water table or to a total depth consistent with previous explorations, depending on the media being sampled in the area of investigation. Soil borings will be used for soil and/or groundwater grab sampling. Borings will be decommissioned according to the Minimum Standards for Construction and Maintenance of wells (WAC 173-160-460) immediately after sampling (Section 2.3).

All borings will be completed by a driller licensed in the State of Washington and will be monitored by an environmental professional. Prior to initiation of drilling or any other intrusive subsurface activity, any available utility maps provided by Boeing will be reviewed to identify major utilities in the vicinity of the proposed exploration locations. Additionally, a public utility locate service will be contacted to confirm the location of and identify other underground utilities in the vicinity of the proposed locations. The final location for each boring will be selected based on the findings of the utility locating and map review. The Boeing Onsite Activities Representative (OAR) will review the boring locations relative to the utility clearance information and sign a Boeing Pre-Dig Utility Clearance Checklist prior to drilling. Before and between drilling of each boring and at the completion of the project, downhole drilling equipment will be cleaned, as described in Section 9.0.

During drilling, continuous soil samples will be collected at all soil boring locations to classify soil lithology in accordance with the Unified Soil Classification System (USCS). Soil samples will be collected using a closed-piston sampling device with a 48-inch-long, 1.5-inch-diameter core sampler. A record of the soil and groundwater conditions observed during drilling will be recorded on a Log of Exploration form. Example forms are provided in the quality assurance project plan (QAPP; Appendix B of the RI work plan). The log of exploration (i.e., boring log) will also show soil types, evidence of contamination based on field screening, and other pertinent information. Discrete soil grab samples will be collected at soil borings in select investigation areas at several depths and sent to a laboratory for analysis. Sample descriptions and other relevant information will be recorded on a sample collection form.

2.1 Field Screening

Soil and groundwater will be field-screened for evidence of environmental impact. Field-screening techniques may include visually inspecting the soil or groundwater for staining, discoloration, and other evidence of environmental impact. Field screening will be conducted at all exploration locations on all media. Volatile organic compound (VOC) monitoring for soil will be conducted using headspace analysis and will be performed by first measuring VOC levels along the length of freshly exposed soil in recovered soil cores using a photoionization detector (PID). If VOC readings above background levels are observed, a small amount of soil from that portion of the soil core yielding the VOCs will be placed in a Ziploc® bag. The bag will then be sealed, the contents broken up, and the bag allowed to equilibrate for 2–5 minutes. Tubing will be attached to the PID and inserted into the Ziploc bag. The bag will be resealed around the tube and the highest reading measured by the PID will be recorded and entered in the comments section of the soil boring logs. Additionally, any PID readings of more than 5 parts per million (ppm) will be noted on the chain-of-custody form to communicate the potential need for dilution to the laboratory; 5 ppm is the threshold as readings below 5 ppm are commonly caused by interference.

If field screening of a soil sample boring indicates the potential presence of contaminants of concern (COCs) at an interval not specified for sampling in the RI work plan, an additional soil sample will be collected at that interval for analysis, and a record of the depth(s) of the soil sample will be recorded. Groundwater samples will be observed for evidence of sheen, odor, and discoloration; observations will be recorded on the appropriate form. Example forms are provided in the QAPP (Appendix B of the RI work plan).

2.2 Soil Sampling

This section discusses soil sampling methodology. Please refer to Section 6.0 of the RI work plan for a discussion of soil sampling locations, sampling intervals, and analytical methods. Sample containers, labeling, and handling methods are discussed below.

Soil samples to be tested for non-volatile parameters (i.e., metals, polychlorinated biphenyls [PCBs], and diesel- and oil-range total petroleum hydrocarbons [TPH]) will be collected from the identified soil sampling intervals using the following methods:

- Scrape the outside of the soil core to expose a fresh sampling surface using a clean, decontaminated stainless steel spoon.
- Using a new, stainless steel spoon, collect soil from the desired interval that did not contact the sides of the tooling/core container.
- Homogenize the soil in a decontaminated stainless-steel bowl using the stainless-steel spoon.
- Transfer the homogenized soil into the appropriate laboratory-supplied sample containers, which includes the extra container(s) for the PCB split sample (see Section 4.0). No special sampling procedures or equipment are necessary for PCB soil sampling.
- Immediately place all sample containers in a pre-chilled cooler and provide PCB split sample container(s) and chain-of-custody form to Ecology representative overseeing sampling.
- If used for collection of samples for analysis by US Environmental Protection Agency (EPA) Method 1668C, collect a rinsate blank from stainless-steel bowl and stainless-steel spoon following decontamination (Section 10.2). Rinse decontaminated sampling tools with purified deionized water from the laboratory and collect samples of the rinse water for analysis by EPA Method 1668C. One rinsate blank will be collected at each sampling location (i.e., each boring), per the QAPP (Appendix B of the RI work plan).

Soil samples collected for analysis for volatile parameters (e.g., gasoline-range TPH and any VOCs including benzene, toluene, ethylbenzene, and xylenes) will be collected in accordance with EPA

Method 5035A. The EPA 5035A soil sampling method is intended to reduce volatilization and biodegradation of samples. The EPA 5035A procedure for soil sample collection is as follows:

- Collect soil samples as soon as possible after the polyethylene sleeve is cut open. Collect the sample using a coring device (i.e., EnCore® sampler, EasyDraw Syringe®, or a Terra Core™ sampling device). Each sample will consist of three, approximately 5-gram, samples from each depth interval sampled.
- Remove excess soil from the coring device. If an EasyDraw Syringe or Terra Core sampling device is used for sample collection, then place the "cored" soil directly into three, pre-weighed (by the analytical lab), preserved 40 milliliter (mL) vials with a stirbar. Vials will be preserved as indicated in Table A-2. If the EnCore sampler is used, then close the sampler for transport to the laboratory.
- Collect 2 ounces of soil and place in a laboratory-supplied jar for moisture content analysis and laboratory screening purposes. Fill the jar to minimize headspace.

Soil samples collected for laboratory analysis will be documented on a sample collection form. Samples collected in SWMU-43 will be labeled using the following format:

"DA(Drainage area #)-(ID #)-(depth interval range ')"

Samples collected in all other investigation areas will be labeled using the following format:

"(Area location prefix)-RISB-(ID #)-(depth interval range ')"

For example, a soil sample collected between 7 and 10 feet (ft) below ground surface (bgs) at RISB-1 in AOC-01/02 would be A0102-RISB-1-(7-10'). A soil sample collected between 7 and 10 ft bgs at DA01-1 in Drainage Area 1 of SWMU-43 would be DA01-1-(7-10').

2.3 Groundwater Grab Sampling

This section discusses groundwater grab sampling methodology. Please refer to Section 6.0 of the RI work plan for a discussion of groundwater grab sampling locations and analytical methods. Sample containers, labeling, and handling methods are discussed below.

Groundwater grab samples will be collected in SWMU-20, SWMU-43, and the Museum of Flight; a total of 22 direct-push borings will be sampled for laboratory analysis, as presented in Table A-1. The groundwater samples will be collected using a groundwater sampler consisting of a 4-ft-long, wire-wrapped, stainless-steel screen (0.010-inch slot size) with a retractable protective steel sheath. The groundwater sampler will be advanced to the sample depth and the protective sheath will be retracted to expose the stainless-steel screen to the formation. Based on field conditions, temporary well points may be constructed with polyvinyl chloride (PVC) screens in the boreholes and used for sample collection; temporary well points will be removed and decommissioned after sampling. Low-flow purging and sample collection will generally be conducted in accordance with procedures described in Section 3.3 of this SAP, with the following exceptions:

- Per the EPA procedure for developing and sampling from temporary wells, peristaltic pumps will be used for groundwater grab sampling from soil borings instead of bladder pumps.[1] Grab samples from soil borings can be much more turbid than samples collected from highly developed monitoring wells; peristaltic pumps are much more effective at reducing turbidity, as these pumps are able to pull water at a higher flow rate. Additionally, the small diameter of direct-push groundwater sampling tooling prevents the use bladder pumps.
- A time limit of 20 minutes will be set for monitoring field parameters during purging prior to sampling groundwater from temporary wells. Purging is typically considered to be complete when all field parameters become stable for three successive readings. This can take longer for grab samples, as the temporary well is not developed using traditional methods and the groundwater in the boring is not at equilibrium with the surrounding aquifer material. Per the EPA groundwater sampling procedure,[1] "the longer a temporary well is in place and not sampled, the more stagnant the water column becomes and the more appropriate it becomes to apply standard permanent monitoring well purging criteria to achieve representative aquifer conditions in the sample." The sample will no longer be considered a grab sample if purging continues for too long in a temporary well.

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The groundwater grab samples collected from SWMU-43 soil borings will be labeled using the following format:

"DA(Drainage area #)-(ID #)-GW(depth interval range ')"

Grab samples collected from soil borings in all other investigation areas will be labeled using the following format:

"(Area Location prefix)-RISB-(ID #)-GW(depth interval range')"

For example, a groundwater grab sample collected at RISB-11 in SWMU-20 would be SWMU20-RISB-11-GW(12-16'). A groundwater grab sampled collected at DA14-1 in Drainage Area 14 of SWMU-43 would be DA14-1-GW(12-16').

Following sample collection, immediately place all sample containers in a pre-chilled cooler and provide PCB split sample container(s) and chain-of-custody form to the Ecology representative overseeing sampling (see Section 4.0).

As some of the groundwater grab sampling locations are located in close proximity to the Lower Duwamish Waterway (LDW), there is a potential for the locations to be within the surface water/groundwater transition zone. The Washington State Department of Ecology (Ecology) has concerns that groundwater sampled within this zone will be diluted by the surface water and not representative of localized contamination. The location of the transition zone has not been evaluated at the DC, so it will be evaluated based on data collected during the RI. Field parameters (i.e., conductivity, pH, etc.) collected during groundwater sampling will be compared to available data at

[1] EPA. 2017. Operating Procedure: Groundwater Sampling. Procedure No. SESDPROC-301-R4. Region 4, US Environmental Protection Agency, Science and Ecosystem Support Division. April 26.

wells located in the center of the site to evaluate how far inland the transitional zone extends. Conductivity, as an indicator of salinity, is of particular interest, as it will indicate if the groundwater sampled is fresh, brackish, or salt water. Conductivity values for freshwater, brackish water, and sea water are as follows:[2]

- Freshwater = 0–1,000 microsiemens per centimeter (µS/cm)
- Brackish water = 1,000–46,000 µS/cm
- Sea water = 46,000–72,000 µS/cm.

If the conductivity of a groundwater sample collected along the LDW is within the freshwater range listed above or is comparable to the average conductivity measured at an upgradient monitoring well, then samples will be considered undiluted. This data will be used to inform future locations of any additional groundwater sampling or monitoring well installation, as required.

2.4 Boring Decommissioning

Following soil and groundwater sample collection, all borings will be decommissioned according to Washington State regulations for resource protection wells (Section 173-160-460 WAC). Per the code, each soil boring not completed as a monitoring well will be decommissioned by sealing the boring from the bottom to land surface using bentonite chips, bentonite slurry, neat cement grout, or neat cement. Material used for sealing the boring below the water table will be placed from the bottom up using methods that avoid segregation or dilution of the sealing material. Application methods include dump bailers and a tremie tube. Above the water table, material can be hand-poured into the boring as the casing is being raised.

The ground surface will be returned to its original condition, or better, after decommissioning soil borings that were not completed as monitoring wells. Asphalt and cement will be patched to cover the bentonite (or other material) seal. Vegetation will be replanted, if necessary, and groundcover will be restored by raking, or other physical means. If working in a landscaped area, efforts will be made to disrupt existing conditions as little as possible during drilling so restoration work is minimal.

2.5 Ground Surface Elevation Survey

Groundwater elevation data will be collected for new sample locations as part of the RI. Depth to water will be measured at time of drilling (ATD) of soil borings for soil sampling and groundwater grab sampling. The difference between the ground surface elevation of the soil boring and the depth to water at that location is the groundwater elevation.

[2] Sensorex. 2017. "Making Sense of Conductivity, TDS, and Concentration in Water Treatment." Sensorex, Inc. November 9. https://sensorex.com/blog/2017/11/09/electrical-conductivity-of-water/.

The ground surface elevation and geographic location of all new subsurface explorations during the RI will be surveyed as soon as possible following drilling. Services will be provided by a licensed land surveying firm.

3.0 MONITORING WELL INSTALLATION, DEVELOPMENT, AND SAMPLING

Procedures for installing and developing monitoring wells and collecting groundwater samples from the monitoring wells are described below. No new permanent monitoring wells are currently planned for the RI. Data collected from temporary groundwater and soil locations will be evaluated to determine if monitoring well installation is necessary.

3.1 Installation and Construction of Monitoring Wells

Boreholes for groundwater monitoring wells, if installed, will be drilled using direct-push, hollow stem auger, or rotosonic drilling equipment. Drilling, field screening, soil sampling, and soil logging procedures are described in Section 2.0. Monitoring wells will be constructed by a Washington-licensed drilling contractor, in accordance with the Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC). Oversight of drilling and well installation activities will be conducted by an environmental professional familiar with environmental sampling and construction of resource protection wells. Soil boring information will be recorded on a Log of Exploration form during drilling, and monitoring well construction details will be recorded on an As-Built Well Completion form. Example forms are provided in the QAPP (Appendix B of the RI work plan).

Because the DC facility boundary along the LDW is tidally influenced, if monitoring wells are to be installed in close proximity to the LDW, they must be installed at a depth such that that sampling can occur at low tide (i.e., do not go dry) and so that saline water from the underlying salt water wedge is not encountered during sampling (not installed in the saltwater/freshwater transition zone). As a result, monitoring wells will not be installed until Boeing and Ecology agree on the approximate top depth and horizontal extent of the transition zone.

Monitoring wells will be constructed with 2-inch-diameter, flush-threaded, Schedule 40 PVC pipe. Well screen lengths may vary depending on installation location conditions, but well screen material will be Schedule 40 PVC with 0.010- or 0.020-inch slots. A filter pack material consisting of pre-washed, pre-sized number 12-20 silica sand (or equivalent) will be placed from the bottom of the well to between 1 and 2 ft above the top of the screen. Filter pack material will be placed slowly and carefully to avoid bridging of material. Well construction details are presented on Figure A-2.

A bentonite seal will be placed above the filter sand pack material to within approximately 3 ft of ground surface (Figure A-2). The seal will consist of bentonite chips. Concrete will be used to backfill the boring to the subgrade for placement of the protective cover. The wells will be completed with either aboveground or flush-mounted protective casings depending on installation location.

The well names and the identification numbers assigned by Ecology will be marked on the well identification tags supplied by Ecology. The tags will be attached to each well casing (inside the well monument) following well installation. Ecology tag numbers must be recorded on the As-Built Well Completion form. An example form is provided in the QAPP (Appendix B of the RI work plan).

3.2 New Well Development and Existing Well Redevelopment

Redevelopment of existing monitoring wells at the DC will be performed prior to sampling for the RI if the monitoring well has not been sampled in the last 5 years. Development of monitoring wells installed at part of this RI will follow this development process no sooner than 72 hours after installation to allow the bentonite seal material to fully hydrate.

Development will be achieved by repeatedly surging the well with a surge block and purging the well at a high flow rate with a Honda or battery-operated submersible pump until the water runs clear or at least 10 well casing volumes have been removed, whichever comes first. During development, the purged groundwater will be monitored for turbidity. “Clear” for the purposes of well development means that the turbidity of purged groundwater decreases to 5 nephelometric turbidity units (NTU). If the well dewaters (i.e., runs dry) during the initial surging and purging effort, one final well casing volume will be removed after the well has fully recharged, if practicable. Well development activities will be recorded on a Well Development form. An example form is provided in the QAPP (Appendix B of the RI work plan).

During a site reconnaissance in September 2019, the presence and condition of existing monitoring wells in areas not regularly sampled (i.e., not in AOC-05, SWMU-17, or SWMU-20) was investigated based on the most recent site figures available. Monitoring wells on the Museum of Flight property were not located during site reconnaissance. Existing monitoring wells were observed in AOC-01/02. These wells have not been sampled since 2002 but are still in suitable condition for sampling (i.e., monument and lid remains in-tact, casing appears undamaged, etc.). The sampling of AOC-01/02 wells is proposed as part of the RI; these wells will be redeveloped prior to sampling according to the procedures described above.

3.3 Monitoring Well Groundwater Sample Collection

Groundwater samples will be collected from monitoring wells at least 48 hours after well development. Water levels will be measured prior to sample collection. Groundwater samples will be collected at each monitoring well using low-flow sampling techniques and the following procedures:

- Immediately following removal of each well monument cover, the well head will be observed for damage, leakage, and staining. Additionally, immediately following removal of the well head cap, any odors will be documented, and the condition of the well opening will be observed. Any damage, leakage, or staining to the well head or well opening will be documented on the sample collection form. An example form is provided in the QAPP (Appendix B of the RI work plan).
- The depth to groundwater will be measured from the north side of the top of the casing prior to extraction of water from the well.

- Prior to sampling, each well will be purged using a non-dedicated bladder pump that is attached to dedicated purge and sample collection tubing made of low-density polyethylene (LDPE). The well will be purged at less than 0.5 liters per minute (L/min) and with drawdown of less than 4 inches (0.3 ft) during purging. Purging will continue until temperature, conductivity, pH, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity have stabilized, as described below.
- Field parameters, including pH, temperature, conductivity, DO, ORP, and turbidity, will be continuously monitored during purging using a flow cell. Purging of the well will be considered to be complete when all field parameters become stable for three successive readings. The three successive readings should be within +/- 3 percent for temperature, +/- 3 percent for conductivity, +/- 10 percent for DO, +/- 10 millivolts (mV) for ORP, and +/- 10 percent for turbidity.
- Purge data will be recorded on a sample collection form including purge volume; time of commencement and termination of purging; any observations regarding color, turbidity, or other factors that may have been important in evaluating sample quality; and field measurements of pH, conductivity, temperature, DO, and turbidity.
- Following the stabilization of field parameters, the flow cell will be disconnected, and groundwater samples will be collected. Sample data will be recorded on a sample collection form, including sample number and time collected, the observed physical characteristics of the sample (e.g., color, turbidity, odor, and sheen), and field parameters (pH, conductivity, temperature, DO, and turbidity).
- Any problems or significant observations will be noted in the "comments" section of the sample collection form.
- Groundwater samples will be collected directly into the appropriate sample containers using the same pump used for purging. To prevent degassing during sampling for VOCs, a pumping rate will be maintained below 100 milliliters per minute (mL/min). The VOC containers will be filled completely so that no head space remains. Samples will be chilled to < 6 degrees Celsius (°C) immediately after collection. Clean gloves will be worn when collecting each sample.
- Groundwater for dissolved metals analyses will be collected last and field-filtered through a 0.45-micron, in-line disposable filter. Groundwater samples for dissolved metals analysis will be preserved, as specified in Table A-2. A note will be made on the sample label, sample collection form, and chain-of-custody form to indicate the sample has been field-filtered.
- Between filling sample containers for petroleum/VOC compounds and metals, the discharge tubing will be reconnected to the flow cell and, after a sufficient volume of water has been purged, replicate groundwater parameter measurements will be recorded on the sample collection form. The purpose of replicate parameter measurements during sample collection is to confirm that groundwater conditions did not significantly change during the act of sampling. If groundwater conditions did change during the filling of containers beyond the stability thresholds discussed above, inform the project manager, continue purging the well, and recollect the samples.

Initial sampling at monitoring wells will be performed with non-dedicated bladder pumps with dedicated bladders and tubing. If subsequent monitoring is required, dedicated bladder pumps will be evaluated for all new wells.

Groundwater samples collected from monitoring wells for laboratory analysis will be labeled using the following format:

"(Well ID #)-YYMMDD"

For example, a groundwater sample collected at MW-8C on October 5, 2020 would be MW8C-201005.

4.0 SPLIT SAMPLE COLLECTION

Commented [A1]: Agree to collect split samples, per discussion with Ecology regarding Ecology Comments #10 and 11.

At the request of Ecology, split samples will be collected by LAI at specific locations under investigation for PCBs. Groundwater and soil samples submitted by LAI for analysis for PCBs will be analyzed for PCB Aroclors by EPA Method 8082A. Depending on the media, the split sample may be analyzed by Ecology, as follows:

- Groundwater sample, monitoring well (BDC-05-05 in SWMU-16) – EPA Method 1668C
- Groundwater sample, direct-push borings (SWMU-43) – EPA Method 8082A
- Soil sample, direct-push borings (SWMU-16 and SWMU-43) – EPA Method 1668C.

The procedure for collection of soil split samples from direct-push borings are as outlined in Section 2.2 of this SAP. There are no special sampling requirements for collecting the Ecology split sample to be held and potentially analyzed by EPA Method 1668C. Similarly, the procedure for collection of groundwater samples from direct-push borings to be analyzed by EPA 8082A are as outlined in Section 2.3 and require no special modification.

As the analytical method for EPA Method 1668C in groundwater has a very low detection limit, the procedure for collection of groundwater split samples from monitoring wells will be adapted per recommended sampling guidelines for PCB Congeners.[3,4] The procedure will be generally as detailed in Section 3.3, but with modifications to minimize the potential for tubing materials to contaminate the groundwater samples with PCB Congeners at low levels. At groundwater monitoring wells sampled for PCB split samples, the modified procedure will be as follows:

- Use a peristaltic pump for PCB sampling.
- Assemble new sample tubing for PCB sampling:
  - Thin-walled flexible copper tubing (0.25-inch outer diameter) for down the well and for sample collection.
  - Platinum-cured silicon tubing through the peristaltic pump.
- Collect source blank sample of purified deionized water from the laboratory for analysis of PCB Congeners by EPA Method 1668C.
- Pump purified deionized water (minimum of 1 liter) from the laboratory through the new sample tubing for PCB sampling before insertion into the well. Collect equipment blank sample from the container of purified deionized water that has passed through the PCB sample tubing for analysis of PCB Congeners by EPA Method 1668C.
- Insert copper tubing into well. Purge groundwater from the well using the peristaltic pump and copper tubing until field parameters have stabilized according to the limits presented in Section 3.3.

[3] Leidos. 2016. Technical Memorandum: Potential for PCB Contamination from Sampling Equipment Tubing Materials. Leidos, Inc. November 23.

[4] Leidos. 2017. Data Report: Lower Duwamish Waterway, Groundwater Sampling for PCB Congeners and Aroclors. Leidos, Inc. July.

- Once field parameters have stabilized and all necessary information has been recorded on the sample collection form (see Section 3.3), fill two, laboratory-provided, 1-liter containers.
- Divide the contents of the two 1-liter containers evenly between the containers necessary for PCB split samples (i.e., for analysis by EPA Method 8082A and EPA Method 1668C).
- Remove copper tubing from the well. Prepare new LDPE sample tubing and assemble non-dedicated bladder pump using a new disposable bladder and decontaminated pump assembly.
- Purge additional groundwater from the well to confirm groundwater parameter stabilization prior to collecting the non-PCB sample(s).
- Sample for all non-PCB analytes at the sampling location according to the procedure detailed in Section 3.3.

For both soil and groundwater split samples, the quantity of containers required for the sampling of PCB Aroclors by EPA Method 8082A, per Table A-2, will be doubled. All containers for the split samples will have identical sample names and labels. Once collected, one set of containers will remain with LAI for analysis by the laboratory listed in Table A-2. The second set of containers and a chain-of-custody form will be provided to an Ecology representative overseeing the sampling. Proper handling, preservation, and analysis of the split and quality assurance/quality control (QA/QC) samples, as well as appropriate level of validation of the resulting data will be the responsibility of Ecology once in its custody.

5.0 GROUNDWATER SEEP RECONNAISSANCE AND SAMPLING

Seep location reconnaissance and sampling was performed along the LDW in 2018. Seven seeps were identified (SP-24, SP-26, SP-27, SP-28, SP-33, SP-35, and SP-37) along the shoreline of the DC during the reconnaissance (Figure A-1). Sampling at all seven groundwater seeps will be attempted in order to determine if potential COCs in site groundwater are reaching the LDW at concentrations of concern.

Before sampling, a reconnaissance will be performed during daytime low tides to evaluate known groundwater seeps and identify new seeps, if present, along the LDW. Notes of past reconnaissance observations and field measurements will be utilized to find the previous seven seep locations, if possible. New, distinctly different groundwater seeps, if present, will also be identified and sampled. Location, accessibility, flow rate, and conductivity of seeps will be evaluated during the reconnaissance to select those seeps that represent discharge of shallow DC groundwater to the LDW. Only freshwater seeps will be sampled, and conductivity will be used as a proxy for determining seep salinity (see Section 2.3 for ranges).

In addition to conductivity, field measurements during the reconnaissance will also include temperature, pH, DO, ORP, and turbidity. Seep water will be collected in a glass beaker; water quality parameters will be measured in the field using a probe placed into the beaker. The global positioning system (GPS) location of each seep will be recorded and a stake will be used to mark each seep in the field. Seep survey observations and measurements will be recorded on a seep reconnaissance survey form. An example of this form is provided in the QAPP (Appendix B of the RI work plan). At least two photographs will be taken of each seep.

Results of the reconnaissance will determine which seeps are sampled for the RI and what approximate tidal elevation is appropriate for sampling. Approximate seep elevations will be determined by measuring from the LDW elevation to the portion of the seep that visually has the highest flow rate using a hand-held sight level and the known elevation of the LDW. Seep samples will be collected using decontaminated stainless-steel drive-point screens in order to minimize turbidity. The 14-inch-long drive-point screens will be driven by hand into the seep to a depth of 0.5–1 ft bgs. Prior to sampling, water will be purged from the drive-point “mini temporary wells” with a peristaltic pump until the water is visibly clear. During purging, water quality parameters, including temperature, conductivity, pH, DO, ORP, and turbidity, will be recorded using a multi-parameter water quality meter and entered on a sample collection form. An example of this form is provided in the QAPP (Appendix B of the RI work plan). Photographs of each seep sampling setup will be taken. Salinity values will be calculated from the measured conductivity and temperature.

Groundwater seep samples collected from any of the seven previously sampled seeps will use their location identifier (SP-24, SP-26, SP-27, SP-28, SP-33, SP-35, SP-37) in place of the “ID #” shown in the following format:

“BDC-(ID #)-YYMMDD”

For example, a seep sample collected at SP-24 on October 5, 2020 would be BDC-SP-24-201005.

If necessary, groundwater seep samples collected from newly identified locations will have location identifiers starting with “RISP-01” and follow the above format for a sample name of BDC-RISP-01-201005.

6.0 BANK EROSION RECONNAISSANCE AND SAMPLING

During the seep sampling reconnaissance along the LDW, shoreline bank area on property owned by Boeing between the 9-120 building and the 9-140 building (Figures 3 and 23 of the RI work plan) will be observed and documented for signs of soil erosion. Documentation will include photographs, descriptions of the bank materials and signs of erosion (bank unravelling, collapse, etc.), and schematic cross-sections of the bank, if necessary.

If bank erosion is observed, soil samples will be collected at a frequency of one discrete sample per 20 ft of relatively continuous bank erosion observed. For example, a 30-ft long area of continuous bank erosion would have two discrete samples collected approximately 20 ft apart. Discrete bank erosion samples will be analyzed for gasoline-range TPH (TPH-G), diesel- and oil-range TPH (TPH-D/O), VOCs, PCBs, polycyclic aromatic hydrocarbons (PAHs) and total metals as outlined in Table A-1 and identified in the following format:

"BE-(ID #)-YYMMDD"

For example, a bank soil sample collected at BE-1 on October 5, 2020 would be BE-1-201005.

7.0 LABORATORY ANALYSIS FOR SOIL AND GROUNDWATER

Soil samples will be selectively analyzed for one or more of the following:

- Gasoline-range TPH (NWTPH-Gx)
- Diesel- and oil-range TPH (NWTPH-Dx)
- Total metals (SW-846 6010C)
- VOCs (SW-846 8260D)
- PCB Aroclors (SW-846 8082A)
- PAHs (SW-846 8270E-SIM).

Groundwater samples will be selectively analyzed for the following:

- Gasoline-range TPH (NWTPH-Gx)
- Diesel- and oil-range TPH (NWTPH-Dx)
- Total/dissolved metals (SW-846 6010C)
- Total/dissolved mercury (SW-846 7471B)
- VOCs (SW-846 8260D)
- PAHs (SW-846 8270E-SIM)
- PCB Aroclors (SW-846 8082A).

Specific analyses vary by sample location; a summary of the analyses by area is provided in Table 4 of the RI work plan. Analytical methods, sample containers, holding times, the laboratory performing each analysis are summarized in Table A-2 of this SAP and in Table B-4 of the QAPP (Appendix B of the RI work plan).

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Analytical samples collected during the RI will follow QA/QC procedures and standards outlined in the QAPP (Appendix B of the RI work plan). Field QA/QC includes the collection of QC samples consisting of blind field duplicate samples, matrix spike and matrix spike duplicate samples, trip blanks, and equipment and source deionized water blanks, as discussed in Section 4.0. The procedures for collection of the QC samples are provided in the QAPP (Appendix B of the RI work plan). Sample containers, preservatives, and holding times for each chemical analysis are provided in Table A-2 of this report and in Table B-4 of the QAPP.

8.1 QC Sample Nomenclature

The following nomenclature will be used to label and identify field QC samples collected during the RI:

- Field duplicates for groundwater samples: "GWDUP-(Duplicate)-YYMMDD"
  - For example, if the first groundwater field duplicate sample was collected on July 17, 2021, it would be GWDUP-1-210717, the second groundwater field duplicate sample collected would be GWDUP-2-210717, and so on.
- Field duplicates for soil samples: "SDUP-(Duplicate #)-YYMMDD"
  - For example, if the first soil field duplicate sample was collected on July 17, 2021 it would be SDUP-1-210717, the second soil field duplicate sample collected would be SDUP-2-210717, and so on.
- Matrix spike and matrix spike duplicates: Labeled with the same sample name and format as the primary sample
- Trip blanks: Labeled by the laboratory that provided them
- Source blanks: "SourceBlank-(Lab)-YYMMDD"
  - For example, a source blank of deionized water provided by Analytical Resources, Inc. laboratory in Tukwila, Washington collected for analysis on July 17, 2021 would be labeled SourceBlank-ARI-210717.
- Equipment blanks: "RinsateBlank-(Identifier)"
  - For equipment blanks collected for a specific sample, the identifier will be the corresponding sample name.
  - For equipment blanks collected for a specific piece of equipment, the identifier will be the type of equipment (e.g., bowl, sample tubing, non-dedicated bladder pump assembly) and the date in YYMMDD format. A rinsate sample collected from a bowl collected on July 17, 2021 would be RinsateBlank-bowl-210717.

8.2 Equipment Calibration

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All field parameter meters will be calibrated daily before use; the results of the calibration will be recorded in a calibration log specific to the meter being used and stored with the meter at all times. Meters will be recalibrated if any anomalous readings are observed. If recalibration does not adequately resolve the anomalous readings, the meter will be replaced prior to collection of additional samples.

9.0 DATA AND RECORDS MANAGEMENT

All field documentation, including the various data collection forms discussed in this SAP, survey information, and field notes, will be reviewed for completeness and accuracy, scanned, and stored electronically on a backed-up server. Hard copies will be retained in the project files for a minimum of 1 year.

All laboratory analytical data generated under this SAP will be submitted to the Ecology project manager in both printed and electronic formats. Data will also be submitted through Ecology's Environmental Information Management System (EIM) in accordance with WAC 173-340-840(5) and Ecology's Toxics Cleanup Program Policy 840: Data Submittal Requirements.

10.0 EQUIPMENT DECONTAMINATION

The decontamination procedures described below are to be used by field personnel to clean drilling, sampling, and related field equipment. Deviation from these procedures must be documented in field records.

10.1 Water Level Indicator

The tape from the water level indicator will be rinsed with Alconox® soap, tap water, and de-ionized water between each well measurement.

10.2 Sampling Equipment

All sampling equipment used (e.g., stainless steel bowls, stainless steel spoons, soil split-spoon samplers, etc.) will be cleaned using a three-step process, as follows:

1. Scrub surfaces of equipment that would be in contact with the sample with brushes using an Alconox and water solution.
2. Rinse and scrub equipment with clean tap water.
3. Rinse equipment a final time with de-ionized water to remove tap water impurities.
4. Collect rinsate blank samples, as appropriate.

Decontamination of reusable sampling devices (i.e., stainless steel drive-point screens, etc.) will occur between each sample collection and will follow the above steps. At least 5 gallons of each decontamination liquid will be pumped through any non-dedicated pump systems or sampling equipment that cannot be fully disassembled.

10.3 Heavy Equipment

Heavy equipment (i.e., drilling equipment that is used downhole, or that contacts material and equipment going downhole) will be cleaned by a hot water, high-pressure wash before each use and at completion of the project. Potable tap water will be used as the cleaning agent.

11.0 RESIDUAL WASTE MANAGEMENT

Investigation-derived waste (IDW), including soil cuttings and water generated during drilling and sampling, and waste/wastewater generated during decontamination of sampling equipment or devices, will be collected and managed in containers provided by Boeing. All waste will be characterized in accordance with applicable regulations based on the laboratory analytical results and historical knowledge. All IDW will be disposed of at facilities approved by Boeing and in accordance with applicable regulations.

12.0 USE OF THIS SAMPLING AND ANALYSIS PLAN

This Sampling and Analysis Plan has been prepared for the exclusive use of The Boeing Company and applicable regulatory agencies for specific application to the Boeing Developmental Center facility in Tukwila, Washington. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.