

18 December 2013

Technical Memorandum

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To: Eugene Freeman, Washington State Department of Ecology
From: Jessica Faragalli, Dean Malte, and Ty Schreiner
Subject: Former Precision Engineering Facility
Site Summary and Data Gaps Assessment
K/J 1396024*00

The purpose of this Technical Memorandum is to summarize documents reviewed by Kennedy/Jenks Consultants for the Precision Engineering facility (Site) that were provided by Washington State Department of Ecology (Ecology) and to identify the current Site conditions related to environmental conditions, including the potential for impacts to the Lower Duwamish Waterway (LDW) Superfund Site.

This Technical Memorandum also identifies potential data gaps that will be addressed in developing a Remedial Investigation Work Plan (RIWP). This Technical Memorandum also presents a preliminary conceptual site model (CSM) for the property and adjacent areas.

Several figures prepared by Kennedy/Jenks Consultants are enclosed depicting areas of concern and prior sampling and investigation locations. Select materials prepared by others for prior reports are included in Attachment 1 and depict details of previous remedial actions and historical Site conditions. Concentration maps for primary contaminants of concern (which include arsenic, total chromium, hexavalent chromium, diesel-range hydrocarbons, trichloroethene, and vinyl chloride) in soil and groundwater are provided in Attachment 2 for reference.

Site Overview

The Site is a former manufacturing facility that specialized in the production and repair of large hydraulic cylinders used in the manufacture of paper and metal sheets. The facility operated from 1968 through 2005. The property was sold in 2005 and is now operated as a retail warehouse (Pacific Industrial Supply) for construction and machinery supplies.

While the property was operated as Precision Engineering, activities at the Site included grinding and polishing, honing, hard-chrome plating, milling, welding, and other flame and arc-applied metal coatings. Precision Engineering's work involved the use of a number of chemicals, particularly chromic acid for plating and trichloroethene (TCE) as a solvent. A number of chromic acid plating tanks were located in the former chrome shop, as were tanks containing hydrochloric acid, sodium carbonate, and sodium hydroxide. At least four trench drains were present in the grinding and chrome shops, located along the eastern and western walls of the shop. Locations of these features are shown on attached Figure 1 and are based on the available information regarding process areas within the facility.

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The Site is located in unincorporated King County near the municipal boundary between the cities of Seattle and Tukwila, Washington, near the southwestern corner of South Director Street and 14th Street South, and is situated less than 200 feet west of the Lower Duwamish Waterway.

Adjacent properties are developed with residences to the north and northwest, Seattle Refrigeration to the west up a steep embankment, highway US-99/West Marginal Way with a cloverleaf interchange to the south and southeast, and Seattle Limousine to the east. Sea King Industrial Park is located east of Seattle Limousine and 14th Avenue South, which extends to the west bank of the Lower Duwamish Waterway. These adjacent properties are depicted on attached Figure 2.

A drainage ditch is located along the southern property line of the Site, and extends eastward along the southern margin and then northward along the eastern property line of the Seattle Limousine property (see Figures 1 and 2). Based on available information, the drainage ditch does not appear to have an outlet (i.e., it does not appear to discharge to surface water beyond the margins of the ditch). The 2011 Feasibility Study (prepared by Maul Foster Alongi) does reference a possible discharge from the ditch to the municipal storm drain system, but no indication of this possible outlet was observed during a recent Site visit.

Environmental Investigation and Cleanup Background

A series of regulatory events, beginning in the mid-1980s, has initiated a number of environmental investigations and remedial actions at the Site. Initially, environmental concerns were raised in February 1986, when Seattle Metro issued a discharge violation to Precision Engineering for discharging chrome-plating wastes to the sanitary sewer after Precision Engineering cancelled its Waste Discharge Permit in September 1985. Ecology and Metro inspected the Site in March 1986 and identified the following environmental conditions of concern:

- Leaks in the concrete sump containing spent/waste chromic acid.
- Improper hazardous waste storage.
- Discharge of wastewater, detergent, and oil from the steam cleaning area into the adjacent drainage ditch located along the southern property margin.
- Chromium contamination on the building roof due to ineffective scrubbers.
- Oil contaminated surface and shallow subsurface soil adjacent to the facility dumpster.
- Groundwater accumulation in Tank 7.

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An Administrative Order was issued by Ecology later in 1986 requiring compliance activities to address the identified issues. The Administrative Order also required characterization of the nature and extent of contaminant impacts to soil and groundwater at the Site, including the drainage ditch south of the Site. A series of investigation and remediation activities have been subsequently performed at the Site and are summarized in the following sections.

Several potential source areas and/or areas of concern have been identified at the Site, many of which have been investigated by Maul Foster Alongi (MFA), Sweet Edwards/EMCON (SE/E), or Ecology and reported previously. Individual areas of concern, previous investigation areas, and previous remedial actions are summarized in attached Table 1 and depicted on Figure 1. Each issue is discussed further in the following sections.

Groundwater conditions were initially investigated in 1988 by SE/E when four monitoring wells and two piezometers were installed at the Site. Additional groundwater wells were installed by MFA in 2005.

Prior Investigation and Remediation Reports

The following reports have been reviewed by Kennedy/Jenks Consultants to establish an understanding of Site conditions and a chronology of events. A brief summary of the reported activities and findings is presented below. Maps showing previous sample locations are provided on attached Figures 3 through 6, and concentration maps for the primary soil and groundwater contaminants are provided in Attachment 2.

Note: Cleanup levels referenced in the following sections are those referenced in the previous reports and are not necessarily current or the cleanup levels that will be applicable for the Site in the future. Cleanup levels for the Site will be identified as part of the ongoing RI process.

1990 M&M Environmental – Letter to Ecology Regarding Precision Engineering, Inc.

This letter report summarizes initial investigation activities conducted near Former Plating Tanks 1 and 2 and the Plating Tank 7 vault, as well as initial sediment sampling in the southern drainage ditch.

Yellow-stained soil was observed near Former Plating Tanks 1 and 2, after which soils were sampled, and the tanks and vaults were later removed and disposed offsite. Concrete and soils were excavated to approximately 13 feet below ground surface (bgs). Groundwater was encountered at the base of the excavation beneath the tanks at an approximate depth of 10 feet bgs.

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An investigation was conducted at Plating Tank 7 after a crack was observed in the northeastern corner of the deep containment vault. A soil boring was advanced northeast of the tank to a depth of 20.4 feet bgs, and a monitoring well was constructed in the borehole (boring B-1). Dense, silty sand and gravel was encountered between 18 and 20 feet bgs and interpreted to be glacial till by M&M Environmental. Soil samples were analyzed for soluble metals using the EP Toxicity method [predecessor to the current Toxicity Characteristic Leaching Procedure (TCLP) technique], which reported detected concentrations of barium, copper, nickel, and zinc (results were not tabulated within this document). Soil pH was also analyzed, with the highest reported pH of 9.4.

Reportedly, two phases of surface sediment sampling occurred in the drainage ditch south of the Site, and samples were analyzed for soluble chromium using the EP Toxicity method. The results of this sampling were not directly included within the report; however, sampling results were reportedly below the 0.5 milligrams per liter (mg/L) level for hazardous waste designation of chromium in accordance with WAC 173-303-090.

1993 Precision Engineering – Independent Remedial Action Report

This report was prepared by Douglas Richardson, the environmental health and safety manager at Precision Engineering, and includes a summary of remedial activities completed between March 1988 and April 1993 at the Site. Prior to 1992 tank removal activities, Precision Engineering reportedly negotiated a soil cleanup level of 400 parts per million (ppm) [milligrams per kilogram (mg/kg)] for hexavalent chromium.

In 1992, Former Plating Tanks 3, 4, 5, and 6 were removed and disposed. A 35-foot by 40-foot section of concrete flooring was cut and removed. Impacted soil was reportedly excavated and stockpiled based on visual observation, and soils were sampled beneath the removed concrete slab. The report suggests that excavated soil and concrete with concentrations of soluble (TCLP) chromium less than 400 mg/L were placed into the excavation as backfill, and a new concrete slab was poured. Analytical results for total chromium and soluble total chromium (analyzed using the TCLP method) are summarized within the report and show soils with soluble total chromium concentrations exceeding 5.0 mg/L were present beneath the replaced concrete slab.

Also in 1992, the deep containment vault for Plating Tank 7 was repaired to reduce flow of groundwater into the vault. Reportedly, the containment vault was pressure washed and damaged concrete was removed and repaired. A polyester/vinyl liner was installed at the base of the vault and partially up the sidewalls, and a new concrete slab was poured at the base of the containment vault. Prior to containment vault repairs, a groundwater sample was collected from within the vault and analyzed for total chromium with a reported concentration below the detection limit (quantified results were not available in the report).

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The Independent Remedial Action Report indicates prior remedial activities were conducted in 1990 near Chrome Plating Tanks 1 and 2, resulting in the removal of the two tanks and adjacent soils (approximately 114 cubic yards). Reportedly, three rounds of soil sampling were conducted prior to excavation and removal of Chrome Plating Tanks 1 and 2, with samples analyzed for soluble total chromium using the EP Toxicity extraction method. A total of 13 hand-auger boreholes and five drilled boreholes were advanced adjacent to Chrome Plating Tanks 1 and 2. The process tanks, concrete vaults, and soil were excavated and disposed offsite in 1990. The excavation area extended 19 feet east-west by 13.5 feet north-south to a depth of approximately 12.5 feet below grade.

Final sampling indicated hexavalent chromium concentrations in soils ranged from below the 0.05 mg/kg reporting limit up to 73 mg/kg in the southern sidewall; however, a soluble (EP Toxicity) chromium concentration of 9.6 mg/L was detected along the southern sidewall and exceeded the limit of 5.0 mg/L for designation as a dangerous waste. Final soil sampling results from the southern sidewall, northern sidewall, and excavation floor indicate hexavalent chromium concentrations exceeding the current Model Toxics Control Act (MTCA) Method A cleanup level of 19 mg/kg for unrestricted land use were left in place.

Reportedly, an investigation into Tank 7 was conducted in 1989. Boring B-1 was drilled to a depth of 20.4 feet, just northeast of the tank, and soils were sampled and analyzed for pH and soluble (EP Toxicity) metals. Results for metals analyses did not indicate soil impacts above cleanup levels at that time. A groundwater monitoring well was installed in boring B-1 and later abandoned. The exact location of boring B-1 was unclear and, therefore, is not shown on attached Figure 3.

2005 Maul, Foster & Alongi, Inc. – Preliminary Soil and Groundwater Site Assessment Report

In 2005, additional Site investigation activities were conducted by MFA and consisted of advancing 11 direct-push borings (GP-1 through GP-11) at the Site near former tanks, floor drains, and trenches. Soil samples were collected at each boring location, and reconnaissance groundwater samples were collected at several other select locations. MFA's initial 2005 investigation identified concentrations of trivalent chromium, hexavalent chromium, and TCE in soil that exceeded MTCA Method A soil cleanup levels for unrestricted land use.

Concentrations of diesel-range hydrocarbons, oil-range hydrocarbons, hexavalent chromium, dissolved total chromium, TCE, and cis-1,2-dichloroethene (cis-1,2-DCE) were detected in one or more groundwater samples above MTCA Method A/B cleanup levels.

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2006 MFA – Supplemental Remedial Investigation

In late 2005, MFA conducted additional direct-push drilling and soil sampling at locations GP-12 through GP-31, including groundwater reconnaissance sampling at GP-13 and GP-15, and installed new groundwater monitoring wells MW-5 through MW-8. Results and findings of the supplemental remedial investigation are discussed below in the Final Remedial Investigation and Risk Assessment (RI/RA) Report section.

2008 MFA – Final RI/RA Report

Results and findings of the 2005 and 2006 investigations conducted by MFA are summarized in the RI/RA Report. No additional investigation was recommended for soil or groundwater at the Site. RI/RA findings included:

- Hexavalent and trivalent chromium, diesel- and oil-range petroleum hydrocarbons, and TCE were identified as indicator hazardous substances (IHSs) in soil at the Site.
- Arsenic, cadmium, copper, hexavalent chromium, trivalent chromium, lead, chrysene, and heavy oil-range petroleum hydrocarbons were identified as IHSs for soil in the drainage ditch located immediately south of the former Site. The drainage ditch receives surface water runoff from the former Site and adjacent properties to the south and east.
- IHSs were also identified in groundwater and include arsenic, copper, hexavalent chromium, trivalent chromium, and selenium, as well as heavy oil range-petroleum hydrocarbons, TCE, and vinyl chloride.

Between October 2007 and March 2008, approximately 100 cubic yards of sediment and surface soil was excavated from the drainage ditch south of the Site to address IHSs present offsite. Reportedly, less than 2 cubic yards of soil impacted above site cleanup levels was left in place and covered with fill material. The report does not state why residual impacted soils were left in place or how this volume was calculated if clean soils were not documented in the confirmational soil samples. The excavated areas in the drainage ditch were reportedly regraded and reseeded following remedial excavation. Since documentation of complete removal was not provided in the confirmational results, this may present a data gap for the Site.

The RI/RA report suggests groundwater impacts are confined to the Site. Using a fate and transport model, MFA derived site-specific groundwater cleanup levels, protective of surface water, then used EPA's BIOCHLOR model to show whether those contaminants would reach the Duwamish Waterway. According to MFA, their model predicts that concentrations of the modeled contaminants above analytical detection limits would not reach the Duwamish Waterway. Groundwater modeling was conducted for indicator hazardous substances, including arsenic, copper, hexavalent chromium, trivalent chromium, selenium, diesel-range hydrocarbons, oil-range hydrocarbons, TCE, and vinyl chloride. The BIOCHLOR model does not account for possible co-mingling of groundwater from the immediately downgradient

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KASPAC/Chiyoda site to the east. As mentioned in Ecology's September 2009 opinion letter regarding the final RI/RA report, the model has not been validated with field data from groundwater monitoring downgradient from the Site.

A sub-slab vapor intrusion mitigation system was suggested by MFA to address concentrations of TCE and breakdown product vinyl chloride present in groundwater at concentrations where vapor intrusion to indoor or outdoor air may occur. In October 2008, MFA submitted a work plan to Ecology regarding vapor intrusion system installation and long-term monitoring; however, there is no documentation in Ecology's files indicating a vapor intrusion mitigation system was actually installed or operated at the Site.

2011 MFA – Final Feasibility Study

The feasibility study summarizes an interim remediation that occurred within the drainage ditch south of the Site between October 2007 and March 2008. Several cleanup alternatives were considered, including:

- Alternative 1: A no-action alternative.
- Alternative 2: An alternative where the building slab would be used as an engineered cap combined with groundwater monitoring and a covenant prohibiting groundwater use.
- Alternative 3: An alternative where approximately 1,000 cubic yards of impacted soil would be excavated, followed by groundwater monitoring and institutional controls.
- Alternative 4: An alternative implementing strategic excavation of approximately 67 cubic yards of soil, combined with injection of EHC-M (an in situ metals immobilization treatment) to treat hexavalent chromium contaminated groundwater, and groundwater monitoring.

Alternative 2 was recommended and included implementing institutional controls, groundwater monitoring, and use of the current building slab and asphalt cover as a cap. In July 2011, Ecology issued an opinion letter responding to the proposed remedial action, which indicated Site characterization was insufficient to establish cleanup standards and select a cleanup action. Ecology's opinion letter indicates the nature and extent of groundwater contamination, particularly downgradient of the Site boundary and the adjacent KASPAC/Chiyoda site, has not been adequately characterized.

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Areas of Concern

Based on review of the available Site information, a number of potential source areas have been identified. These areas associated contaminants of concern and confirmed or suspected affected media are summarized on Table 1. Figure 1 depicts the location of each area or concern on the Site. Locations where prior sampling has occurred are shown on the attached Figures 3 through 6, and concentration maps for primary contaminants are provided in Attachment 2.

Identification of Data Gaps

Following review of the available reports, a number of potential data gaps have been identified for consideration in developing an RI work plan for the former Site. These data gaps are summarized below.

- 1) No information is currently available that indicates the complete scope of Site closure activities.**
 - a. It is unclear whether or how some containment vaults were taken out of service and what residual contamination may have been left in place.
 - b. What subgrade features remain beneath the building that may present preferential pathways for vapor intrusion or groundwater flow or serve as a continuing source of contamination?
 - i. Former containment vaults/testing vaults.
 - ii. Trenches/drains/sewer lines.

- 2) Lithologic boring logs for wells MW-1, MW-2, and MW-3 were not available for review. This missing data makes it difficult to confirm/interpret the hydrogeologic Site conditions and modeling results described by MFA.**
 - a. The definition of glacial till, which may be acting as an upper confining layer of the advance outwash hydrogeologic unit, is not explicitly identified. Near surface soils containing gravels appear in many boring logs to be described similarly to the generalized till description on SE/E's generalized cross section (see Attachment 1).
 - b. Many of the soil borings advanced in 2005 were only to the first occurrence of groundwater and not to refusal or glacial till. Therefore, the thickness and lithology of the alluvial unit beneath the building is not fully characterized.
 - c. It is unclear from the existing boring logs whether the alluvium is homogenous or interbedded with zones of higher permeability. The depth to and thickness of the glacial till does not appear to be defined throughout the Site.
 - d. It is unclear from existing data whether, or not, the glacial till is acting as a competent confining layer.

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- e. The hydraulic connectivity between the advance outwash, till, alluvial aquifer, and Duwamish Waterway is not fully explained. There is very limited data provided for the regional area as to the correlation of the stratigraphic units.
 - f. It is unclear whether some of the existing wells are installed exclusively in the alluvial aquifer or if they penetrate the top of the till unit (i.e., bridge two stratigraphic units).
- 3) There is no long-term groundwater sampling record for existing monitoring wells.**
- a. Wells have not been sampled regularly, and it is difficult to determine seasonal variations from any long-term trend.
 - b. The most recent groundwater sampling event occurred in 2010. Current groundwater conditions onsite and offsite are not fully characterized.
- 4) There are only two deeper monitoring wells. A groundwater flow gradient and direction for deeper groundwater in the advance outwash cannot be established with this limited information.**
- 5) Air sampling data for TCE and vinyl chloride suggests there is likely a complete pathway connecting soil, groundwater, shallow vapor, and indoor air.**
- a. It is unclear whether cracks in the concrete slab or other features may be contributing to the apparently widespread distribution of TCE in indoor air across the eastern half of the building.
 - b. The source (or sources) of TCE in vapor does not appear to be identified or defined with currently available data. The distribution of deeper soil samples (those below the groundwater interface or the base of alluvium) analyzed for volatile organic compounds (VOCs) does not adequately define the extent of impacted soil or groundwater. Reportedly, parts washing was conducted in many areas of the shop, suggesting one or more possible source areas, in addition to the former floor drain system.
- 6) It is unclear from the available groundwater elevation data record whether groundwater flow may be contributing to surface water in the drainage ditch south of the Site.**
- a. If shallow groundwater flow from beneath the current structure is southerly, it may discharge to the southern drainage ditch.
- 7) Groundwater conditions south of the drainage ditch and east of the ditch along the eastern edge of the adjacent KASPAC/Chiyoda/Seattle Limousine site are not currently known.**
- a. It is not known what contaminant concentrations are migrating onto the KASPAC/Chiyoda/Seattle Limousine site from the west or what is leaving the site from the east. A better understanding of these conditions will help assess possible impacts to the LDW from the Site.

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- 8) Former Plating Tanks 1 and 2.** Immediately following the 1990 remedial action, groundwater was not sampled, although it was encountered at the base of the excavation. Additional drilling was conducted by MFA in 2005, and grab groundwater samples were collected from two locations.
- Existing monitoring well MW-5 is located crossgradient, well MW-4 is located upgradient, and well MW-8 is located at least 50 feet downgradient.
 - Groundwater grab samples were collected nearby at GP-4 and GP-8. In June 2005, hexavalent chromium was detected at concentrations of 294 mg/L at GP-8 and 236 mg/L at GP-4, above the MTCA Method A groundwater cleanup level of 50 mg/L.
 - TCE was detected above the method detection limit in groundwater at GP-8 (16.8 µg/L in June 2005). The only soil sample at GP-8 analyzed for VOCs was collected at 1.5 feet bgs, and TCE was reported below the detection/reporting limit.
 - Groundwater to the south of Former Plating Tanks 1 and 2 has not been characterized.
 - TCE may be a contaminant of concern in soil/groundwater; however, soil samples below the groundwater interface have not been collected at GP-4, GP-8, or south of Former Plating Tanks 1 and 2.
- 9) Former Plating Tanks 3, 4, 5, and 6.** In 1992, tanks and associated shallow, visibly impacted soil were removed. Additional drilling and sampling was conducted by MFA in 2005 to evaluate possible recontamination of soils following 1992 remedial action.
- Soil samples were collected by MFA at GP-18, GP-32, GP-6, GP-2, and GP-3.
 - Samples collected from a depth of 1 foot bgs at GP-18, GP-32, GP-2, and GP-6 suggest hexavalent chromium impacted soil is present above the MTCA Method B soil cleanup levels (240 mg/kg), and remedial action may be warranted.
 - Soil sample collected from GP-6 at 14.5 feet bgs contains TCE at a concentration above the MTCA Method A cleanup level and above concentrations protective of vapor intrusion.
 - Groundwater grab samples were collected at GP-6 and GP-2 in 2005. TCE was detected in the sample collected from GP-6 at a concentration of 1,130 µg/L. Hexavalent chromium was detected in both GP-6 (300,000 µg/L) and GP-2 (4,720 µg/L) samples at concentrations exceeding the MTCA Method B cleanup level (490 µg/L) for surface water.
 - Monitoring well MW-5 is located downgradient of the former tank locations, but not in the potential source area itself. Sampling results from 2005, 2006, and 2010 report concentrations of hexavalent chromium up to 450,000 µg/L, above the MTCA Method B surface water cleanup level of 490 µg/L. During two of the last three groundwater sampling events, TCE has been detected in groundwater at well MW-5 at concentrations exceeding the MTCA Method B cleanup levels.

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- d. The lateral and vertical extent of TCE and chromium impacted groundwater is not fully defined to the northeast and east of the Site. Additional definition between well MW-5 and the eastern exterior building wall is needed.
- e. TCLP chromium results in soils at base of 1992 excavation all exceed the regulatory limit of 5.0 mg/L for designation as a dangerous waste. Additional TCLP analysis of soils in the Former Plating Tanks 3, 4, 5, and 6 areas is needed to identify soils requiring special handling for waste disposal.

10) Trenches and floor drains in the grinding and chrome plating shop areas.

Reportedly, the trenches and floor drains in these shops conveyed liquid process waste to the sanitary sewer until about 1986 when they were rerouted and then operated as sumps. Reportedly, the trenches were inspected and determined to be in good condition prior to being filled with concrete. These subgrade features may serve as a preferential pathway for vapor or as a source of chromium and/or solvent impacts to soil and groundwater.

- a. Soil and/or groundwater samples have been previously collected and analyzed more extensively in the chrome shop area, but not as much in the grinding shop. Groundwater sampling (grab) and soil sampling adjacent to the former trench drains may assist in determining whether these features represent a source of soil and/or groundwater impacts.

11) Former and current sanitary sewer piping beneath the building and connecting to the main sewer line. Reportedly, cleanout activities were necessary for the Metro sewer lines following the 1986 discharge violation. It is unclear whether these pipes are still in place beneath the slab and whether the pipes or the trenches they are set in may be serving as an ongoing source of metals or solvent impacts to soil and groundwater. These could also be acting as conduits for vapor migration.**12) Plating Tank 7 Vault.** This vault was reportedly 24 feet long, 8 feet wide, and 16 feet deep. The closure/decommissioning of the vault was not reported in the files reviewed. Previously, groundwater infiltration was observed in the vault. In 1989, repairs and improvements were made to the vault to reduce groundwater infiltration. The current status/condition of the Tank 7 vault is not currently known.

- a. Borings GP-9, GP-10, GP-7, GP-23, GP-3, and GP-22 were advanced and soils sampled by MFA in 2005. Soils were not sampled at depths equal to or greater than the total depth of the vault. Concentrations of hexavalent chromium reported in three samples collected at GP-3 exceeded MTCA Method A cleanup levels; however, location GP-3 is more closely located to the southern end of the western chrome shop trench drain than to Tank 7. None of these sampling locations are located south of the Tank 7 vault.
- b. In 2005, a grab groundwater sample was collected at GP-7. GP-7 is located adjacent to, but upgradient of, the Tank 7 vault. Hexavalent chromium was reported at a concentration of 101 µg/L.

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- c. The nearest groundwater monitoring wells are MW-4, approximately 45 feet to the south, and MW-5, approximately 80 feet to the northeast. Relative to the presumed shallow groundwater gradient (generally to the east), well MW-5 is downgradient from the Tank 7 vault, and well MW-4 is lateral to slightly downgradient. Groundwater sampling results for hexavalent chromium and TCE exceeded one or more MTCA cleanup levels at well MW-5. Detected hexavalent chromium concentrations at well MW-4 are below MTCA Method B cleanup levels, and concentrations of TCE are reported to be below reporting/detection limits.

13) Hydraulic Cylinder Test Vault. Reportedly, a deep test vault (25 feet deep) for testing hydraulic cylinders was located near the western edge of the building, outside the structure. In 2005, sample location GP-5 was drilled and soil and groundwater sampled to characterize the area near the former test vault. The current status/disposition of the test vault is not known. Both soil samples collected at GP-5 were located above the base of the test vault. Hexavalent chromium was detected in groundwater at GP-5 above the MTCA Method B cleanup level. (Note: There are discrepancies in data presented for total chromium in reconnaissance groundwater between Table 9 in the RI versus Table 12 in the Feasibility Study.)

14) Scrubber Room. The scrubber room is located south of the Tank 7 vault and previously contained a chromic acid purification unit, holding tank, and evaporator. The evaporator was reportedly used after 1986 for the incineration/management of liquid plating waste, which accumulated in the floor drains and trenches. Reportedly, the evaporator was contained within a subgrade containment vault. The current status of that vault is not known.

- a. In 2005, GP-26 and GP-28 were drilled south of the scrubber room with GP-26 located upgradient from the scrubber room and GP-28 located downgradient. Borings GP-9, GP-7, and GP-22 are located north of the Tank 7 vault. GP-22 is located downgradient from the scrubber room, and GP-7 and GP-9 are located lateral to the scrubber room (with respect to the presumed shallow zone groundwater gradient). No soil borings were drilled immediately north, east, or west of the evaporator within the scrubber room. Soil samples were collected and analyzed at locations GP-26 and GP-28. Concentrations of hexavalent chromium and TCE in soil samples within the upper 10 feet were below method reporting limits. Arsenic was detected in GP-28 above the MTCA Method B soil cleanup level.
- b. No soil sampling or groundwater sampling was conducted in the center of the scrubber room or along the northern wall separating the scrubber room from the Tank 7 vault area.

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While not a data gap, the selected site cleanup levels for each affected media should be evaluated and revised appropriately. A number of the cleanup levels selected in the reports provided by prior consultants may not be appropriate for protection of all possible receptors. Appropriate cleanup levels are necessary to begin estimating the volume and extent of contamination associated with the Site.

Preliminary Draft CSM

A preliminary CSM based on the information reviewed in previous reports is presented on Figure 7 and summarized below. The preliminary CSM presents a generalized representation of Kennedy/Jenks Consultants understanding of current Site conditions and potential exposure pathways. Areas where the current data is insufficient (i.e., data gaps) to evaluate the completeness of potential exposure pathways are also identified.

Geology

Previous reports describe three main geologic units at the Site, in addition to shallow fill materials primarily located beneath Site structures. These reportedly include:

- Silt and sandy alluvium with some gravel and organics locally. The shallow alluvium is described as occurring only on the eastern portion of the Site (generally beneath the central part of the main Site structure and eastward) from ground surface to a depth of up to approximately 20 feet bgs (and over 30 feet on the eastern-adjointing Seattle Limousine site). The thickness of shallow alluvium reportedly increases eastward.
- Glacial till described as dense gravely, sandy silt occurs below the shallow alluvium (where shallow alluvium is present). The top of the till unit was reportedly encountered at or near ground surface on the western portion of the Site and at increasing depth to approximately 20 feet bgs in the central to eastern portions of the Site. The top of the till reportedly slopes to the east from the central part of the Site, with the steepest slope beneath the main Site structure (refer to the cross-section in Attachment 1). The till appears to be up to 30 feet thick in the western portion of the Site, decreasing to 20 feet or less beneath the eastern portion of the Site, as the upper surface slopes downward to the east, but the bottom of the till unit is not well defined, as only a limited number of borings have been advanced through the till.

Some boring logs show a weathered zone at the top of the till unit, suggesting the upper surface may have been exposed at ground surface for a period of time. Some boring logs also describe organic debris and woody debris at depths that may correlate with the top of the till.

- Advance outwash described as sand and gravel alluvium is located below the till. The thickness of the advance outwash alluvium was not determined, and it has been described in only a few soil borings advanced to sufficient depth (30 or more feet bgs).

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The geologic units described in previous Site reports are shown a 2005 Geologic Map of Seattle [U.S. Geological Survey (USGS) 2005] and are described as follows:

- Shallow alluvium. Holocene alluvium (Qal) described as sand, silt, gravel, and cobbles deposited by streams and running water a few meters to 30 meters thick and loose to dense or soft to stiff.
- Glacial till. Pleistocene Vashon till (Qvt) described as compact diamict of silt, sand and subrounded to well-rounded gravel, glacially transported and deposited under ice. Commonly fractured and has intercalated sand lenses. Qvt is described as 1 to 10 meters thick and very dense.
- Advance outwash. Advance outwash deposits (Qva) described as well-sorted sand and gravel deposited by streams issuing from advancing ice sheet. May grade upward into till. Silt lenses locally present in upper part and are common in lower part. Advance outwash deposits are locally over 60 meters thick and are dense to very dense.

Other geologic units shown on the 2005 Geologic Map of Seattle and located in proximity to the Site include:

- Peat (Qp) described as organic matter consisting of plant material and woody debris, accumulated in bodies greater than about 1 meter in thickness and of mappable extent. Peat may range in thickness from greater than 1 to 10 meters. The geologic map shows peat deposits to the south and east of the Site.
- Recessional outwash deposits (Qvr) described as stratified sand and gravel, moderately sorted to well sorted, and less common silty sand and silt, typically 1 to 6 meters thick and loose to dense. Recessional outwash deposits are depicted to the north and west of the Site on the southern portion of the hill that adjoins the Site to the north and west.
- Blakeley Formation Bedrock (Tb) described as medium-grained sandstone, coarse-grained sandstone, conglomerate, and minor siltstone that is over 1,000 meters thick and weakly to moderately lithified. The Blakeley formation is shown on the geologic map to the north of the Site (forming the northern portion of the hill that adjoins the Site to the north and west) and to the northwest.

The cross-section included in Attachment 1 was prepared by SE/E [included in the 1993 Independent Remedial Action Report (Precision Engineering 1993)] and provides a generalized overview of the geologic conditions as described in the previous Site reports, including the Final Feasibility Study prepared in 2011. The cross-section provides a plausible representation of the big-picture interpretation of Site geology and is generally consistent with the geologic units depicted on the 2005 Geologic Map, but with some exceptions:

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- Layering depicted in the shallow alluvium unit above the till is simplified. Based on the available boring logs, lateral correlation of individual layers within the alluvium unit does not appear to be as straightforward as depicted on the cross-section (i.e., textural descriptions do not appear to support the presence of distinct laterally continuous layers) and may be inconsistent with the description of the shallow alluvium as predominantly sandy and horizontally bedded with fine and coarser-grained lenses provided on the 2005 Geologic Map. In addition, many of the soil borings at the Site did not fully penetrate the shallow alluvium unit.
- Areas of possible fill, primarily under the existing building, are not well defined.
- The till is shown as a massive (i.e., not stratified) unit although textural variation and saturated intervals within the till unit are described on boring logs, suggesting some degree of heterogeneity or layering. In addition, the 2005 Geologic Map describes sand lenses occurring within the till. Some boring logs also describe a weathered interval at the top of the till unit, which is consistent with the 2005 Geologic Map description.
- The upper surface of the till unit may not be as well-defined as depicted on the cross-section, but this is difficult to determine based on the boring logs, because they do not necessarily provide an adequate description of density differences between different units, and because many borings appear to have been terminated above the top of the till unit.
- On the western portion of the Site, it is possible the shallow soil may include some recessional outwash deposits above the till. The southern portion of the hill to the north and west of the Site appears to be capped with recessional outwash deposits. A portion of the hill appears to have been removed when the Site was developed (i.e., a notch was cut out of the hill), but the degree to which the till beneath the recessional outwash was exposed by the cut is not evident.
- As indicated on the cross-section, the contact between the till and underlying advance outwash deposits is not well defined based on a limited number of borings advanced to sufficient depth.

Hydrogeology

The previous reports suggest that two separate saturated zones may be present beneath the Site, including a shallow saturated zone within both the shallow alluvium and till units and a deeper saturated zone within the advance outwash alluvium as follows:

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Shallow Saturated Zone

A shallow saturated zone is described in the 2011 Final Feasibility Study as a confined alluvial water bearing zone within the upper alluvium (eastern part of Site only) and glacial till units (western part of the Site). Groundwater is reportedly initially encountered between 5 and 8 feet bgs in the shallow alluvium and between 7 and 14 feet bgs in the till. The shallow saturated zone is described as confined, based on static water elevations in wells being typically at higher elevations than the saturated intervals spanned by the well screens. The hydraulic gradient in the shallow saturated zone is, reportedly, generally to the east, toward the LDW.

A 1995 USGS water resources investigation report for southwestern King County (USGS, 1995) indicates the upper alluvium may include both confined and unconfined saturated conditions. The Vashon till is described in the 1995 USGS report as a confining bed, but does contain saturated sand and gravel lenses particularly in the upper portions.

Within both of the shallow zone lithologic units (shallow alluvium and till), saturated conditions do not appear to be continuous vertically (dry conditions are noted in layers located below the initial occurrence of saturated conditions on the boring logs). Lateral continuity of shallow saturated intervals also does not appear to be well characterized across the Site based on the descriptions provided in the boring logs, including hydraulic connections between the shallow saturated intervals within the upper alluvium and glacial till units.

In general, shallow saturated conditions at the Site do not appear to be fully characterized and could include various elements, such as, but not necessarily limited to, the following:

- Laterally continuous saturated layers with varying degrees of lateral and vertical interconnectivity.
- Saturated lenses with varying degrees of lateral and vertical interconnectivity.
- Localized perched saturated zones.
- The extent and hydrogeologic effect of the weathered zone described at the top of the till unit, which appears to slope to the east.
- Shallow depressions on the upper surface of the till unit possibly facilitating DNAPL accumulation, if any is present.

Saturated conditions may also differ between the shallow alluvium and glacial till units, and the nature of the hydraulic connections between the two units is not adequately characterized to evaluate potential contaminant migration to the Duwamish Waterway.

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As discussed above, the 1993 cross section (refer to Attachment 1) depicts the upper surface of the till sloping steeply to the east approximately beneath the building, with the shallow alluvium contacting the till laterally along the steeper sections of the slope. To the east of the building, the till is shown beneath the shallow alluvium with a more gradual slope to the east.

The locally steep slope of the upper surface of the till unit indicates a potential for lateral hydraulic connectivity between the shallow saturated zones within the till and those in the shallow alluvium to the east. The nature and degree of hydraulic interaction between the upper saturated zone units is not adequately characterized.

Deep Saturated Zone

A deeper saturated zone is described in the 2011 Final Feasibility Study as a confined sand and gravel water bearing zone within the advance outwash alluvium located below the glacial till unit. The nature of the deeper saturated zone is not fully characterized, as only two wells have been installed in the advance outwash alluvium. The gradient is assumed to be generally to the east (based on the head elevation in the two wells), but this has not been verified.

The 1995 USGS water resources investigation report indicates the advance outwash unit typically serves as an aquifer where the coarse-grained portions are saturated (silt lenses are common) and is typically encountered below the Vashon till.

The till unit at the Site is likely acting as a confining layer to some degree, particularly with respect to the underlying advance outwash unit but also for the saturated intervals that have been identified within the till. The degree to which potential migration pathways (lateral and vertical) may be present within the till (i.e., along fractures and/or interconnected coarser-grained saturated intervals) and the degree of interconnectivity between the shallow and deep saturated zones have not been adequately characterized.

Potential Exposure Pathways

Based on the available information, potential exposure pathways for the Site may include (but are not necessarily limited to) the following:

- Direct contact with soil and surface water in the drainage ditch.
- Direct contact with groundwater in wells through seepage into tanks/vaults in the building or through seepage into the drainage ditch.
- Direct contact with soil throughout the Site by workers for any subsurface work.
- Soil to groundwater (leaching) pathway in saturated intervals.

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- Groundwater to surface water pathway by shallow groundwater seepage into the drainage ditch or possibly the LDW.
- Surface water pathway through the drainage ditch and possibly into the municipal storm drain system with possible discharge to the LDW.
- Surface water infiltration to groundwater in the drainage ditch and any unpaved portions of the Site.
- Vapor infiltration into the building from impacted soil and/or groundwater with former pipelines, trenches, vaults, etc. possibly acting as conduits.

The potential exposure pathways are illustrated on Figure 7. Evaluation of potential human and ecological receptors will be performed during the ongoing RI process.

CSM Data Gaps Summary

Based on the available information, additional data is needed to characterize the nature of the saturated zones previously identified at the Site and to refine the CSM. These data needs are primarily related to characterization of the structure of the saturated intervals identified at the Site and how these saturated intervals are (or are not) interconnected. The nature of the shallow saturated zones has a significant bearing on contaminant transport in the subsurface, particularly for those contaminants with higher specific gravities (i.e., solvents) and identification of potential exposure pathways.

References

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Enclosure(s): Table 1 – Summary of Areas of Concern
Figure 1 – Former Process Areas
Figure 2 – Neighboring Properties
Figure 3 – Prior Drilling and Sampling Locations
Figure 4 – Groundwater Monitoring Wells and Sampling Locations
Figure 5 – Air and Vapor Sampling Locations
Figure 6 – Drainage Ditch Sampling and Excavation Locations
Figure 7 – Preliminary Draft Conceptual Site Model
Attachment 1 – Select Reference Materials from Previous Reports
Attachment 2 – Concentration Contour Maps

Table

TABLE 1: SUMMARY OF AREAS OF CONCERN
Former Precision Engineering Facility, Seattle, Washington

Area of Concern	Description	Investigation history	Remediation History	Current Conditions	Potential On-Going Source?	Associated Contaminants of Concern (COCs)	Potentially Affected Media	Recommendations
Drainage Ditch	The drainage ditch is located south of the property boundary. The ditch wraps around the eastern side of the adjacent Chiyoda property and receives overland flow from the Chiyoda property, as well as the Precision Engineering site, 14th Street South, and the US-99 northbound entrance ramp. There is no apparent connectivity to a storm sewer or other drainage features to convey water in the ditch. One catch basin located near the southern property line at Precision Engineering discharges directly to the drainage ditch.	In April 1986, four sediment samples were collected. Chromium was detected at a "high concentration"; however, Maul Foster Alongi (MFA) questioned the units in which they were presented. In 1989, a subsequent investigation was conducted and 15 shallow soil/sediment samples were analyzed for metals, again identifying chromium concentrations of concern. MFA collected additional sediment samples in the drainage ditch in 2006. Hexavalent chromium was identified near the stormwater outfall, and lead and arsenic were detected above Model Toxics Control Act (MTCOA) Method A soil cleanup levels at several other locations within the ditch.	In October 2007, approximately 100 cubic yards of soil were excavated from the ditch and disposed offsite. Following confirmation sampling, additional excavation was conducted at two ditch locations in March 2008. Excavated areas were backfilled and reseeded. Not all impacted soil was removed.	One confirmation soil sample had concentrations of lead and arsenic above the MTCOA Method A soil cleanup levels.	The ditch received impacted surface runoff and possible process wastes. It could be either an ongoing source or a sink.	Chromium, arsenic, lead.	Sediment, surface soil, surface water.	Further assessment is warranted.
Former Plating Tank 1	Installed in an in-ground containment vault in 1968. Removed and reconstructed in early 1990s during remedial action; removed from the site in 2005. Replaced by Tank 3.	Sweet Edwards/EMCON in 1988 and 1989. Yellow-stained soil was observed in an opening in the concrete floor. Thirteen hand-augered borings and borings B-1 through B-5 were completed adjacent to former Plating Tanks 1 and 2. Additional drilling was conducted in 2005 and 2006 by MFA to characterize soils near Plating Tanks 1 and 2. MFA 2005 investigation conducted until groundwater encountered. Deeper soil conditions not documented at locations GP-1 and GP-11.	Tanks removed following 1989 investigation. Contaminated soil excavated in 1990. Approximately 114 cubic yards of soil and concrete removed; soils excavated up to 13 feet below ground surface (bgs) (1993). Groundwater was encountered in base of excavation.	Hexavalent chromium detected in four of five confirmation samples up to 73 milligrams per kilogram (mg/kg).	Possible source.	Trichloroethene (TCE), chromium, and hexavalent chromium.	Soil and groundwater.	Further assessment is warranted, particularly in saturated soils and south of the former tank location
Former Plating Tank 2	Installed in an in-ground containment vault in 1968. Removed and reconstructed in early 1990s during remedial action; removed from the site in 2005. Replaced by Tank 3.	Sweet Edwards/EMCON in 1988 and 1989. Yellow stained soil was observed in an opening in the concrete floor. Thirteen hand-augered borings and borings B-1 through B-5 were completed adjacent to former Plating Tanks 1 and 2. Additional drilling was conducted in 2005 and 2006 by MFA to characterize soils near Plating Tanks 1 and 2.	Tanks removed following 1989 investigation. Contaminated soil excavated in 1990. Approximately 114 cubic yards of soil and concrete removed; soils excavated up to 13 feet bgs (1993). Groundwater was encountered in base of excavation.	Hexavalent chromium detected in four of five confirmation samples up to 73 mg/kg.	Possible source.	TCE, chromium, and hexavalent chromium.	Soil and groundwater.	Further assessment is warranted, particularly in saturated soils and south of the former tank location
Former Plating Tank 3	Aboveground tank with a concrete curb surround. Concrete-lined floor trenches located to the east and west. Located in the plating shop. Removed in the early 1990s during remedial action and replaced by Tanks 3 and 4.	In 1992, Plating Tanks 3, 4, 5, and 6 were removed, as was a 35-foot by 40-foot section of concrete below the tanks. Visibly contaminated soils were removed with the excavation extending up to 28 inches bgs. Chromium [Toxicity Characteristic Leaching Procedure (TCLP)] was detected in soils and concrete, and soil and concrete with low detections was used as excavation backfill. Additional geoprobe drilling was conducted in 2005 by MFA for soil and groundwater analysis. TCE and hexavalent chromium concentrations exceeded MTCOA Method A/B soil, Method A groundwater (TCE), and Method B surface water (hexavalent chromium) cleanup levels.	Tanks removed in 1992; some soil excavated and concrete below the tanks were also removed. Excavation backfilled with excavated material.	2005 soil sampling suggests hexavalent chrome present in soils.	Yes.	TCE, chromium, and hexavalent chromium.	Soil and groundwater.	Further assessment is warranted.

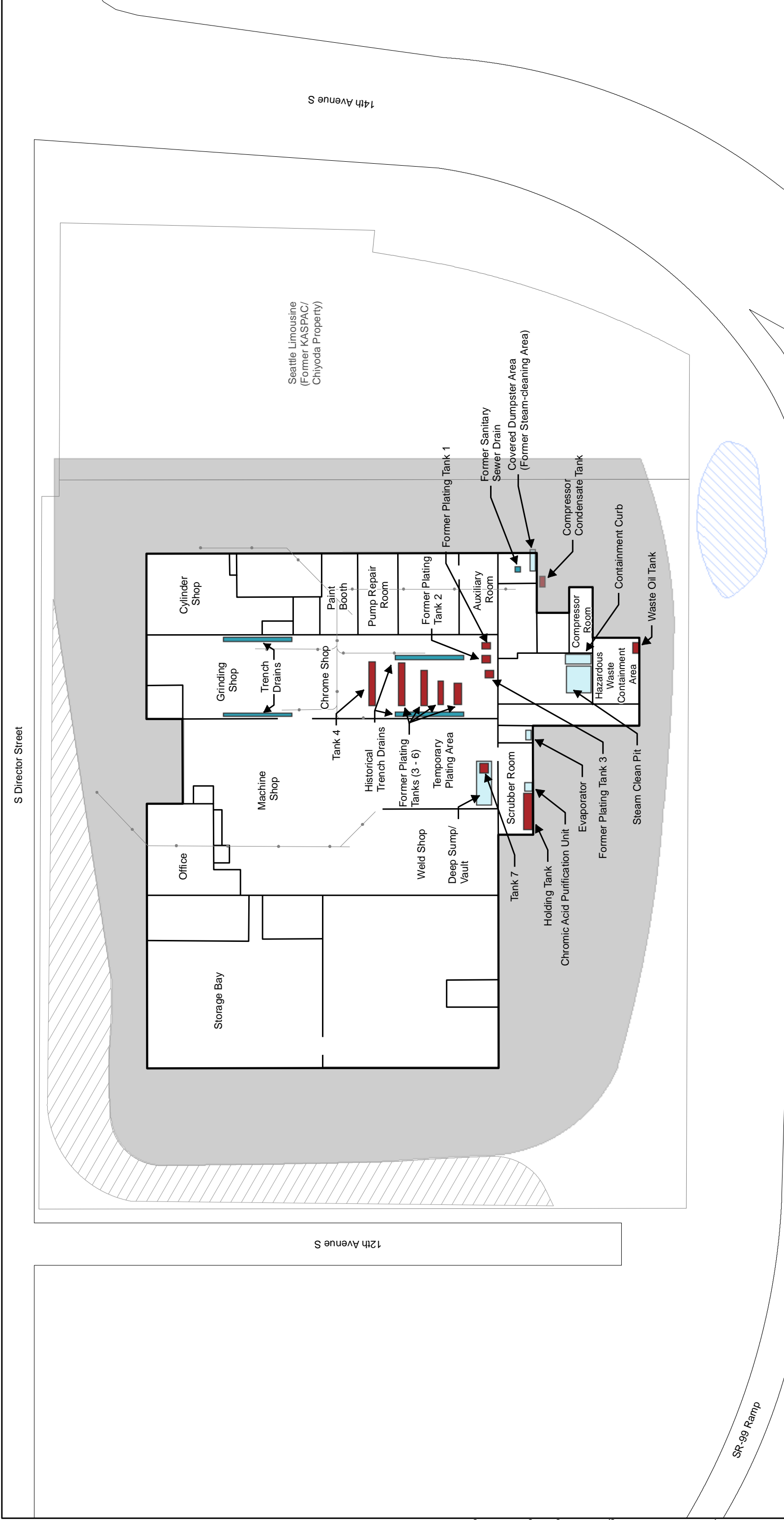
TABLE 1: SUMMARY OF AREAS OF CONCERN
Former Precision Engineering Facility, Seattle, Washington

Area of Concern	Description	Investigation history	Remediation History	Current Conditions	Potential On-Going Source?	Associated Contaminants of Concern (COCs)	Potentially Affected Media	Recommendations
Former Plating Tank 4	Aboveground tank with a concrete curb surround. Concrete-lined floor trenches located to the east and west. Located in the plating shop. Removed in the early 1990s during remedial action and replaced by Tanks 3 and 4.	In 1992, Plating Tanks 3, 4, 5, and 6 were removed, as was a 35-foot by 40-foot section of concrete below the tanks. Visibly contaminated soils were removed with the excavation extending up to 28 inches bgs. Chromium (TCLP) was detected in soils and concrete, and soil and concrete with low detections was used as excavation backfill. Additional geoprobe drilling was conducted in 2005 by MFA for soil and groundwater analysis. TCE and hexavalent chromium concentrations exceeded MTCA Method A/B soil, Method A groundwater (TCE), and Method B surface water (hexavalent chromium) cleanup levels.	Tanks removed in 1992; some soil excavated and concrete below the tanks were also removed. Excavation backfilled with excavated material.	2005 soil sampling suggests hexavalent chrome present in soils.	Yes.	TCE, chromium, and hexavalent chromium.	Soil and groundwater.	Further assessment is warranted.
Former Plating Tank 5	Aboveground tank with a concrete curb surround. Concrete-lined floor trenches located to the east and west. Located in the plating shop. Removed in the early 1990s during remedial action and replaced by Tanks 3 and 4.	In 1992, Plating Tanks 3, 4, 5, and 6 were removed, as was a 35-foot by 40-foot section of concrete below the tanks. Visibly contaminated soils were removed with the excavation extending up to 28 inches bgs. Chromium (TCLP) was detected in soils and concrete, and soil and concrete with low detections was used as excavation backfill. Additional geoprobe drilling was conducted in 2005 by MFA for soil and groundwater analysis. TCE and hexavalent chromium concentrations exceeded MTCA Method A/B soil, Method A groundwater (TCE), and Method B surface water (hexavalent chromium) cleanup levels.	Tanks removed in 1992; some soil excavated and concrete below the tanks were also removed. Excavation backfilled with excavated material.	2005 soil sampling suggests hexavalent chrome present in soils.	Yes.	TCE, chromium, and hexavalent chromium.	Soil and groundwater.	Further assessment is warranted.
Former Plating Tank 6	Aboveground tank with a concrete curb surround. Concrete-lined floor trenches located to the east and west. Located in the plating shop. Removed in the early 1990s during remedial action and replaced by Tanks 3 and 4.	In 1992, Plating Tanks 3, 4, 5, and 6 were removed, as was a 35-foot by 40-foot section of concrete below the tanks. Visibly contaminated soils were removed with the excavation extending up to 28 inches bgs. Chromium (TCLP) was detected in soils and concrete, and soil and concrete with low detections was used as excavation backfill. Additional geoprobe drilling in 2005 by MFA for soil and groundwater analysis. TCE and hexavalent chromium concentrations exceeded MTCA Method A/B soil, Method A groundwater (TCE), and Method B surface water (hexavalent chromium) cleanup levels.	Tanks removed in 1992; some soil excavated and concrete below the tanks were also removed. Excavation backfilled with excavated material.	2005 soil sampling suggests hexavalent chrome present in soils.	Yes.	TCE, chromium, and hexavalent chromium.	Soil and groundwater.	Further assessment is warranted.
Plating Tank 7 Vault	A large, single, containment vault 24 feet long, 8 feet wide, and 16 feet deep held three tanks. These tanks included Plating Tank 7, a sodium hydroxide strip tank, and a sodium bicarbonate strip tank. Plating Tank 7 was 9 feet long, 7.5 feet wide, and 16 feet deep. All tanks in the large vault were removed in 2005.	One 20-foot soil boring was drilled northeast of Tank 7 in 1989. Groundwater was encountered at 9 feet bgs. Soil was sampled for pH and metals. Chromium was not detected in leachate above the EP toxicity reporting limit of 0.005 milligrams per liter (mg/L). Three additional soil borings, GP-7, GP-9, and GP-10 were drilled north of the Tank 7 vault during MFA's 2005 investigation. Soil samples were not collected from depths below that of the adjacent vault. Hexavalent chromium, 1,1-dichloroethene (1,1-DCE), methylene chloride, and total petroleum hydrocarbons (TPHs) were detected at concentrations below MTCA Method A cleanup levels for soil. Hexavalent chromium was detected in a grab groundwater sample at GP-7 above the MTCA Method B groundwater cleanup level.	In 1989, groundwater was sampled from within the vault, concrete repaired, a liner installed at the base, and a new concrete slab was poured at the base of the vault. Current status/condition of the Tank 7 vault not specified.	Unknown; vault no longer in use.	Possible source. Apparently, groundwater has previously infiltrated the vault surrounding Tank 7. Current conditions not specified.	Hexavalent chromium, 1,1-DCE, methylene chloride, and TPH	Groundwater, possibly soil.	Further assessment is warranted; particularly to the east of the former tank and vault, extending to a depth below 16 feet bgs.

TABLE 1: SUMMARY OF AREAS OF CONCERN
Former Precision Engineering Facility, Seattle, Washington

Area of Concern	Description	Investigation history	Remediation History	Current Conditions	Potential On-Going Source?	Associated Contaminants of Concern (COCs)	Potentially Affected Media	Recommendations
Trenches and Drains	Prior to 1986, floor drains and trenches discharged to Metro's sanitary sewer system. Chrome-plating rinse water was permitted to discharge from a small rinse tank to the sanitary system. After July 1986, trenches and drains were rerouted to drain to containment vaults.	Several soil borings were drilled in 2005 and 2006 near trench and drain features. TCE, chromium, and hexavalent chromium were observed in one or more locations at concentrations exceeding MTCA Method A soil cleanup levels.	Upon facility closure, trenches were apparently filled with concrete. Other specifics of closure are not specified.	2005 soil samples suggest hexavalent chromium and TCE are present in soils. Trenches and drains are no longer in use.	Former drain lines may be a preferential pathway for vapor migration.	TCE, chromium, and hexavalent chromium.	Soil and groundwater.	Further assessment is warranted. TCE has not been assessed in groundwater near trench drains located in the grinding shop. Further assessment of soil and groundwater near sanitary sewer drains or junctions is warranted.
Hydraulic Cylinder Test Vault	Reportedly, a hydraulic cylinder test vault was located outside the building, approximately 10 feet from the western wall of the building. This vault measured 4 feet in diameter and was reportedly 25 feet deep.	Two soil samples were collected in 2005 at location GP-5 near the hydraulic cylinder test vault. Hexavalent chromium was detected in groundwater in excess of the MTCA Method B groundwater cleanup level.	None. Current status/condition of test vault not specified.	Unknown; vault no longer in use.	Unknown.	Hexavalent chromium.	Groundwater.	Further assessment is warranted. Saturated soils near the approximate base of the test vault have not been assessed.
Temporary Plating Tanks	Temporary, aboveground, plating tanks were used in the area north of Plating Tank 7.	Several soil borings were drilled in 2005 near the temporary plating area. Hexavalent chromium detected in groundwater at location GP-7 above MTCA Method B groundwater cleanup level.	None.	No longer in use.	Unknown.	Hexavalent chromium.	Possibly soil and/or groundwater.	Further assessment is warranted.
Scrubber Room	A cooling-water tank, chromic-acid evaporator, chromic-acid purification unit, and large aboveground chromic-acid holding tank were located in the scrubber room. The evaporator was located in an in-ground containment vault and used to concentrate chromic-acid wastes.	Several soil borings were drilled in 2005 south of the scrubber room. Arsenic was reported in soil and groundwater at these locations above MTCA Method A soil and groundwater cleanup levels.	None.	No longer in use.	Unknown.	Hexavalent chromium, arsenic.	Possibly soil and/or groundwater.	Further assessment is warranted. Soils within the scrubber room have not been assessed.
Parts Washing	Parts washing and degreasing was conducted throughout the building. Solvents used included methyl ethyl ketone (MEK), Stoddard solvent, and TCE. Prior to 1986, a closed-loop vapor degreaser system in the cylinder shop used TCE. A TCE tank was located in the chrome plating area.	Exact locations not specified. Parts washing areas may have been investigated in conjunction with sampling at other areas of concern.	None.	No longer in use.	Unknown.	TCE and degradation products.	Surface soil, sediment, and surface water runoff.	Evaluate potential as an on-going source.
Steam Cleaning Area	An outdoor steam cleaning area was located southeast of the building prior to 1986. Liquids were discharged to an oil/water separator. In 1986, the oil/water separator was dismantled, and steam-cleaning operations were moved inside. A sodium hydroxide stripping tank was also located in this area.	Surface water and sediment samples were collected in the drainage ditch, which would have received surface water runoff (see above). Three geoprobe locations were sampled surrounding steam cleaning area in 2005. Arsenic was reported at location GP-31 at a concentration exceeding the MTCA Method B soil cleanup level, and diesel-range organics were reported in soil at a concentration exceeding the MTCA Method A soil cleanup level at location GP-21.	None.	Unknown; not believed to be in use.	Not expected to be an ongoing source.	Oil and grease, arsenic, diesel-range TPH, copper, nickel, zinc, chromium, and caustics.	Surface soil, sediment, surface water runoff.	Evaluate potential as an on-going source.
Solid Waste Dumpster	A solid waste dumpster was located near the southeastern corner of the facility. Surface runoff from the dumpster area drains into the drainage ditch.	Surface water and sediment samples were collected in the southern ditch, which would have received surface water runoff (see above). 2005 geoprobe sampling location GP-29 is located closest to this area; arsenic was reported in soil at a concentration exceeding the MTCA Method B soil cleanup level. Benzo(a)pyrene was detected in soil samples collected in the drainage ditch downstream from the dumpster at concentrations above the MTCA Method A soil cleanup level.	None.	Waste storage area still present at this location.	Unknown.	Oil and grease, arsenic, copper, nickel, zinc, and benzo(a)pyrene.	Surface soil, sediment, surface water runoff.	Evaluate potential as an on-going source.

Figures



Legend

- Sewer Line
- Other
- Tank
- Drain
- Sediment Excavation Area
- Steep Bank
- Paved Area
- Parcel Boundary

Notes:

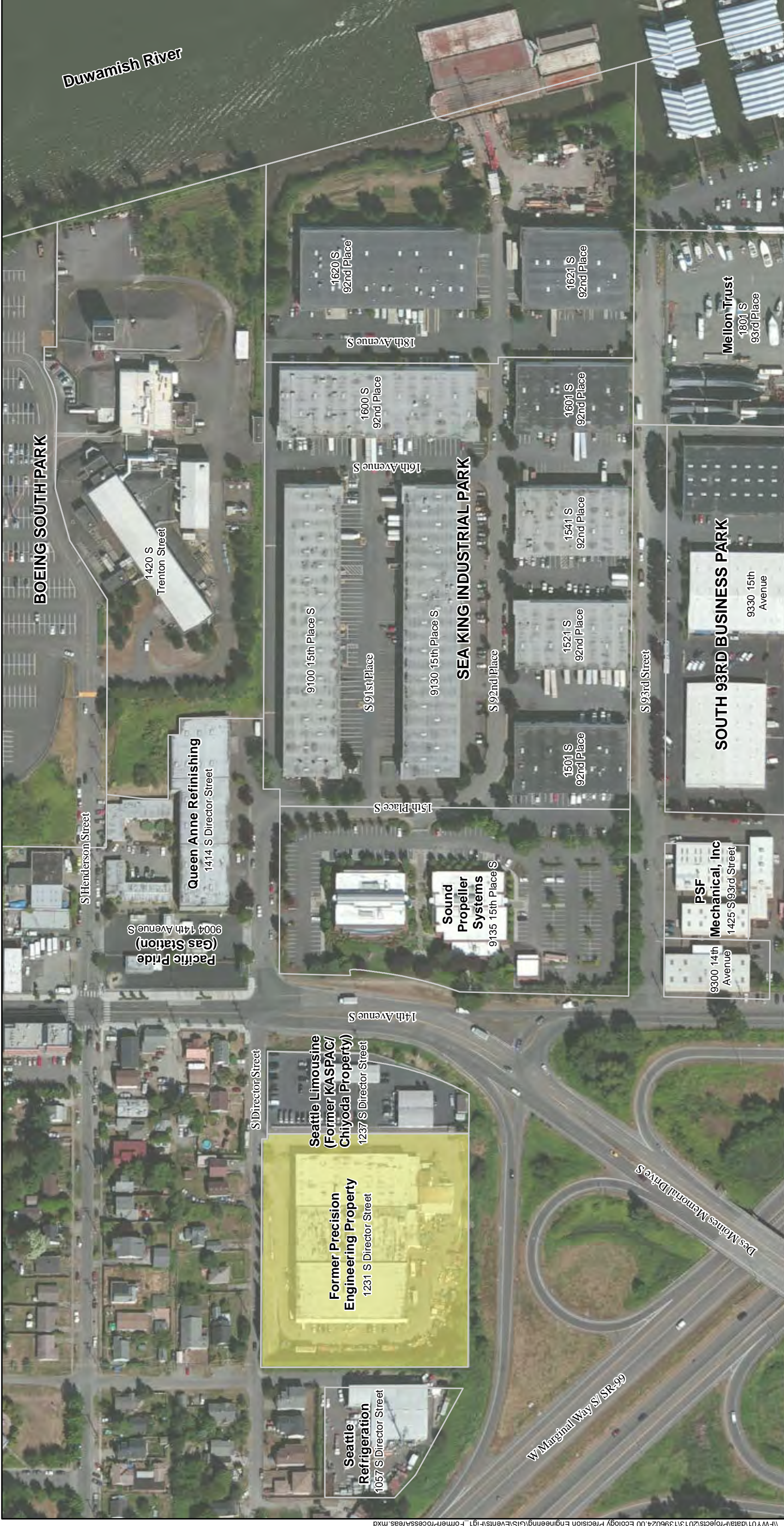
1. All locations are approximate



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Seattle, Washington

Former Process Areas
Figure 1

K/J Project Number 1396024.00



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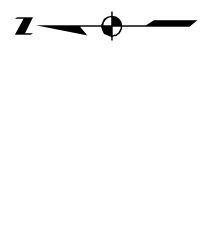
Map Source: Maui Foster & Alongi, Final Feasibility Study, Former Precision Engineering, Inc., Site, March 3, 2011.
 Imagery Source: Esri, DigitalGlobe, GeoEye, USDA, USGS, AEX, Geomapping, Aerogrid, TGN, IGF, swisstopo, and the GIS User Community

Legend

- Former Precision Engineering Property
- Adjacent and Neighboring Properties

Notes:

1. All locations are approximate

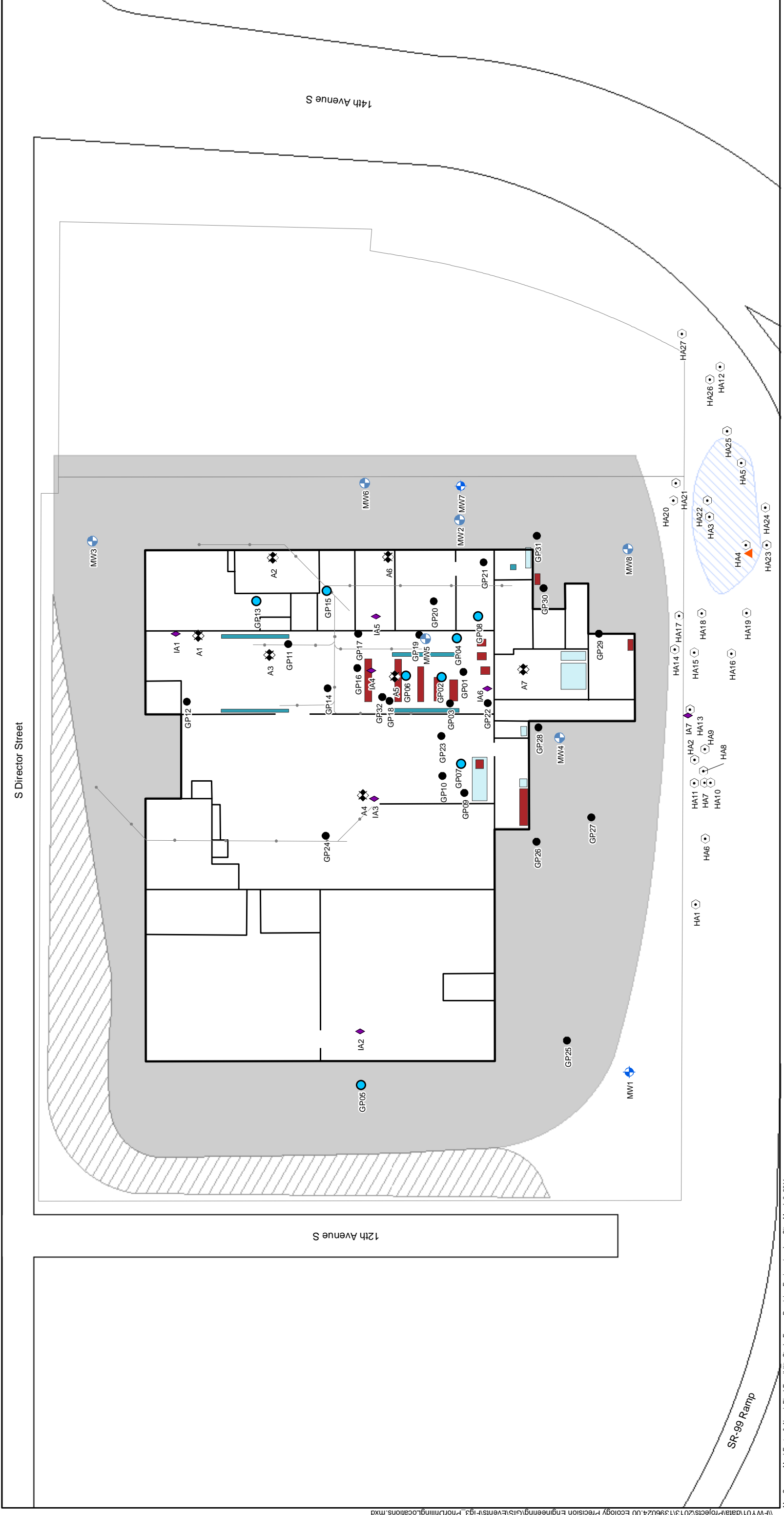


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 Precision Engineering Facility
 Seattle, Washington

Neighboring Properties
Figure 2

K/J Project Number 1396024.00

Map Source: Maui Foster & Alongi, Final Feasibility Study, Former Precision Engineering, Inc., Site, March 3, 2011.

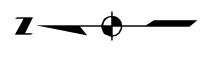


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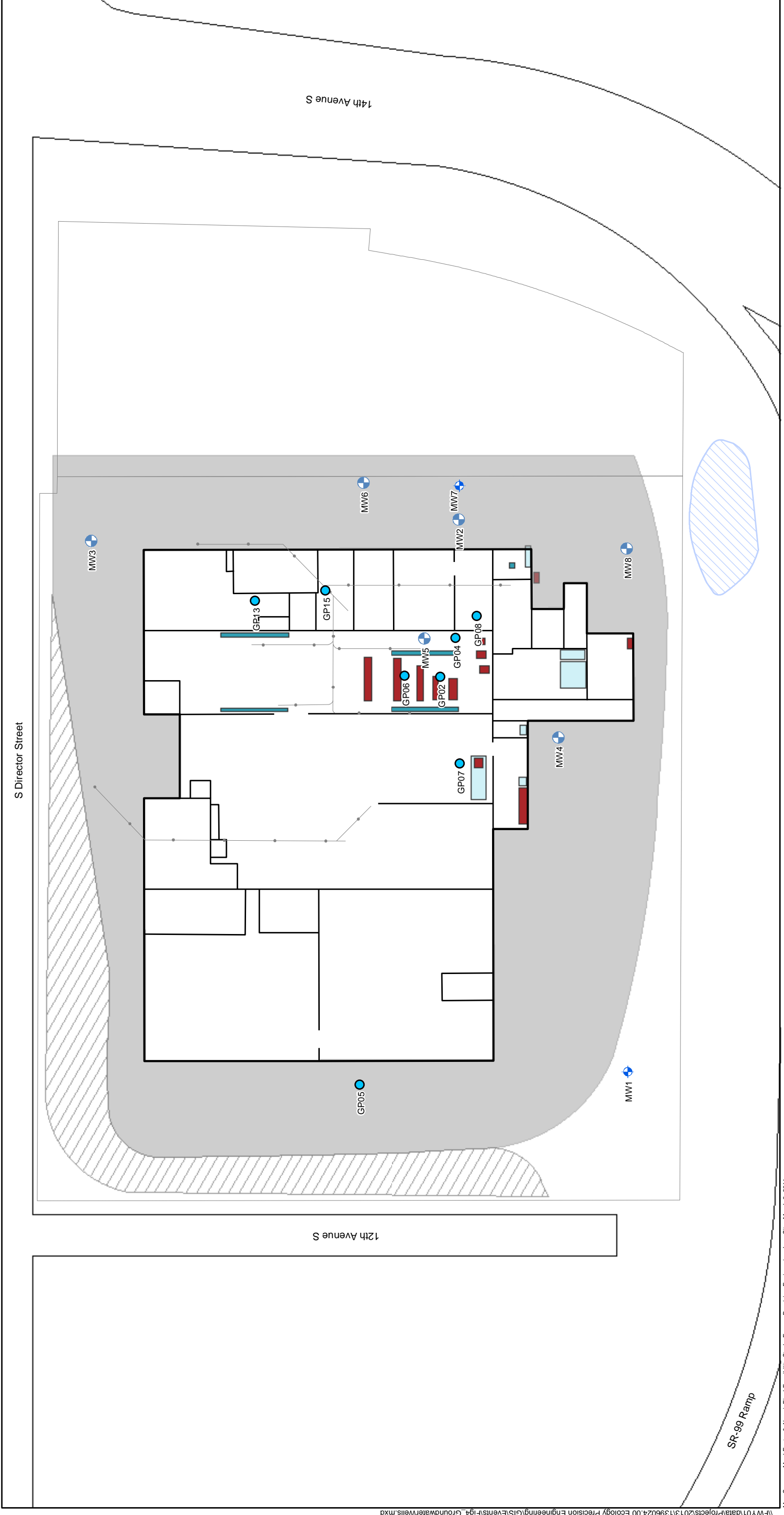
- ◆ Air Sample Point
- Reconnaissance Groundwater Sample
- Deep Monitoring Well
- Shallow Monitoring Well
- Geoprobe boring
- ▲ Staff Gauge
- ◆ Hand Auger Boring
- ◆ Vapor Monitoring Sample
- Sewer Line
- Other
- Tank
- Drain
- ▨ Sediment Excavation Area
- ▨ Steep Bank
- ▨ Paved Area
- ▨ Parcel Boundary

Notes:

1. All locations are approximate
2. Geoprobe borings and reconnaissance groundwater samples collected in 2005.
3. Hand Auger borings collected between 2005 and 2007.
4. Vapor monitoring samples collected below the concrete slab on April 18, 2006.
5. Air samples collected June 13, 2006 from indoor/ambient locations.
6. Staff gauge sampled in 2005 and 2006, but no sampling data was reported.
7. Monitoring wells sampled between 1988 and 2010.



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Existing Monitoring Well and Sampling Locations
 Figure 3
 K/J Project Number 1396024.00



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 Map Source: Maui Foster & Alongi, Final Feasibility Study, Former Precision Engineering, Inc., Site, March 3, 2011.

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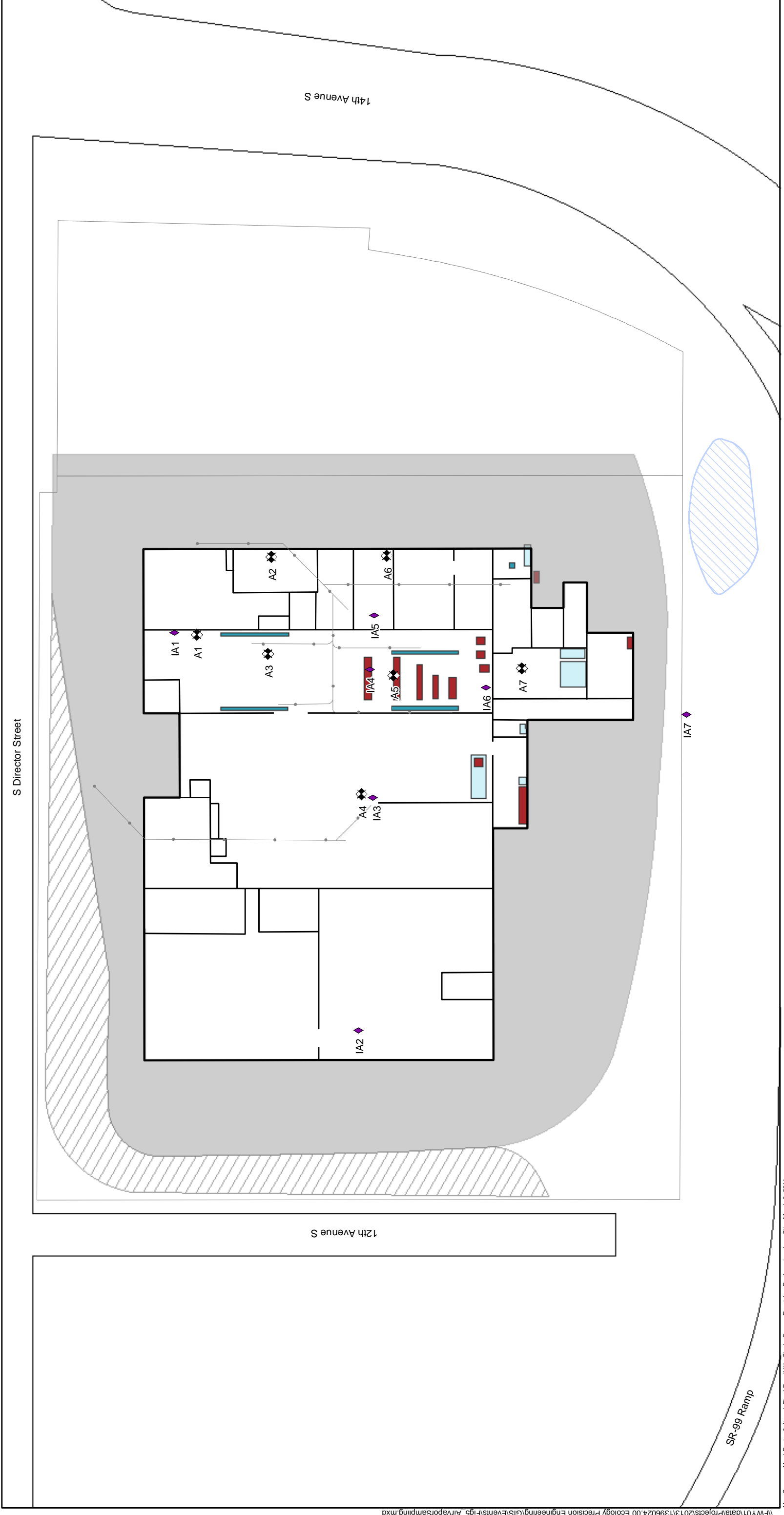
- Deep Monitoring Well
- Shallow Monitoring Well
- Reconnaissance Groundwater Sample
- Sewer Line
- Other
- Tank
- Drain
- ▨ Sediment Excavation Area
- ▨ Steep Bank
- ▨ Paved Area
- ▨ Parcel Boundary

Notes:

1. All locations are approximate
2. Reconnaissance groundwater samples collected in 2005.
3. Monitoring wells sampled between 1988 and 2010.



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**Groundwater Monitoring Wells and
 Reconnaissance Sampling Locations**
 Figure 4
 K/J Project Number 1396024.00

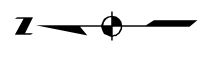


\\FW01\data\Projects\20131396024.00 Ecology Precision Engineering\GIS\Events\Figs_AirVaporSampling.mxd

Map Source: Maui Foster & Alongi, Final Feasibility Study, Former Precision Engineering, Inc., Site, March 3, 2011.

- Legend**
- ◆ Air Sample Point
 - ◆ Vapor Monitoring Sample
 - Sewer Line
 - Other
 - Tank
 - Drain
 - Sediment Excavation Area
 - Steep Bank
 - Paved Area
 - Parcel Boundary

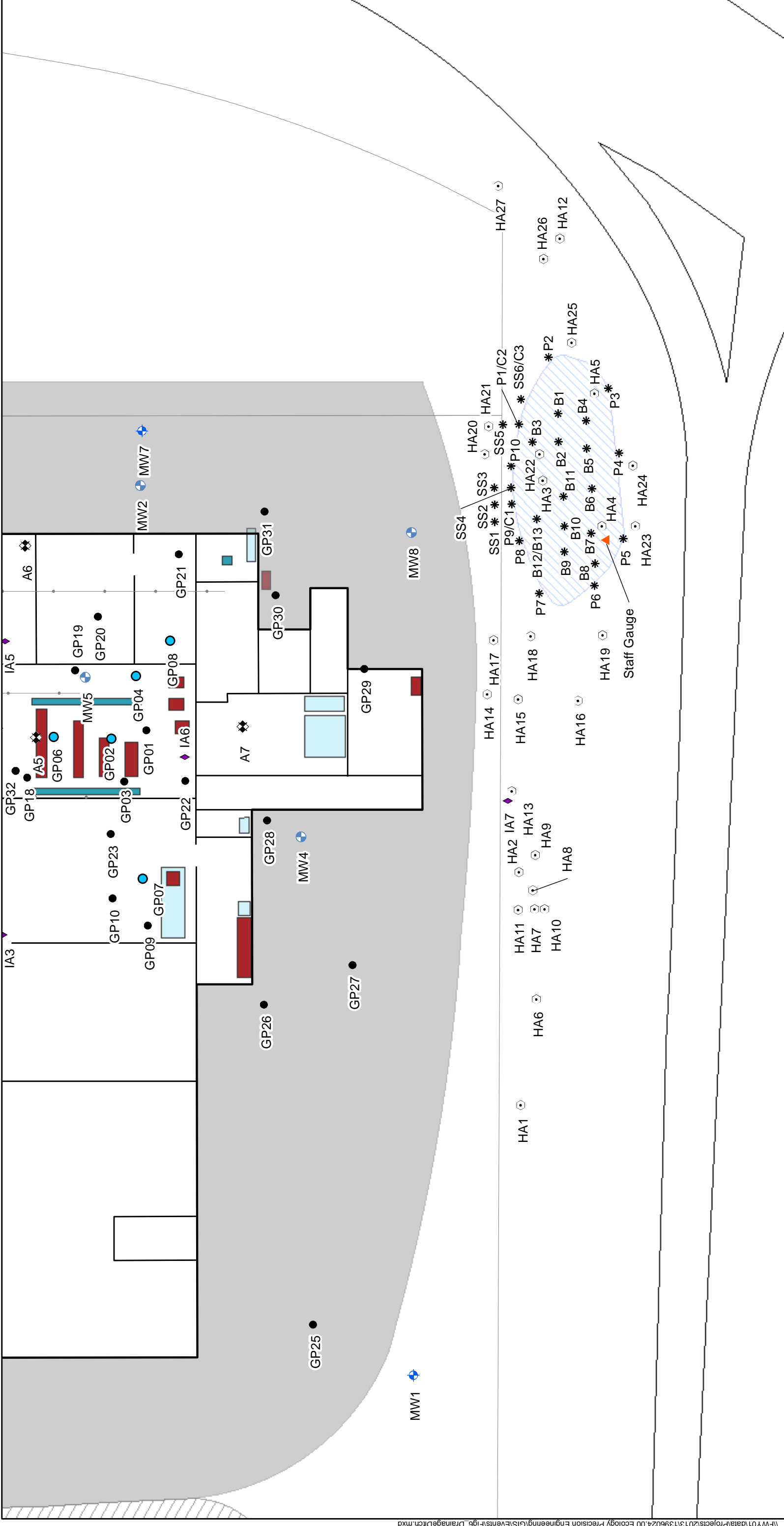
- Notes:**
1. All locations are approximate
 2. Vapor monitoring samples collected below the concrete slab on April 18, 2006.
 3. Air samples collected June 13, 2006 from indoor/ambient locations.



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Precision Engineering Facility
Seattle, Washington

Air and Vapor Sampling Locations
Figure 5

K/J Project Number 1396024.00



\\FWY01\data\Projects\201311396024\00 Ecology Precision Engineering\GIS\Events\Fig6_DrainageDitch.mxd

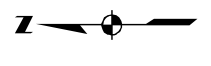
Map Source: Maui Foster & Alongi, Final Feasibility Study, Former Precision Engineering, Inc., Site, March 3, 2011.

Legend

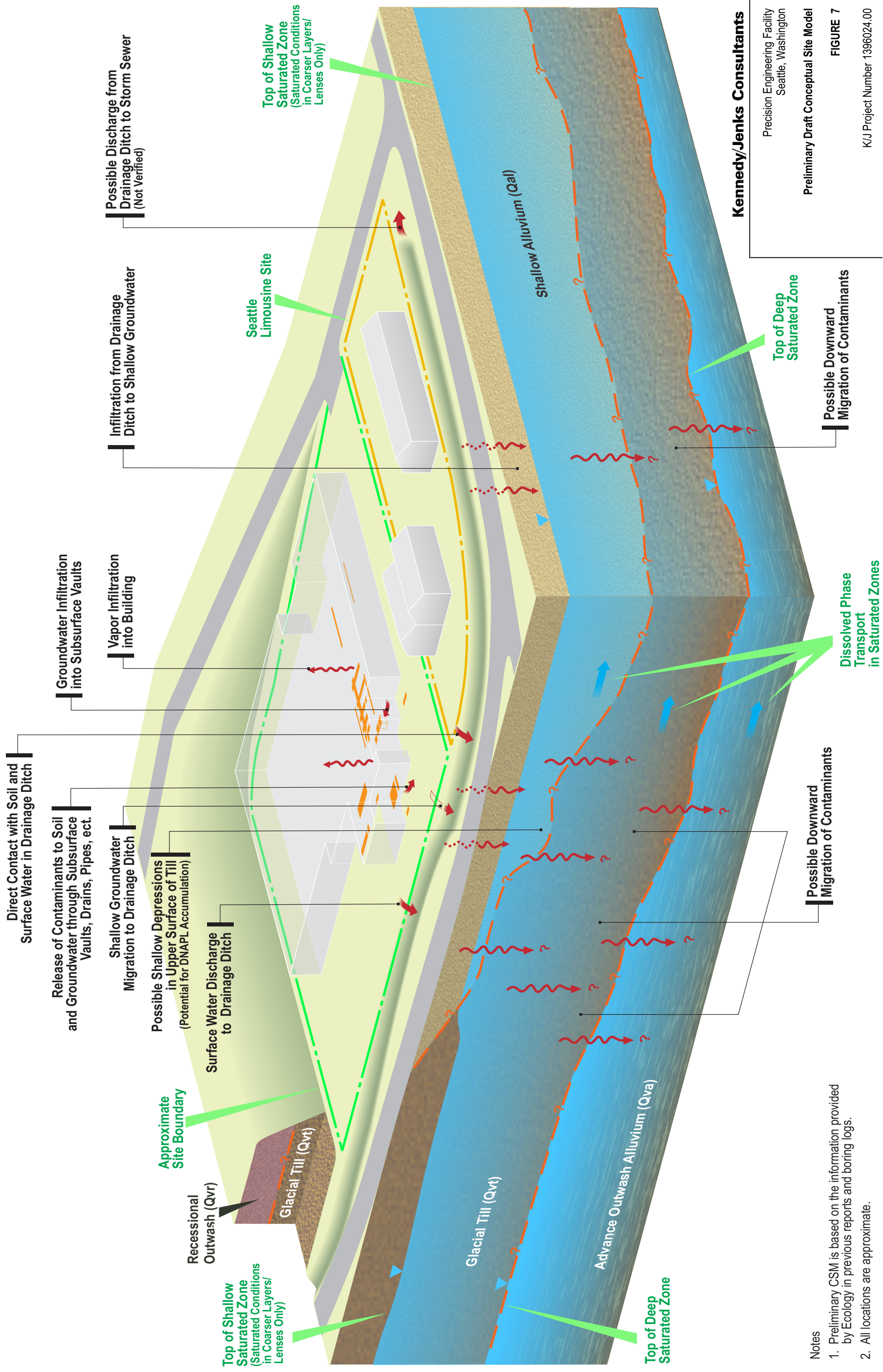
- ◆ Air Sample Point
- * Confirmation Grab Sample
- Deep Monitoring Well
- Geoprobe boring
- Hand Auger Boring
- Reconnaissance Groundwater Sample
- Shallow Monitoring Well
- Staff Gauge
- Vapor Monitoring Sample
- Sewer Line
- Other
- Tank
- Drain
- ▨ Sediment Excavation Area
- ▨ Steep Bank
- ▨ Paved Area
- ▨ Parcel Boundary

Notes:

1. All locations are approximate
2. Geoprobe borings and reconnaissance groundwater samples collected in 2005.
3. Hand Auger borings collected between 2005 and 2007.
4. Vapor monitoring samples collected below the concrete slab on April 18, 2006.
5. Air samples collected June 13, 2006 from indoor/ambient locations.
6. Staff gauge sampled in 2005 and 2006, but no sampling data was reported.
7. Monitoring wells sampled between 1988 and 2010.



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Seattle, Washington
**Drainage Ditch Sampling and
Excavation Locations**
Figure 6
K/J Project Number 1396024.00



Notes

1. Preliminary CSM is based on the information provided by Ecology in previous reports and boring logs.
2. All locations are approximate.

Kennedy/Jenks Consultants

Precision Engineering Facility
Seattle, Washington

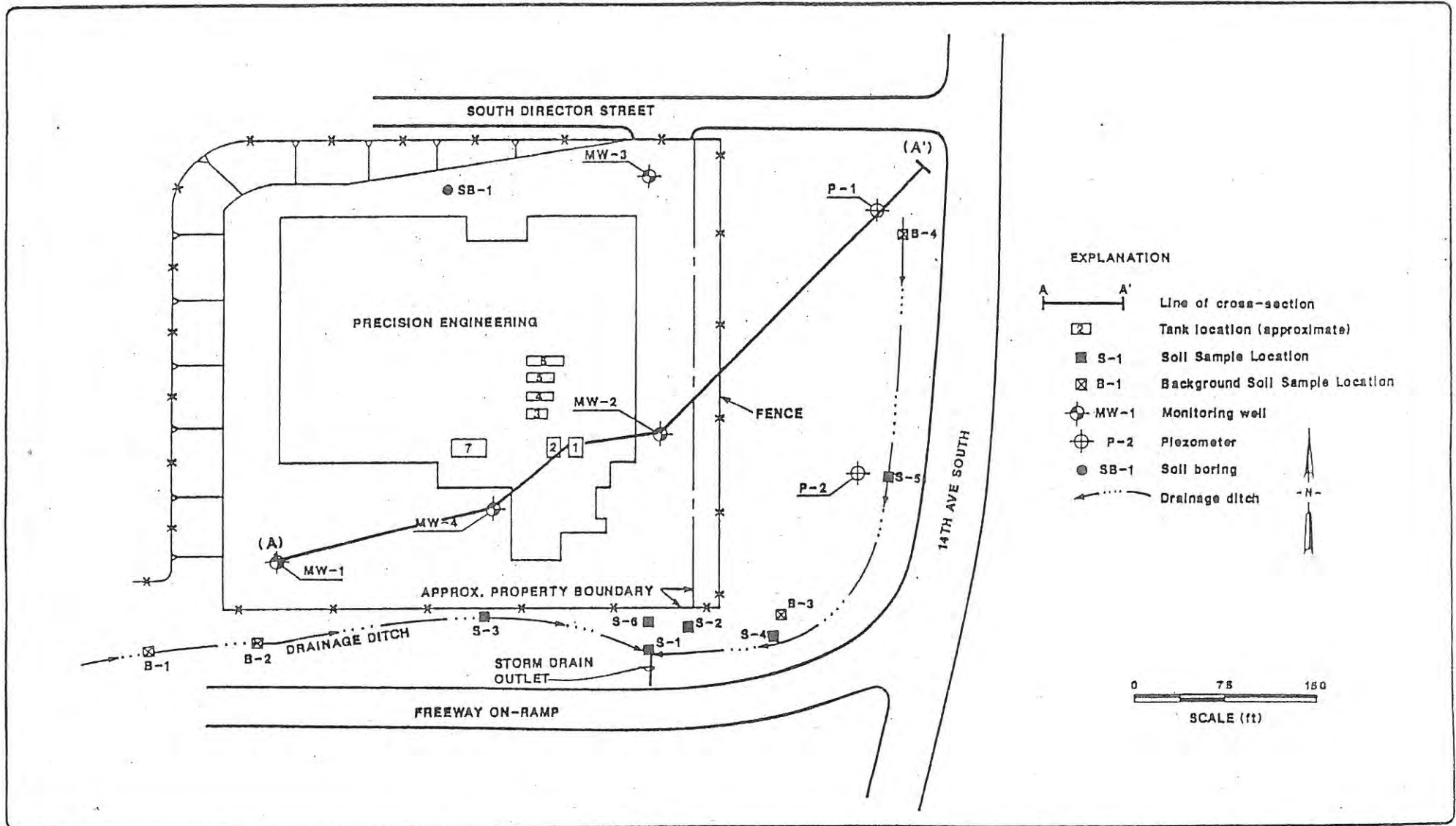
Preliminary Draft Conceptual Site Model

FIGURE 7

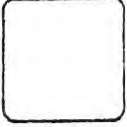
KJJ Project Number 1396024.00

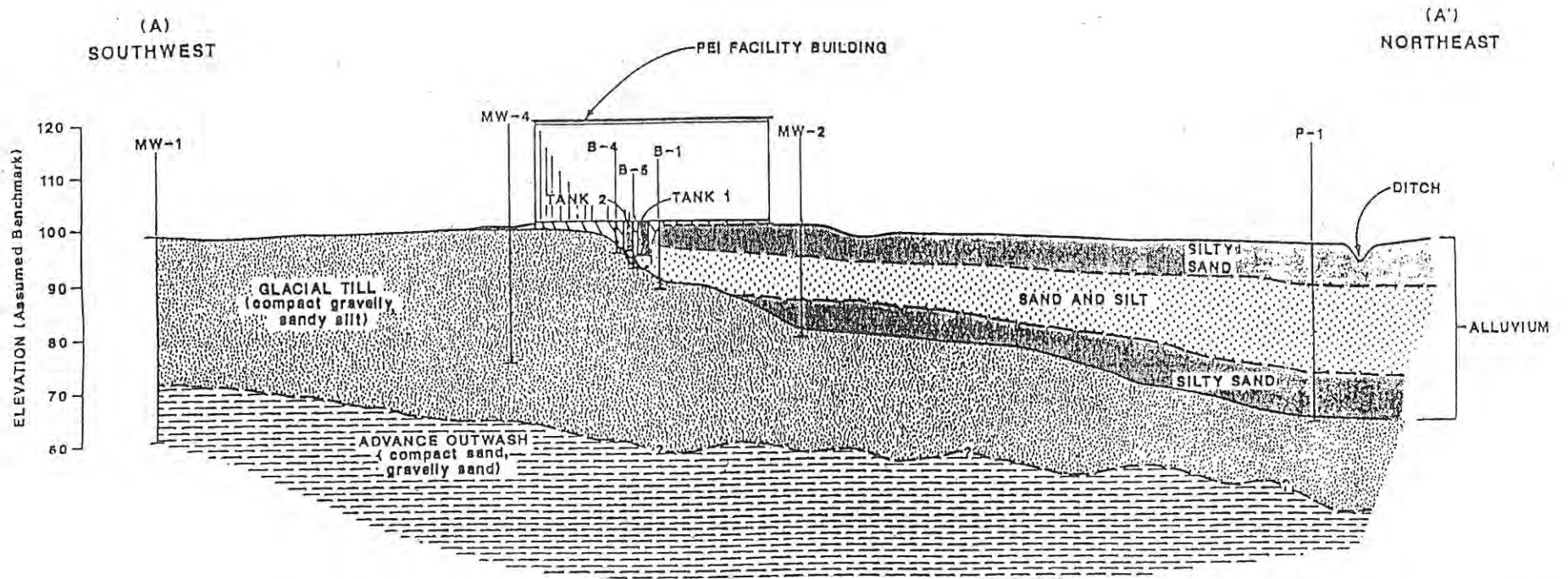
Attachment 1

Select Reference Materials from Previous Reports



PRECISION ENGINEERING, INC
SITE EXPLORATION MAP





VERTICAL EXAGGERATION = 2.5
VIEWING NORTHWEST

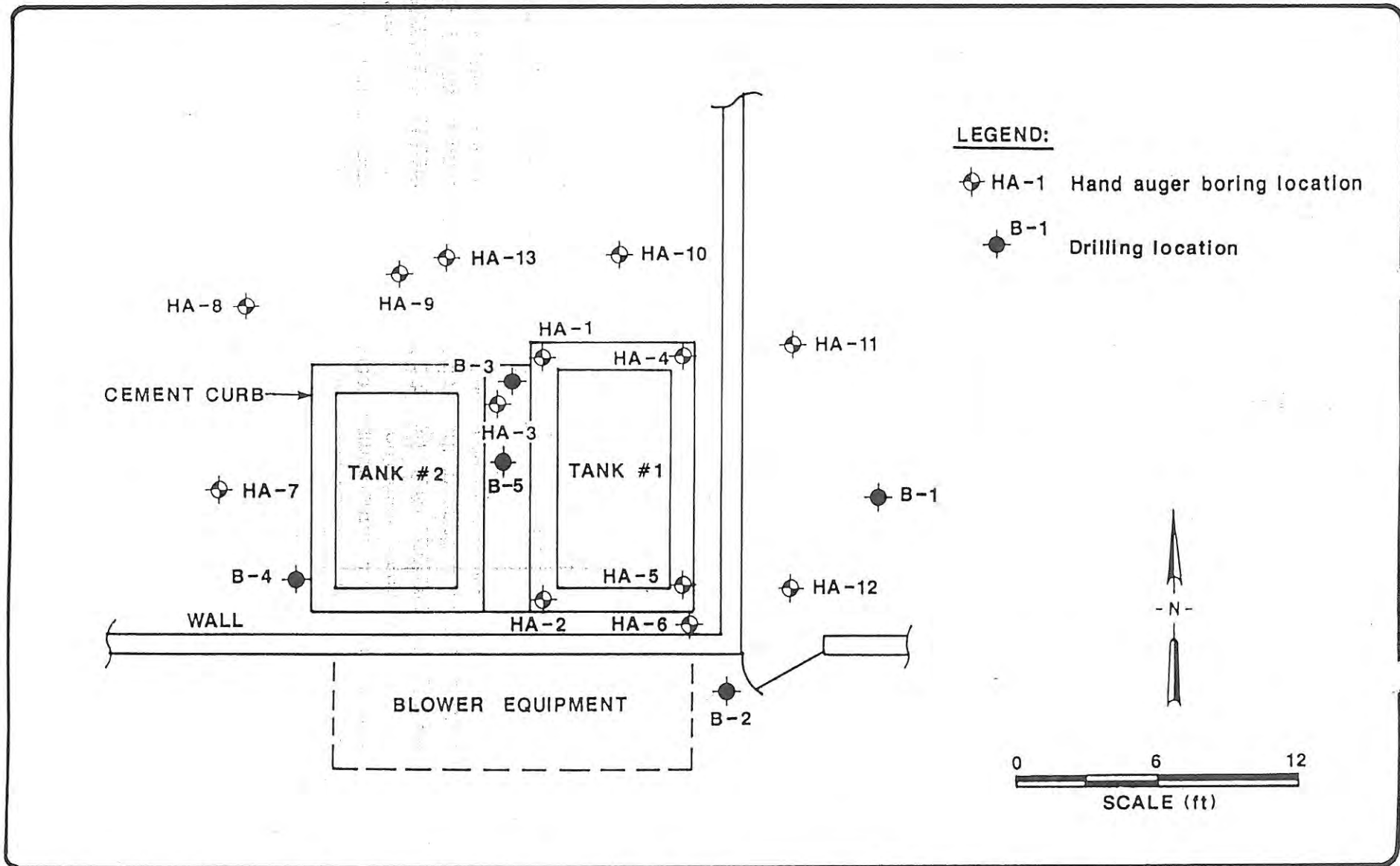


Sweet-Edwards
EMCON

DATE 6-90
DWR JA
APPN. PR
REVIS.
PROJECT NO.

PRECISION ENGINEERING, INC.
GEOLOGIC CROSS-SECTION

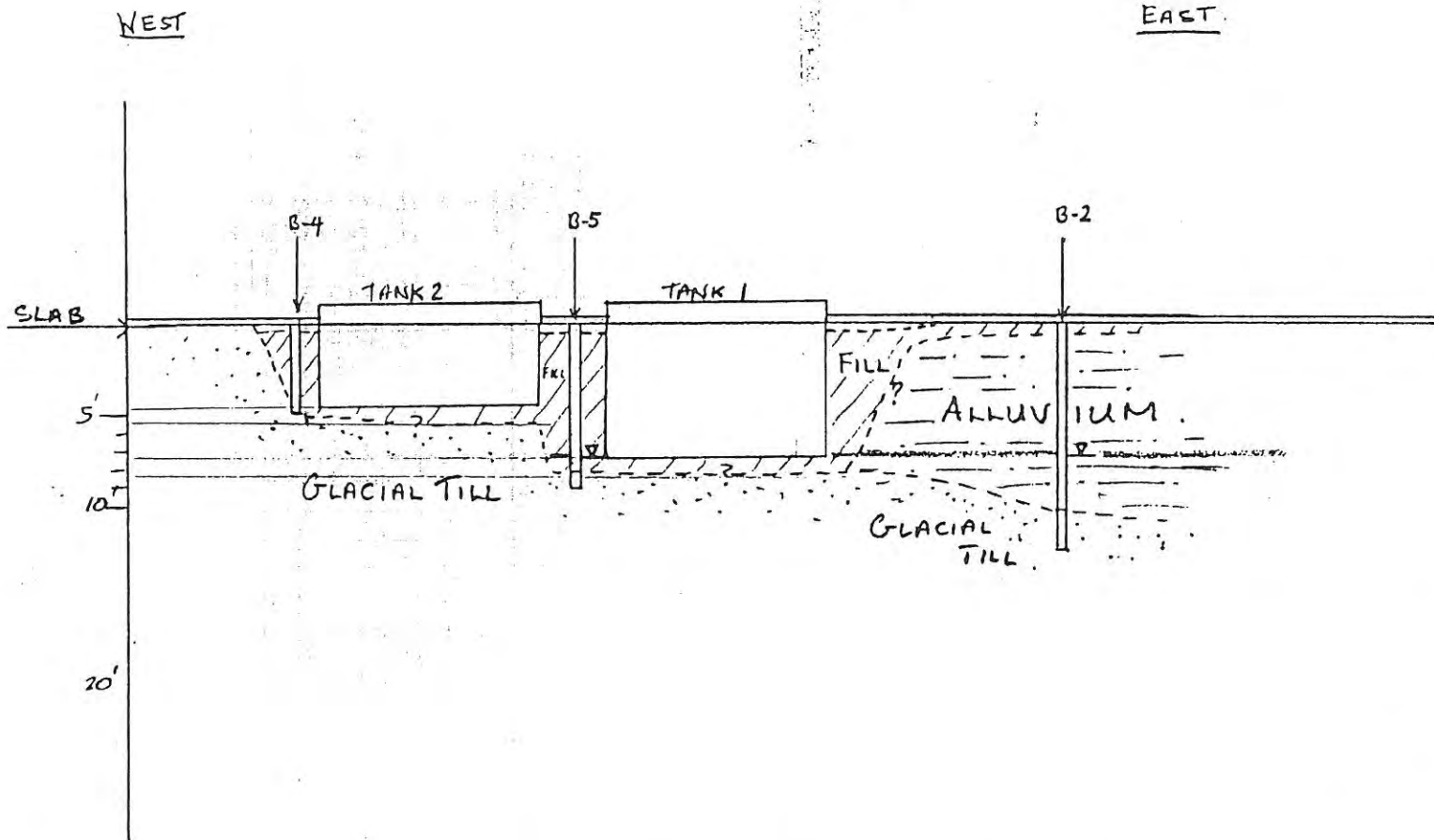
Figure 2.8.1 is a cross-section through the study area that depicts the stratigraphic relationship between the soil units. The cross-section shows the alluvium thinning towards the west until it is absent beneath the PEI facility.



Sweet-Edwards
EMCON

DATE 11-89
 DWN. MP
 APPR. KL
 REVIS. _____
 PROJECT NO.
 T2001.02

Figure 1
 PRECISION ENGINEERING, INC.
 SEATTLE, WASHINGTON
 TANK #1-#2 DRILLING LOCATIONS



LOG OF EXPLORATORY BORING

PROJECT NAME
LOCATION
DRILLED BY
DRILL METHOD
LOGGED BY

Chromium Tank Soil Sampling
Precision Engineering, Seattle, Washington
Pearson Drilling
3" SS Auger
Jeff Kirtland

BORING NO.
PAGE
REFERENCE ELEV.
TOTAL DEPTH
DATE COMPLETED

21

B-1
1 OF 1
12.70'
11/29/89

SAMPLE NUMBER	SAMPLE METHOD	BLOW PER 6 INCHES	GROUND WATER LEVELS	DEPTH IN FEET	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
1	SS	1		5				0 - 0.5 feet: CONCRETE. 0.5 - 1.5 feet: SILTY SAND; brown; trace silt; predominantly fine to medium; trace gravel (subrounded, to 1/2 inch); loose; dry. (FILL) (SM)
2	SS			10				1.5 - 5.5 feet: SILTY SAND; grey trace fines with red-brown mottles; predominantly fine to medium, medium dense; moist (ALLUVIUM) (SM) 5.5 - 9.8 feet: SILTY SAND; same as above; no mottles, slightly plastic; trace organic debris; medium dense; cohesive; moist to wet (ALLUVIUM) (SM) 9.8 - 10.5 feet: SILT; grey to blue; predominantly low plasticity fines, trace organic debris; finely bedded; cohesive; moist; 0.2 foot organic beds - 9.8 to 10.2 feet (ALLUVIUM) (OL) 10.5 - 12.5 feet: GRAVELLY SAND; brown to grey; little non-plastic fines, predominantly medium to coarse, little fine gravel (subrounded, to 1/2 inch); dense; moist (WEATHERED TILL) 12.5 - 12.7 feet: GRAVELLY SAND; brown with bluish streaks; little non-plastic fines, predominantly medium to coarse, few fine gravel (subrounded, to 1/2 inch); very dense; dry. (TILL) (SM)
				20				12.7 feet: Boring terminated due to split spoon refusal

DRAFT

REMARKS

i. Two-inch split spoon driven with a 50-pound hammer. ii. All depths are referenced to concrete floor surface. 1. Sample number PEI-1-5-0-7.0 (1140)
PEI-1-2-5-0-7.0, PEI-1-2-9.8-11.0



LOG OF EXPLORATORY BORING

PROJECT NAME
LOCATION
DRILLED BY
DRILL METHOD
LOGGED BY

Chromium Tank Soil Sampling
Precision Engineering, Seattle, Washington
Pearson Drilling
3" SS Auger
Jeff Kirtland

BORING NO.
PAGE
REFERENCE ELEV.
TOTAL DEPTH
DATE COMPLETED

B-4
1 OF 1
ii
5.70'
11/29/89

SAMPLE NUMBER	SAMPLE METHOD	BLOW PER 6 INCHES	GROUND WATER DEPTH	DEPTH IN FT.	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
1	SS	1		5				0 - 0.5 feet CONCRETE 0.5 - 5.0 feet SILTY SAND; brown; few fines predominantly fine to medium; trace fine gravel (subrounded, to 1/2 inch); medium dense; dry. (FILL) (SM)
2	SS			5				5.0 - 5.7 feet SILTY SAND; red-brown to grey with red-brown mottles; few non-plastic fines; predominantly fine to medium; trace fine gravel (subrounded, to 1/2 inch) dense to very dense; dry. (WEATHERED TILL) (GM)
				10				At 5.7 feet GRAVELLY SAND; brown; very dense. (TILL) Boring terminated at 5.7 feet due to split spoon refusal.
				15				
				20				

DRAFT

REMARKS

i. Two-inch split spoon driven with a 50-pound hammer. ii. Depths are reference to concrete floor surface. 1. Sample number PEI-4-1.0-2.5(1710). 2. Sample number PEI-4-5.0-5.7(1630). Boring backfilled with bentonite chips to concrete base, capped with concrete, and sealed.



LOG OF EXPLORATORY BORING

PROJECT NAME
LOCATION
DRILLED BY
DRILL METHOD
LOGGED BY

Chromium Tank Soil Sampling
 Precision Engineering, Seattle, Washington
 Pearson Drilling
 3"SS Auger
 Jeff Kirtland

BORING NO. B-5
PAGE 1 OF 2
REFERENCE ELEV. ii
TOTAL DEPTH 9.20'
DATE COMPLETED 11/30/89

SAMPLE NUMBER	SAMPLE METHOD	BLOW PER 6 INCHES	GROUND WATER LEVEL	DEPTH IN FEET	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
		1						0 - 0.5 feet CONCRETE
								0.5 - 1.7 feet: SILTY SAND; dark brown; little non-plastic fines, predominantly fine to medium, trace fine to medium gravel (subrounded, to 1 inch); medium dense to dense; dry. (FILL) (SM)
								1.7 - 2 feet: CHERT; blue-grey; fine to medium gravel (angular, to 1-1/2 inch); very dense; dry. (CHERT) (GP)
								2 - 2.5 feet: SILTY SAND; as above; brown to grey; moist.
								2.5 - 2.7 feet: SILTY SAND; yellow; little non-plastic fines, predominantly fine to medium, trace fine to medium gravel (subrounded, to 1 inch); dense; slightly moist. (FILL) (SM)
								2.7 - 5.5 feet: SILTY SAND; as above; brown; trace coarse sand; trace organic debris.
SS		12						
		35						
		25						
SS		21						
		32						
		41						
SS		16						
		38						
		32						

DRAFT

REMARKS

i. Two-inch spoon driven with a 50-pound hammer. ii. All depths are referenced to concrete floor surface. 1. Sample number PEI-45-7-0-8-5 (1600). 2. Sample number PEI-45-8-5-9-2 (1630). Boring backfilled with bentonite chips to concrete base, capped with concrete, and sealed.



SWEET-EDWARDS/EMCON

LOG OF EXPLORATORY BORING

PROJECT NAME
LOCATION
DRILLED BY
DRILL METHOD
LOGGED BY

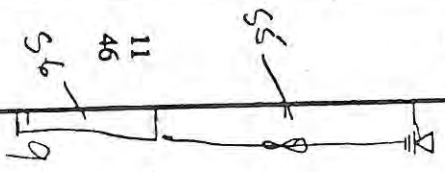
Chromium Tank Soil Sampling
 Precision Engineering, Seattle, Washington
 Pearson Drilling
 3" SS Auger
 Jeff Kirtland

BORING NO.
PAGE
REFERENCE ELEV.
TOTAL DEPTH
DATE COMPLETED

B-5
 2 OF 2
 ii
 9.20'
 11/30/89

SAMPLE NUMBER	SAMPLE METHOD	BLOW PER 6 INCHES	GROUND WATER LEVEL	DEPTH IN FT.	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
	SS	16 15 16						5.5 - 7 feet SILTY SAND; as above; slightly cohesive; moist
1	SS	11 6 5						7 - 8.2 feet SILTY SAND; as above; trace medium gravel with brown mottles; trace fine (subrounded, to 1 inch); moist to wet
2	SS	11 46						8.2 - 8.5 feet SILTY SAND; as above; grey-brown with brown mottles; trace fine gravel (subrounded, to 1/2 inch). 8.5 - 9 feet GRAVELLY SAND; grey brown with orange mottles; trace fines; trace medium sand, predominantly coarse sand, few fine to medium gravel (subrounded, to 1 inch); very dense; moist. (WEATHERED TILL) (SW) 9 - 9.7 feet GRAVELLY SAND; as above; very dense. (TILL) (SW). Boring terminated at 9.2 feet due to auger refusal.

DRAFT



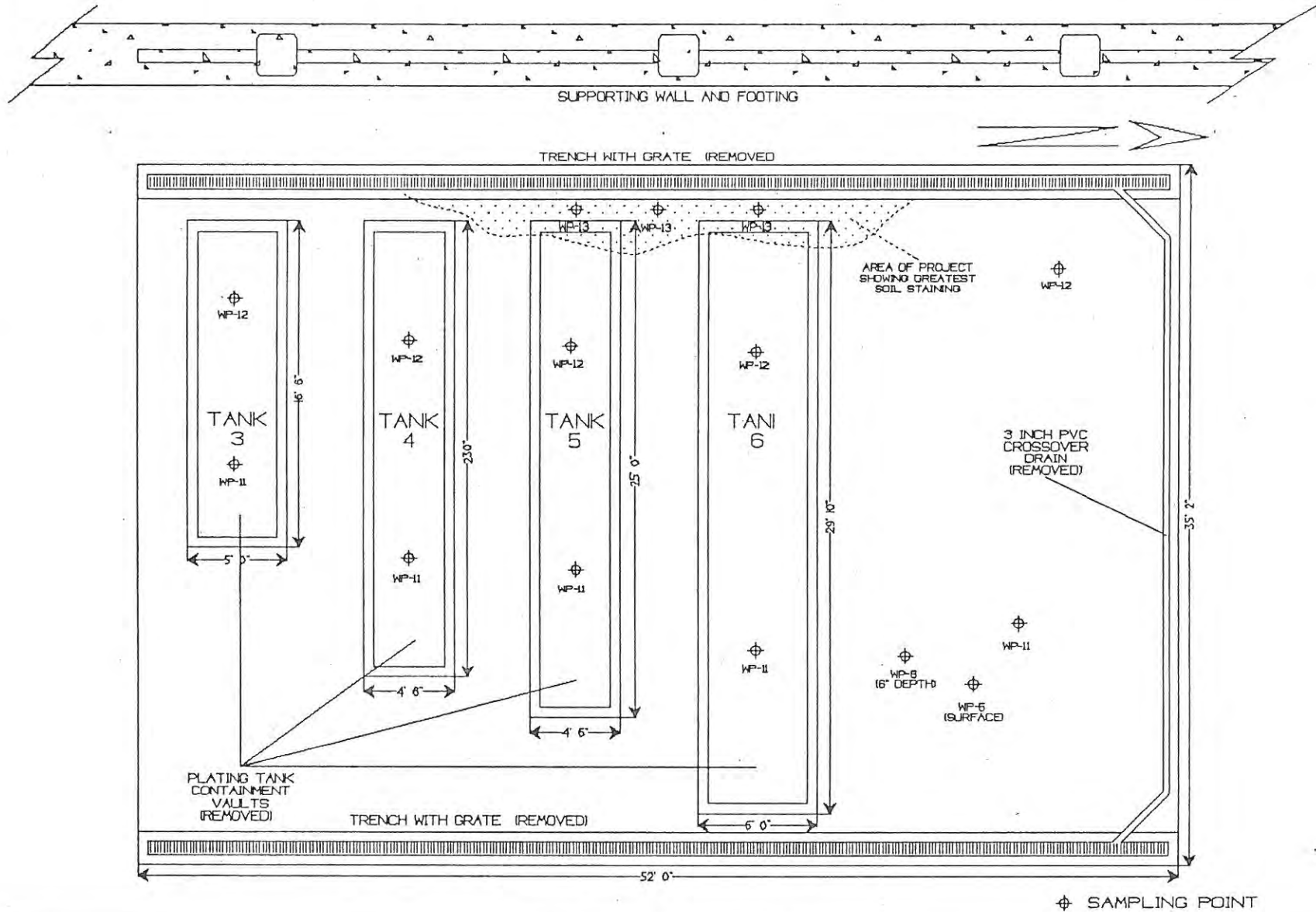
REMARKS
 i. Two-inch spoon driven with a 50-pound hammer. ii. All depths are referenced to concrete floor surface. 1. Sample number PEI-45-7.0-8.5 (1600). 2. Sample number PEI-45-8.5-9.2 (1630). Boring backfilled with bentonite chips to concrete base, capped with concrete, and sealed.



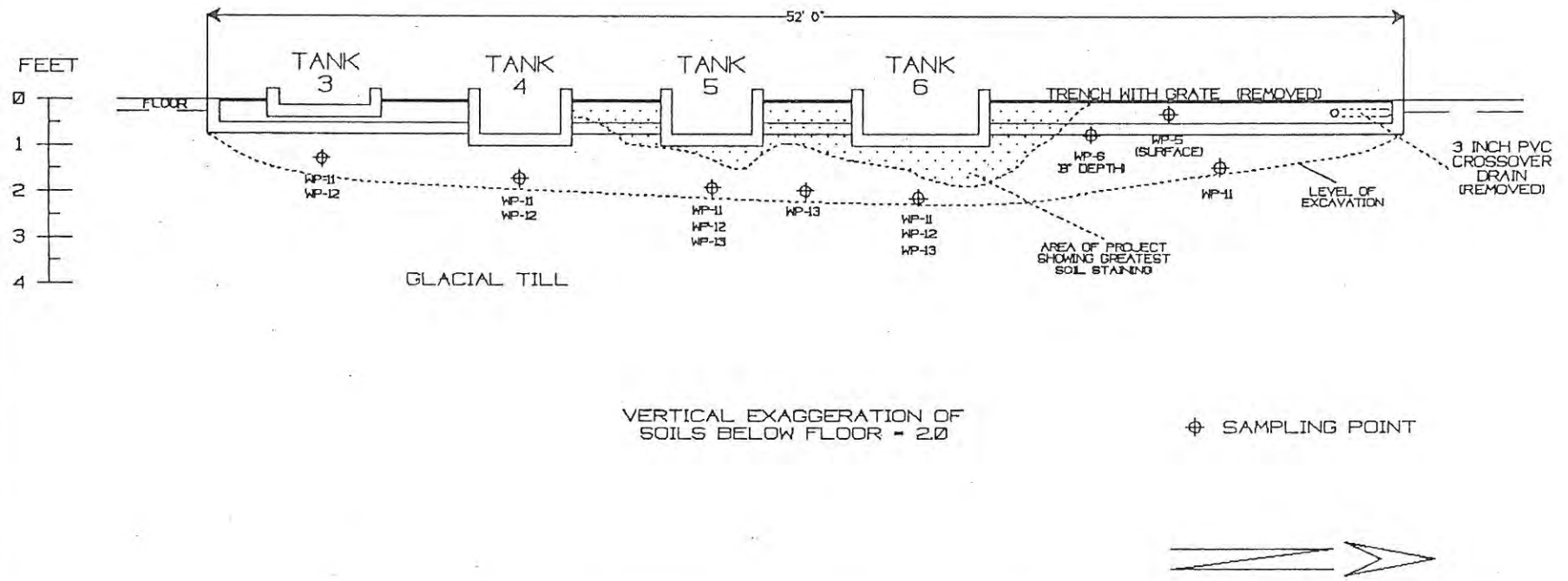
SMCRT-EDWARDS/EMCON

2.17

Map of Site - Remediation Site

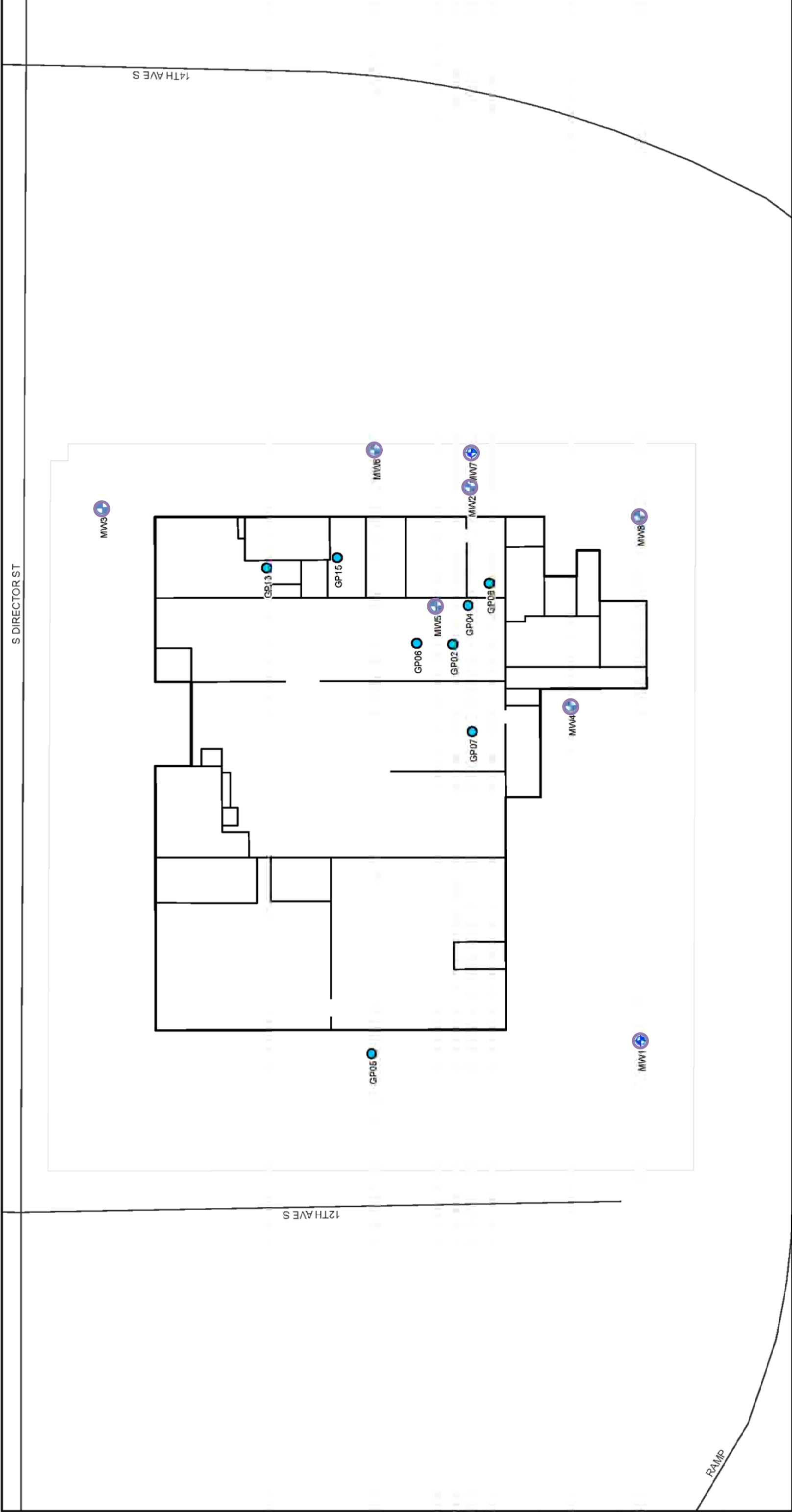


2.18 Map of Site - Cross-section



Attachment 2

Concentration Contour Maps



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 Seattle, Washington

**Groundwater Monitoring Wells and
 Sampling Locations**

Arsenic in Groundwater
 KJJ Project Number 1396024.00

○ Arsenic in Groundwater >0.12 ug/L
 (2x MTCA Method B Groundwater)

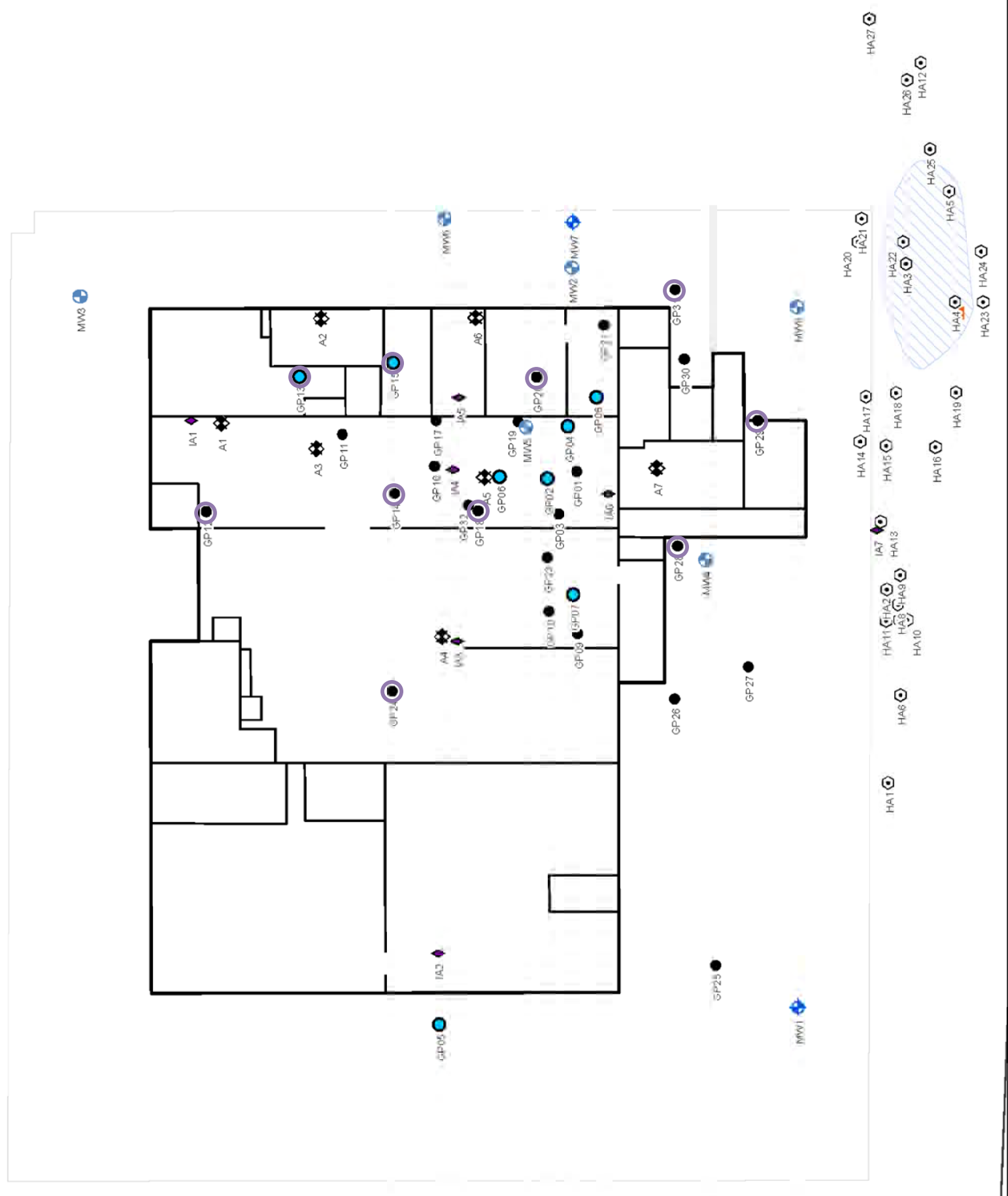
- Legend**
- Deep Monitoring Well
 - Shallow Monitoring Well
 - Reconnaissance Groundwater Sample
 - ▭ Parcel Boundary

S DIRECTOR ST

14TH AVE S

12TH AVE S

RAMP



○ Arsenic in Soil > 1.4 mg/kg
(2x MTCA Method B Soil)

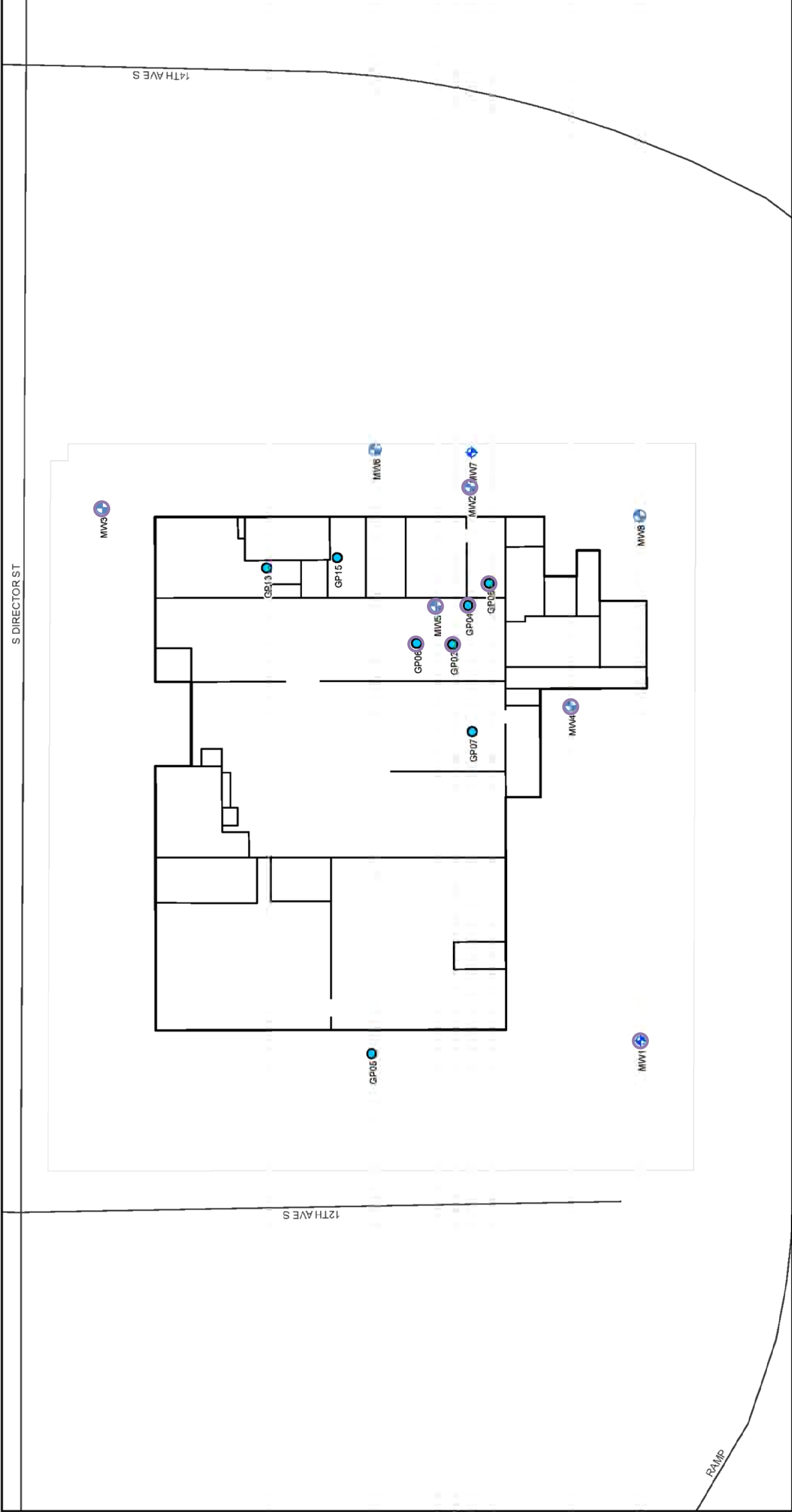
- ◆ Air Sample Point
- Deep Monitoring Well
- Geoprobe boring
- Hand Auger Boring
- Reconnaissance Groundwater Sample
- Shallow Monitoring Well
- Staff Gauge
- Vapor Monitoring Sample
- Excavation Area
- Parcel Boundary



Kennedy/ Jenks Consultants
Precision Engineering Facility
Seattle, Washington

Prior Drilling and Sampling Locations
Arsenic in Soil

KJ Project Number 1396024.00



○ Chromium (total) in Groundwater > 100 ug/L
(2x MTCA Method A Groundwater)

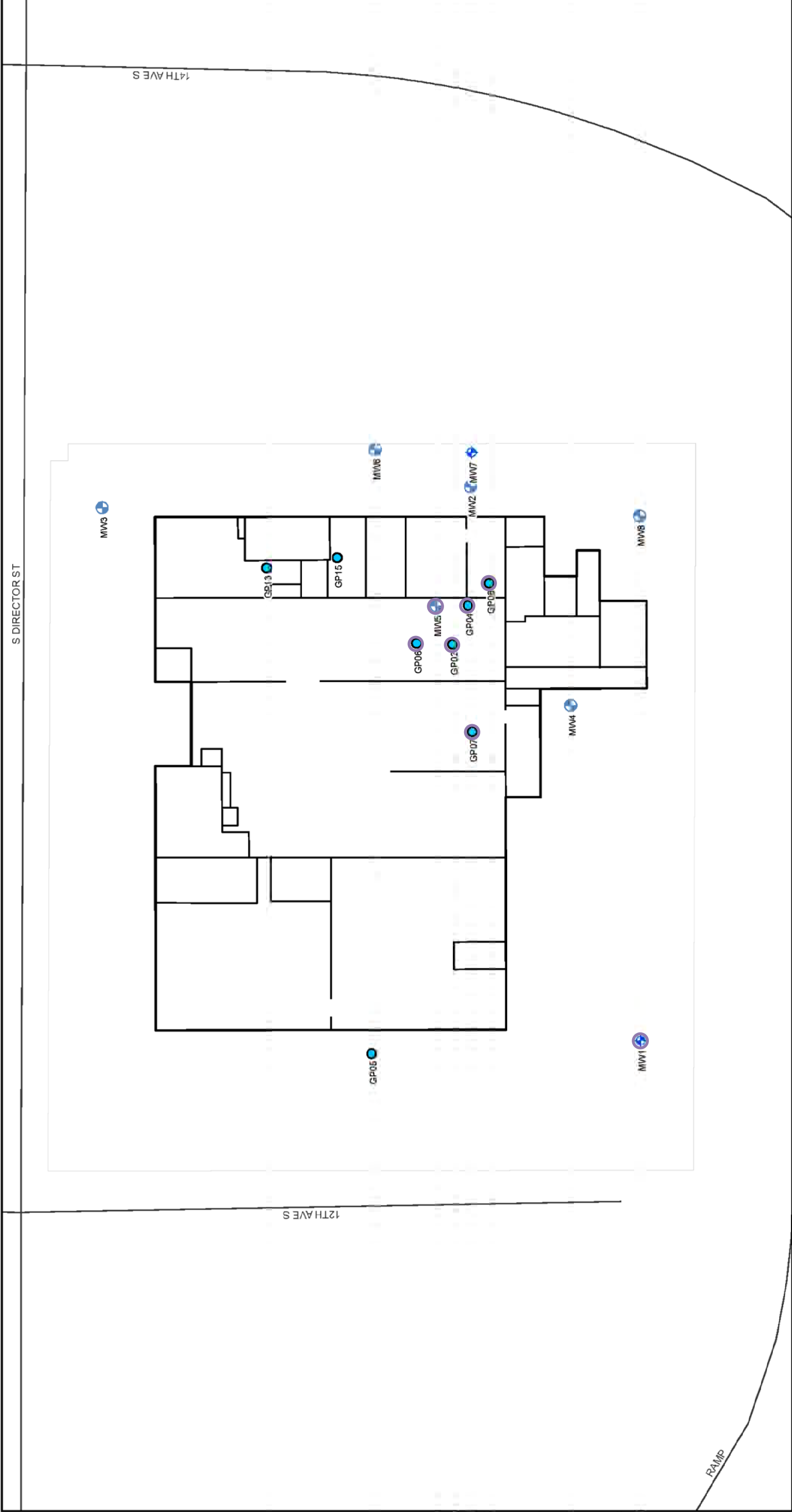
- Legend**
- ⊕ Deep Monitoring Well
 - Shallow Monitoring Well
 - ⊕ Reconnaissance Groundwater Sample
 - ▭ Parcel Boundary



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Seattle, Washington

**Groundwater Monitoring Wells and
Sampling Locations**

Chromium in Groundwater
KJJ Project Number 1396024.00



Kennedy/ Jenks Consultants
 Precision Engineering Facility
 Seattle, Washington

**Groundwater Monitoring Wells and
 Sampling Locations
 Hexavalent Chromium in
 Groundwater**

KJJ Project Number 1396024.00

○ Hexavalent Chromium in Groundwater > 96 ug/L
 (2x MTCA Method B Groundwater)

- Legend**
- ⊕ Deep Monitoring Well
 - ⊕ Shallow Monitoring Well
 - Reconnaissance Groundwater Sample
 - ▭ Parcel Boundary

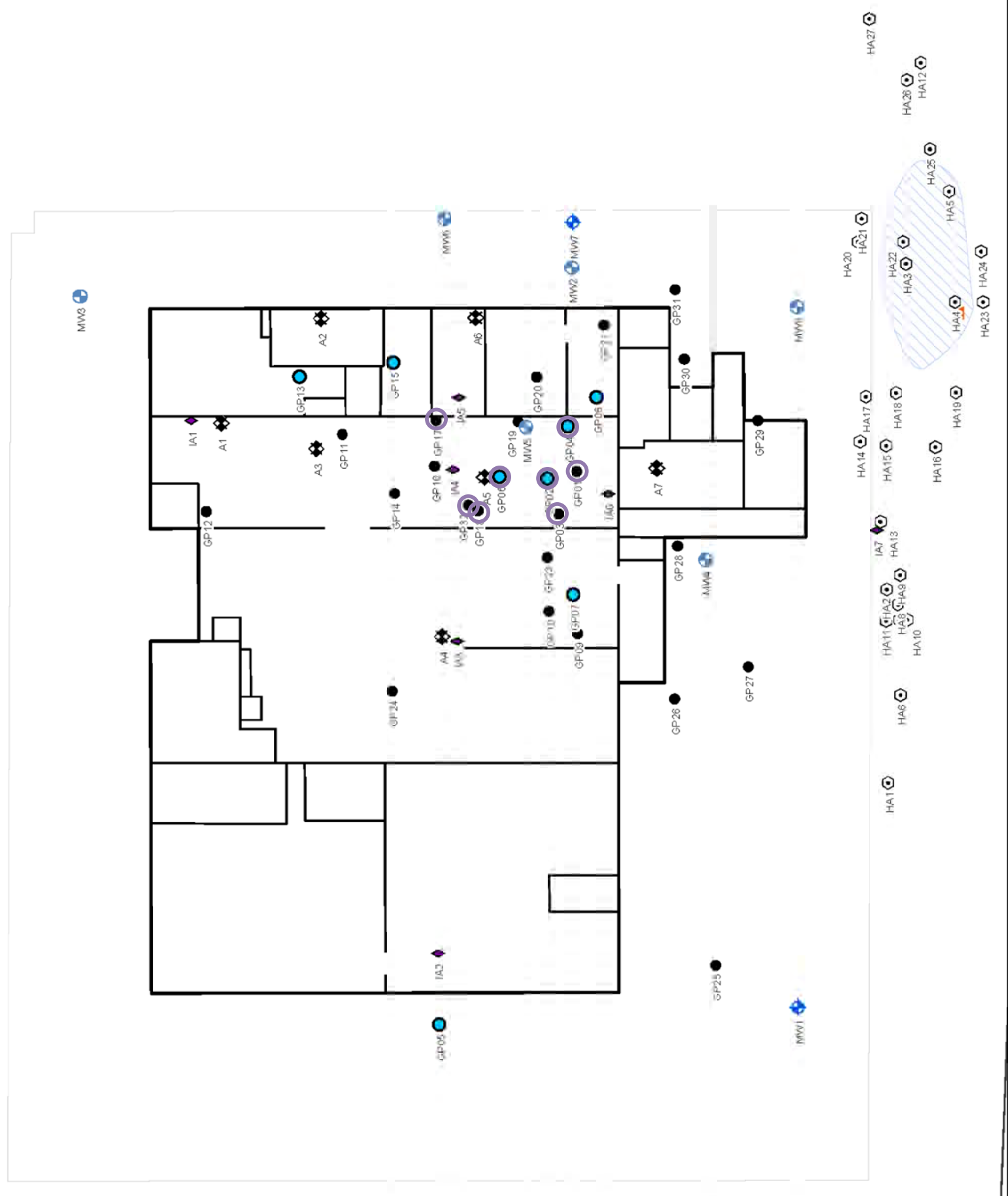


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RAMP



○ Hexavalent Chromium in Soil > 38 mg/kg
(2x MTCA Method A Soil)

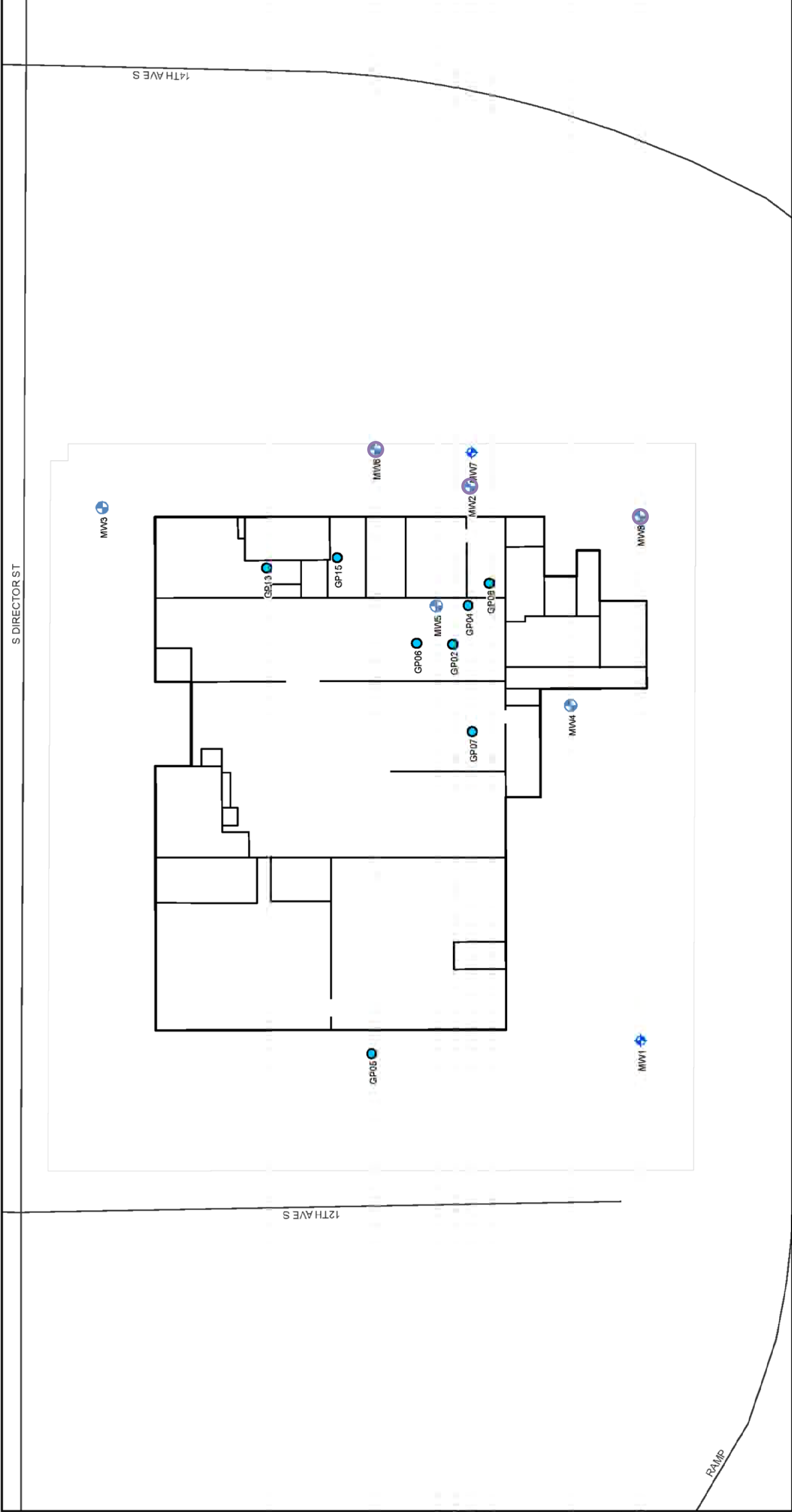
- ◆ Air Sample Point
- Deep Monitoring Well
- Geoprobe boring
- Hand Auger Boring
- Reconnaissance Groundwater Sample
- Shallow Monitoring Well
- Staff Gauge
- Vapor Monitoring Sample
- Excavation Area
- Parcel Boundary



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 Precision Engineering Facility
 Seattle, Washington

Prior Drilling and Sampling Locations
 Hexavalent Chromium
 in Soil

KUJ Project Number 1396024.00



○ Diesel-Range Organics in Groundwater > 1,000 ug/L
(2x MTCA Method A Groundwater)

- Legend**
- ⊕ Deep Monitoring Well
 - Shallow Monitoring Well
 - ⊕ Reconnaissance Groundwater Sample
 - ▭ Parcel Boundary

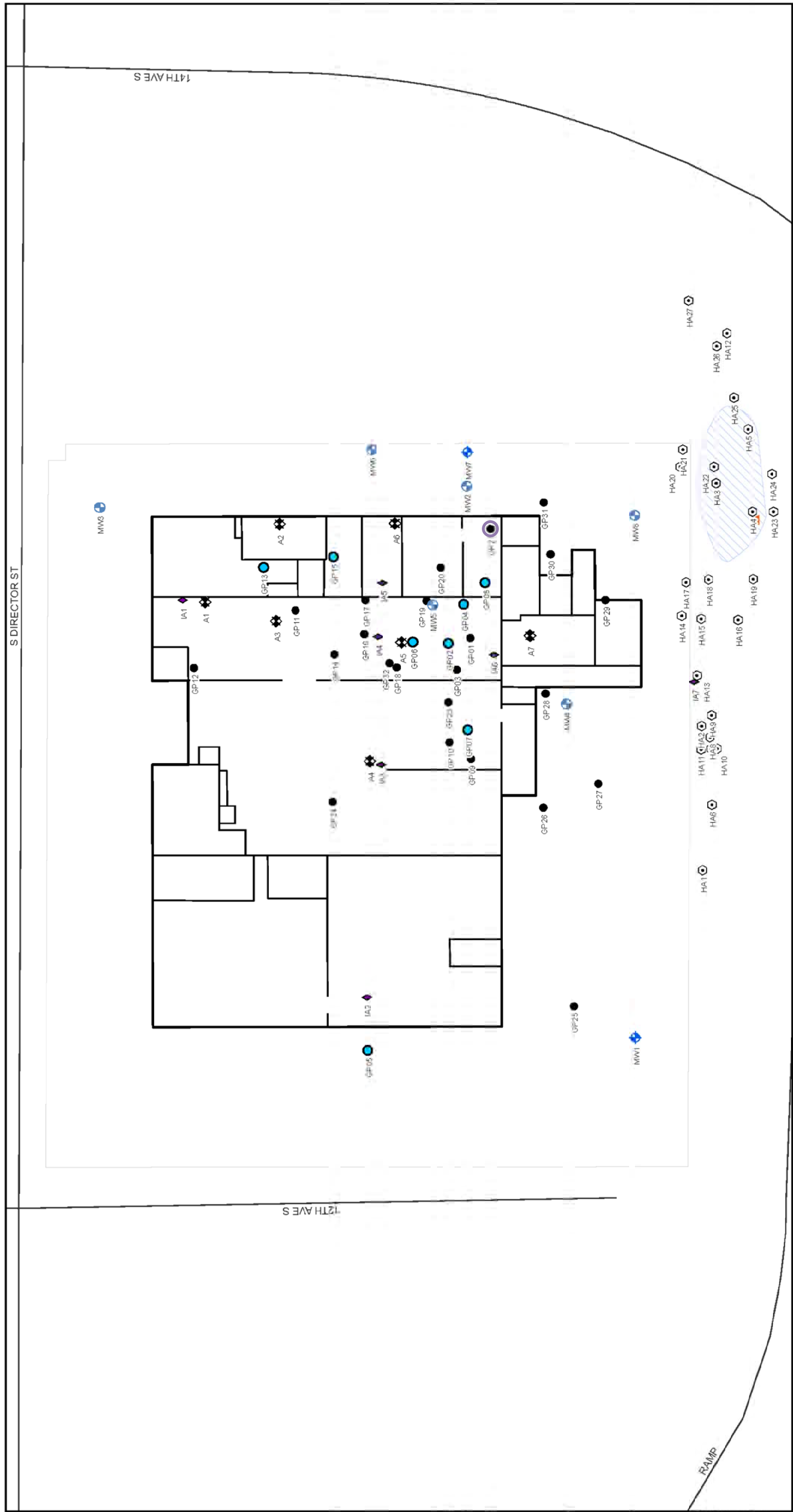


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Seattle, Washington

**Groundwater Monitoring Wells and
Sampling Locations**

**Diesel-Range Organics in
Groundwater**

KJJ Project Number 1396024.00



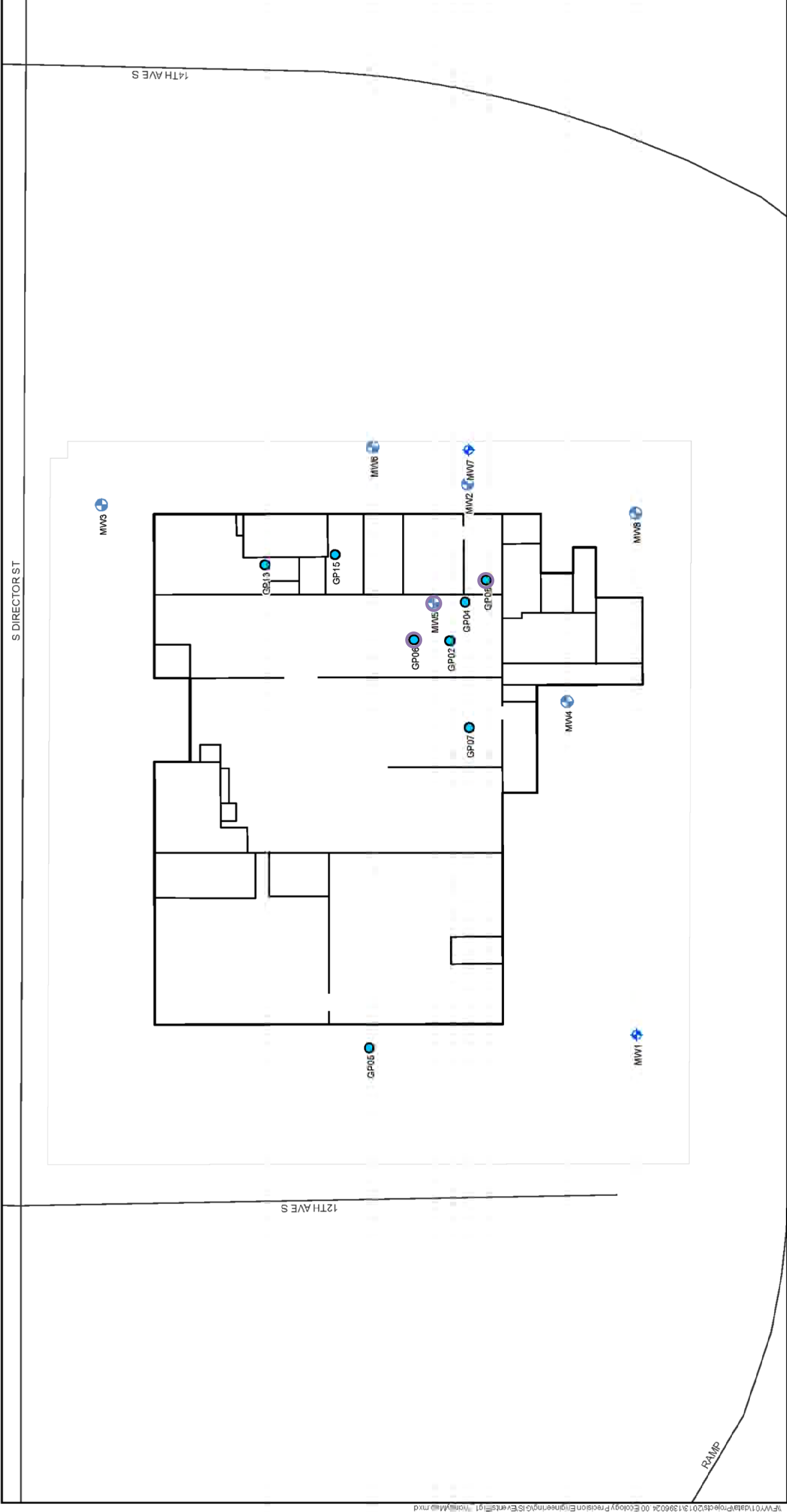
Legend

- Air Sample Point
- Deep Monitoring Well
- Geoprobe boring
- Hand Auger Boring
- Vapor Monitoring Sample
- Excavation Area
- Parcel Boundary
- Reconnaissance Groundwater Sample
- Shallow Monitoring Well
- Staff Gauge

**Diesel-Range Organics in Soil > 4,000 mg/kg
(2x MTCA Method A Soil)**

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Seattle, Washington

Prior Drilling and Sampling Locations in
Diesel-Range Organics in
Soil
KJ Project Number 1396024.00



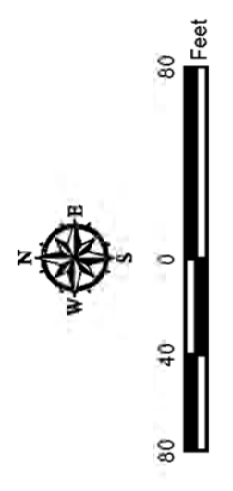
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 Precision Engineering Facility
 Seattle, Washington

**Groundwater Monitoring Wells and
 Sampling Locations**

Trichloroethene in Groundwater
 KJJ Project Number 1396024.00

○ Trichloroethene (TCE) in Groundwater > 10 ug/L
 (2x MTCA Method A Groundwater)

- Legend**
- Deep Monitoring Well
 - Shallow Monitoring Well
 - Reconnaissance Groundwater Sample
 - Parcel Boundary

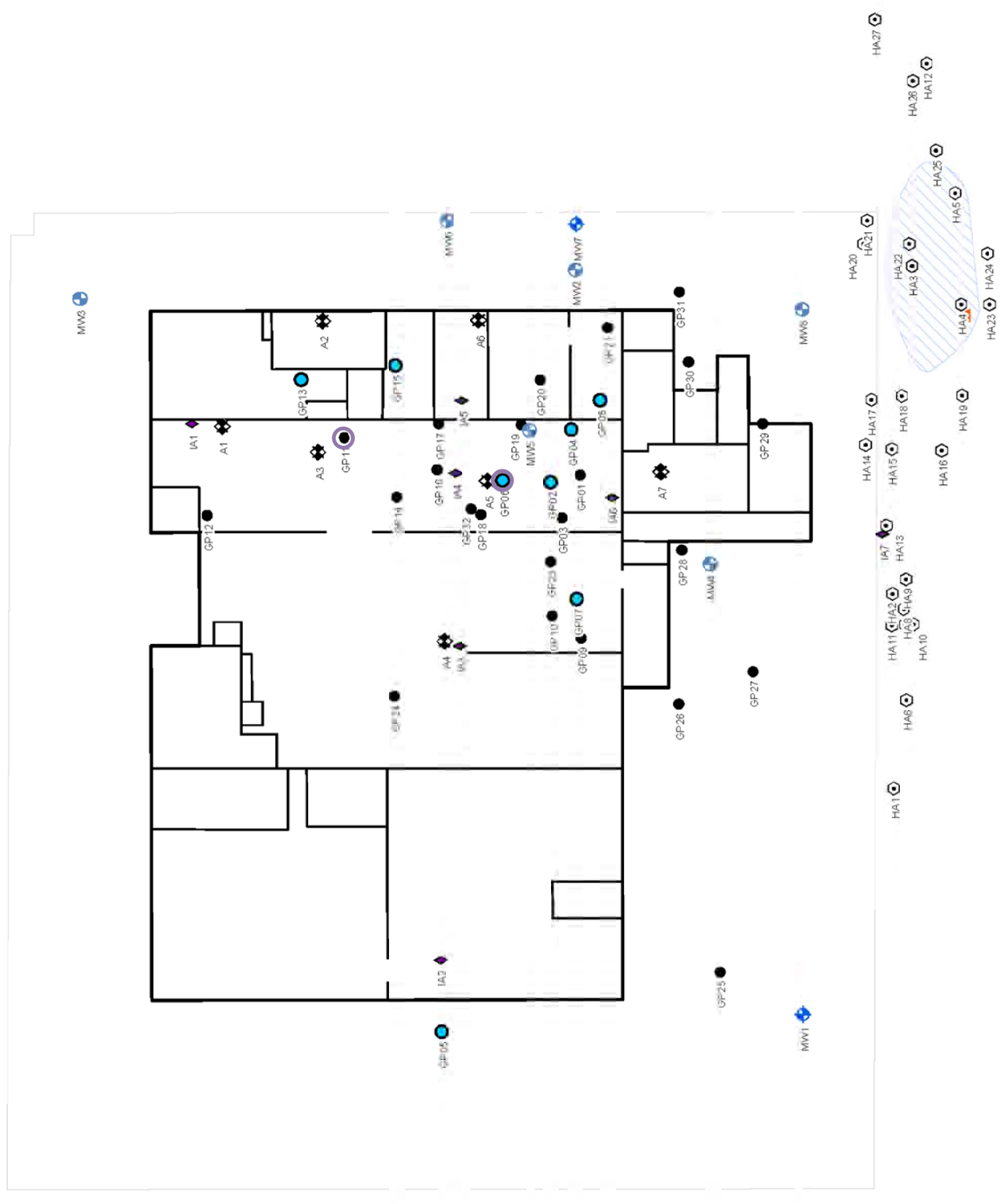


S DIRECTOR ST

14TH AVE S

12TH AVE S

RAMP



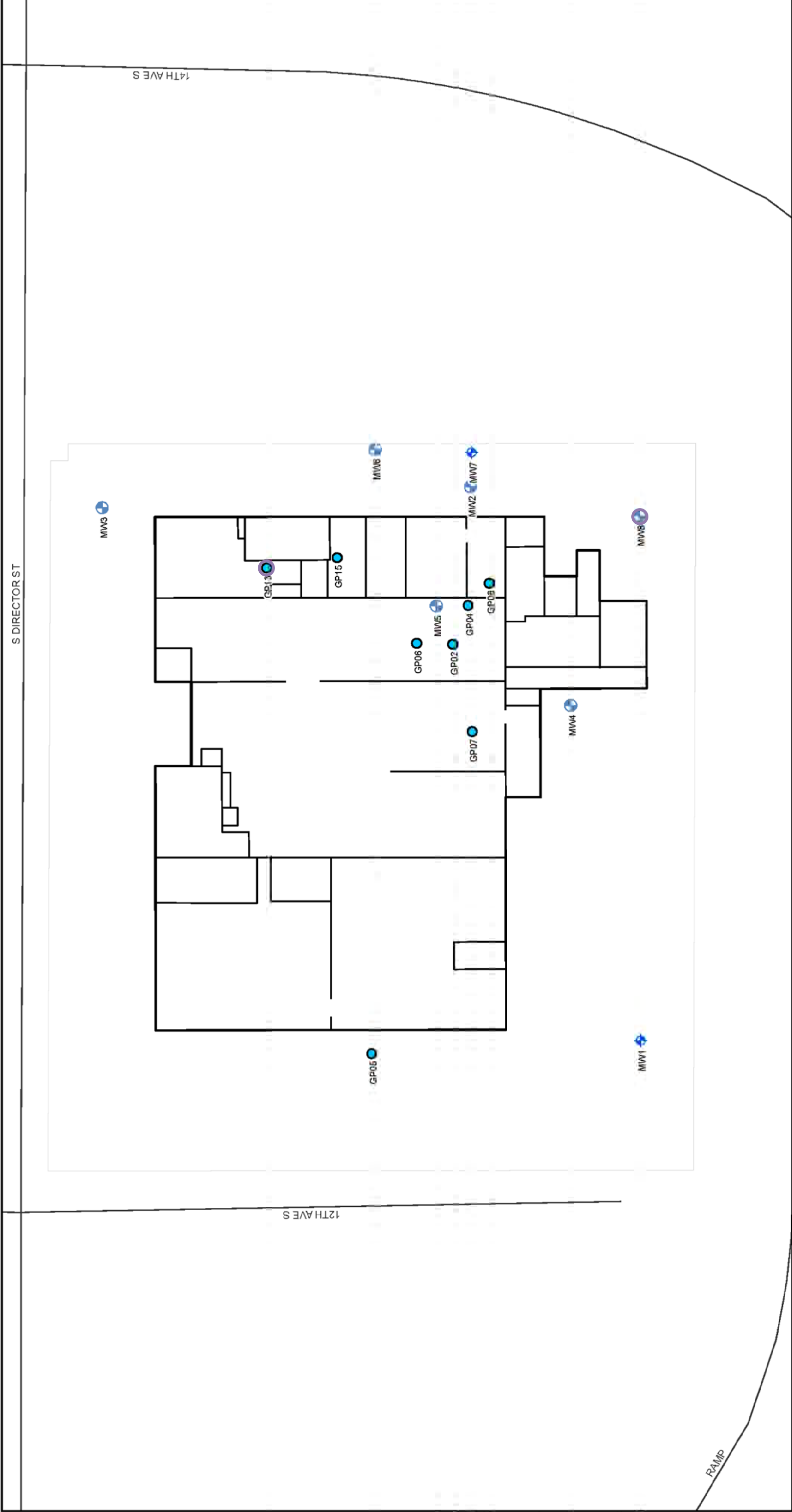
Legend

- Trichloroethene (TCE) in Soil > 0.06 mg/kg (2x MTCA Method A Soil)
- Air Sample Point
- Reconnaissance Groundwater Sample
- Deep Monitoring Well
- Shallow Monitoring Well
- Geoprobe boring
- Staff Gauge
- Hand Auger Boring
- Vapor Monitoring Sample
- Excavation Area
- Parcel Boundary



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 Precision Engineering Facility
 Seattle, Washington

Prior Drilling and Sampling Locations
 Trichloroethene in Soil
 K/J Project Number 1396024.00



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 Precision Engineering Facility
 Seattle, Washington

**Groundwater Monitoring Wells and
 Sampling Locations**

Vinyl Chloride in Groundwater
 KJJ Project Number 1396024.00

○ Vinyl Chloride (VC) in Groundwater > 0.4 ug/L
 (2x MTCA Method A Groundwater)

- Legend**
- ⊕ Deep Monitoring Well
 - ⊕ Shallow Monitoring Well
 - Reconnaissance Groundwater Sample
 - ▭ Parcel Boundary