# SITE HAZARD ASSESSMENT
# Worksheet 1: Summary Score Sheet

**SITE NAME: Boeing Developmental Center** **Rank: 1**

Cleanup Site ID: 5059

Facility/Site ID: 2101

Ranked for inclusion on the February 2019 Hazardous Sites List.

## LOCATION OF SITE

9725 East Marginal Way South

Tukwila, King County, WA 98108

Township 23N, Range 4E, Section 4

Latitude, Longitude: 47.51488, -122.30011

Tax Parcel ID: 5624200980, 5624200985, 5624200990, 5624200992, 5624201032, 5624201036, 5624201038, 0003400018, 0003400023, 0003400026, 0003400028, 0003400048, 0423049016, 0423049183

## SITE DESCRIPTION

*Within Currently Defined Site Boundaries*

The Boeing Developmental Center site (Site) includes 14 tax parcels, listed above. The Site includes 117.3 acres of property zoned for heavy industrial (MIC-H) use. Boeing owns most of the property and leases the remaining parcels from D&T Enterprises and Desimone Trust. The Site is located adjacent to the Duwamish River on the east side of the river.

The Site is currently used as an aerospace industry research and development facility by the Boeing Company, and portions of the property have been used for this purpose since as early as 1956. General activities on the Site from 1956 to the present include machining, painting, assembly, and parts cleaning. Historically, activities on Site included electroplating, chemical milling, and conversion coating. Records indicate that these activities occurred during the 1960s and 1970s. The Site is currently classified as a hazardous waste generator, with most of the hazardous waste produced by activities in building 9-101. Figures included below provide additional information on the general location of the Site, buildings currently on the Site with building numbers, and details on areas discussed in the Site Characterization and Remediation section.

Historically, this Site has been considered two Ecology cleanup sites. The first, previously known as the Boeing A&M Development Center, includes areas of contamination with petroleum hydrocarbons and chlorinated solvents. This area is enrolled in the Voluntary Cleanup Program under VCP ID NW0324. The second area, previously known as Boeing Developmental Center Norfolk, includes areas of the Site that may be contributing to contamination of Duwamish River sediments with polychlorinated biphenyls (PCBs). This area is enrolled in the Voluntary Cleanup Program under VCP ID NW1083. These sites were administratively combined into one Site in 2018, and renamed the Boeing Developmental Center.

*Historical Owners and Operators*

| From | To | Owner/Operator | Site Uses |
|---|---|---|---|
| | 1918 | | farmland prior to channelization of Lower Duwamish |
| 1927 | 1985 | multiple | commercial businesses, including stockyard, welding supply company, winery, granary, sawmill, grocery store, gas station, warehouse, tavern, construction yard, auto wrecking yard, trucking, propane distributor |
| 1976 | 1985 | Port of Seattle | owned northern 38 acres, including Slip 6 |

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| | | | |
|---|---|---|---|
| 1956 | present | Boeing | Boeing - Military Airplane Company division; renamed Boeing Developmental Center in 1980 |
| | 1990 | Boeing | Military Flight Center separated from Developmental Center |

*Area Surrounding the Site*

The Site is located between the Duwamish River and East Marginal Way South. The area surrounding the site is full of commercial and industrial properties, including Container Properties to the north (across Slip 6) and a vehicle and container storage yard to the south (across South 102nd St). The Boeing Military Flight Center is located across East Marginal Way South to the east of the Site. The Museum of Flight is located along East Marginal Way South on the northeast corner of the Site. The Museum of Flight parcels contain property that was historically part of the Developmental Center, but no longer owned by Boeing (see figures).

The closest park with significant amounts of vegetation is the Hamm Creek Natural Area, located 2600 feet west of the Site, across the Duwamish River. The closest park on the same side of the river is the Site 1 Duwamish archaeological site, located 2800 feet south of the Site.

The in-water portion of the Duwamish River is an Environmental Protection Agency (EPA) led cleanup site, and 12 additional Ecology cleanup sites are located within a half mile of the Site. Four of these have received a No Further Action designation, 5 have Started Cleanup, and 3 are Awaiting Cleanup. Sites started or awaiting cleanup include Container Properties (Ecology Cleanup Site ID 1312), the Museum of Flight property (CSID 11334), and the Boeing Military Flight Center (CSID 12904) located on the perimeters of this Site. The Site spans three of Ecology's Lower Duwamish Waterway source control areas: Slip 6, Boeing Developmental Center, and Norfolk CSO/SD.

## SITE CHARACTERIZATION AND/OR REMEDIATION

Based on the size of the Site and relatively long history of remedial actions, this section will only focus on the major areas of known contamination and not on smaller spill events that either entered directly into the stormwater system or did not reach the environment. Area names are based on solid waste management unit (SWMU) or area of concern (AOC) identifiers established in the 1994 RCRA Facility Assessment Report from SAIC. Multiple “cleanup” or screening levels have been utilized over the years to assess site conditions, so references to exceeding cleanup levels below do not always mean MTCA cleanup levels.

Remedial actions have focused on groundwater cleanup. Soil samples were collected and analyzed from borings as monitoring wells were installed, and in some cases following excavations, but groundwater data is more up-to-date and is the focus of the following discussion. As of May 2018, the most recent groundwater monitoring report reviewed for this Site Hazard Assessment, 40 wells were being monitored: 4 in AOC-05, 22 in SWMU-17, and 14 in SWMU-20. Groundwater sampling generally occurs twice a year.

AREA AOC-01/02: UNDERGROUND STORAGE TANKS (USTs) NEAR BUILDING 9-52
A 500 gallon unleaded gasoline tank and 300 gallon diesel tank were removed in 1990. These are the tanks associated with Ecology LUST ID 1476. During tank removal, soil surrounding the tanks was also removed down to 2 feet below the water table. Soil samples did not contain total petroleum hydrocarbons (TPH) or associated compounds above cleanup levels. Groundwater in this area was contaminated with gasoline range petroleum hydrocarbons (TPH-G), benzene, toluene, ethylbenzene, and xylenes (BTEX) above cleanup levels. Groundwater monitoring was discontinued in this area in 2002, following two consecutive quarterly sampling events with TPH and BTEX below laboratory reporting limits.

AREA AOC-03/04: USTs NEAR BUILDING 9-50
In 1992, a contractor for Boeing removed and replaced two 20,000 gallon boiler fuel oil tanks from this location after they were discovered to be leaking. Remedial actions during tank replacement included the removal of 250 cubic yards of contaminated soil, excavation dewatering to remove contaminated groundwater, and water jetting

of exposed soils to remove oil present as free product (not sorbed to soil or dissolved in groundwater). The final estimate of free product removed was 200-500 gallons. The final excavation depth was 16 feet below ground surface (bgs). Samples collected from the base of the excavation contained TPH above cleanup levels. Groundwater monitoring in this area ended in 2003, following four consecutive quarterly sampling events with groundwater concentrations below laboratory reporting limits.

AREA SWMU-16: BUILDINGS 9-69 AND 9-70

Buildings 9-69/-70 were part of a list of buildings that were formerly used to store hazardous waste. In the early 1990s, Boeing changed the hazardous waste facility classification of the Developmental Center from Transfer, Storage, and Disposal to Generator. As part of the process for this change, buildings formerly used to store hazardous waste underwent a closure process that included sampling of the concrete slabs and subsurface under the buildings. Initial sampling events in 1994 identified buildings 9-69/-70 as those with potential subsurface contamination. The concrete slabs were demolished and removed in 1996, and soil that was contaminated with polychlorinated biphenyls (PCBs) was excavated from underneath the buildings. The final extent of excavation was approximately 60 feet by 90 feet. No source of PCBs was identified in these buildings, and it was proposed in a meeting between Ecology and Boeing representatives that they may have been present in fill dredged from the Duwamish prior to it being placed on the property. Groundwater samples collected from nearby area AOC-05 have not indicated PCB contamination.

AREA AOC-05: UST NEAR BUILDING 9-61

A 1000 gallon gasoline UST, located approximately 20 feet from the southwest corner of building 9-61, was punctured with a measuring rod in August 1985. This resulted in the release of 830 gallons of gasoline before the tank was removed in September 1985. An estimated 500-600 gallons of free product was also removed at the time of tank excavation. Further characterization of this area did not occur until 2001, at which time TPH-G and benzene were present above cleanup levels in groundwater. The first attempt to remediate groundwater in this area was performed in 2002. Oxygen Releasing Compound (ORC) was added to the groundwater to stimulate aerobic biodegradation of the hydrocarbons. This remedial action was not successful. Since groundwater at the Site is naturally anaerobic, the second remedial action was designed to stimulate anaerobic degradation of the petroleum hydrocarbons. A pilot study using nitrate amendment of groundwater was done in 2007. Based on good results from the pilot study, full scale nitrate injections began in this area in 2008. As of January 2019, a total of 11 injections have been done – 3 in 2008, 2 in 2009, 1 in 2010, 2 in 2012, 1 in 2013, and 2 in 2016. These injections have been successful in decreasing concentrations of TPH-G and BTEX in groundwater. Concentrations of these contaminants were below laboratory reporting limits in the May 2018 groundwater samples.

AREA SWMU-17: CHLORINATED SOLVENTS NEAR BUILDING 9-64

The source of contamination in this area was a waste oil UST and associated sump. The oil was collected from hydraulic testing shops, auto maintenance shops, and other sources across the Site. Soil contamination was discovered and the tank was removed in 1986. Groundwater in this area was found to be contaminated with tetrachloroethylene (PCE) and copper above cleanup levels. Remediation in this area has used the injection of amendments to stimulate bioremediation, enhance PCE breakdown, and immobilize copper. A pilot study was done in 2008 to confirm that the planned remediation strategy would be effective, and a full scale injection into 11 wells was done in 2011. The injection was a mixture of sodium lactate, vegetable oil, and ferrous sulfate. An additional injection was done in 2017 into 5 wells that still had groundwater with elevated concentrations of PCE and/or trichloroethylene (TCE), a PCE breakdown product. By the 2017 injection event, copper had decreased to below cleanup levels. Arsenic had increased, an expected side effect of the remedial action, and is present in groundwater above cleanup levels. As of May 2018, TCE remained present in groundwater from 1 well (BDC-05-02) above proposed cleanup levels and vinyl chloride, a PCE and TCE breakdown product, remained present in groundwater from 2 wells (BDC-05-09 and BDC-05-18) above proposed cleanup levels.

AREA SWMU-20: NORTHWEST CORNER OF BUILDING 9-101

Multiple potential sources of environmental contamination have been identified within this area. The first potential source was 3 aboveground waste storage tanks outside the building that were removed in 1985. These included a 3000 gallon holding tank for alkaline waste (Tank A), a 2000 gallon holding tank for acid waste (Tank B), and a 10,000 gallon holding tank for wastewater (Tank C). Tank C was not a RCRA-regulated tank, and

closure sampling after the tanks were removed in 1993 focused on the areas that formerly held tanks A and B. Four soil samples and 3 groundwater samples were collected and analyzed for priority pollutant metals. No contamination above cleanup levels was present.

Additional subsurface sampling occurred near this corner of the building as part of building improvements in 1989. Some soil samples contained elevated concentrations of polycyclic aromatic hydrocarbons (PAHs). The source of the PAHs was identified as the creosote-treated timber piles that are present under the building to support it, and PAH contamination is expected to be limited to soil near these piles.

The primary contaminants of concern discovered in this area in 1989 were PCE and TCE in soil and groundwater. The source of this contamination was identified as a vapor degreaser and associated sump that were located in the northwest corner of building 9-101. The degreaser reportedly used PCE and TCE, and was in operation from approximately 1956 to 1984. Approximately 1400 tons of contaminated soil was removed during building improvements. Monitoring wells were installed in 1989 and 1991 to determine the extent of contamination; these targeted multiple groundwater depth ranges below ground. “A” wells are located 10-20 feet bgs, “B” wells are 22-28 feet bgs, “C” wells are 30-40 feet bgs, and “D” wells are 42-50 feet bgs. A, B, and C wells are all located in a shallow unconfined aquifer, while D wells are located in a deeper confined aquifer. Contamination was identified at multiple depths in the shallow aquifer, but never in the deeper aquifer.

Initially, groundwater was contaminated with PCE, TCE, cis-1,2-dichloroethylene (DCE), and vinyl chloride above cleanup levels. DCE and vinyl chloride are both breakdown products of PCE and TCE. A pump-and-treat system was installed and began operating in 1993 to address groundwater contamination. Treatment was done using a sieve tray aerating system to volatilize the contaminants and remove them from the groundwater. This system remained in operation until December 2001, when it was stopped to evaluate the potential use of monitored natural attenuation as a remedial action to address remaining contamination. Overall, the system is estimated to have removed 80 pounds of contaminants between 1993 and 2001.

Injection of amendments to promote biodegradation, similar to that used at SWMU-17, was the next remedial action implemented in this area. Injections were done twice in 2004 and once each in 2005, 2008, and 2015. The injection formula was primarily sodium lactate, with the addition of vegetable oil emulsion, yeast extract, and defoamer, depending on the injection date. As of the May 2018 groundwater sampling event, the only contaminant above proposed cleanup levels was vinyl chloride in 1 well in the shallow groundwater zone (MW-17A).

A brief evaluation of potential impacts of contamination on indoor air via the vapor intrusion pathway was performed by Landau in 2006, as contaminated groundwater moved toward building 9-90. This evaluation used the Johnson-Ettinger model to determine a groundwater concentration that was protective of indoor air. To confirm model results, indoor air samples from 2 locations in building 9-90 and 1 outdoor air sample were collected. DCE and vinyl chloride were not detected above laboratory reporting limits in the samples. PCE and TCE were present in indoor and outdoor air samples at similar concentrations, suggesting that ambient air and not vapor intrusion was the source of these chemicals in indoor air samples.

SOUTH STORM DRAIN SYSTEM

The South Storm Drain system refers to the stormwater infrastructure associated with one outfall to the Duwamish River that is located on the southern end of the Site. This system receives stormwater from approximately 9.3 acres of the Site, including the south end of the roof of building 9-101 and parking lots to the south of that building (see figures), and drains directly into the Duwamish River downstream of the Norfolk CSO outfall. In 1999, King County's Wastewater Treatment Division, as part of their Sediment Management Program, excavated contaminated sediments in this portion of the river in an area known as early action area 7 (EAA-7). A 2003 Ecology sampling event confirmed suspicions that EAA-7 sediment was becoming recontaminated with PCBs. One potential source of these PCBs was contaminated sediment located between EAA-7 and the shoreline, near the South Storm Drain outfall. In 2003, Boeing excavated sediment with concentrations of PCBs above 65 mg/kg organic carbon (OC). The excavation was lined with granular activated carbon fabric, filled with clean sand, and habitat for aquatic species was reestablished by the addition of woody debris and the planting of sedge.

A 2001 evaluation of the South Storm Drain area had confirmed PCBs present in stormwater system solids, but sampling of the building materials within the drainage area did not identify a likely source of these PCBs.

Improvements to the stormwater system were made in 2003 to limit the reintroduction of PCBs to the excavated sediment area. These improvements included cleaning out the stormwater system to remove accumulated solids and installation of a new treatment vault within the South Storm Drain line to remove suspended solids from stormwater before they reach the river.

The stormwater system has been cleaned out again in 2008 and 2015, and annual sampling is performed on sediment within the remediated area, solids from within the stormwater vault, and solids upstream and downstream of the vault. The last report available for Ecology review included the 2015 sampling event. Results in this report follow the same pattern as those in previous annual reports: sediment has been recontaminated with PCBs at locations S1 (closest to the outfall) and to a lesser extent at S2, solids from the stormwater vault contain PCBs, and concentrations in upstream solids are higher than in downstream solids, confirming that the vault is partially effective in removing PCBs prior to stormwater discharge into the river.

OTHER STORMWATER CONSIDERATIONS
The South Storm Drain has received the bulk of the attention with regards to stormwater on the Site, but it is only 1 of 19 outfalls. Prior sampling of the oil-water separators located on multiple stormwater lines identified PCBs in multiple outflows. The Site operates under an Industrial Stormwater General Permit (permit number WAR000146). In 2018, Boeing entered into an Agreed Order with Ecology's Water Quality Program to address corrective actions triggered by prior exceedances of permit benchmarks, specifically those for copper and zinc. The Agreed Order also requires Boeing to monitor for PCBs and diesel-range TPH. This additional stormwater information was not directly reflected in scoring.

## ADDITIONAL INFORMATION COLLECTED BY THE SITE HAZARD ASSESSOR

A number of additional site reports were reviewed by the Assessor, but not included in the reference list because they were not used to provide information specifically included in this report. This included a number of inspection reports on the Boeing Developmental Center completed by Ecology Hazardous Waste and Toxics Reduction staff. The most recent of these reports reviewed was from 2016. None of the inspection reports gave any indication that conditions on Site were different from those represented in site reports addressing site characterization and remediation.

## SPECIAL CONSIDERATIONS

Checked boxes indicate routes applicable for Washington Ranking Method (WARM) scoring

☑ **Surface Water**

PCBs from the South Storm Drain outfall are likely entering surface water via direct discharge of stormwater and through the contact of surface water with recontaminated sediment in this area.

☑ **Air**

Volatile chemicals are present in the subsurface. The indoor air evaluation of Building 9-90 (see Site Characterization and Remediation, Area SWMU-20) did not address all buildings that may be impacted by vapor intrusion, based on the location of remaining volatile chemicals in the subsurface and the lateral screening distances recommended in Ecology vapor intrusion guidance.

☑ **Groundwater**

Contamination remains in groundwater above proposed cleanup levels.

To simplify scoring, a short list of primary contaminants of concern was developed. Proposed cleanup levels for the Site were used as screening values, and chemicals that remain present on Site above these values were included on the short list. For surface water, this included PCBs from the south storm drain system and recontaminated sediment. For air and groundwater, based on May 2018 groundwater sampling data, this included TCE and vinyl chloride. This list is not intended to represent the complete list of contaminants remaining on Site. It does not include things like soil contamination in areas that have not been sampled recently, including PAHs associated with treated timber under building 9-101 and possible remaining soil

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contamination with petroleum hydrocarbons and chlorinated solvents in areas of groundwater remediation. Inclusion of additional chemicals would not change the overall site rank, however, so only the short list of chemicals was used for scoring.

To determine substance quantity for scoring for the air and groundwater routes, recent groundwater data was used to estimate the area of remaining groundwater contamination above proposed cleanup levels. This is likely an underestimate of remaining contamination when all media are considered (i.e. soil, see previous paragraph), but increasing the score for this parameter does not change the overall Site rank. Only the groundwater area was used to simplify scoring. For surface water, in the absence of an identified PCB source, the entire area of the Site draining to the south storm drain system was used as an estimated aerial extent of contamination.

Shallow contaminated groundwater on Site flows toward the Duwamish River. The river is assumed to provide a groundwater discontinuity, and wells on the west side of the river were not considered in groundwater scoring.

## ROUTE SCORES

| | | | |
|---|---|---|---|
| Surface Water/ Human Health: | 32.6 | Surface Water/ Environment: | 74.6 |
| Air/ Human Health: | 12.7 | Air/ Environment: | 1.1 |
| Groundwater/ Human Health: | 35.1 | | |

**Overall Rank: 1**

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# Worksheet 1: Summary Score Sheet

## REFERENCES


1 Boeing. January 2003. Letter Re: Summary of Data from PCB Sampling Associated with Oil/Water Separators at the Developmental Center.

2 Boeing. October 2002. Letter Re: Completion of Groundwater Monitoring at AOC-01/02, Boeing Developmental Center, Tukwila, Washington.

3 Calibre. May 2016. 2015 Annual Sampling Report, South Storm Drain System, Boeing Developmental Center.

4 Ecology. February 2003. Norfolk Combined Sewer Overflow (Duwamish River) Sediment Cap Recontamination, Phase I Investigation. Publication No. 03-03-004.

5 Ecology. January 2018. Agreed Order Docket #15600.

6 Ecology. September 2007. Lower Duwamish Waterway, Early Action Area 7, Final Summary of Existing Information and Identification of Data Gaps Report. (prepared by Ecology & Environment, Inc. for the Department of Ecology)

7 ESRI. Accessed 2018. World Annual Evapotranspiration Map. Accessed through https://www.esri.com/arcgis-blog/products/arcgis-online/mapping/world-average-annualevapotranspiration-web-map-now-available/

8 IT Corporation. February 2001. Memo: AOC 5 and SWMU 16 Investigation Results, Boeing Developmental Center, Tukwila, Washington.

9 IT Corporation. October 2001. SWMU 16 and AOC 05 Site Assessment Report, Boeing Developmental Center, Tukwila, Washington.

10 King County iMap. Accessed 2018. https://gismaps.2 kingcounty.gov/iMap/

11 King County Wastewater Services: Norfolk CSO sediment remediation project. Accessed 2019. https://www.kingcounty.gov/services/environment/wastewater/sediment-management/projects/Norfolk.aspx

12 Landau. April 2002. Work Plan: ORC Injection Plan: AOC-05, Boeing Developmental Center, Tukwila, Washington.

13 Landau. August 2013. 2012 Annual Report, AOC-05 Remedial Action, Enhanced Anaerobic Biodegradation of Gasoline-Range Petroleum Hydrocarbons, Boeing Developmental Center, Tukwila, Washington.

14 Landau. December 1990. Final Report: Underground Storage Tank Removal, Former Tanks DC-13 and DC-14, Building 9-52, Boeing Developmental Center, Tukwila, Washington.

15 Landau. December 2004. Technical Memorandum: SWMU-20 Well installation and First Electron Donor Injection, Boeing Developmental Center, Tukwila, Washington.

16 Landau. February 1993. Report: Site Characterization, Building 9-50 Underground Boiler Fuel Tank Replacement Project, Boeing Developmental Center Facility, Tukwila, Washington.

17 Landau. February 2002. Summary Report: Corrective Action, Boeing Developmental Center.

18 Landau. February 2004. Construction Completion Report, Stormwater Treatment Vault Installation, Boeing Developmental Center, Tukwila, Washington.

19 Landau. February 2005. Technical Memorandum: SWMU-20 Groundwater and Indoor Air Modeling and Recommended Actions, Boeing Developmental Center, Tukwila, Washington.

20 Landau. July 2018. May 2018 Semiannual Groundwater Monitoring Report, Boeing Developmental Center, Tukwila, Washington.

21 Landau. June 1993. Report: Aboveground Tank Closure Investigation, Building 9-101, Boeing Developmental Center, Tukwila, Washington.

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22 Landau. June 2001. Pump and Treat Remedial System Evaluation - SWMU-20, Boeing Developmental Center, Tukwila, Washington.

23 Landau. March 2004. Evaluation Report, SWMU-17, SWMU-20, and AOC-05, Boeing Developmental Center, Tukwila, Washington.

24 Landau. March 2006. Technical Memorandum: Results of Indoor Air Sampling, SWMU-20 Building 9-90, Boeing Developmental Center, Tukwila, Washington.

25 Landau. March 2016. Technical Memorandum: SWMU-20 Bioremediation, Summary of Fifth Electron Donor Injection, Boeing Developmental Center, Tukwila, Washington.

26 Landau. March 2018. 2017 Annual Report, SWMU-17 Remedial Action, Enhanced Anaerobic Biodegradation, Boeing Developmental Center, Tukwila, Washington.

27 Landau. May 2013. Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila, Washington.

28 Landau. November 1990. Final Report: Summary of Soil and Ground Water Quality, Building 9-101 Structural Improvements, Boeing Developmental Center, Tukwila, Washington.

29 Landau. November 2007. Work Plan, AOC-05 Remedial Action Plan, Enhanced Anaerobic Degradation of Gasoline-Range Petroleum Hydrocarbons, Boeing Developmental Center, Tukwila, Washington.

30 Landau. October 1992. Phase III Report: Soil and Groundwater Characterization, Building 9-101, Boeing Developmental Center, Tukwila, Washington.

31 Landau. October 2008. Work Plan, SWMU-17 Pilot Test, Boeing Developmental Center, Tukwila, Washington.

32 Landau. October 2017. Addendum No. 1 - Revised, SWMU-17 Remedial Action Work Plan, Enhanced Anaerobic Degradation, Boeing Developmental Center, Tukwila, Washington.

33 Missouri Census Data Center. Accessed 2018. Circular Area Profiles – Version 10C. http://mcdc.missouri.edu/websas/caps10c.html

34 NOAA National Centers for Environmental Information. Accessed 2018. Global Summary of the Year 2013 - 2017 – Lakeland North 0.5ENE station. Requested from https://www.ncdc.noaa.gov/cdo-web/

35 NOAA. Accessed 2018. Atlas 2: Precipitation Frequency Estimates. http://www.nws.noaa.gov/oh/hdsc/noaaatlas2.htm

36 Project Performance Corporation. December 2003. Cleanup Action Report, Sediment Removal Near South Storm Drain Outfall, Boeing Developmental Center, Tukwila, Washington.

37 Project Performance Corporation. July 2001. Data Summary of PCB Sampling From Accumulated Solids and Construction Materials In and Around Storm Sewer Lines at the Developmental Center.

38 Roy F. Weston Inc. April 1997. Closure Certification, Building (-50, 9-60, and 9-69/70 Container Storage Areas, Boeing Developmental Center, Tukwila, Washington.

39 Roy F. Weston Inc. November 1995. Building 9-70 TSD Subsurface Soil Investigation, Boeing Developmental Center, Tukwila, Washington.

40 SAIC. September 1994. RCRA Facility Assessment Report for Boeing Developmental Center, Tukwila, Washington, EPA ID No. WAD 093639946 and Boeing Military Flight Center, Seattle, Washington, EPA ID No. WAD 988475943. Prepared for US Environmental Protection Agency, Seattle, Washington.

41 WA Dept. of Ecology. Accessed 2018. Water Rights Tracking System (WRTS).

42 WA Dept. of Ecology. Accessed 2018. What's in My Neighborhood. https://fortress.wa.gov/ecy/neighborhood/

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43 WA Dept. of Fish & Wildlife. Accessed 2018. Priority Habitats and Species (PHS on the Web). http://apps.wdfw.wa.gov/phsontheweb/

44 WA Dept. of Health Office of Drinking Water. Accessed 2018. Find Water System. https://fortress.wa.gov/doh/eh/portal/odw/si/FindWaterSystem.aspx

# SITE HAZARD ASSESSMENT
# Worksheet 2: Route Documentation

## Boeing Developmental Center

Cleanup Site ID: 5059

Facility/Site ID: 2101

## 1. SURFACE WATER ROUTE

**List those substances to be considered for scoring:**

PCBs

**Explain the basis for choice of substances to be used in scoring:**

PCBs have been documented in south storm drain line and sediment near outfall

**List those management units to be considered for scoring:**

Sediment, storm drain line sampling

**Explain basis for choice of unit to be used in scoring:**

Contaminated media that are in direct contact with surface water

## 2. AIR ROUTE

**List those substances to be considered for scoring:**

Trichloroethylene, vinyl chloride

**Explain the basis for choice of substances to be used in scoring:**

Volatile contaminants in groundwater during most recent sampling event (May 2018)

**List those management units to be considered for scoring:**

Groundwater

**Explain basis for choice of unit to be used in scoring:**

Volatile chemicals documented to be present in groundwater on Site

## 3. GROUNDWATER ROUTE

**List those substances to be considered for scoring:**

Trichloroethylene, vinyl chloride

**Explain the basis for choice of substances to be used in scoring:**

Contaminants above proposed cleanup levels in groundwater during most recent sampling event (May 2018)

**List those management units to be considered for scoring:**

Groundwater

**Explain basis for choice of unit to be used in scoring:**

Contaminants have been detected in groundwater

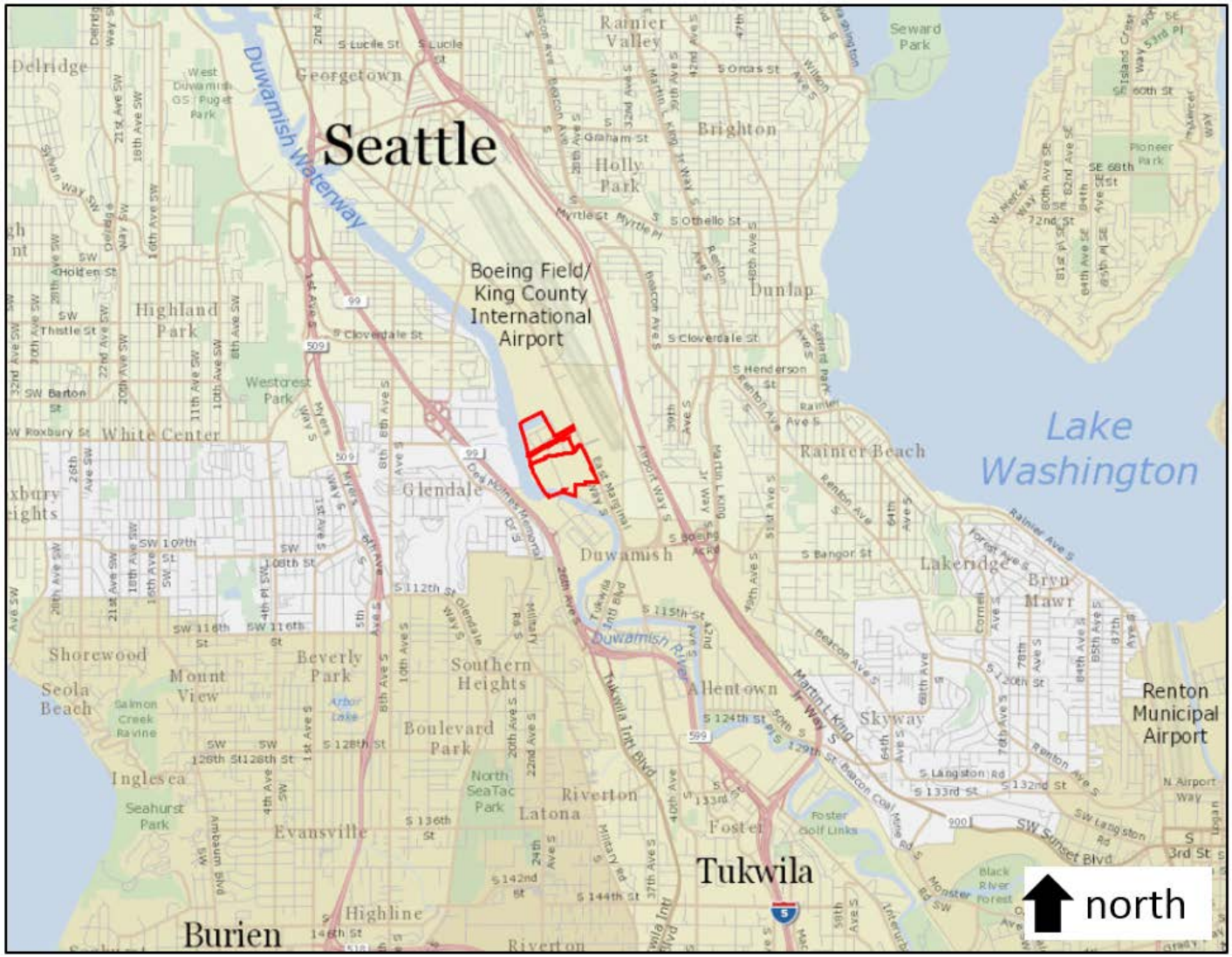


**Figure 1.** General location of the Boeing Developmental Center (outlined in red).

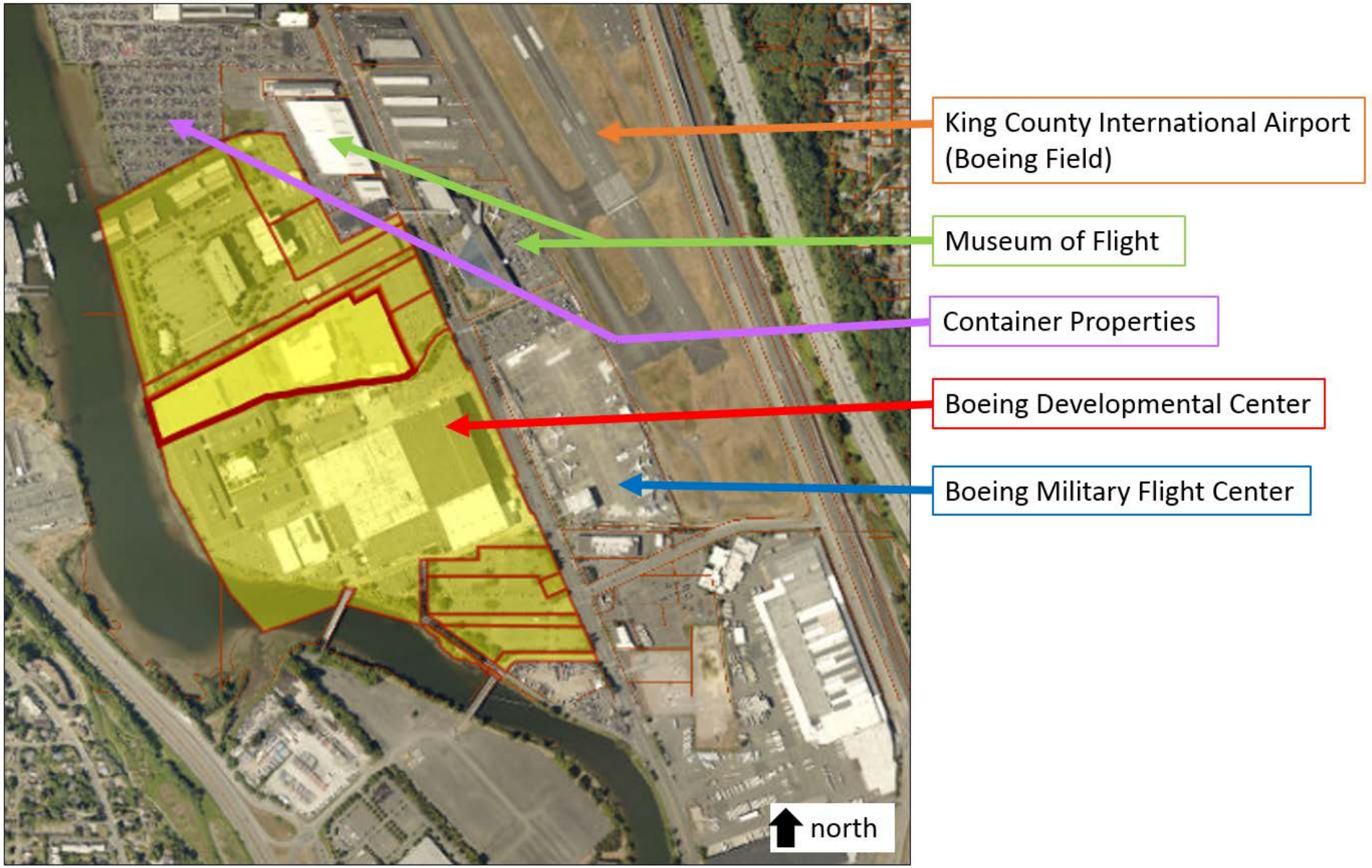


**Figure 2.** Location of Boeing Developmental Center relative to nearby properties of note. Individual parcels are outlined in red, and the entire Developmental Center Site is shaded in yellow.

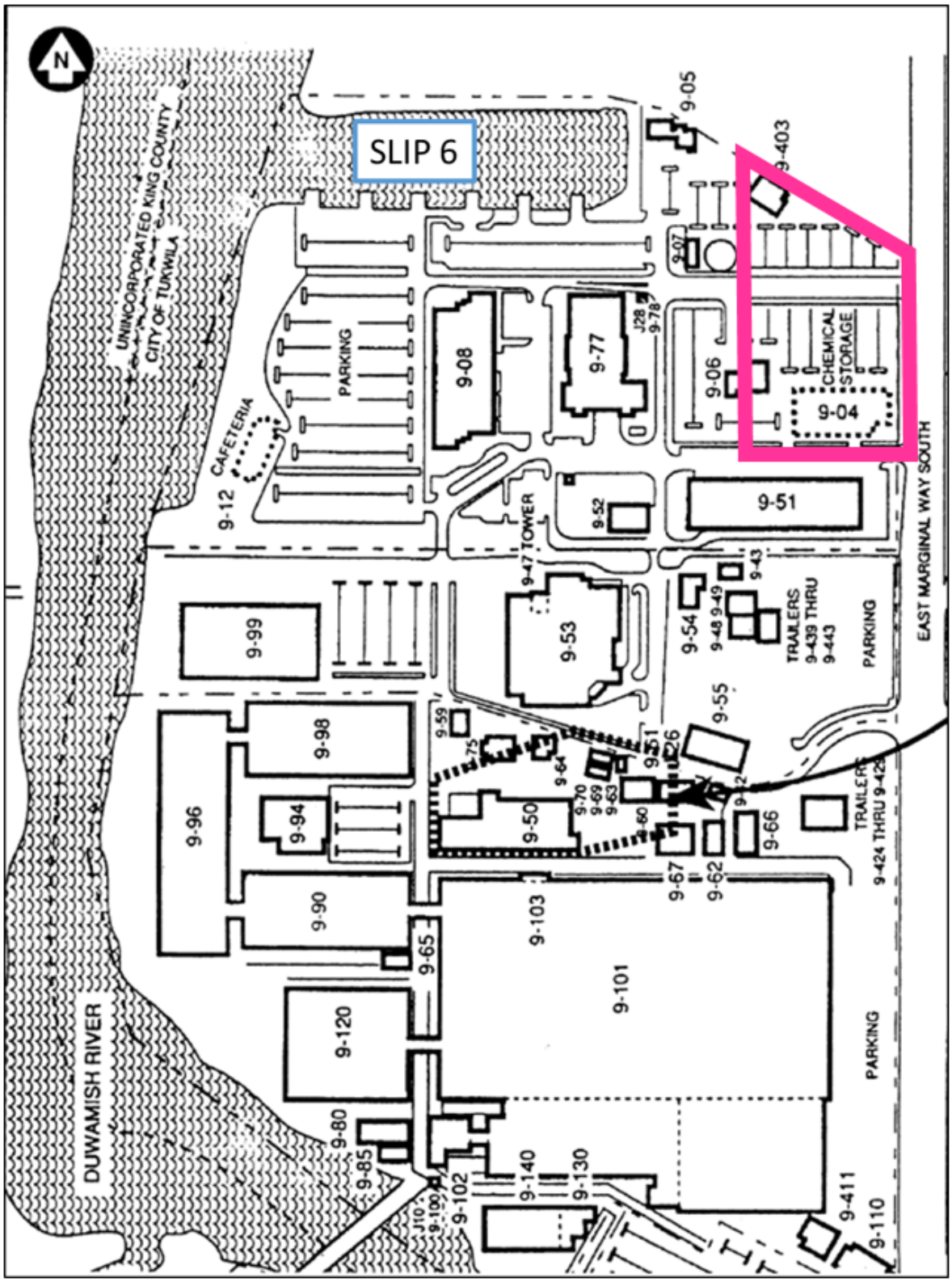


**Figure 3.** Buildings within the Developmental Center with building numbers. The southernmost parcels are not included in this figure, but are covered by parking lots and do not contain any buildings referenced in the Site Hazard Assessment. Dashed circle and arrow indicate general location of hazardous waste storage areas that underwent closure in the mid-1990s (figure taken from 1997 Weston closure report). The in-water area known as Slip 6 is also indicated on the northern portion of the Site. The area within the pink outline in the northeast corner of the property is currently part of the Museum of Flight property.

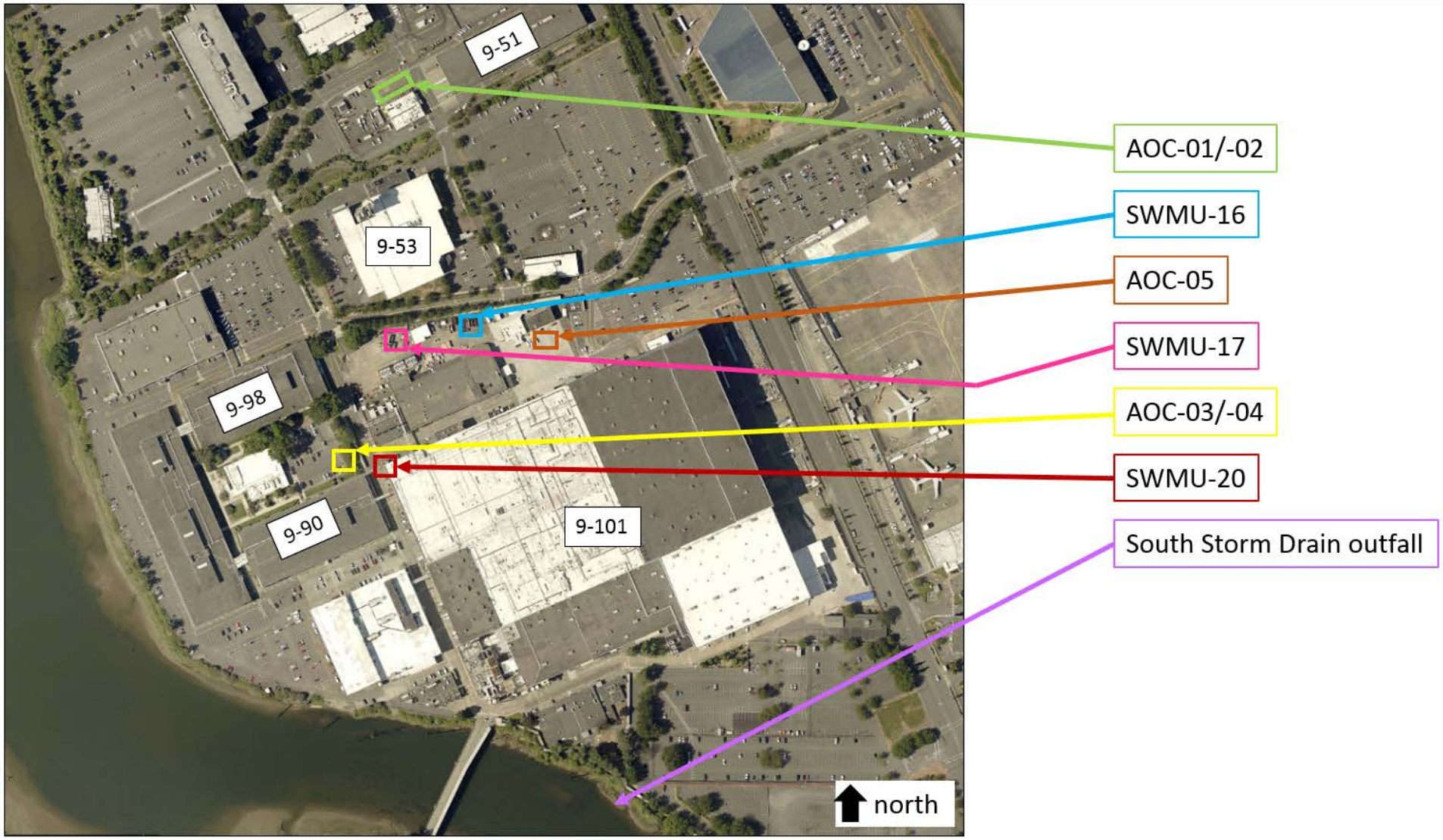


**Figure 4.** General location of areas of contamination detailed under Site Characterization and/or Remediation in the above report text. Northern and southern parts of the property are cut off on the base map, as contaminated areas are mostly on the center part of the property. Building numbers for some of the larger buildings area included.

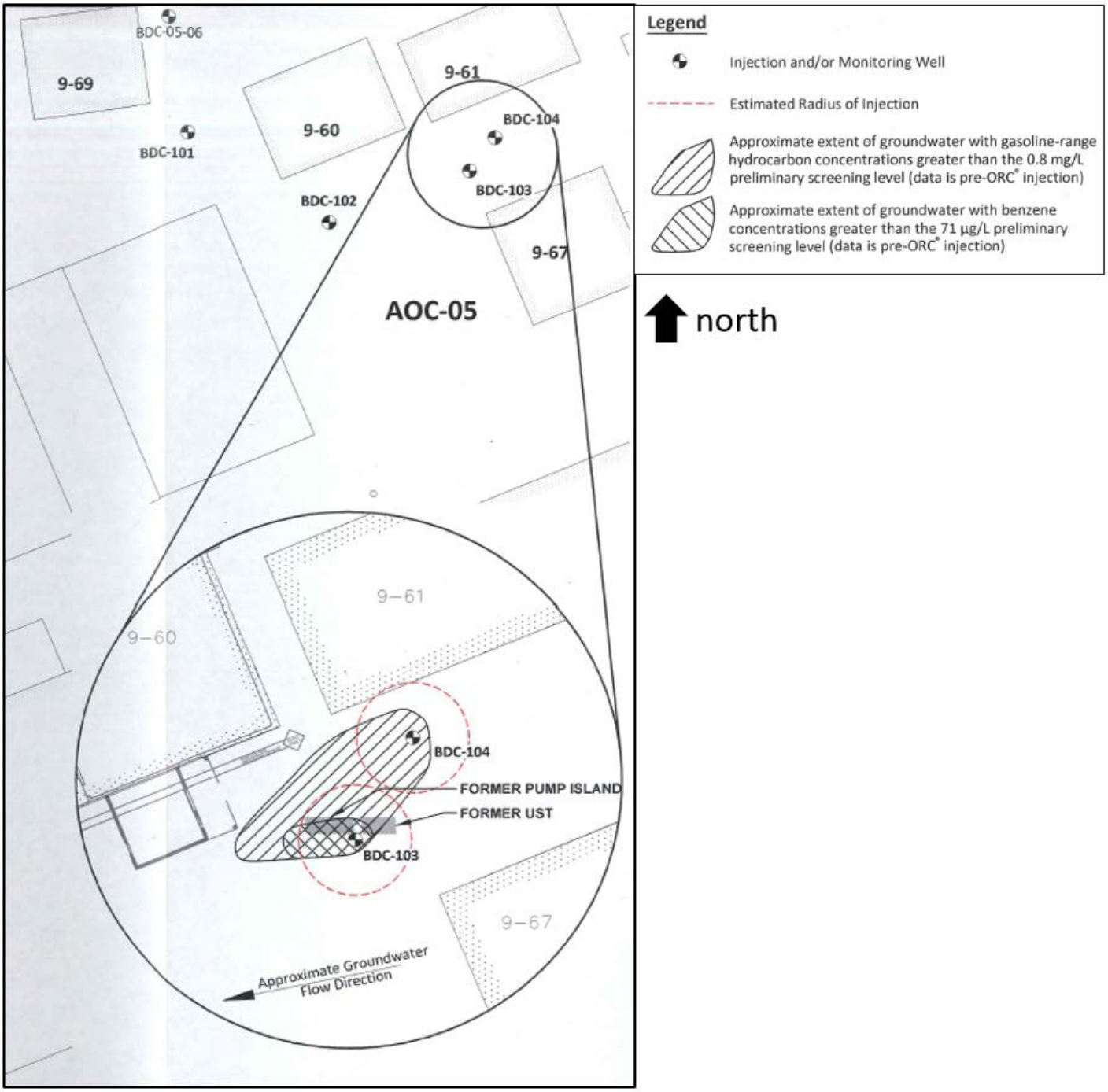


**Figure 5.** Details of AOC-05 area of contamination, including monitoring well locations and extent of contaminated groundwater prior to remedial actions.

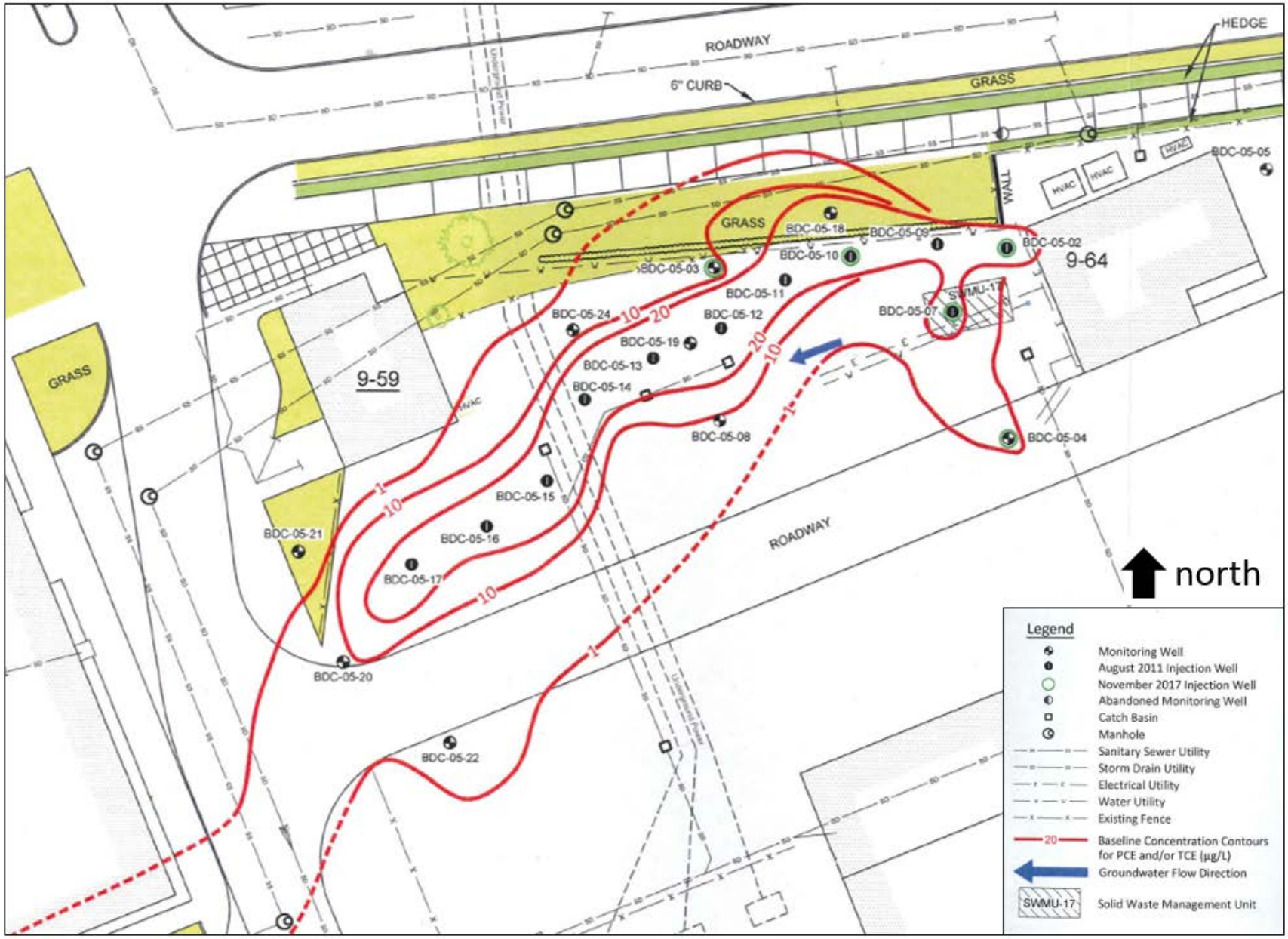


**Figure 6.** Details of SWMU-17 area of contamination, including monitoring well locations and extent of PCE and TCE contaminated groundwater prior to any remedial actions. As of May 2018, only the wells north of the SWMU-17 area remained contaminated (BDC-05-02, -09, and -18), so just a portion of the original area of contamination was considered in the area of remaining contamination for scoring.

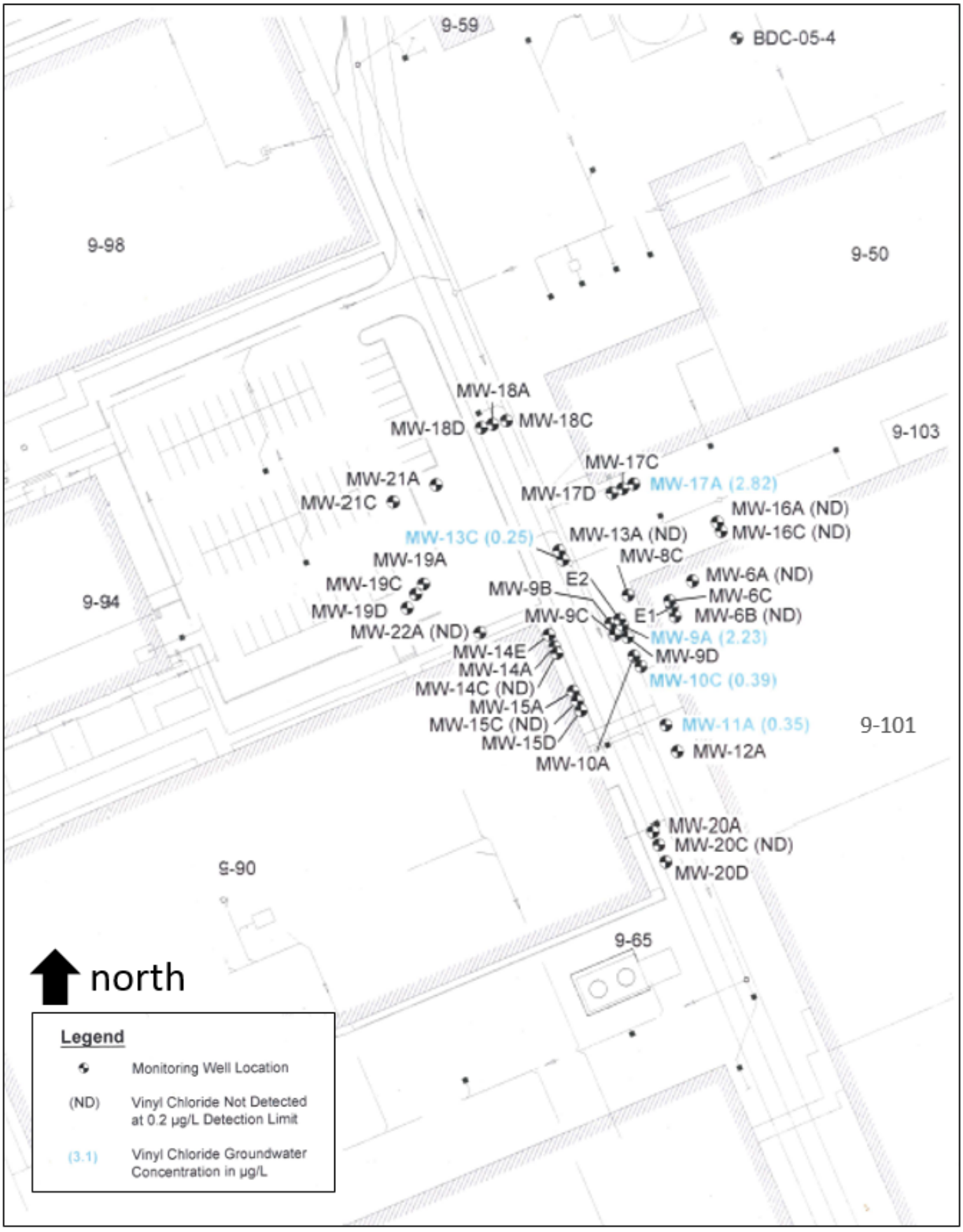


**Figure 7.** Details of SWMU-20 area of contamination, including monitoring well locations and vinyl chloride concentrations from May 2018 sampling. Wells without concentration data are not currently included in semi-annual monitoring. All wells with concentrations in blue are above MTCA Method A cleanup levels, so an area including all of those wells was used to determine area of contamination for scoring.

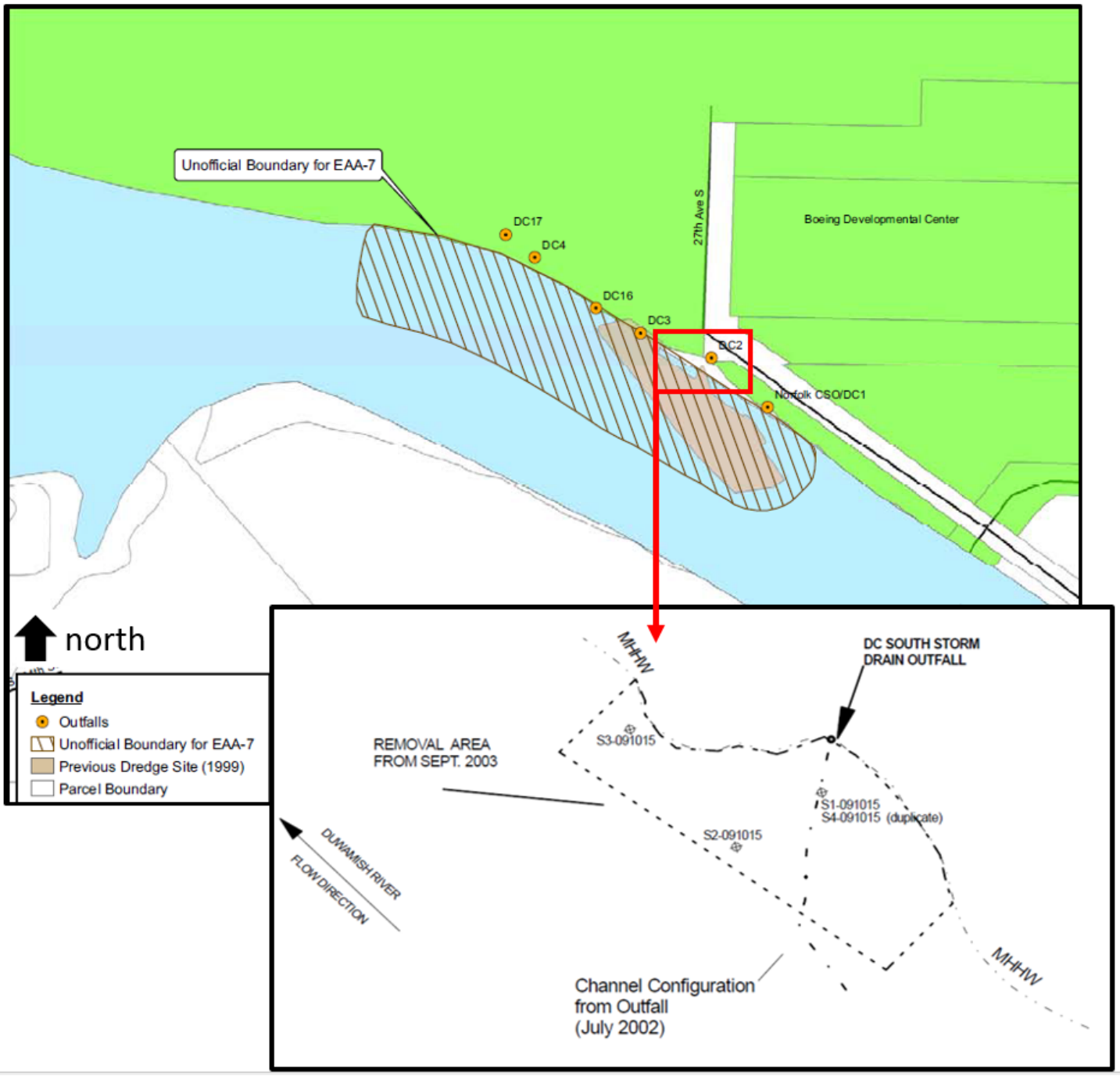


**Figure 8.** Location of 1999 dredging in EAA-7 (top) and details on sampling locations within Boeing 2003 sediment remediation area (bottom). The Boeing south storm drain is location DC2 on the top figure, and the area of 2003 remediation was located between the 1999 dredge area and the shoreline.

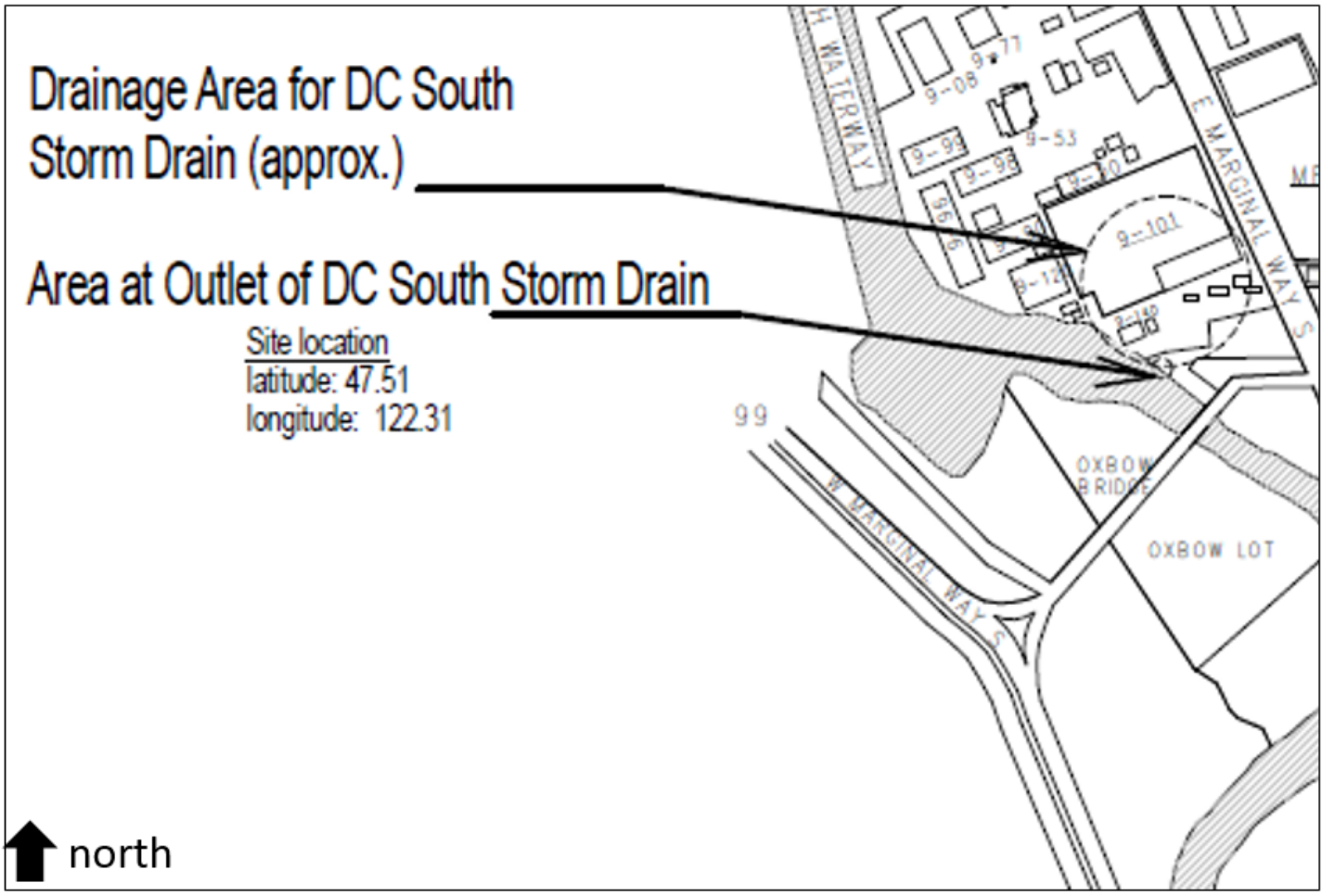


**Figure 9.** Area of Site drained by South Storm Drain stormwater infrastructure.

# Worksheet 4
# Surface Water Route

**CSID: 5059**

**Site: Boeing Developmental Center**

**1.0 SUBSTANCE CHARACTERISTICS**

1.1 Human Toxicity

| | Drink. Wat. Stnd. | | Acute Toxicity | | Chronic Toxicity | | Carcinogenicity | |
|---|---|---|---|---|---|---|---|---|
| Substance | Value (ug/L) | Score | Value (mg/kg) | Score | Value (mg/kg/day) | Score | Adj. CPFo (risk/mg/kg-day) | Score |
| PCBs | 5.00E-01 | 10 | 1.32E+03 | 3 | -- | X | 1.60E+00 | 7 |

Maximum score: 10
Bonus points:
Human Toxicity Score: 10
Source: WARM Toxicity Database
Range: 1-12

1.2 Environmental Toxicity

Freshwater:
Marine: X

| | Acute Water Quality Criterion | |
|---|---|---|
| Substance | Value (ug/L) | Score |
| PCBs | 1.00E+01 | 8 |

Maximum score: 8
Environmental Toxicity Score: 8
Source: WARM Toxicity Database
Range: 2-10

1.3 Substance Quantity

Amount: 9.3 acres
Basis: approximate area of site drained by south storm drain
Source: site reports
Substance Quantity Score: 9
Range: 1-10

2.1 Containment

Description: contaminated sediment in direct contact with surface water with no containment

Source: site reports — Containment Score: 10

Range: 0-10

**SUBSTANCE PARAMETER CALCULATIONS**

Human Health Pathway

SUBh (Human Toxicity + 3) x (Containment + 1) + Substance Quantity — 152.0

Environmental Pathway

SUBe (Environ. Toxicity + 3) x (Containment + 1) + Substance Quantity — 130.0

**2.0 MIGRATION POTENTIAL**

2.2 Surface Soil Permeability

Description: piped or adjacent to surface water, so scores a 7 per the WARM scoring manual

Source: site reports — Soil Permeability Score: 7

Range: 1-7

2.3 Total Annual Precipitation

Amount (in.): 36.75 — Annual Precipitation Score: 3

Source: NOAA — Range: 1-5

2.4 Maximum Two-Year/24-Hour Precipitation

Amount (in.): 1.98 — 24-Hour Precipitation Score: 2

Source: WARM Scoring Manual — Range: 1-5

2.5 Flood Plain

Classification: portion of the site is within the 100 year floodplain — Floodplain Score: 2

Source: iMap — Range: 0-2

2.6 Terrain Slope

Degree of slope: piped/culverted (based on stormwater system discharge)

Source: iMap — Terrain Slope Score: 3

Range: 1-5

**MIGRATION PARAMETER CALCULATION**

MIG = Soil Permability + Annual Precip. + 24-Hour Precip. + Floodplain + Slope — 17.0

**3.0 TARGETS**

3.1 Distance to Surface Water

| | | | |
|---|---|---|---|
| Name: | Lower Duwamish | | |
| Distance (ft): | adjacent | Distance to Surface Water Score: | 10 |
| Source: | iMap | Range: | 0-10 |

3.2 Population Served within 2 Miles

| | | | |
|---|---|---|---|
| Population: | 0; surface water is marine | Population Served Score: | 0 |
| Source: | site reports | Range: | 0-75 |

3.3 Area Irrigated within 2 Miles

| | | | |
|---|---|---|---|
| Basis: | search of surface water rights for Duwamish River in section-township-range 4-23N-4E, 33-24N-4E, 32-24N-4E, 29-14N-4E | | |
| Area (acres): | 0 | Area Irrigated Score: | 0 |
| Source: | WRTS | Range: | 0-30 |

3.4 Distance to Nearest Fishery Resource

| | | | |
|---|---|---|---|
| Name: | Duwamish River | | |
| Distance (ft): | adjacent | Distance to Fishery Score: | 12 |
| Source: | iMap | Range: | 0-12 |

3.5 Distance to Nearest Sensitive Environment

| | | | |
|---|---|---|---|
| Name: | Duwamish River (fisheries resource) | | |
| Distance (ft): | adjacent | Distance to Sensitive Environment Score: | 12 |
| Source: | iMap | Range: | 0-12 |

**TARGET PARAMETER CALCULATIONS**

Human Health Pathway

TARh: Dist. to Surface Water + Population Served + Area Irrigated **10.0**

Environmental Pathway

TARe Dist. to Surface Water + Dist. to Fishery + Dist. to Sensit. Environ. **34.0**

**4.0 RELEASE**

| | | | |
|---|---|---|---|
| Evid. of release? | confirmed PCBs in sediment and in storm drain system | | |
| Source: | site reports | Release Score (REL): | 5.0 |
| | | Range: | 0 or 5 |

**SURFACE WATER ROUTE CALCULATIONS**

Human Health Pathway

SWh = (SUBh x 40/175) x [(MIG x 25/24)) + REL + (TARh x 30/115)] / 24 **36.6**

Environmental Pathway

SWe = (SUBe x 40/153) x {(MIG x 25/24)) + REL + (TARe x 30/34)} / 24 **74.6**

Range: 0-100

# Worksheet 5
# Air Route

**CSID: 5059**

**Site: Boeing Developmental Center**

**1.0 SUBSTANCE CHARACTERISTICS**

1.1 Introduction

No scoring in Section 1.1.

1.2 Human Toxicity

| Substance | Amb. Air Stnd. Value ($ug/m^3$) | Score | Acute Toxicity Value ($mg/m^3$) | Score | Chronic Toxicity Value (mg/kg/day) | Score | Carcinogenicity Adj. CPFi (risk/mg/kg-day) | Score |
|---|---|---|---|---|---|---|---|---|
| trichloroethylene | 5.00E-01 | 10 | 1.56E+04 | 3 | 5.71E-04 | 10 | 1.44E-02 | 5 |
| vinyl chloride | 1.28E-02 | 10 | 4.60E+05 | 1 | 2.86E-02 | 5 | 3.10E-02 | 5 |

Maximum score: 10

Bonus points: 2 Human Toxicity Score: 12

Source: WARM Toxicity Database Range: 1-12

1.3 Mobility

Gaseous Mobility

| Substance | Vapor Pressure Value (mm Hg) | Score | Henry's Law Value (atm-m3/ mol) | Score |
|---|---|---|---|---|
| trichloroethylene | | | 1.03E-02 | 4 |
| vinyl chloride | | | 2.71E-02 | 4 |

Maximum score: 4

Source: WARM Toxicity Database

Particulate Mobility

Soil type:

Erodibility factor:

Climatic factor:

Mobility value: Mobility Score: 4

Source: Range: 0-4

1.4 Human Toxicity/Mobility

Source: WARM Scoring Manual

Human Tox/Mobil Score: 24

Range: 1-24

1.5 Environmental Toxicity/Mobility

| Substance | Acute Value ($mg/m^3$) | Score |
|---|---|---|
| trichloroethylene | 1.56E+04 | 3 |
| vinyl chloride | 4.60E+05 | 1 |

Maximum score 3

Source: WARM Toxicity Database

Environmental Toxicity Score: 3

Range: 1-10

Environmental Tox/Mobil Score: 6

Range: 1-24

1.6 Substance Quantity

Quantity: 4500 $ft^2$

Basis: area of remaining groundwater contamination in SWMU-17 + SWMU-20

Source: site reports

Substance Quantity Score: 5

Range: 1-10

2.1 Containment

Description: cover > 2 ft thick + no vapor collection system

Basis: site reports

Containment Score: 5

Range: 0-10

**SUBSTANCE PARAMETER CALCULATIONS**

Human Health Pathway

SUBh (Human Tox/Mobil + 5) x (Containment +1) + Substance Quantity 179.0

Environmental Pathway

SUBe (Environ. Tox/Mobil + 5) x (Containment +1) + Substance Quantity 71.0

**3.0 TARGETS**

3.1 Nearest Population

Description: Museum of Flight building

Distance (ft): 1,200

Source: iMap

Nearest Population Score: 8

Range: 0-10

3.2 Nearest Sensitive Environment

| | | | |
|---|---|---|---|
| Description: | Hamm Creek Natural Area | | |
| Distance (ft): | 2,600 | Nearest Sensitive Environment Score: | 5 |
| Source: | iMap | Range: | 0-7 |

3.3 Population within One-Half Mile

| | | | |
|---|---|---|---|
| Number: | 213 | Population within Half Mile Score: | 14.6 |
| Source: | MO CDC | Range: | 0-75 |

**TARGET PARAMETER CALCULATIONS**

Human Health Pathway

TARh: Nearest Population + Population within Half Mile **22.6**

Environmental Pathway

TARe Nearest Sensitive Environment **5.0**

**4.0 RELEASE**

| | | | |
|---|---|---|---|
| Evid. of release? | no confirmed vapor from subsurface sources | | |
| Source: | site reports | Release Score (REL): | 0.0 |
| | | Range: | 0 or 5 |

**AIR ROUTE CALCULATIONS**

Human Health Pathway

AIRh = (SUBh x 60/329) x {REL + (TARh x 35/85} / 24 **12.7**

Environmental Pathway

AIRe = (SUBe x 60/329) x {REL + (TARe x 35/85} / 24 **1.1**

Range: 0-100

# Worksheet 6
# Groundwater Route

**CSID: 5059**

**Site: Boeing Developmental Center**

**1.0 SUBSTANCE CHARACTERISTICS**

1.1 Human toxicity

| Substance | Drink. Wat. Stnd Value (ug/L) | Score | Acute Toxicity Value (mg/kg) | Score | Chronic Toxicity Value (mg/kg/day) | Score | Carcinogenicity Adj. CPFo (risk/mg/kg-day) | Score |
|---|---|---|---|---|---|---|---|---|
| trichloroethylene | 5.00E+00 | 8 | 2.40E+03 | 3 | 5.00E-04 | 5 | 4.64E-02 | 5 |
| vinyl chloride | 2.00E+00 | 8 | 5.00E+02 | 5 | 3.00E-03 | 3 | 1.50E+00 | 7 |

Maximum score: 8
Bonus points: 2 — Human Toxicity Score: 10
Source: WARM Toxicity Database — Range: 1-12

1.2 Mobility

| Substance | Solubility Value (mg/L) | Score |
|---|---|---|
| trichloroethylene | 1.10E+03 | 3 |
| vinyl chloride | 2.76E+03 | 3 |

Maximum value: 3 — Mobility Score: 3
Source: WARM Toxicity Database — Range: 1-3

1.3 Substance quantity

Quantity: 500 $yd^3$
Basis: area of remaining groundwater contamination in SWMU-17 + SWMU+20 (500 $yd^2$) x assumed 1 yard depth
Source: site reports — Substance Quantity Score: 3
Range: 1-10

2.1 Containment

Description: no containment - groundwater is contaminated
Source: site reports — Containment Score: 10
Range: 0-10

**SUBSTANCE PARAMETER CALCULATION**

SUB = (Human Toxicity + Mobility + 3) x (Containment + 1 ) + Substance Quantity **179.0**

**2.0 MIGRATION POTENTIAL**

2.2 Net precipitation

| | | | |
|---|---|---|---|
| Amount (in.): | 18 | Net Precipitation Score: | 2 |
| Source: | NOAA, ESRI | Range: | 0-5 |

2.3 Subsurface Hydraulic Conductivity

| | | | |
|---|---|---|---|
| Description: | silt and sand fill | | |
| Source: | site reports | Hydraulic Conductivity Score: | 3 |
| | | Range: | 1-4 |

2.4 Vertical Depth to Aquifer

| | | | |
|---|---|---|---|
| Depth (ft): | groundwater is contaminated | Depth to Aquifer Score: | 8 |
| Source: | site reports | Range: | 1-8 |

**MIGRATION PARAMETER CALCULATION**

MIG = Depth to Aquifer + Net Precipitation + Hydraulic Conductivity **13.0**

**3.0 TARGETS**

3.1 Aquifer Usage

| | | | |
|---|---|---|---|
| Description: | a specific justification for non-potability was not found in the files, so groundwater is conservatively assumed to be not used but usable | | |
| Source: | iMap, WDOH Water System Database, site reports | Aquifer Use Score: | 2 |
| | | Range: | 1-10 |

3.2 Distance to Nearest Drinking Water Well

| | | | |
|---|---|---|---|
| Distance (ft): | >2 mi; Seattle Public Utilities and City of Tukwila utilities cover all areas within 2 miles of the Site on the east side of the Duwamish (see Special Considerations) | | 0 |
| Source: | iMap, WDOH Water System Database, WRTS | Range: | 0-5 |

3.3 Population Served by Drinking Water Wells within Two Miles — Population Served Score: 0.0

| | | | |
|---|---|---|---|
| No. of people: | 0 | Range: | 0-100 |
| Source: | WDOH Water System Database, Well Log Viewer | | |

3.4 Area Irrigated by Wells within Two Miles — Area Irrigated Score: 0.0

| | | | |
|---|---|---|---|
| Area (acres): | 0 | Range: | 0-50 |
| Source: | Water Resources Explorer | | |

**TARGET PARAMETER CALCULATION**

2.0

TAR = Aquifer Use + Well Distance + Population Served + Area Irrigated

**4.0 RELEASE**

Evid. of release? contamination detected in groundwater Release Score (REL): 5.0

Source: site reports Range: 0 or 5

**GROUND WATER ROUTE CALCULATION**

35.1

GW = (SUB x 40/208) x {(MIG x 25/17) + REL + (TAR x 30/165)} / 24

Range: 0-100

# Washington Ranking Method
# Route Scoring Summary and Ranking Calculation

**CSID:** **5059**

**Site:** **Boeing Developmental Center**

Human Health Route Scores

| Pathway | Score | Quintile |
|---|---|---|
| Surface water | 36.6 | 5 |
| Air | 12.7 | 2 |
| Groundwater | 35.1 | 3 |

| Quintile | Value |
|---|---|
| High (H) | 5 |
| Middle (M) | 3 |
| Low (L) | 2 |

Human Health Pathway Quintiles - based off August 2018 HSL

| Quintile | Surface Water | | Air | | Groundwater | |
|---|---|---|---|---|---|---|
| 1 | <= | 7.9 | <= | 8.6 | <= | 24.1 |
| 2 | 8.0 | 15.1 | 8.7 | 16.3 | 24.2 | 33.1 |
| 3 | 15.2 | 21.2 | 16.4 | 25.3 | 33.2 | 40.4 |
| 4 | 21.3 | 29.7 | 25.4 | 40.1 | 40.5 | 49.6 |
| 5 | >= | 29.8 | >= | 40.2 | >= | 49.7 |

$(H^2 + 2M + L) / 8$

Human Health Priority Bin Score: 4.1

Environmental Route Scores

| Pathway | Score | Quintile |
|---|---|---|
| Surface water | 74.6 | 5 |
| Air | 1.1 | 1 |

| Quintile | Value |
|---|---|
| High (H) | 5 |
| Low (L) | 1 |

Environmental Pathway Quintiles - based off August 2018 HSL

| Quintile | Surface Water | | Air | |
|---|---|---|---|---|
| 1 | <= | 11.3 | <= | 1.2 |
| 2 | 11.4 | 24.1 | 1.3 | 1.5 |
| 3 | 24.2 | 31.6 | 1.6 | 13.8 |
| 4 | 31.7 | 49.7 | 13.9 | 26.5 |
| 5 | >= | 49.8 | >= | 26.6 |

$(H^2 + 2L) / 7$

Environmental Priority Bin Score: 3.9

**FINAL MATRIX RANKING**

| Human Health Priority | Environmental Priority 5 | 4 | 3 | 2 | 1 | n/a |
|---|---|---|---|---|---|---|
| 5 | 1 | 1 | 1 | 1 | 1 | 1 |
| 4 | 1 | 2 | 2 | 2 | 3 | 2 |
| 3 | 1 | 2 | 3 | 4 | 4 | 3 |
| 2 | 2 | 3 | 4 | 4 | 5 | 3 |
| 1 | 2 | 3 | 4 | 5 | 5 | 5 |
| n/a | 3 | 4 | 5 | 5 | 5 | NFA |

n/a - not applicable

NFA - no further action

**Site Rank:** 1