APPENDIX A

Sampling and Analysis Plan (SAP)

Draft
Sampling and Analysis Plan
Remedial Investigation Work Plan
Boeing Developmental Center
Tukwila, Washington

October 23, 2019

Prepared for

The Boeing Company
Seattle, Washington

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Remedial Investigation Work Plan
Boeing Developmental Center
Tukwila, Washington

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LIST OF ABBREVIATIONS AND ACRONYMS

°C	degrees Celsius
µS/cm	microsiemens per centimeter
AOC	Area of Concern
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
LNAPL	light non-aqueous phase liquid
mL	milliliter
mL/min	milliliters per minute
mV	millivolt
MLLW	mean lower low water
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
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
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 in specific investigation areas will only be used for soil and/or groundwater grab sampling and well installation. Boreholes will be decommissioned according to the Minimum Standards for Construction and Maintenance of wells (Section 173-160-460 WAC) immediately after sampling (Section 2.3). Soil borings in other investigation areas will be used for soil and groundwater sampling; these borings will be completed as groundwater monitoring wells, according to the specifications presented in Section 3.1.

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 borehole 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 8.0.

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 for contamination to the laboratory. 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 container.

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 US Environmental Protection Agency (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 and labeled using the following format:

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

For example, a soil sample collected between 4 and 5 feet (ft) below ground surface (bgs) at RISB-1 in AOC-01/02 would be A0102-RISB-1-(4-5').

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 for laboratory analysis from three direct-push borings as described 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 monitoring wells with PVC screens may be constructed in the boreholes and used for sample collection. Low-flow purging and sample collection will be conducted in accordance with procedures described in Section 3.3 of this SAP.

The groundwater grab samples collected from the soil borings 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-8 would be SWMU20-RISB-8-GW(12-16').

2.4 Boring Decommissioning

Borings used only for soil and/or groundwater grab sampling (Table 4 of the RI work plan; Table A-1 of this SAP) will not be completed as monitoring wells; these 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.

3.0 MONITORING WELL INSTALLATION AND SAMPLING

Procedures for installing and developing monitoring wells and collecting groundwater samples from the monitoring wells are described below. Well construction details are provided as Figure A-2.

3.1 Installation and Construction of Monitoring Wells

Boreholes for groundwater monitoring wells will be drilled using direct-push 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).

Monitoring wells will be installed along the Lower Duwamish Waterway (LDW) for the SWMU-43 (stormwater sewer system) investigation with well depths and screen lengths as summarized below.

Area	Well Depth (ft bgs)	Screen Length (ft)
SWMU-43	To be determined	5

bgs = below ground surface
ft = feet

Because the DC facility boundary along the LDW is tidally influenced, monitoring wells installed along the LDW for the SWMU-43 (stormwater sewer system) investigation must be installed so that sampling can occur at low tide and so that saline water from the underlying salt water wedge is not encountered during sampling. The hydraulic gradient at the shoreline during low tide is toward the LDW. As a result, low tide installation and sampling is required in order to maximize the likelihood of collecting samples that are representative of site groundwater potentially impacted by stormwater from leaking storm drain lines immediately adjacent to the LDW. Wells will be installed within 10 ft of the oil/water separators associated with each stormwater outfall/storm drain line of interest in order to avoid fill material used during construction of the oil/water separator vaults but ensure that samples collected in these locations are representative of groundwater potentially impacted by site stormwater.

In order to install monitoring wells along the LDW that meet the sampling requirements, the completed depth will be determined on-site by an environmental professional during drilling in coordination with the project manager. The boring for the first monitoring well along the LDW will be drilled during low tide (0 mean lower low water [MLLW] or lower). The first boring will be advanced until groundwater is encountered; this water level will represent the low-tide groundwater level for

the entire DC facility boundary along the LDW. Each monitoring well along the LDW will be installed with a bottom depth of 6 ft below the low-tide groundwater level, creating a well screened from 1 to 6 ft below the low-tide groundwater level.

Each monitoring well will be constructed with 2-inch-diameter, flush-threaded, Schedule 40 PVC pipe (Figure A-2). SWMU-43 wells installed along the LDW will have a 5-ft-long screen. 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.

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 flush-mounted protective casings.

The well names and the identification numbers assigned by the Washington State Department of Ecology (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

The monitoring wells will be developed no earlier than 24 hours after construction to remove formation material from the well borehole and the filter pack prior to groundwater level measurement and sampling. 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).

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. 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 Groundwater Sample Collection

Groundwater samples will be collected 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 peristaltic pump that is attached to dedicated purge and sample collection tubing. 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.

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

"BDC-(ID #)-YYMMDD"

For example, a groundwater sample collected at BDC-201 on October 5, 2019 would be BDC-201-191005.

4.0 GROUNDWATER SEEP RECONNAISSANCE AND SAMPLING

Seep location reconnaissance and sampling was performed along the LDW in 2018. Six seeps were identified (SP-24, 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 six 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 six 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:[1]

- 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.

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). 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 tidal elevation is appropriate for sampling. 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.

[1] 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/.

Groundwater seep samples collected from any of the six previously sampled seeps will use their location identifier (SP-24, 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, 2019 would be BDC-SP-24-191005.

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-01-191005.

5.0 BANK EROSION RECONNAISSANCE AND SAMPLING

During the seep sampling reconnaissance along the LDW, shoreline bank area controlled by Boeing between the 9-120 building and the 9-140 building (Figures 3 and 20 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 composite sample per 100 ft (or less) of relatively continuous bank erosion observed. Each sample will be a composite consisting of approximately one sample per 10 ft of eroded bank length. For example, a 30-ft long area of continuous bank erosion would have one composite sample consisting of three subsamples, while a 140-ft long area of bank erosion would consist of two composite samples, one consisting of 10 subsamples and the other consisting of four subsamples. Composite bank erosion samples will be analyzed for PCBs 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, 2019 would be BE-1-191005.

6.0 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)
- PCBs (SW-846 8082A).

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)
- Polycyclic aromatic hydrocarbons (PAHs; SW-846 8270E-SIM)
- PCBs (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).

7.0 QUALITY ASSURANCE AND QUALITY CONTROL

Analytical samples collected during the RI will follow quality assurance/quality control (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, and trip blanks. 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.

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.

8.0 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 via email and 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.

9.0 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.

9.1 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.

9.2 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.

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.

9.3 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.

10.0 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.

11.0 SCHEUDLE

An anticipated schedule for the RI is summarized below. This schedule assumes that all necessary approvals will be in place by December 31, 2019. Drilling tasks are dependent on driller availability. Ecology will be provided with a seven (7) day notice prior to beginning sampling activities in order to be present onsite and/or collect split samples.

Tasks	Date Range
Redevelopment of existing monitoring wells, utility and UST locating, and collection and laboratory analysis of groundwater samples from existing wells	January–February 2020
Collection and laboratory analysis of soil samples from new soil borings in select investigation areas, and installation and sampling of monitoring wells in select investigation areas. Reconnaissance, and collection and laboratory analysis of groundwater samples from groundwater seeps along the LDW	March–April 2020
Submittal of Draft RI report	August 30, 2020

Variations from this schedule may be necessary based on unanticipated findings, site access constraints, weather delays, and potential revisions to the existing scope and budget authorization, if needed. If additional RI activities are needed to meet the objectives of the RI work plan, the scope, schedule, and submittal requirements for this additional work will be developed and discussed with Ecology. Substantial changes/additions will be submitted as RI work plan addenda to Ecology for review and approval.

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.

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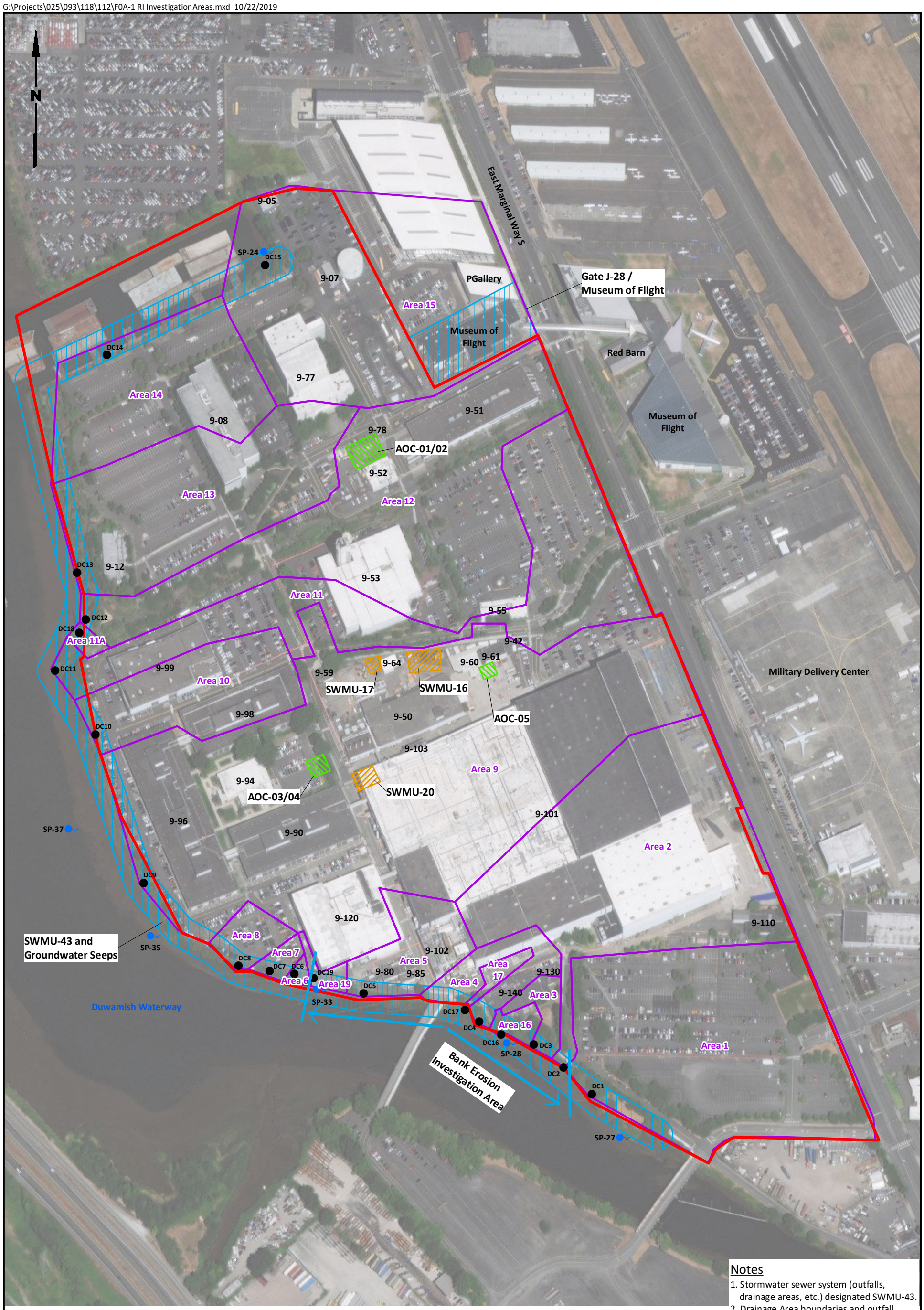

Legend

- Known Seep Location
- Outfall
- AOCs
- SWMUs
- Other Investigation Areas
- Drainage Areas
- Facility Boundary

0 300 600

Scale in Feet

Notes

1. Stormwater sewer system (outfalls, drainage areas, etc.) designated SWMU-43.
2. Drainage Area boundaries and outfall locations are subject to change due to planned modifications required for stormwater treatment.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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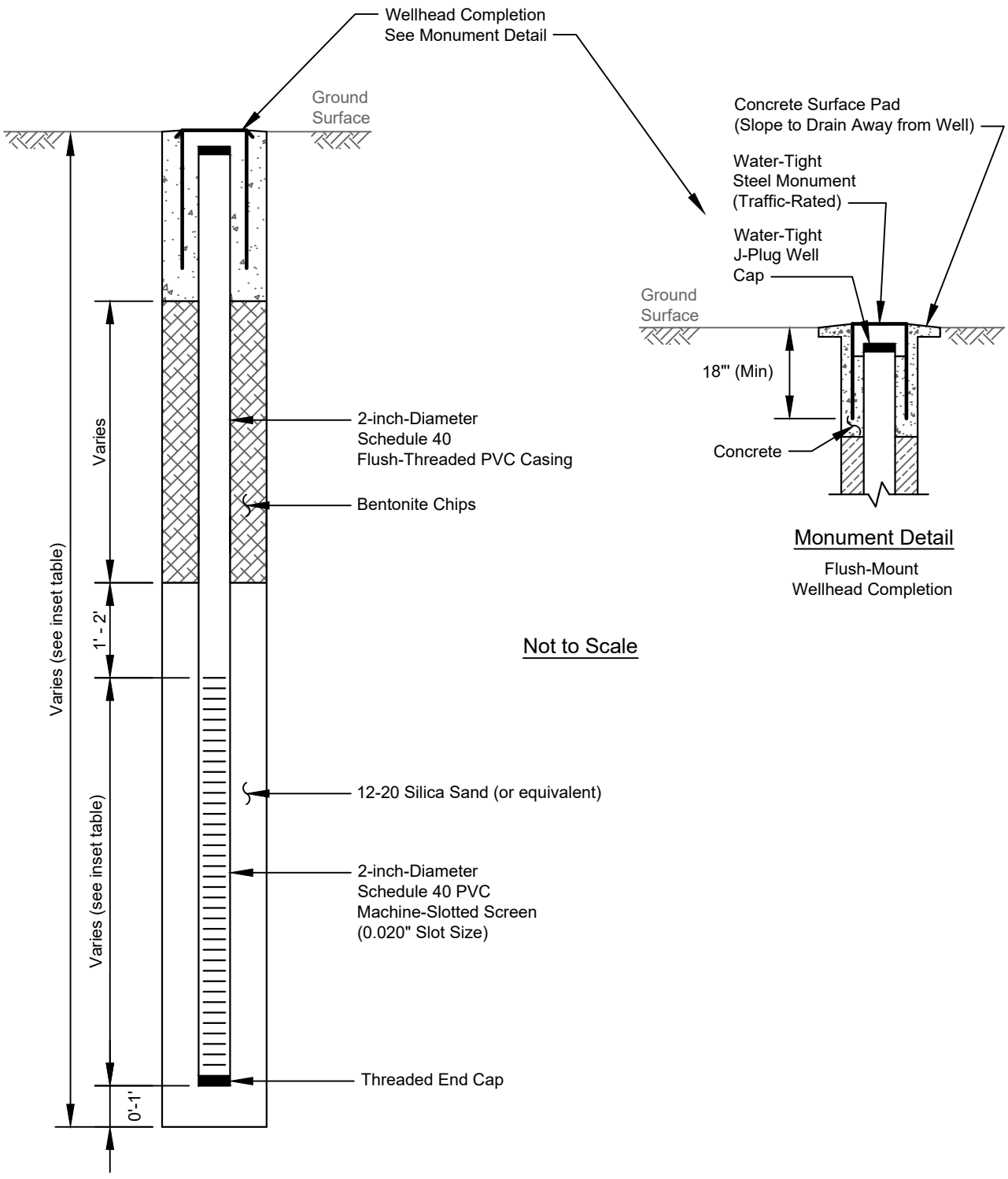
Data Sources: Boeing; Esri World Imagery.

Boeing Developmental Center
Tukwila, Washington

Boeing Facility and RI Investigation Areas

Figure A-1



Note:

1. The groundwater elevation at proposed wells associated with SWMU-43 (stormwater sewer system) is tidally-influenced. The well depth will be determined at the time of drilling and based on the low-tide groundwater elevation along the Lower Duwamish Waterway.

Area	Well Depth	Screen Length
SWMU-43	TBD	5'

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Boeing Developmental Center
Tukwila, Washington

Monitoring Well Construction Detail

Figure
A-2

Table A-1
Summary of Proposed Sampling and Analyses
Boeing Developmental Center
Tukwila, Washington

Investigation Area	GROUNDWATER SAMPLING										SOIL SAMPLING								
	Sample Count (c)										Sample Count (d)								
	TPH, diesel- and oil-range (NWTPH-Dx) (a)	TPH, gasoline-range (NWTPH-Gx) (a)	VOCs (8260C)	PCBs (8082A)	PAHs (8270D)	Total/dissolved metals (6010C) (b)	Total/dissolved mercury (7471B) (b)	Sampling Scope	Sample Location ID(s)	Screened Interval (bgs)	TPH, diesel- and oil-range (NWTPH-Dx) (a)	TPH, gasoline-range (NWTPH-Gx) (a)	VOCs (8260C)	PCBs (8082A)	Total metals (6010C)	Sampling Scope	Sample Location ID(s)	Sampling Intervals (bgs)
AOC-01/02	3	3	3			3	3	Three existing wells	DC-9-52-1, DC-9-52-2, DC-52-3 (existing)	None	3	3	3			One soil boring	RISB-1	(7-10') (10-13') (13-16')
AOC-03/04	2							Two existing wells	MW-21A, MW-21C (existing)	None	6					Two soil borings	RISB-2, RISB-3	(7-10') (10-13') (13-16')
AOC-05								None	None	None		3	3			One soil boring	RISB-4	(7-10') (10-13') (13-16')
SWMU-16				1				One existing well	BDC-05-05 (existing)	None				10		Two soil borings	RISB-5, RISB-6	(WT-3') (3-6') (6-9') (9-12') (12-15') below WT
SWMU-17								None	None	None			3		3	One soil boring	RISB-7	(7-10') (10-13') (13-16')
SWMU-20					5			Two new grabs, three existing wells	RISB-8, RISB-9 (grabs) MW-8C, MW-15A, MW-22A (existing)	~12-16' (grab)			12			Two soil borings	RISB-8, RISB-9	(7-10') (10-13') (13-16') (16-19') (19-22') (22-25')
SWMU-43	4	4	4	4	4	4	4	Four new wells	BDC-201, BDC-202, BDC-203, BDC-204	TBD (e)	12	12	12	12	12	Boreholes for four new monitoring wells	BDC-201, BDC-202, BDC-203, BDC-204	(7-10') (10-13') (13-16')
Gate J-28/Museum of Flight	1	1						One new grab	RISB-10	~12-16' (grab)						None	None	None
Groundwater seeps	6	6	6	6	6	6	6	Six known groundwater seeps	SP-24, SP-27, SP‑28, SP-33, SP-35, SP-37	None						None	None	None
Bank Erosion								None	None	None						TBD based on erosion observed	BE-1, BE-2, etc.	One composite sample per 100 feet of bank erosion observed

Abbreviations and Acronyms:

AOC = Area of Concern
bgs = below ground surface
ID = identification
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
SWMU = Solid Waste Management Unit
TBD = to be determined
TPH = total petroleum hydrocarbons
VOC = volatile organic compound
WT = water table

Notes:

(a) Washington State Department of Ecology method. All other methods are US Environmental Protection Agency methods.
(b) Samples field filtered.
(c) Maximum number of water samples to be collected per area. All water samples except those collected from groundwater seeps will be collected from existing or new monitoring wells.
(d) Maximum number of soil samples to be collected per area based on average historical depth to water measurements and an assumed sampling frequency of 1 sample per 3 feet. Samples only collected above the water table, as measured at the time of drilling.
(e) The groundwater elevation at proposed wells is tidally-influenced. The screened interval (and total well depth) will be determined at the time of drilling and based on the low-tide groundwater elevation along the Lower Duwamish Waterway.

Table A-2
Sample Containers, Preservatives, and Holding Times
Boeing Developmental Center
Tukwila, Washington

Matrix	Method	Container	Preservative	Holding Time (a)	Laboratory Performing Analyses
Soil	Gasoline-range Petroleum Hydrocarbons by NWTPH-Gx	2 x 40-mL glass	Methanol	14	ARI
Groundwater	Gasoline-range Petroleum Hydrocarbons by NWTPH-Gx	40-mL glass	<6°C; Add HCl to pH<2	14	ARI
Soil	Diesel- and Oil-range Petroleum Hydrocarbons by NWTPH-Dx	8 oz wide-mouth glass	<6°C	14 days/40 days	ARI
Groundwater	Diesel- and Oil-range Petroleum Hydrocarbons by NWTPH-Dx	2 x 500-mL amber glass	<6°C	7 days/40 days	ARI
Soil	Total Metals by SW-846 6010C	4 oz wide-mouth glass	<6°C	180	ARI
Groundwater	Total/Dissolved Metals by SW-846 6010C	500 mL high density polyethylene	<6°C; Total metals or field filtered, HNO_3 to pH <2	180	ARI
Groundwater	Total/Dissolved Mercury by SW-846 7471B	500 mL high density polyethylene	<6°C; Total metals or field filtered, 5 mL 1:1 HNO_3	28	ARI
Soil	VOCs by SW-846 8260D	40-mL amber glass	<6°C; $NaHSO_4$ (2 vials), Methanol (2 vials)	14 days	ARI
Groundwater	VOCs by SW-846 8260D	40-mL glass, no headspace	<6°C; HCl to pH<2 (b)	14 days (7 days unpreserved or pH >2)	ARI
Groundwater	PAHs by SW-846 8270E-SIM	2 x 500-mL amber glass	<6°C	7 days/40 days	ARI
Soil	PCBs by SW-846 8082A	8 oz wide-mouth glass	<6°C	365 days/40 days	ARI
Groundwater	PCBs by SW-846 8082A	2 x 500-mL amber glass	<6°C	365 days/40 days	ARI

Acronyms/Abbreviations:

°C = degrees Celsius
ARI = Analytical Resources, Inc.
HCL = Hydrochloric acid
HNO_3 = nitric acid
mL = milliliter
$NaHSO_4$ = sodium hydrogen sulfate
oz = ounces
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
SIM = selected ion monitoring
VOC = volatile organic compound

Notes:

(a) Time from sample collection to extraction/time from sample extraction to analysis.
(b) Analysis of acid-reactive volatiles (if applicable) must be completed from unpreserved samples per the analytical method.