Pre-Remedial Design Investigation Work Plan

Gas Works Park Site
Seattle, Washington

for
Puget Sound Energy and the City of Seattle

February 26, 2024

GeoEngineers
Earth Science + Technology

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ABBREVIATIONS AND ACRONYMS

ALU	Ambient Lake Union
ARI	Analytical Resources, LLC
AO	Agreed Order
bgs	below ground surface
bml	below mudline
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
City	City of Seattle
cm	centimeters
COC	contaminants of concern
cPAHs	carcinogenic polycyclic hydrocarbons
CPT	cone penetration test
CyDSS	Cyclic direct simple shear test
DNAPL	dense non-aqueous phase liquid
DSS	Direct simple shear test
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
EPA	United States Environmental Protection Agency
ER	electrical resistivity
GeoEngineers	GeoEngineers, Inc.
HASP	Health and Safety Plan
IDP	Inadvertent Discovery Plan
JARPA	Joint Aquatic Resource Permit Application
LM	tomography and linear microtremor
mg/kg	milligrams per kilogram
MGP	Manufactured Gas Plant
MLS	multi-level sampler
MNR	monitored natural recovery
MTCA	Model Toxics Control Act
NAPL	non-aqueous phase liquid

OHWM	ordinary high- water mark
ORP	oxidation/reduction potential
PAH	polycyclic aromatic hydrocarbon
PLP	potentially liable party
PRDI	Pre-Remedial Design Investigation
PSE	Puget Sound Energy
psf	pounds-force per square foot
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SEPA	State Environmental Policy Act
Site	Gas Works Park Site
SMA	Sediment Management Area
SMS	Sediment Management Plan
SPT	standard penetration test
SWAC	surface weighted average concentration
USACE	United States Army Corps of Engineers
VOCs	volatile organic compounds
WAC	Washington Administrative Code
µg/L	micrograms per liter

1.0 INTRODUCTION

This Pre-Remedial Design Investigation (PRDI) Work Plan (Work Plan) describes the field and laboratory activities that will be completed to collect supplemental data for the engineering analysis and design of the Washington State Department of Ecology's (Ecology) selected cleanup action for the Gas Works Park Site (GWPS) in Seattle, Washington (Figure 1). The cleanup action is described in a Cleanup Action Plan (CAP) (Ecology 2023a) which is an exhibit to Consent Decree No. 23-2-25643-3 (CD; Ecology 2024) between Ecology, the City of Seattle (City), and Puget Sound Energy (PSE). The PRDI, remedial design, permitting, cleanup construction and post-construction monitoring activities are being completed under the CD pursuant to requirements of the Washington State Model Toxics Control Act (MTCA) (Chapter 70.105D of the Revised Code of Washington [RCW] and Chapter 173-340 of the Washington State Administrative Code [WAC]) and Sediment Management Standards (SMS) (Chapter 173-204 WAC).

1.1. General Site Description

The GWPS encompasses contamination associated with the former MGP and tar refinery, and other historical industrial activities (Figure 2). The former Manufactured Gas Plant (MGP) operated from 1907 to 1956. Gas Works Park opened between 1973 and 1976. Additional information on the history of the GWPS can be found in Section 1.0 of the Ecology-approved GWPS Remedial Investigation/Feasibility Study (RI/FS) (GeoEngineers 2023).

The GWPS contains both upland and sediment areas.

The upland area of the GWPS is approximately 21 acres and is located landward of the ordinary high-water mark (OHWM [1]). It includes Gas Works Park, part of Waterway 19, and the Seattle Police Harbor Patrol (Harbor Patrol) facility. The City owns the upland area, except for Waterway 19, which is owned by the State of Washington (State) and managed by the Washington State Department of Natural Resources (WDNR) (Figure 3). Contamination in most of the upland area was previously addressed through a variety of remedial actions including a cleanup action under Consent Decree—99-2-52532-9 (Ecology 1999). Additional information on previous actions to address contamination in the upland area can be found in Section 2.2 of the RI/FS.

The sediment area of the GWPS is approximately 56-acres and is located waterward of the OHWM. The sediment area incorporates most of the aquatic area of Waterway 19, all the aquatic area of Waterway 20 and the lake bottom adjacent to the Metro Lake Union (South Yard), Harbor Patrol, and Gas Works Park (Figure 2). The State owns most of the sediment area of the GWPS (Figure 3), except for the following:

- A small parcel in the western portion of the GWPS (Metro Lake Union [South Yard]) is owned by King County,
- Multiple, small parcels between Waterway 20 and Waterway 19 (Harbor Patrol and Gas Works Park) are owned by the City, and
- A small parcel in the eastern portion of the GWPS adjacent to Waterway 19 is owned by Gasworks Park Marina.

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[1] The OHWM is at an elevation of 22 feet USACE Locks Datum.

Gasworks Park Marina, the City, and Northlake Shipyard lease or have permits to use state-owned aquatic land (Figure 3):

- Gasworks Park Marina: Residents at the Marina lease three small parcels at the southern end of the marina property from WDNR (Lease Numbers 20-013648, 20-A79485, and 20-B12133).
- Harbor Patrol: Several overwater structures at Harbor Patrol are on state-owned aquatic property subject to a use permit and lease between the City and WDNR (Aquatic Waterway Use Permit No. 20-08991 and Lease No. 20-009624).
- Northlake Shipyard: Most of the Northlake Shipyard structures fall within four parcels owned by the state and leased from WDNR, three that are outside of the AOI and one that is within the AOI and waterward of the Metro South Yard (Lease No. 20-A12992). The remainder of the structures fall within the shipyard property boundary.

The remaining areas of the GWPS requiring cleanup include a small area of uncapped contaminated shoreline bank soil, an area of shoreline arsenic-impacted groundwater, and the sediment area. These areas comprise the Settlement Area defined in the CD, and identified in Figure 3, which will be addressed by the Ecology-selected cleanup described in the CAP. The PRDI field activities will take place within the Settlement Area except for the air and soil vapor sampling discussed in Section 3.0 and some of the upland groundwater sampling discussed in Section 4.0. In addition, as noted in Section 14, the topographic and bathymetric surveys will extend approximately 50 feet beyond the Settlement Area boundary.

1.2. Relationship to Adjacent MTCA Cleanup Sites

Several MTCA cleanup sites are in the general vicinity of the GWPS as shown in Figure 4 and described below.

1.2.1. Northlake Shipyard

The Northlake Shipyard is located north and west of the GWPS and has been operating since at least 1956. The shipyard entered into an agreement with the United States Environmental Protection Agency (EPA) to clean up the site and this agreement was later transferred to Ecology. The shipyard funded a trust allowing the State to conduct an interim cleanup action. Ecology completed an interim action in early 2014 that included dredging 8,300 cubic yards of sandblast grit and contaminated sediment, removing 23 tons of scrap metal and 20 pilings, and backfilling the dredged area with clean sand. The footprint of the dredge area is shown in Figure 4. As noted in Section 7.2 of the RI/FS, no post-dredging data outside of the dredge footprint were collected to assess the extent, if any, of the dredging impacts to the surrounding area. The construction completion report (Hart Crowser 2014) noted releases during dredging and that not all sediment contamination within the shipyard was removed as part of dredging.

1.2.2. Metro North and South Yards

West and northwest of the upland portion of the GWPS is the former Chevron Bulk Fueling Terminal that is comprised of two separate parcels referred to as the North and South Yards of the Metro Lake Union facility. The South Yard parcel is owned by King County and leased to the Center for Wooden Boats. The South Yard parcel borders the GWPS west of Waterway 20. Overwater structures associated with the historical activities at the South Yard are located within the sediment area of the GWPS. The former North Yard consisted of a tank farm that stored gasoline, gasoline distillates, fuel oil, refined oil, lubricating oils, and diesel oil until 1992 when Metro decommissioned the fueling equipment, including the aboveground tanks (Ecology

2023b). Although not immediately adjacent to the GWPS, subsurface fuel distribution pipes extended from the North Yard to the lakeshore and daylighted beneath fueling docks that are within the sediment portion of the GWPS. Separate cleanup actions were implemented in the former North and South Yards between 1988 and 2015 to address contaminated soil and groundwater. According to the Executive Summary, Draft Cleanup Action Plan for the Metro Lake Union facility (available on Ecology's Metro Lake Union project website), "subsurface product piping traversing the North and South Yards was cleaned and capped in 1992."

In April 2023 Ecology completed a periodic review of post-cleanup site conditions and monitoring data to ensure that human health and the environment are being protected (Ecology 2023b). The review yielded several conclusions, including, that groundwater should be monitored regularly until cleanup levels are met at the conditional point of compliance.

1.2.3. Former ATCO Facility

The former ATCO facility (referred to as Nortar Inc on Ecology's project website), which manufactured roofing products and formulated wood preservatives from 1956 to the late 1980s, was located immediately north of Gas Works Park on North Northlake Way (Figure 4). Nortar purchased the property in the 1990s and leased the property to several tenants (Equipoise Corporation 1999). Ecology added the site to the list of Hazardous Sites and Confirmed and Suspected Contaminated Sites in 1997 because soil and groundwater had been impacted by releases of petroleum hydrocarbons, pentachlorophenol, and polycyclic aromatic hydrocarbons (PAHs). The site was remediated under Consent Decree No. 99-2-09071-3SEA between Ecology and Triad Northlake LLC. Although the site does not border the shoreline, stormwater from the property is discharged within the GWPS to Lake Union through a municipal outfall located in Waterway 20.

1.2.4. Waterway 20

Ecology added the Waterway 20 upland area ("Waterway 20 Upland") to the list of Confirmed and Suspected Contaminated Sites in 2021 based on a soil investigation completed by the City of Seattle Department of Finance and Administrative Services (FAS) (Herrera 2016). Historical operations on the property are not known at this time. Carcinogenic PAHs (cPAHs) were detected in soil at concentrations greater than the MTCA Method A soil cleanup level of 0.1 mg/kg for unrestricted land use, but less than the MTCA Method A soil cleanup level of 2.0 milligrams per kilogram (mg/kg) for industrial properties.

FAS, as licensee (WDNR Aquatic Waterway User Permit No. 20-089981), completed a soil and groundwater investigation in 2023 with WDNR oversight (Herrera 2023). Lube oil and cPAHs were detected in soil at concentrations greater than the MTCA Method A soil cleanup levels for unrestricted land use and for industrial purposes. Lead was detected in soil at concentrations greater than the MTCA Method A cleanup level for unrestricted land use, but less than the MTCA Method A soil cleanup level for industrial purposes. No analytes were detected in groundwater at concentrations greater than the MTCA Method A groundwater cleanup levels.

1.3. Ecology-Selected GWPS Cleanup Action Summary

The Ecology-selected GWPS cleanup action is described in detail in the CAP and summarized in Figure 5. The cleanup action includes the following elements:

- Treat dissolved arsenic in shoreline groundwater associated with thioarsenate sources to the extent feasible, using in-situ treatment and monitor groundwater to evaluate long-term conditions (GWMA-1).
- Excavate the exposed tar mound in the northeast shoreline (Sediment Management Area-1 [SMA-1]).
- Excavate, grade, and cap (permeable vegetated) upland soil as needed to match the adjacent sediment excavation, to cap uncapped shoreline bank soil, and to integrate respective cap surfaces (SMA-1 and SMA-2).
- Excavate sediment to the extent feasible to reduce mass of contaminants from within the cap limits and prevent loss of aquatic lands due to cap placement. Excavation will be accomplished in the dry using land-based methods and a cofferdam system to separate the excavation from surrounding surface water (SMA-3 and SMA-4).
- Dredge shallow sediment using mechanical or hydraulic methods where necessary and feasible prior to capping to avoid shallowing water depths (SMA 5 and SMA-10).
- Install an enhanced cap (low-permeability multi-layer cap) to contain contaminated sediment and to direct groundwater discharge away from nearshore sediment containing higher concentrations of contaminants and non-aqueous phase liquid (NAPL) (majority of SMA-3 and SMA-4, and all of SMA-5).
- Place an enhanced cap (amended sand cap) to provide attenuation of contaminants where increased groundwater discharge and mass flux is anticipated at the toe of the low permeability- caps and in areas where there is shallow NAPL (SMA-7 and SMA-9).
- Place a thick sand cap (minimum of 3 feet thick, plus armor) to contain shallow NAPL and to increase attenuation (SMA-8 and SMA-12).
- Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels (SMA-3, SMA-4, SMA-6, SMA-10, and SMA-11).
- Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels in limited portions of SMAs that do not require an enhanced cap (SMA-7 and SMA-9) or that do not require a thick sand cap (portion SMA-12).
- Place a thin sand enhanced natural recovery (ENR) layer to accelerate natural recovery (SMA-13).
- Monitor sediment to assess natural recovery (SMA-14).

The GWPS cleanup action also includes:

- Disposing of excavated/dredged material off-site at a permitted disposal facility.
- Restoring shoreline habitat to existing conditions.
- Completing a pre-design investigation to collect supplemental data that will be used to refine the design of the cleanup action.
- Applying institutional controls.
- Completing storm drain modifications, where necessary to prevent infiltration of contaminated soil from the GWPS.
- Performing long-term monitoring and maintenance.

2.0 PRDI OVERVIEW

Activities that will be completed as part of the PRDI are described in summary below and the details for each of the PRDI activities are presented in Sections 3 through 15. Table 1 presents a summary of the proposed sampling activities and the objectives associated with each sample type. Table 2 presents the rationale for the selection of the analytes for each sample type. Proposed sample locations are shown in Figures 6 through 12.

Detailed descriptions of the field and laboratory testing procedures supporting the various PRDI activities are presented in the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) provided in Appendix A. A Health and Safety Plan (HASP) is provided in Appendix B. Detailed descriptions of geotechnical field and laboratory testing procedures are provided in Appendix C. The Inadvertent Discovery Plan (IDP) is presented in Appendix D.

2.1. Air and Soil Vapor Sampling

Indoor and outdoor air sampling will be completed at the previously established sampling locations in addition to new sub-slab and outdoor air sampling locations at the Harbor Patrol Building. Four (4) indoor air, six (6) outdoor air, and four (4) sub-slab soil vapor samples will be collected for chemical analyses using 1- or 6-liter Summa canisters at the locations shown on Figure 6. The air and vapor sampling data will be used to confirm the risk evaluation conclusions of the Remedial Investigation/Feasibility Study (RI/FS). Further details on the purpose and execution of proposed air and soil vapor sampling are presented in Section 3.0.

2.2. Upland Groundwater Sampling

Upland groundwater sampling will be completed at existing and new monitoring wells to be installed downgradient of existing shoreline wells (Figure 7A). Six soil samples will be collected from the soil borings for the three (3) new monitoring wells, 2 from each soil boring, for chemical analyses. Forty-seven (47)[2] groundwater samples will be collected for chemical analyses using low-flow sampling techniques at 40 existing and three (3) new monitoring well locations shown using blue and green symbols on Figure 7A. Six (6) groundwater samples will be collected for chemical analyses of arsenic speciation from monitoring well pairs MW-49D/AW-49D, MW-50D/AW-50D, MW-52D/AW-52D. Figure 7B is a typical cross-section showing an existing monitoring well and its paired, new angled monitoring well. The upland groundwater data will be used to: confirm and update groundwater chemical concentrations; characterize the extent of thioarsenate impacts downgradient of the existing shoreline wells within GWMA-1 for design of the groundwater treatment; and evaluate groundwater flow pathways for sediment cap modelling. Further details on the proposed upland groundwater sampling are presented in Section 4.0.

2.3. Shoreline Soil Sampling (SMA-1 and SMA-2)

Shoreline soil samples will be collected from within the proposed upland excavation areas in SMA-1 and SMA-2 to characterize the excavation materials for offsite disposal. Fifteen (15) soil samples will be

[2] Monitoring wells MLS-6 and MLS-7 are multi-level sampler (MLS) wells. Three samples will be collected from each well (see Appendix A, Table A-1a for the screen interval depths for each sample).

collected for chemical analyses using hand augers at the locations shown on Figures 8A and 8B. Further details on the proposed shoreline soil sampling are presented in Section 5.0.

2.4. Storm Drain Inspection

The GWPS storm drain system (underground pipes, catch basins and outfalls) includes outfalls that discharge to the Settlement Area from the park and Harbor Patrol as well as outfalls in Waterway 19 and Waterway 20 that capture stormwater from the upland portion of the GWPS and off-property areas. The CAP requires the completion of storm drain modifications, where necessary, to prevent infiltration and discharge of contaminated soil from the GWPS. As part of the PRDI, the City will inspect the storm drains at the GWPS to evaluate if there are open gaps or cracks within the pipes that would allow subsurface soil to enter the drain system.

2.5. Sediment and Offshore Groundwater[3] Characterization (SMA-3 through SMA-5)

Subsurface sediment sampling will be completed within and at the base of the proposed dredge prism within SMA-3, SMA-4, and SMA-5. Subsurface offshore groundwater will also be collected at the base of the dredge prisms (Figure 9A). Forty-four (44) subsurface sediment samples will be collected for chemical analyses using vibracore methods at the 22 locations shown on Figures 9B and 9C. Seventeen (17) subsurface offshore groundwater samples will be collected for chemical analyses using temporary piezometers and low-flow sampling techniques at the locations shown on Figures 9B and 9C. If offshore groundwater samples cannot be collected from the temporary piezometers due to inadequate volume recovery, offshore groundwater samples will be obtained by collecting sediment using vibracore methods and extracting offshore groundwater from the sediment using centrifuge techniques. Centrifuging will be completed by EcoAnalysts as necessary using their standard operating procedures. The sediment and offshore groundwater data will be used to: evaluate groundwater flow pathways, refine the delineation of NAPL in dredging areas, document conditions of sediment left in place following dredging, define the extent of enhanced caps and cap amendment materials, establish a baseline for cap modeling, characterize planned dredged material for offsite disposal, and support the coastal engineering evaluation.

Further details on the proposed sediment and offshore groundwater sampling in SMAs 3 through 5 are presented in Section 7.0.

2.6. Sediment and Offshore Groundwater Characterization (SMAs 6 through SMA 12)

Near surface sediment (0 to 1 feet below mudline [bml]) and offshore groundwater sampling (0.5 to 1.5 feet bml) and near surface NAPL field screening (0 to 1-foot bml) will be completed within SMA-6 through SMA-12 at the locations shown on Figures 9B, 9C, and 9D. Forty-two (42) near surface sediment samples will be collected for chemical analyses and for visual screening of dense non-aqueous phase liquid (DNAPL) using power-grab methods (piston sampler or vibracore methods will be used if the power grab methods are not successful). Nineteen (19) near surface offshore groundwater samples will be collected for chemical analyses using temporary piezometers and low-flow sampling techniques. If the temporary piezometers are not successful, offshore groundwater samples will be obtained by collecting sediment as described above and extracting offshore groundwater from the sediment using centrifuge techniques. Twenty-four (24) near

[3] Offshore groundwater is defined as groundwater waterward of the OHWM and extending to the base of the biologically active zone (top 10 centimeters [cm] of sediment). In accordance with Ecology guidance, water within the biologically active zone is porewater.

surface sediment samples will be collected for visual screening of DNAPL only (no chemical analyses) using power-grab methods. The near surface sediment, offshore groundwater, and DNAPL visual screening samples will be used to: evaluate groundwater flow pathways, evaluate the absence or presence of NAPL in near surface sediment, document conditions of sediment that will be capped, define the extent of enhanced caps and cap amendment materials, define the extent of thick sand caps, establish a baseline for cap modeling, and support coastal engineering evaluation.

Nine of the near surface offshore groundwater samples will be used for evaluation of background arsenic concentrations. These nine offshore groundwater samples will be collected at locations where surface sediment arsenic concentrations are representative of the preliminary regional background concentration of 24 mg/kg. Figure 10 shows the location of these nine near surface offshore groundwater samples and the sediment area where arsenic surface sediment concentrations (from samples collected between 1999 and 2005) are equal to or less than 24 mg/kg (see white or blue areas). The offshore groundwater arsenic data will be used to develop a site-specific natural background concentration.

Further details on the proposed sediment and offshore groundwater sampling in SMAs 6 through 12 are presented in Section 8.0.

2.7. Natural Recovery Evaluation (SMAs 13 and 14)

The natural recovery evaluation includes collecting surface sediment samples, sediment cores and comparison of the PRDI bathymetric survey to previous surveys completed at the GWPS. Forty-five (45) surface sediment samples (0 to 10 centimeters [cm] bml) will be collected for chemical analyses using power-grab methods at locations shown on Figure 9E for comparison to previous sampling results to evaluate the rate of chemical reduction over-time (piston sampler methods will be used if the power grab methods are not successful). Nine (9) sediment cores will be completed using vibracore methods at locations shown on Figure 11 to confirm sedimentation rate using depth to “gray marker bed.” The surface sediment sampling data, in addition to comparison of the bathymetric surveys and the sedimentation rate will be used to confirm the natural recovery conclusions in the RI/FS. Further details on the natural recovery sampling and evaluation are presented in Section 9.0.

2.8. Geotechnical Characterization (SMAs 3 through 14)

Subsurface sediment explorations, cone penetration tests (CPTs), and field vane sheer tests will be completed to characterize the geotechnical parameters at the site. A total of thirty-five explorations (35) consisting of a combination of 13 borings and 22 CPTs will be completed at 22 locations shown on Figure 12. The borings will be completed using mud rotary methods. Sediment and soil samples will be collected using a combination of standard penetration tests, Piston samplers, and Shelby tube samplers. Cone penetration tests will be completed using either truck-mounted or track-mounted rigs. In addition, field vane shear tests will be performed within soft sediment and lakebed deposit materials.

Representative soil and sediment samples will be selected and tested in the laboratory to obtain typical soil properties, e.g., density and plasticity, shear strength, consolidation/compression properties, and dynamic soil strength and stiffness properties. A project-specific laboratory testing program has been developed for the soft sediments to characterize their time rate and magnitude of sedimentation or settling under the proposed capping material thickness, and their bearing capacity to support the weight of the capping material during and post-construction.

Optionally, an in-water geophysical survey will be completed along multiple lines to characterize both the nearshore and offshore sediment conditions. The decision to complete the geophysical survey will be based on review and evaluation of the initial geotechnical data collected as part of the PRDI. The criteria that will be used to support the decision are described in Section 10.1. The proposed in-water geophysical survey may include two methods: electrical resistivity (ER) tomography and linear microtremor (LM), that complement each other to collect subsurface geophysical property measurements via remote sensing techniques. Two-dimensional (2D) shear-wave velocity (Vs) profiles can be developed from the in-water geophysical survey, which can be used to distinguish different geological unit boundaries and be used as direct measures of soil stiffness. For situations such as when the slope stability factors of safety of the permanent slope configuration under seismic loading fail to meet the design criteria and slope deformation analysis is warranted, completing the geophysical survey will become critical to obtain direct measures of the soil stiffness.

The geotechnical characterization data will be used to: refine the characterization of sediment material types; evaluate construction techniques for capping and dredging, including protection of existing structures; evaluate slope stability for dredge cuts and sediment caps; and evaluate seismic stability of sediment caps. Further details on the proposed geotechnical characterization are presented in Section 10.0.

2.9. Inventory and Assessment of Existing Structures

A conditions assessment will be completed within the settlement area (Figure 5) to record the existing structures that are located near and within the cleanup footprint and will include a review of existing as built and design drawings, as available. The inventory and assessment of existing structures data will be used to evaluate construction and protection techniques for capping and dredging in the vicinity of existing structures. Further details on the proposed inventory and assessment of existing structures are presented in Section 12.0.

2.10. Coastal Engineering Evaluation

The coastal engineering evaluation will include an analysis of coastal and morphologic processes including scour potential on the proposed cap surfaces and development of concept-level recommendations for stable material sizing for the nearshore sediment cap. Further details on the proposed coastal engineering evaluation are presented in Section 13.0.

2.11. Topographic and Bathymetric Surveys

Topographic and bathymetric surveys will be completed within and will extend up to 50 feet beyond the settlement area (Figure 5). The topographic and bathymetric survey data will be used to: establish the pre-construction condition for design and volumetric calculations; provide comparative data for the evaluation of natural recovery; provide surface elevations for the coastal engineering evaluation and define elevations for the shoreline habitat survey. Further details on the proposed topographic and bathymetric surveys are presented in Section 14.0.

2.12. Nearshore Habitat Survey

A shoreline habitat survey will be completed within the settlement area (Figure 5) by reviewing existing data and completing a field reconnaissance. The habitat survey would cover the lake bottom, lake slope, lakeshore, and riparian habitat areas. The nearshore habitat survey data will be used to document shoreline and shallow lake habitat conditions and to provide a basis to evaluate the potential habitat impacts of the cleanup action. Further details on the proposed nearshore habitat survey are presented in Section 15.0.

3.0 AIR AND SOIL VAPOR SAMPLING

Air and soil vapor sampling are needed to provide updated data that will be used to confirm the conclusions of the RI/FS. Indoor and outdoor air samples were previously collected during three rounds of sampling in 2007 and 2008 to characterize the air quality at several locations and during multiple seasons. Indoor air samples were collected in the Harbor Patrol building and the Play Barn Basement; outdoor air samples were collected at the Prow, the Cracking Tower, and along the East Shoreline (Figure 6). The results from the 2007 and 2008 air sampling were evaluated as part of the GWPS RI/FS (see RI/FS Appendix 4D). The indoor and outdoor air risk evaluation concluded that the air concentrations detected "are unlikely to pose an unacceptable risk to park users, Harbor Patrol workers, and park workers that access the Play Barn basement."

New indoor and outdoor air samples will be collected at the same locations sampled in 2007/2008, except for the Play Barn Basement, due to the age of the existing data to obtain data representative of current conditions. Additionally, new sub-slab soil vapor and building-specific outdoor air samples will be collected at the Harbor Patrol building. The City considers the Play Barn Basement a confined space and park workers are not allowed access to the basement without Hazardous Materials and Confined Space Training. Because there is no potential exposure, an indoor air sample will not be collected in the Play Barn Basement.

The results from the PRDI air and soil vapor samples will be used to confirm the air risk evaluation presented in RI/FS Appendix 4D by comparing the resulting data to the screening levels discussed below.

3.1. Indoor and Outdoor Air and Soil Vapor Sampling and Analysis

The Harbor Patrol facility includes two buildings. For this Work Plan, these buildings are referred to as the Main Office and the Warehouse Buildings. In 2007/2008, the air quality in the Main Office Building was evaluated using indoor air samples collected from within the building. Ecology's vapor intrusion guidance recommends collecting sub-slab soil vapor samples and building-specific outdoor air samples to help evaluate the source of any contaminants detected indoors (Ecology 2022). Sub-slab soil vapor samples and building-specific outdoor air samples were not collected in 2007/2008.

To confirm the previous sampling results and to acquire data recommended by Ecology's 2022 vapor intrusion guidance, indoor air, outdoor air, and sub-slab soil vapor samples will be collected in or around the Main Office Building and the Warehouse Building at the following locations and as shown on Figure 6:

- Indoor Air Samples will be collected at four locations, two in each building. Main Office Building indoor air samples will be positioned in the common use areas of the building (i.e., the classroom and the women's locker room). Samples in the Warehouse Building will be collected from locations in the middle of the south side of the building and office space on the north side of the building.
- Outdoor air samples will be collected near the air intake for the HVAC units that directs indoor air into the Main Office Building and in the upwind direction of the Warehouse Building. The outdoor air sample location upwind of the Warehouse Building (HA-OA-2) will be determined on the day of sampling based on the prevailing wind direction.

- Sub-Slab Soil Vapor Samples will be collected at four uncarpeted locations, two in each building. The sub-slab soil vapor samples will each be co-located with an indoor air sample. Main Office Building sub-slab soil vapor samples will target the evidence storage room (adjacent to the classroom) and the women's locker room. Sample locations in the Warehouse Building will be in the middle of the south side of the building and office space on the north side of the building.

Consistent with Ecology's vapor intrusion guidance, the indoor air concentrations will be adjusted by subtracting building-specific outdoor air concentrations from indoor air concentrations. Adjusted indoor air and sub-slab soil vapor results will be compared to MTCA commercial worker screening levels (Ecology 2023c).

A building survey will be completed prior to sampling. The purpose of the survey is to obtain data that will allow a qualitative assessment of factors that potentially could influence air quality. The physical survey includes collecting data on aspects of the building configuration such as building layout, utility entrances into the building, HVAC system design (if present), foundation conditions, building material types (e.g., recent carpeting/linoleum and/or painting), and other building configuration aspects that could influence sample data. The building survey also includes collecting data related to products used in the building and indoor storage of chemicals, paints, petroleum hydrocarbon products, or other potential sources of volatile contaminants. The results of the building survey will be used to adjust sampling locations as necessary. The building survey will be documented by completing the Building Survey Form in Appendix A.

Indoor and building-specific outdoor air samples will be collected over an 8-hour period using evacuated 6-liter Summa canisters. The sample intakes will be situated approximately 3 to 5 feet aboveground to collect samples representative of the breathing zone for building occupants. Sub-slab soil vapor samples will be collected using Vapor Pin™ sampling devices using evacuated 1-liter Summa canisters.

Air and soil vapor samples will be submitted to Friedman and Bruya, Inc. in Seattle, Washington (an Ecology-accredited laboratory) for chemical analysis of benzene, toluene, ethylbenzene, and total xylenes (BTEX), naphthalene, and petroleum hydrocarbons (C5-C8 aliphatics, C9-C12 aliphatics and C9-C10 aromatics). Soil vapor samples will also be analyzed for chemical analysis of helium[4].

Details on the sampling and analysis procedures for air and soil vapor are presented in the SAP/QAPP provided in Appendix A.

3.2. Gas Works Park - Outdoor Air Sampling and Analysis

Three outdoor air samples (Prow, Cracking Tower, and East Shoreline) will be collected within Gas Works Park at the same locations that were sampled in 2007/2008 (Figure 6). An additional outdoor air sample (Parking Lot; PL-OA-1) will be collected in the parking lot at the north side of Gas Works Park. The location of sample PL-OA-1 may be adjusted to account for wind direction on the day of sampling. Outdoor air sample results will be compared to site-specific park user air screening levels developed in the GWPS RI/FS.

[4] Following Ecology's vapor intrusion guidance, helium is used to make sure the Vapor Pin sampling devices are adequately sealed. During sampling, a shroud filled with helium is placed around the entire sub-slab soil vapor sample train. Helium detected in the soil vapor samples indicates that indoor air may have entered the sample (See Appendix A, Attachment A-2 for more details).

Outdoor air samples will be collected over an 8-hour period using evacuated 6-liter Summa canisters. The sample intakes will be situated approximately 3 to 5 feet aboveground to collect samples representative of the breathing zone for park users.

Air and soil vapor samples will be submitted to Friedman and Bruya, Inc. in Seattle, Washington (an Ecology-accredited laboratory) for chemical analysis of BTEX, naphthalene, and petroleum hydrocarbons (C5-C8 aliphatics, C9-C12 aliphatics and C9-C10 aromatics).

Sampling and analysis procedures for air and soil vapor are presented in greater detail in the SAP/QAPP provided in Appendix A.

4.0 UPLAND GROUNDWATER SAMPLING

Upland groundwater sampling will include two tasks. The first is an inspection of the monitoring well network and well gauging. The inspection and gauging task will include all the monitoring wells shown on Figure 7A (wells shown with blue, green, and magenta symbols). The second task is the collection of groundwater samples from the monitoring wells shown on Figure 7A with blue (existing wells) and green (proposed angled monitoring wells) symbols.

Upland groundwater samples will be collected from monitoring wells that are located along the shoreline of Gas Works Park and the adjacent Harbor Patrol facility (Figures 7A) to update contaminant concentrations in groundwater at the GWPS and provide upland groundwater data near the shoreline of Lake Union to compare with offshore groundwater data collected along the groundwater flow path to evaluate the fate and transport of groundwater contaminants. Groundwater sampling will be conducted in the area within and downgradient of the Play Area, where an arsenic groundwater treatment interim action was conducted between 2017 and 2020, to evaluate current conditions that will inform the design of additional arsenic treatment in groundwater during the cleanup action. Outside of the Play Area, the shoreline groundwater wells were last sampled in October 2013. Within the Play Area, the groundwater wells were last sampled in December 2020.

The new groundwater data will be used to update the conceptual site model for the upland groundwater to surface water/sediment pathway. Updated shoreline groundwater conditions will be used as a baseline for the evaluation of the groundwater flow pathways, which will inform the design of the sediment caps. To evaluate the groundwater flow pathways, shoreline groundwater concentrations will be evaluated in conjunction with downgradient sediment and offshore groundwater concentrations (discussed in Section 7.0) to evaluate the effect of the upland groundwater on sediments and the effect of sediments on offshore groundwater and surface water at the conditional point of compliance.

The new groundwater data, including data from new shoreline monitoring wells, will also be used for the design of dissolved arsenic treatment near the Play Area that is included in the cleanup action.

Upland groundwater data will be compared to groundwater cleanup levels from the CAP.

4.1. New Angled Monitoring Wells

Additional groundwater monitoring wells are needed along the shoreline downgradient of existing shoreline wells MW-49D, MW-50D, and MW-52D to evaluate dissolved arsenic concentrations in outwash unit groundwater as far as possible downgradient of the existing wells. The new angled monitoring wells

(AW-49D, AW-50D, and AW-52D) will be paired with existing wells (MW-49D, MW-50D, and MW-52D). To complete the new angled monitoring wells with screened sections downgradient of their respective paired existing shoreline wells, the wells will be constructed with angled borings that allow the surface completion of each well to be in the upland and the screened section to be located as far offshore as possible.

The new angled monitoring wells will be used to:

- Characterize arsenic concentrations in outwash groundwater downgradient of the three existing shoreline outwash unit wells with the highest arsenic concentrations.
- Evaluate the fate and transport of arsenic in the outwash unit.

New angled monitoring wells AW-49D, AW-50D, and AW-52D will be installed adjacent to existing monitoring wells MW-49D, MW-50D, and MW-52D, respectively as shown on Figure 7a. The 5- or 10-foot well screens in the angled wells will be at approximately the same elevation as the well screens in the respective paired shoreline outwash unit monitoring wells, but downgradient of the existing wells, as far away from the OHWM under Lake Union as possible. Figure 7B is a typical cross-section showing an existing well and its paired, new angled well.

The soil borings for the new angled monitoring wells will be completed using sonic drilling equipment. Soil borings will be logged, sampled, and field screened in accordance with Appendix A – SAP/QAPP. Soil data are needed from the three soil borings to evaluate the groundwater flow pathways. Two soil samples will be collected from each soil boring. One sample will be collected within the outwash unit at the same approximate elevations where each well will be screened. The second sample will be collected within the fill unit at a depth approximately five feet above the outwash unit. Soil samples will be submitted to ARI for chemical analysis of PAHs and arsenic.

The new angled wells will be installed to depths and screen intervals identified in Appendix A. Following completion of well installation and development for the three new wells, groundwater samples will be obtained from the three new angled monitoring wells as part of the shoreline well groundwater sampling events described below (Section 4.2).

4.2. Groundwater Sampling and Analysis

Two groundwater sampling events will be completed as part of the PRDI to provide an assessment of current conditions, and to evaluate spatial and temporal contaminant concentration trends. Groundwater sampling as part of the 2013 Supplemental Site Investigation was conducted in April and October 2013 (RI/FS Appendix 2A). Therefore, for data compatibility purposes, PRDI groundwater sampling will be conducted in April and October 2024.

Since many of the existing wells at the GWPS have not been sampled for up to 10 years, the existing shoreline and select Play Area wells shown on Figure 7A with blue symbols will be re-developed to remove solids that may have accumulated in monitoring wells. Both the existing and new monitoring wells will be developed prior to the first groundwater monitoring event in accordance with procedures described in Appendix A.

Prior to collecting groundwater samples, the GWPS monitoring well network, which includes all the monitoring wells shown on Figure 7A, will be inspected and gauged[5]. Well gauging will consist of obtaining water level and total depth measurements, evaluating the presence of NAPL in wells where NAPL has previously been noted and measuring the thickness of NAPL if encountered. The NAPL measurements will be used to adjust the water levels in the wells where NAPL is present.

After completing groundwater level measurements, forty-seven (47)[6] groundwater samples will be collected from the 40 existing and three new monitoring well monitoring wells (shown as blue and green symbols on Figure 7A) using standard low-flow sampling methods following purging. Field parameters will be measured during sample collection that include dissolved oxygen; oxidation/reduction potential (ORP); specific conductance; turbidity; temperature; and pH.

Additional groundwater samples will be collected from the three Play Area shoreline well pairs (each pair consists of an existing well and a new, angled well): MW-49D/AW-49D, MW-50D/AW-50D, and MW-52D/AW-52D for arsenic speciation analysis to evaluate the dominant forms of arsenic in groundwater near the Play Area, including determining if a significant fraction of dissolved arsenic remains as thioarsenate, the original form of arsenic released from the Thylox process. These samples will be collected using the anoxic field sample technique presented in Appendix A, Attachment 1.

The groundwater samples will be collected using standard low-flow sampling methods. Groundwater samples will be submitted to Analytical Resources (ARI) of Tukwila, Washington (an Ecology-accredited laboratory) for chemical analysis including benzene, ethylbenzene, toluene, naphthalene, cPAHs, and arsenic. The groundwater samples collected for arsenic speciation will be submitted to Brooks Applied Labs in Bothell, Washington (an Ecology-accredited laboratory) for chemical analysis using Method BAL-4100 for determination of arsenic species.

Procedures for well development, well gauging, and groundwater sample collection are described in the SAP/QAPP presented in Appendix A.

5.0 SHORELINE SOIL SAMPLING (SMA-1 AND SMA-2)

Soil data are needed at SMA-1 and SMA-2 to characterize the materials along the shoreline that will be excavated and disposed of offsite as part of the nearshore dredging. Waste disposal characterization soil samples will be collected from the surface to the approximate base of the planned excavation (0 to 3 feet bgs) at the 15 locations (HA-1 through HA-15 shown on Figures 8A and 8B using hand auger borings. Foreign material including debris, rocks and grass will not be sampled. Soil samples will be submitted to ARI for chemical analysis of the following landfill waste characterization parameters: Resource Conservation and Recovery Act (RCRA) metals, BTEX, diesel- and oil-range petroleum hydrocarbons, and PAHs.

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[5] Because of how they are constructed, gauging cannot be completed at the multi-level sampler (MLS) wells (MLS-6 and MLS-7).

[6] Monitoring wells MLS-6 and MLS-7 are multi-level sampler (MLS) wells. Three samples will be collected from each well (see Appendix A, Table A-1a for the screen interval depths for each sample).

Two additional hand auger borings (HA-2a and HA-2b) will be completed to visually delineate the west side of the tar mound. No samples will be collected from these two borings.

Soil sample data are also needed to document the concentrations that will remain following excavation. However, soil samples to document the concentrations remaining following excavation will not be collected during the PRDI and will be collected after the upland excavation construction is completed.

Procedures for shoreline soil sample collection are described in the SAP/QAPP presented in Appendix A.

6.0 STORM DRAIN INSPECTION

The GWPS storm drain system (underground pipes, catch basins and outfalls) includes outfalls that discharge to the Settlement Area from the park and Harbor Patrol as well as outfalls in Waterway 19 and Waterway 20 that capture stormwater from the upland portion of the GWPS and off-property areas. In accordance with the CAP, storm drains discharging to the Settlement Area will be modified, where necessary, to prevent infiltration and discharge of contaminated soil from the GWPS. Infiltration of contaminated soil or groundwater could occur through gaps or breaches of the underground pipes or other subsurface storm drain structures where the pipes are routed through contaminated GWPS soils. As part of the PRDI, the City will inspect the storm drains at the GWPS to determine if there are open gaps or cracks within the pipes that would allow subsurface soil to enter the drain system.

The storm drains will be inspected via video survey of the underground pipes and visual inspection of structures directly accessible from the ground surface. Much of the GWPS storm drain system was inspected during the RI/FS and some modifications of the system have already been made. The inspections completed as part of the PRDI will update the previous inspections. The City performs operations and maintenance of City storm drains as part of its storm water permit including periodic inspection of catch basins. The results of these storm drain inspections will also be considered as appropriate.

The storm drain system associated with the Play Area was redesigned and constructed during the Play Area renovation in 2018 to eliminate the potential for infiltration of GWPS soil. The new storm drain structures associated with the renovation will not be inspected as part of the PRDI.

Seattle Parks and Recreation is currently building a new comfort station at the park. Development of the new comfort station involves grading and modifications to the original drainage features in the area. Similar to the Play Area, the new storm drain system at the comfort station is expected to eliminate the potential for infiltration of GWPS soil and groundwater and, therefore, will not be inspected as part of the PRDI.

7.0 SEDIMENT AND OFFSHORE GROUNDWATER CHARACTERIZATION (SMA-3 THROUGH SMA-5)

Sediment and offshore groundwater data from SMA-3 through SMA-5 are needed for multiple purposes to support the cleanup design. SMA-3 through SMA-5 represent the areas of contaminated sediment that is located closest to the shoreline both at Gas Works Park and along the shoreline of adjacent properties. The proposed cleanup remedy within these SMAs includes varying degrees of sediment excavation and dredging and placement of multi-layer low-permeability sediment caps.

Generally, the objectives of sediment and offshore groundwater sampling in SMA-3 through SMA-5 are as follows:

- Characterize the presence or absence of NAPL in sediment within and below the planned dredge prism along the shoreline to establish current NAPL area limits and inform the design of dredging and/or capping design.
- Characterize sediment contaminant concentrations within the dredge prism along the shoreline to support the evaluation of disposal methods and volume of dredged sediment for disposal.
- Characterize contaminant concentrations in sediment and offshore groundwater that is located immediately below the dredge prism that is representative of sediment that will be exposed and capped. Samples collected below the dredge prism will represent the conditions along the flow path of groundwater originating from the upland. Data from these samples will be used to evaluate the condition of groundwater being discharged at the toe of the low-permeability caps and will be used as cap modeling input data, if needed.
- Eight of the co-located sediment and offshore groundwater samples collected from SMA-3 (PRDI-7 through PRDI-11) and SMA-4 (PRDI-15, PRDI-16, and PRDI-18) immediately below the dredge prism will be collected at locations downgradient of upland groundwater monitoring wells that will be sampled as described in Section 4.2. Data from the upland groundwater, offshore groundwater, and subsurface sediment samples will be used to evaluate the fate and transport of upland groundwater contaminants, with the goal of confirming the assumption that groundwater contaminants attenuate prior to reaching the mudline and/or that sediment impacts are a greater source to offshore groundwater concentrations than upland groundwater.

Table 1 presents a summary of the proposed sediment and offshore groundwater sampling activities in SMA-3 through SMA-5 and the objectives associated with each sample type. Table 2 presents the rationale for the selection of the analytes for each sample type.

Figure 7B shows a typical subsurface sediment and offshore groundwater location - a sediment sample will be collected within the dredge prism and co-located sediment and offshore groundwater samples will be collected at the base of the dredge prism.

Figure 9A is a summary of sediment and offshore groundwater sampling locations within the Settlement Area, including those in SMAs 3 through 5. Figure 9B focuses on SMA-3, SMA-7, and SMA-10; Figure 9C focuses on SMA-4, SMA-5, SMA-9, and SMA-12.

Within SMA-3 in the eastern portion of the Settlement Area, sediment samples will be collected at three locations (PRDI-1 through PRDI-3_ and co-located sediment and offshore groundwater will be collected at nine locations (PRDI-4 through PRDI-12) shown on Figure 9B. At locations PRDI-1 through PRDI-12, sediment samples will be collected from two intervals; one sediment sample will be collected from the interval representative of sediment planned to be dredged prior to capping (approximately 2 feet to 8 feet bml) and one sediment sample will be collected from the sediment interval located immediately below the base of the planned dredge prism (approximately 9 feet to 10 feet bml). The location-specific target depths and elevations of the sediment samples are presented in Table A-1 of the SAP/QAPP included as Appendix A.

Offshore groundwater samples are proposed to be collected at the sample locations within the portion of SMA-3 that will be addressed by enhanced capping methods (locations PRDI-4 through PRDI-12 on Figure 9B). At these locations, one offshore groundwater sample will be collected from the deeper sediment sampling interval that is located immediately below the planned dredge prism base. Five offshore groundwater sampling locations are positioned downgradient of existing monitoring wells to further evaluate the groundwater flow pathways. Offshore groundwater sampling locations PRDI-7, PRDI-8, PRDI-9, and PRDI-10 are positioned downgradient of the four monitoring wells with the highest arsenic groundwater concentrations along the shoreline (MW-52D, MW-50D, MW-36D, and MW-49D). In addition, location PRDI-11 is positioned downgradient of monitoring wells OBS-1; the compliance monitoring point for the AS/SVE that operated from 2001 in 2006.

Within SMA-4 in the western portion of the Settlement Area, sediment and offshore groundwater will be collected at the four locations (PRDI-13 through PRDI-16) shown on Figure 9C. Similar to the approach used in SMA-3, at each of the locations proposed within SMA-4, sediment samples will be collected from two intervals, within and immediately below the planned dredge prism, at depths and elevations listed in Table A-1 of the SAP/QAPP.

In addition to collection of sediment samples, each sample location within SMA-4 will also be sampled for offshore groundwater at the deeper sampling interval located immediately below the planned dredge prism base. Two offshore groundwater sampling locations are positioned downgradient of existing monitoring wells to further evaluate the groundwater flow pathways. Location PRDI-15 is positioned downgradient of monitoring wells MW-32S. Location PRDI-16 is positioned downgradient of monitoring well TDW-2, one of the wells on the western shoreline with the highest benzene groundwater concentrations.

At SMA-5, along the shoreline of upland properties outside Gas Works Park (adjacent to Harbor Patrol, Waterway 20 Upland, and Metro Lake Union (South Yard) – See Figure 4), sediment samples will be collected at two locations (PRDI-21 and PRDI-22) and co-located sediment and offshore groundwater samples will be collected at four locations (PRDI-17 through PRDI-20) shown on Figure 9C. At locations PRDI-17 through PRDI-22, sediment samples will be collected from two intervals located within and immediately below the planned dredge prism base. Due to the planned dredged depth in SMA-5 of approximately 3 feet below the existing mudline, the sample depths in this area will be relatively shallow compared to SMA-3 and SMA-4 and as a result, the waste characterization sample will be collected from the existing mudline down to 3 feet bml and the deeper samples representative of the base of the dredge prism will be collected from 3 feet to 4 feet bml.

At four of the SMA-5 sample locations shown on Figure 9C adjacent to the Harbor Patrol facility (PRDI-17 through PRDI-20), offshore groundwater will be collected from the same interval as the deeper sediment samples, approximately 3 to 4 feet bml. Location PRDI-18 is downgradient of monitoring wells MLW-7 and CMP-1, two of the wells on the western shoreline with the highest benzene, naphthalene, and arsenic groundwater concentrations, to help evaluate the groundwater flow pathways.

Sediment samples within SMA-3 through SMA-5 will be collected from a sampling vessel using vibracore methods. On retrieval, the sediment samples will be logged, and field screened for the presence of NAPL. Following core processing, the sediment samples collected from within the dredge prism for the purpose of waste characterization will be submitted to ARI for analysis of the following landfill waste characterization parameters: BTEX, RCRA metals, and sediment contaminants of concern (COCs) (see Table 3). Select sediment samples from the surface of the dredge prism also will be submitted to ARI for grain size analysis to characterize existing habitat conditions within the biologically active zone throughout the Settlement Area. The deeper samples collected from the sediment interval representative of the dredge prism base will be submitted to ARI and analyzed for benzene, ethylbenzene, toluene, PAHs, and arsenic. Select deeper sediment samples from SMA-3 through SMA-5 (see Table A-1 of the SAP/QAPP included as Appendix A) will be submitted to ARI for TOC and grain size analysis to help evaluate contaminant mobility.

Two of the sediment samples collected from SMA-3 (PRDI-8) and SMA-4 (PRDI-16) immediately below the dredge prism will be submitted to ARI for analysis of Total PCBs (Aroclors) and dioxins and furans to document the concentration of these ambient Lake Union (ALU) contaminants that will remain below the sediment caps. Dioxins and furans are included because they have not been previously evaluated and are likely present. They are considered an ALU contaminant because there are no known sources from the historical industrial activities at the GWPS but there are documented sources in other parts of Lake Union.

Offshore groundwater samples within SMA-3 through SMA-5 will be collected using temporary piezometers placed in the sediment from a sampling vessel. After placing the piezometer to the target sampling interval, groundwater will be collected using standard low-flow groundwater sampling methods. Field parameters will be measured and recorded during sample collection that include dissolved oxygen; ORP; specific conductance; turbidity; temperature; and pH. If the temporary piezometers are not successful, offshore groundwater samples will be obtained by collecting sediment as described above and extracting offshore groundwater from the sediment using centrifuge techniques. Offshore groundwater samples will be submitted to ARI and analyzed for benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic to evaluate cap amendment selection and performance. Groundwater collected from the three locations offshore of the Play Area (PRDI-8 through PRDI-10) will also be analyzed for arsenic speciation determination. The groundwater samples collected for arsenic speciation (PRDI-8 through PRDI-10) using the anoxic field sample technique will be submitted to Brooks Applied Labs for chemical analysis using Method BAL-4100.

Sediment and groundwater sample collection and analytical methods are described further in the SAP/QAPP, included as Appendix A of this Work Plan.

8.0 SEDIMENT AND OFFSHORE GROUNDWATER CHARACTERIZATION (SMA-6 THROUGH SMA-12)

Sediment and offshore groundwater data from SMA-6 through SMA-12 are needed for multiple purposes to support the cleanup design. The proposed remedy within these SMAs includes varying types of sediment capping, including conventional sand caps, thick sand caps, and enhanced caps containing amendments to attenuate contaminants within the caps. Within SMA-6 through SMA-12, sediment excavation or dredging is not planned, so the focus of investigation in these areas is on the condition of surface and near surface sediment and co-located offshore groundwater that will underly the caps.

8.1. Sampling Objectives, Locations, and Analyses

Generally, the objectives of sediment and offshore groundwater sampling in SMA-6 through SMA-12 are as follows:

- Characterize contaminant concentrations in near surface sediment and offshore groundwater (0 to 1 feet bml) located immediately offshore of the proposed low-permeability caps at SMA-3 through SMA-5, adjacent to SMA-7 and SMA-9. SMA-7 and SMA-9 will be subject to additional groundwater discharge at the toe of the adjacent low-permeability caps and will be addressed by installing amended sand caps. This data will be used to confirm the assumption in the existing cap model and/or as input data for additional cap modeling conducted during design.

- Evaluate the presence or absence of NAPL in near surface sediment (0 to 1 feet bml) at the edges of the current NAPL areas and corresponding proposed thick sand caps or amended cap types to confirm the extent of the proposed sand and amended sand caps.
- Characterize contaminant concentrations in near surface sediment (0 to 1 feet bml) in SMA-6 and SMA-11 to confirm assumptions regarding sediment contaminant concentrations made during the RI/FS and determine if adjacent areas of enhanced capping need to expand to include portions of SMA-6 or SMA-11.
- Characterize contaminant concentrations in surface sediment (0 to 10 cm bml) adjacent to the SMA-13 and SMA-14 boundaries to help estimate surface sediment concentrations near the boundary of the natural recovery area (SMA-13 and SMA-14). The natural recovery evaluation is discussed in Section 9.0.
- Use sediment and offshore groundwater data to evaluate the fate and transport of upland groundwater COCs and arsenic along the groundwater flow pathways in conjunction with the upland groundwater sampling discussed in Section 4.2 and offshore groundwater sampling discussed in Section 7.0. Sediment and offshore groundwater data, particularly in SMA-7 and SMA-9 where enhanced capping methods are proposed, will also be used to confirm the assumptions in the existing cap model and/or as input data for additional cap modeling conducted during design.
- Determine a site-specific arsenic offshore groundwater natural background concentration.

Table 1 presents a summary of the proposed sediment and offshore groundwater sampling activities in SMA-3 through SMA-5 and the objectives associated with each sample type. Table 2 presents the rationale for the selection of the analytes for each sample type.

Figure 7B shows typical near surface sediment and offshore groundwater locations - co-located sediment and offshore groundwater samples will be collected below the mudline.

Figure 9A is a summary of sediment and offshore groundwater sampling locations within the Settlement Area, including those in SMAs 6 through 12. Figure 9B focuses on SMA-3, SMA-7, and SMA-10; Figure 9C focuses on SMA-4, SMA-5, SMA-9, and SMA-12; and Figure 9D focuses on SMA-6, SMA-8, and SMA-11.

At SMA-6, eight sample locations are proposed across the SMA (PRDI-42 through PRDI-46 and PRDI-107 through PRDI-109), to characterize sediment and offshore groundwater conditions near the shoreline, as shown on Figure 9D. The eight locations will include sampling the near surface sediment. Seven of the eight locations will also include sampling offshore groundwater.

Within SMA-7 in the eastern portion of the Settlement Area, sediment and offshore groundwater will be collected at 28 locations, as shown on Figure 9B. Eight of the proposed locations will be sampled for near surface sediment and offshore groundwater (PRDI-26, PRDI-27, PRDI-30, PRDI-31, PRDI-32, PRDI-33, PRDI-36, PRDI-37), seven of the proposed locations will be sampled for near surface sediment (PRDI-25. PRDI-28, PRDI-29, PRDI-34, PRDI-35, PRDI-38, and PRDI-39), 10 of the proposed locations will be sampled for near surface sediment NAPL field screening (DP-1 through DP-10), and three of the proposed locations at the outer edge of SMA-7 will be sampled for surface sediment (PRDI-63 through PRDI-65) to help estimate surface sediment concentrations near the boundary of the natural recovery area (SMA-13 and SMA-14).

Within SMA-8, two near surface sediment sample locations (DP-12 and DP-14) will be established to confirm the absence or presence of NAPL in near surface sediment. At these two locations no laboratory analyses will be completed. The results will be based on screening the sample material in the field.

Within SMA-9 in the western portion of the Settlement Area, sediment and offshore groundwater will be collected at 15 locations (PRDI-47 through PRDI-61), as shown on Figure 9C. The sampling within SMA-9 includes eight locations for near surface sediment and offshore groundwater sampling and an additional seven locations for near surface sediment sampling only.

At SMA-10, located within the footprint of the Gas Works Marina, three sample locations will be completed as shown on Figure 9B. Two locations adjacent to SMA-3 (PRDI-23 and PRDI-24) will consist of sampling only near surface sediment. One location that is positioned farther offshore near SMA-7 (PRDI-62) will consist of sampling surface sediment to support the confirmation of natural recovery evaluation discussed in Section 9.0.

At SMA-11, in the central portion of the Settlement Area, sediment and offshore groundwater will be collected at 11 locations as shown on Figure 9D. Sampling in SMA-11 includes two locations along the shoreline (PRDI-41 and PRDI-110) for near surface sediment and offshore groundwater sampling, one location adjacent to SMA-7 (PRDI-40) for near surface sediment, two locations adjacent to SMA-8 (DP-11 and DP-13) for near surface sediment field screening for NAPL, and six locations in the deeper areas of SMA-11 (PRDI-66 through PRDI-71) for surface sediment to support the confirmation of natural recovery evaluation discussed in Section 9.0.

At SMA-12, in the western portion of the of the Settlement Area, sediment samples will be collected at 15 locations, as shown on Figure 9C. This includes 10 locations for near surface sediment field screening for NAPL (DP-15 through DP-24), one location for near surface sediment sampling (PRDI-72), and five locations toward the outer limits of SMA-12 (PRDI-72 through PRDI-76) for surface sediment sampling and analysis to support the confirmation of natural recovery evaluation discussed in Section 9.0.

Sediment samples within SMA-6 through SMA-12 will be collected from a water-based vessel using power grab methods (piston sampler or vibracore methods will be used if the power grab methods are not successful). The sediment samples will be logged in the field, and field screened for the presence or absence of NAPL. Except for locations designated solely for NAPL field screening, near surface sediment samples will be submitted to ARI for analysis of benzene, ethylbenzene, toluene, PAHs, and arsenic. Surface sediment samples collected in SMA-7, SMA-10, SMA-11, and SMA-12 will be submitted to ARI for analysis of the bioaccumulation COCs (cPAHs, hexachlorobenzene, pentachlorophenol, Total PCBs (Aroclors), arsenic, chromium, and methylmercury). Select sediment samples from SMA-7 and SMA-9 (see Table A-1 of the SAP/QAPP included as Appendix A) will be submitted to ARI for TOC and grain size analysis to help evaluate contaminant mobility. Select sediment samples from SMA-6 through SMA-12 will be submitted to ARI for grain size analysis to characterize existing habitat conditions within the biologically active zone throughout the Settlement Area.

One sediment sample collected from SMA-9 (PRDI-56) will be submitted to ARI for analysis of Total PCBs (Aroclors) and dioxins and furans and three sediment samples from SMA-10 (PRDI-62), SMA-11 (PRDI-40), and SMA-12 (PRDI-72) will be submitted to ARI for analysis of dioxins and furans. The purpose of these samples is to document the concentration of these ALU contaminants that will remain below the sediment caps.

Offshore groundwater samples that are collected from within SMA-6 through SMA-11 will be collected using temporary piezometers placed in the sediment surface through the water column from a sampling vessel. After placing the piezometer, groundwater will be collected using standard low-flow groundwater sampling methods. Field parameters will be measured during sample collection that include dissolved oxygen; ORP; specific conductance; turbidity; temperature; and pH. If the temporary piezometers are not successful for collecting offshore groundwater samples, the offshore groundwater samples will be obtained by collecting sediment as described above and extracting offshore groundwater from the sediment using centrifuge techniques. Offshore groundwater will be submitted to ARI for analysis of benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic to evaluate cap amendment selection and performance. Offshore groundwater from the locations in SMA-6 through SMA-11 will also be analyzed for the remaining offshore groundwater COCs (see Table 3).

Sediment and offshore groundwater sample collection and analytical methods are described further in the SAP/QAPP, included as Appendix A of this Work Plan.

8.2. Arsenic Offshore Groundwater Natural Background Concentration

Offshore groundwater sampling and analysis for arsenic is needed to evaluate natural background concentrations. The RI/FS identified that the arsenic groundwater CUL of 8 micrograms per liter (µg/L) may not be achievable due to the high arsenic surface sediment and offshore groundwater concentrations present throughout Lake Union. As discussed in the Section 9.3.2 of RI/FS, the estimated offshore groundwater arsenic concentration is 32 µg/L[7]. Therefore, because the estimated offshore groundwater concentration is greater than the arsenic groundwater cleanup level, a site-specific arsenic natural background groundwater concentration will be developed using data from the samples described below.

Nine near surface offshore groundwater samples from SMA-6 and SMA-11 (PRDI-41, PRDI-43 through PRDI-46, and PRDI-107 through PRDI-110) will be collected and analyzed. The arsenic concentrations from the samples will be used to derive a site-specific arsenic natural background groundwater concentration.

Consistent with the RI/FS procedure used to calculate the preliminary regional background arsenic sediment concentration of 24 mg/kg (see RI/FS Appendix 4A), EPA's ProUCL statistical software (Version 5.2) will be used to calculate the 90/90 upper tolerance limit from the new sampling and analysis data for use as the site-specific arsenic natural background offshore groundwater concentration.

The arsenic natural background offshore groundwater sample locations are within the groundwater discharge zone/groundwater compliance area and in areas where surface sediment arsenic concentrations are similar to the preliminary regional background arsenic concentration of 24 mg/kg (see Figure 10).

[7] The estimated offshore groundwater arsenic concentration was calculated using the ambient Lake Union arsenic surface sediment concentration of 53 mg/kg and the site-specific arsenic Kd.

9.0 NATURAL RECOVERY CONFIRMATION EVALUATION (SMA-13 AND SMA-14)

Surface and subsurface sediment sampling is needed to confirm the conclusions of the natural recovery evaluation in the RI/FS. In addition to sediment sampling, evaluation of the bathymetric changes over time will be used to evaluate natural recovery. The RI/FS restoration timeframe evaluation showed that within SMA-13 and SMA-14 the GWPS COCs would achieve cleanup standards at the time of construction and ALU COCs would achieve screening levels within a reasonable restoration time frame. GWPS and ALU COCs are identified in Table 3. The RI/FS restoration timeframe evaluation was based on an evaluation of existing data from sediment samples that were collected between 1999 and 2005 and focused on SMA-13 and SMA-14, where ENR and monitored natural recovery (MNR) are the selected cleanup actions, respectively.

The RI/FS restoration timeframe evaluation was completed for benthic COCs in SMA-13 and bioaccumulative contact COCs in SMA-13 and SMA-14 (see RI/FS Appendix 13A). Benthic and bioaccumulative COCs are identified in Table 3.

The benthic restoration timeframe evaluation focused on the maximum detected surface sediment concentrations in SMA-13, adjusted to account for the placement of a 6-inch ENR clean sand layer. The ENR-adjusted maximum detected surface sediment concentrations from 2004/2005 were used to represent post-construction conditions and were compared to benthic GWPS COC cleanup levels and ALU COC screening levels.

The bioaccumulative restoration timeframe evaluation used surface-area-weighted average concentrations (SWACs) from individual SMAs to calculate SWACs for the in-water portion of the Settlement Area (SMAs 3 through 14) for comparison to the cleanup standards. The SWAC calculation considers the outcomes of each of the remedial technologies that will be applied (capping, ENR, and MNR). The SWACs were then compared to GWPS COC cleanup levels and ALU COC screening levels. The SWACs for the capped SMAs were set at the concentrations of the individual COCs representative of clean sand materials that would be used for the cleanup. The SWACs for SMA-13 and SMA-14 were calculated using surface sediment data from samples collected within these SMAs in 2004/2005. Like the benthic evaluation above, the SWACs for SMA-13 were adjusted to account for the placement of a six-inch ENR clean sand layer. For all COCs except cPAHs, the 2004/2005 sediment data were used to represent post-construction conditions in 2029. For cPAHs, initial SWACs for SMA-13 and SMA-14 were calculated using the 2004/2005 data, then the RI/FS natural recovery model (see RI/FS Appendix 11C) was used to estimate the 2029 post-construction cPAH conditions. The natural recovery model relied on several assumptions including the annual rate of chemical concentration reduction based on a comparison of five SWACs for the in-water portion of the Settlement Area calculated using cPAH surface sediment data collected in 1984/1985, 1995, 1999, 2002, and 2004/2005 and the sediment deposition rate as determined from evaluation of existing core sample logs. These two assumptions will be confirmed using data collected as part of the PRDI and are discussed in the following sections.

Additional data will be collected to confirm the conclusions of the RI/FS restoration timeframe evaluation, including:

- Collection and analysis of surface sediment samples to evaluate the rate of chemical concentration reduction by comparing COC concentrations to results from previous sampling events (discussed in Section 9.1). For benthic COCs, the comparison will use data from surface sediment samples collected at or near previous sampling locations in SMA-13. For bioaccumulative COCs, the comparison will use data from surface sediment samples collected in SMAs 7 and 10 through 14 to calculate SWACs in SMA-13 and SMA-14. The surface sediment samples in SMAs 7 and 10 through 12 will be collected near the boundaries of SMAs 13 and 14. The purpose of the samples in SMAs 7 and 10 through 12 is to inform the boundaries of SMAs 13 and 14 and to provide a better GIS interpolation of surface sediment results within SMAs 13 and 14.

- Collection and analysis of sediment cores to confirm the sedimentation rate based on the depth from the mudline to the “gray marker bed” (discussed further in Section 9.2). A gray marker bed was created during the initial flush of sediment from Lake Washington to Lake Union following completion of the Montlake Cut in 1916. The gray marker bed demarcates native sediment and early industrial impacts (below the marker bed) from later industrial impacts (above the marker bed). The depth from the mudline to the gray marker bed indicates how much sedimentation has occurred since 1916.
- Completion of a bathymetric survey, which will be compared to previous bathymetric surveys to determine changes in bottom elevations over time (discussed in Section 9.3). Details for the bathymetric survey to be completed as part of this PRDI are provided in Section 14.

Following completion of the PRDI, the surface sediment restoration timeframe will be reevaluated using the same approach that was used in the RI/FS.

Figure 9A is a summary of sediment and offshore groundwater sampling locations within the Settlement Area, including those in SMAs 13 and 14. Figure 9E focuses on SMA-7, SMA-10, and SMAs 11 through 14.

9.1. Surface Sediment Sampling and Analysis

Surface sediment samples (0 to 10 cm bml) will be collected at 45 locations for chemical analyses using power-grab methods at locations shown on Figure 9E (piston sampler methods will be used if the power grab methods are not successful). The primary focus of the surface sediment sampling is to characterize surface sediment in SMAs 13 and 14 (PRDI-77 through PRDI-106). However, surface sediment samples will also be collected in adjacent SMAs 7, 11, and 12 (PRDI-62 through PRDI-76) to provide additional spatial coverage to support the calculation of SWACs in SMAs 13 and 14.

The surface sediment sample locations in SMAs 13 and 14 were generally spread out evenly across each SMAs. However, five locations in SMA 13 are positioned at previously established sample locations where benthic COCs were detected at concentrations greater than benthic criteria (see Figure 9E). Because benthic COCs are evaluated for compliance based on a point-by-point basis, these locations were selected to see the changes in COC concentrations between 2005 and 2024.

Surface sediment will be submitted to ARI for chemical analysis. The surface sediment samples collected from SMA-13 will be analyzed for benthic[8] and bioaccumulation COCs[9]. The surface sediment samples from SMA-7, SMA-10, SMA-11, SMA-12, and SMA-13 will be analyzed for bioaccumulation COCs. All the surface sediment samples will be analyzed for GWPS COCs and select sediment samples will also be

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[8] Benthic COCs = sulfide, Total PAH, diesel-range hydrocarbons, 4-methylphenol, benzoic acid, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, di-n-butylphthalate, di-n-octylphthalate, phenol, 4,4’-DDE, Total PCBs (Aroclors), tributyltin, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and silver.

[9] Bioaccumulative COCs = cPAHs, hexachlorobenzene, pentachlorophenol, chlordane, Total PCBs (Aroclors), arsenic, chromium, and methylmercury.

analyzed for ALU COCs (see Appendix A, Table A-1a). GWPS, ALU, benthic, and bioaccumulative COCs are presented in Table 4.

Select surface sediment samples from SMA-7, SMA-11, SMA-12, and SMA-13 will be submitted to ARI for grain size analysis to characterize existing habitat conditions within the biologically active zone throughout the Settlement Area.

Four of the sediment samples collected from SMA-13 (PRDI-81) and SMA-14 (PRDI-90, PRDI-99, and PRDI-105) will be submitted to ARI for analysis of dioxins and furans to document the concentration of these ALU contaminants within the ENR and MNR areas.

The surface sediment sample results will be used to determine the rates of chemical concentration reduction between 2004/2005 and 2024 using different approaches for benthic and bioaccumulative COCs as follows:

- Benthic COCs: chemical concentration data from surface sediment samples collected at previously established sample locations (PRDI-77, -79, -80, -83, and -85) in SMA-13 will be compared to the previous results for these locations.
- For bioaccumulative COCs, chemical concentration data from surface sediment samples collected in SMAs 7 and 10 through 14 will be used to calculate SWACs in SMA-13 and SMA-14, which will be compared to SWACs calculated using chemical concentration data from surface sediment samples collected in 2004/2005.

9.2. Subsurface Sediment Cores

The proposed cleanup action in SMA-13 and SMA-14 relies on natural recovery of sediment that is partially due to sedimentation (burial beneath clean sediment). The natural recovery evaluation in RI/FS Appendix 13A utilized a sedimentation rate of 1 cm/year. This sedimentation rate was based on several previous studies completed between 1977 and 2005. Previous studies estimated sedimentation rates using sediment dating and by evaluating sediment accumulation above the buried gray marker bed that was deposited around 1916 following completion of the Montlake Cut, which connected Lake Washington to Lake Union. Locations used to estimate the sedimentation rate were generally limited to the central and eastern Lake Bottom zone. There were no locations in SMA-13.

Nine (9) sediment cores will be completed in SMA-13 and SMA-14 using vibracore methods to confirm the sedimentation rate based on the degree of sediment accumulation above the “gray marker bed” (C-1 through C-9). Sediment core locations are shown in Figure 11. Five of the six locations proposed for SMA-14 were sampled as part of the previous studies completed between 1977 and 2005 (C-1 through C-5).

The core samples will be evaluated using the same approach used in RI/FS Appendix 11C. The depth below mudline to the “gray marker bed” will be used to estimate the sediment deposition rate at the core location by measuring the sediment thickness above the marker layer and dividing it by the number of years since 1916. The individual core sample evaluations will be used to determine an average deposition rate across SMA-13 and SMA-14.

9.3. Bathymetry

The high-resolution, multibeam bathymetric survey to be completed for the PRDI (see Section 14) will be compared to previous high-resolution, multibeam bathymetric surveys completed in 2002 and 2006 to identify changes in the bottom elevations. This comparison will be used to generally identify areas where deposition is occurring, and the rate of deposition based on the time between the surveys that are being compared.

10.0 GEOTECHNICAL CHARACTERIZATION (SMA-3 THROUGH SMA-15)

The objective of the geotechnical field and laboratory testing program is to characterize the key soil units, i.e., fluid mud (also referred to as soft sediments), lakebed deposits, and glacial outwash materials, and develop baseline geotechnical design parameters for use in the engineering analyses to support the execution of the planned clean up actions that consist primarily of dredging, including cofferdam design, and capping.

In this section, for the purposes of the geotechnical investigation, the term soil or soils refers to the combination of fluid mud, lake deposits, and glacial outwash materials.

10.1. In-water Geophysical Testing (Optional)

An in-water geophysical survey can be performed along multiple lines to characterize both the nearshore and offshore soil conditions. The proposed geophysical survey will include two methods: electrical resistivity (ER) tomography and linear microtremor (LM). These methods complement each other to collect subsurface geophysical property measurements via remote sensing techniques. Two-dimensional (2D) shear-wave velocity (Vs) profiles will be developed from the geophysical survey, which will be used to distinguish different geological unit boundaries and be used as direct measures of soil stiffness for use in determining the seismic response of the site soils. Details about in-water geophysical testing equipment and procedures are presented in Appendix C.

The in-water geophysical survey is an optional task. The need to perform the geophysical survey will be evaluated after the initial geotechnical data are evaluated and if one of the following situations emerges. The situations include, but not limited to, 1) when soils at depth greater than 40 feet are identified to be potentially liquefiable and the potential liquefaction-induced deformation (e.g., settlement and lateral spreading) has significantly negative impact on the mitigation system; and 2) when the desired dredging depth or slope pose significantly negative impact on the existing structures and a soil-structure interaction analysis is warranted to optimize the dredging design or temporary shoring design.

10.2. Nearshore Geotechnical Condition Characterization

The anticipated cleanup actions in SMA-3 through SMA-6 include dredging and capping along and near the shoreline where the fluid mud material, also referred to as the very soft sediment, is not anticipated to be present. The key geotechnical engineering issues along the nearshore areas include the stability of the proposed dredged slope and consolidation settlement (both magnitude and time rate) of the materials underlying the caps.

10.2.1. Borings, CPTs, and Field Vane Shear Tests

Generally, field exploration will consist of performing standard penetration tests (SPTs) and field vane shear tests in the borings completed using a truck-mounted drill rig and completing CPTs using either a low-stress cone rig and/or a compensated shear rig. Both SPT and CPT rigs will be mounted on a floating barge that is large enough to provide sufficiently stable support for the drilling operations and has a moon pool through which the drill can be deployed.

Figure 12 shows the 22 proposed geotechnical exploration locations. CPT will be completed at all 22 locations. SPT will be completed at 13 of the 22 locations as shown in Figure 12. The 13 SPT locations were spatially distributed to cover the entire sediment area. Seven of the SPTs are along the shoreline, from which fill and glacial soil samples may be collected. Three SPTs are at locations with potentially thick fluid mud and lake deposits, from which high-quality undisturbed fluid mud and lake deposit samples may be collected. The other SPTs are at locations with moderately thick fluid mud and lake deposits. The goal is to collect fluid mud samples at all SPT locations where such material likely presents. This is because collecting fluid mud samples is challenging, and they are the critical material to support the project-specific sediment column testing (detailed in Section 10.3.5) to estimate post-capping shear strength.

CPTs are proposed at each location because CPT is considered to be able to better measure the in-situ strength of the fluid mud nearly continuously along the depth. In addition to the conventional CPTu penetrometer (with an end area of typically 15 cm^2), a second CPT is proposed at every location using the full-flow penetrometer, which is either a T-bar or a ball with an end area of 100 cm^2. The full-flow penetrometer is believed to be able to obtain more accurate measurements of very soft sediments (DeJong et al. 2011). There are however limited reliable correlations between full-flow penetrometer measurements and soil strength due to this penetrometer is still gaining its popularity. We, therefore. propose two CPT pushes at each location, one using a CPTu penetrometer and the other using the full-flow penetrometer.

In addition, CPTs and SPTs will be paired at adjacent locations so that the soil data collected can be cross-checked. Pairing CPTs and SPTs can also help reduce the barge mobilization time and make the geotechnical exploration more cost-effective.

For the SPTs, drilling will be performed using the mud rotary method. Alternating field vane shear tests and Piston or Shelby tube sampling of undisturbed soils will be completed in the lakebed deposits. Blow counts and disturbed soil samples using a split spoon sampler will be taken in the glacial outwash materials.

For the CPTs, the procedure presented in Appendix C will be followed. Piezocone penetrometers with the following features will be used: have fully compensated independent load cells for both the tip and sleeve, designed with equal end area friction sleeves and have a net end area ratio consistent with the current industry standard. These piezocone features are critical to obtain accurate sleeve friction data within fluid mud under water (Boggess and Robertson 2010). More details regarding CPT equipment and procedure are presented in Appendix C.

Several nearshore boring locations may have limited water depth (e.g., 2 feet or less) for barge access. In these areas a low-pressure buggy drill may be employed instead of a floating barge. The low-pressure buggy drilling work will be completed in accordance with the conditions of United States Army Corps of Engineers' (USACE's) permit. Given the offshore slope is relatively steep based on the bathymetry data, it is anticipated that a small amount (e.g., 100 ft or less) of location adjustment may be needed based on field conditions.

The exact location can be flexible, as long as it is not getting too close to the neighboring drilling locations and provides for a well-distributed soil dataset.

10.2.2. Subsurface Soil Samples

Soil samples will be collected at 2.5-foot intervals using Shelby tube samplers per ASTM D1587 within the lakebed deposits and then at 5-foot intervals using split spoon or Shelby tube samples below or within the glacial outwash materials. One Shelby tube sample of the undisturbed glacial outwash materials will be taken from each of the 13 SPT boreholes shown on Figure 12.

10.2.3. Laboratory Testing Program to Characterize Soil Shear Strength

The laboratory testing program will include testing representative samples from the field studies with a focus on index testing (e.g., grain-size distribution and hydrometer per ASTM D422, specific gravity per ASTM D854, and Atterberg limits per ASTM D4318) as well as direct simple shear tests (DSS) per ASTM D6528 and/or triaxial shear tests (per ASTM D2850, D4767, or USACE EM 1110-2-1906). This testing is used to characterize material types (i.e., USCS classification) and properties, such as density and strength to inform engineering design inputs that would be used in static and dynamic models of slope stability and deformation.

10.2.4. Laboratory Testing Program to Characterize Soil Consolidation Properties

Conventional consolidation laboratory tests per ASTM standard D2435 or D4186 and/or low-stress consolidation laboratory tests based on USACE EM 1110-2-5027 will be performed on representative samples of the lakebed deposits and/or glacial outwash materials to evaluate the time rate of settlement and strength increase due to soil consolidation to inform the design and construction of the sediment caps.

10.2.5. Laboratory Testing Program to Characterize Soil Liquefaction Susceptibility

Lake deposits and glacial outwash materials are potentially susceptible to liquefaction. Consolidated-undrained cyclic direct simple shear (CyDSS) testing per ASTM D8296 will be performed on representative samples for each unit (i.e., lakebed deposits and glacial outwash materials) to characterize the engineering properties of each unit under cyclic seismic loading.

10.3. Offshore Geotechnical Condition Characterization

The cleanup actions in SMA-7 through SMA-13 include capping within the lake slope and lake bottom areas where fluid mud is present (up to 20 feet of fluid mud). A limited amount of dredging may be conducted in SMA-10, if deemed necessary. The key geotechnical engineering issues within these areas potentially include the stability of the proposed dredged slope, consolidation settlement (regarding both magnitude and time rate) of the underlying soils under the capping materials, and the bearing capacity and compressibility of the fluid mud, which can result in potential losses and settlement of placed capping materials into the softer materials.

The key difference in geotechnical conditions at offshore locations compared to nearshore locations is the presence of fluid mud. This section focuses on the proposed exploration plan for characterizing the fluid mud. The exploration plan for characterizing the other soil units, i.e., lake deposits and glacial materials, remains the same as presented in Section 10.2.

10.3.1. Borings, CPTs and Field Vane Shear Tests

The offshore geotechnical field program also consists of performing SPTs and field vane shear tests in the borings and completing cone penetration tests (CPTs) using the same rigs and barge as presented in Section 10.2.

The same CPT and SPT equipment and procedures as presented in Section 10.2 will be used. For the fluid mud, alternating field vane shear tests and Piston sampling of soils will be performed as continuously as practically feasible. If the Piston Sampler method fails to collect fluid mud samples after three consecutive attempts, then the contingency plan is to decrease the spacing between locations for the field vane shear tests.

10.3.2. Subsurface Soil Samples

Soil samples will be collected as continuously as practicable within the fluid mud or for the top 10 feet using Piston sampling (also known as Osterberg sampling) per ASTM D6519. The same sampling procedure described in Section 10.2.2 will be followed within the lakebed deposits and the glacial outwash materials.

10.3.3. Laboratory Testing Program to Characterize Soil Shear Strength

The same laboratory testing described in Section 10.2.3 will be completed for the fluid mud materials. It is anticipated that 20 to 30 tests will be completed for each of the index testing parameters, including grain-size distribution and hydrometer, specific gravity, and Atterberg limits, and 20 to 30 of either DSS or unconsolidated undrained tests collectively for the nearshore and offshore locations.

10.3.4. Laboratory Testing Program to Characterize Soil Consolidation Properties of Lakebed Deposits and Stiffer Materials

The same consolidation laboratory tests described in Section 10.2.4 will be performed on representative soil samples of the lakebed deposits and/or glacial outwash materials. It is anticipated that 10 to 15 consolidation tests will be completed collectively for the nearshore and offshore locations.

10.3.5. Laboratory Testing Program to Characterize the Fluid Mud's Bearing Capacity and Compressibility

A project-specific laboratory testing program has been developed to characterize the fluid mud with a specific focus on time rate and magnitude of sedimentation or settling under the proposed capping material thickness, and the bearing capacity of the fluid mud to support the weight of the capping material during and post-construction. The laboratory testing will include:

- Self-weight sedimentation / settling tests for vertical stresses less than 10 pounds-force per square foot (psf) based on USACE EM 1110-2-5027 and EM 1110-2-5025,
- Low-stress oedometer testing for vertical stresses from 10 up to 100 psf based on USACE EM 1110-2-5027,
- Conventional consolidation tests under vertical stresses greater than 100 psf (up to 1,000 psf depending on maximum sample strain) by performing either 1D consolidation using incremental loading per ASTM D2435 or 1D Controlled Rate of Strain (CRS) consolidation per ASTM D4186, and
- 'Bench Scale' testing of a sediment column to assess sedimentation/settling and consolidation of the fluid mud when a sand cap is added. The bench scale testing would help understand the potential

losses and settlement of sand cap materials into the fluid mud found at the site, which will be key considerations in project construction.

10.3.6. Laboratory Testing Program to Characterize Soil Liquefaction Susceptibility

Consolidated fluid mud materials, lakebed deposits and glacial outwash materials are potentially susceptible to liquefaction. Consolidated-undrained CyDSS testing per ASTM D8296 will be performed on representative soils samples for each unit to characterize its engineering properties under cyclic seismic loading. It is expected that five CyDSS tests will be completed collectively for the nearshore and offshore locations.

10.4. Key Geotechnical Investigation Considerations

The fluid mud is the key soil unit to be characterized for the GWPS. Obtaining undisturbed samples of these very soft sediments is challenging. In addition to attempting to take undisturbed samples at multiple locations, the exploration and laboratory testing program has considered this challenge by focusing on field testing techniques to characterize the shear strength of the very soft sediments through field vane shear tests and CPTs. The consolidation properties of the very soft fluid mud material will be characterized by performing laboratory tests using reconstituted samples. As a result, obtaining undisturbed samples of the very soft sediments becomes less critical.

11.0 INVESTIGATION DERIVED WASTE

Investigation derived waste (IDW) will be placed in labeled storage containers and stored on Site in a designated containment area, which will be enclosed by fencing. Each waste container will be labeled, secured, stored, and disposed of according to applicable local, State, and Federal regulations within 90 days after drums have been filled. Appendix A provides further procedures for labeling containers and collecting samples for characterizing IDW.

12.0 INVENTORY AND ASSESSMENT OF EXISTING STRUCTURES

12.1. Structural Conditions Assessment

A structural conditions assessment will be completed to document the as-built condition of structures that are located within the Settlement Area. The baseline conditions will be used to assist in evaluating construction approaches to minimize impacts on the existing structures.

A baseline conditions report will be developed based on evaluation of existing available information such as as-built drawings of existing structures, bathymetric and topographic surveys and the results of field reconnaissance completed by structural engineers.

The field reconnaissance will be completed to:

- Verify that the structures were built according to the design drawings, if available,
- Gather sufficient information to support developing the scope of construction elements (capping methods, dredging limits and methods, etc.), and
- Evaluate the condition of structures.

The field reconnaissance will include the following activities:

- Visually observe the above water structural elements,
- Visually observe the below water components with a diver,
- Confirm mudline elevations at foundation of the identified structures, and
- Establish likely locations to monitor for structure movements during construction.

The structural condition assessment will provide conditions assessment ratings for the major structural elements identified, including bulkheads, rip-rap revetments, piles, pile caps, stringers, deck, and major appurtenances.

The structural conditions data will be used to complete a structural analysis during remedial design using the structural conditions assessment and the geotechnical characterization information described in Section 10.0. The structural analysis will evaluate the potential impacts on existing structures from the proposed dredging and capping. The proposed dredging and capping will be modified, as necessary, to minimize impacts on existing structures. The modification may include ground improvement or shoring of existing structures. The structural analysis and any resulting modifications to the proposed cleanup action is expected to be an iterative process to reach a final design and approach.

13.0 COASTAL ENGINEERING

Coastal engineering and modeling will be completed to evaluate scour potential at the proposed cap surfaces and to provide recommendations for the armoring materials that will protect the cap.

The following tasks will be completed to evaluate coastal engineering conditions within the Settlement Area:

- Determine site conditions by compiling, processing, and reviewing publicly available data to use for modeling including, but not limited to, comparative analysis of historical bathymetric data sets (see Section 14.2), identifying key site features, and completing in-person site visit to identify existing site conditions.
- Develop a conceptual site model as a basis for coastal engineering analysis including:
    - Modeling criteria such as project site datum, winds, waves, water elevation, service life of cleanup action, and design storm conditions.
    - Complete a nearshore wave modeling and analysis for the Site using Metocean to conduct a cross-shore wave transformation analysis.
    - Evaluate vessel wakes and propwash based on review of vessel traffic in the vicinity of GWPS to inform future design.
- Complete coastal engineering modeling and analysis to provide recommendations for stable material sizes based on analysis criteria and project risk. The modelling includes estimates of stable grain size for different cleanup action elements based on wave energy and project criteria including material type, grain size and material thickness for the design storm event.

The results of the coastal engineering analysis will be used to inform materials selection for the caps during the design phase of the project.

14.0 TOPOGRAPHIC AND BATHYMETRIC SURVEYS

Topographic and bathymetric surveys will be completed as part of the PRDI using the USACE Locks Datum. The results of the topographic and bathymetric surveys will be combined to provide complete coverage of the Settlement Area.

14.1. Topographic Survey

The current topography along the shoreline will be surveyed for the design of shoreline excavation and capping. The topographic survey will extend up to 50 feet beyond the upland boundary of the Settlement Area, to the extent practicable (Figure 5) and will be performed down to the waterline to meet up with the area where bathymetric survey will be performed as described in Section 14.2. The survey will provide surface elevations for the upland area adjacent to Lake Union and will document the presence of debris and riprap on the surface that will require removal prior to excavation.

For well installation, the new monitoring wells (discussed in Section 4.1) will be surveyed, documenting the horizontal position and elevation of the top of the well casing, the well monument, as well as the adjacent ground surface.

The upland survey will use the USACE Locks Datum and established control points from previous surveys conducted as part of the Kite Hill and Play Area Interim Action activities. The land-based topographic survey will be performed in accordance with WAC 332-130 and other Washington State requirements for land surveys and will be completed by a contracted professional surveyor licensed in the State of Washington.

14.2. Bathymetric Survey

The bathymetric survey will be performed using multibeam survey methods deployed from a vessel and will provide survey coverage for the areas accessible by the vessel. The bathymetric survey will generally extend beyond the Settlement Area boundary, to the extent practicable to ensure complete coverage (Figure 5).

The bathymetric survey will be completed to:

- Establish the existing conditions for design and volumetric calculations,
- Provide comparative data for the evaluation of natural recovery as described in Section 9.3,
- Identify the location of larger debris that is present within the in-water portion of the Settlement Area,
- Document the location of existing structures that exist within the in-water portion of the Settlement Area,
- Provide surface elevations for the coastal engineering evaluation described in Section 13, and
- Provide surface elevations for the shoreline habitat survey described in Section 15.

The bathymetric survey will use the USACE Locks Datum and established control points from previous surveys conducted as part of the Kite Hill and Play Area Interim Action activities. The bathymetric survey will be performed in accordance with the USACE Engineering and Design Hydrographic Surveying Engineer Manual (EM 1110-2-1003) and will be performed by a professional surveyor licensed in the State of Washington.

15.0 NEARSHORE HABITAT SURVEY

A survey of habitat conditions within the Settlement Area will be completed that includes reviewing existing data and conducting a site reconnaissance visit. The habitat survey will cover the lakeshore, riparian zones, lake slope, and lake bottom within the Settlement Area.

The two deeper water habitats (lake bottom and lake slope) will be assessed by examining the substrate conditions through sediment sampling and bathymetric data and will not involve additional fieldwork. The grain size of the substrate will be used, in conjunction with bathymetry data, to infer the function of the deepwater habitats. The shallow lakeshore habitat will be assessed based on available grain size data from sediment sampling data along the shoreline. This information will be supplemented by observations during the reconnaissance. Riparian habitat will be assessed by examining available aerial photographs in conjunction with observations during the site reconnaissance.

With the aquatic habitat, the site visit will entail observing slopes and observing substrate conditions in the shallow water areas near the high-water mark. Habitat elements such as woody debris will be noted and located via GPS. The in-water efforts will extend to the limit that could be covered by wading from shore. Photographs will be taken along the shoreline and tied to the location using a GPS. The riparian vegetation will be described by species and the width of the riparian zone measured from the water’s edge to the start of grass or the edge of the developed upland.

The information from the habitat survey will be used to describe the potential benefits and impacts of the remediation alternatives on aquatic habitat for the purposes of permitting the project.

16.0 PROCEDURES FOR THE INADVERTENT DISCOVERY OF CULTURAL RESOURCES

An IDP is included in Appendix D. The IDP outlines procedures to perform in the event of a discovery of archaeological materials or human remains, in accordance with applicable state and federal laws. The IDP will be reviewed by the field team prior to beginning fieldwork and kept at the project site during the PRDI to reference in the event of a discovery.

17.0 PERMITS AND AUTHORIZATIONS

Under RCW 70.105D.090, remedial actions conducted under a consent decree are exempt from the procedural requirements of Chapters 70.94, 70.95, 70.105, 77.55, 90.48, and 90.58 RCW, and the procedural requirements of laws requiring or authorizing local government permits or approvals for the remedial action. However, exempted remedial actions still must comply with the substantive requirements of these laws. These exemptions apply to the proposed sediment sampling activities.

Regarding the State Environmental Policy Act (SEPA) review, under WAC 197-11-800(17), the proposed sampling activities are categorically exempt.

Any remaining applicable state or local agency substantive requirements will be identified through review of the Joint Aquatic Resource Permit Application (JARPA), as described in the following paragraph. The City has approved the shoreline permit exemption requests; conditions of exemption approval are included in the approval notice.

Procedural requirement exemptions for activities conducted under a Consent Decree do not apply to federal permits. Sediment investigations typically fall under the Nationwide Permit #6, which governs survey activities. Because of the federal nexus, a biological evaluation was completed to allow consideration of potential impacts to protected species and critical habitats resulting from PRDI activities. Accordingly, a JARPA was completed and submitted to the USACE on August 18, 2023, to comply with federal regulations under the Clean Water Act and Endangered Species Act. Currently the permit application is under review by the USACE.

18.0 HEALTH AND SAFETY PLAN

Site cleanup-related activities need to be performed in accordance with the requirements of the Washington Industrial Safety and Health Act (RCW 49.17) and the federal Occupational Safety and Health Act (29 CFR 1910, 1926). These applicable regulations include requirements that workers are to be protected from exposure to contaminants. A HASP for project personnel implementing the field work is provided in Appendix B.

19.0 REPORTING

Following completion of investigation activities described in this work plan, a Pre-Remedial Design Investigation Data Report (PRDI Report) will be prepared that will be appended to the Engineering Design Report. The PRDI Report will describe the results of the investigation activities, describe the degree to which existing data gaps described in the sections above have been addressed.

20.0 SCHEDULE

A specific field sampling schedule will be developed following Ecology approval of the Final PRDI Project Plans. It is currently anticipated that the field work will be initiated in March 2024. Ecology will be notified at the time unanticipated conditions or changed circumstances are discovered that might result in a schedule delay. Any requests for a schedule extension will be undertaken as required by the CD.

21.0 REFERENCES

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GeoEngineers

Table 1
Sample Descriptions and Objectives
Gas Works Park Site
Seattle, Washington

Sample Area	Sample Type	Location Names	Number of Locations	Analyses[7]	Objectives
Air and Soil Vapor Sampling - Figure 6					
Harbor Patrol and Gas Works Park	Indoor Air	HP-IA-1 through HP-IA-4	4	Benzene, toluene, ethylbenzene, total xylenes, naphthalene, C5-C8 aliphatics, C9-C12 aliphatics, and C9-C10 aromatics Helium (soil vapor samples only)	Characterize indoor air, outdoor air, and sub-slab soil vapor concentrations to verify conclusions of the indoor/outdoor air risk evaluation presented in Appendix 4D of the GWPS RI/FS.
	Sub-Slab Soil Vapor	HP-SV-1 through HP-SV-4	4		
	Outdoor Air	HP-OA-1, HP-OA-2 ES-OA-1, PR-OA-1, CT-OA-1, PL-OA-1	6		
Upland Groundwater Sampling - Figures 7A and 7B					
New and Existing Wells	Well gauging (no samples)	All monitoring wells shown on Figure 7A (including Shoreline and Play Area wells listed in Note 1 below)	77	None	To obtain water level and total depth measurements, evaluate for the presence of NAPL in wells where NAPL has previously been noted, and measuring the thickness of NAPL, if encountered. LNAPL measurements will be used to adjust the water levels in the wells where LNAPL is present. Water elevations will be used to prepare groundwater contour maps that will inform design.
Existing Wells	Groundwater	Shoreline and Play Area Monitoring Wells (see Note 1 below).	40	Benzene, toluene, ethylbenzene, naphthalene, cPAHs, and dissolved arsenic Arsenic speciation limited to MW-49D/AW-49D, MW-50D/AW-50D, and MW-52D/AW-52D	Document current groundwater chemical concentrations; inform the design of the groundwater treatment in GWMA-1; and evaluate groundwater flow pathways.
New Shoreline Angled Wells	Groundwater	AW-49D, AW-50D, and AW-52D	3		Characterize arsenic concentrations in outwash groundwater downgradient of the three existing shoreline outwash unit wells with the highest arsenic concentrations; evaluate the fate and transport of arsenic in the outwash unit, and establish the post-construction groundwater monitoring points as far offshore as possible downgradient of the existing shoreline wells.
	Soil			PAHs and dissolved arsenic	Characterize soil conditions in the outwash unit where the new shoreline wells will be screened and in the fill unit, at depths approximately 5 feet above the outwash unit.
Shoreline Soil (SMA-1 and SMA-2) - Figures 8A and 8B					
SMA-1	Soil samples (0 to 3 feet bgs)	HA-1 through HA-10	10	RCRA metals, benzene, ethylbenzene, toluene, xylenes, diesel- and oil-range petroleum hydrocarbons, and PAHs	Characterize material that will be excavated and disposed offsite at appropriate permitted landfill facility.
SMA-2		HA-11 through HA-15	5		
Subsurface Sediment and Offshore Groundwater (SMA-3, SMA-4 and SMA-5) - Figures 9B and 9C					
SMA-3	Sediment - base of dredge prism (~9 to 10 ft bml)	PRDI-1 through PRDI-12	12	Benzene, ethylbenzene, toluene, PAHs, arsenic, grain size, and TOC Total PCBs (Aroclors) and dioxins and furans (see Note 6)	Characterize contaminant concentrations in sediment and offshore groundwater that is located immediately below the dredge prism to obtain data that will be used for the design of the amended sand caps. Characterize the concentrations of Total PCBs (Aroclors), dioxins and furans in sediment that will be capped.
	Offshore groundwater - base of dredge prism (~9 to 10 ft bml)	PRDI-4 through PRDI-12	9	Benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic	
		PRDI-8 through PRDI-10	3	Arsenic speciation	
	Sediment - interval representative of dredge prism (~2 to 8 ft bml)	PRDI-1 through PRDI-12	12	Benzene, ethylbenzene, toluene, xylenes, RCRA metals, GWPS sediment COCs (see Note 2 below).	Characterize sediment that will be dredged and disposed offsite at appropriate permitted landfill facility.
SMA-4	Sediment - base of dredge prism (~9 to 11-ft bml)	PRDI-13 through PRDI-16	4	Benzene, ethylbenzene, toluene, PAHs, arsenic, grain size, and TOC Total PCBs (Aroclors) and dioxins and furans (see Note 6)	Characterize contaminant concentrations in sediment and offshore groundwater that is located immediately below the dredge prism to obtain data that will be used for the design of the amended sand caps. Characterize the concentrations of Total PCBs (Aroclors), dioxins and furans in sediment that will be capped.
	Offshore groundwater - base of dredge prism (~9 to 10 ft bml)	PRDI-13 through PRDI-16	4	Benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic	
	Sediment - interval representative of dredge prism (~2 to 8 ft bml)	PRDI-13 through PRDI-16	4	Benzene, ethylbenzene, toluene, xylenes, RCRA metals, GWPS sediment COCs (see Note 2 below).	Characterize sediment that will be dredged and disposed offsite at appropriate permitted landfill facility.
SMA-5	Sediment - base of dredge prism (~9 to 10 ft bml)	PRDI-17 through PRDI-22	6	Benzene, ethylbenzene, toluene, PAHs, arsenic, TOC, and grain size and TOC	Characterize contaminant concentrations in sediment and offshore groundwater that is located immediately below the dredge prism to obtain data that will be used for the design of the amended sand caps.
	Offshore groundwater - base of dredge prism (~9 to 10 ft bml)	PRDI-17 through PRDI-20	4	Benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic	
	Sediment - interval representative of dredge prism (~2 to 8 ft bml)	PRDI-17 through PRDI-22	6	Benzene, ethylbenzene, toluene, xylenes, RCRA metals, GWPS sediment COCs (see Note 2 below)	Characterize sediment that will be dredged and disposed offsite at appropriate permitted landfill facility.

Sample Area	Sample Type	Location Names	Number of Locations	Analyses[7]	Objectives
Sediment and Offshore Groundwater (SMA-6 through SMA-12) - Figures 9B through 9D					
SMA-6	Sediment - near surface (0 to 1 ft bml)	PRDI-42 through PRDI-46, PRDI-107 through PRDI-109	8	Benzene, ethylbenzene, toluene, PAHs, arsenic, and grain size.	Characterize sediment and offshore groundwater conditions near the shoreline to obtain data that will be used for the design of the sand cap.
	Offshore groundwater - near surface (0.5 to 1.5 ft bml)	PRDI-43 through PRDI-46, PRDI-107 through PRDI-109	7	Benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic + Offshore Groundwater COCs (see Note 3 below).	
SMA-7	Sediment - near surface (0 to 1 ft bml)	PRDI-25 through PRDI-39	8	Benzene, ethylbenzene, toluene, PAHs, arsenic, TOC, and grain size.	Characterize contaminant concentrations in near surface sediment and offshore groundwater located immediately offshore of the proposed low-permeability caps in SMA-3 to obtain data that will be used for the design of the amended sand cap.
	Offshore groundwater - near surface (0.5 to 1.5 ft bml)	PRDI-26, PRDI-27, PRDI-30 through PRDI-33, PRDI-36 and PRDI-37	8	Benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic + Offshore Groundwater COCs (see Note 3 below)	
	Sediment - near surface (0 to 1 ft bml)	DP-1 through DP-10	10	None	Evaluate near surface sediment samples for evidence of NAPL. Results of field screening will provide mapping of near surface NAPL-impacted sediment and inform the thickness of sand caps.
	Sediment - surface (0 to 10 cm bml)	PRDI-63 through PRDI-65	3	Bioaccumulative COCs (see Note 4)	Characterize contaminant concentrations in surface sediment adjacent to the SMA-13 and SMA-14 to help estimate surface-area weighted average concentrations in SMA-13 and SMA-14.
SMA-8	Sediment - near surface (0 to 1 ft bml)	DP-12 and DP-14	2	None	Evaluate near surface sediment samples for evidence of NAPL. Results of field screening will provide mapping of near surface NAPL-impacted sediment and inform the thickness of sand caps.
SMA-9	Sediment - near surface (0 to 1 ft bml)	PRDI-47 through PRDI-61	15	Benzene, ethylbenzene, toluene, PAHs, arsenic, grain size, and TOC Total PCBs (Aroclors) and dioxins and furans (see Note 6)	Characterize contaminant concentrations in near surface sediment and offshore groundwater located immediately offshore of the proposed low-permeability caps in SMA-4 and SMA-5 to obtain data that will be used for the design of the amended sand cap. Characterize the concentrations of Total PCBs (Aroclors), dioxins and furans in sediment that will be capped.
	Offshore groundwater - near surface (0.5 to 1.5 ft bml)	PRDI-47, PRDI-48, PRDI-51 through PRDI-54, PRDI-57 and PRDI-59	8	Benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic + Offshore Groundwater COCs (see Note 3 below)	
SMA-10	Sediment - near surface (0 to 1 ft bml)	PRDI-23 through PRDI-24	2	Benzene, ethylbenzene, toluene, PAHs, arsenic, and grain size	Characterize contaminant concentrations in near surface sediment and offshore groundwater located immediately offshore of the proposed dredge prism in SMA-3.
	Sediment - surface (0 to 10 cm bml)	PRDI-62	1	GWPS Bioaccumulative COCs (cPAHs and arsenic) Dioxins and furans (see Note 6)	Characterize contaminant concentrations in surface sediment adjacent to the SMA-13 and SMA-14 to help estimate surface-area weighted average concentrations in SMA-13 and SMA-14. Characterize the concentrations of dioxins and furans in sediment that will be capped.
SMA-11	Sediment - near surface (0 to 1 ft bml)	PRDI-40, PRDI-41, PRDI-110	3	Benzene, ethylbenzene, toluene, PAHs, and arsenic Dioxins and furans (see Note 6)	Characterize sediment and offshore groundwater conditions near the shoreline to obtain data that will be used for the design of the sand cap. Characterize the concentrations of dioxins and furans in sediment that will be capped.
	Offshore groundwater - near surface (0.5 to 1.5 ft bml)	PRDI-41 and PRDI-110	2	Benzene, ethylbenzene, toluene, PAHs, and dissolved arsenic + Offshore Groundwater COCs (see Note 3 below)	
	Sediment - near surface (0 to 1 ft bml)	DP-11 and DP-13	10	None	Evaluate near surface sediment samples for evidence of NAPL. Results of field screening will provide mapping of near surface NAPL-impacted sediment and inform the thickness of sand caps.
	Sediment - surface (0 to 10 cm bml)	PRDI-66 through PRDI-71	6	GWPS and ALU Bioaccumulative COCs (see Note 4) and grain size	Characterize contaminant concentrations in surface sediment adjacent to the SMA-13 and SMA-14 to help estimate surface-area weighted average concentrations in SMA-13 and SMA-14.
SMA-12	Sediment - near surface (0 to 1 ft bml)	DP-15 through DP-24	10	None	Evaluate near surface sediment samples for evidence of NAPL. Results of field screening will provide mapping of near surface NAPL-impacted sediment and inform the thickness of sand caps.
	Sediment - near surface (0 to 1 ft bml)	PRDI-72	1	Dioxins and furans (see Note 6)	Characterize the concentrations of dioxins and furans in sediment that will be capped.
	Sediment - surface (0 to 10 cm bml)	PRDI-72 through PRDI-76	5	GWPS and ALU Bioaccumulative COCs (see Note 4) and grain size	Characterize contaminant concentrations in surface sediment adjacent to the SMA-13 and SMA-14 to help estimate surface-area weighted average concentrations in SMA-13 and SMA-14.
Natural Recovery Evaluation (SMA-13 and SMA-14) - Figure 9E					
SMA-13	Sediment - surface (0 to 10 cm bml)	PRDI-77 through PRDI-86	10	GWPS and ALU Bioaccumulative COCs (see Note 4) and GWPS and ALU Benthic COCs (see Note 5), and grain size Dioxins and furans (see Note 6)	Characterize contaminant concentrations in surface sediment in SMA-13 and SMA-14 to help estimate surface-area weighted average concentrations in SMA-13 and SMA-14. Characterize sediment and inventory dioxins and furans in sediment in the enhanced and monitored natural recovery areas.
SMA-14		PRDI-87 through PRDI-106	20	GWPS and ALU Bioaccumulative COCs (see Note 4), and grain size Dioxins and furans (see Note 6)	

Sample Area	Sample Type	Location Names	Number of Locations	Analyses[7]	Objectives
Geotechnical Characterization (SMA-3 through SMA-14) - Figure 12					
SMA-3 through SMA-14	Sediment	B-1 through B-22	22	Soil properties including: density and plasticity, shear strength, consolidation/compression properties, and dynamic soil strength and stiffness	Refine the characterization of sediment material types; evaluate construction techniques for capping and dredging, including protection of existing structures; evaluate slope stability for dredge cuts and sediment caps; and evaluate seismic stability of sediment caps.

Notes:

1 Shoreline and Play Area Monitoring Wells - CMP-1, MLS-6, MLS-7, MW-13, MW-22 through MW-25, MW-32 through MW-40, MW-44 through MW-52, OBS-1 and OBS-2, PZ-1, TDW-1 through TDW-3, and TSW-1 through TSW-3.

2. Sediment COCs -sulfide, Total PAHs, cPAHs, 4-methylphenol, benzoic acid, bis(2-ethylhexy)phthalate, carbazole, dibenzofuran, di-n-butylphthalate, di-n-octylphthalate, hexachlorobenzene, pentachlorophenol, phenol, chlordane, 4,4'-DDE, Total PCBs, tributyltin, arsenic, cadmium, chromium, copper, lead, mercury, methylmercury, nickel, and silver.

3. Offshore Groundwater COCs - benzene, ethylbenzene, fluoranthene, pyrene, cPAHs, bis(2-ethylhexy)phthalate, carbazole, dibenzofuran, arsenic, cadmium, copper, lead, mercury, nickel, and silver (metals will be analyzed for the dissolved fraction).

4. GWPS and ALU Bioaccumulation COCs - cPAHs, hexachlorobenzene, pentachlorophenol, chlordane, Total PCBs, arsenic, and chromium.

5. GWPS and ALU Benthic COCs - sulfide, Total PAHs, 4-methylphenol, benzoic acid, bis(2-ethylhexy)phthalate, carbazole, dibenzofuran, di-n-butylphthalate, di-n-octylphthalate, phenol, 4,4'-DDE, Total PCBs, tributyltin, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and silver.

6. Dioxins and furans are included because they have not been previously evaluated and are likely present. They are considered an ALU contaminant because there are no known sources from the historical industrial activities at the GWPS but there are documented sources in other parts of Lake Union.

7. The analytes listed in each row for indoor air, outdoor air, sub-slab soil vapor, upland groundwater, shoreline soil, sediment, and offshore groundwater are general lists and may not be analyzed for at each sample location. Details on specific analytes at specific sample locations are presented in Appendix A, Tables 1a and 1b.

GWPS = Gas Works Park Site
ALU = Ambient Lake Union
SMA = Sediment Management Area
bml = below mud line
cm = centimeters
ft = feet
BETX = Benzene, ethylbenzene, toluene, total xylenes
PAHs = Polyaromatic hydrocarbons
cPAHs = Carcinogenic polyaromatic hydrocarbons
RCRA = Resource Conservation and Recovery Act
COC = Contaminants of concern
PCBs = Polychlorinated biphenyls

Table 2

Rationale for Proposed Analytes

Gas Works Park Site

Seattle, Washington

Media	Sample Analytes	Location	Purpose and Rationale for Proposed Analytes
Air and Soil Vapor	Benzene, toluene, ethylbenzene, and xylenes (BTEX) Naphthalene Petroleum fractions (C5-C8 aliphatics, C9-C12 aliphatics, and C9-C10 aromatics) Helium (soil vapor only)	Harbor Patrol, Greater Gas Works Park	Purpose - to confirm RI/FS risk evaluation. Benzene, naphthalene, chloroform, and 1,2-dichlorobenzene detected in 2007/2008 air samples at concentrations greater than MTCA Method B air CULs. Proposed analytes are required by Ecology VI guidance for petroleum sites. Benzene is a GWPS groundwater COC. Naphthalene is a GWPS soil and groundwater COCs. Chloroform and 1,2-dichlorobenzene are not GWPS COCs and will not be analyzed.
Groundwater	Benzene, toluene, and ethylbenzene (BTE) Naphthalene cPAHs Arsenic (dissolved arsenic)	Shoreline and select Play Area wells	Purpose - to characterize groundwater in shoreline and select Play Area wells to support design of arsenic groundwater treatment system and to support evaluation of groundwater flow pathways. BTE, naphthalene and cPAHs are upland groundwater COCs. Arsenic is the focus of the groundwater treatment system and is a sediment and an offshore groundwater COC.
	Arsenic speciation	Paired shoreline wells	Purpose - to evaluate how far downgradient thioarsenate has migrated and to support design of arsenic groundwater treatment system.
Soil **New Angled Monitoring Wells**	PAHs Arsenic	AW-49D, AW-50D, and AW-52D	Purpose - to characterize soil conditions in the outwash unit where the new shoreline wells will be screened and in the fill unit, at depths approximately 5 feet above the outwash unit. PAHs and arsenic are soil COCs
Soil **(Landfill Characterization)**	PAHs BTEX RCRA Metals (see rationale column) TPH-Dx	SMA-1 and SMA-2	Purpose - to characterize upland soil for landfill disposal. PAHs and arsenic are soil COCs BTE are upland groundwater COCs and BTEX is common landfill requirement if benzene is present. RCRA Metals (As, Ba, Cd, Cr, Pb, Hg, Se, Ag) and TPH-Dx common landfill requirements
Subsurface Sediment **(within dredge prism)** **(Landfill Characterization)**	Sulfides PAHs SVOCs (see rationale column) Chlordane and DDE Total PCBs (aroclors) Tributyltin BTEX TPH-Dx RCRA Metals + Cu, methylmercury, and Ni	SMA-3, SMA-4, and SMA-5	Purpose - to characterize sediment for landfill disposal. Sulfides, PAHs, SVOCs (4-methylphenol, benzoic acid, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, di-n-butylphthalate, di-n-ocytylphthalate, hexachlorobenzene, pentachlorophenol, phenol), chloridane, DDE, Total PCBs (aroclors), tributyltin, and metals (As, Cd, Cr, Cu, Pb, Hg, methylmercury, Ni, and Ag) are sediment COCs BTEX - expected to be present in the vicinity of NAPL impacts. Benzene, in particular, has been associated with NAPL and BTEX is common landfill requirement if benzene is present. RCRA Metals (As, Ba, Cd, Cr, Pb, Hg, Se, Ag) and TPH-Dx are common landfill requirements
Subsurface Sediment **(below dredge prism)**	BTE PAHs Arsenic TOC and grain size Total PCBs and dioxins and furans (see Note 1)	SMA-3, SMA-4, and SMA-5	Purpose - to evaluate groundwater flow pathway and to characterize the exposed sediment surface that will be capped following dredging. BTE, napthalene, cPAHs, and arsenic are upland groundwater COCs. Benzene, naphthalene, arsenic and, to a lesser extent, cPAHs are the focus of the groundwater flow pathway evaluation. Purpose of TOC and grain size analyses - to help evaluate contaminant mobility Purpose of Total PCBs and dioxins and furans - to characterize the concentrations of Total PCBs, dioxins and furans that will be capped (SMA-3 and SMA-4).
Subsurface Offshore Groundwater **(below dredge prism)**	BTE PAHs Arsenic (dissolved arsenic)	SMA-3, SMA-4, and SMA-5	Purpose - to evaluate groundwater flow pathway and to provide chemical analytical data for cap model. BTE, napthalene, cPAHs, and arsenic are upland groundwater COCs and are expected to be present in sediment within the groundwater flow path. Remaining PAHs to support cap model. Total PAHs are a sediment COC that may affect cap model.
	Arsenic speciation	PRDI-8 through PRDI-10 (downgradient of paired wells)	Purpose - to evaluate how far downgradient thioarsenate has migrated.

Media	Sample Analytes	Location	Purpose and Rationale for Proposed Analytes
Nearsurface Sediment	BTE PAHs Arsenic TOC Grain size Total PCBs and dioxins and furans (see Note 1)	SMA-6, SMA-7, and SMA-9 through SMA-11	Purpose - to evaluate sediment conditions at the pre-cap surface and within the groundwater flow pathway for mobile contaminants that are the focus of amended capping. The sediment data along with offshore groundwater data will inform cap modeling used to design the amended caps. BTE, napthalene, cPAHs, and arsenic are upland groundwater COCs and concentrations in sediment and offshore groundwater are proposed to be characterized at multiple points along the groundwater flow path to confirm that sediment is the primary source of contaminants in offshore groundwater. Purpose of TOC analysis - to help evaluate contaminant mobility Purpose of grain size analysis - to charaterize existing habitat conditions within the biologically acitve zone throughout the Settlement Area and to help evaluate contaminant mobility. Purpose of Total PCBs and dioxins and furans - to characterize the concentrations of Total PCBs, dioxins and furans that will be capped (SMA-9 and SMA-11).
Nearsurface Offshore Groundwater	BTE PAHs BEHP, carbazole, and dibenzofuran As, Cd, Cu, Pb, Hg, Ni, and Ag (dissolved metals)	SMA-6, SMA-7, and SMA-9 through SMA-11	Purpose - to evaluate offshore groundwater conditions at pre-cap surfaces along the groundwater flow pathway for mobile contaminants driving the use of amended capping methods (benzene, naphthalene, cPAHs, and arsenic). This data will be used for cap modeling to inform the design of the amended caps. Analytes include offshore groundwater COCs, except for toluene. Toluene retained because it is an upland groundwater COC. Total PAHs are a sediment COC that may affect cap performance. These results can be incorporated into the cap model to ensure cap design considers the effect of the additional PAHs.
Surface Sediment	cPAHs Hexachlorobenzene and PCP Chlordane Total PCBs (aroclors) As and Cr Methylmercury Grain size Dioxins and furans (see Note 1)	SMA-7 and SMA-10 through SMA-14	Purpose - to evalute natural recovery of bioaccumulative COCs. Natural recovery of bioaccumulative COCs was evaluated in the RI/FS, and will be evaluated in the PRDI, for SMAs 13 and 14. The natural recovery of bioaccumulative COCs in SMAs 3 through 12 was not evaluated because those SMAs will be capped. Surface sediment samples will be collected in SMA-7 and SMAs 10 through 12 to help estimate surface-area weighted average concentrations in SMA-13 and SMA-14. Analytes include GWPS and ALU bioaccumulative sediment COCs. Purpose of grain size analysis - to charaterize existing habitat conditions within the biologically active zone throughout the Settlement Area. Purpose of dioxins and furans - to characterize the concentrations of dioxins and furans that will be capped (SMA-10) and to characterize the concentrations of dioxins and furans in the monitored natural recovery area (SMA-14).
	Sulfide PAHs SVOCs (see rationale column) DDE Total PCBs (aroclors) Tributyltin As, Cd, Cr, Cu, Pb,Hg, Ni, and Ag Dioxins and furans (see Note 1)	SMA-13	Purpose - to evalute natural recovery of benthic COCs (SVOCs = 4-methylphenol, benzoic acid, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, di-n-butylphthalate, di-n-ocytylphthalate, phenol). The benthic toxicity area identified in the RI/FS includes SMAs 3 through 13. The natural recovery of benthic COCs was evaluated in the RI/FS for SMA 13. The natural recovery of benthic COCs in SMAs 3 through 12 was not evaluated because those SMAs will be capped. Analytes include GWPS and ALU benthic sediment COCs. Purpose of dioxins and furans - to characterize the concentrations of dioxins and furans in the enhanced natural recovery area (SMA-13).

Notes

1. Dioxins and furans are included because they have not been previously evaluated and are likely present. They are considered an ALU contaminant because there are no known sources from the historical industrial activities at the GWPS but there are documented sources in other parts of Lake Union.

RCRA Metals: As, Ba, Cd, Cr, Pb, Hg, Se, Ag

Table 3

Summary of Contaminants of Concern

Gas Works Park Site
Seattle, Washington

Analyte Group	Contaminants of Concern (COCs)		Medium			
			Soil	Upland Groundwater	Offshore Groundwater	Sediment
Conventionals	Sulfide		--	--	--	X
BTEX	Benzene		--	X	X	--
	Ethylbenzene		--	X	X	--
	Toluene		--	X	--	--
PAHs	Total PAH		--	--	--	X
	Fluoranthene		X	--	X	--
	Naphthalene		X	X	X	--
	Pyrene		X	--	X	--
	cPAHs	Benzo(a)anthracene	X	X	X	--
		Benzo(a)pyrene	X	X	X	--
		Benzo(b)fluoranthene	X	X	X	--
		Benzo(k)fluoranthene	X	X	X	--
		Chrysene	X	X	X	--
		Indeno(1,2,3-cd)pyrene	X	X	X	--
		Dibenzo(a,h)anthracene	X	X	--	--
	Total cPAHs TEQ		--	--	X	X
TPH	Diesel Range Hydrocarbons		--	--	--	X
SVOCs	4-Methylphenol		--	--	--	X
	Benzoic Acid		--	--	--	X
	Bis(2-ethylhexyl)phthalate		--	--	X	X
	Carbazole		--	--	X	X
	Dibenzofuran		--	--	X	X
	Di-n-Butyl phthalate		--	--	--	X
	Di-n-Octyl phthalate		--	--	--	X
	Hexachlorobenzene		--	--	--	X
	Pentachlorophenol		--	--	--	X
	Phenol		--	--	--	X
Pesticides	Chlordane		--	--	--	X
	4,4'-DDE		--	--	--	X
PCBs	Total PCBs (Aroclor)		--	--	--	X
Butyltins	Tributyltin		--	--	--	X
Metals	Arsenic		X	--	X	X
	Cadmium		--	--	X	X
	Chromium		--	--	--	X
	Copper		--	--	X	X
	Lead		--	--	X	X
	Mercury		--	--	X	X
	Methylmercury		--	--	--	X
	Nickel		--	--	X	X
	Silver		--	--	X	X

Notes:

X = Chemical identified as a COC

-- Chemical not identified as a COC

PAHs = polycyclic aromatic hydrocarbons

cPAHs = carcinogenic polycyclic hydrocarbons

DDE = dichlorodiphenyldichloroethylene

PCB = polychlorinated biphenyls

Table 4

Summary of Sediment Contaminants of Concern - Breakdown by Sources and Pathways

Gas Works Park Site

Seattle, Washington

Analyte Group	Contaminants of Concern (COCs)	Sources		Pathways	
		GWPS COCs	ALU COCs	Bioaccumulative COCs	Benthic COCs
Conventionals	Sulfide	--	X	--	X
PAHs	Total PAH	X	--	--	X
	Total cPAHs TEQ	X	--	X	--
TPH	Diesel Range Hydrocarbons	--	X	--	X
SVOCs	4-Methylphenol	--	X	--	X
	Benzoic Acid	--	X	--	X
	Bis(2-ethylhexyl)phthalate	--	X	--	X
	Carbazole	X	--	--	X
	Dibenzofuran	X	--	--	X
	Di-n-Butyl phthalate	--	X	--	X
	Di-n-Octyl phthalate	--	X	--	X
	Hexachlorobenzene	--	X	X	--
	Pentachlorophenol	--	X	X	--
	Phenol	--	X	--	X
Pesticides	Chlordane	--	X	X	
	4,4'-DDE	--	X	--	X
PCBs	Total PCBs (Aroclor)	--	X	X	X
Butyltins	Tributyltin	--	X	--	X
Metals	Arsenic	X	--	X	X
	Cadmium	--	X	--	X
	Chromium	--	X	X	X
	Copper	--	X	--	X
	Lead	--	X	--	X
	Mercury	--	X	--	X
	Methylmercury	--	X	X	--
	Nickel	X	--	--	X
	Silver	--	X	--	X

Notes:

GWPS = Gas Works Park Site

ALU = Ambient Lake Union

X = Chemical identified as a COC

-- Chemical not identified as a COC

PAHs = polycyclic aromatic hydrocarbons

cPAHs = carcinogenic polycyclic hydrocarbons

DDE = dichlorodiphenyldichloroethylene

PCB = polychlorinated biphenyls

TPH = total petroleum hydrocarbons

SVOCs = semivolatile organic compounds

FIGURES

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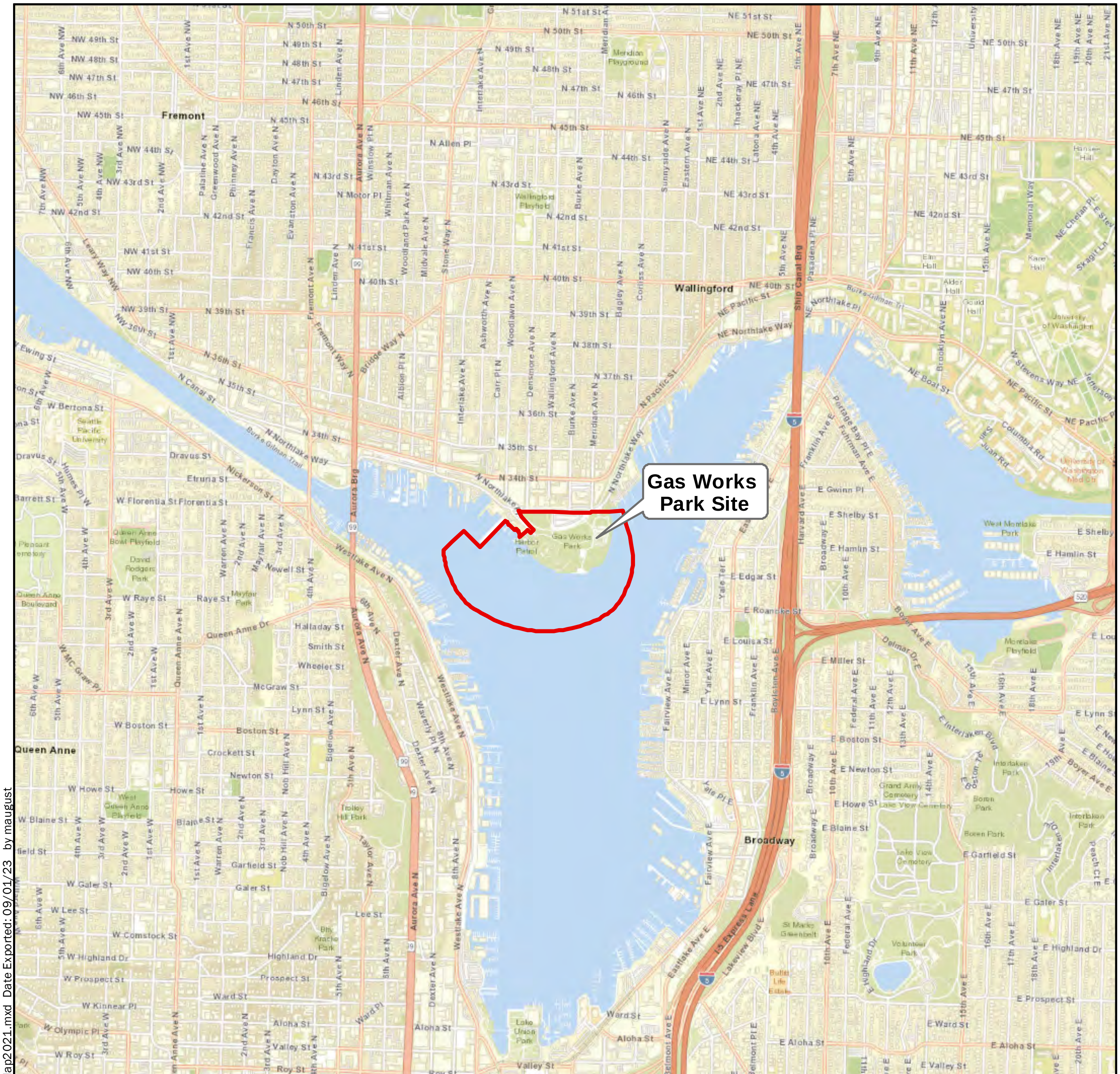

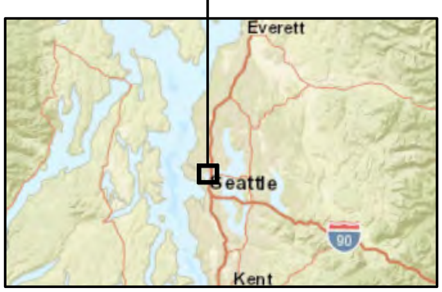

Gas Works Park Site

N
W
E
S

2,000 0 2,000
Feet

Notes:
1. Basemap - ESRI, 2021.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Vicinity Map

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 1

Legend

- Gas Works Park Site
- Shoreline (OHWM)
- Impervious (Paved or Structures)
- Gravel

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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N
W E
S

200 0 200
Feet

Site Plan

Gas Works Park Site
Seattle, Washington

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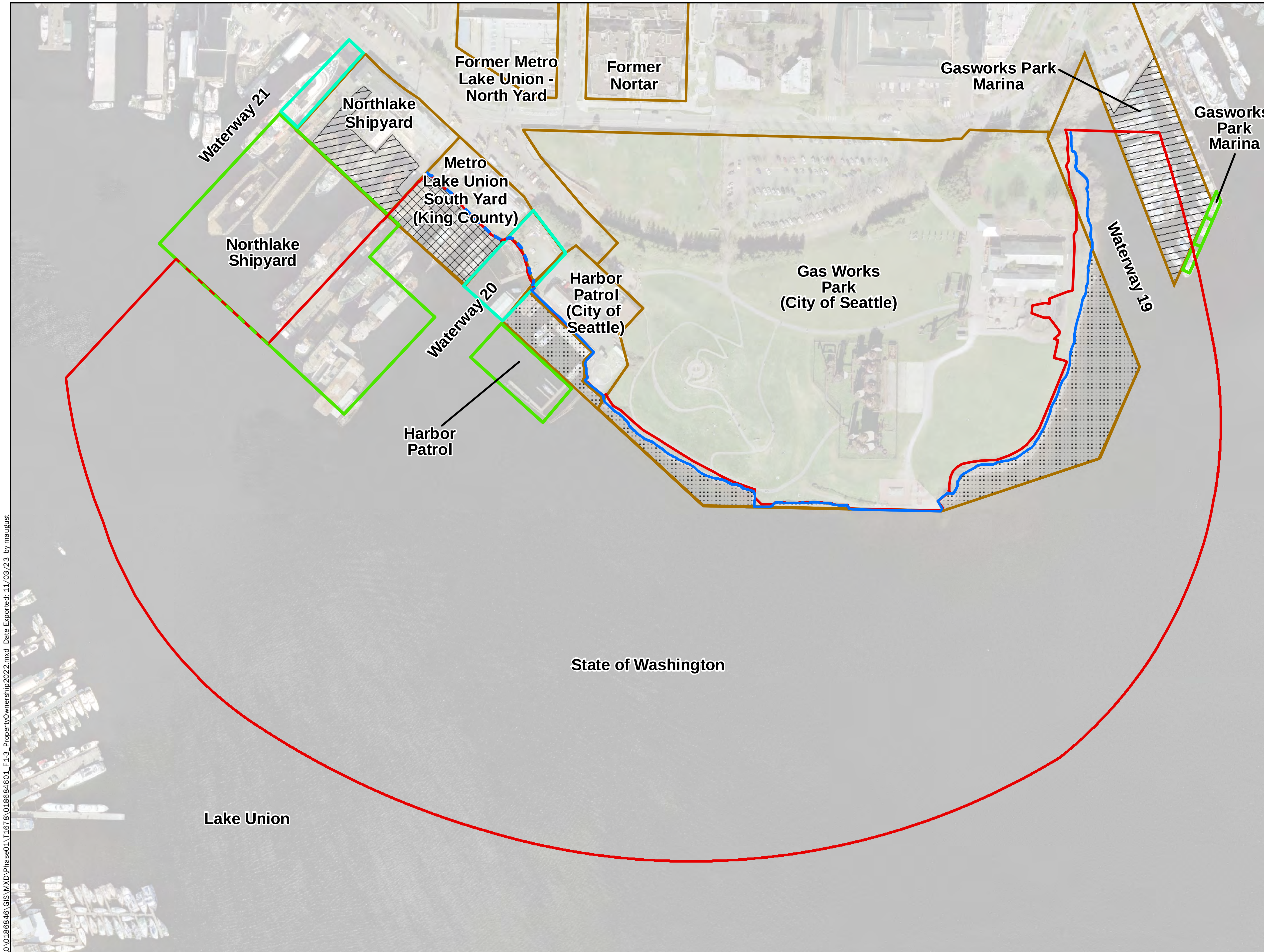
Figure 2

P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F02_SitePlan2021.mxd Date Exported: 12/19/23 by maugust



Legend

- Settlement Area
- Shoreline (OHWM)

Properties

- City Owned Aquatic Property
- County Owned Aquatic Property
- Privately Owned Aquatic Property

Boundaries

- Property Boundary
- Aquatic Lease Boundary (State-Owned Aquatic Property)
- Waterway Use Permit Boundary (State-Owned Upland and Aquatic Property)

Notes:

1. Reference: Department of Parks, Property Acquisition Map (1984). King County Parcel Viewer (2013). King County iMap (2013).
2. Record of Surveys: Northlake Shipyard - DNR Lease 20-A12992 and Waterway 21 DNR Aquatic Waterway User Permit [February 2008]; Waterway 20 DNR Aquatic Waterway User Permit No. 20-089981 [June 21, 2018]; Gas Works Park Marina DNR Lease 20-013648 [December 5, 2018], DNR Lease 20-A79485 [September 17, 2019], and DNR Lease 20-B12133 [September 17, 2019].
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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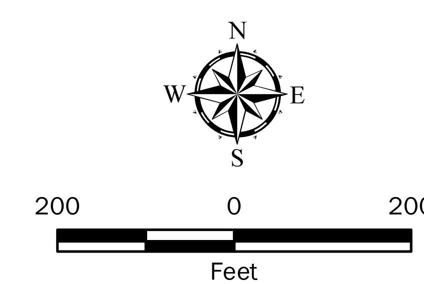

Property Ownership

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3

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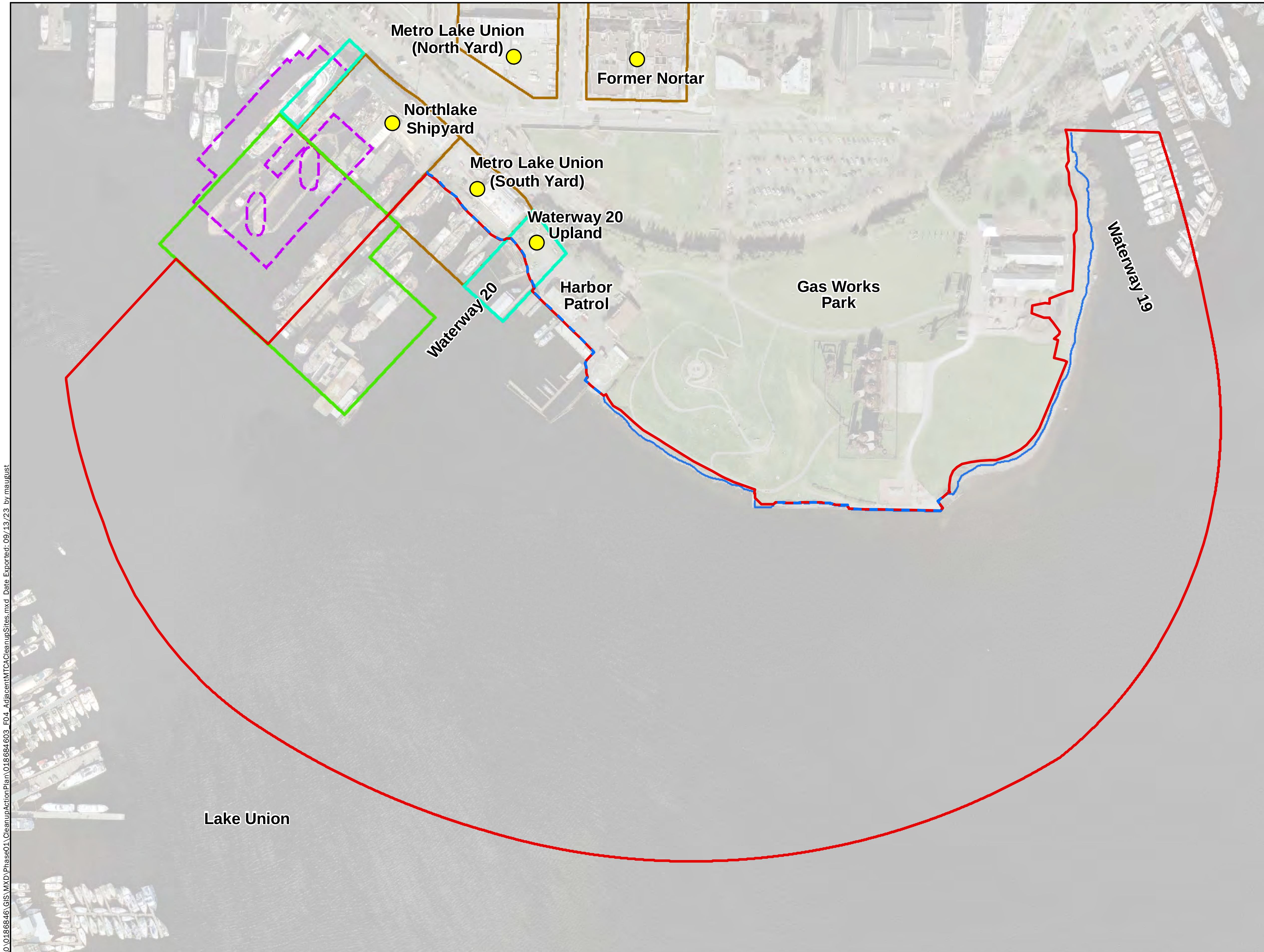


Legend

- Settlement Area
- Shoreline (OHWM)
- MTCA Cleanup Site

Boundaries

- Property Boundary
- Aquatic Lease Boundary
- Waterway Use Permit Boundary
- Northlake Shipyard 2014 Interim Action Dredge Footprint

Notes:

1. Reference: Department of Parks, Property Acquisition Map (1984). King County Parcel Viewer (2013). King County iMap (2013).
2. Record of Surveys: Northlake Shipyard - DNR Lease 20-A12992 and Waterway 21 DNR Aquatic Waterway User Permit [February 2008]; Waterway 20 DNR Aquatic Waterway User Permit No. 20-089981 [June 21, 2018].
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
S

200 0 200

Feet

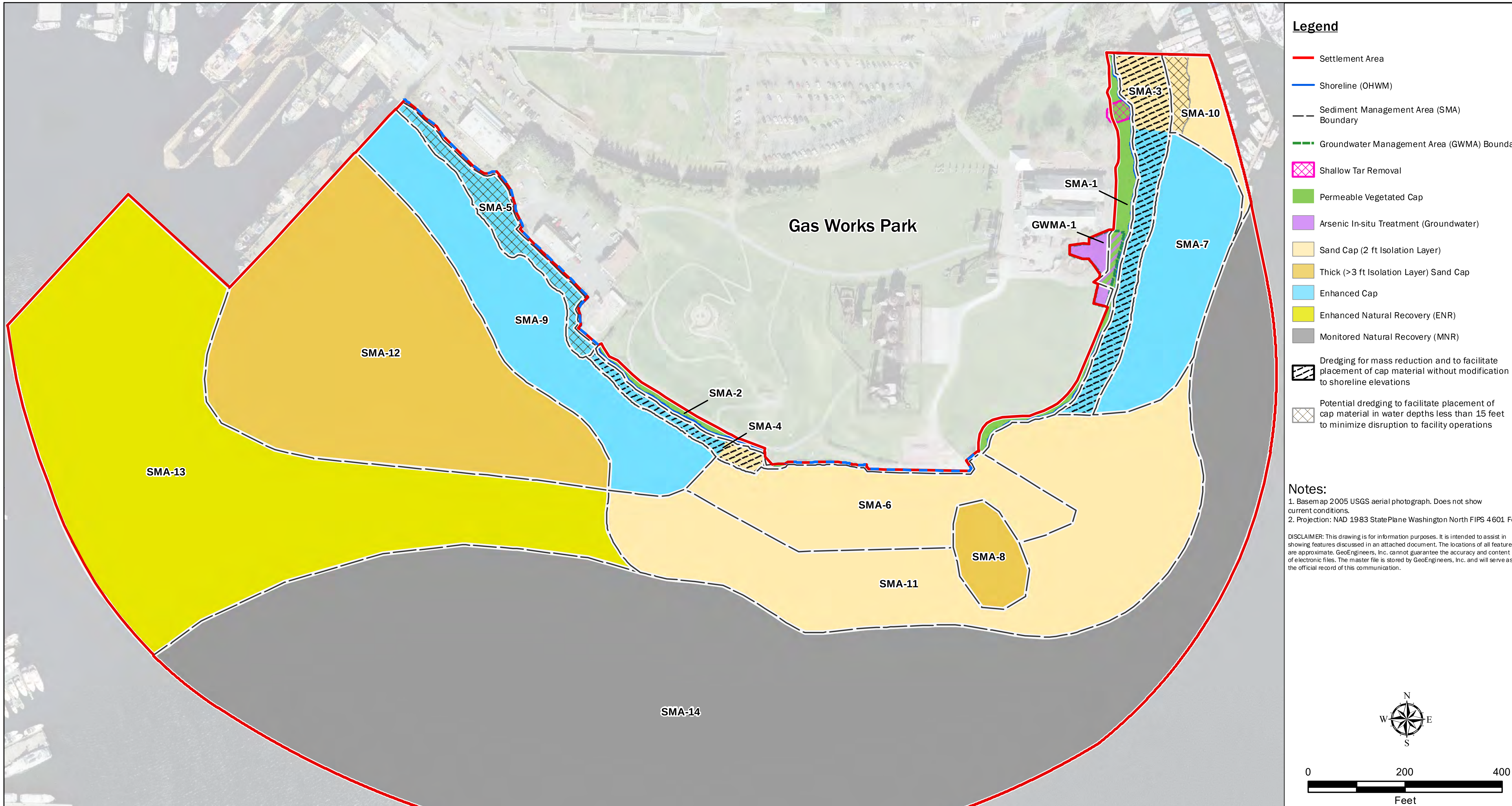
Adjacent MTCA Cleanup Sites

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4

P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F04_AdjacentMTCACleanupSites.mxd Date Exported: 09/13/23 by maugust



Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

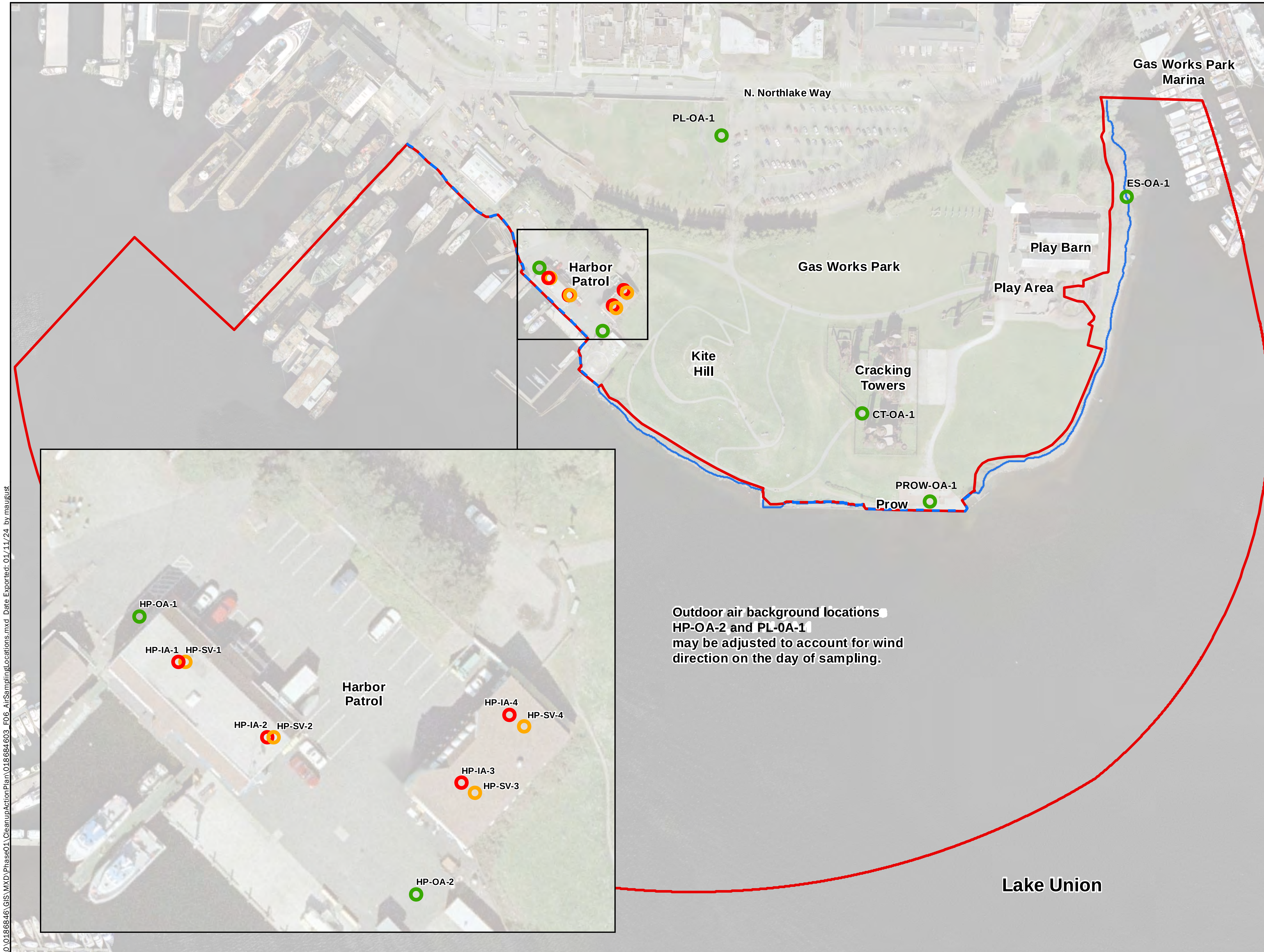
Cleanup Action

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684600_F05_ProposedCAP.mxd Map Revised: 19 December 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Indoor Air Sampling Location
- Outdoor Air Sampling Location
- Sub-Slab Soil Vapor Sampling Location

Notes:

1. The AOI is documented in the 2013 Amendment of Agreed Order DE 2008 (Ecology 2013).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Air and Soil Vapor Sampling Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 6

P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F06_AirSamplingLocations.mxd Date Exported: 01/11/24 by maugust

Legend

- Settlement Area
- Shoreline (OHWM)
- Groundwater Monitoring Well (Chemical Analyses and Well Gauging)
- Groundwater Monitoring Well (Well Gauging Only)
- Proposed Angled Shoreline Groundwater Monitoring Well (Chemical Analyses and Well Gauging)

Notes:

1. Because of how they are constructed, gauging cannot be completed at multi-level sample (MLS) wells (MLS-6 and MLS-7).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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N W E S

100 0 100

Feet

Upland Groundwater Sampling Locations

Gas Works Park Site
Seattle, Washington

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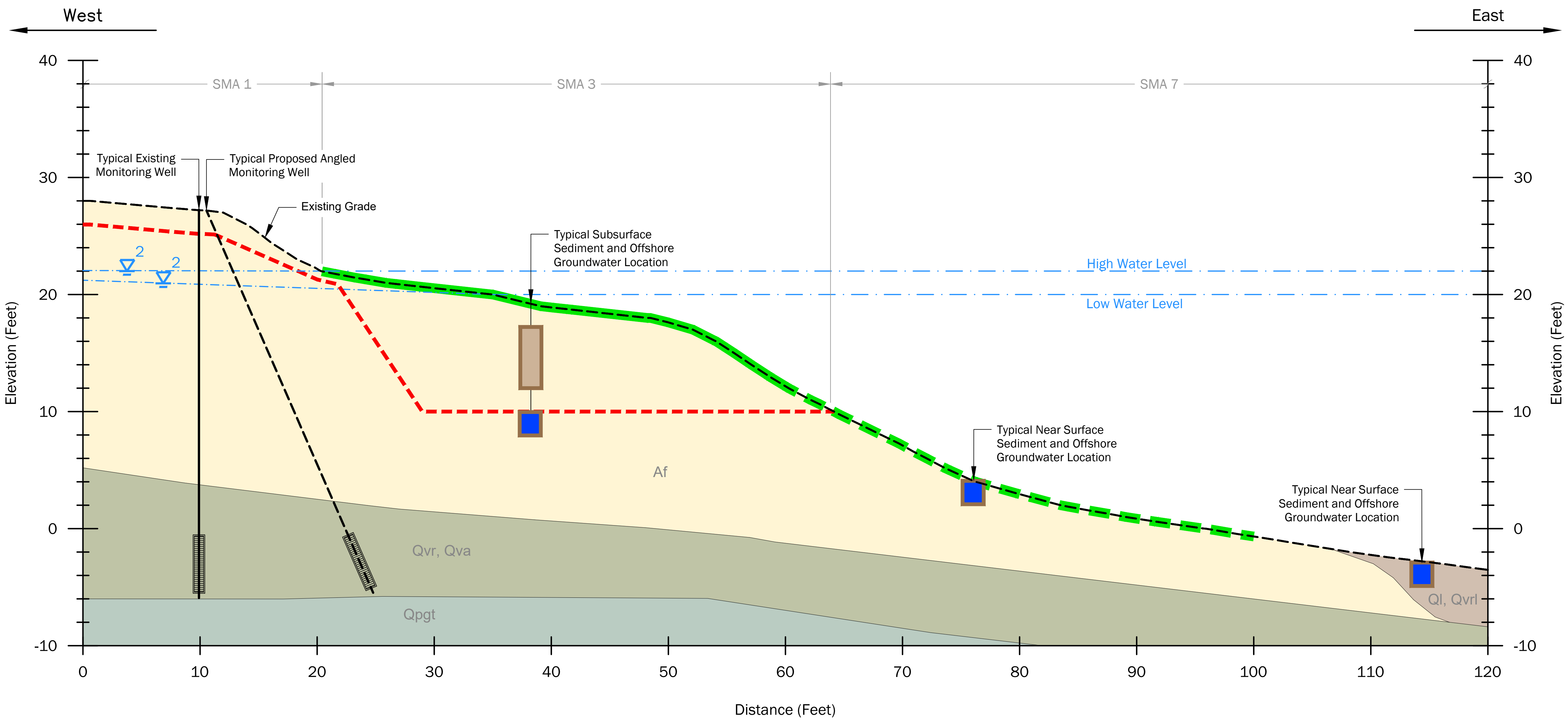
Figure 7A

Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684601_F07A_UplandGWLocations.mxd Map Revised: 19 September 2023 maugust



Legend

- Existing Grade
- Approximate Extent of the Groundwater Discharge Zone Downgradient of GWMA-1 (See Note 3)
- Water Table
- Fill (Af)
- Lake Sediment (Ql, Qvrl)
- Outwash (Qvr, Qva)
- Till (Qpgt)
- Partial Removal Limits
- Well Casing
- Well Screen
- Proposed Sediment Sample
- Proposed Sediment and Offshore Groundwater Sample

Notes:

1. 22-foot Contour = Shoreline (OHWM).
2. Water table in upland is estimated based on groundwater elevations observed in shoreline water table wells in April and October 2013.
3. The extent of the Groundwater Discharge Zone depends on the location of this cross section (see dashed green line and Figure 9B).

10 0 10
Scale in Feet

Vertical Datum: USACE
Horizontal Datum: WASPN

Typical Cross Section Downgradient of Play Area

Gas Works Park Site
Seattle, Washington

GeoEngineers | **Figure 7B**

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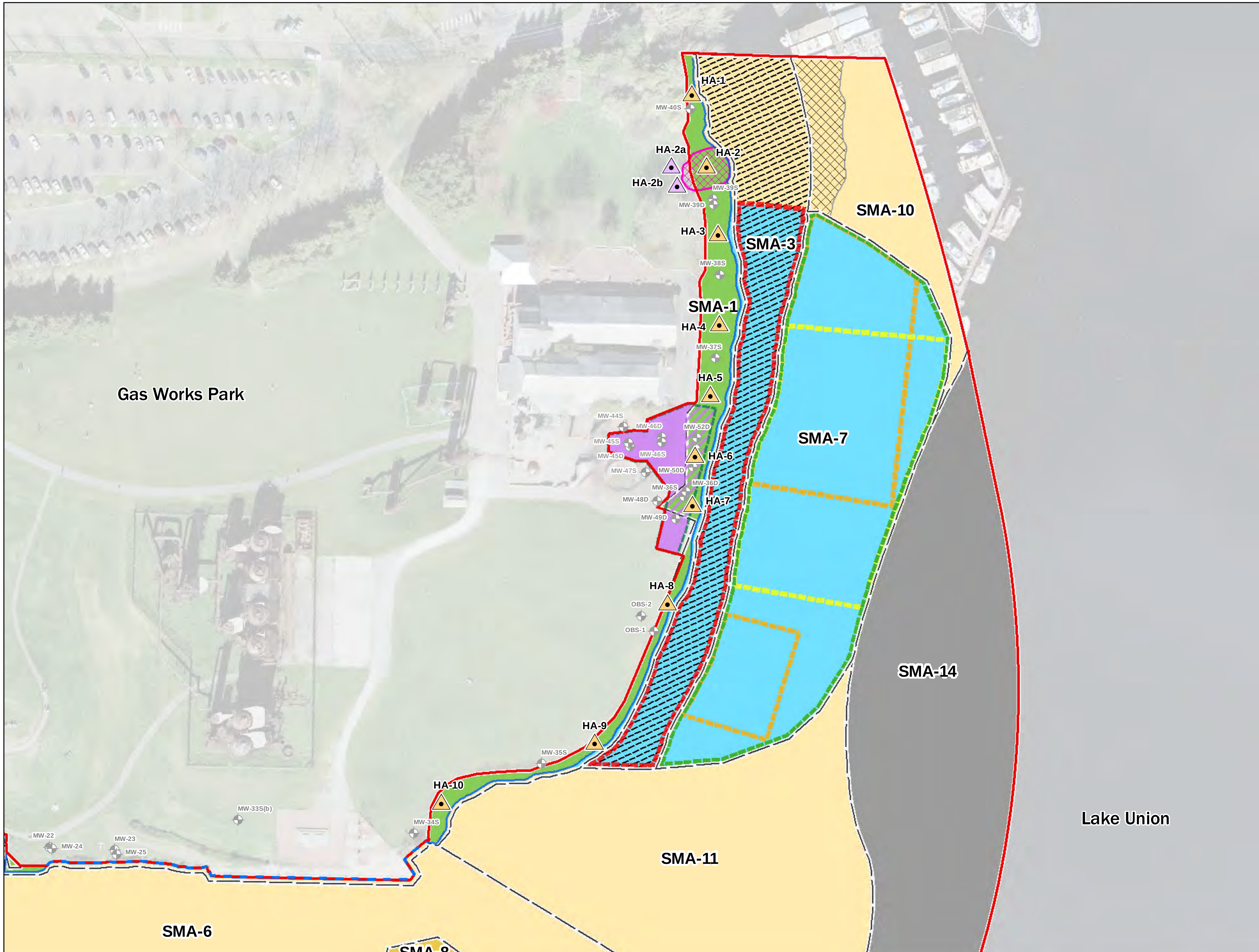

Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Enhanced Cap Elements

- Activated Carbon Amended Sand Cap
- Low-Permeability Cap
- Organoclay Amended Sand Cap
- Zero Valent Iron Amended Sand Cap

Proposed Sample Location

- Hand Collected Soil Core (Chemical Analyses)
- Hand Collected Soil Core (Field Screening for Tar Mound extent only)
- Current Shoreline Groundwater Monitoring Well

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601

N W E S

0 100 200
Feet

Upland Soil Sampling Locations - SMA-1

Gas Works Park Site
Seattle, Washington

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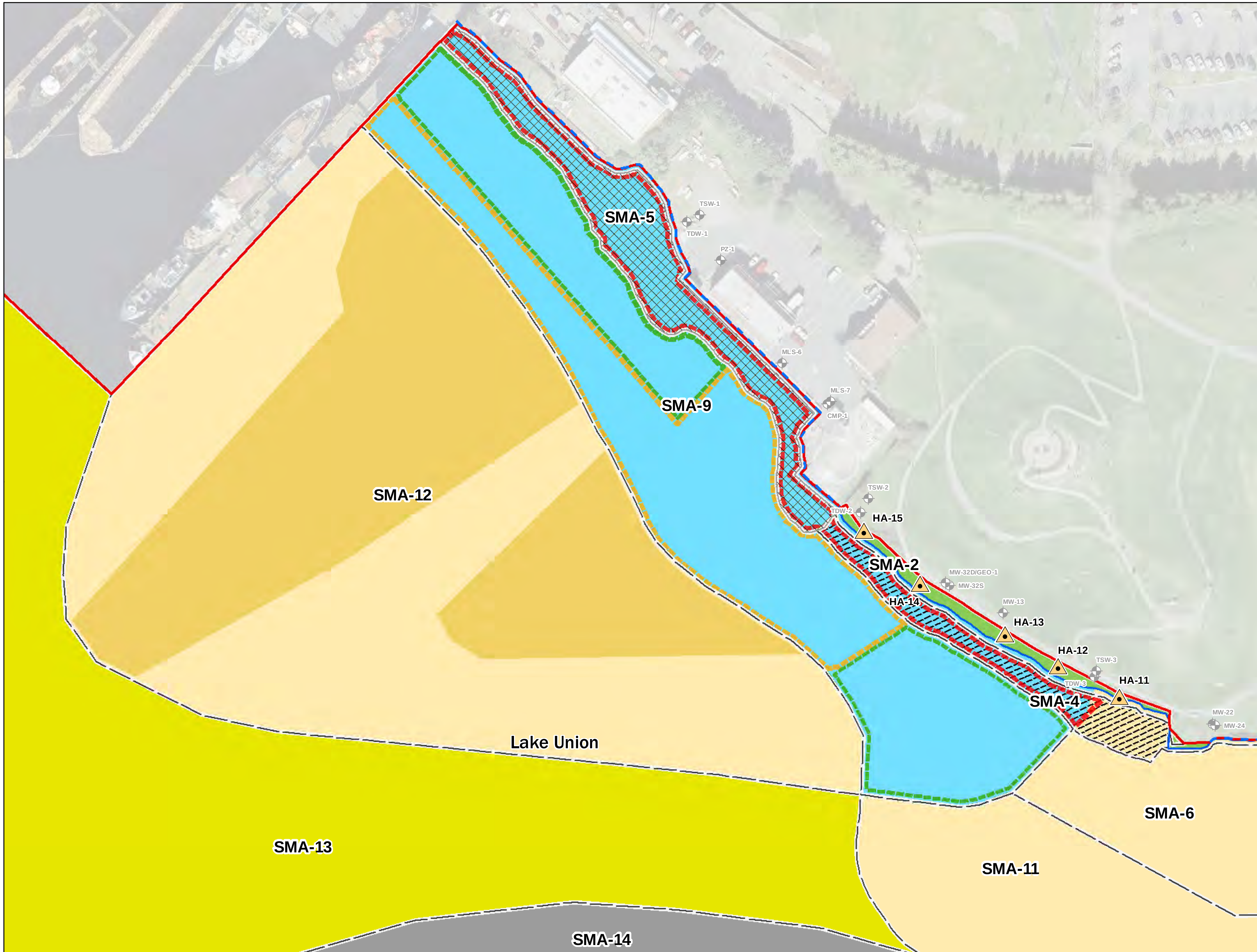
Figure 8A

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F08A_UplandSampleLocationsSMA3_7.mxd Map Revised: 25 October 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap
- Arsenic In-situ Treatment (Groundwater)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Enhanced Cap Elements

- Activated Carbon Amended Sand Cap
- Low-Permeability Cap
- Organoclay Amended Sand Cap

Proposed Sample Location

- Hand Collected Soil Core
- Current Shoreline Groundwater Monitoring Well

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601.

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N W E S

0 100 200
Feet

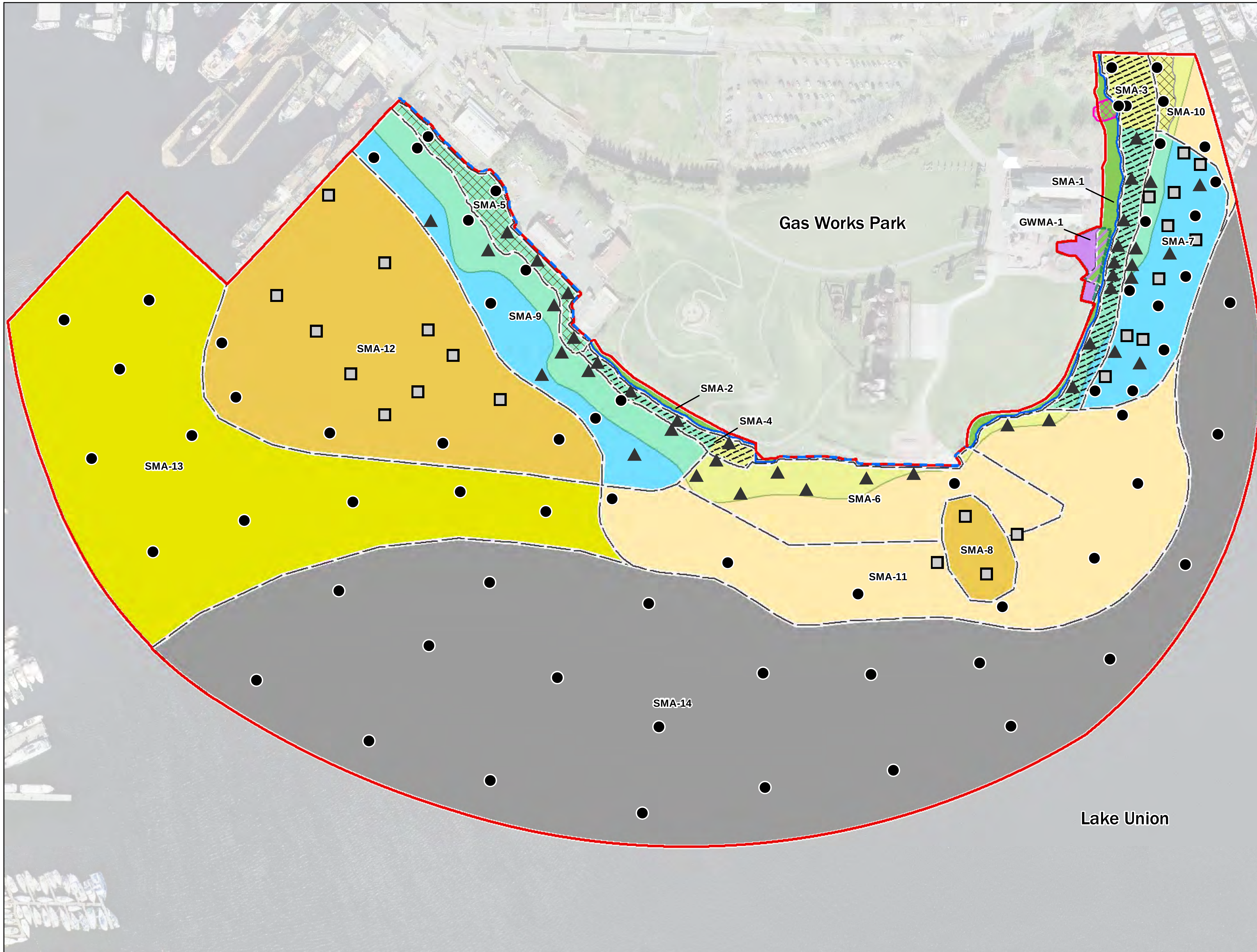
Upland Soil Sampling Locations - SMA-2

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 8B

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F08B_UplandSampleLocationsSMA4_5_9_12.mxd Map Revised: 19 September 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations
- Surface Sediment Grab Sample - Only NAPL Field Screening (24)
- Sediment and Offshore Groundwater Sample Location (42)
- Sediment Sample Location (68)
- Groundwater Discharge Zone/ Groundwater Compliance Area

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

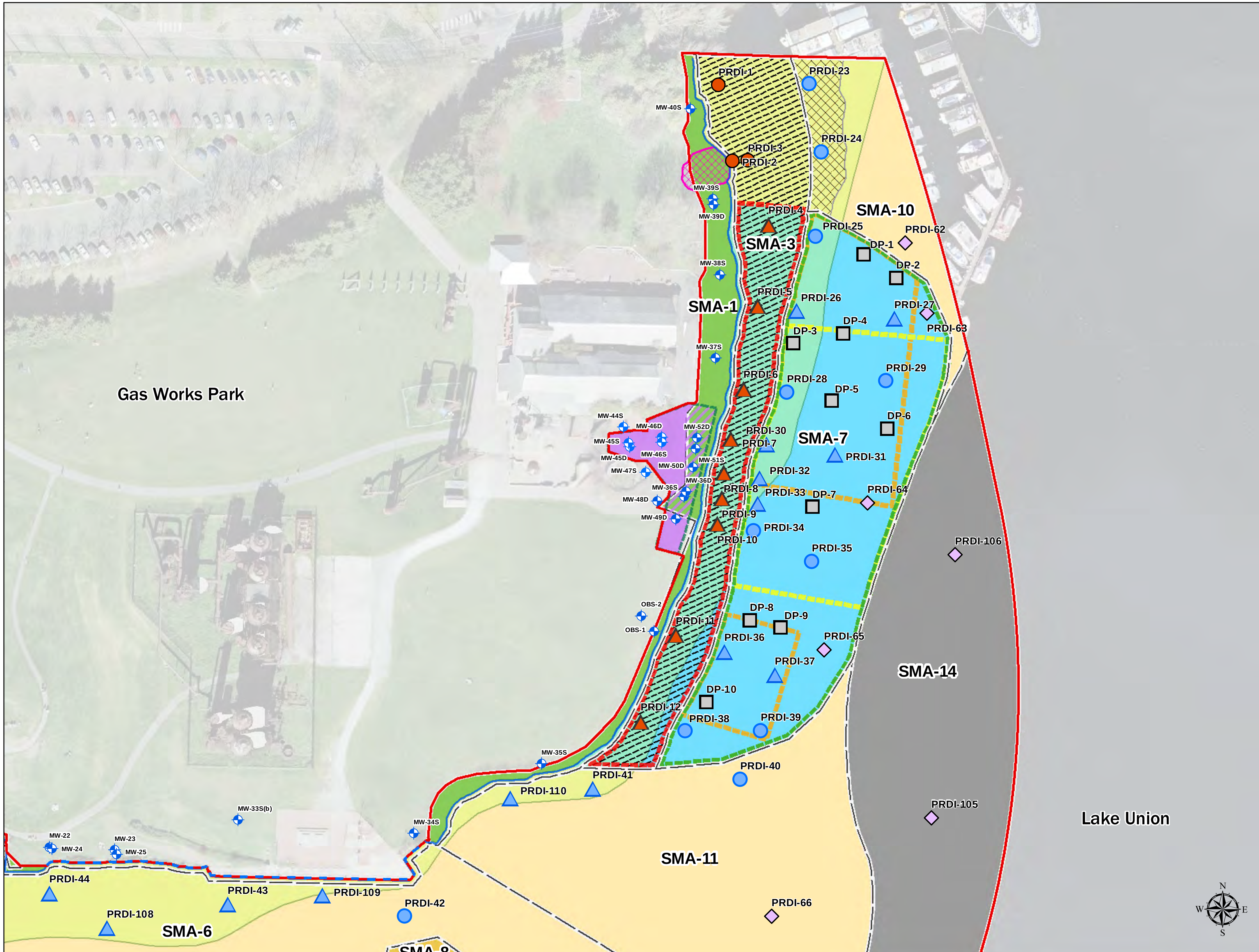
Summary of Sediment and Offshore Groundwater Sampling Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 9A

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9A_SamplingSummary.mxd Map Revised: 20 December 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Enhanced Cap Elements

- Activated Carbon Amended Sand Cap
- Low-Permeability Cap
- Organoclay Amended Sand Cap
- Zero Valent Iron Amended Sand Cap

Proposed Sample Location

- Current Shoreline Groundwater Monitoring Well
- Subsurface Sediment Core Sample
- Subsurface Sediment Core and Offshore Groundwater Sample
- Near Surface Sediment Sample
- Near Surface Sediment and Offshore Groundwater Samples
- Surface Sediment Grab Sample
- Surface Sediment Grab Sample - Only NAPL Field Screening
- Groundwater Discharge Zone/ Groundwater Compliance Area

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601.

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0 100 200
Feet

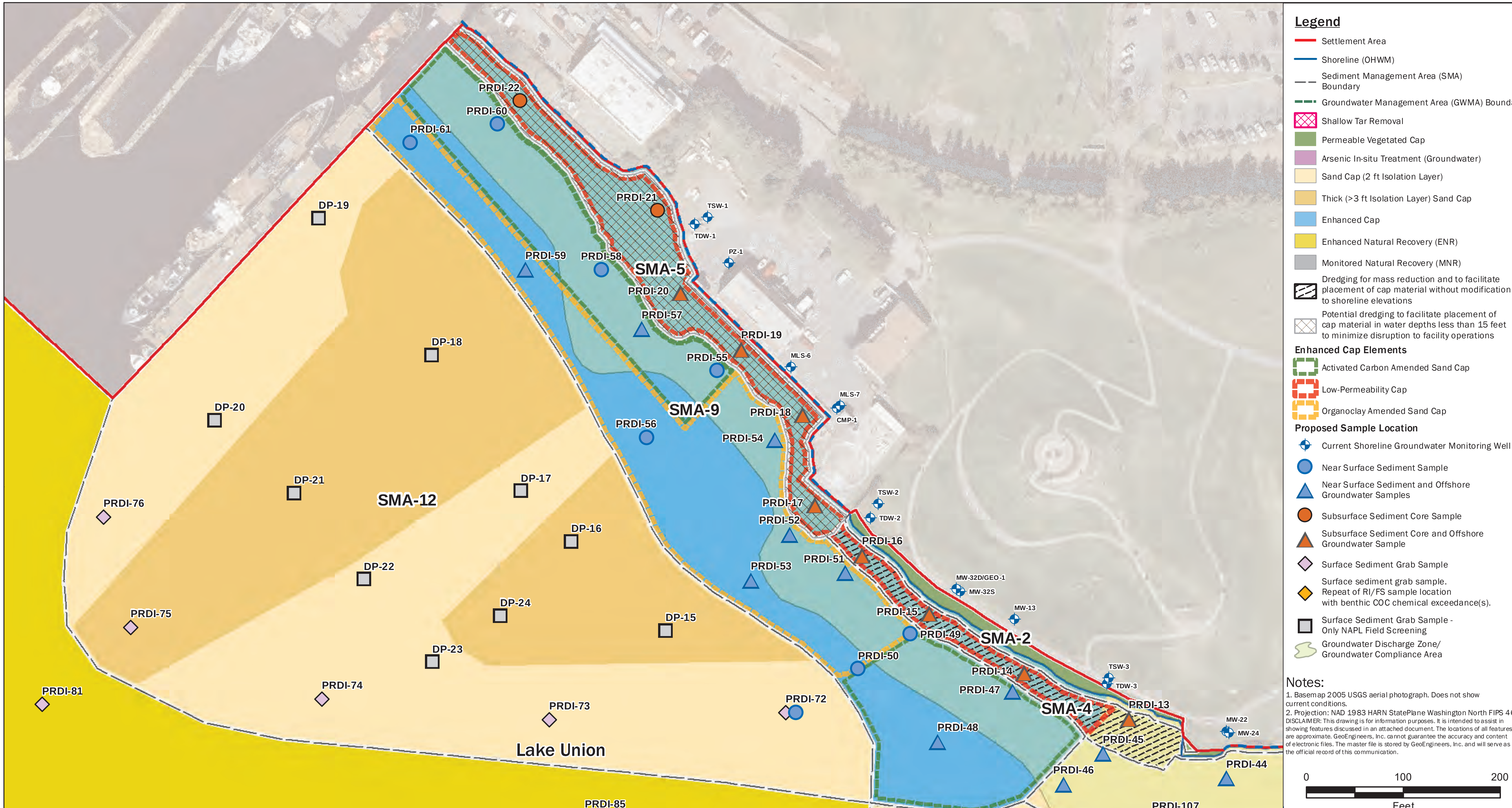
Sediment and Offshore Groundwater Locations - SMA-3, SMA-7, and SMA-10

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 9B

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9B_SampleLocationsSMA3_7_gwca.mxd Map Revised: 20 December 2023 maugust



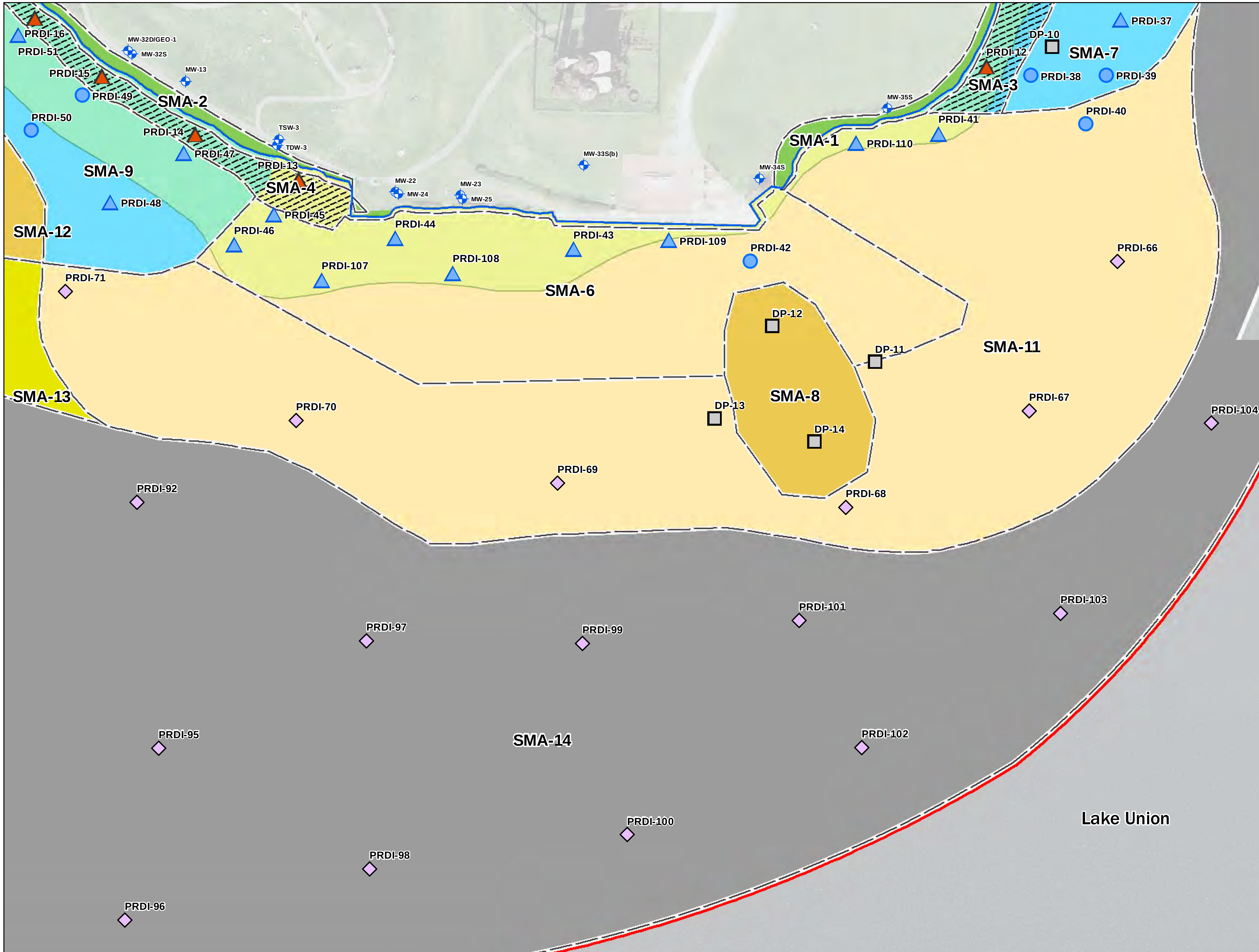
Sediment and Offshore Groundwater Locations - SMA-4, SMA-5, SMA-9, and SMA-12

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 9C

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186684603_F9C_SampleLocationsSMA4_5_9_12_gwca.mxd Map Revised: 12 February 2024 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Proposed Sample Location

- Current Shoreline Groundwater Monitoring Well
- Subsurface Sediment Core Sample
- Subsurface Sediment Core and Offshore Groundwater Sample
- Near Surface Sediment Sample
- Near Surface Sediment and Offshore Groundwater Samples
- Surface Sediment Grab Sample
- Surface Sediment Grab Sample - Only NAPL Field Screening
- Groundwater Discharge Zone/ Groundwater Compliance Area

Notes:

1. Locations PRDI-107 through PRDI-110 will be analyzed for arsenic only.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
S

0 100 200
Feet

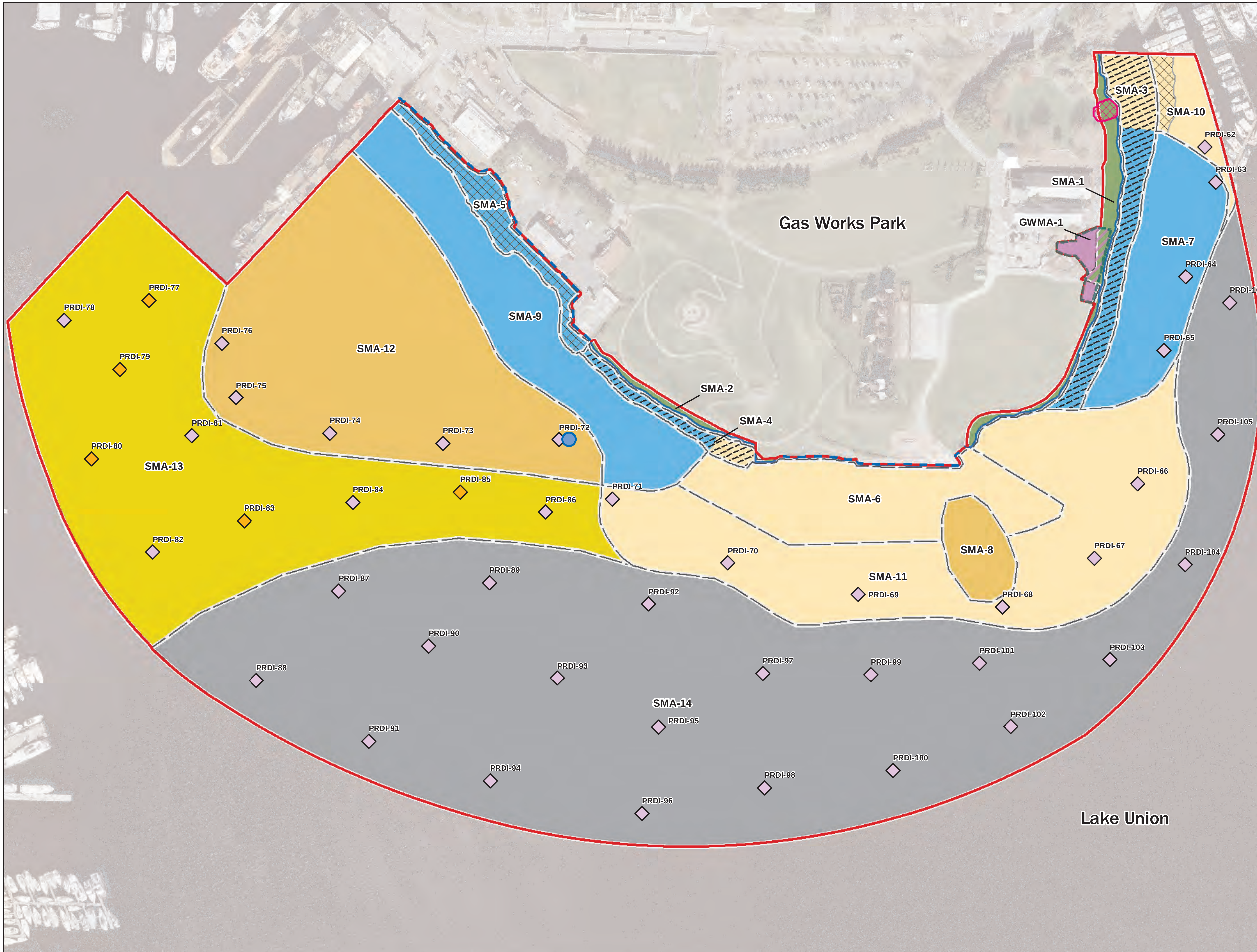
Sediment and Offshore Groundwater Locations - SMA-6, SMA-8, and SMA-11

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 9D

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9D_SampleLocationsSMA6_8_11_gwca.mxd Map Revised: 20 December 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Proposed Sample Location

- Current Shoreline Groundwater Monitoring Well
- Surface Sediment Grab Sample
- Surface sediment grab sample. Repeat of RI/FS sample location with benthic COC chemical exceedance(s).
- Near Surface Sediment Sample

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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N
W E
S

0 200 400
Feet

Sediment Locations - SMA-7, SMA-10, and SMA-11 through SMA-14

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 9E

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9E_ENR-MNRSurfSed_Locations.mxd Map Revised: 12 February 2024 maugust

Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment and Offshore Groundwater Sample Location
- RI/FS Sample Location

Arsenic Surface Sediment Concentration (mg/kg)

- ≤24 (Potential Offshore Groundwater Background Sample Area Background)
- >24 - ≤200
- >200 - ≤2,000
- >2,000
- Groundwater Discharge Zone/ Groundwater Compliance Area

Notes:

1. Arsenic sediment cleanup level and preliminary regional background = 24 mg/kg.
2. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
3. For non-detects, 1/2 the reporting limit is posted and used for interpolations. Interpolations include detects and non-detects.
4. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = 1,000).
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

Feet

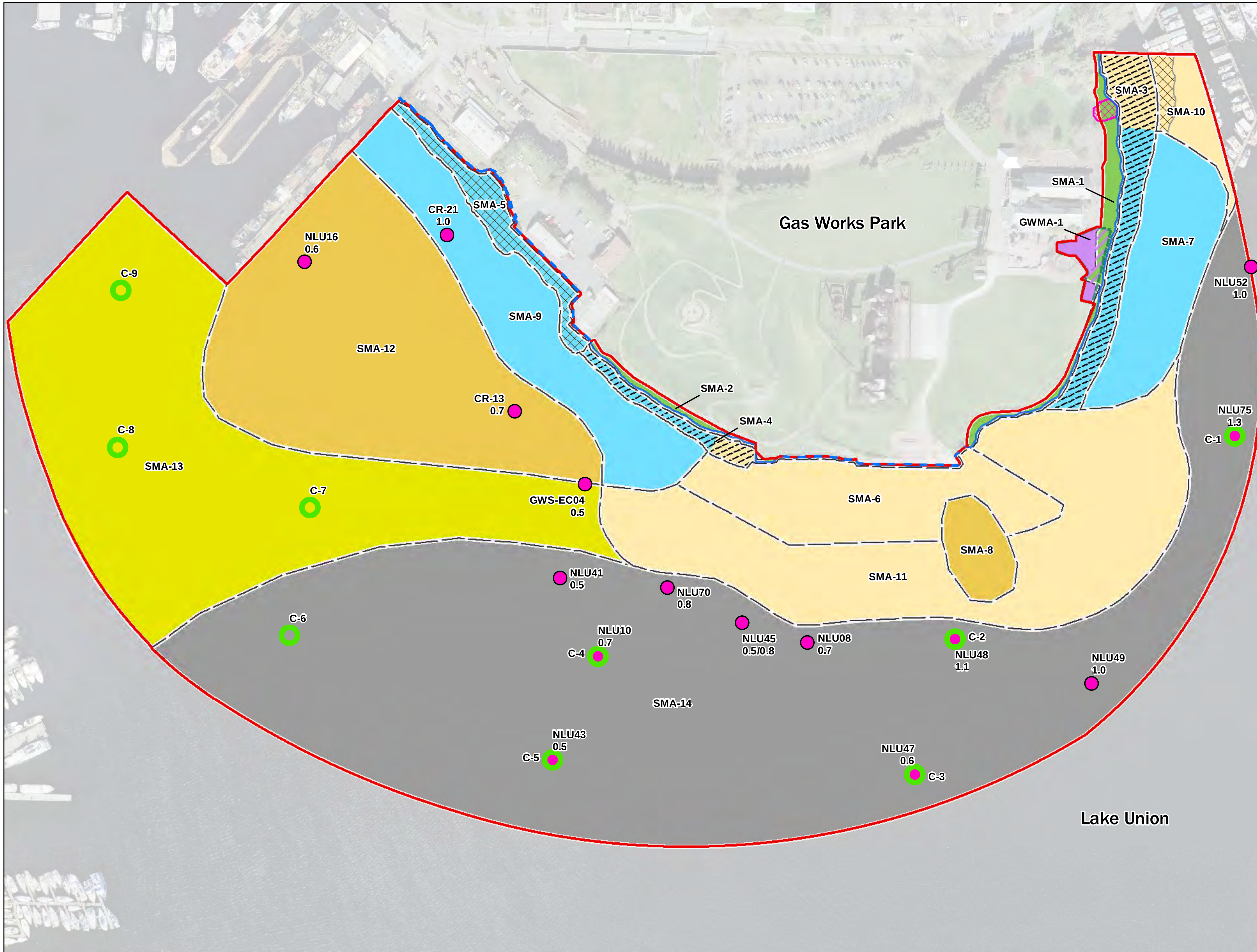
Arsenic Natural Background Offshore Groundwater Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 10

Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684601_F10_ArsenicBckgrndOffshore.mxd Map Revised: 23 January 2024 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations
- Proposed Deposition Rate Core Location
- RI/FS Deposition Rate in cm/year

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

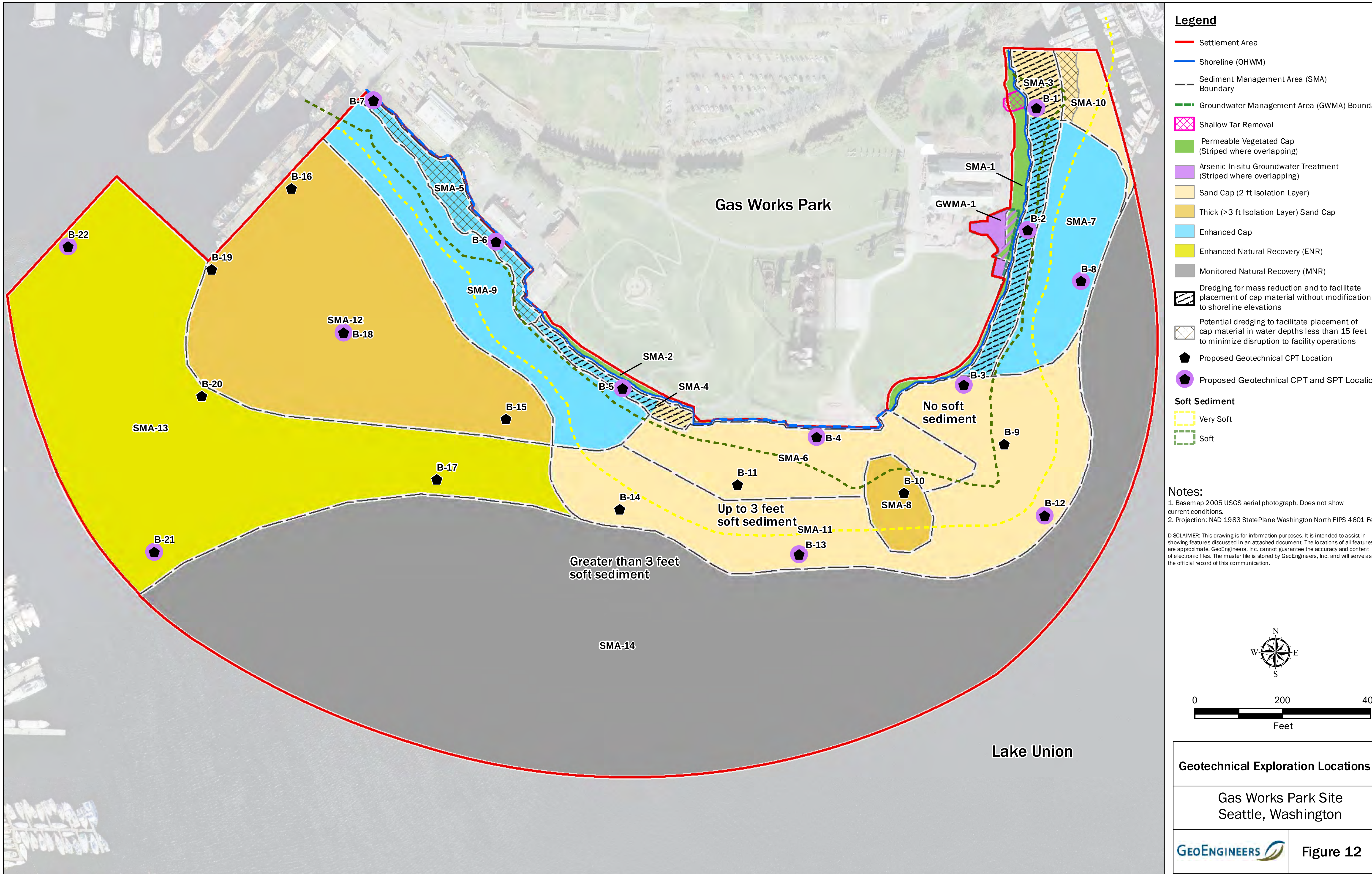
Deposition Rate Sediment Core Locations - SMA-13 and SMA-14

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 11

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F11_DepositionRates.mxd Map Revised: 19 December 2023 maugust



Geotechnical Exploration Locations

Gas Works Park Site
Seattle, Washington

Figure 12

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F12_GeotechnicalExplorations.mxd Map Revised: 19 December 2023 maugust

APPENDICES

APPENDIX A
Sampling and Analysis Plan/ Quality Assurance Project Plan

Appendix A
Pre-Remedial Design Investigation Environmental Sampling and Analysis Plan/Quality Assurance Project Plan

Gas Works Park Site
Seattle, Washington

for

Puget Sound Energy and the City of Seattle

February 26, 2024

GeoEngineers
Earth Science + Technology

Appendix A
Pre-Remedial Design Investigation Environmental Sampling and Analysis Plan/Quality Assurance Project Plan

Gas Works Park Site
Seattle, Washington

for
Puget Sound Energy and the City of Seattle

February 26, 2024

GeoEngineers

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Gas Works Park Site
Seattle, Washington

File No. 0186-846-04

February 26, 2024

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LIST OF ABBREVIATIONS AND ACRONYMS

%D	percent difference
ARI	Analytical Resources, Inc.
ASTM	ASTM International
bgs	below ground surface
bml	below mudline
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
City	City of Seattle
cm	centimeters
COC	chain of custody
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
CT	Cracking Towers
DQOs	data quality objectives
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
Eh	redox potential
EPA	United States Environmental Protection Agency
ES	East Shoreline
FS	Feasibility Study
ft	feet
GeoEngineers	GeoEngineers, Inc.
GPS	global positioning system
GWPS	Gas Works Park Site
HASP	health and safety plan
HP	Harbor Patrol
HS	heavy sheen
IA	indoor air
IDW	investigation derived waste
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
LNAPL	light non-aqueous phase liquid
LOQ	limits of quantification

MDL	method detection limit
MGP	manufactured gas plant
mL	milliliters
MRL	method reporting limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MTCA	Model Toxics Control Act
MS	moderate sheen
mV	millivolts
NAPL	non-aqueous phase liquid
NS	no sheen
NTU	nephelometric turbidity
OA	outdoor air
OSHA	Occupational Safety and Health Act
PAH	polycyclic aromatic hydrocarbons
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyls
PID	photoionization detector
ppm	parts per million
PQL	practical quantitation limit
PR	Prow
PRDI	Pre-Remedial Design Investigation
PSE	Puget Sound Energy
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI	Remedial Investigation
RPD	relative percent difference
RSD	relative standard deviations
SAP	Sampling and Analysis Plan
SC	Sediment Core

SMS	Sediment Management Standards
SOP	standard operating procedures
SS	slight sheen
SV	sub-slab vapor
SVOCs	semi-volatile organic compounds
TCLP	toxicity characteristic leaching procedure
TRLs	target reporting limits
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act

APPENDIX A
PRE-REMEDIAL DESIGN INVESTIGATION SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

1.0 INTRODUCTION

This Pre-Remedial Design Investigation (PRDI) Environmental Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) describes the field and laboratory activities that will be completed to collect supplemental environmental data for use in the engineering analysis and design of the planned cleanup actions at the Gas Works Park Site (GWPS) in Seattle, Washington (Figure A-1). The GWPS encompasses contamination associated with the former manufactured gas plant (MGP) and tar refinery and other historical industrial activities (Figure A-2). The Washington State Department of Ecology (Ecology)-approved Cleanup Action Plan (CAP) for the GWPS (Ecology 2023) presents the details on the cleanup action that will be completed pursuant to requirements of the Washington State Model Toxics Control Act (MTCA) (Chapter 70.105D of the Revised Code of Washington [RCW] and Chapter 173-340 of the Washington State Administrative Code [WAC]) and Sediment Management Standards (SMS) (Chapter 173-204 WAC). The PRDI, remedial design, permitting, cleanup construction and post-construction monitoring activities are being completed under Consent Decree No. 23-2-25643-3 (Ecology 2024) between Ecology, the City of Seattle (City), and Puget Sound Energy (PSE).

This SAP/QAPP serves as the primary guide for the integration of quality assurance (QA) and quality control (QC) functions for the PRDI environmental sampling including air, soil vapor, soil, groundwater, sediment, and offshore groundwater[1]. The SAP presents the objectives, procedures, organization, functions, activities, and specific QA/QC activities designed to achieve the environmental data quality objectives (DQOs) established for the project. Environmental measurements will be taken to produce data that are scientifically valid, of known and acceptable quality, and meet the PRDI objectives. The QAPP describes the QA/QC procedures that will be implemented so that the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the environmental data generated meet the specified DQOs to the maximum extent possible.

The QA/QC portions of this SAP/QAPP were prepared following the United States Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (EPA 2001), Guidance for Quality Assurance Project Plans (EPA 2002) and Ecology's Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology 2016). The SAP and QAPP have also been prepared in general accordance with requirements of the MTCA (Chapter 173-340 WAC) and SMS (Chapter 173-204 WAC).

2.0 PRDI ENVIRONMENTAL STUDY DESIGN

Air, soil vapor, soil, groundwater, sediment, and offshore groundwater will be sampled as part of the field activities for the PRDI. The sampling and analysis objectives and how the data will be utilized for future engineering analysis design work is presented in the PRDI Work Plan. Tables A-1a and A-1b present a summary of the proposed environmental sampling locations, targeted sample intervals and analytes. An overview of the study design for air, soil vapor, soil, groundwater, sediment, and offshore groundwater

[1] Offshore groundwater is defined as groundwater waterward of the OHWM and extending to the base of the biologically active zone (top 10 centimeters [cm] of sediment). In accordance with Ecology guidance, water within the biologically active zone is offshore groundwater.

sampling is provided in the sections below. The subsequent sections provide descriptions of the field equipment and procedures that will be used to obtain the identified data.

2.1. PRDI Environmental Elements

Proposed sample locations are presented in figures as follows:

- Air and Soil Vapor Sampling – Figure A-3.
- Upland Groundwater Sampling – Figures A-4A and A-4B.
- Upland Soil Sampling – Figures A-5A and A-5B.
- Sediment and Offshore Groundwater Sampling – Figures A-6A through A-6E and Figure A-7.

2.1.1. Air and Soil Vapor Sampling and Analysis

Four (4) indoor air, six (6) outdoor air, and four (4) sub-slab soil vapor samples will be collected in the GWPS uplands to confirm the conclusions from the air risk evaluation presented in Remedial Investigation/Feasibility Study (RI/FS) Appendix 4D. The indoor and outdoor air and soil vapor samples to be collected and analyzed are summarized in Table A-1a.

Indoor and outdoor air samples will be collected using 6-liter Summa canisters and sub-slab soil vapor samples will be collected using Vapor Pins and 1-liter Summa canisters at the locations shown on Figure A-3. The locations of air and soil vapor samples shown on Figure A-3 are approximate and may be adjusted during investigation activities if conditions do not allow samples to be collected at the proposed locations.

The samples that are collected will be submitted for the following laboratory analyses:

- Benzene, ethylbenzene, toluene, total xylenes, and naphthalene using EPA Method TO-15
- Petroleum hydrocarbons (C5-C8 aliphatics, C9-C12 aliphatics and C9-C10 aromatics) using EPA Method TO-15.
- Helium using ASTM International (ASTM) D 1946 (soil vapor only).

Air and soil vapor samples will be delivered to Friedman & Bruya, Inc. in Seattle, Washington (an Ecology-accredited laboratory) for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-2).

2.1.2. Groundwater Sampling and Analysis

Forty-seven (47) [2] groundwater samples will be collected for laboratory analysis from 40 existing and three (3) new angled monitoring wells to confirm and update groundwater chemical concentrations. The location of the new angled monitoring wells will be surveyed to document the horizontal position and elevation of the top of the well casing, the well monument, as well as the adjacent ground surface (see Section 14 for details).

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[2] Monitoring wells MLS-6 and MLS-7 are multi-level sampler (MLS) wells. Three samples will be collected from each well (see Appendix A, Table A-1a for the screen interval depths for each sample).

Groundwater sampling as part of the 2013 Supplemental Site Investigation was conducted in April and October 2013 (RI/FS Appendix 2A). Therefore, for data compatibility purposes, PRDI groundwater samples will also be collected in April and October. New angled monitoring wells will be installed and developed prior to sampling. Existing wells will be re-developed prior to the first groundwater monitoring event to remove suspended solids that may have accumulated in each well.

The groundwater samples to be collected as part of each of the activities are identified in Table A-1a. The locations of existing and new angled monitoring wells are shown on Figure A-4A. Groundwater samples will only be collected at the wells shown on Figure A-4A with blue and green symbols and identified as requiring "Chemical Analysis and Well Gauging."

The groundwater samples collected will be submitted for the following laboratory analyses:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and naphthalene using EPA Method 8270E-SIM;
- Dissolved arsenic using EPA Method 6010C. As noted in Table A-1A, arsenic groundwater samples for Play Area wells MW-36S, MW-36D, MW-44S, MW-45S, MW-45D, MW-46S, MW-46D, MW-47S, MW-48D, MW-49D, AMW-49D, MW-50D, AMW-50D, MW-51S, MW-52D, and AMW-52D should be unpreserved and filtered at the laboratory to avoid precipitation; and
- Arsenic speciation (arsenite/trivalent arsenic [As(III)], arsenate/pentavalent arsenic [As(V)] monomethylarsonic acid and dimethylarsinic acid) using Method BAL-4100. As noted in Table A-1A, arsenic speciation samples will only be collected from wells downgradient of the Play Area MW-49D/AW-49D, MW-50D/AW-50D, and MW-52D/AW-52D.

Except for the arsenic speciation samples, the groundwater samples will be delivered to Analytical Resources Inc. (ARI) in Tukwila, Washington (an Ecology-accredited laboratory) for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-3). Groundwater samples for analysis of arsenic speciation will be shipped to Brooks Applied Labs in Bothell, Washington (an Ecology-accredited laboratory) for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-3).

2.1.3. Soil Sampling and Analysis

Soil samples will be collected in SMA-1 and SMA-2 adjacent to the shoreline to characterize soil that will be excavated as part of the nearshore cleanup action. The soil samples to be collected and analyzed are summarized in Table A-1a.

Soil samples will be collected from the existing ground surface to the approximate base of the proposed excavation (3 feet below ground surface [bgs]) using a hand auger at ten (10) locations (HA-1 through HA-10) in SMA-1 and at five (5) locations (HA-11 through HA-15) in SMA-2 as shown on Figures A-5A and A-5B. The locations of the soil borings shown on Figures A-5A and A-5B are approximate and may be adjusted during investigation activities based on observations during field screening in adjacent borings or to avoid obstructions encountered during field sampling.

Soil samples will also be collected from the new angled monitoring wells (AMW-49D, AMW-50D and AMW-52D) during drilling activities.

The soil samples collected at the hand auger locations will be submitted for the following laboratory analyses:

- Resource Conservation and Recovery Act (RCRA) Metals using EPA Method 6010/6020;
- Benzene, ethylbenzene, toluene, and xylenes using EPA Method 8260D;
- Diesel- and oil-range petroleum hydrocarbons using NWTPH-Dx; and
- Polycyclic aromatic hydrocarbons (PAHs) using EPA Method 8270E-SIM.

The soil samples collected from sonic drilling cores during will be submitted for the following laboratory analyses:

- Arsenic using EPA Method 6010/6020; and
- Polycyclic aromatic hydrocarbons (PAHs) using EPA Method 8270E-SIM.

Soil samples will be delivered to ARI for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-4). Split soil samples will also be collected for archive at the laboratory for the possibility of performing follow-up toxicity characteristic leaching procedure (TCLP) analysis as may be required for landfill disposal characterization.

2.1.4. Subsurface Sediment and Offshore Groundwater Samples in SMA-3 through SMA-5

Forty-four (44) subsurface sediment samples will be collected at twenty-two (22) sediment sample locations (PRDI-1 through PRDI-22) in SMA-3, SMA-4, and SMA-5 to characterize sediment that will be dredged as part of the cleanup action and to characterize sediment that will be left in place below the proposed dredge prism. At 17 of the sediment sampling locations, offshore groundwater will also be collected to characterize conditions at the base of the dredge prism. The sediment and offshore groundwater samples to be collected and analyzed are summarized in Table A-1b.

The locations of sediment and offshore groundwater samples shown on Figures A-6B and A-6C are approximate and may be adjusted during investigation activities.

2.1.4.1. Subsurface Sediment Sampling

At the subsurface sample locations in SMA-3, SMA-4, and SMA-5, sediment cores will be completed using vibracore methods to one foot below the base of the proposed dredge prism (approximately Elevation +10 feet U.S. Army Corps of Engineers [USACE] Locks Datum) to a target depth of an approximate Elevation +8 feet USACE Locks Datum. Table A-1b provides target depths for the sediment core locations.

Sediment samples will be collected from the interval in each core that represents material that will be dredged as detailed in Table A-1b. Samples representing the material that will be dredged will be submitted for the following laboratory analyses:

- Sulfides using EPA Method 9034;

- Benzene, ethylbenzene, toluene, and xylenes using EPA Method 8260D;
- Diesel-, and oil--range petroleum hydrocarbons using NWTPH-Dx;
- PAHs, including cPAHs, using EPA Method 8270E-SIM;
- Tributyltin using EPA Method 8270E-SIM
- 4-methylphenol, benzoic acid, bis(2-ethylhexyl)phthalate (BEHP), di-n-butylphthalate, di-n-ocytyphthalate, hexachlorobenzene, pentachlorophenol, phenol, carbazole, dibenzofuran using EPA Method 8270E;
- Chlordane and 4,4' DDE using EPA Method 8081;
- Polychlorinated biphenyl (PCB) Aroclors using EPA Method 8082;
- Methylmercury using SOP-BAL-3200, and
- RCRA metals plus copper and nickel using EPA Method 6010/6020.

Sediment samples representing the dredge material will also be collected for archive at the laboratory for the possibility of performing follow-up TCLP analysis as required for landfill disposal characterization.

Sediment samples will also be collected from the cores at the interval that is representative of the material that is located immediately below the base of the proposed dredge prism (approximately Elevation +8 to +10 feet USACE Locks Datum) as detailed in Table A-1b. Samples representing the material at the base of the proposed dredge prism will be submitted for the following analyses:

- Benzene, ethylbenzene, toluene and using EPA Method 8260D;
- PAHs, including cPAHs, using EPA Method 8270-SIM;
- Arsenic by 6010
- Polychlorinated biphenyl (PCB) Aroclors using EPA Method 8082 (two locations only);
- Dioxins and furans using EPA Method 1613 (two locations only); and
- Total organic carbon (TOC) by PSEP 1986 and grain size by ASTM D-6913/D-7928 at select locations.

Sediment samples will be delivered to ARI for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-5).

2.1.4.2. Subsurface Offshore Groundwater Sampling

At 17 of the subsurface sediment sampling locations in SMA-3, SMA-4, and SMA-5, an offshore groundwater sample will be collected by placing a temporary piezometer to an elevation below the proposed dredge prism (approximately Elevation +8 to +10 feet USACE Locks Datum) as detailed in Table A-1b. Offshore groundwater samples will be collected from the temporary piezometer and submitted for the following analyses:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- PAHs, including cPAHs, using EPA Method 8270E-SIM;

- Dissolved arsenic using EPA Method 6010C. As noted in Table A-1b, arsenic offshore groundwater samples for subsurface sampling locations PRDI-8 through PRDI-10 should be unpreserved and filtered at the laboratory to avoid precipitation; and
- Arsenic speciation (arsenite/trivalent arsenic [As(III)], arsenate/pentavalent arsenic [As(V)] monomethylarsonic acid and dimethylarsinic acid) using Method BAL-4100. As noted in Table A-1B, arsenic speciation samples will only be collected from subsurface sampling locations PRDI-8 through PRDI-10.

Offshore groundwater samples will be delivered to ARI for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-3). Groundwater samples for analysis of arsenic speciation will be delivered to Brooks Applied Labs for standard turnaround time in accordance with sample handling procedure (see Table A-3).

2.1.5. Near Surface Sediment and Offshore Groundwater Samples in SMA-6, SMA-7, SMA-9, SMA-10, and SMA-11

At 43 sediment sample locations located in SMA-6, SMA-7, and SMA-9 through SMA-11 near surface sediment samples will be collected from approximately 0 to 1 feet below mudline (bml) to characterize sediment that will be capped as part of the cleanup action (as identified in Table A-1b and Figures A-6B through A-6D). Additionally, at 20 of the sampling locations, co-located offshore groundwater will be collected within the 0 to 1 feet bml interval.

A combination of the bathymetric survey and, if necessary, real-time sonar and/or video tools will be used to identify the mudline.

2.1.5.1. Near Surface Sediment Sampling

At each sample location in SMA-6, SMA-7 and SMA-9 through SMA-12, a near surface sediment will be collected by using power grab methods (piston sampler or vibracore methods will be used if the power grab methods are not successful) from the sediment surface to 1 feet bml. The sampling method will be based on sediment material to obtain a representative and undisturbed sample.

One sample will be collected from the top one foot of sediment at each location as detailed in Table A-1b. This sample will be analyzed for:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- PAHs, including cPAHs, using EPA Method 8270E-SIM;
- Arsenic by 6010;
- Polychlorinated biphenyl (PCB) Aroclors using EPA Method 8082 (one location only);
- Dioxins and furans using EPA Method 1613 (three locations only); and
- Total organic carbon (TOC) by PSEP 1986 and grain size by ASTM D-6913/D-7928 at select locations.

Sediment samples will be delivered to ARI for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-5).

2.1.5.2. Near Surface Offshore Groundwater Sampling

At 20 near surface sediment locations in SMA-6, SMA-7 and SMA-9 through SMA-11, offshore groundwater will be collected as detailed in Table A-1b. The offshore groundwater sample will be collected from 0.5 to 1.5 feet bml interval. The offshore groundwater sample will be collected with a temporary piezometer and analyzed for:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- PAHs, including cPAHs, using EPA Method 8270E-SIM;
- BEHP, carbazole and dibenzofuran using EPA Method 8270E; and
- Dissolved arsenic, cadmium, copper, lead, mercury, nickel, and silver by EPA Method 6010/7470.

Offshore groundwater samples will be delivered to ARI for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-3).

2.1.6. Surface Sediment Samples in SMA-7 and SMA-10 through SMA-14

At 45 sediment sample locations in SMA-7 and SMA-10 through SMA-14, surface sediment samples will be collected using power grab sampling methods as identified in Table A-1b and Figure A-6E. The surface sediment samples will be collected from 0 to 10 cm bml and will be analyzed for the following bioaccumulative contaminants of concern:

- cPAHs using EPA Method 8270E-SIM;
- Hexachlorobenzene and pentachlorophenol using EPA Method 8270E;
- Chlordane using EPA Method 8081;
- PCB Aroclors using EPA Method 8082
- Arsenic and chromium using EPA Method 6010/7470;
- Dioxins and furans using EPA Method 1613 (five locations only); and
- Methylmercury using SOP-BAL-3200.

Select surface sediment samples, PRDI-71 through PRDI-82, that are in SMA-13 will also be analyzed for the following benthic contaminants of concern:

- Sulfides using EPA Method 9034;
- PAHs and Tributyltin using EPA Method 8270E-SIM;
- Diesel- and oil-range petroleum hydrocarbons using NWTPH-Dx;
- 4-methylphenol, benzoic acid, bis(2-ethyl)phthalate, carbazole, dibenzofuran, di-n-butyl phthalate, di-n-octyl phthalate, and phenol using EPA Method 8270E;
- 4,4’ DDE using EPA Method 8081;
- PCB Aroclors using EPA Method 8082;
- Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and silver by EPA Method 6010/7470; and

- Grain size by ASTM D-6913/D-7928 at select locations.

A combination of the bathymetric survey and, if necessary, real-time sonar and/or video tools will be used to identify the mudline.

Sediment samples will be delivered to ARI for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-5).

2.1.7. Near Surface Sediment Visual Field Screening for DNAPL in SMA-7, SMA-8, SMA-11, and SMA-12

At 24 sample locations in SMA-7, SMA-8, SMA-11, and SMA-12, near surface sediment samples will be collected by power grab methods as identified in Table A-1b and Figures A-6B, A-6C, and A-6D for non-aqueous phase liquid (NAPL) field screening. The near surface sediment samples will be collected from 0 to 1-foot bml for visual observation of the presence or absence of NAPL. A combination of the bathymetric survey and, if necessary, real-time sonar and/or video tools will be used to identify the mudline.

2.1.8. Sediment Cores for Deposition Rate in SMA-13 and SMA-14

Sediment cores will be completed at nine (9) sampling locations in SMAs 13 and 14 as shown on Figure A-7 to evaluate the rate of historical sediment deposition. Sediment cores will be completed using vibracore methods to a target depth of approximately 7 feet bml. The cores will be logged to classify sediment lithology and to identify the "gray marker bed" that was deposited around 1916, which will be used to measure the thickness of sediment that has accumulated since that time and calculate the accompanying average sedimentation rate at the sampling location.

2.1.9. Surface Sediment Grain Size

Grain size samples will be collected and analyzed from select sample locations in SMA-3 through SMA-14 to characterize existing habitat conditions within the biologically active zone throughout the Settlement Area. A total of 26 samples will be collected and analyzed for grain size by ASTM Methods D-6913 and D-7928 as identified on Table A-1b. Samples will be collected from 0 to 10 cm below mudline. Samples will be collected from the corresponding location using the methods to collect sediment for chemical analysis.

The samples for grain size will be delivered to ARI for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-5).

2.2. Sample Identifier Designation System

2.2.1. Air and Sub-Slab Soil Vapor Sample Designations

The air and sub-slab soil vapor samples will be assigned a unique sample identifier. The sample designator will include the sample location (Harbor Patrol [HP], East Shoreline [ES], Prow [PR], Cracking Towers [CT] or Parking Lot [PL]), the sample media (indoor air [IA], outdoor air [OA], or sub-slab soil vapor [SV] followed by the sample number for that media at that location as presented in Table A-1a and shown on Figure A-3.

For example, the second indoor air sample collected in the Harbor Patrol Building would be designated as HP-IA-02. The sample identification will be placed on the sample label, field report form, and chain-of-custody form.

2.2.2. Groundwater Sample Designation

Groundwater samples collected from monitoring wells will be assigned a unique sample identifier consisting of the well identification, as presented in Table A-1a, and shown on Figure A-4A, and the sample date. For example, a sample collected from monitoring well MW-32S on January 15, 2024, would be identified as MW-32S-011524. The sample names will be recorded in the field notes, on the sample label and on the chain-of-custody form.

2.2.3. Soil Sample Designation

The soil samples will be assigned a unique sample identifier. The sample boring designator will include the sampling method: hand auger (HA), followed by the sample location number as presented in Table A-1 and shown on Figures A-5A and A-5B. The sample interval depth in feet bgs will be added following the sample location number.

For example, a soil sample collected from a depth of 0 to 3 feet bgs at location HA-1 would be designated as HA-1_0-3. The sample identification will be placed on the sample label, field report form, and chain-of-custody form.

2.2.4. Sediment Sample Designations

Discrete sediment samples collected from the subsurface, near surface and surface sediment will be assigned unique sample identifiers consisting of the sample location number, sample type and depth interval in feet (ft) or centimeters (cm) bml. The sample type will be one of the following:

- Sediment Core (SC) for samples collected from a vibracore at a depth below the mudline from approximately 2 to 11 ft bml.
- Near Surface (NS) for samples collected using a power grab sampler (or other method such as vibracore or piston sampler) to collect sediment from 0 to 1 ft bml.
- Surface Sample (SS) for surface samples collected using a power grab sampler representing the biologically active compliance zone from 0 to 10 cm bml.

For example, a sample collected from PRDI-1 from 2 to 4 ft bml using a vibracore would be identified as PRDI-1-SC-2-4. A sample from PRDI-62 from 0 to 10 cm bml using a power grab would be identified as PRDI-62-SS and a sample from PRDI-23 from 0 to 1 ft bml using a power grab would be identified as PRDI-23-NS. The near surface (NS) and surface (SS) sample do not require the sample ID to include the depth because NS and SS are consistent depths.

2.2.5. Offshore Groundwater Sample Designation

Discrete offshore groundwater samples collected from the Marine Unit will be designated with the sample location followed by "OG." For example, a sample collected from PRDI-4 would be identified as PRDI-4-OG.

3.0 UPLAND AREA FIELD SAMPLING EQUIPMENT AND PROCEDURES

The following sections summarize the upland area sample collection procedures for the PRDI. The upland area investigation includes the collection and analysis of air and soil vapor samples, groundwater samples and soil samples and the installation of new angled monitoring wells. The PRDI Work Plan and Table A-1a provide rationale and details for the planned sampling objectives and analytical program.

3.1. Underground Utilities Clearance

Prior to beginning subsurface investigations in the upland area of the GWPS, the exploration locations will be marked in the field using stakes, marking paint or similar techniques. The following general procedures will be followed for utility clearances.

- Locations of proposed explorations will be visually observed to determine whether debris or other objects may need to be removed prior to drilling.
- Location coordinates of the proposed explorations will be determined using a portable global positioning system (GPS) unit.
- GeoEngineers, Inc. (GeoEngineers) will contact the Washington State Utility Notification Center (1-800-424-5555 or 811) at least 48 hours prior to intrusive activities to arrange for the location of underground utilities.
- GeoEngineers will coordinate with the City to obtain as built drawings of existing park and Harbor Patrol utilities (if available) prior to intrusive subsurface activities.
- GeoEngineers will subcontract a private commercial utility locating service to mark underground utilities in the vicinity of planned exploration locations, including soil vapor locations inside the Harbor Patrol buildings, prior to intrusive subsurface activities.

The exploration locations may be modified as necessary, to stay clear of identified utilities.

3.2. Air and Sub-Slab Soil Vapor Sampling Methods

The following methods will be used to collect the indoor air, outdoor air, and sub-slab soil vapor samples.

A building survey will be completed prior to sampling. The purpose of the survey is to obtain data that will allow a qualitative assessment of factors that potentially could influence air quality. The building survey includes collecting data on aspects of the building configuration such as building layout, utility entrances into the building, HVAC system design (if present), foundation conditions, and building material types (e.g., recent carpeting/linoleum and/or painting) and other building configuration aspects that could influence sample data. The building survey also includes collecting data related to products used in the building and any indoor storage of chemicals, paints and/or petroleum hydrocarbon products, and other potential sources of volatile contaminants that may influence the sampling results. The results of the building survey will be used to adjust sampling locations as necessary. The building survey will be documented by completing the Building Survey Form in Attachment A-1.

3.2.1. Air Sampling Methods

- Indoor and outdoor air samples will be collected at the same time over an 8-hour period using laboratory-provided, evacuated 6-Litre Summa canisters.
- Air sampling will be conducted using a vacuum gauge and an 8-hour flow controller.

- The canisters for indoor air samples will be placed on the ground and the canister intake situated approximately 3- to 5-feet aboveground to collect samples representative of the breathing zone for building occupants.
- Outdoor air samples will be collected near the air intake for the HVAC units that directs indoor air into the Main Office Building and in the upwind direction of the Warehouse Building.
- To the extent practicable, indoor air sampling will be conducted under conservative (i.e., “worst case”) conditions as recommended by Ecology guidance. Specifically, windows will be kept closed and ingress and egress activities will be minimized to the extent possible during sampling. The intent is to obtain indoor air samples that are representative of conservative, normal conditions, but sample when few building occupants are present and few windows and exterior doors are opening and closing, to reduce potential interferences.

3.2.2. Sub-Slab Soil Vapor Sampling Methods

- Sub-slab soil vapor probe installation and sampling procedures are outlined in Attachment A-2.
- Prior to installing the soil vapor probes, a subcontractor will perform a private utility locate to clear the sub-slab soil vapor sample locations.
- The sub-slab samples will be collected using Vapor Pin™ sampling devices like the one shown on Attachment A-3. The Vapor Pin™ will be installed in general accordance with the manufacturers' standard operating procedures (Attachment A-3), which involves drilling a hole through the concrete slab to insert the Vapor Pin™ and secure it in place with the silicone gasket.
- Pre-sampling quality control procedures (shut-in test, leak testing, and purging) and soil vapor sampling will not take place for at least 30 minutes following installation of the vapor pin.
- Sub-slab soil vapor samples will be collected using laboratory-provided, evacuated 1-liter Summa canisters.
- Following soil vapor sample collection, the Vapor Pin™ sampling devices will be removed, and the holes will be patched with concrete.

3.3. New Angled Monitoring Well Installation

New angled groundwater monitoring wells will be installed along the shoreline and paired and adjacent to existing wells MW-49D, MW-50D and MW-52D. The planned locations of the new wells are shown in Figure A-4A and the typical layout of angled monitoring wells relative to the vertical wells is shown in section view in Figure A-4B. Monitoring well construction details will be recorded on field forms/logs. Well construction elements are discussed below.

Drilling activities will conform to State and local regulations including Chapter 173-160 WAC, *Minimum Standards for Construction and Maintenance of Wells*. Drilling activities for the PRDI will be completed using sonic drilling methods operated by a licensed drilling subcontractor.

Subsurface debris or structures may be encountered, resulting in drilling refusal. If refusal is encountered, the exploration will be relocated as close to the originally planned location as practical and based on field conditions and other considerations at the time of the work. The required amount of workspace for the sonic drill track rig to comfortably achieve an angled well installation is approximately 40 feet by 20 feet. If this workspace is not available in the desired location, the exploration will be relocated. The ideal angle of the wells based on the drilling constraints is 30 to 33 degrees with a maximum angle of 45 degrees.

Soil samples will be collected from the sonic drilling cores during drilling activities. Two soil samples will be collected from each of the angled monitoring wells at the following intervals:

- Sample from within the outwash unit, at the middle of the well screen interval.
- Sample from within the fill unit, approximately 5 feet above the outwash unit.

Samples will be collected in accordance with Section 3.7.1.

3.3.1. Well Casing

The new angled monitoring wells will be constructed using 2-inch diameter, Schedule 40, threaded, polyvinyl chloride (PVC) casing that meets the following requirements: 1) casing will be new (unused); 2) glue will not be used to join casing sections; casing sections will be joined only by tightening the threaded sections; and 3) casing will be set at a consistent angle.

3.3.2. Well Screen

New angled monitoring wells AMW-49D, AMW-50D, and AMW-52D will be constructed at an angle of approximately 30 to 33 degrees towards the water as shown in Figure A-4B. AMW-49D will have a screened interval of 10 feet in length set across the upper saturated zone and positioned from approximately 25 to 35 feet bgs. The screened interval is targeting the upper section of the shallow groundwater table waterward of the existing well MW-49D that has a well screen completed to the same depth (25 to 35 feet bgs; Elevation 5.4 to -4.6 feet USACE Locks Datum). The well screen will consist of 2-inch diameter, Schedule 40, 0.010-inch or 0.020-inch machine-slotted, pre-packed PVC well screens. A PVC end cap will be installed on the bottom of the well screen. AMW-49D will be installed approximately 5 to 10 feet waterward (east) of the MW-49D vertical well. The purpose of this installation location is to stay as close as possible to the original MW-49D, while maintaining a reasonable drilling angle during installation (equal to or less than approximately 33 degrees).

New angled monitoring wells AMW-50D and AMW-52D will be constructed with a screened interval mirroring the screened interval of existing wells MW-50D and MW-52D (both of which are screened from 30 to 35 feet bgs; Elevation -0.8 to -5.8 feet USACE Locks Datum). Like AMW-49D, the well screens for AMW-50D and AMW-52D will consist of 2-inch diameter, Schedule 40, 0.010-inch or 0.020-inch machine-slotted, pre-packed PVC well screens with an end cap installed on the bottom of the well screen.

Well Identification	Approximate Well Angle (degree)	Approximate Screened Depth (ft bgs)	Approximate Screened Elevation (ft USACE Locks Datum)	Description for Placement
AMW-49D	33	25 to 35	5.4 to -4.6	Wells to be screened in the same depths as the paired vertical wells (MW-49D, MW-50D, and MW-52D).
AMW-50D	31	30 to 35	-0.8 to -5.8	
AMW-52D	33	30 to 35	-0.8 to -5.8	

3.3.3. Filter Pack

The filter pack for the new wells will consist of silica sand with the appropriate grain size distribution to reduce the entry of fine-grained particulates from the surrounding formation into the wells (e.g., 10-20 or 20-40 sand). The filter pack will extend from the bottom of the well screen to at least 1 foot above the top of the well screen. The top of the sand pack will be sounded to verify its depth during placement.

3.3.4. Annular Seal

The annular seal will consist of a minimum 3-foot-thick layer of hydrated bentonite pellets or chips installed between the filter pack and the concrete surface seal.

3.3.5. Surface Completion

The new angled monitoring wells will be completed with an oversized flush-mount monument. The well casing will be cut approximately 3 inches bgs, and a locking J-plug (compression) or similar well cap will be installed to prevent surface water from entering the well. The well monument will be installed in a concrete surface seal. The well number will be marked on the well monument lid and/or the well cap. The new monitoring well will be secured with a corrosion-resistant lock.

3.4. New and Existing Monitoring Well Development

New angled monitoring wells will be developed no sooner than 24 hours after installation to allow the surrounding water-bearing zone to recover after well installation and allow the bentonite annular seal to cure. Many of the existing monitoring wells to be sampled as part of the PRDI groundwater monitoring events have not been sampled for approximately 7 to 10 years. To increase the likelihood that groundwater sampling data achieves reasonable representation of groundwater conditions, existing wells that will be sampled during the PRDI will be redeveloped before sampling. The groundwater monitoring wells that will be redeveloped and sampled during the PRDI are shown on Figure A-4A with blue and green symbols and identified as requiring “Chemical Analysis and Well Gauging.” Groundwater monitoring wells shown on Figure A-4A with pink symbols and identified as requiring “Well Gauging Only” will not be redeveloped or sampled.

Before each well is developed, the depth to water in the well and the total well depth will be measured, and the well will be checked for the presence of light non-aqueous phase liquid (LNAPL). Monitoring wells with a measurable thickness of LNAPL, if encountered, will not be developed or sampled. The new and existing monitoring wells will be developed using a combination of surging and purging. The wells will be purged until at least five well casing volumes have been removed and turbidity has stabilized. The target turbidity is less than 10 nephelometric turbidity units (NTU) but may not be achieved in all wells. Water quality parameters (e.g., temperature, pH, conductivity, turbidity) will be measured and recorded on field logs during well purging. Groundwater sampling will be conducted no sooner than 48 hours after well development.

3.5. Manual Water and Product Level Monitoring

Depth to groundwater will be measured in each of the monitoring wells, piezometers, and reported from the Ballard Locks Station Gage as described in Attachment A-4. Field staff will measure depth to groundwater using an electronic water level indicator to the nearest 0.01 foot for all monitoring wells and piezometers within the week before groundwater sampling begins. A digital reading of the water level at the Ballard Locks station will be recorded. Total well depth will also be measured for the monitoring wells and piezometers. A water level measurement form for this activity is included in Attachment A-4.

Depth to LNAPL will be measured in the 14 wells with historic presence of LNAPL and any new wells that may contain LNAPL (identified on Attachment A-4). Because LNAPL has previously been observed in MW-52D, the well it will be paired with (AW-52D) will initially be treated the same as the 14 wells identified in Attachment A-4. LNAPL has not been observed in the other two wells (MW-49D and MW-50D) that will be paired with the new wells AW-49D and AW-50D, so LNAPL is not expected to be present in these two new wells. However, wells AW-49D and AW-50D will be treated as LNAPL wells if LNAPL is observed in the soil cores obtained during well construction. Field staff will measure depth to LNAPL using an electronic interface probe to the nearest 0.01 foot for all monitoring wells and piezometers within the week before groundwater sampling begins. Water elevations will be corrected based on LNAPL specific gravity of 0.92 (Product sample MW09-130415-LNAPL).

3.6. Groundwater Sampling Methods

Prior to sampling, each of the existing monitoring wells will be inspected for signs of tampering or other damage. If tampering is suspected (i.e., casing is damaged, lock or cap is missing), this will be recorded in the field report and on the well sampling form and reported to the Project Manager.

Groundwater monitoring activities will be recorded in field reports, and well purging/sampling data will be recorded on groundwater sampling forms. The following sections describe the groundwater sampling process.

3.6.1. Well Purging Prior to Sampling

Monitoring wells will be purged prior to sampling using low-flow methods to evacuate standing water in the well that may not be representative of groundwater in the surrounding formation. Before the start of purging/sampling activities, plastic sheeting will be placed on the ground surrounding the well, if necessary, to provide a clean working area around the well and to reduce the possibility of soil contaminants contacting the groundwater sampling equipment.

Well purging will be accomplished using new dedicated tubing and a portable peristaltic pump, submersible pump, or bladder pump. The pump intake will be placed near the middle of the well screen interval, and the well will be purged at a target rate of 250 to 500 milliliters (mL) per minute. A flow-through cell and portable water quality meter(s) will be used to monitor water quality parameters during purging. The wells will be purged until water quality parameters have stabilized.

The water quality stabilization goals are as follows:

- Temperature ± 1°C
- pH ± 0.1 pH units
- Salinity and/or conductivity/specific conductance ± 3 percent
- Dissolved oxygen ± 0.3 milligrams per liter
- Redox potential (Eh) ± 10 millivolts (mV)
- Turbidity <10 NTU (if 10 NTU cannot be achieved, then ± 10 percent)

The portable water quality meter will be calibrated in accordance with manufacturer specifications prior to use.

3.6.2. Groundwater Sample Collection

Groundwater samples will be collected after water quality parameters have stabilized as discussed above. The samples will be collected using a peristaltic pump, submersible pump, or bladder pump and analyzed for the constituents listed in Table A-1A. Groundwater samples will be collected into labeled, pre-cleaned sample bottles provided by the analytical laboratory. The sample containers will be retained on ice and delivered under chain of custody to the analytical laboratory. Required sample containers, preservation methods, volumes, and holding times are summarized in Table A-3.

Reusable sampling equipment will be decontaminated prior to commencing sampling activities and between each well following decontamination procedures described in Section 5.3.

3.6.2.1. Groundwater Sampling Procedures for Arsenic Speciation Sampling

At six (6) monitoring well locations (MW-49D/AMW-49D, MW-50D/AMW-50D and MW-52D/AMW-52D) downgradient of the Play Area groundwater samples will be collected for analysis of arsenic speciation analysis by Brooks Applied Labs using method BAL-4100. Samples for this speciation analysis will be collected using vacuettes provided by the lab. Procedures for collecting these samples are provided in Attachment A-5.

3.7. Soil Sampling Methods

3.7.1. Hand Auger Exploration Methods

Soil borings will be advanced using hand auger methods to collect soil from the surface to target depths of approximately 0 to 3 feet bgs. If the hand auger meets refusal other hand tools may be used such as hand trowel or shovel. Hand auger locations HA-1 through HA-15 in SMA-1 and SMA-2 are shown in Figures A-5A and Figure A-5B. Sample material will be visually classified in accordance with ASTM D 2488 methods and the Unified Soil Classification System (ASTM D 2487), recorded on a field log, and photographed. In addition to the visual classification, soil samples will be observed for biota, debris, and evidence of contamination including staining or smell. A PID will be used to screen soil headspace for soil samples. If debris is observed[3] the estimated quantity (i.e., observed percent by volume) of each type of debris, and the depth interval where the debris is observed will be recorded on the field log. A portable GPS unit will be utilized to collect the coordinates of the soil boring location.

3.7.2. Sonic Drilling Methods

Soil borings will be advanced using sonic drilling methods to install the new angled monitoring wells. Continuous soil cores will be collected in 5-foot-long increments prior to well installation. The soil will be extruded from the core barrel for field screening and sampling. The soil core will be visually classified and documented in field boring logs and photos will be taken of the sampled material. The sample intervals will be collected from the core barrels recovered during sonic drilling. The soil from each interval will be placed into a stainless-steel bowl for homogenization and sampling. After mixing, the sample will be placed in the appropriate containers for laboratory analysis. The samples will be placed in coolers with ice for storage and throughout transport to analytical laboratory.

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[3] If debris triggering the inadvertent discovery plan is observed, the field team will follow the procedures in Appendix D.

3.7.3. Soil Collection Methods

Soil samples will be collected for chemical analysis by placing representative material volumes from the hand auger (or other hand tools) into laboratory-supplied containers. Soil samples for VOCs analysis will be collected by Method 5035. The samples for other analyses to be submitted for chemical analysis will be placed into containers and then lightly packed in and capped with a lid. The sand-sized and finer fractions of the soil will be targeted for collection. Foreign material including debris, rocks and grass will not be sampled.

The soil samples will be collected at the target intervals identified in Table A-1a and based on subsurface conditions and field observations at the time of the work. The sample depth intervals may be adjusted based on field conditions and observations.

Soil samples will be collected into labeled; pre-cleaned sample bottles provided by the analytical laboratory in accordance with Table A-4. The samples will be placed in containers with ice and delivered under chain-of-custody protocols to the analytical laboratory for analysis of constituents listed in Table A-1a.

Reusable equipment used to obtain soil samples will be decontaminated prior to each use using an aqueous Alconox® or Liqui-Nox® solution and a distilled water rinse as described in Section 5.3.

4.0 SEDIMENT AREA FIELD SAMPLING EQUIPMENT AND PROCEDURES

The following sections summarize the sediment area sample collection procedures for the PRDI. The sediment area sampling activities include collection and analysis of subsurface sediment and offshore groundwater samples adjacent to the shoreline in areas planned for dredging and capping, near surface sediment and offshore groundwater samples in areas planned for capping, surface sediment samples in areas planned for monitored natural recovery. Additionally, near surface sediment will be collected to evaluate the presence of NAPL in areas planned for capping and sediment cores will be completed to evaluate the depositional rate in in areas planned for monitored natural recovery. The PRDI Work Plan and Table A-1b provide rationale and details for the planned sampling objectives and analytical program.

4.1. Vibracore Sediment Sampling Procedures

Vibracoring technology will be utilized to collect sediment cores by attaching a core tube to a vibrational drive head. The vibrational energy from the drive head allows the core tube to be driven into sediment by the force of gravity, minimizing disturbance of the core. The core tube liner will be 4 to 5 inches diameter and made of polycarbonate. A core catcher will be secured in the leading end of the core tube to reduce the loss of sample material as the tube is withdrawn from the sediment following completion of the drive. Cores will be driven to the target depth or until practical refusal. Sample collection will be continuous and withdrawal and readvancement of the core tube will be avoided.

Upon extraction of the liner from the core barrel, the liner will be capped, and the core will be evaluated by the following acceptance criteria:

- Overlying water is present, and the sediment surface is intact.
- Length of recovered core sample is a minimum of 75 percent of the sampler drive length.
- The core tube appears intact without obstructions or blockage.

If the core acceptance criteria are not achieved, the sample will be rejected, and the drive will be repeated at a suitable location approximately 10 to 15 feet (laterally) from the proposed drive location and at least 5 feet from any previous drive location. Rejected samples will be capped, stored, and recorded with the same procedure as approved samples. The GPS coordinates of each attempted core will be recorded. If the acceptance criteria are not satisfied after four attempts, the Project Manager will be notified, and an alternate location will be determined based on consultation with Ecology.

Cores meeting the acceptance criteria will be visually classified in accordance with ASTM D 2488 methods and the Unified Soil Classification System (ASTM D 2487) and recorded on a field sediment core log. In addition to the visual classification, sediment cores will be observed for biota, debris, and presence of contamination including staining. If debris is present, the type (s) of debris, the estimated quantity (i.e., observed percent by volume) of each type of debris, and the depth interval where the debris is observed will be recorded on the core log.

Prior to sampling, the core will be photographed. Included in the camera's field of view will be a sheet of paper or whiteboard with the sample name. Care will be taken to not touch the sediment with the paper/whiteboard or with hands contaminated with whiteboard ink. To avoid cross-contamination, a clean hands/dirty hands approach will be utilized during all sample collection activities where subsequent chemical analyses will be carried out on the samples collected. Gloves that have been in contact with lab pens and whiteboard pens will not be used for sample handling.

The sediment sampling target intervals will be identified, and samples will be collected for VOCs analysis from the undisturbed core by Method 5035. For the remaining analyses, the target intervals will be removed from the core, placed in a stainless-steel bowl, and mixed thoroughly until uniform color and consistency are achieved. After mixing, the sample will be placed in appropriate containers for laboratory analysis as described in Table A-5. Samples will then be placed in coolers with ice throughout transport to the analytical laboratory.

4.2. Power Grab Sediment Sampling Procedures

Surface sediment samples will be collected from the subtidal zone using a Power Grab sampler operated from a subcontracted research vessel(s). Sampling equipment will be decontaminated and inspected before use.

There are two types for power grab sampling equipment that will be used:

- Standard Power Grab sampler to collect surface sediment samples within the upper 10 cm (4 inches [in]).
- XL Power Grab sampler to collect near surface sediment samples within the upper 40cm (16 in).

Discrete surface grab samples will be collected from the upper 10 cm or the upper approximately 40 cm, depending on the target interval, from the sampler for processing on board the vessel. Upon retrieval of the sampler, the following surface sediment acceptance criteria will be evaluated:

- The sampler jaw is closed.
- The sampler is not overfilled so that the sediment surface is pressing against the top of the sampler.

- Minimal leakage has occurred, as evidenced by overlying water on the sediment surface.
- Minimal sample disturbance has occurred, as evidenced by limited turbidity in the water overlying the sample.
- A penetration depth greater than the target interval depth (10 cm or 40 cm) has been achieved. Greater than the target depth interval shall be the target penetration depth to sample sediment that has not contacted the side or bottom of the sampler.

Sediment grab samples that do not meet the acceptance criteria (above) will be rejected. Sediment grab samples achieving the acceptance criteria will be retained for processing. If a grab sample is rejected, additional surface sediment grab samples will be collected (as needed) within 10 feet of the first location. The Project Manager will be contacted if the acceptance criteria cannot be achieved after four deployments or where a sampling station needs to be moved more than 10 feet from the initial target location and an alternate location will be determined based on consultation with Ecology.

Samples meeting the acceptance criteria will be visually classified in accordance with ASTM D 2488 methods and the Unified Soil Classification System (ASTM D 2487) and recorded on a field log. In addition to the visual classification, sediment samples will be observed for biota, debris, and presence of contamination including staining. If debris is present, the type or types of debris, the estimated quantity (i.e., observed percent by volume) of each type of debris, and the depth interval where debris is observed will be recorded on the field log.

Prior to processing, samples will be photographed. Included in the camera's field of view will be a sheet of paper or whiteboard with the sample name.

Care will be taken to not touch the sediment with the paper/whiteboard or with hands contaminated with whiteboard ink. To avoid cross-contamination, a clean hands/dirty hands approach will be utilized during all sample collection activities where subsequent chemical analyses will be carried out on the samples collected. Gloves that have been in contact with lab pens and whiteboard pens will not be used for sample handling.

Samples of sediment from 0 to 10 cm or 0 to 40 cm will be placed in a stainless-steel bowl and mixed thoroughly until uniform color and consistency are achieved. After mixing, the sample will be placed in appropriate containers for laboratory analysis as described in Table A-1b. Samples will then be placed in coolers with ice throughout transport to the analytical laboratory.

4.3. Piston Sampler Sediment Sampling Procedures

For near surface sediment sampling of very soft sediment that cannot be effectively collected using power grab or vibracore methods, piston sampling methods will be utilized. The following steps will be taken to collect soft sediment using piston sampling methods:

- Use a video camera at the sampling location to determine the mudline depth below the surface water.
- Lower the piston sampling device to the sediment surface making sure to keep the device in a vertical position.

- Lower the piston sampler into the sediment surface to the desired depth below mudline. The weighted core barrel sinks into the sediment due to its own weight. The piston inside moves upward, creating a vacuum that effectively prevents sediment disturbance and maintains the sediment-water interface.
- Lift the core device carefully to the surface and onto the research vessel.
- Immediately cap both ends of the core tube.
- Transport the core carefully to avoid disturbing the sediment.
- In a controlled setting, process the core tube by cutting it open to log and sample the core in accordance with the general procedures described in Section 5.0.

4.4. Offshore Groundwater Sampling Procedures

Offshore groundwater samples will be collected at subsurface and near surface sampling locations using a custom piezometer driven by a low frequency drive head. The frequency of the drive head can be adjusted in the field to minimize disturbance of sediment substrates. The piezometer is made from stainless tube that is 2 inches in diameter with slotted holes covered by 200-micron stainless mesh. The sampling interval of the mesh is 12 inches. Offshore groundwater samples will be collected using a Teflon™ lined tube that is placed inside of the piezometer that will collect water via a peristaltic pump. Water from the piezometer will be pumped using low flow techniques to ensure only offshore groundwater is collected (<0.2 liters per minute).

Acceptance criteria for offshore groundwater samples include:

- The piezometer penetrated to the proper target depth interval.
- Offshore groundwater extracted at a volume of less than 0.2 liters per minute.
- There are no obstructions that block the entry of water into the piezometer.

If any of the offshore groundwater acceptance criteria are not achieved, the sample will be rejected, and another sample attempt will be completed within 10 to 15 feet (laterally) from the proposed drive location and at least 5 feet from any previous drive location.

During sampling, water will be pumped through a flow-through cell to collect water quality parameters including temperature, pH, salinity, conductivity, dissolved oxygen, redox potential, and turbidity. The portable water quality meter will be calibrated in accordance with manufacturer specifications prior to use.

Water quality parameters will be recorded on field forms. There is not a minimum required volume of water to be purged prior to sampling. Samples should be collected once the initial turbid water has been removed and the water quality parameters stabilize. Samples will be collected from the Teflon tubing into laboratory-provided bottles. Sample bottles will then be placed in coolers with ice throughout transport to the analytical laboratory.

The stainless-steel piezometers will be decontaminated and cleaned upon each use in accordance with decontamination procedures described in Section 5.3.

4.4.1. Contingent Sampling Procedures for Near Surface Offshore Groundwater Sampling

In areas of the Site where soft sediment exists at the near surface target interval (approximately 0 to 1 bml), temporary piezometers will be deployed for sample collection without using a mechanical drive head. At these locations the following steps will be taken:

- Use a video camera to identify the depth from the water surface to mudline.
- Place the piezometer in a mounted frame and set the screen interval to be located between 0.5 ft and 1.5 ft bml.
- Keep the piezometer attached to the research vessel and maintain the elevation of the temporary piezometer during sampling consistent with methods described in Section 4.1 above.

4.5. Field Screening for Evidence of NAPL in Sediment

At locations where near surface sediment will be collected to screen the sediment for evidence of NAPL the following procedures will be followed:

- Using the XL Power Grab sampler device collect sediment to depths of approximately 40 cm (16 in) bml in accordance with power grab sampling procedures identified in Section 4.2.
- Bring the sampling device to the research vessel and open the sample for field screening. Use stainless steel spoons/bowls to visually screen the entire sample.
- Complete field screening including visual, olfactory, headspace vapor, sheen testing and NAPL shake test screening as described in Section 5.2.
- Document in field logs and photographs observations including sediment type, field screening results and presence/absence of NAPL.
- Disposition of sample material will depend on permit conditions. Sample material with obvious signs of NAPL will be placed in drums and managed in accordance with investigation derived waste (IDW) procedures in Section 5.6.

4.6. Sampling Method for Porewater Extraction from Sediment

For near surface or subsurface locations where temporary piezometers are unable to collect in situ porewater, sediment may be collected and transferred to a laboratory to extract water using centrifuge techniques. A relatively large volume of sediment is required to ensure that sufficient water volume is extracted from the sediment during centrifuging to provide enough volume of water for porewater analyses. The amount of porewater in sediment that can be extracted by centrifuging is dependent on the sediment makeup. In general, the volume of sediment will need to be four to six times the volume of water required for the analysis. For example, if we are targeting a total of 0.5 liters of porewater for chemical analyses, 2 to 3 liters of sediment would be collected for porewater extraction. Multiple power grab or vibracore attempts may be required to achieve sufficient volume of sediment. If multiple attempts are needed the samples will be collected within 5 to 10 feet of the proposed sample location. Sediment collected for porewater extraction will be placed in a bucket lined with clean plastic for delivery to EcoAnalysts Laboratory in Port Gamble, Washington for centrifuging. EcoAnalysts will use the extracted water to fill laboratory-provided bottles with appropriate preservatives (Table A-3) during transport to the laboratory for chemical analyses. Appropriate chain of custody documents will be completed to track the locations of the samples.

5.0 GENERAL FIELD PROCEDURES

This section provides general field procedures and standard practices that apply to upland and sediment area environmental sample collection.

5.1. Field Logging

The stratigraphy encountered in soil borings and sediment cores will be logged by the field geologist on field forms. Information on the boring/core logs will include the exploration location; general information about the drilling/coring equipment; sampling information such as sample intervals/depths, sample recoveries, stratigraphy, and field screening results. The stratigraphy encountered will generally be described in accordance with ASTM D 2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). In addition, identification of the Unified Soil Classification System (United State Geological Survey [USGS]) group symbol will be recorded on the field logs.

As applicable, additional information will be recorded on field logs during soil boring drilling including depth to groundwater/saturated soil, heaving conditions, changes in drilling rate, and other noteworthy observations or conditions such as the type and occurrence of anthropogenic materials and qualitative description of biota and debris. If debris[4] is encountered, the type of debris (i.e., wood debris, glass, brick, refuse, etc.) and estimated quantity (i.e., observed percent volume) of each type of debris present will be recorded on the field form.

A photograph will be taken of the soil or sediment samples.

5.2. Field Screening

Field screening results will be recorded on the field logs. The following field screening methods will be used: 1) visual screening, 2) water sheen screening, and 3) headspace vapor screening.

5.2.1.1. Visual and Olfactory Screening

Soil and sediment will be observed for unusual color and stains and/or odor (e.g., hydrogen sulfide [rotten egg smell], petroleum hydrocarbons) indicative of possible contamination. Visual observation will also include presence of debris type, vegetation, and biological activity.

5.2.1.2. Water Sheen Screening

Water sheen screening can help identify the presence or absence of petroleum hydrocarbons. A portion of the soil sample will be placed in a pan containing distilled water. The water surface will be observed for signs of sheen. The following sheen classifications will be used:

Classification	Identifier	Description
No Sheen	(NS)	No visible sheen on the water surface
Slight Sheen	(SS)	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly

[4] If debris triggering the inadvertent discovery plan is observed, the field team will follow the procedures in Appendix D.

Moderate Sheen	(MS)	Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on the water surface
Heavy Sheen	(HS)	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen

5.2.1.3. Headspace Vapor Screening

Headspace vapor screening can help identify the presence or absence of volatile chemicals. Where visual or olfactory screening indicates evidence of contamination (e.g., NAPL, sheen, staining, hydrocarbon odor), headspace vapor screening will be completed as soon as possible after collecting a soil or sediment sample. A portion of the sample will be placed in a resealable plastic bag. Ambient air is captured in the bag; the bag is sealed and then shaken gently to expose the soil to the air trapped in the bag. Vapors present within the sample bag headspace are measured by inserting the probe of a photoionization detector (PID) through a small opening in the bag. A PID measures the concentration of organic vapors ionizable by a 10.6 electron volt lamp (standard) in parts per million (ppm) and quantifies organic vapor concentrations in the range between 0.1 ppm and 2,000 ppm (isobutylene-equivalent) with an accuracy of 1 ppm between 0 ppm and 100 ppm. The maximum vapor concentration will be recorded on the field report for each sample. The PID will be calibrated to 100 ppm isobutylene.

5.3. Decontamination Procedures

To prevent cross-contamination of collected samples, reusable sampling equipment will be decontaminated prior to collecting each sample using the following procedures.

5.3.1. Drilling Equipment

For large pieces of drilling equipment (such as sonic core casing, drill rods, drill bits, and those portions of the drill rig that may be positioned directly over a boring location), the following procedure will be used to decontaminate the equipment between borings and upon completion of drilling activities. The equipment will be pressure-washed and, if necessary, scrubbed to remove visible dirt, grime, grease, oil, rust flakes, etc. The equipment will then be rinsed with potable water.

Sampling devices will be cleaned using an aqueous Alconox® or Liqui-Nox® solution and a distilled water rinse before each sample is collected.

5.3.2. Sediment Sampling Equipment

For sediment sampling equipment that is deployed from the research vessel (such as vibracore head, aluminum core casing, power grab sampler and other related equipment that contacts contaminated media), the equipment will be pressure-washed and scrubbed to remove visible dirt, grime, grease, oil, and other debris. The equipment will be washed with potable water at the end of each workday.

5.3.3. Reusable Sampling Equipment

When possible, disposable sampling equipment will be used to minimize the need for decontaminating equipment. Prior to and between sample collection, reusable sampling equipment that contacts soil, groundwater, sediment, or offshore groundwater will be decontaminated. Reusable sampling equipment may include temporary piezometers, hand auger, Power Grab sediment sampler, groundwater sampling pumps, water quality meter, interface probes, sounding tapes, trowels, spoons, bowls and other hand tools or sampling/measuring devices.

For sampling equipment, excess soil or sediment will first be removed from the equipment by rinsing. The sampling equipment will then be pressure-washed or washed using an aqueous Alconox® or Liqui-Nox® detergent solution and a brush. Detergent will be used to clean surfaces of sampling tools that directly contact samples (e.g., temporary piezometer, hand auger/tools); equipment that does not directly contact samples (e.g., outer core barrel or casing) will be pressure-washed and rinsed. Decontaminated equipment will be temporarily staged on clean plastic sheeting, wrapped, or covered with aluminum foil, and/or stored in a clean, dry place.

Oil-water interface probes and electronic water level indicators/well sounders used for well gauging will be decontaminated before and after use at each well. Decontamination will be performed as follows:

1. Wipe off any visible LNAPL with disposable towels.
2. Clean measurement probe and tape with an aqueous Alconox® or Liqui-Nox® solution.
3. Rinse with distilled water.

5.3.4. Sample Containers

Pre-cleaned sample bottles and jars will be supplied by the subcontracted analytical laboratory. The sample containers will be protected from contact with dust, dirt, and other potential sources of cross-contamination. Sample containers will not be reused.

5.3.5. Used Decontamination Water

Used decontamination water will be stored on-property in labeled 55-gallon drums for subsequent characterization and off-property disposal at a permitted facility.

5.4. Field Documentation

Three primary types of field documentation will used for this project: field reports and field forms, sample container labels, and chain of custody (COC) forms. A description of each of these documentation methods is provided in the following sections.

5.4.1. Field Reports

Field reports will be used to document the field and sampling activities performed at the project site for each day of field work. Field reports will include the date, time, description of field activities performed, names of personnel and site visitors, weather conditions, areas where photographs were taken (if applicable), and other data pertinent to the project. Field reports will also contain sample collection and identification information, and if appropriate, a drawing of each area sampled, along with the locations (coordinates) where samples were collected. Sample data recorded in field reports will include the sample date, time, location, identification number, matrix, collection method, analyses to be performed, any comments and the sampler's name. Field reports will also document identified safety issues; quality control samples collected (e.g., duplicate samples, trip blanks); calibration checks of field monitoring/measuring instruments (e.g., PID, water quality meter); field measurements; and IDW disposition (e.g., number of drums generated and their contents and location).

Soil boring and sediment core information will be recorded on boring logs attached to the field report. Sediment sampling logs will be recorded for surface sediment samples recording the sediment type and field screening results and attached to the field report. A groundwater/well sampling record will be used for each well to record the information collected during water sampling.

Following review by the Project Manager, the original field records will be scanned and kept in the project file.

5.4.2. Sample Labels

Sample containers will be clearly labeled with waterproof black ink at the time of sampling. Sample labels will include the following information:

- Project/site name;
- Sampling date;
- Sampling time;
- Sample identification number;
- Preservation used, if any; and
- Initials of sampler.

The same information entered on the sample label will be recorded on the chain of custody form and in the field report.

5.4.3. Chain of Custody Forms

After samples have been collected and labeled, they will be maintained under chain of custody procedures. These procedures document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a COC form.

The COC form documents sample names, dates, times, and analyses to be performed for each sample, as well as all transfers of sample custody from the field to the analytical laboratory. The COC form will be completed using waterproof ink. Any corrections will be made by drawing a line through and initialing and dating the change, then entering the correct information.

When transferring custody of samples, the individuals relinquishing and receiving them will sign, date, and note the time on the COC form. Sample coolers shipped by common carrier will have the COC form enclosed in a resealable plastic bag and placed in the sample cooler prior to sealing the cooler for shipping. Custody seals will be used on sample coolers that are shipped by common carrier or delivered by courier to the laboratory. The sample shipping receipt will be retained in the project files as part of the COC documentation. The shipping company will not sign the COC forms as a receiver; instead, the laboratory will sign as a receiver when the samples are received. Internal laboratory records will document custody of the samples from the time they are received through final disposition.

5.5. Exploration Location and Surveying

5.5.1. Exploration Location by Field Crews

The horizontal coordinates of soil and groundwater exploration locations will be determined using a hand-held Trimble GeoXT® GPS unit or similar equipment. GeoEngineers field personnel will log the exploration location names and coordinates in the GPS unit for subsequent downloading to a computer. For sediment and offshore groundwater sample locations collected in-water from a research vessel, the vessel will be equipped with GPS equipment, and the vessel operator will provide GPS coordinates for each sediment sampling location.

5.5.2. Surveying by Professional Land Surveyor

As part of the PRDI, the location of the new angled monitoring wells will be surveyed to document the horizontal position and elevation of the top of the well casing, the well monument, as well as the adjacent ground surface (see PRDI Work Plan Section 14 for details).

5.6. Investigation Derived Waste

IDW will be placed in Department of Transportation (DOT)-approved 55-gallon drums and stored on Site in a designated containment area, which will be enclosed by fencing. Each waste container will be labeled with "Investigation-Derived Waste – Pending Analysis" and the following information:

- A description of the media (i.e., soil, water, sediment)
- Origin of the media
- Accumulation start date
- Site identification
- Generator name
- Contact person
- Drum ID number corresponding to the drum inventory form

Drums will be stored on a hard, flat surface in a secure location pending characterization and disposal in accordance with applicable local, State, and Federal regulations.

Once waste characterization has been completed, drums will then be labeled with Hazardous/Dangerous Waste or Non-Hazardous/Non-Dangerous Waste labels, as appropriate. Placement of these labels will occur no later than 30 days after receipt of the final analytical results used for waste characterization and classification.

5.6.1. Soil

Soil cuttings from well drilling and decontamination water will be placed into separate 55-gallon drums and labeled and stored as noted above.

Composite samples will be collected from the soil drums and analyzed for GWPS media-specific contaminants of concern including:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- PAHs, including cPAHs, using EPA Method 8270E-SIM;
- Diesel- and oil-range petroleum hydrocarbons using NWTPH-Dx; and
- RCRA metals by 6010/6020.

Soil samples will also be collected for archive at the laboratory for the possibility of performing follow-up TCLP analysis as required for landfill disposal characterization.

Analytical results will be used to develop a waste profile and the drums will be transported and disposed of at an appropriate permitted landfill.

5.6.2. Groundwater and Decontamination Water

Well development and purge water removed from monitoring wells and decontamination water generated during sampling activities will be placed in 55-gallon drums labeled and stored as noted above.

Composite water samples will be collected from the groundwater and decontamination drums and analyzed for GWPS media-specific contaminants of concern including:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- PAHs, including cPAHs, using EPA Method 8270E-SIM; and
- Total arsenic using EPA Method 6010C.

Analytical results will be used to develop a waste profile and the drums will be transported and disposed of at an appropriate permitted landfill.

5.6.3. Sediment

Excess sediment materials from surface grabs and cores will be placed back at the general position of the sampling location to the extent practicable. Sediment core material that is not placed back at the sampling location will be collected in 55-gallon drums labeled and stored as noted above. To the extent practicable, sediment with visual evidence of contamination (e.g., sheen, NAPL, hydrocarbon odor) will be placed in separate drums from sediment without evidence of contamination.

Composite samples will be collected from the drums and analyzed for GWPS media-specific contaminants of concern including:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- Diesel-, and oil-range petroleum hydrocarbons using NWTPH-Dx;
- PAHs, including cPAHs, and tributyltin using EPA Method 8270E-SIM;
- SVOCs 4-methylphenol, benzoic acid, BEHP, di-n-butylphthalate, di-n-ocytyphthalate, hexachlorobenzene, pentachlorophenol, phenol, carbazole, dibenzofuran using EPA Method 8270E;
- Pesticides Chlordane and 4,4' DDE using EPA Method 8081;
- PCB Aroclors using EPA Method 8082; and
- RCRA metals by 6010/6020.

Sediment samples will also be collected for archive at the laboratory for the possibility of performing follow-up TCLP analysis as required for landfill disposal characterization.

Analytical results will be used to develop a waste profile and the drums will be transported and disposed of at an appropriate permitted landfill.

5.6.4. Offshore Groundwater

Purge water removed from temporary piezometers generated during sampling activities will be placed in 55-gallon drums labeled and stored as noted above.

Composite water samples will be collected from the offshore groundwater and decontamination drums and analyzed for GWPS media-specific contaminants of concern including:

- Benzene, ethylbenzene, and toluene using EPA Method 8260D;
- PAHs, including cPAHs, using EPA Method 8270E-SIM;
- BEHP, carbazole and dibenzofuran using EPA Method 8270E; and
- Total metals including arsenic, cadmium, chromium, lead, mercury, nickel, and silver by EPA Method 6010/7470.

Analytical results will be used to develop a waste profile and the drums will be transported and disposed of at an appropriate permitted landfill.

5.6.5. Incidental Waste

Incidental waste generated during field activities includes items such as disposable personal protective clothing, gloves, and sampling supplies such as aluminum foil, paper towels, plastic bags/sheeting, and similar discarded materials. These materials will be placed in plastic garbage bags or other appropriate containers. At the completion of the field investigation, incidental waste will be removed from the staging area and disposed of as municipal waste at a local trash receptacle.

6.0 HEALTH AND SAFETY

Field activities will be performed in accordance with the requirements of the Washington Industrial Safety and Health Act (WISHA; RCW 49.17) and the Federal Occupational Safety and Health Act (OSHA; 29 Code of Federal Regulations [CFR] 1910, 1926). These regulations include requirements that workers are to be protected from exposure to contaminants. A Site-specific health and safety plan (HASP) describing actions that will be taken to protect the health and safety of GeoEngineers personnel is presented in Appendix B. Companies providing services for this project on a subcontracted basis (if applicable) will be responsible for developing and implementing their own HASP.

7.0 QUALITY ASSURANCE (QA) PROCEDURES

7.1. Chemical Analyses and Methods

Samples of soil, groundwater, sediment, and offshore groundwater will be collected as part of the PRDI. Samples, analytes, and analytical methods are listed in Tables A-1a and A-1b.

7.2. Sample Preservation, Container, and Holding Times

Samples subject to laboratory analyses will be prepared, containerized, and preserved in the field according to the guidelines detailed in Tables A-2, A-3, A-4, and A-5 for air/soil vapor, groundwater/offshore groundwater, soil, and sediment, respectively. Samples will be kept on ice in coolers while at the Site. The samples will be preserved and either hand-delivered by the GeoEngineers' field representative to the laboratory or to a laboratory courier. In cases where hand-delivery is not possible (inclement weather, after-hours sampling,), the samples will be kept at 4°C until the next day or dropped off in the laboratory after hour secure drop off. The samples will remain in a safe, refrigerated state upon delivery to the laboratory, and at the laboratory, until analyzed.

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a recommended holding time for analysis only. For many methods, recommended holding times may be extended by sample preservation techniques in the field. If a sample exceeds a recommended holding time, then the results may be biased low. For example, if the extraction holding time for volatile analysis of soil samples is exceeded, then the possibility exists that some of the organic constituents may have volatilized from the sample or degraded. Results for that analysis would be qualified as estimated to indicate that the reported results may be lower than actual site conditions. Recommended holding times are presented in Tables A-2, A-3, A-4, and A-5 for air/soil vapor, groundwater/offshore groundwater, soil, and sediment, respectively.

7.3. Data Quality Objectives

The environmental data quality assurance objective is to collect data of known, acceptable, and documentable quality. The QA objectives established for the project are:

- Implement the procedures outlined herein for field sampling, sample custody, equipment operation and calibration, laboratory analysis, and data reporting that will facilitate consistency and thoroughness of data generated.
- Achieve the acceptable level of confidence and quality required so that data generated are scientifically valid and of known and documented quality. This will be performed by establishing criteria for precision, accuracy, representativeness, completeness, and comparability, and by testing data against these criteria.

The QA/QC procedures are set up to provide high-quality data for use in this project. Specific quality factors that may affect data usability include quantitative factors (bias, detection limits, precision, accuracy, and completeness) and qualitative factors (representativeness and comparability). The laboratory QA/QC requirements for air/soil vapor (Table A-6), groundwater and offshore groundwater (Table A-7), soil (Table A-8), and sediment (Table A-9) will be followed so that data of adequate quality is generated to support site characterization.

7.3.1. Analytical Detection Limits

Analytical methods have quantitative limitations at a given statistical level of confidence that are often expressed as the method detection limit (MDL). Although results reported near the MDL provide insight to Site conditions, quality assurance dictates that analytical methods achieve a consistently reliable level of detection known as the limits of quantification (LOQ) or practical quantitation limit (PQL), which is typically demonstrated with the lowest point of a linear calibration. The contract laboratory will provide numerical results for all analytes and report them as detected above the PQL or undetected at the PQL. It will be ensured with the laboratory to take extra care to keep PQLs below the cleanup or screening levels.

Laboratory PQLs for air, groundwater and offshore groundwater, soil, and sediment analyses are presented in Tables A-10, A-11, A-12, and A-13 respectively, and are considered target reporting limits (TRLs) because several factors may influence final reporting limits. First, moisture and other physical conditions affect detection limits. Second, analytical procedures may require sample dilutions or other practices to accurately quantify a particular analyte at concentrations above the range of the instrument. The effect is that other analytes could be reported as undetected but at a value higher than a specified TRL. Data users must be aware that high non-detect values, although correctly reported, can bias statistical summaries and careful interpretation is required to correctly characterize Site conditions.

7.3.2. Precision

Precision is the measure of mutual agreement among replicate or duplicate measurements of an analyte from the same sample and applies to laboratory duplicates, field duplicates and/or duplicates of spiked environmental samples. The closer the measured values are to each other, the more precise the measurement process. Precision error may affect data usefulness. Good precision is indicative of relative consistency and comparability between different samples. Precision will be expressed as the relative percent difference (RPD) for spike sample comparisons of various matrices and duplicate comparisons. This value is calculated by:

$$RPD(\%) = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} X\ 100,$$

Where

D_1 = Recovery for Matrix Spike (MS) or Duplicate 1

D_2 = Recovery for Matrix Spike Duplicate (MSD) or Duplicate 2

The calculation applies to split samples, replicate analyses, duplicate spiked environmental samples (matrix spike duplicates), and laboratory control duplicates. The RPD will be calculated for samples and compared to the applicable criteria. Precision can also be expressed as the percent difference (%D) between replicate analyses. The RPD limits applicable for air, groundwater/offshore groundwater, soil, and sediment analyses are presented in Tables A-6, A-7, A-8, and A-9, respectively, unless the primary and duplicate sample results are less than 5 times the method reporting limit (MRL), in which case RPD goals will not apply for data quality assessment purposes and the absolute difference will be used as a measurement of precision.

7.3.3. Accuracy

Accuracy is a measure of bias in the analytic process. The closer the measurement value is to the true value, the greater the accuracy. This measure is defined as the difference between the reported values versus the actual value and is often measured with the addition of a known compound to a sample. The amount of known compound reported in the sample, or percent recovery, assists in determining the performance of the analytical system in correctly quantifying the compounds of interest. Since most environmental data collected represent one point spatially and temporally rather than an average of values, accuracy plays a greater role than precision in assessing the results. In general, if the percent recovery is low, non-detect results may indicate that compounds of interest are not present when in fact these compounds are present. Detected compounds may be biased low or reported at a value less than actual environmental conditions. The reverse is true when recoveries are high. Non-detect values are considered accurate while detected results may be higher than the true value.

For this project, accuracy will be expressed as the percent recovery of a known surrogate spike, matrix spike, or laboratory control sample (blank spike), concentration:

$$Recovery\,(\%) = \frac{Spiked\ Result - Unspiked\ Result}{Known\ Spike\ Concentration}\ X\ 100$$

7.3.4. Representativeness

Representativeness expresses the degree to which data accurately and precisely represent the actual Site conditions. The determination of the representativeness of the data will be performed by completing the following:

- Comparing actual sampling procedures to those specified in this SAP.
- Invalidating non-representative data or identifying data to be classified as questionable or qualitative.

Only representative data will be used in subsequent data reduction, validation, and reporting activities.

7.3.5. Completeness

Completeness establishes whether a sufficient amount of valid measurements was obtained to meet project objectives. The number of samples and results expected establishes the comparative basis for completeness. Completeness goals are 90 percent useable data for samples/analyses planned. If the completeness goal is not achieved an evaluation will be made to determine if the data are adequate to meet study objectives.

$$Completeness = \frac{number\ of\ valid\ measurements}{total\ number\ of\ data\ points\ planned}\ x\ 100$$

7.3.6. Comparability

Comparability expresses the confidence with which one set of data can be compared to another. Although numeric goals do not exist for comparability, a statement on comparability will be prepared to determine overall usefulness of data sets, following the determination of both precision and accuracy.

7.3.7. Calibrations

Several types of instrument calibrations will be used by the laboratory, depending on the analytical method, to assess the linearity of the calibration curve and assure that the sample results reflect accurate and precise measurements. The main calibrations used are initial calibrations, daily calibrations, and continuing calibration verification. Calibration procedures will be performed in general accordance with the methods cited and laboratory standard operating procedures. Calibration documentation will be retained at the laboratory and readily available for a period of 6 months.

8.0 QUALITY CONTROL (QC) SAMPLES AND PROCEDURES

QC samples will be analyzed to ensure the precision, accuracy, representativeness, comparability, and completeness of the data. Table A-14 summarizes the types and frequency of QC samples to be analyzed during the investigation, including both field QC and laboratory QC samples.

8.1. Field Quality Control Samples

Field QC samples serve as a control and check mechanism to monitor the consistency of sampling methods and potential influence of off-site factors on environmental samples. Examples of potential off-site factors include airborne VOCs and potable water used in drilling activities. As shown in Table A-14, field QC samples will include field duplicates. A description of this type of QC sample and other QC samples are provided in the following subsections.

8.1.1. Field Duplicates

Field duplicates serve as measures for precision. They are created by placing aliquots of a homogenized sample in separate containers and identifying one of the aliquots as the primary or parent sample and the other as the duplicate sample. Field duplicates measure the precision and consistency of laboratory analytical procedures and methods, as well as the consistency of the sample processing techniques used by field personnel and/or the relative homogeneity of sample matrices. The duplicate sample is submitted to gain precision information on sample homogeneity, handling, shipping, storage and preparation, and analysis. Field duplicates will be analyzed for the same parameters as the associated primary samples.

One field duplicate will be collected for every twenty (20) primary air, soil, groundwater, sediment, and offshore groundwater samples (i.e., a frequency of 5 percent for each matrix). The duplicate samples will be collected at the same locations and as close as possible to the same times as the associated primary samples.

8.1.2. Field Blanks

According to the National Functional Guidelines for Organic Data Review (EPA 2020b), “The purpose of laboratory (or field) blank analysis is to assess the existence and magnitude of contamination resulting from laboratory (or field) activities. The criteria for evaluation of blanks apply to any blank associated with the samples…” Field blanks will not initially be used; however, field blanks will be introduced into the sampling and analysis effort at the discretion of the QA Leader if information arises for which to suspect contamination is being introduced by ambient conditions in the field. Field blanks are samples of distilled water poured directly into sample containers in the field. Field blanks are analyzed for the same parameters as the associated project samples. Analytical results for field blanks will be interpreted in general accordance with EPA’s National Functional Guidelines for Inorganic (EPA 2020a) and Organic Data Review (EPA 2020b) and professional judgment.

8.2. Chemical Laboratory Quality Control

The analytical laboratories will follow standard analytical method procedures that include specified QC monitoring requirements. These requirements will vary by method, but generally include:

- Method blanks;
- Internal standards;

- Instrument calibrations;
- Matrix spikes/matrix spike duplicates (MS/MSDs);
- Laboratory control samples/laboratory control sample duplicates (LCS/LCSDs);
- Laboratory replicates or duplicates; and
- Surrogate spikes.

8.2.1. Laboratory Blanks

Laboratory procedures employ the use of several types of blanks but the most commonly used blanks for QA/QC assessments are method blanks. Method blanks are laboratory QC samples that consist of either a soil/sediment-like material that has undergone a contaminant destruction process, or a sample of reagent water. Method blanks are extracted and analyzed with each batch of environmental samples undergoing analysis. Method blanks are particularly useful during volatiles analysis since VOCs can be transported in the laboratory through the vapor phase. If a substance is found in the method blank, it indicates that one (or more) of the following occurred:

- Measurement apparatus or containers were not properly cleaned and contained contaminants.
- Reagents used in the analytical process were contaminated with a substance(s) of interest.
- Contaminated analytical equipment was not properly cleaned.
- Volatile substances in the air with high solubility or affinities toward the sample matrix contaminated the samples during preparation or analysis.

It is difficult to determine which of the above scenarios took place if method blank contamination occurs. However, it is assumed that the conditions that affected the blanks also likely affected the project samples. If method blank contamination is identified, validation guidelines assist in determining which substances detected in associated project samples are likely truly present in the samples and which ones are likely attributable to the analytical process.

8.2.2. Matrix Spike/Matrix Spike Duplicates

MS/MSDs are used to assess influences or interferences caused by the physical or chemical properties of the sample itself. For example, extreme pH can affect the results of SVOC analyses or, the presence of a particular analyte in a sample may interfere with accurate quantitation of another analyte. MS/MSD data are reviewed in combination with other QC monitoring data to evaluate matrix effects. In some cases, matrix effects cannot be determined due to dilution and/or high levels of related substances in the sample. An MS is created by spiking a known amount of one or more of the target analytes into a project sample, ideally at a concentration at least 5 to 10 times higher than the concentration in the unspiked sample. Percent recovery value is calculated by subtracting the unspiked sample result from the spiked sample result, dividing by the spike amount, and multiplying by 100.

The samples designated for MS/MSD analysis should be obtained from a sampling location that is suspected to not be highly contaminated. A sample from an area of low-level contamination is needed because the objective of MS/MSD analyses is to assess possible matrix interferences, which can best be achieved with low levels of contaminants. For the pre-remedial design investigation, additional sample volume will be collected for MS/MSD analysis for every twenty (20) primary soil, groundwater, sediment, and offshore groundwater samples, or as determined as necessary by the analytical laboratory.

8.2.3. Laboratory Control Spikes/ Laboratory Control Spike Duplicates

Also known as blank spikes, laboratory control spikes (LCS) and laboratory control spike duplicates (LCSDs) are similar to MS/MSD samples in that a known amount of one or more of the target analytes is spiked into a prepared medium and the percent recovery is calculated for the spiked substance(s). The primary difference between an MS and LCS is that the LCS spike medium is considered "clean" or contaminant-free. For example, reagent water is typically used for LCS water analyses. The purpose of an LCS is to help assess the overall accuracy and precision of the analytical process including sample preparation, instrument performance, and analyst performance. LCS data must be reviewed in context with other laboratory QC data to determine if corrective action is necessary for laboratory control limit exceedances.

8.2.4. Laboratory Replicates/Duplicates

Laboratories often utilize MS/MSDs, LCS/LCSDs, and/or laboratory replicates to assess precision. Replicates are a second analysis of a field-collected environmental sample. Replicates can be split at varying stages of the sample preparation and analysis process, but most commonly consist of a second analysis on the extracted media.

8.2.5. Surrogate Spikes

Surrogate spikes are used to verify the accuracy of the analytical instrument and extraction procedures used. Surrogates are substances similar to target analytes. A known concentration of surrogate is added to each project sample and passed through the analysis process, noting the surrogate recovery. Each surrogate used has an acceptable range of percent recovery. If a surrogate recovery is low, sample results may be biased low, and, depending on the percent recovery, a possibility of false negatives may exist. Conversely, when surrogate recoveries are above the specified range of acceptance, a possibility of false positives exists, although non-detected results are considered accurate.

8.3. Calibration Procedures

8.3.1. Field Instrumentation

Field instrument calibration and calibration checks facilitate accurate and reliable field measurements. The calibration of the instruments will be checked and adjusted as necessary in general accordance with manufacturers' recommendations. Methods and frequency of calibration checks and instrument maintenance will be based on the type of instrument, stability characteristics, required accuracy, intended use, and environmental conditions.

8.3.2. Laboratory Instrumentation

Several types of instrument calibrations are used, depending on the method, to determine whether the methodology is 'in control' by verifying the linearity of the calibration curve and to assure that the sample results reflect accurate and precise measurements. This is done by verifying that the percent relative standard deviations (RSD) and/or the correlation coefficients are within the control limits specified in the validation documents. The main calibrations used are initial calibrations, daily calibrations, and continuing calibration verification.

For chemical analytical testing, calibration procedures and their appropriate chemical standards are to comply with the specific methods within EPA SW-846, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, 3rd Edition, December 1996 and the laboratory's Standard Operating Procedures (SOP). Calibration documentation will be retained at the laboratory for a minimum period of 6 months.

9.0 LABORATORY DATA REPORTING AND DELIVERABLES

Laboratories will report data in electronic form to the Project Manager and QA Leader. Upon completion of analyses, the laboratory will prepare electronic data deliverables (EDDs) required for completion of a Stage 2B data validation that includes the appropriate QC documentation. Analytical laboratory measurements will be recorded in standard formats that display, at a minimum, the client/field sample identification, the laboratory sample identification, reporting units, analytical methods, analytes tested, analytical results, extraction and analysis dates, quantitation limits, and data qualifiers. Each sample delivery group will be accompanied by sample receipt forms and a case narrative identifying data quality issues.

GeoEngineers will establish EDD requirements with the contract laboratories, as part of subcontracting.

10.0 DATA REDUCTION AND ASSESSMENT PROCEDURES

This section describes the process for generating and checking data, as well as the process for producing reports for field and analytical laboratory data.

10.1. Data Reduction

Data reduction involves the conversion or transcription of field and analytical data to a useable format. The laboratory personnel will reduce the analytical data for review by the QA Leader and the data validation subcontractor (see Section 10.4.6). This will involve both hard-copy forms and EDDs. Both forms of data will be compared with each other to verify that the data are reliable and error-free.

10.2. Review of Field Documentation and Laboratory Receipt Information

Documentation of field sampling data will be reviewed periodically for conformance with project QC requirements. At a minimum, field documentation will be checked for proper documentation of the following:

- Sample collection information (date, time, location, matrices, etc.);
- Field instruments used and calibration data;
- Sample collection protocol;
- Sample containers, preservation, and volume;
- Field QC samples collected at the frequency specified;
- Chain-of-custody protocols; and
- Sample shipment information.

Sample receipt forms provided by the laboratories will be reviewed for QC exceptions. The final laboratory data package will describe (in the case narrative) the effects that any identified QC exceptions have on data quality. The laboratories will review transcribed sample collection and receipt information for correctness prior to delivering the final data package.

10.3. Chemical Data Verification/Validation

Project decisions, conclusions, and recommendations will be based upon verified (validated) data. The purpose of data verification is to ensure that data used for subsequent evaluations and calculations are scientifically valid, of known and documented quality, and legally defensible. Field data verification will be used to eliminate data not collected or documented in accordance with the protocols specified in the SAP/QAPP. Laboratory data verification will be used to eliminate data not obtained using prescribed laboratory procedures.

The data validation subcontractor (see Section 10.4.6) will validate data collected during the PRDI to ensure that the data are valid and usable. The QA Leader will oversee the data validation subcontractor.

The data validation subcontractor will perform an EPA-defined Stage 2B validation on organic and inorganic analytical data in general accordance with EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 2020a) and EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 2020b). Additional specifications and professional judgment by the QA Leader and the data validation subcontractor may be incorporated when appropriate data from specific matrices and field samples are available.

At a minimum, the following items will be reviewed to verify the data as applicable:

- Documentation that a final review of the data was completed by the Laboratory QA Coordinator;
- Documentation of analytical and QC methodology;
- Documentation of sample preservation and transport;
- Sample receipt forms and case narratives; and
- The following QC parameters:
  - Holding times and sample preservation
  - Method blanks
  - MS/MSDs
  - LCS/LCSDs
  - Surrogate or Labeled Compound spikes
  - Duplicates/replicates
  - Initial Calibrations
  - Continuing Calibrations
  - Internal Standards

When sample analytical data are received from the analytical laboratory, they will undergo a QC review by the data validation subcontractor. The accuracy and precision achieved will be compared to the laboratory's analytical control limits. Additional specifications and professional judgment by the data validation subcontractor may be incorporated when appropriate data from specific matrices and field samples are available.

Data validation will be completed and a data validation report will be prepared to document the overall quality of the data relative to the DQOs. The major components of the data validation report are as follows:

- **Data Validation Summary.** Summarizes the data validation results for all sample delivery groups by analytical method. The summary identifies any systematic problems, data generation trends, general conditions of the data, and reasons for any data qualification.
- **QC Sample Evaluation.** Evaluates the results of QC sample analyses, and presents conclusions based on these results regarding the validity of the project data.
- **Assessment of DQOs.** An assessment of the quality of data measured and generated in terms of accuracy, precision, and completeness relative to objectives established for the project.
- **Summary of Data Usability.** Summarizes the usability of data, based on the assessment performed in the three preceding steps.

The data validation will help to achieve an acceptable level of confidence in the decisions that are to be made based upon the project data. The project analytical data will be submitted to Ecology's Environmental Information Management (EIM) system after the data validation is completed.

10.4. Project Organization and Responsibilities

The key PRDI personnel and responsibilities are identified below. These key personnel are responsible for ensuring that the sampling and analysis activities are conducted in a manner sufficient to meet the PRDI objectives.

10.4.1. Principal-in-Charge

John Herzog is the Principal-in-Charge and has overall responsibility for seeing that the project is implemented in accordance with the PRDI and related requirements.

10.4.2. Project Manager

Neil Morton is the Project Manager and will coordinate and schedule field and laboratory testing activities, assign project team members, coordinate subcontractors, and track budgets and schedules. Neil will also verify that SAP and QAPP objectives are achieved, or that potential modifications are documented if such changes are needed based on conditions at the time of the work. Additionally, he will provide technical oversight and coordinate production and review of PRDI deliverables.

10.4.3. Field Coordinator

The Field Coordinator is responsible for the daily management of activities in the field. Specific responsibilities include:

- Provide technical direction to the field staff.
- Develop schedules and allocate resources for field tasks.
- Coordinate data collection activities to be consistent with information requirements.
- Supervise the compilation of field data and laboratory analytical results.

- Review data for correct and complete reporting.
- Implement and oversee field sampling in accordance with the PRDI Project Plans, SAP, and QAPP.
- Supervise field personnel.
- Coordinate work with on-site subcontractors.
- Schedule sample shipments with the analytical laboratory.
- Monitor that appropriate sampling, testing, and measurement procedures are followed.
- Coordinate the transfer of field data, sample tracking forms, and log books to the Project Manager for data reduction and review.
- Identify whether deviations from the SAP and QAPP procedures are appropriate to achieve the investigation goals and discuss these changes with the Project Manager.

The Field Coordinator will be confirmed before beginning the field work.

10.4.4. Quality Assurance Leader

The Quality Assurance (QA) Leader is responsible for coordinating QA/QC for laboratory testing of field samples. Specific responsibilities include the following:

- Serve as the official contact for laboratory data QA questions and concerns.
- Confirm acceptability of the laboratory QA Plan.
- Respond to laboratory data QA needs, answer laboratory requests for guidance and assistance, and resolve issues.
- Monitor laboratory compliance with data quality requirements.
- Confirm that appropriate sampling, testing, and analysis procedures are followed and that proper QC checks are implemented.
- Review the implementation of the QAPP and the overall quality of the analytical data generated.
- Implement or direct corrective actions if necessary.
- Review project policies, procedures, and guidelines and review the project activities to verify that the QA program is being properly implemented.
- Provide oversight of the data development and review process and of subcontracting laboratories.
- Develop work scopes for the subcontracting laboratories that incorporate QAPP requirements.
- Oversee Data Validation subcontractor.
- Enter data into Ecology's EIM system.

The QA Leader will be confirmed before beginning the field work.

10.4.5. Laboratory Management

The subcontracted laboratory(ies) conducting analytical testing for this project are required to confirm with the QA Leader that laboratory procedures are consistent with the project QA objectives. The Laboratory QA

Coordinator administers the Laboratory QA Plan and is responsible for QC. Specific responsibilities of the Laboratory QA Coordinator include:

- Verify implementation of the Laboratory QA Plan.
- Serve as the laboratory point of contact.
- Activate corrective action as necessary when analytical control limits are exceeded.
- Issue the final laboratory QA/QC report.
- Comply with QAPP and contractual requirements for laboratory services.
- Participate in QA audits and compliance inspections if determined by GeoEngineers to be needed.

ARI will be the primary Ecology-accredited analytical laboratory for the PRDI. Sue Dunihoo or designate will be ARI's Laboratory QA Coordinator.

Brooks Applied Labs will be the Ecology-accredited analytical laboratory for arsenic speciation. Amy Goodall or designate will be Brooks Applied Lab's Laboratory QA Coordinator.

Friedman & Bruya will be the Ecology-accredited analytical laboratory for air and soil vapor samples. Eric Young or designate will be Friedman & Bruya's Laboratory QA Coordinator.

10.4.6. Data Validation

EcoChem, Inc (Seattle, Washington) will serve as the data validation subcontractor and will review and validate the analytical data provided by the analytical laboratories. Christine Ransom or designate will be EcoChem's project lead. Specific data validation responsibilities include:

- Verify electronic data packages deliverables received from the laboratories.
- Complete EPA Stage 2B data validation.
- Add data qualifiers to the data as necessary.
- Prepare data validation reports.

11.0 LIMITATIONS

This SAP/QAPP has been prepared for the exclusive use of the PSE and the City of Seattle, their authorized agents and regulatory agencies in their evaluation of the South State Street Site. No other party may rely on the product of our services unless we agree in advance and in writing to such reliance.

Within the limitations of scope, schedule and budget, our services were executed in accordance with generally accepted environmental science practices in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

12.0 REFERENCES

U.S. Environmental Protection Agency (EPA) 2001. “EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5,” EPA-240/B-01/003, Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC. March 2001.

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Washington State Department of Ecology (Ecology) 2016. “Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies,” Published July 2004, Revised December 2016.

Washington State Department of Ecology (Ecology) 2023. Cleanup Action Plan, Gas Works Park Site, Seattle, Washington. July 24, 2023.

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TABLES

Table A-1a

Proposed Sample Locations, Objectives and List of Analyses for Upland Air, Groundwater and Soil

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Sample				Proposed Location[1]			List of Analyses																Objectives[8]
							Air			Upland Groundwater							Upland Soil						
				Coordinates[2]																			
Identification	Media	Collection Method	Number of Sample for Analysis	Northing	Easting	Sample Target Depth Interval[3]	Benzene, Ethylbenzene, Toluene, Xylenes, and Naphthalene (EPA TO-15)	Petroleum Fractions - C5-C8 aliphatics, C9-C12 aliphatics and C9-C10 aromatics (EPA TO-15)	Helium (ASTM D 1946)	Develop and Gauge Well Prior to Groundwater Sampling	Benzene, Ethylbenzene, Toulene (EPA 8260D)	Napthalene (EPA 8270E-SIM)	cPAHs (EPA 8270E-SIM)	Dissolved Arsenic (EPA 6010C preserved)[4]	Dissolved Arsenic (EPA 6010C unpreserved)[5]	Arsenic Speciation[6] (BAL-4100)	RCRA Metals[7] (EPA 6020B/7471B)	Arsenic (EPA 6020B)	Benzene, Ethylbenzene, Tolene, and Xylenes (EPA 8260D)	Diesel Range Total Petroleum Hydrocarbons (NWTPH-Dx)	PAHs and cPAHs (EPA 8270E-SIM)	Laboratory Archive[8]	
Upland Air Samples																							
HP-SV-1	Soil Vapor	Vapor Pins/Summa Cannister (1-liter/5-min)	1	1269632.67	239172.34	Sub-slab	X	X	X														Soil vapor, Indoor and outdoor air sampling is needed to verify conclusions of indoor/outdoor air risk evaluation included in Appendix 4D of the GWPS RI/FS.
HP-SV-2	Soil Vapor	Vapor Pins/Summa Cannister (1-liter/5-min)	1	1269674.36	239136.71		X	X	X														
HP-SV-3	Soil Vapor	Vapor Pins/Summa Cannister (1-liter/5-min)	1	1269769.82	239110.50		X	X	X														
HP-SV-4	Soil Vapor	Vapor Pins/Summa Cannister (1-liter/5-min)	1	1269793.03	239141.93		X	X	X														
HP-IA-1	Indoor Air	Summa Cannister (6-liter/8-hr)	1	1269618.43	239185.90	Approx 3 to 5 ft above ground surface	X	X															
HP-IA-2	Indoor Air	Summa Cannister (6-liter/8-hr)	1	1269643.35	239142.58		X	X															
HP-IA-3	Indoor Air	Summa Cannister (6-liter/8-hr)	1	1269763.54	239115.09		X	X															
HP-IA-4	Indoor Air	Summa Cannister (6-liter/8-hr)	1	1269786.13	239147.47		X	X															
HP-OA-1	Outdoor Air	Summa Cannister (6-liter/8-hr)	1	1269594.01	239255.71	Approx 3 to 5 ft above ground surface	X	X															
HP-OA-2	Outdoor Air	Summa Cannister (6-liter/8-hr)	1	1269741.92	239062.15		X	X															
ES-OA-1	Outdoor Air	Summa Cannister (6-liter/8-hr)	1	1270835.08	239342.23		X	X															
PR-OA-1	Outdoor Air	Summa Cannister (6-liter/8-hr)	1	1270425.46	238705.45		X	X															
CT-OA-1	Outdoor Air	Summa Cannister (6-liter/8-hr)	1	1270283.95	238889.78		X	X															
PL-OA-1	Outdoor Air	Summa Cannister (6-liter/8-hr)	1	1269990.15	239466.37		X	X															

Sample				Proposed Location[1]			List of Analyses															Objectives[8]
							Air			Upland Groundwater							Upland Soil					
				Coordinates[2]																		
Identification	Media	Collection Method	Number of Sample for Analysis	Northing	Easting	Sample Target Depth Interval[3]	Benzene, Ethylbenzene, Toluene, Xylenes, and Naphthalene (EPA TO-15)	Petroleum Fractions - C5-C8 aliphatics, C9-C12 aliphatics and C9-C10 aromatics (EPA TO-15)	Helium (ASTM D 1946)	Develop and Gauge Well Prior to Groundwater Sampling	Benzene, Ethylbenzene, Toulene (EPA 8260D)	Napthalene (EPA 8270E-SIM)	cPAHs (EPA 8270E-SIM)	Dissolved Arsenic (EPA 6010C preserved)[4]	Dissolved Arsenic (EPA 6010C unpreserved)[5]	Arsenic Speciation[6] (BAL-4100)	RCRA Metals[7] (EPA 6020B/7471B)	Arsenic (EPA 6020B)	Benzene, Ethylbenzene, Tolene, and Xylenes (EPA 8260D)	Diesel Range Total Petroleum Hydrocarbons (NWTPH-Dx)	PAHs and cPAHs (EPA 8270E-SIM)	Laboratory Archive[8]	
Upland Groundwater Samples from Existing Wells																						
CMP-1	Groundwater	Low Flow	2	1269720.27	239054.53	6.5 to 21.5 ft				X	X	X	X	X									Upland groundwater data from shoreline wells are needed for multiple reasons. - Confirm and update shoreline groundwater concentrations. Outside of the Play Area, the shoreline groundwater wells were last sampled in 2013. - Confirm the Conceptual Site Model for the upland groundwater to surface water/sediment pathway. The shoreline groundwater wells will provide the initial groundwater concentrations for the evaluation of meeting the cleanup standards at the Conditional Point of Compliance. Upland groundwater concentrations will be compared to offshore groundwater (OSGW) concentrations to evaluate the effect of the upland groundwater on sediments and the effect of sediments on OSGW and surface water at the Conditional Point of Compliance. - Provide groundwater concentrations for the design of the required arsenic treatment near the Play Area. - Use shoreline groundwater concentrations to inform in-water cap modeling.
MLS-6-1	Groundwater	Low Flow	2	1269672.36	239097.37	24 to 25 ft				X	X	X	X	X									
MLS-6-2	Groundwater	Low Flow	2	1269672.36	239097.37	19.5 to 20.5 ft				X	X	X	X	X									
MLS-6-4	Groundwater	Low Flow	2	1269672.36	239097.37	10.5 to 11.5 ft				X	X	X	X	X									
MLS-7-1	Groundwater	Low Flow	2	1269723.35	239057.29	24 to 25 ft				X	X	X	X	X									
MLS-7-2	Groundwater	Low Flow	2	1269723.35	239057.29	19.5 to 20.5 ft				X	X	X	X	X									
MLS-7-4	Groundwater	Low Flow	2	1269723.35	239057.29	10.5 to 11.5 ft				X	X	X	X	X									
MW-13	Groundwater	Low Flow	2	1269903.01	238836.40	7.3 tp 17.3 ft				X	X	X	X	X									
MW-22	Groundwater	Low Flow	2	1270121.67	238720.78	24 to 34 ft				X	X	X	X	X									
MW-23	Groundwater	Low Flow	2	1270189.86	238717.52	22 to 32 ft				X	X	X	X	X									
MW-24	Groundwater	Low Flow	2	1270124.82	238719.09	5 to 15 ft				X	X	X	X	X									
MW-25	Groundwater	Low Flow	2	1270191.99	238713.35	5 to 15 ft				X	X	X	X	X									
MW-32D/GEO-1	Groundwater	Low Flow	2	1269843.36	238868.08	42 to 47 ft				X	X	X	X	X									
MW-32S	Groundwater	Low Flow	2	1269847.40	238865.02	16.5 to 31 ft				X	X	X	X	X									
MW-33SB	Groundwater	Low Flow	2	1270318.73	238749.02	13 to 22 ft				X	X	X	X	X									
MW-34S	Groundwater	Low Flow	2	1270501.84	238734.98	5 to 9.8 ft				X	X	X	X	X									
MW-35S	Groundwater	Low Flow	2	1270634.92	238807.94	4 to 6.8 ft				X	X	X	X	X									
MW-36S	Groundwater	Low Flow	2	1270783.67	239086.82	8 to 22.8 ft				X	X	X	X		X								
MW-36D	Groundwater	Low Flow	2	1270785.69	239091.54	29.3 to 33.8 ft				X	X	X	X		X								
MW-37S	Groundwater	Low Flow	2	1270816.81	239231.23	5.1 to 14.8 ft				X	X	X	X	X									
MW-38S	Groundwater	Low Flow	2	1270820.94	239318.15	7.1 to 16.6 ft				X	X	X	X	X									
MW-39S	Groundwater	Low Flow	2	1270814.15	239397.34	3.9 to 14.1 ft				X	X	X	X	X									
MW-39D	Groundwater	Low Flow	2	1270814.15	239397.34	17 to 21.8 ft				X	X	X	X	X									
MW-40S	Groundwater	Low Flow	2	1270790.45	239491.08	4 to 10.9 ft				X	X	X	X	X									
MW-44S	Groundwater	Low Flow	2	1270720.72	239159.31	7.4 to 17.4 ft				X	X	X	X		X								
MW-45S	Groundwater	Low Flow	2	1270725.64	239142.50	6.8 to 16.8 ft				X	X	X	X		X								
MW-45D	Groundwater	Low Flow	2	1270727.34	239138.49	25.6 to 30.6 ft				X	X	X	X		X								
MW-46S	Groundwater	Low Flow	2	1270760.23	239143.44	7.5 to 17.5 ft				X	X	X	X		X								
MW-46D	Groundwater	Low Flow	2	1270760.23	239143.44	24.5 to 29.5 ft				X	X	X	X		X								
MW-47S	Groundwater	Low Flow	2	1270743.90	239111.94	14.8 to 19.8 ft				X	X	X	X		X								
MW-48D	Groundwater	Low Flow	2	1270756.15	239081.86	22.5 to 32.5 ft				X	X	X	X		X								
MW-49D	Groundwater	Low Flow	2	1270775.15	239063.29	24.6 to 34.6 ft				X	X	X	X		X	X							
MW-50D	Groundwater	Low Flow	2	1270793.29	239117.04	29.6 to 34.6 ft				X	X	X	X		X	X							
MW-51S	Groundwater	Low Flow	2	1270795.79	239136.65	6.9 to 16.9 ft				X	X	X	X		X								
MW-52D	Groundwater	Low Flow	2	1270796.96	239147.84	29.8 to 34.8 ft				X	X	X	X		X	X							
OBS-1	Groundwater	Low Flow	2	1270752.38	238945.55	2 to 11.7 ft				X	X	X	X	X									
OBS-2	Groundwater	Low Flow	2	1270739.25	238962.08	2 to 11.7 ft				X	X	X	X	X									
PZ-1	Groundwater	Low Flow	2	1269608.57	239204.23	3 to 13 ft				X	X	X	X	X									
TDW-1	Groundwater	Low Flow	2	1269573.53	239244.68	37.5 to 42.5 ft				X	X	X	X	X									
TDW-2	Groundwater	Low Flow	2	1269754.81	238940.89	34.5 to 39.5 ft				X	X	X	X	X									
TDW-3	Groundwater	Low Flow	2	1269998.31	238769.63	34.5 to 39.5 ft				X	X	X	X	X									
TSW-1	Groundwater	Low Flow	2	1269586.36	239252.03	5.3 to 10.3 ft				X	X	X	X	X									
TSW-2	Groundwater	Low Flow	2	1269762.80	238955.77	7 to 12 ft				X	X	X	X	X									
TSW-3	Groundwater	Low Flow	2	1270000.34	238775.70	6 to 11 ft				X	X	X	X	X									

Sample				Proposed Location[1]			List of Analyses																
							Air			Upland Groundwater							Upland Soil						
				Coordinates[2]																			
Identification	Media	Collection Method	Number of Sample for Analysis	Northing	Easting	Sample Target Depth Interval[3]	Benzene, Ethylbenzene, Toluene, Xylenes, and Naphthalene (EPA TO-15)	Petroleum Fractions - C5-C8 aliphatics, C9-C12 aliphatics and C9-C10 aromatics (EPA TO-15)	Helium (ASTM D 1946)	Develop and Gauge Well Prior to Groundwater Sampling	Benzene, Ethylbenzene, Toulene (EPA 8260D)	Napthalene (EPA 8270E-SIM)	cPAHs (EPA 8270E-SIM)	Dissolved Arsenic (EPA 6010C preserved)[4]	Dissolved Arsenic (EPA 6010C unpreserved)[5]	Arsenic Speciation[6] (BAL-4100)	RCRA Metals[7] (EPA 6020B/7471B)	Arsenic (EPA 6020B)	Benzene, Ethylbenzene, Tolene, and Xylenes (EPA 8260D)	Diesel Range Total Petroleum Hydrocarbons (NWTPH-Dx)	PAHs and cPAHs (EPA 8270E-SIM)	Laboratory Archive[8]	Objectives[8]
Upland Groundwater Samples From New Angled Monitoring Wells																							
AW-49D	Groundwater	Low Flow	2	1270778.99	239059.90	25 to 35 ft				X	X	X	X		X	X							Characterize arsenic concentrations in outwash groundwater downgradient of the three existing shoreline outwash unit wells with the highest arsenic concentrations; evaluate the fate and transport of arsenic in the outwash unit, and establish the post-construction groundwater monitoring points as far offshore as possible downgradient of the existing shoreline wells.
AW-50D	Groundwater	Low Flow	2	1270797.70	239112.25	30 to 35 ft				X	X	X	X		X	X							
AW-52D	Groundwater	Low Flow	2	1270804.06	239147.83	30 to 35 ft				X	X	X	X		X	X							
Upland Soil Samples From New Angled Monitoring Wells																							
AW-49D	Soil	Sonic Drilling	2	1270778.99	239059.90	20 to 35 ft												X			X		Characterize arsenic and PAH concentrations in outwash material in the shoreline to evaluate the fate and transport of arsenic and PAHs in the outwash unit within the screened interval and directly above the screened interval.
AW-50D	Soil	Sonic Drilling	2	1270797.70	239112.25	25 to 35 ft												X			X		
AW-52D	Soil	Sonic Drilling	2	1270804.06	239147.83	25 to 35 ft												X			X		
Upland Soil Samples in SMAs 1 and 2																							
HA-1	Soil	Hand Auger/Excavation	1	1270792.50	239508.07	0 to 3 ft											X		X	X	X	X	Sample soil in SMAs 1 and 2 to characterize material that will be excavated and disposed offsite at appropriate permitted landfill facility.
HA-2	Soil	Hand Auger/Excavation	1	1270807.55	239432.46	0 to 3 ft											X		X	X	X	X	
HA-2a	Soil	Hand Auger/Excavation	1	1270770.80	239432.15	0 to 3 ft																	
HA-2b	Soil	Hand Auger/Excavation	1	1270776.84	239412.27	0 to 3 ft																	
HA-3	Soil	Hand Auger/Excavation	1	1270819.44	239360.90	0 to 3 ft											X		X	X	X	X	
HA-4	Soil	Hand Auger/Excavation	1	1270820.24	239267.28	0 to 3 ft											X		X	X	X	X	
HA-5	Soil	Hand Auger/Excavation	1	1270810.96	239193.03	0 to 3 ft											X		X	X	X	X	
HA-6	Soil	Hand Auger/Excavation	1	1270795.22	239129.67	0 to 3 ft											X		X	X	X	X	
HA-7	Soil	Hand Auger/Excavation	1	1270792.40	239078.42	0 to 3 ft											X		X	X	X	X	
HA-8	Soil	Hand Auger/Excavation	1	1270766.57	238975.92	0 to 3 ft											X		X	X	X	X	
HA-9	Soil	Hand Auger/Excavation	1	1270690.70	238830.23	0 to 3 ft											X		X	X	X	X	
HA-10	Soil	Hand Auger/Excavation	1	1270530.49	238767.68	0 to 3 ft											X		X	X	X	X	
HA-11	Soil	Hand Auger/Excavation	1	1270024.92	238748.81	0 to 3 ft											X		X	X	X	X	
HA-12	Soil	Hand Auger/Excavation	1	1269960.80	238780.39	0 to 3 ft											X		X	X	X	X	
HA-13	Soil	Hand Auger/Excavation	1	1269905.30	238813.88	0 to 3 ft											X		X	X	X	X	
HA-14	Soil	Hand Auger/Excavation	1	1269816.31	238866.51	0 to 3 ft											X		X	X	X	X	
HA-15	Soil	Hand Auger/Excavation	1	1269757.93	238922.02	0 to 3 ft											X		X	X	X	X	

Notes:

[1] Approximate locations are shown on Figures A-3 through A-5.

[2] Coordinates are presented in North American Datum (NAD) of 1983, Washington State Plane North.

[3] Depth is presented in feet (ft) below ground surface (bgs) for soil samples. Depth for monitoring wells is ft bgs of the screened interval. While air samples are ft above ground surface unless otherwise noted.

[4] Sample will be collected for dissolved arsenic and placed in a laboratory provided bottle **with** preservative and filtered at the lab.

[5] Sample will be collected for dissolved arsenic and placed in a laboratory provided bottle **without** preservative and filtered at the lab

[6] Arsenic speciation samples to be collected by syringe method identified in Attachment A-3 of the SAP/QAPP. Samples to be analyzed by Brooks Applied Labs by Method SOP BAL-4100.

[7] RCRA metals including arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver.

[8] Soil sample volume collected for archival at the laboratory for potential follow-up TCLP analyses as required for landfill waste characterization.

[9] See PRDI Work Plan for further detail of sampling and analysis data objectives.

ASTM = ASTM International

EPA = U.S. Environmental Protection Agency

ENR = Enhanced Natural Recovery

MNR = Monitored Natural Recovery

TPH = Total Petroleum Hydrocarbons

TOC = Total Organic Carbon

Table A-1b

Proposed Sample Locations, Objectives and List of Analyses for Sediment and Porewater

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Proposed Location																																												
Sample Station Information[1]						Proposed Samples							Sediment Analyses[3]																								Offshore Groundwater Analyses							
Sediment Sampling Station Location	Sediment Management Area (SMA)	Number of Sample for Analysis	Coordinates[2] Northing	Coordinates[2] Easting	Elevation: Mudline Elevation (ft USACE Locks Datum)	Sample Identification	Media	Collection Method	Sample Target Depth Interval (ft USACE Locks Datum) Top	Sample Target Depth Interval (ft USACE Locks Datum) Bottom	Sample Target Depth Interval[4] (ft below mudline) Top	Sample Target Depth Interval[4] (ft below mudline) Bottom	VOCs (EPA 8260D/5035): Benzene, Ethylbenzene and Toulene	VOCs (EPA 8260D/5035): BETX	PAHs (EPA 8270E-SIM): PAHs[5]	PAHs (EPA 8270E-SIM): Total cPAHs[6] Only	Metals (EPA 6020B/7471B/SOP BAL-3200): Arsenic	Metals: RCRA Metals and GWPS and ALU COCs[7]	Metals: Methylmercury (ALU COC)[8]	Metals: Chromium (ALU COC)	Metals: Nickel	Metals: ALU Benthic COCs[9]	SVOCs (EPA 8270E/8270E-SIM): GWPS and ALU COCs[10]	SVOCs: ALU Bioaccumulative COCs[11]	SVOCs: Carbazole and Dibenzofuran	SVOCs: ALU Benthic COCs[12]	Pesticides (EPA 8081): Chlordane	Pesticides (EPA 8081): 4-4' DDE	Total Petroleum Hydrocarbons (NWTPH-Dx)	Sulfides (EPA 9034)	Total PCBs Aroclors (EPA 8082)	Dioxins/Furans (EPA 1613)	Tributyltin (EPA 8270E SIM)	Total Organic Carbon (ASTM D422)	Grain Size (ASTM D-6913/D-7928)[13]	Laboratory Archive[14]	Benzene, Ethylbenzene and Toluene (EPA 8260D)	PAHs[6] (EPA 8270E SIM)	Dissolved Arsenic (EPA 6010C preserved)[15]	Dissolved Arsenic (EPA 6010C unpreserved)[16]	Dissolved Metals[17] (EPA 6020B/7470A)	Arsenic Speciation[18] (BAL-4100)	SVOCs[19] (EPA 8270D)	Objectives[20]
Subsurface Sediment and Offshore Groundwater in SMA-3, SMA-4 and SMA-5																																												
PRDI-1	SMA-3	2	239515.790	1270819.755	18.51	PRDI-1-SC	Sediment	Vibracore	16.5	12.0	2.0	6.5		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	8.5	9.5	X		X		X																	X	X									
PRDI-2	SMA-3	2	239436.363	1270834.338	21.41	PRDI-2-SC	Sediment	Vibracore	19.4	12.0	2.0	9.4		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	11.4	12.4	X		X		X																											
PRDI-3	SMA-3	2	239436.884	1270850.223	19.20	PRDI-3-SC	Sediment	Vibracore	17.2	12.0	2.0	7.2		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	9.2	10.2	X		X		X																											
PRDI-4	SMA-3	3	239369.957	1270871.838	17.34	PRDI-4-SC	Sediment	Vibracore	15.3	12.0	2.0	5.3		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	7.3	8.3	X		X		X																	X	X									
						PRDI-4-OG	Offshore GW	Temporary Piezometer	10.0	9.0	7.3	8.3																									X	X	X					
PRDI-5	SMA-3	3	239285.061	1270860.639	19.25	PRDI-5-SC	Sediment	Vibracore	17.3	12.0	2.0	7.3		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	9.3	10.3	X		X		X																											
						PRDI-5-OG	Offshore GW	Temporary Piezometer	10.0	9.0	9.3	10.3																									X	X	X					
PRDI-6	SMA-3	3	239198.603	1270845.535	19.25	PRDI-6-SC	Sediment	Vibracore	17.3	12.0	2.0	7.3		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	9.3	10.3	X		X		X																											
						PRDI-6-OG	Offshore GW	Temporary Piezometer	10.0	9.0	9.3	10.3																									X	X	X					
PRDI-7	SMA-3	3	239146.199	1270832.612	19.25	PRDI-7-SC	Sediment	Vibracore	17.3	12.0	2.0	7.3		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	9.3	10.3	X		X		X																											
						PRDI-7-OG	Offshore GW	Temporary Piezometer	10.0	9.0	9.3	10.3																									X	X	X					
PRDI-8	SMA-3	3	239110.976	1270824.979	19.25	PRDI-8-SC	Sediment	Vibracore	17.3	12.0	2.0	7.3		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	9.3	10.3	X		X		X														X	X		X	X									
						PRDI-8-OG	Offshore GW	Temporary Piezometer	10.0	9.0	9.3	10.3																									X	X		X		X		
PRDI-9	SMA-3	3	239084.396	1270823.080	18.46	PRDI-9-SC	Sediment	Vibracore	16.5	12.0	2.0	6.5		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	8.5	9.5	X		X		X																											
						PRDI-9-OG	Offshore GW	Temporary Piezometer	10.0	9.0	8.5	9.5																									X	X		X		X		
PRDI-10	SMA-3	3	239058.098	1270818.378	18.46	PRDI-10-SC	Sediment	Vibracore	16.5	12.0	2.0	6.5		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	8.5	9.5	X		X		X																											
						PRDI-10-OG	Offshore GW	Temporary Piezometer	10.0	9.0	8.5	9.5																									X	X		X		X		
PRDI-11	SMA-3	3	238941.832	1270774.961	21.25	PRDI-11-SC	Sediment	Vibracore	19.3	12.0	2.0	9.3		X	X			X	X				X				X	X	X	X	X		X			X								Nearshore subsurface sediment samples will be collected within sediment that is planned for dredging. These samples will be collected throughout the sediment interval to be excavated at each location. Sediment data will be characterized for offsite upland disposal at a permitted landfill facility. Sediment samples and offshore groundwater samples will be collected at the base of the planned dredge limit to obtain data that will be used for the design of amended sand caps at the Site.
									10.0	9.0	11.3	12.3	X		X		X																	X	X									
						PRDI-11-OG	Offshore GW	Temporary Piezometer	10.0	9.0	11.3	12.3																									X	X	X					
PRDI-12	SMA-3	3	238851.294	1270738.500	20.25	PRDI-12-SC	Sediment	Vibracore	18.3	12.0	2.0	8.3		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	10.3	11.3	X		X		X																											
						PRDI-12-OG	Offshore GW	Temporary Piezometer	10.0	9.0	10.3	11.3																									X	X	X					
PRDI-13	SMA-4	3	238733.163	1270021.058	18.71	PRDI-13-SC	Sediment	Vibracore	16.7	12.0	2.0	6.7		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	8.7	9.7	X		X		X																											
						PRDI-13-OG	Offshore GW	Temporary Piezometer	10.0	9.0	8.7	9.7																									X	X	X					
PRDI-14	SMA-4	3	238780.483	1269913.179	16.54	PRDI-14-SC	Sediment	Vibracore	14.5	12.0	2.0	4.5		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	6.5	7.5	X		X		X																	X	X									
						PRDI-14-OG	Offshore GW	Temporary Piezometer	10.0	9.0	6.5	7.5																									X	X	X					
PRDI-15	SMA-4	3	238841.791	1269815.570	16.73	PRDI-15-SC	Sediment	Vibracore	14.7	12.0	2.0	4.7		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	9.0	6.7	7.7	X		X		X																											
						PRDI-15-OG	Offshore GW	Temporary Piezometer	10.0	9.0	6.7	7.7																									X	X	X					
PRDI-16	SMA-4	3	238902.121	1269746.126	16.27	PRDI-16-SC	Sediment	Vibracore	14.3	12.0	2.0	4.3		X	X			X	X				X				X	X	X	X	X		X			X								
									10.0	8.0	6.3	8.3	X		X		X														X	X												
						PRDI-16-OG	Offshore GW	Temporary Piezometer	10.0	8.0	6.3	8.3																									X	X	X					
PRDI-17	SMA-5	3	238954.204	1269697.515	20.63	PRDI-17-SC	Sediment	Vibracore	20.6	17.6	0.0	3.0		X	X			X	X				X				X	X	X	X	X		X			X								
									17.6	16.6	3.0	4.0	X		X		X																											
						PRDI-17-OG	Offshore GW	Temporary Piezometer	17.6	15.6	3.0	5.0																									X	X	X					
PRDI-18	SMA-5	3	239047.521	1269684.929	27.51	PRDI-18-SC	Sediment	Vibracore	27.5	24.5	0.0	3.0		X	X			X	X				X				X	X	X	X	X		X			X								
									24.5	23.5	3.0	4.0	X		X		X																	X	X									
						PRDI-18-OG	Offshore GW	Temporary Piezometer	24.5	22.5	3.0	4.0																									X	X	X					
PRDI-19	SMA-5	3	239114.795	1269621.127	14.26	PRDI-19-SC	Sediment	Vibracore	14.3	11.3	0.0	3.0		X	X			X	X				X				X	X	X	X	X		X			X								
									10.3	9.3	3.0	4.0	X		X		X																											
						PRDI-19-OG	Offshore GW	Temporary Piezometer	10.3	8.3	3.0	4.0																									X	X	X					
PRDI-20	SMA-5	3	239172.955	1269558.627	15.28	PRDI-20-SC	Sediment	Vibracore	15.3	12.3	0.0	3.0		X	X			X	X				X				X	X	X	X	X		X			X								
									12.3	11.3	3.0	4.0	X		X		X																											
						PRDI-20-OG	Offshore GW	Temporary Piezometer	12.3	11.3	3.0	4.0																									X	X	X					
PRDI-21	SMA-5	2	239258.417	1269535.054	20.91	PRDI-21-SC	Sediment	Vibracore	20.9	17.9	0.0	3.0		X	X			X	X				X				X	X	X	X	X		X			X								
									17.9	16.9	3.0	4.0	X		X		X																											
PRDI-22	SMA-5	2	239372.091	1269393.424	11.57	PRDI-22-SC	Sediment	Vibracore	11.6	8.6	0.0	3.0		X	X			X	X				X				X	X	X	X	X		X			X								
									8.6	7.6	3.0	4.0	X		X		X																	X	X									

Sediment Sampling Station Location	Sediment Management Area (SMA)	Number of Sample for Analysis	Northing (Coordinates[2])	Easting (Coordinates[2])	Mudline Elevation (ft USACE Locks Datum)	Sample Identification	Media	Collection Method	Sample Target Depth Interval (ft USACE Locks Datum) Top	Sample Target Depth Interval (ft USACE Locks Datum) Bottom	Sample Target Depth Interval[4] (ft below mudline) Top	Sample Target Depth Interval[4] (ft below mudline) Bottom	VOCs (EPA 8260D/5035): Benzene, Ethylbenzene and Toluene	VOCs: BETX	PAHs (EPA 8270E-SIM): PAHs[5]	PAHs: Total cPAHs[6] Only	Metals (EPA 6020B/7471B/SOP BAL-3200): Arsenic	Metals: RCRA Metals and GWPS and ALU COCs[7]	Metals: Methylmercury (ALU COC)[8]	Metals: Chromium (ALU COC)	Metals: Nickel	Metals: ALU Benthic COCs[9]	SVOCs (EPA 8270E/8270E-SIM): GWPS and ALU COCs[10]	SVOCs: ALU Bioaccumulative COCs[11]	SVOCs: Carbazole and Dibenzofuran	SVOCs: ALU Benthic COCs[12]	Pesticides (EPA 8081): Chlordane	Pesticides: 4-4'DDE	Total Petroleum Hydrocarbons (NWTPH-Dx)	Sulfides (EPA 9034)	Total PCBs Aroclors (EPA 8082)	Dioxins/Furans (EPA 1613)	Tributyltin (EPA 8270E SIM)	Total Organic Carbon (ASTM D422)	Grain Size (ASTM D-6913/D-7928)[13]	Laboratory Archive[14]	Offshore Groundwater: Benzene, Ethylbenzene and Toluene (EPA 8260D)	Offshore Groundwater: PAHs[6] (EPA 8270E SIM)	Offshore Groundwater: Dissolved Arsenic (EPA 6010C preserved)[15]	Offshore Groundwater: Dissolved Arsenic (EPA 6010C unpreserved)[16]	Offshore Groundwater: Dissolved Metals[17] (EPA 6020B/7470A)	Offshore Groundwater: Arsenic Speciation[18] (BAL-4100)	Offshore Groundwater: SVOCs[19] (EPA 8270D)	Objectives[20]
Near Surface (NS) Sediment and Offshore Groundwater Sampling in SMA-6, SMA-7 and SMA-9 through SMA-11																																												
PRDI-23	SMA-10	1	239516.916	1270914.226	10.10	PRDI-23-NS	Sediment	XL Power Grab	10.1	9.1	0.0	1.0	X		X		X																										Near surface (approximately 0 to 1 feet bml) sediment and offshore groundwater sample collected to characterize existing sediment that will be capped. The data will provide a basis for sand cap design including thickness and amendment(s).
PRDI-24	SMA-10	1	239445.999	1270927.253	9.03	PRDI-24-NS	Sediment	XL Power Grab	9.0	8.0	0.0	1.0	X		X		X																										
PRDI-25	SMA-7	1	239357.717	1270921.317	6.95	PRDI-25-NS	Sediment	XL Power Grab	7.0	6.0	0.0	1.0	X		X		X																	X	X									
PRDI-26	SMA-7	1	239279.592	1270901.264	4.95	PRDI-26-NS	Sediment	XL Power Grab	5.0	4.0	0.0	1.0	X		X		X																										
		1				PRDI-26-OG	Offshore GW	Temporary Piezometer	4.5	3.5	0.5	1.5																									X	X	X		X		X	
PRDI-27	SMA-7	1	239271.780	1271003.348	-10.85	PRDI-27-NS	Sediment	XL Power Grab	-10.9	-11.9	0.0	1.0	X		X		X																		X								
		1				PRDI-27-OG	Offshore GW	Temporary Piezometer	-11.4	-12.4	0.5	1.5																									X	X	X		X		X	
PRDI-28	SMA-7	1	239195.478	1270890.847	4.91	PRDI-28-NS	Sediment	XL Power Grab	4.9	3.9	0.0	1.0	X		X		X																										
PRDI-29	SMA-7	1	239206.936	1270994.494	-13.55	PRDI-29-NS	Sediment	XL Power Grab	-13.6	-14.6	0.0	1.0	X		X		X																										
PRDI-30	SMA-7	1	239140.470	1270870.111	7.75	PRDI-30-NS	Sediment	XL Power Grab	7.8	6.8	0.0	1.0	X		X		X																										
		1				PRDI-30-OG	Offshore GW	Temporary Piezometer	7.3	6.3	0.5	1.5																									X	X	X		X		X	
PRDI-31	SMA-7	1	239130.053	1270940.945	-8.83	PRDI-31-NS	Sediment	XL Power Grab	-8.8	-9.8	0.0	1.0	X		X		X																										
		1				PRDI-31-OG	Offshore GW	Temporary Piezometer	-9.3	-10.3	0.5	1.5																									X	X	X		X		X	
PRDI-32	SMA-7	1	239105.247	1270862.479	3.71	PRDI-32-NS	Sediment	XL Power Grab	3.7	2.7	0.0	1.0	X		X		X																	X	X									
		1				PRDI-32-OG	Offshore GW	Temporary Piezometer	3.2	2.2	0.5	1.5																									X	X	X		X		X	
PRDI-33	SMA-7	1	239078.666	1270860.580	2.63	PRDI-33-NS	Sediment	XL Power Grab	2.6	1.6	0.0	1.0	X		X		X																										
		1				PRDI-33-OG	Offshore GW	Temporary Piezometer	2.1	1.1	0.5	1.5																									X	X	X		X		X	
PRDI-34	SMA-7	1	239050.694	1270856.631	2.56	PRDI-34-NS	Sediment	XL Power Grab	2.6	1.6	0.0	1.0	X		X		X																										
PRDI-35	SMA-7	1	239018.655	1270917.149	-8.63	PRDI-35-NS	Sediment	XL Power Grab	-8.6	-9.6	0.0	1.0	X		X		X																										
PRDI-36	SMA-7	1	238924.124	1270826.003	3.80	PRDI-36-NS	Sediment	XL Power Grab	3.8	2.8	0.0	1.0	X		X		X																	X	X									
		1				PRDI-36-OG	Offshore GW	Temporary Piezometer	3.3	2.3	0.5	1.5																									X	X	X		X		X	
PRDI-37	SMA-7	1	238899.905	1270878.347	-11.66	PRDI-37-NS	Sediment	XL Power Grab	-11.7	-12.7	0.0	1.0	X		X		X																										
		1				PRDI-37-OG	Offshore GW	Temporary Piezometer	-12.2	-13.2	0.5	1.5																									X	X	X		X		X	
PRDI-38	SMA-7	1	238841.855	1270785.185	3.82	PRDI-38-NS	Sediment	XL Power Grab	3.8	2.8	0.0	1.0	X		X		X																										
PRDI-39	SMA-7	1	238842.092	1270863.503	-10.49	PRDI-39-NS	Sediment	XL Power Grab	-10.5	-11.5	0.0	1.0	X		X		X																		X								
PRDI-40	SMA-11	1	238791.383	1270842.220	-6.68	PRDI-40-NS	Sediment	XL Power Grab	-6.7	-7.7	0.0	1.0	X		X		X														X												
PRDI-41	SMA-11	1	238780.967	1270688.748	19.25	PRDI-41-NS	Sediment	XL Power Grab	19.3	18.3	0.0	1.0	X		X		X																		X								
		1				PRDI-41-OG	Offshore GW	Temporary Piezometer	18.8	17.8	0.5	1.5																									X	X	X		X		X	
PRDI-42	SMA-6	1	238648.328	1270492.219	15.80	PRDI-42-NS	Sediment	XL Power Grab	15.8	14.8	0.0	1.0	X		X		X																										
PRDI-43	SMA-6	1	238660.516	1270308.045	14.37	PRDI-43-NS	Sediment	XL Power Grab	14.4	13.4	0.0	1.0	X		X		X																		X								
		1				PRDI-42-OG	Offshore GW	Temporary Piezometer	13.9	12.9	0.5	1.5																									X	X	X		X		X	
PRDI-44	SMA-6	1	238671.940	1270121.928	10.57	PRDI-44-NS	Sediment	XL Power Grab	10.6	9.6	0.0	1.0	X		X		X																										
		1				PRDI-44-OG	Offshore GW	Temporary Piezometer	10.1	9.1	0.5	1.5																									X	X	X		X		X	
PRDI-45	SMA-6	1	238697.108	1269994.917	8.35	PRDI-45-NS	Sediment	XL Power Grab	8.4	7.4	0.0	1.0	X		X		X																										
		1				PRDI-45-OG	Offshore GW	Temporary Piezometer	7.9	6.9	0.5	1.5																									X	X	X		X		X	
PRDI-46	SMA-6	1	238665.340	1269953.834	-1.85	PRDI-46-NS	Sediment	XL Power Grab	-1.9	-2.9	0.0	1.0	X		X		X																										
		1				PRDI-42-OG	Offshore GW	Temporary Piezometer	-2.4	-3.4	0.5	1.5																									X	X	X		X		X	
PRDI-47	SMA-9	1	238760.952	1269901.026	4.27	PRDI-47-NS	Sediment	XL Power Grab	4.3	3.3	0.0	1.0	X		X		X																	X	X									
		1				PRDI-47-OG	Offshore GW	Temporary Piezometer	3.8	2.8	0.5	1.5																									X	X	X		X		X	
PRDI-48	SMA-9	1	238709.412	1269824.251	-12.91	PRDI-48-NS	Sediment	XL Power Grab	-12.9	-13.9	0.0	1.0	X		X		X																		X								
		1				PRDI-48-OG	Offshore GW	Temporary Piezometer	-13.4	-14.4	0.5	1.5																									X	X	X		X		X	
PRDI-49	SMA-9	1	238821.297	1269795.808	8.84	PRDI-49-NS	Sediment	XL Power Grab	8.8	7.8	0.0	1.0	X		X		X																										
PRDI-50	SMA-9	1	238784.933	1269742.220	-15.88	PRDI-50-NS	Sediment	XL Power Grab	-15.9	-16.9	0.0	1.0	X		X		X																										
PRDI-51	SMA-9	1	238883.892	1269728.331	2.54	PRDI-51-NS	Sediment	XL Power Grab	2.5	1.5	0.0	1.0	X		X		X																										
		1				PRDI-51-OG	Offshore GW	Temporary Piezometer	2.0	1.0	0.5	1.5																									X	X	X		X		X	
PRDI-52	SMA-9	1	238923.389	1269671.473	-1.62	PRDI-52-NS	Sediment	XL Power Grab	-1.6	-2.6	0.0	1.0	X		X		X																										
		1				PRDI-52-OG	Offshore GW	Temporary Piezometer	-2.1	-3.1	0.5	1.5																									X	X	X		X		X	
PRDI-53	SMA-9	1	238876.080	1269631.109	-14.46	PRDI-53-NS	Sediment	XL Power Grab	-14.5	-15.5	0.0	1.0	X		X		X																										
		1				PRDI-53-OG	Offshore GW	Temporary Piezometer	-15.0	-16.0	0.5	1.5																									X	X	X		X		X	
PRDI-54	SMA-9	1	239021.045	1269655.849	-0.55	PRDI-54-NS	Sediment	XL Power Grab	-0.6	-1.6	0.0	1.0	X		X		X																	X	X									
		1				PRDI-54-OG	Offshore GW	Temporary Piezometer	-1.1	-2.1	0.5	1.5																									X	X	X		X		X	
PRDI-55	SMA-9	1	239093.094	1269596.821	-0.04	PRDI-55-NS	Sediment	XL Power Grab	0.0	-1.0	0.0	1.0	X		X		X																										
PRDI-56	SMA-9	1	239024.083	1269523.904	-15.33	PRDI-56-NS	Sediment	XL Power Grab	-15.3	-16.3	0.0	1.0	X		X		X													X	X			X									
PRDI-57	SMA-9	1	239135.628	1269518.696	-3.21	PRDI-57-NS	Sediment	XL Power Grab	-3.2	-4.2	0.0	1.0	X		X		X																										
		1				PRDI-57-OG	Offshore GW	Temporary Piezometer	-3.7	-4.7	0.5	1.5																									X	X	X		X		X	
PRDI-58	SMA-9	1	239197.400	1269477.204	-3.56	PRDI-58-NS	Sediment	XL Power Grab	-3.6	-4.6	0.0	1.0	X		X		X																										
PRDI-59	SMA-9	1	239197.261	1269398.905	-16.73	PRDI-59-NS	Sediment	XL Power Grab	-16.7	-17.7	0.0	1.0	X		X		X																										
		1				PRDI-59-OG	Offshore GW	Temporary Piezometer	-17.2	-18.2	0.5	1.5																									X	X	X		X		X	
PRDI-60	SMA-9	1	239347.640	1269370.028	-1.26	PRDI-60-NS	Sediment	XL Power Grab	-1.3	-2.3	0.0	1.0	X		X		X																	X	X									
PRDI-61	SMA-9	1	239328.771	1269279.982	-18.13	PRDI-61-NS	Sediment	XL Power Grab	-18.1	-19.1	0.0	1.0	X		X		X																		X								
PRDI-72 (SS and NS samples)	SMA-12	1	238739.795	1269667.133	-18.55	PRDI-72-NS	Sediment	XL Power Grab	-18.6	-19.6	0.0	1.0																				X												
PRDI-107	SMA-6	1	238628.4127	1270044.956	2.19	PRDI-107-NS	Sediment	XL Power Grab	2.2	1.2	0.0	1.0					X																										Near surface (approximately 0 to 1 feet bml) sediment and offshore groundwater samples within the groundwater discharge zone to evaluate background arsenic contamination in offshore groundwater.
		1				PRDI-107-OG	Offshore GW	Temporary Piezometer	1.7	0.7	0.5	1.5																												X				
PRDI-108	SMA-6	1	238635.7476	1270181.875	4.56	PRDI-108-NS	Sediment	XL Power Grab	4.6	3.6	0.0	1.0					X																										
		1				PRDI-108-OG	Offshore GW	Temporary Piezometer	4.1	3.1	0.5	1.5																												X				
PRDI-109	SMA-6	1	238669.9776	1270406.814	14.63	PRDI-109-NS	Sediment	XL Power Grab	14.6	13.6	0.0	1.0					X																										
		1				PRDI-109-OG	Offshore GW	Temporary Piezometer	14.1	13.1	0.5	1.5																												X				
PRDI-110	SMA-11	1	238771.4444	1270602.413	21.25	PRDI-110-NS	Sediment	XL Power Grab	21.3	20.3	0.0	1.0					X																										
		1				PRDI-110-OG	Offshore GW	Temporary Piezometer	20.8	19.8	0.5	1.5																												X				

		Proposed Location																																										
Sample Station Information[1]						Proposed Samples							Sediment Analyses[3]																								Offshore Groundwater Analyses							Objectives[20]
Sediment Sampling Station Location	Sediment Management Area (SMA)	Number of Sample for Analysis	Coordinates[2]		Elevation	Sample Identification	Media	Collection Method	Sample Target Depth Interval (ft USACE Locks Datum)		Sample Target Depth Interval[4] (ft below mudline)		VOCs (EPA 8260D/5035)		PAHs (EPA 8270E-SIM)		Metals (EPA 6020B/7471B/SOP BAL-3200)						SVOCs (EPA 8270E/8270E-SIM)				Pesticides (EPA 8081)																
			Northing	Easting	Mudline Elevation (ft USACE Locks Datum)				Top	Bottom	Top	Bottom	Benzene, Ethylbenzene and Toulene	BETX	PAHs[5]	Total cPAHs[6] Only	Arsenic	RCRA Metals and GWPS and ALU COCs[7]	Methylmercury (ALU COC)[8]	Chromium (ALU COC)	Nickel	ALU Benthic COCs[9]	GWPS and ALU COCs[10]	ALU Bioaccumulative COCs[11]	Carbazole and Dibenzofuran	ALU Benthic COCs[12]	Chlordane	4-4' DDE	Total Petroleum Hydrocarbons (NWTPH-Dx)	Sulfides (EPA 9034)	Total PCBs Aroclors (EPA 8082)	Dioxins/Furans (EPA 1613)	Tributyltin (EPA 8270E SIM)	Total Organic Carbon (ASTM D422)	Grain Size (ASTM D-6913/D-7928)[13]	Laboratory Archive[14]	Benzene, Ethylbenzene and Toluene (EPA 8260D)	PAHs[6] (EPA 8270E SIM)	Dissolved Arsenic (EPA 6010C preserved)[15]	Dissolved Arsenic (EPA 6010C unpreserved)[16]	Dissolved Metals[17] (EPA 6020B/7470A)	Arsenic Speciation[18] (BAL-4100)	SVOCs[19] (EPA 8270D)	
Surface Sediment (SS) Sampling in SMA-7 and SMA-10 through SMA-14																																												
PRDI-62	SMA-10	1	239350.946	1271014.286	-6.87	PRDI-62-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X															X												Surface sediment samples from the top 10 cm to characterize the biologically active zone. Data will be used to determine the extent of ENR and MNR and data to be used for develop surface weighted average concentrations to evaluate that cleanup action is completed in accordance with MTCA requirements.
PRDI-63	SMA-7	1	239277.509	1271036.942	-12.77	PRDI-63-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-64	SMA-7	1	239080.113	1270974.962	-14.33	PRDI-64-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-65	SMA-7	1	238926.727	1270929.649	-15.30	PRDI-65-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-66	SMA-11	1	238648.327	1270874.858	-11.53	PRDI-66-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-67	SMA-11	1	238492.078	1270783.191	-12.09	PRDI-67-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X				X										
PRDI-68	SMA-11	1	238391.383	1270591.524	-15.25	PRDI-68-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-69	SMA-11	1	238417.079	1270290.830	-14.19	PRDI-69-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-70	SMA-11	1	238482.357	1270018.608	-12.86	PRDI-70-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																		X										
PRDI-71	SMA-11	1	238616.903	1269777.792	-16.13	PRDI-71-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-72 (SS and NS samples)	SMA-12	1	238739.795	1269667.133	-18.55	PRDI-72-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-73	SMA-12	1	238732.417	1269423.209	-19.71	PRDI-73-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-74	SMA-12	1	238753.792	1269188.436	-19.23	PRDI-74-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																		X										
PRDI-75	SMA-12	1	238827.687	1268991.352	-19.12	PRDI-75-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-76	SMA-12	1	238941.837	1268963.140	-19.38	PRDI-76-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-77	SMA-13	1	239030.776	1268811.130	-19.33	PRDI-77-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X		X	X	X	X		X	X	X	X	X	X	X	X		X												
PRDI-78	SMA-13	1	238989.671	1268632.656	-18.85	PRDI-78-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X				X				X																				
PRDI-79	SMA-13	1	238887.547	1268749.281	-18.77	PRDI-79-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X				X				X										X										
PRDI-80	SMA-13	1	238699.829	1268690.687	-18.15	PRDI-80-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X		X	X	X	X		X	X	X	X	X	X	X	X		X												
PRDI-81	SMA-13	1	238748.309	1268900.041	-19.06	PRDI-81-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X				X				X								X												
PRDI-82	SMA-13	1	238506.211	1268818.487	-18.67	PRDI-82-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X				X				X																				
PRDI-83	SMA-13	1	238570.706	1269008.613	-19.21	PRDI-83-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X		X	X	X	X		X	X	X	X	X	X	X	X		X												
PRDI-84	SMA-13	1	238609.769	1269236.477	-19.46	PRDI-84-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X				X				X																				
PRDI-85	SMA-13	1	238631.470	1269460.001	-19.63	PRDI-85-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X		X	X	X	X		X	X	X	X	X	X	X	X		X												
PRDI-86	SMA-13	1	238589.152	1269637.953	-19.58	PRDI-86-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)			X		X				X				X										X										
PRDI-87	SMA-14	1	238424.571	1269206.401	-19.67	PRDI-87-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-88	SMA-14	1	238237.590	1269034.654	-18.58	PRDI-88-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-89	SMA-14	1	238442.212	1269520.872	-20.03	PRDI-89-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-90	SMA-14	1	238309.834	1269394.920	-19.14	PRDI-90-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X	X													
PRDI-91	SMA-14	1	238110.637	1269269.029	-18.31	PRDI-91-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-92	SMA-14	1	238397.095	1269852.797	-20.12	PRDI-92-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-93	SMA-14	1	238242.428	1269662.866	-21.16	PRDI-93-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-94	SMA-14	1	238028.172	1269522.936	-18.84	PRDI-94-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-95	SMA-14	1	238140.279	1269875.148	-20.93	PRDI-95-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-96	SMA-14	1	237960.897	1269839.776	-20.15	PRDI-96-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-97	SMA-14	1	238252.085	1270091.924	-21.12	PRDI-97-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-98	SMA-14	1	238014.197	1270095.418	-21.97	PRDI-98-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-99	SMA-14	1	238249.526	1270317.206	-20.40	PRDI-99-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X															X												
PRDI-100	SMA-14	1	238049.873	1270363.864	-22.92	PRDI-100-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-101	SMA-14	1	238273.397	1270543.443	-20.84	PRDI-101-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-102	SMA-14	1	238141.019	1270608.548	-24.09	PRDI-102-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-103	SMA-14	1	238280.993	1270815.796	-25.22	PRDI-103-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												
PRDI-104	SMA-14	1	238479.148	1270973.087	-25.32	PRDI-104-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X														
PRDI-105	SMA-14	1	238751.020	1271041.664	-21.85	PRDI-105-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X		X	X				X			X				X	X													
PRDI-106	SMA-14	1	239026.153	1271066.447	-18.28	PRDI-106-SS	Sediment	Power Grab	–	–	0	0.33 (10cm)				X	X																												

Sample Station Information[1]: Sediment Sampling Station Location	Sediment Management Area (SMA)	Number of Sample for Analysis	Proposed Location: Coordinates[2] Northing	Coordinates[2] Easting	Elevation: Mudline Elevation (ft USACE Locks Datum)	Proposed Samples: Sample Identification	Media	Collection Method	Sample Target Depth Interval (ft USACE Locks Datum): Top	Sample Target Depth Interval (ft USACE Locks Datum): Bottom	Sample Target Depth Interval[4] (ft below mudline): Top	Sample Target Depth Interval[4] (ft below mudline): Bottom	Sediment Analyses[3] – VOCs (EPA 8260D/5035): Benzene, Ethylbenzene and Toulene	VOCs: BETX	PAHs (EPA 8270E-SIM): PAHs[5]	PAHs: Total cPAHs[6] Only	Metals (EPA 6020B/7471B/SOP BAL-3200): Arsenic	Metals: RCRA Metals and GWPS and ALU COCs[7]	Metals: Methylmercury (ALU COC)[8]	Metals: Chromium (ALU COC)	Metals: Nickel	Metals: ALU Benthic COCs[9]	SVOCs (EPA 8270E/8270E-SIM): GWPS and ALU COCs[10]	SVOCs: ALU Bioaccumulative COCs[11]	SVOCs: Carbazole and Dibenzofuran	SVOCs: ALU Benthic COCs[12]	Pesticides (EPA 8081): Chlordane	Pesticides: 4-4' DDE	Total Petroleum Hydrocarbons (NWTPH-Dx)	Sulfides (EPA 9034)	Total PCBs Aroclors (EPA 8082)	Dioxins/Furans (EPA 1613)	Tributyltin (EPA 8270E SIM)	Total Organic Carbon (ASTM D422)	Grain Size (ASTM D-6913/D-7928)[13]	Laboratory Archive[14]	Offshore Groundwater Analyses: Benzene, Ethylbenzene and Toluene (EPA 8260D)	PAHs[6] (EPA 8270E SIM)	Dissolved Arsenic (EPA 60010C preserved)[15]	Dissolved Arsenic (EPA 60010C unpreserved)[16]	Dissolved Metals[17] (EPA 6020B/7470A)	Arsenic Speciation[18] (BAL-4100)	SVOCs[19] (EPA 8270D)	Objectives[20]
Near Surface Sediment Sampling for Evidence of NAPL																																												
DP-1	SMA-7	0	239339.265	1270970.983	-2.78	–	Sediment	XL Power Grab	–	–	0	1.0																																Near surface sediment samples from the top 1 ft of sediment to screen sediment material for evidence of NAPL. Results of field screening will provide mapping of near surface NAPL-impacted sediment and inform the thickness of sand caps.
DP-2	SMA-7	0	239314.620	1271005.106	-8.73	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-3	SMA-7	0	239246.374	1270897.997	4.53	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-4	SMA-7	0	239256.800	1270950.129	-5.66	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-5	SMA-7	0	239186.658	1270937.807	-5.18	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-6	SMA-7	0	239157.274	1270995.627	-14.31	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-7	SMA-7	0	239075.757	1270917.902	-6.24	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-8	SMA-7	0	238957.274	1270852.498	-1.45	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-9	SMA-7	0	238949.690	1270884.726	-8.72	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-10	SMA-7	0	238871.965	1270807.000	0.78	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-11	SMA-10	0	238543.467	1270622.775	-2.96	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-12	SMA-10	0	238580.496	1270514.918	9.11	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-13	SMA-8	0	238484.439	1270455.413	-7.13	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-14	SMA-8	0	238459.922	1270558.937	-8.47	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-15	SMA-12	0	238824.430	1269543.435	-18.72	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-16	SMA-12	0	238916.445	1269445.779	-19.19	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-17	SMA-12	0	238968.962	1269393.696	-19.73	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-18	SMA-12	0	239109.153	1269302.116	-20.26	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-19	SMA-12	0	239250.647	1269185.363	-21.18	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-20	SMA-12	0	239042.097	1269077.724	-20.00	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-21	SMA-12	0	238966.359	1269160.189	-19.73	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-22	SMA-12	0	238877.600	1269231.803	-19.37	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-23	SMA-12	0	238792.313	1269302.550	-19.32	–	Sediment	XL Power Grab	–	–	0	1.0																																
DP-24	SMA-12	0	238840.160	1269372.406	-19.43	–	Sediment	XL Power Grab	–	–	0	1.0																																
Subsurface Sediment Core for Deposition Rate																																												
C-1	SMA-14	1	1271077.028	238748.381	-22.78	C-1	Sediment	Vibracore	-22.78	-29.78	0	7.0																																Complete sediment cores to depths of approximately 7-feet to log and classify sediment lithology and to identify the "gray marker bed" that was deposited around 1916, which will be used to measure the thickness of sediment that has accumulated since that time and calculate the accompanying average sedimentation rate.
C-2	SMA-14	1	1270492.777	238323.992	-20.00	C-2	Sediment	Vibracore	-20.00	-27.00	0	7.0																																
C-3	SMA-14	1	1270409.196	238041.862	-23.33	C-3	Sediment	Vibracore	-23.33	-30.33	0	7.0																																
C-4	SMA-14	1	1269747.626	238288.874	-20.84	C-4	Sediment	Vibracore	-20.84	-27.84	0	7.0																																
C-5	SMA-14	1	1269652.976	238071.824	-19.46	C-5	Sediment	Vibracore	-19.46	-26.46	0	7.0																																
C-6	SMA-14	1	1269103.324	238332.658	-19.33	C-6	Sediment	Vibracore	-19.33	-26.33	0	7.0																																
C-7	SMA-13	1	1269146.461	238599.326	-19.17	C-7	Sediment	Vibracore	-19.17	-26.17	0	7.0																																
C-8	SMA-13	1	1268744.500	238724.816	-18.39	C-8	Sediment	Vibracore	-18.39	-25.39	0	7.0																																
C-9	SMA-13	1	1268752.343	239052.268	-19.51	C-9	Sediment	Vibracore	-19.51	-26.51	0	7.0																																

Notes:

[1] Approximate sample station locations are shown on Figures A-6A through A-6E.

[2] Coordinates are presented in North American Datum (NAD) of 1983, Washington State Plane North.

[3] All samples are to be submitted to Analytical Resources, Inc (ARI) of Tukwila, Washington for chemical analysis, with the exception of samples taken for arsenic speciation and methyl mercury, whhich will completed at Brooks Applied Labs in Bothell, Washington.

[4] Depth is presented in feet (ft) below ground surface (bgs) or centimeter (cm) below mudline (bml) for sediment samples.

[5] PAHs analytes include cPAHs (see list in footnote 6 below) and 2-methylnaphthalene, acenaphthene, ancenphthylene, anthracene, benzo(g,h,i)perylene, flourene, phenanthrere, naphthalene, flouranthene and pyrene.

[6] cPAHs analytes to report include benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-dc)pyrene.

[7] RCRA and GWPS and ALU COCs in sediment include the following metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver, as well as copper and nickel.

[8] Methylmercury to be analyzed by Method SOP-BAL-3200 at Brooks Applied Labs

[9] ALU Benthic COCs in sediment include the following metals: cadmium, chromium, copper, lead, mercury, and silver.

[10] GWPS (waste characterization) COCs in sediment include the following SVOCs: 4-methylphenol, benzoic acid, BEHP, di-n-butylphthalate, di-n-ocytyphthalate, hexschlorobenze, pentachlorophenol, phenol, carbazole, and dibenzofuran.

[11] ALU Bioaccumulative COCs in sediment include the following SVOCs: hexachlorobenzene and PCP.

[12] ALU benthic COCs in sediment include the following SVOCs: 4-methylphenol, benzoic acid, bis(2-ethyl)phthalate, di-n-butyl phthalate, di-n-octyl phthalate, and phenol.

[13] The target interval for grain size samples will surface sediment from approximately 0 to 10cm.

[14] Sediment sample volume collected for archival at the laboratory for potential follow-up TCLP analyses as required for landfill waste characterization.

[15] Sample will be collected for dissolved arsenic and placed in a laboratory provided bottle **with** preservative and filtered at the lab.

[16] Sample will be collected for dissolved arsenic and placed in a laboratory provided bottle **without** preservative and filtered at the lab

[17] Dissolved metals to be analyzed for offshore-groundwater include cadmium, copper, lead, mercury, nickel, and silver.

[18] Arsenic speciation analysis to be completed at Brooks Applied Labs of Bothell, Washington.

[19] SVOC analytes for offshore groundwater to report includes bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran.

[20] See PRDI Work Plan for further detail of sampling and analysis data objectives.

ASTM = ASTM International
EPA = U.S. Environmental Protection Agency
ENR = Enhanced Natural Recovery
MNR = Monitored Natural Recovery
TPH = Total Petroleum Hydrocarbons
BETX = Benzene, Ethylbenzene, Toluene, Xylenes
VOCs = Volatile Organic Compounds
SIM = Selective Ion Monitoring
SVOCs = Semi Volatile Organic Compounds
PAHs = Polycyclic Aromatic Hydrocarbons
cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons
RCRA = Resource Conservation and Recovery Act

Table A-2

Air and Soil Vapor Analytical Methods, Sample Size, Containers, Preservation and Holding Times

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Parameter	Method	Air Sample Container Size and Type	Soil Vapor Container Size and Type	Holding Time for Indicated Preservation Technique
BTEX	EPA TO-15	6-liter Summa canisters	1-liter Summa canisters	30 days
Naphthalene	EPA TO-15			
Petroleum Fractions (Aliphatics and Aromatics)	APH-MA DEP			
Helium	ASTM D 1946	Air samples will not be analyzed for helium		

Notes:

[1] Petroleum Fractions include Aliphatic C5-C8, Aliphatics C9-C12, and Aromatics C9-C10.

°C = degrees centigrade

APH = Air Phase Hydrocarbons

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

EPA = Environmental Protection Agency

MA DEP = Massachusetts Department of Environmental Protection

SIM = Selective Ion Monitoring

Table A-3

Upland Groundwater and Offshore Groundwater Analytical Methods, Sample Size, Containers, Preservation and Holding Times

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Parameter	Method	Container Size and Type	Sample Preservation Technique	Holding Time for Indicated Preservation Technique
VOCs[1]	EPA 8260D	Three 40 mL VOAs	Cool, ≤ 6°C, with HCl	14 days until extraction
Dissolved Metals[2]	EPA 6020B/7470A	500 mL HDPE	Cool, ≤ 6°C, with Lab filter and preserve with HNO3 or Field filtered, Cool, ≤ 6°C, with HNO2	6 months
Dissolved Arsenic (preserved)	EPA 6010C	500 mL HDPE	Cool, ≤ 6°C, with Lab filter and preserve with HNO3 or Field filtered, Cool, ≤ 6°C, with HNO2	6 months
Dissolved Arsenic (unpreserved)	EPA 6010C	500 mL HDPE	Cool, ≤ 6°C with Lab filter	Must be filtered within 48 hours; hold time 6 months
Arsenic Speciation	SOP BAL 4100	Two 10 mL vials	Field-filtration (0.45 um) into vacuatiners pre-preserved with EDTA; minimal headspace; keep dark; Cool, 0-4 °C	Recommended 14 days
PAHs	EPA 8270D-SIM	Two 500 mL Amber	Cool, ≤ 6°C	7 days until extraction
SVOCs[3]	EPA 8270D-SIM	Two 500 mL Amber	Cool, ≤ 6°C	7 days until extraction

Notes:

[1] VOCs to be analyzed include Benzene, Ethylbenzene, and Toluene.

[2] Dissolved metals to be analyzed include cadmium, copper, lead, mercury, nickel, and silver.

[3] Arsenic speciation samples will be collected in accordance with methods described in Attachment A-3. Analysis will be completed by Brooks Applied Labs.

[4] SVOCs to be analyzed include Bis(2-ethylhexyl)phthalate, Carbazole, and Dibenzofuran.

°C = degrees centigrade

PAHs = Polycyclic Aromatic Hydrocarbons

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons

EPA = Environmental Protection Agency

HDPE = High-density polyethylene

mL = milliliter

VOCs = Volatile Organic Compounds

SIM = Selective Ion Monitoring

VOA = volatile organic analysis

SVOCs = Semi Volatile Organic Compounds

Table A-4

Soil Analytical Methods, Sample Size, Containers, Preservation and Holding Times

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Parameter	Method	Minimum Sample Size (dry weight)	Container Size and Type	Sample Preservation Technique	Holding Time for Indicated Preservation Technique
Diesel- and Heavy Oil-Range Hydrocarbons	NWTPH-Dx	15 g	8-oz WM-Glass	Cool, ≤ 6°C	14 days until extraction 40 days after extraction
BTEX	EPA 8260D	5 g	40 mL VOA vial	l, ≤ 6°C with NaHSO4 preserva	14 days until extraction
PAHs[1]	EPA 8270D - SIM	300 g	8-oz WM Jar	Cool, ≤ 6°C	14 days until extraction 40 days after extraction
RCRA Metals[2]	EPA 6010/6020	100 g	4-oz WM Glass	Cool, ≤ 6°C	6 months, except Hg is 28 days
TCLP[3]	EPA 1311	8 oz	4-oz WM Glass	Cool, ≤ 6°C	28 days

Notes:

[1] PAHs to be analyzed include cPAHs, napthlalene, pyrene, and fluoranthene.

[2] Metals to be analyzed include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

[3] TCLP to be completed on archived soil as needed for the purposes of waste characterization.

°C = degrees centigrade

PAHs = Polycyclic Aromatic Hydrocarbons

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons

TCLP = Toxicity Characteristic Leaching Procedure

EPA = U.S. Environmental Protection Agency

g = gram

oz =ounce

SIM = Selective Ion Monitoring

Table A-5

Sediment Analytical Methods, Sample Size, Containers, Preservation and Holding Times

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Parameter	Method	Minimum Sample Size (dry weight)	Container Size and Type	Sample Preservation Technique	Holding Time for Indicated Preservation Technique
Conventionals (Sulfide)	EPA 9034	100 g	4-oz WM Glass	Cool, ≤ 6°C with ZnOAc preservative	7
Diesel- and Heavy Oil-Range Hydrocarbons	NWTPH-Dx	15 g	8-oz WM-Glass	Cool, ≤ 6°C	14 days until extraction 40 days after extraction
BTEX	EPA 8260D	5 g	40 mL VOA vial	Cool, ≤ 6°C with NaHSO4 preservative	14 days until extraction
SVOCs[1]	EPA 8270D	150 g	8-oz WM jar	Cool, ≤ 6°C	14 days
PAHs[2]	SW8270D-SIM	300 g	8-oz WM Jar	Cool, ≤ 6°C	14 days until extraction 40 days after extraction
Pesticides (Chlordane and 4,4' DDE)	EPA 8081	150 g	8-oz WM jar	Cool, ≤ 6°C	14 days
PCBs	EPA 8082	150 g	8-oz WM jar	Cool, ≤ 6°C	14 days
Butyltins	EPA 8270 SIM	150 g	8-oz WM jar	Cool, ≤ 6°C	14 days
Metals[3]	EPA 6010/6020	100 g	4-oz WM Glass	Cool, ≤ 6°C	6 months, except Hg is 28 days
Methylmercury[4]	SOP BAL-3200	20 g	4-oz WM Glass	Freeze if possible. If not, 0 - 4°C and deliver to lab within 48 hours.	Recommended 7 days to freeze; 1 year to analyze
Grain Size[5]	ASTM D6913 (sieve), ASTM D7928 (hydrometer)	16 oz	16-oz WM-HDPE	NA	NA
TOC	PSEP 1986	100 g	4-oz WM jar	Cool, ≤ 6°C	28 days
Dioxins/Furans	EPA 1613	100 g	8-oz WM Amber Glass	Freeze -18°C	1 year until extraction
TCLP[6]	EPA 1311	8 oz	4-oz WM Glass	Cool, ≤ 6°C	28 days

Notes:

[1] SVOCs to be analyzed include 4-methylphenol, benzoic acid, BEHP, di-n-butylphthalate, di-n-ocytyphthalate, hexschlorobenze, pentachlorophenol, phenol, carbazole, dibenzofuran, and bis(2-ethyl)phthalate.

[2] PAHs to be analyzed include cPAHs, napthlalene, fluoranthene, and pyrene.

[3] Metals to be analyzed include arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver.

[4] Methylmercury will be anayzed by Brooks Applied Laboratory by Method SOP BAL-3200..

[5] Grain size samples will be delivered to ARI and analyzse by a subcontractor to ARI.

[6] TCLP to be completed on archived sediment as needed for the purposes of waste characterization.

ASTM = ASTM International
°C = degrees centigrade
PAHs = Polycyclic Aromatic Hydrocarbons
cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons
g = gram
HDPE = High-density polyethylene
mL = milliliter
NA = Not applicable
oz =ounce
EPA = U.S. Environmental Protection Agency
SIM = Selective Ion Monitoring
VOA = volatile organic analysis
SVOCs = Semi Volatile Organic Compounds
TCLP = Toxicity Characteristic Leaching Procedure
WM = wide mouth

Table A-6

Air and Soil Vapor Laboratory Quality Assurance/Quality Control Requirements

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate (MSD) Samples or Lab Duplicate %RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
BTEX	Benzene	70 - 130	NA	≤30	70 - 130
	Toluene	70 - 130	NA	≤30	70 - 130
	Ethylbenzene	70 - 130	NA	≤30	70 - 130
	Xylenes	70 - 130	NA	≤30	70 - 130
PAHs	Naphthalene	70 - 130	NA	≤30	70 - 130
Petroleum Fractions	Aliphatics C5-C8	70 - 130	NA	≤30	70 - 130
	Aliphatics C9-C12	70 - 130	NA	≤30	70 - 130
	Aromatics C9-C10	70 - 130	NA	≤30	70 - 130

Notes:

[1] RPD control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the method reporting limit (MRL). For results less than 5 times the MRL, the difference between the primary and duplicate samples must be less than 2 times the MRL.

NA = Not applicable

%R = Percent Recovery

RPD = Relative percent difference

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

PAHs = Polycyclic Aromatic Hydrocarbons

Table A-7

Groundwater and Porewater Laboratory Quality Assurance/Quality Control Requirements

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate (MSD) Samples or Lab Duplicate %RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
BTEX	Benzene	80 - 120	same as LCS	≤30	Dibromofluoromethane (80 - 120) 1,2-Dichloroethane-d4 (80 - 129) Toluene-d8 (80 - 120) 4-Bromofluorobenzene (80 - 120) 1,2-Dichlorobenzene-d4 (80 - 120)
	Toluene	80 - 120	same as LCS	≤30	
	Ethylbenzene	80 - 120	same as LCS	≤30	
PAHs	2-Methylnaphthalene	37 - 120	same as LCS	≤30	2-Methylnaphthalene-d10 (42 - 120) Dibenzo[a,h]anthracene-d14 (29 - 120) Fluoranthene-d10 (57 - 120)
	Acenaphthene	41 - 120	same as LCS	≤30	
	Acenaphthylene	41 - 120	same as LCS	≤30	
	Anthracene	40 - 120	same as LCS	≤30	
	Benzo(g,h,i)perylene	38 - 120	same as LCS	≤30	
	Fluorene	43 - 120	same as LCS	≤30	
	Phenanthrene	41 - 120	same as LCS	≤30	
	Fluoranthene	43 - 120	same as LCS	≤30	
	Naphthalene	37 - 120	same as LCS	≤30	
	Pyrene	41 - 120	same as LCS	≤30	
cPAHs	Benzo(a)anthracene	42 - 120	same as LCS	≤30	2-Methylnaphthalene-d10 (42 - 120) Dibenzo[a,h]anthracene-d14 (29 - 120) Fluoranthene-d10 (57 - 120)
	Benzo(a)pyrene	35 - 120	same as LCS	≤30	
	Benzo(b)fluoranthene	44 - 120	same as LCS	≤30	
	Benzo(k)fluoranthene	50 - 120	same as LCS	≤30	
	Chrysene	44 - 120	same as LCS	≤30	
	Indeno(1,2,3-cd)pyrene	37 - 120	same as LCS	≤30	
	Dibenzo(a,h)anthracene	38 - 120	same as LCS	≤30	

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate (MSD) Samples or Lab Duplicate %RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
SVOCs	Bis(2-ethylhexyl)phthalate	67.2 - 123	same as LCS	≤30	2-Fluorophenol (32.5 - 120) Phenol-d5 (17.8- 120) 2-Chlorophenol-d4 (55 - 120) 1,2-Dichlorobenzene-d4 (49.3 - 120) Nitrobenzene-d5 (56.1 - 120) 2-Fluorobiphenyl (54.4 - 120) 2,4,6-Tribromophenol (49.3 - 128) p-Terphenyl-d14 (60 - 120) 1,4-Dioxane-d8 (0 - 200)
	Carbazole	58 - 123	same as LCS	≤30	
	Dibenzofuran	61.9 - 120	same as LCS	≤30	
Arsenic Species		80 - 120	75 - 125	≤MRL	NA
Dissolved Metals[2]		80 - 120	75 - 125	≤20	NA

Notes:

[1] RPD control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the method reporting limit (MRL). For results less than 5 times the MRL, the difference between the primary and duplicate samples must be less than 2 times the MRL for soils/sediments.

[2] Dissolved metals to be analyzed include arsenic, cadmium, copper, lead, mercury, nickel, and silver.

NA = Not applicable

%R = Percent Recovery

RPD = Relative percent difference

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

PAHs = Polycyclic Aromatic Hydrocarbons

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons

SVOCs = Semi Volatile Organic Compounds

Table A-8

Soil Laboratory Quality Assurance/Quality Control Requirements

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate Samples or Lab Duplicate RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
Diesel- and Heavy Oil-Range Hydrocarbons		30 - 160	same as LCS	≤30	o-Terphenyl (50 - 150) n-Triacontane (50 - 150)
VOCs	Benzene	80 - 120	same as LCS	≤30	Dibromofluoromethane (80 - 120) 1,2-Dichloroethane-d4 (80 - 149) Toluene-d8 (77 - 120) 4-Bromofluorobenzene (80 - 120) 1,2-Dichlorobenzene-d4 (80 - 120).
	Ethylbenzene	80 - 125	same as LCS	≤30	
	Toluene	75 - 120	same as LCS	≤30	
PAHs	2-Methylnaphthalene	43-120	same as LCS	≤30	2-Fluorophenol (27 - 120) Phenol-d5 (29 - 120) 2-Chlorophenol-d4 (31 - 120) 1,2-Dichlorobenzene-d4 (32 - 120) Nitrobenzene-d5 (30 - 120) 2-Fluorobiphenyl (35 - 120) 2,4,6-Tribromophenol (24 - 134) p-Terphenyl-d14 (37 - 120)
	Acenaphthene	45-120	same as LCS	≤30	
	Acenaphthylene	42-120	same as LCS	≤30	
	Anthracene	45-120	same as LCS	≤30	
	Benzo(g,h,i)perylene	46-148	same as LCS	≤30	
	Fluorene	45-120	same as LCS	≤30	
	Phenanthrene	49-120	same as LCS	≤30	
	Fluoranthene	53-145	same as LCS	≤30	
	Naphthalene	43-120	same as LCS	≤30	
	Pyrene	52-134	same as LCS	≤30	
cPAHs	Benzo(a)anthracene	49 - 120	same as LCS	≤30	2-Fluorophenol (27 - 120) Phenol-d5 (29 - 120) 2-Chlorophenol-d4 (31 - 120) 1,2-Dichlorobenzene-d4 (32 - 120) Nitrobenzene-d5 (30 - 120) 2-Fluorobiphenyl (35 - 120) 2,4,6-Tribromophenol (24 - 134) p-Terphenyl-d14 (37 - 120)
	Benzo(a)pyrene	42 - 120	same as LCS	≤30	
	Benzo(b)fluoranthene	42 - 132	same as LCS	≤30	
	Benzo(k)fluoranthene	39 - 129	same as LCS	≤30	
	Chrysene	47 - 120	same as LCS	≤30	
	Dibenzo(a,h)anthracene	30 - 133	same as LCS	≤30	
	Indeno(1,2,3-cd)pyrene	42 - 163	same as LCS	≤30	
Metals	Arsenic	80 - 120	75 - 125	≤20	NA
	Barium	80 - 120	75 - 125	≤20	
	Cadmium	80 - 120	75 - 125	≤20	
	Chromium	80 - 120	75 - 125	≤20	
	Lead	80 - 120	75 - 125	≤20	
	Mercury	80 - 120	75 - 125	≤20	
	Selenium	80 - 120	75 - 125	≤20	
	Silver	80 - 120	75 - 125	≤20	

Notes:

[1]RPD control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the method reporting limit (MRL). For results less than 5 times the MRL, the difference between the primary and duplicate samples must be less than 2 times the MRL for soils/sediments.

PAHs = Polycyclic Aromatic Hydrocarbons

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons

RPD = Relative percent difference

%R = Percent Recovery

Table A-9

Sediment Laboratory Quality Assurance/Quality Control Requirements

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate (MSD) Samples or Lab Duplicate %RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
Conventionals		80 - 120	75 - 125	≤20	NA
Sulfide		75 - 125	same as LCS	≤20	NA
Diesel- and Heavy Oil-Range Hydrocarbons		30 - 160	same as LCS	≤30	o-Terphenyl (50 - 150) n-Triacontane (50 - 150)
VOCs	Benzene	80 - 120	same as LCS	≤30	Dibromofluoromethane (80 - 120) 1,2-Dichloroethane-d4 (80 - 149) Toluene-d8 (77 - 120) 4-Bromofluorobenzene (80 - 120) 1,2-Dichlorobenzene-d4 (80 - 120)
	Ethylbenzene	80 - 125	same as LCS	≤30	
	Toluene	75 - 120	same as LCS	≤30	
PAHs	2-Methylnaphthalene	43-120	same as LCS	≤30	2-Fluorophenol (27 - 120) Phenol-d5 (29 - 120) 2-Chlorophenol-d4 (31 - 120) 1,2-Dichlorobenzene-d4 (32 - 120) Nitrobenzene-d5 (30 - 120) 2-Fluorobiphenyl (35 - 120) 2,4,6-Tribromophenol (24 - 134) p-Terphenyl-d14 (37 - 120)
	Acenaphthene	45-120	same as LCS	≤30	
	Acenaphthylene	42-120	same as LCS	≤30	
	Anthracene	45-120	same as LCS	≤30	
	Benzo(g,h,i)perylene	46-148	same as LCS	≤30	
	Fluorene	45-120	same as LCS	≤30	
	Phenanthrene	49-120	same as LCS	≤30	
	Fluoranthene	53-145	same as LCS	≤30	
	Naphthalene	43-120	same as LCS	≤30	
	Pyrene	52-134	same as LCS	≤30	
cPAHs	Benzo(a)anthracene	49 - 120	same as LCS	≤30	2-Fluorophenol (27 - 120) Phenol-d5 (29 - 120) 2-Chlorophenol-d4 (31 - 120) 1,2-Dichlorobenzene-d4 (32 - 120) Nitrobenzene-d5 (30 - 120) 2-Fluorobiphenyl (35 - 120) 2,4,6-Tribromophenol (24 - 134) p-Terphenyl-d14 (37 - 120)
	Benzo(a)pyrene	42 - 120	same as LCS	≤30	
	Benzo(b)fluoranthene	42 - 132	same as LCS	≤30	
	Benzo(k)fluoranthene	39 - 129	same as LCS	≤30	
	Chrysene	47 - 120	same as LCS	≤30	
	Dibenzo(a,h)anthracene	30 - 133	same as LCS	≤30	
	Indeno(1,2,3-cd)pyrene	42 - 163	same as LCS	≤30	
SVOCs	4-Methylphenol	30 - 160	same as LCS	≤30	2-Fluorophenol (27 - 120) p-Terphenyl-d14 (37 - 120)
	Benzoic Acid	10 - 160	same as LCS	≤30	
	Bis(2-ethylhexyl)phthalate	34 - 130	same as LCS	≤30	
	Carbazole	43 - 135	same as LCS	≤30	
	Dibenzofuran	43 - 120	same as LCS	≤30	
	Di-n-Butyl phthalate	48 - 126	same as LCS	≤30	
	Di-n-Octyl phthalate	28 - 124	same as LCS	≤30	
	Hexachlorobenzene	32 - 120	same as LCS	≤30	
	Pentachlorophenol	26 - 120	same as LCS	≤30	
	Phenol	30 - 160	same as LCS	≤30	
Pesticides	Chlordane	30 - 160	same as LCS	≤30	Decachlorobiphenyl (30 - 160) Tetrachlorometaxylene (30 - 160)
	4,4'-DDE	35 - 120	same as LCS	≤30	

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate (MSD) Samples or Lab Duplicate %RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
PCBs	Aroclor 1016	56 - 120	same as LCS	≤30	Decachlorobiphenyl (40-126) Tetrachlorometaxylene (44 - 120)
	Aroclor 1221	NA	NA	≤30	
	Aroclor 1232	NA	NA	≤30	
	Aroclor 1242	NA	NA	≤30	
	Aroclor 1248	NA	NA	≤30	
	Aroclor 1254	NA	NA	≤30	
	Aroclor 1260	58 - 120	same as LCS	≤30	
	Aroclor 1262	NA	NA	≤30	
	Aroclor 1268	NA	NA	≤30	
Tributyltin		30 - 160	same as LCS	≤30	Tripentyltin (30 - 160) Tripropyltin (30 - 160)
Metals	Arsenic	80 - 120	75 - 125	≤20	NA
	Cadmium	80 - 120	75 - 125	≤20	
	Chromium	80 - 120	75 - 125	≤20	
	Copper	80 - 120	75 - 125	≤20	
	Lead	80 - 120	75 - 125	≤20	
	Mercury	80 - 120	75 - 125	≤20	
	Methylmercury	80 - 120	65 - 135	≤MRL	
	Nickel	80 - 120	75 - 125	≤20	
	Silver	80 - 120	75 - 125	≤20	
Dioxin/Furans	2,3,7,8-TCDD	67 - 158	NA	≤25	25-164
	2,3,7,8-TCDF	75 - 158	NA	≤25	24-169
	1,2,3,7,8-PeCDD	70 - 142	NA	≤25	25-181
	1,2,3,7,8-PeCDF	80 - 134	NA	≤25	24-185
	2,3,4,7,8-PeCDF	68 - 160	NA	≤25	21-178
	1,2,3,4,7,8-HxCDD	70 - 164	NA	≤25	32-141
	1,2,3,6,7,8-HxCDD	76 - 134	NA	≤25	28-130
	1,2,3,7,8,9-HXCDD	64 - 162	NA	≤25	NA
	1,2,3,4,7,8-HxCDF	72 - 134	NA	≤25	26-152
	1,2,3,6,7,8-HxCDF	84 - 130	NA	≤25	26-123
	1,2,3,7,8,9-HxCDF	78 - 130	NA	≤25	29-147
	2,3,4,6,7,8-HxCDF	70 - 156	NA	≤25	28-136
	1,2,3,4,6,7,8-HpCDD	70 - 140	NA	≤25	23-140
	1,2,3,4,6,7,8-HpCDF	82 - 122	NA	≤25	28-143
	1,2,3,4,7,8,9-HpCDF	78 - 138	NA	≤25	26-138
	OCDD	78 - 144	NA	≤25	17-157
	OCDF	63 - 170	NA	≤25	NA

Notes:

[1] RPD control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the method reporting limit (MRL). For results less than 5 times the MRL, the difference between the primary and duplicate samples must be less than 2 times the MRL for soils/sediments.

%R = Percent Recovery

RPD = Relative percent difference

PAHs = Polycyclic Aromatic Hydrocarbons

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons

SVOCs = Semi Volatile Organic Compounds

PCBs = Polychlorinated Biphenyls

Table A-10

Air Cleanup Levels (CULs), Screening Levels (SLs) and Practical Quantitation Limits (PQLs)

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Analysis	CAS Number	Units	MTCA Method B CUL[1]	Commercial Worker Air SL[1]	Park User Air SL[2]	Soil Gas Samples	Air Samples
						Practical Quantification Limit (PQL)	Practical Quantification Limit (PQL)
Leak Test Tracer Gas							
Helium	--	µg/m³	--	--	--	3.6	0.6
BTEX							
Benzene	71-43-2	µg/m³	0.32	1.5	13	1.92	0.32
Toluene	108-88-3	µg/m³	2,300	19,000	95,000	45	7.5
Ethylbenzene	100-41-4	µg/m³	460	3,900	19,000	2.58	0.43
Xylenes	1330-20-7	µg/m³	46	390	1,900	7.8	1.30
Polyaromatic Hydrocarbons (PAHs)							
Naphthalene	91-20-3	µg/m³	0.074	0.34	3.1	0.31	0.073J
Petroleum Hydrocarbon Fractions							
Aliphatics C5-C8	--	µg/m³	--	--	--	610	75
Aliphatics C9-C12	--	µg/m³	--	--	--	210	25
Aromatics C9-C10	--	µg/m³	--	--	--	200	25
TPH + BTEXN Totals	--	µg/m³	46	390	1,900	--	--

Notes:

[1] Model Toxics Control Act (MTCA) Method B indoor air cleanup levels and Commercial Worker air exposure are from Washington State Department of Ecology's (Ecology's) "CLARC Master Spreadsheet.xlsx" dated July 2023.

[2] Park User air screening levels are presented in the GWPS Remedial Investigation and Feasibility Report (GeoEngineers 2023).

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

CAS = Chemical Abstract Services

CUL = Cleanup Level

MTCA = Model Toxics Control Act

N = Naphthalene

PAH = Polyaromatic Hydrocarbons

SL = Screening Level

µg/m³ = micrograms/cubic meter

"--" = Not Available

Table A-11

Groundwater and Offshore Groundwater Cleanup Levels (CULs) and Practical Quantitation Limits (PQLs)

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Analysis	CAS Number	Units	Groundwater Cleanup Level	Practical Quantification Limit (PQL)
Volatile Organic Compounds (VOCs)				
Benzene	71-43-2	µg/L	0.44	0.20
Toluene	108-88-3	µg/L	--	0.20
Ethylbenzene	100-41-4	µg/L	29	0.20
Polyaromatic Hydrocarbons (PAHs)				
2-Methylnaphthalene	91-57-6	µg/L	--	0.01
Acenaphthene	83-32-9	µg/L	--	0.01
Acenaphthylene	208-96-8	µg/L	--	0.01
Anthracene	120-12-7	µg/L	--	0.01
Benzo(g,h,i)perylene	191-24-2	µg/L	--	0.01
Fluorene	86-73-7	µg/L	--	0.01
Phenanthrene	85-01-8	µg/L	--	0.01
Fluoranthene	206-44-0	µg/L	6	0.01
Naphthalene	91-20-3	µg/L	160	0.01
Pyrene	129-00-0	µg/L	8	0.01
Carcinogenic PAHs[1] (cPAHs)				
Benzo(a)anthracene	56-55-3	µg/L	0.01	0.01
Benzo(a)pyrene	50-32-8	µg/L	0.01	0.01
Benzo(b)fluoranthene	205-99-2	µg/L	0.01	0.01
Benzo(k)fluoranthene	207-08-9	µg/L	0.01	0.01
Chrysene	218-01-9	µg/L	0.016	0.01
Dibenzo(a,h)anthracene	53-70-3	µg/L	--	0.01
Indeno(1,2,3-cd)pyrene	193-39-5	µg/L	0.01	0.01
Total cPAHs TEQ	--	µg/L	0.02	--
Semivolatile Organic Compounds (SVOCs)				
Bis(2-ethylhexyl)phthalate	117-81-7	µg/L	3.0	3.0
Carbazole	86-74-8	µg/L	2.0	1.0
Dibenzofuran	132-64-9	µg/L	16	1.0
Arsenic Speciation				
As(III)	1303-33-9	µg/L	--	0.004
As(V)	17428-41-0	µg/L	--	0.010
DMAs	15132-04-4	µg/L	--	0.005
MMAs	124-58-3	µg/L	--	0.004

Analysis	CAS Number	Units	Groundwater Cleanup Level	Practical Quantification Limit (PQL)
Dissolved Metals				
Arsenic	7440-38-2	µg/L	8	0.2
Cadmium	7440-43-9	µg/L	0.72	0.1
Copper	7440-50-8	µg/L	11	0.5
Lead	7439-92-1	µg/L	2.5	0.1
Mercury	7439-97-6	µg/L	0.10	0.0001
Nickel	7440-02-0	µg/L	52	0.5
Silver	7440-22-4	µg/L	3.2	0.2

Notes:

[1]The chemical analytical results of individual compounds will be used to calculate toxic equivalency quotient (TEQ) in accordance with Environmental Protection Agency's toxicity equivalency factor (TEF) methodology. For non-detect results, one-half the practical quantitation limit (PQL) result will be used in the TEQ calculations. The calculated TEQ will be screened against the applicable screening level.

CAS = Chemical Abstract Services

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

MMAs = monomethylarsenates

DMAs = dimethylarsenates

µg/L = micrograms/liter

TEQ = toxic equivalency quotient

"--" = Not Available

Table A-12

Soil Cleanup Levels (SLs) and Practical Quantitation Limits (PQLs)

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site
Seattle, Washington

Analysis	CAS Number	Units	Soil Cleanup Levels[2]	Practical Quantification Limit (PQL)
Total Petroleum Hydrocarbons				
Diesel-Range Hydrocarbons	--	mg/kg	--	50
Volatile Organic Compounds (VOCs)				
Benzene	71-43-2	mg/kg	--	0.001
Ethylbenzene	100-41-4	mg/kg	--	0.001
Toluene	108-88-3	mg/kg	--	0.001
Polyaromatic Hydrocarbons (PAHs)				
2-Methylnaphthalene	91-57-6	mg/kg	--	0.02
Acenaphthene	83-32-9	mg/kg	--	0.02
Acenaphthylene	208-96-8	mg/kg	--	0.02
Anthracene	120-12-7	mg/kg	--	0.02
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	0.02
Fluorene	86-73-7	mg/kg	--	0.02
Phenanthrene	85-01-8	mg/kg	--	0.02
Fluoranthene	206-44-0	mg/kg	--	0.02
Naphthalene	91-20-3	mg/kg	--	0.02
Pyrene	129-00-0	mg/kg	--	0.02
Carcinogenic PAHs[1] (cPAHs)				
Benzo(a)anthracene	56-55-3	mg/kg	--	0.02
Benzo(a)pyrene	50-32-8	mg/kg	--	0.02
Benzo(b)fluoranthene	205-99-2	mg/kg	--	0.02
Benzo(k)fluoranthene	207-08-9	mg/kg	--	0.02
Chrysene	218-01-9	mg/kg	--	0.02
Dibenzo(a,h)anthracene	53-70-3	mg/kg	--	0.02
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	--	0.02
Total cPAHs TEQ	--	mg/kg	--	--
Metals				
Arsenic	7440-38-2	mg/kg	--	0.2
Barium	7440-39-3	mg/kg	--	0.5
Cadmium	7440-43-9	mg/kg	--	0.1
Chromium	7440-47-3	mg/kg	--	0.5
Lead	7439-92-1	mg/kg	--	0.1
Mercury	7439-97-6	mg/kg	--	0.025
Selenium	7782-49-2	mg/kg	--	0.5
Silver	7440-22-4	mg/kg	--	0.2

Notes:

[1]The chemical analytical results of individual compounds will be used to calculate TEQ in accordance with Environmental Protection Agency's toxicity equivalency factor (TEF) methodology. For non-detect results, one-half the practical quantitation limit (PQL) result will be used in the TEQ calculations. The calculated TEQ will be screened against the applicable screening level.

[2]Soil cleanup levels were not proposed in the Cleanup Action Plan (Ecology 2023a). Soil samples are being collected for waste characteriztion pruposes. However, the PQLs presented are equal to or less than MTCA Method A or B soil cleanup levels.

CAS = Chemical Abstract Services

mg/kg = milligrams/kilogram

TEQ = toxic equivalency quotient

"--" = Not Available.

Table A-13

Sediment Cleanup Levels (CULs), Screening Levels (SLs), and Practical Quantitation Limits (PQLs)

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Analysis	CAS Number	Units	ALU Sediment Cleanup Objective	ALU Cleanup Screening Level	GWPS Sediment Cleanup Level	Practical Quantification Limit (PQL)
Conventionals						
Sulfide	18496-25-8	mg/kg	39	61	--	20
Volatile Organic Compounds (VOCs)						
Benzene	71-43-2	µg/kg	--	--	--	1
Ethylbenzene	100-41-4	µg/kg	--	--	--	1
Toluene	108-88-3	µg/kg	--	--	--	1
Xylenes	1330-20-7	µg/kg	--	--	--	2
Polyaromatic Hydrocarbons (PAHs)						
2-Methylnaphthalene	91-57-6	mg/kg	--	--	--	0.02
Acenaphthene	83-32-9	mg/kg	--	--	--	0.02
Acenaphthylene	208-96-8	mg/kg	--	--	--	0.02
Anthracene	120-12-7	mg/kg	--	--	--	0.02
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	--	--	0.02
Fluorene	86-73-7	mg/kg	--	--	--	0.02
Phenanthrene	85-01-8	mg/kg	--	--	--	0.02
Naphthalene	91-20-3	mg/kg	--	--	--	0.02
Fluoranthene	206-44-0	mg/kg	--	--	--	0.02
Pyrene	129-00-0	mg/kg	--	--	--	0.02
Total PAHs	--	mg/kg	--	--	30	--
Carcinogenic PAHs (cPAHs)[1]						
Benzo(a)anthracene	56-55-3	mg/kg	--	--	--	0.02
Benzo(a)pyrene	50-32-8	mg/kg	--	--	--	0.02
Benzo(b)fluoranthene	205-99-2	mg/kg	--	--	--	0.02
Benzo(k)fluoranthene	207-08-9	mg/kg	--	--	--	0.02
Chrysene	218-01-9	mg/kg	--	--	--	0.02
Dibenzo(a,h)anthracene	53-70-3	mg/kg	--	--	--	0.02
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	--	--	--	0.02
Total cPAHs TEQ	--	mg/kg	--	--	0.21	--
Total Petroleum Hydrocarbons						
Diesel-Range Hydrocarbons	--	mg/kg	340	510	--	50
Semivolatile Organic Compounds (SVOCs)						
4-Methylphenol	106-44-5	mg/kg	0.26	2.0	--	0.005
Benzoic Acid	65-85-0	mg/kg	2.9	3.8	--	0.10
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	0.50	22	--	0.05
Carbazole	86-74-8	mg/kg	--	--	0.90	0.02
Dibenzofuran	132-64-9	mg/kg	--	--	0.20	0.02
Di-n-Butyl phthalate	84-74-2	mg/kg	0.38	1.00	--	0.02
Di-n-Octyl phthalate	117-84-0	mg/kg	0.04	>1.1	--	0.02
Hexachlorobenzene	118-74-1	mg/kg	0.01	0.01	--	0.005
Pentachlorophenol	87-86-5	mg/kg	0.02	0.02	--	0.02
Phenol	108-95-2	mg/kg	0.12	0.21	--	0.005

Table A-13

Sediment Cleanup Levels (CULs), Screening Levels (SLs), and Practical Quantitation Limits (PQLs)

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Analysis	CAS Number	Units	ALU Sediment Cleanup Objective	ALU Cleanup Screening Level	GWPS Sediment Cleanup Level	Practical Quantification Limit (PQL)
Pesticides						
Chlordane	57-74-9	mg/kg	0.001	0.001	--	--
Cis-Chlordane	5103-71-9	mg/kg	--	--	--	0.002
Trans-Chlordane	5103-74-2	mg/kg	--	--	--	0.0005
Cis-Nonachlor	5103-73-1	mg/kg	--	--	--	0.001
Trans-Nonachlor	39765-80-5	mg/kg	--	--	--	0.001
Oxy-Chlordane	27304-13-8	mg/kg	--	--	--	0.001
4,4'-DDE	72-55-9	mg/kg	0.021	0.033	--	0.001
Polychlorinated Biphenyls (PCBs)						
Total PCBs (Aroclor)	--	mg/kg	0.02	0.02	--	--
Aroclor 1016	12674-11-2	µg/kg	--	--	--	4
Aroclor 1221	11104-28-2	µg/kg	--	--	--	4
Aroclor 1232	11141-16-5	µg/kg	--	--	--	4
Aroclor 1242	53469-21-9	µg/kg	--	--	--	4
Aroclor 1248	12672-29-6	µg/kg	--	--	--	4
Aroclor 1254	11097-69-1	µg/kg	--	--	--	4
Aroclor 1260	11096-82-5	µg/kg	--	--	--	4
Aroclor 1262	37324-23-5	µg/kg	--	--	--	4
Aroclor 1268	11100-14-4	µg/kg	--	--	--	4
Butyltins						
Tributyltin	688-73-3	mg/kg	0.047	0.32	--	0.00386
Metals						
Arsenic	7440-38-2	mg/kg	--	--	24	0.2
Cadmium	7440-43-9	mg/kg	2.1	5.4	--	0.1
Chromium	7440-47-3	mg/kg	62	62	--	0.5
Copper	7440-50-8	mg/kg	400	1,200	--	0.5
Lead	7439-92-1	mg/kg	360	>1,300	--	0.1
Mercury	7439-97-6	mg/kg	0.66	0.8	--	0.025
Methylmercury	16056-34-1	mg/kg	0.000058	0.000058	--	1.1E-05
Nickel	7440-02-0	mg/kg	--	--	50	0.5
Silver	7440-22-4	mg/kg	0.57	2	--	0.2

Table A-13

Sediment Cleanup Levels (CULs), Screening Levels (SLs), and Practical Quantitation Limits (PQLs)

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Analysis	CAS Number	Units	ALU Sediment Cleanup Objective	ALU Cleanup Screening Level	GWPS Sediment Cleanup Level	Practical Quantification Limit (PQL)
Dioxins/Furans						
2,3,7,8-TCDD	9014-42-0	ng/kg	--	--	--	1
2,3,7,8-TCDF	40321-76-4	ng/kg	--	--	--	1
1,2,3,7,8-PeCDD	39227-28-6	ng/kg	--	--	--	1
1,2,3,7,8-PeCDF	57653-85-7	ng/kg	--	--	--	2.5
2,3,4,7,8-PeCDF	19408-74-3	ng/kg	--	--	--	1
1,2,3,4,7,8-HxCDD	39227-28-6	ng/kg	--	--	--	2.5
1,2,3,6,7,8-HxCDD	3268-87-9	ng/kg	--	--	--	2.5
1,2,3,7,8,9-HXCDD	51207-31-9	ng/kg	--	--	--	2.5
1,2,3,4,7,8-HxCDF	57117-41-6	ng/kg	--	--	--	2.5
1,2,3,6,7,8-HxCDF	70648-26-9	ng/kg	--	--	--	2.5
1,2,3,7,8,9-HxCDF	70648-26-9	ng/kg	--	--	--	2.5
2,3,4,6,7,8-HxCDF	57117-44-9	ng/kg	--	--	--	2.5
1,2,3,4,6,7,8-HpCDD	72918-21-9	ng/kg	--	--	--	2.5
1,2,3,4,6,7,8-HpCDF	60851-34-5	ng/kg	--	--	--	2.5
1,2,3,4,7,8,9-HpCDF	67562-39-4	ng/kg	--	--	--	2.5
OCDD	55673-89-7	ng/kg	--	--	--	5
OCDF	39001-02-0	ng/kg	--	--	--	5
Total Dioxins/Furans TEQ	--	ng/kg	--	--	--	--

Notes:

[1] Toxic equivalency quotients (TEQs) will be calculated using Environmental Protection Agency's (EPA's) toxic equivalency factors (TEF) methodology. For non-detect results, one-half the PQL result will be used in the TEQ calculations.

CAS = Chemical Abstract Services

mg/kg = milligrams/kilogram

DDE = 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethylene

Table A-14

Quality Control Samples Type and Frequency

Pre-Remedial Design Investivation SAP/QAPP, Gas Works Park Site

Seattle, Washington

Parameter	Field QC Samples		Laboratory QC Samples[1]			
	Field Duplicates	Trip Blanks	Method Blanks	LCS or OPR	MS/MSD	Lab Duplicates
Air						
Select VOCs (BTE-N)	1 per 20 primary air samples	NA	1/batch	1/batch	1 set/batch	1/batch
Petroleum Fractions	1 per 20 primary air samples	NA	1/batch	1/batch	1 set/batch	1/batch
Soil						
PAHs	1 per 20 primary soil samples	NA	1/batch	1/batch	1 set/batch	NA
cPAHs	1 per 20 primary soil samples	NA	1/batch	1/batch	1 set/batch	NA
Metals (Arsenic)	1 per 20 primary soil samples	NA	1/batch	1/batch	NA	1/batch
Groundwater and Porewater						
VOCs[2]	1 per 20 primary groundwater/ porewater samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
PAHs[3]	1 per 20 primary groundwater/ porewater samples	NA	1/batch	1/batch	1 set/batch	NA
SVOCs (Bis(2-ethylhexyl)phthalate, Carbzole, Dibenzofuran)	1 per 20 primary groundwater/ porewater samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
Arsenic Speciation	1 per 20 primary groundwater/ porewater samples	NA	4/batch	1/batch	1 set/batch of 10	1/batch of 10
Metals (Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, Silver)	1 per 20 primary groundwater/ porewater samples	NA	1/batch	1/batch	NA	1/batch
Sediment						
Conventionals	1 per 20 primary sediment samples	NA	1/batch	1/batch	NA	1/batch
VOCs[2]	1 per 20 primary groundwater/ porewater samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
PAHs[3]	1 per 20 primary sediment samples	NA	1/batch	1/batch	1 set/batch	NA
Diesel- and Oil-Range Hydrocarbons	1 per 20 primary sediment samples	NA	1/batch	1/batch	1 set/batch	NA
SVOCs[4]	1 per 20 primary sediment samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
Pesticides (Chlordane and 4,4'-DDE)	1 per 20 primary sediment samples	NA	1/batch	1/batch	1 set/batch	NA
PCBs	1 per 20 primary sediment samples	NA	1/batch	1/batch	1 set/batch	NA
Tributyltin	1 per 20 primary sediment samples	NA	1/batch	1/batch	NA	1/batch
Dioxins/Furans	1 per 20 primary sediment samples	NA	1/batch	1/batch	NA	NA
Methylmercury	1 per 20 primary sediment samples	NA	1/batch	1/batch	1 set/batch of 10	1/batch of 10
Metals (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Silver)	1 per 20 primary sediment samples	NA	1/batch	1/batch	NA	1/batch

Notes:

[1]An analytical batch is defined as a group of samples taken through a preparation procedure and sharing a method blank, LCS, and MS/MSD (or MS and lab duplicate). No more than 20 field samples are contained in one batch.

[2]VOCs to be analyzed for groundwater and offshore groundwater include benzene, toluene, and ethylbenzene.

[3]PAHs to be analyzed for sediment, groundwater, and offshore groundwater include 2-methylnaphthalene, acenaphthene, ancenphthylene, anthracene, benzo(g,h,i)perylene, flourene, phenanthrere, naphthalene, flouranthene, pyrene and cPAHs, which are benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-dc)pyrene.

[2]VOCs to be analyzed for sediment include benzene, toluene, ethylbenzene, and xylenes. See Table A-1b for disclosure on what combination of these VOCs are sampled when.

[4]SVOCs to be analyzed for sediment include 4-Methylphenol, Benzoic acid, Bis(2-ethylhexyl)phthalate, Carbazole, Dibenzofuran, Di-n-Butyl phthalate, Di-n-Octyl phthalate, Hexachlorobenzene, Pentachlorophenol, and Phenol.

LCS = laboratory control sample

MS = matrix spike

MSD = matrix spike duplicate

NA = Not applicable

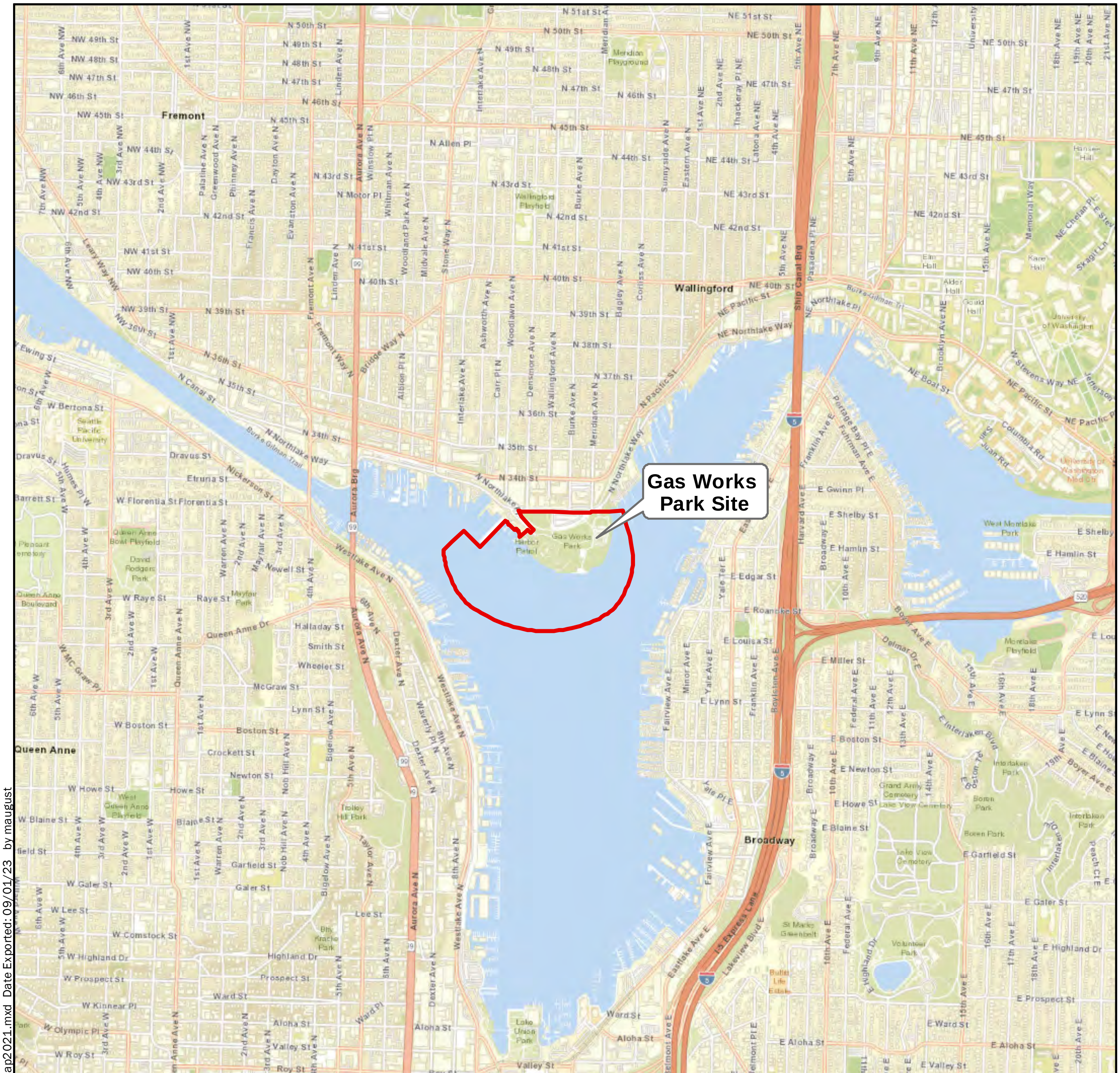
OPR = ongoing precision and recovery

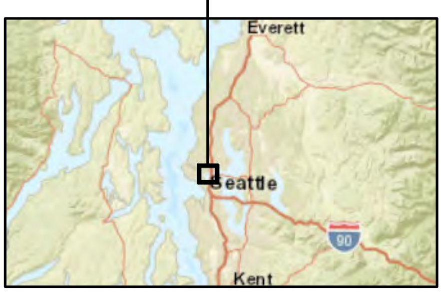
QC = quality control

SVOCs = semivolatile organic compounds

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

FIGURES





Gas Works Park Site

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Feet

Notes:

1. Basemap - ESRI, 2021.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Vicinity Map

Gas Works Park Site
Seattle, Washington

GEOENGINEERS

Figure A-1

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Legend

- Gas Works Park Site
- Shoreline (OHWM)
- Impervious (Paved or Structures)
- Gravel

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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N
W E
S

200 0 200

Feet

Site Plan

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-2

P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F02_SitePlan2021.mxd Date Exported: 12/19/23 by maugust

Notes:

1. The AOI is documented in the 2013 Amendment of Agreed Order DE 2008 (Ecology 2013).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Air and Soil Vapor Sampling Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-3

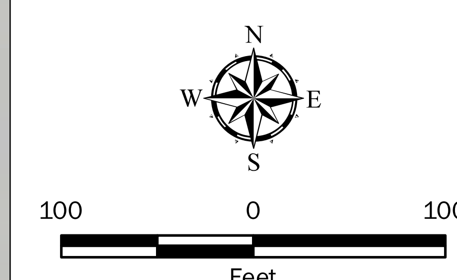
P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F06_AirSamplingLocations.mxd Date Exported: 01/11/24 by maugust

Legend

- Settlement Area
- Shoreline (OHWM)
- Groundwater Monitoring Well (Chemical Analyses and Well Gauging)
- Groundwater Monitoring Well (Well Gauging Only)
- Proposed Angled Shoreline Groundwater Monitoring Well (Chemical Analyses and Well Gauging)

Notes:

1. Because of how they are constructed, gauging cannot be completed at multi-level sample (MLS) wells (MLS-6 and MLS-7).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

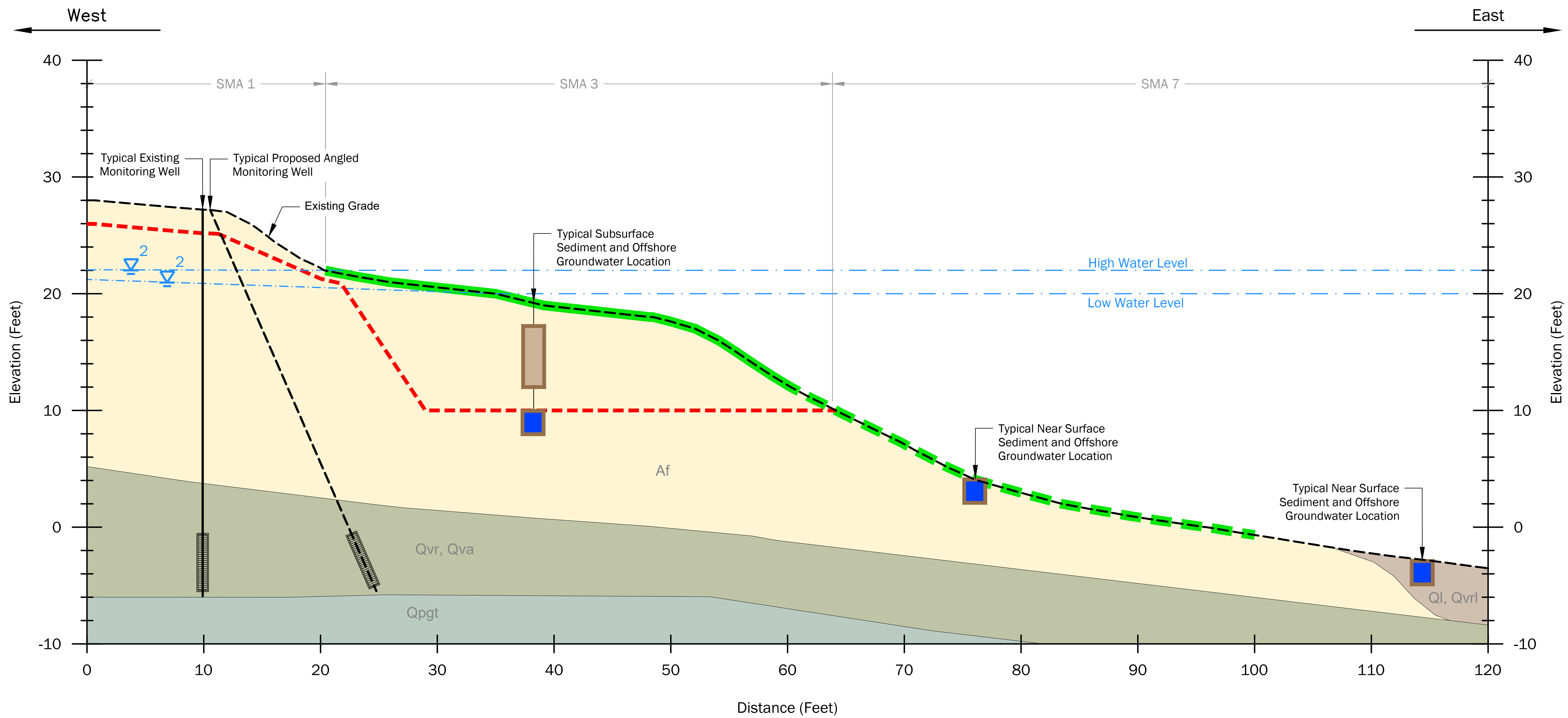


Upland Groundwater Sampling Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-4A



Legend

- Existing Grade
- Approximate Extent of the Groundwater Discharge Zone Downgradient of GWMA-1 (See Note 3)
- Water Table
- Fill (Af)
- Lake Sediment (Ql, Qvrl)
- Outwash (Qvr, Qva)
- Till (Qpgt)
- Partial Removal Limits
- Well Casing
- Well Screen
- Proposed Sediment Sample
- Proposed Sediment and Offshore Groundwater Sample

Notes:

1. 22-foot Contour = Shoreline (OHWM).
2. Water table in upland is estimated based on groundwater elevations observed in shoreline water table wells in April and October 2013.
3. The extent of the Groundwater Discharge Zone depends on the location of this cross section (see dashed green line and Figure 9B).

10 0 10
Scale in Feet

Vertical Datum: USACE
Horizontal Datum: WASPN

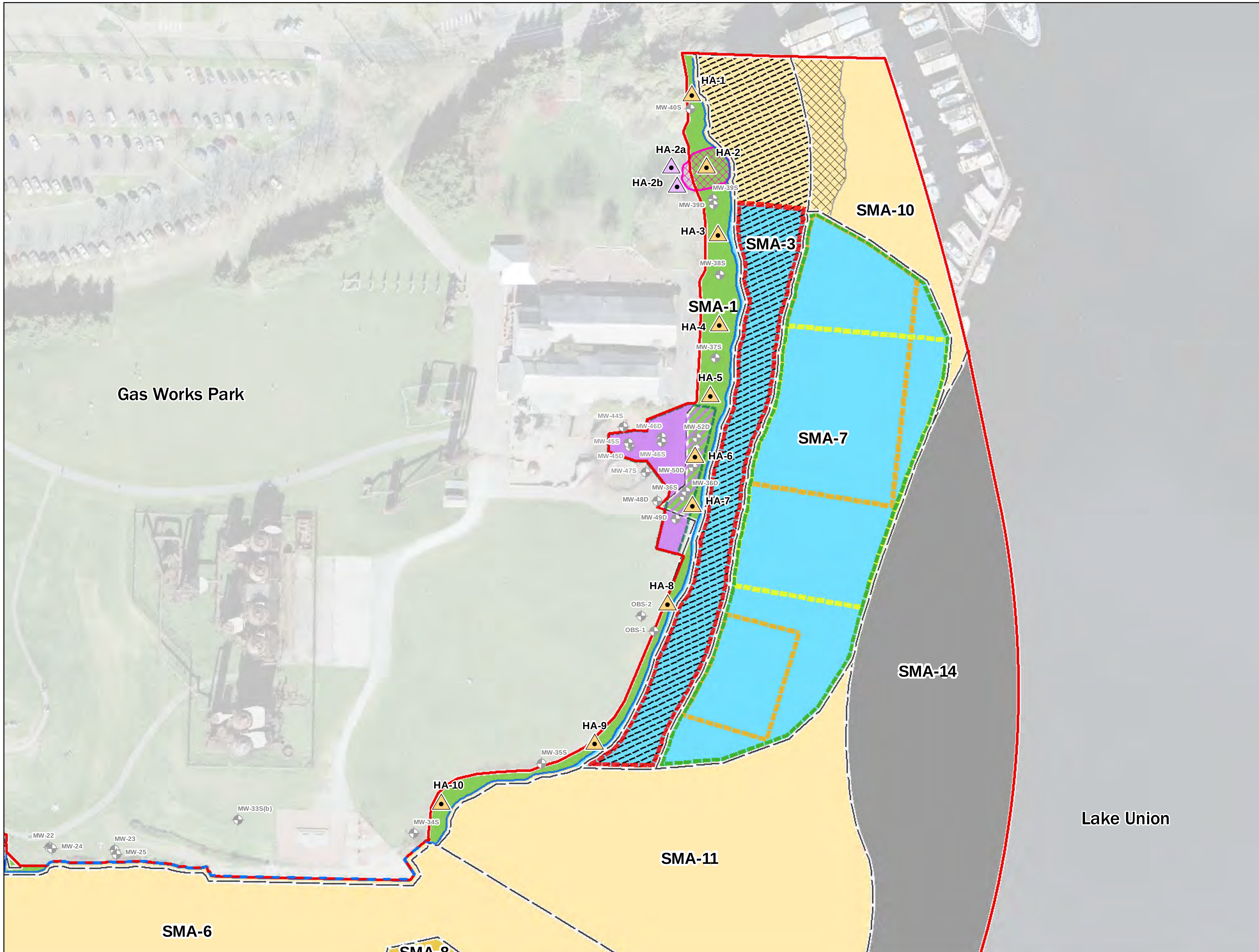
Typical Cross Section Downgradient of Play Area

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-4B

P:\0\0186846\CAD\04\Task 600\PRDI Work Plan\018684604_F07B_Cross-Section.dwg TAB:7B Date Exported: 02/12/24 - 11:14 by cstickel



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Enhanced Cap Elements

- Activated Carbon Amended Sand Cap
- Low-Permeability Cap
- Organoclay Amended Sand Cap
- Zero Valent Iron Amended Sand Cap

Proposed Sample Location

- Hand Collected Soil Core (Chemical Analyses)
- Hand Collected Soil Core (Field Screening for Tar Mound extent only)
- Current Shoreline Groundwater Monitoring Well

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601

N W E S

0 100 200
Feet

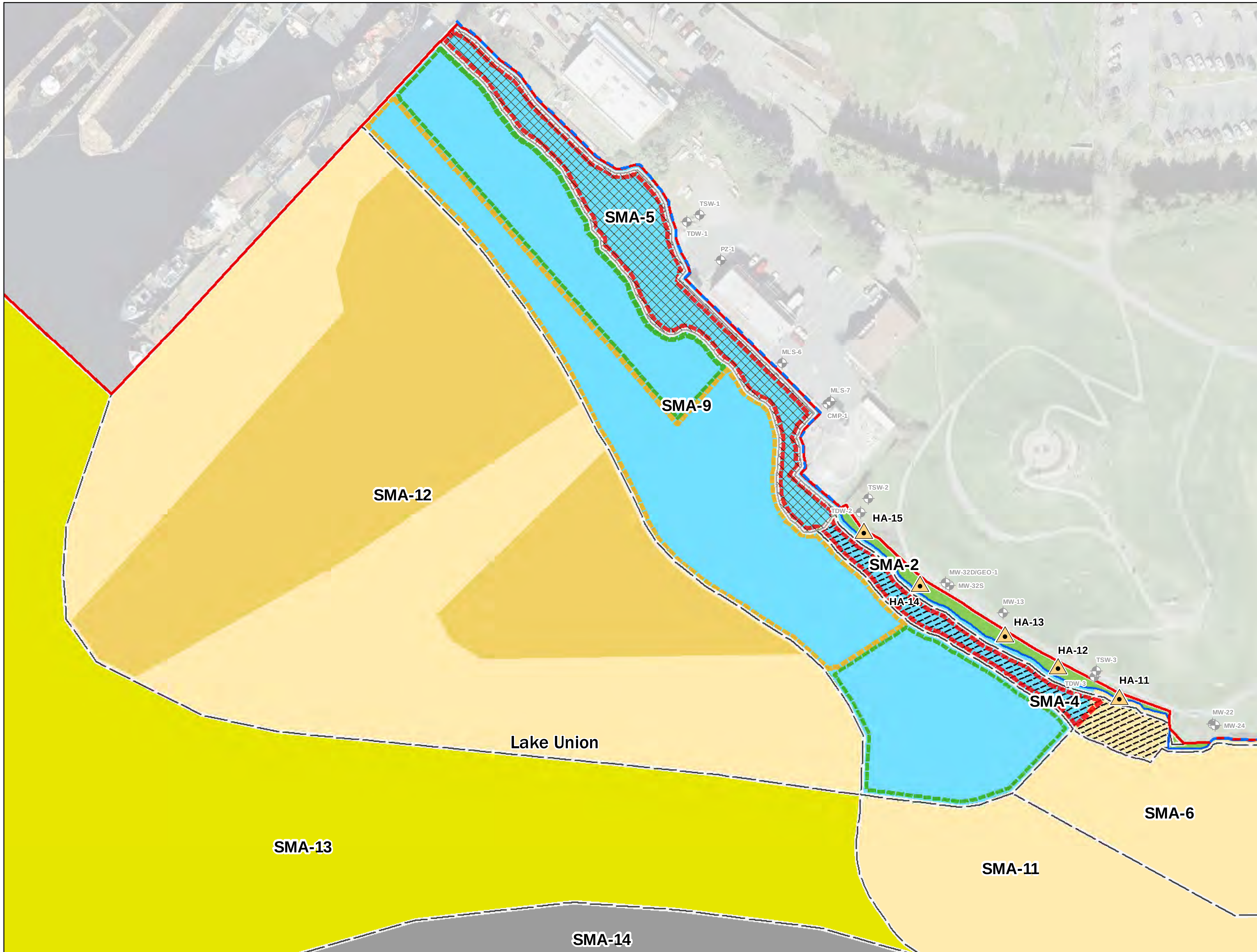
Upland Soil Sampling Locations - SMA-1

Gas Works Park Site
Seattle, Washington

GEOENGINEERS

Figure A-5A

Office: SEA Path: P:\01\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F08A_UplandSampleLocationsSMA3_7.mxd Map Revised: 25 October 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap
- Arsenic In-situ Treatment (Groundwater)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Enhanced Cap Elements

- Activated Carbon Amended Sand Cap
- Low-Permeability Cap
- Organoclay Amended Sand Cap

Proposed Sample Location

- Hand Collected Soil Core
- Current Shoreline Groundwater Monitoring Well

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601.

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N W E S

0 100 200
Feet

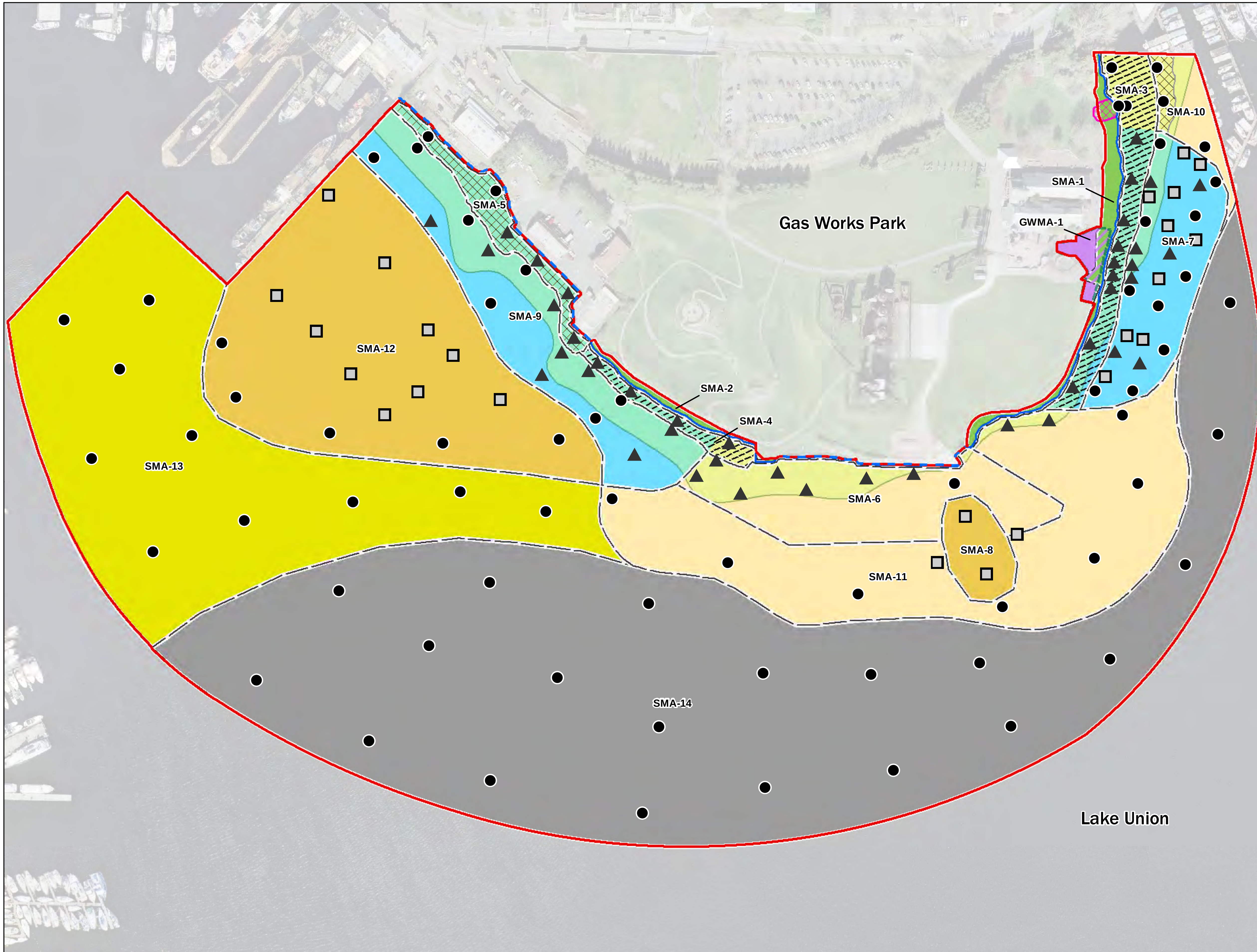
Upland Soil Sampling Locations - SMA-2

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-5B

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F08B_UplandSampleLocationsSMA4_5_9_12.mxd Map Revised: 19 September 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations
- Surface Sediment Grab Sample - Only NAPL Field Screening (24)
- Sediment and Offshore Groundwater Sample Location (42)
- Sediment Sample Location (68)
- Groundwater Discharge Zone/ Groundwater Compliance Area

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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N S W E

0 200 400

Feet

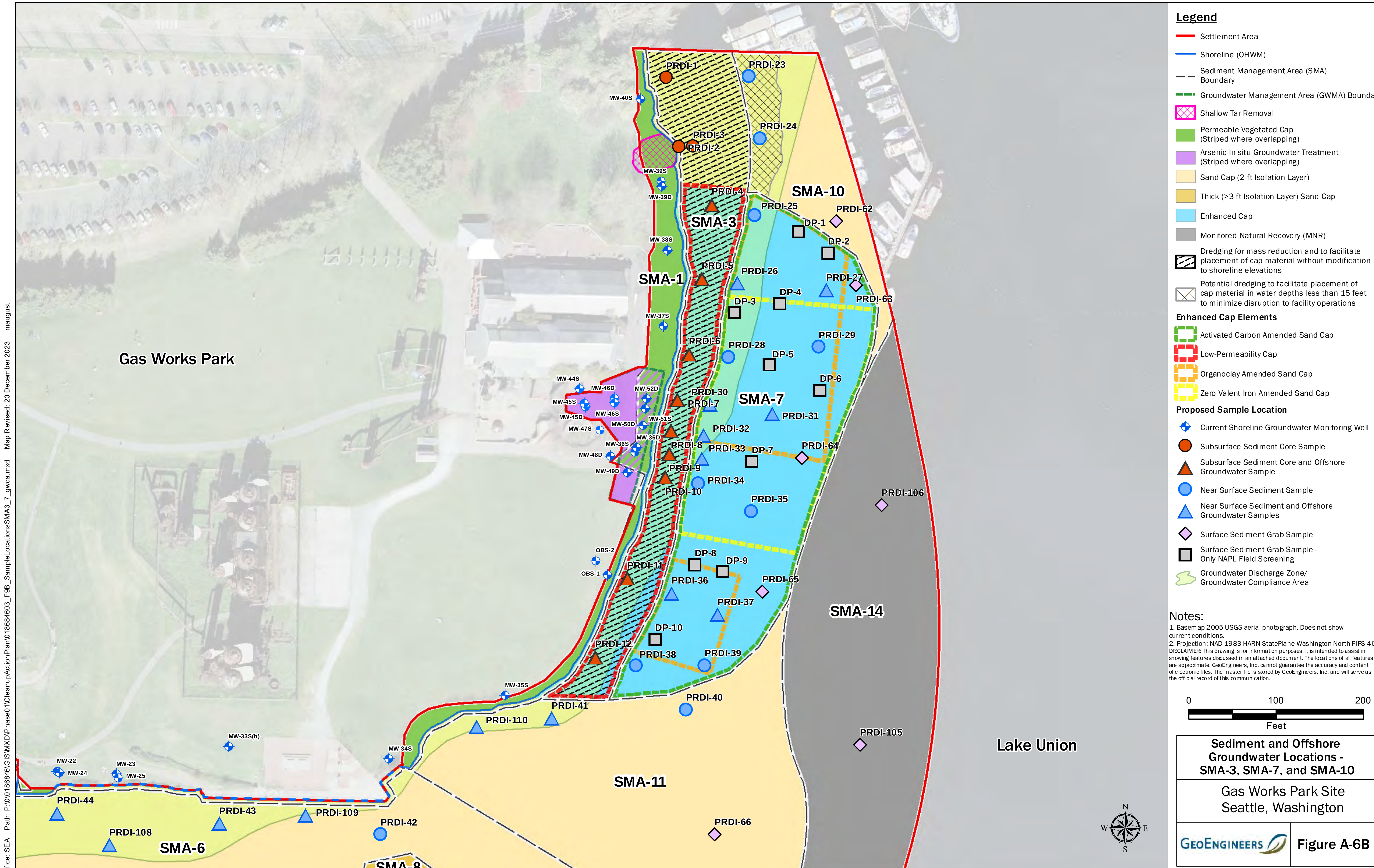
Summary of Sediment and Offshore Groundwater Sampling Locations

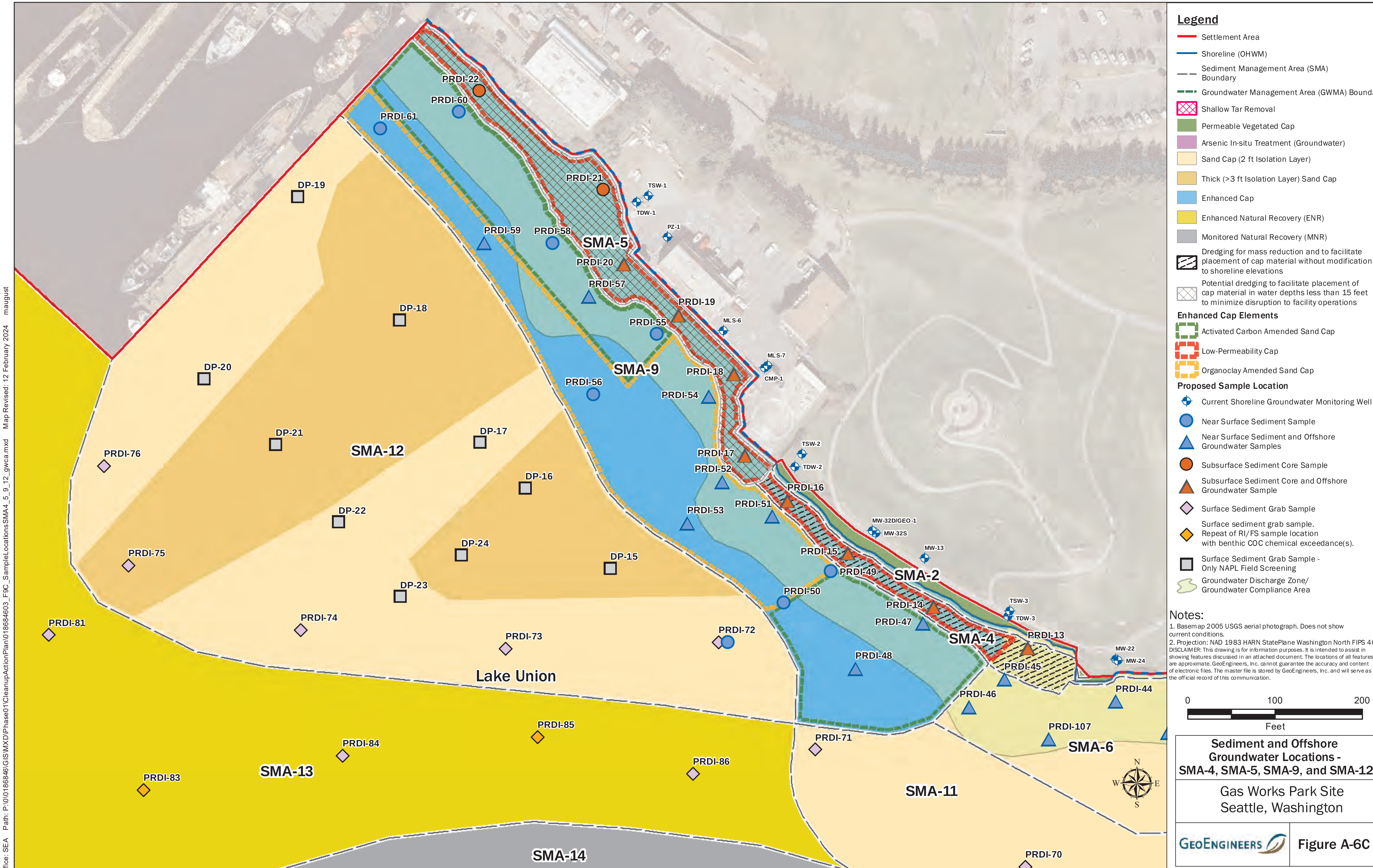
Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-6A

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9A_SamplingSummary.mxd Map Revised: 20 December 2023 maugust


Legend
Settlement Area
Shoreline (OHWM)
Sediment Management Area (SMA) Boundary
Groundwater Management Area (GWMA) Boundary
Shallow Tar Removal
Permeable Vegetated Cap (Striped where overlapping)
Arsenic In-situ Groundwater Treatment (Striped where overlapping)
Sand Cap (2 ft Isolation Layer)
Thick (>3 ft Isolation Layer) Sand Cap
Enhanced Cap
Monitored Natural Recovery (MNR)
Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations
Enhanced Cap Elements
Activated Carbon Amended Sand Cap
Low-Permeability Cap
Organoclay Amended Sand Cap
Zero Valent Iron Amended Sand Cap
Proposed Sample Location
Current Shoreline Groundwater Monitoring Well
Subsurface Sediment Core Sample
Subsurface Sediment Core and Offshore Groundwater Sample
Near Surface Sediment Sample
Near Surface Sediment and Offshore Groundwater Samples
Surface Sediment Grab Sample
Surface Sediment Grab Sample - Only NAPL Field Screening
Groundwater Discharge Zone/ Groundwater Compliance Area
Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601.
DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
0 100 200
Feet
Sediment and Offshore Groundwater Locations - SMA-3, SMA-7, and SMA-10
Gas Works Park Site
Seattle, Washington
GeoEngineers
Figure A-6B
Gas Works Park
Lake Union
SMA-1
SMA-3
SMA-6
SMA-7
SMA-8
SMA-10
SMA-11
SMA-14
N
W
E
S
Office: SEA Path: P:\01\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9B_SampleLocationsSMA3_7_gwca.mxd Map Revised: 20 December 2023 maugust

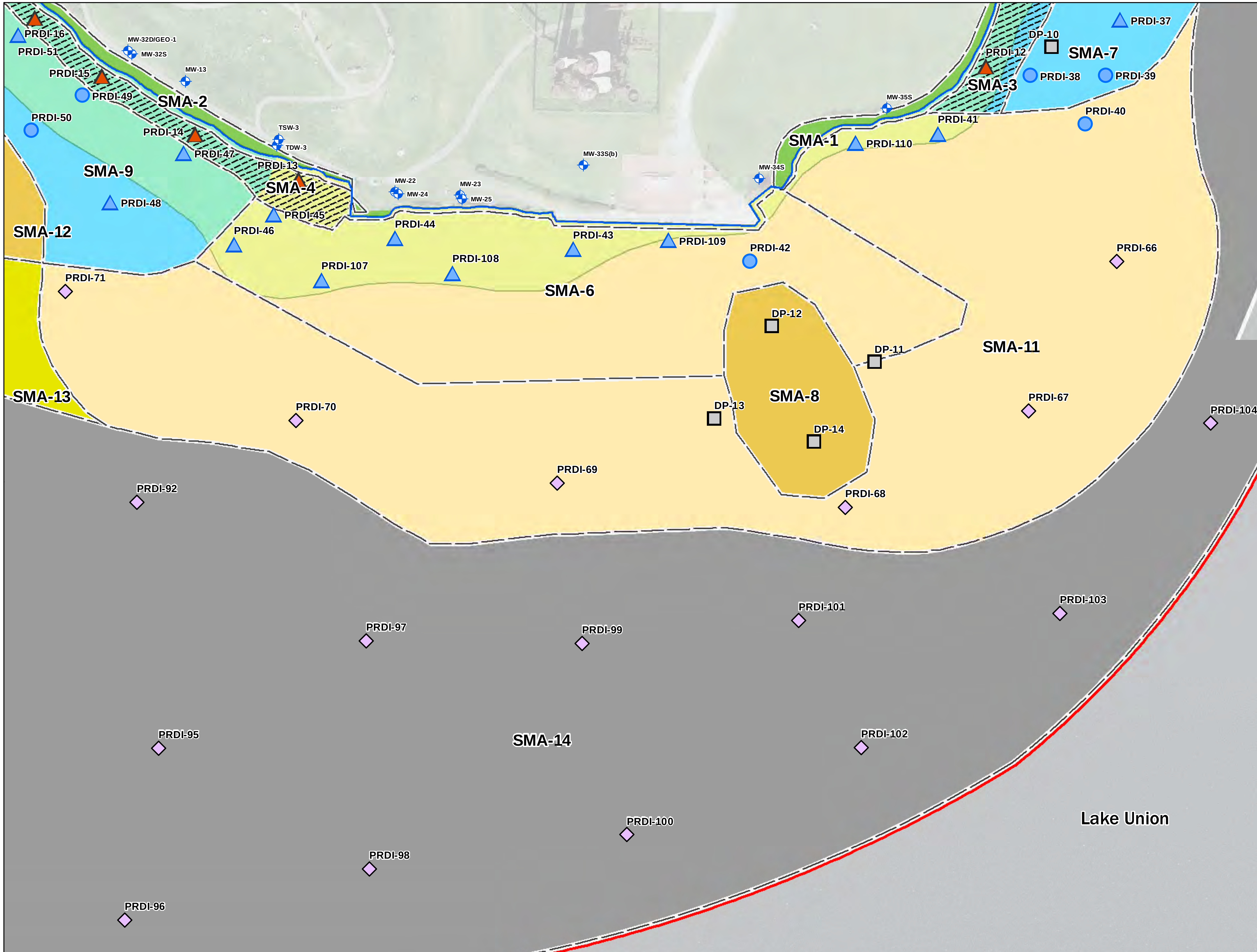


Sediment and Offshore Groundwater Locations - SMA-4, SMA-5, SMA-9, and SMA-12

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-6C



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Proposed Sample Location

- Current Shoreline Groundwater Monitoring Well
- Subsurface Sediment Core Sample
- Subsurface Sediment Core and Offshore Groundwater Sample
- Near Surface Sediment Sample
- Near Surface Sediment and Offshore Groundwater Samples
- Surface Sediment Grab Sample
- Surface Sediment Grab Sample - Only NAPL Field Screening
- Groundwater Discharge Zone/ Groundwater Compliance Area

Notes:

1. Locations PRDI-107 through PRDI-110 will be analyzed for arsenic only.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

0 100 200
Feet

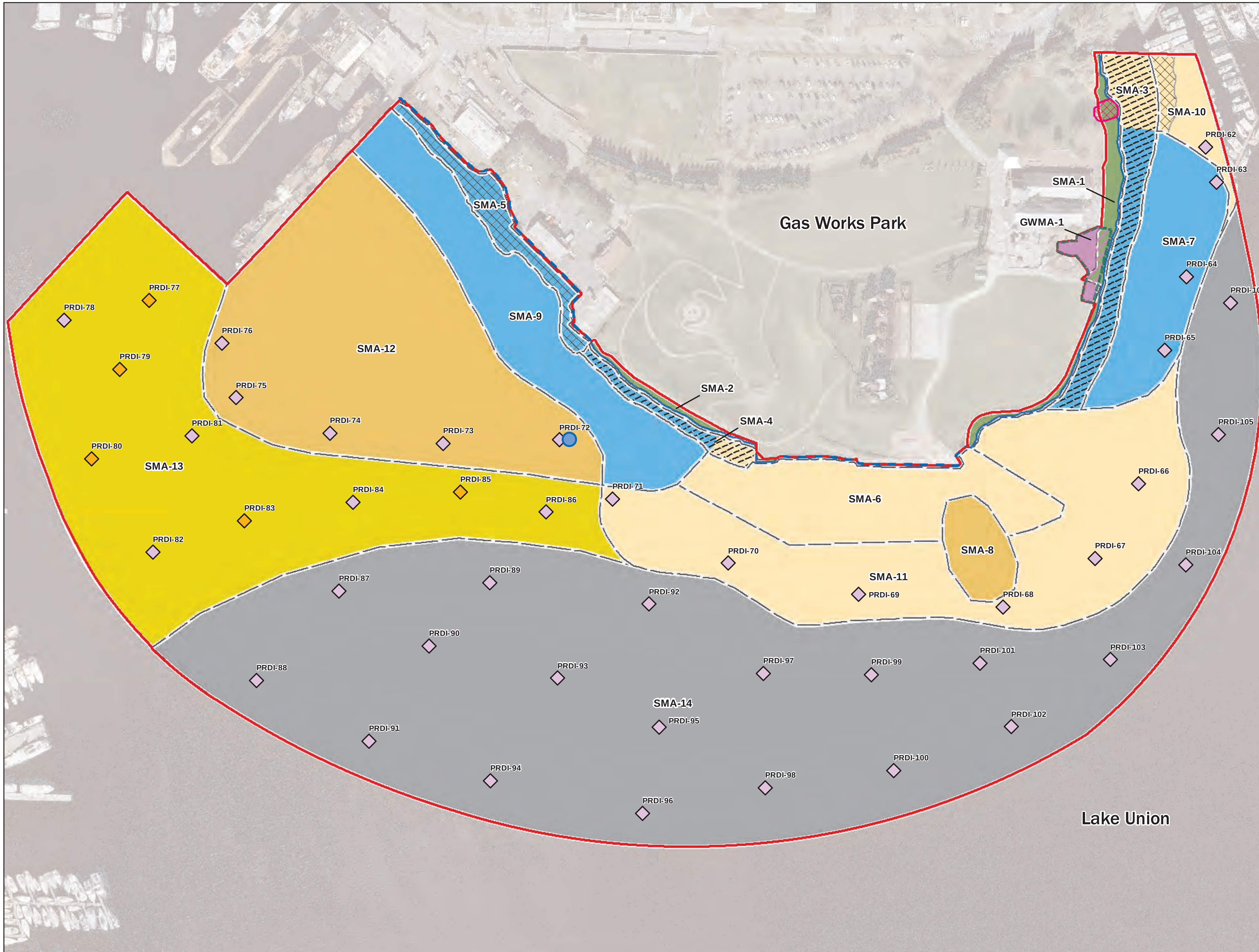
Sediment and Offshore Groundwater Locations - SMA-6, SMA-8, and SMA-11

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-6D

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9D_SampleLocationsSMA6_8_11_gwca.mxd Map Revised: 20 December 2023 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations

Proposed Sample Location

- Current Shoreline Groundwater Monitoring Well
- Surface Sediment Grab Sample
- Surface sediment grab sample. Repeat of RI/FS sample location with benthic COC chemical exceedance(s).
- Near Surface Sediment Sample

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

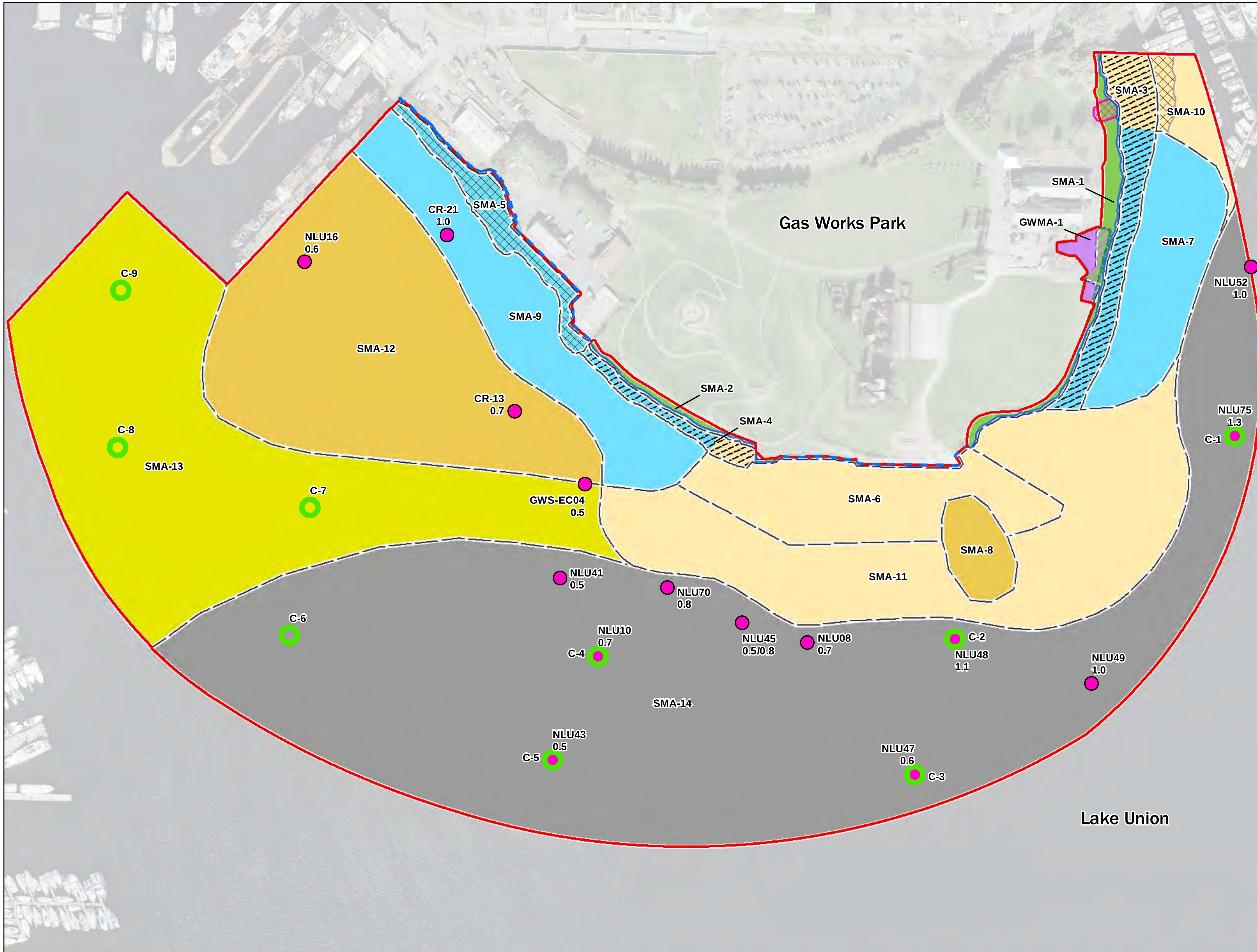
0 200 400
Feet

Sediment Locations - SMA-7, SMA-10, and SMA-11 through SMA-14

Gas Works Park Site
Seattle, Washington

GeoEngineers | **Figure A-6E**

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F9E_ENR-MNRSurfSed_Locations.mxd Map Revised: 12 February 2024 maugust



Legend

- Settlement Area
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Shallow Tar Removal
- Permeable Vegetated Cap (Striped where overlapping)
- Arsenic In-situ Groundwater Treatment (Striped where overlapping)
- Sand Cap (2 ft Isolation Layer)
- Thick (>3 ft Isolation Layer) Sand Cap
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging for mass reduction and to facilitate placement of cap material without modification to shoreline elevations
- Potential dredging to facilitate placement of cap material in water depths less than 15 feet to minimize disruption to facility operations
- Proposed Deposition Rate Core Location
- RI/FS Deposition Rate in cm/year

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
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0 200 400
Feet

Deposition Rate Sediment Core Locations - SMA-13 and SMA-14

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure A-7

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F10_DepositionRates.mxd Map Revised: 22 September 2023 maugust

APPENDICES

GeoEngineers

ATTACHMENT A-1
Building Survey Form

BUILDING SURVEY FORM

This form must be completed for each building involved in indoor air testing.

Preparer's Name ______________________________________ Date/Time Prepared _______________

Preparer's Affiliation __________________________________ Phone No.________________________

Purpose of Investigation____

1. OCCUPANT:

Interviewed: Y / N

Last Name: ___________________________ First Name: ___________________________

Address: ____

County: __________________

Home Phone: _____________________ Office Phone: _____________________

Number of Occupants/persons at this location _______ Age of Occupants ________________________

2. OWNER OR LANDLORD: (Check if same as occupant ___)

Interviewed: Y / N

Last Name: ___________________________ First Name: ___________________________

Address: ____

County: __________________

Home Phone: _____________________ Office Phone: _____________________

3. BUILDING CHARACTERISTICS

Type of Building: (Circle appropriate response)

Residential Commercial/Multi-use Other: __________________

If the property is residential, type? (Circle appropriate response)

2-Family	3-Family	
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Other:________________	

If multiple units, how many? ________

If the property is commercial, type?

Business Type(s) ______________________________________

Does it include residences (i.e., multi-use)? Y / N If yes, how many? ______

Other characteristics:

Number of floors______ Building age______

Is the building insulated? Y / N How air tight? Tight / Average / Not Tight

4. BASEMENT AND CONSTRUCTION CHARACTERISTICS (Circle all that apply)

Above grade construction: wood frame concrete stone brick

Foundation type: crawlspace slab-on-grade other ________________

Foundation walls: poured block stone other ________

Foundation walls: unsealed sealed sealed with _________________

If building has a crawlspace, please answer the following questions:

1) Does the crawlspace have air vents leading out of the house or building? Y / N
2) **Crawl space vents:** always open always closed open/closed based on season
3) **Crawlspace floor:** N/A dirt concrete other ________
4) Is the crawlspace lined with a plastic liner (vapor barrier)? Y / N
5) **Position of the liner:** On ground Attached to floor joist Attached to foundation
6) **Condition of liner:** whole partial torn
7) **Crawlspace is:** wet damp dry moldy

If house or building is slab-on-grade, please answer the following questions:

1) **Concrete floor:** unsealed sealed sealed with _________________
2) **Concrete floor:** uncovered covered covered with _________________

If the house or building has a sump, please answer the following questions:

1) **Water in sump?** Y / N / not applicable
2) **Sump lined?** Y / N / not applicable lined with _________________

Lowest level depth below grade: ________(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

____

____

____

5. HEATING, VENTING and AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in the house or building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard	
Space Heaters	Stream radiation	Radiant floor	
Electric baseboard	Wood stove	Outdoor wood boiler	Other ___________

The primary type of fuel used is:

Natural Gas	Fuel Oil	Kerosene
Electric	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: ____________________________

Where is Boiler/furnace/air conditioning located:

Are there air distribution ducts present? Y / N

Describe the air intakes (where applicable), supply and cold air return ductwork, and their condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

6. OCCUPANCY

Is lowest level occupied? Full-time Occasionally Seldom Almost Never

<u>Level General Use of Each Floor (e.g., family room, store, laundry, workshop, storage)</u>

1st Floor ____

2nd Floor ____

7. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y / N

b. Does the garage have a separate heating unit? Y / N / NA

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, atv, car) Y / N / NA Please specify____________________

d. Has the building ever had a fire? Y / N When?___________________

e. Is a kerosene or unvented gas space heater present? Y / N Where? __________________

f. Is there a workshop or hobby/craft area? Y / N Where & Type? ________________

g. Is there smoking in the building? Y / N How frequently? _______________

h. Have cleaning products been used recently? Y / N When & Type? ________________

i. Have cosmetic products been used recently? Y / N When & Type? __________________

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _________________

k. Is there new carpet, drapes or other textiles? Y / N Where & When? _________________

l. Have air fresheners been used recently? Y / N When & Type? __________________

m. Is there a kitchen exhaust fan? Y / N If yes, where vented?______________

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?______________

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?___________________

Are there odors in the house or building? Y / N

If yes, please describe: ____

Do any of the house or building occupants use solvents at work? Y / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Y/ N

Do any of the house or building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly)	No
Yes, use dry-cleaning infrequently (monthly or less)	Unknown
Yes, work at a dry-cleaning service	

Is there a radon mitigation system for the house/building? Y / N Date of Installation: __________

Is the system active or passive? Active/Passive

8. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the house/building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the house/building does not have a basement, please note.

Basement:

First Floor:

9. OUTDOOR PLOT (Draw a sketch of the area surrounding the house/building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.)

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

10. PRODUCT INVENTORY FORM Make & Model of field instrument used:

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description*	Comments	PID Reading

* Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D)** ** Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

ATTACHMENT A-2
Soil Vapor Sampling Methods

ATTACHMENT A-2
SUB-SLAB SOIL VAPOR PROBE INSTALLATION AND SOIL VAPOR SAMPLING PROCEDURES

Sub-Slab Soil Vapor Probe Installation Procedures

Sub-slab soil vapor samples will be collected inside buildings using Vapor Pin™ sampling devices. The Vapor Pins™ are installed following the manufacturers' standard operating procedures (SOPs) included as Attachment A-3.

General installation procedures for the sub-slab sampling device were as follows:

- Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding. A subcontractor will perform a private utility locate to clear the sub-slab soil vapor sample locations.
- Set up vacuum to collect drill cuttings.
- Drill a 5/8-inch-diameter hole through the slab and approximately 1 inch into the underlying soil to form a void.
- Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.
- Place the lower end of sampling device assembly into the drilled hole. Place the small hole located in the handle of the extraction/installation tool over the sampling device to protect the barb fitting and cap and tap the sampling device into place using a dead blow hammer. Make sure the extraction/installation tool is aligned parallel to the sampling device to avoid damaging the barb fitting.
- During installation, the silicone sleeve forms a slight bulge between the slab and the sample device shoulder creating a seal. Place a protective cap on sampling device to prevent vapor loss prior to sampling.
- Allow at least 60 minutes for the sub-slab soil vapor conditions to equilibrate prior to sampling.
- Following soil vapor sample collection, the Vapor Pin™ sampling device will be removed, and the hole will be patched with concrete.

Sub-Slab Soil Vapor Sampling Procedures

The following procedures are followed to collect sub-slab soil vapor samples:

- Connect new fluoropolymer (Teflon®) tubing to the sub-slab soil vapor probe, using the barb fitting on the top of the sampling device.
- Connect the tubing (aboveground) to a sampling manifold.
- Vacuum test the sampling manifold (shut-in test) by briefly introducing a vacuum to the aboveground portion of the sampling train and checking for loss of vacuum. If vacuum loss is observed, connections and fittings in the sample train are checked and adjusted, then vacuum-tested again. This test is repeated until the sampling train has demonstrated that tightness is achieved.
- A tracer gas shroud (clear plastic bag) is placed around the entire sample train (that is, the sub-slab soil vapor probe where it enters the ground surface, the 1-liter Summa canister and associated tubing and manifold).

- The shroud is charged (filled) with a tracer gas (spec-grade 99.995 percent helium gas) and the tracer gas concentration within the shroud is measured using a hand-held monitor (Dielectric MGD-2002 Multi-Gas Leak Detector), which is capable of measuring helium in air to a concentration of 0.5 percent) prior to, during and after completion of the sampling event. To charge the shroud a Teflon tube with a ball valve is inserted under the shroud to connect with the compressed helium bottle. This same tube is used to monitor the helium concentration within the shroud periodically throughout the sampling process. The purpose of the periodic monitoring is to make sure helium is in contact with the sample train and the ground surface while the sub-slab vapor sample is collected.
- The sampling train (aboveground and belowground components) is purged using a vacuum purge pump or a multi-gas meter. Purge volumes are calculated based on the flow rate of the purge pump and the volume of the soil vapor probe and sample train. After purging three sampling train volumes, the helium concentration within the sampling train is measured and recorded. If the helium concentration in the sample train is greater than or equal to 5 percent of the helium concentration in the shroud, the bentonite seal is re-applied, fittings re-tightened, and the previous purging and measurement tests are repeated (Ecology 2022).
- The soil vapor sample is obtained using a 1-liter evacuated Summa canister (with approximately 30 inches of mercury vacuum set by the laboratory) and tedlar bag (helium analysis) with a regulated flow rate of less than or equal to approximately 200 milliliters per minute (Ecology 2022). The canister is filled with soil vapor for approximately 5 minutes or until a vacuum equivalent of approximately 5 inches of mercury remains in the Summa canister, whichever comes first. The initial and final canister vacuums are recorded on a soil vapor sampling field form.
- The canisters are provided by the subcontracted analytical laboratory.

Reference

Ecology 2022. Guidance for Evaluating Vapor Intrusion in Washington State, Investigation and Remedial Action. Publication No. 09-09-047. March 2022.

ATTACHMENT A-3
Vapor Pin Standard Operating Procedure

Standard Operating Procedure

Installation and Extraction
Vapor Pin® Sampling Device

Scope & Purpose

Scope

This standard operating procedure describes the installation and extraction of the Vapor Pin® Sampling Device for use in sub-slab soil-gas sampling.

Purpose

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin® Sampling Device.

Equipment Needed

- Vapor Pin® Sampling Device
- Vapor Pin® Sleeves
- Vapor Pin® Cap
- Installation/Extraction Tool
- Rotary Hammer Drill
  - ⅝-Inch (16mm) diameter hammer bit
  - 1½-Inch (38mm) diameter hammer bit for flush mount applications
- ¾-Inch (19mm) diameter bottle brush
- Wet/Dry Vacuum with HEPA filter (optional)
- Dead Blow Hammer
- VOC-free hole patching material (hydraulic cement) and a putty knife or trowel
  - This is for repairing the hole following the extraction of the Vapor Pin® Sampling Device

Installation Procedure

1. Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.
2. Set up wet/dry vacuum to collect drill cuttings.
3. For a temporary installation, drill a ⅝-inch (16mm) diameter hole through the slab and approximately 1-inch (25mm) into the underlying soil to form a void. The hole must be ⅝-inch (16mm) in diameter to ensure a seal.
   - If a flush mount installation is required, drill a 1½-inch (38mm) diameter hole at least 1¾-inches (45mm) into the slab. We highly recommend using the Stainless Steel Drilling Guide and to reference the Standard Operating Procedure Drilling Guide & Secure Cover.
4. Remove the drill bit, brush the hole with the bottle brush and remove the loose cuttings with the vacuum.
5. Assemble the Vapor Pin® Sampling Device and Vapor Pin® Sleeve (Figure 1).
6. Place the lower end of the Vapor Pin® Sampling Device assembly into the drilled hole. Place the small hole located in the handle of the Installation/Extraction Tool, over the Vapor Pin® to protect the barb fitting and tap the Vapor Pin® into place using a dead blow hammer (Figure 2). Make sure the Installation/Extraction Tool is aligned parallel to the Vapor Pin® to avoid damaging the barb.
   - During installation, the Vapor Pin® Sleeve may form a slight bulge between the slab and the Vapor Pin® Sampling Device shoulder.
7. Place the Vapor Pin® Cap on the Vapor Pin® to prevent vapor loss prior to sampling (Figure 3).
8. For flush mount installations, cover the Vapor Pin® with a flush mount cover, using either the plastic cover or the optional Stainless Steel Secure Cover (Figure 4).
9. Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to re-equilibrate prior to sampling.

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Sampling

1. Remove the Vapor Pin® Cap and connect your sample tubing to the barb fitting of the Vapor Pin® Sampling Device.
2. Create a connection by using a short piece of Tygon™ tubing to join the Vapor Pin® Sampling Device with the Nylaflow tubing (Figure 5). Put the Nylaflow tubing as close to the Vapor Pin® Sampling Device as possible to minimize contact between soil gas and Tygon™ tubing. You do not **have** to use Nyflaflow tubing, any stiff tubing will suffice.
3. Prior to sampling, conduct a leak test in accordance with applicable guidance. If a leak test is not specified, refer to the SOP Leak Testing the Vapor Pin® Sampling Device, via Mechanical Means (Figure 6). For flush-mount installations, distilled water can be poured directly into the 1½ inch (38mm) hole.

Figure 5.

Figure 6.

Figure 7.

Extraction Procedure & Reuse Notes

1. Remove the protective cap, and thread the Installation/Extraction Tool onto the Vapor Pin® Sampling Device (Figure 7). Turn the tool clockwise continuously, don't stop turning, the Vapor Pin® Sampling Device will feed into the bottom of the Installation/Extraction Tool and will extract from the hole like a wine cork, **DO NOT PULL!**
2. Fill the void with hydraulic cement and smooth with a trowel or putty knife.
3. Prior to reuse, remove the silicon Vapor Pin® Sleeve and Vapor Pin® Cap and discard. Decontaminate the Vapor Pin® Sampling Device in a Alconox® solution, then heat in an oven to a temperature of 265° F (130°C). For Stainless – ½ hour, Brass 8 minutes.

ATTACHMENT A-4
Manual Groundwater Level Measurements Form

Attachment A-4
Well Inspection and Manual Water Level Measurement Form
Gas Works Park Site

Date ____________ **Staff** ________________ **Weather** ________________

Area	Time of Gauging	Well	Depth to LNAPL (ft TOC)	PID (ppm)	Depth to LNAPL (ft TOC)	Depth to Water (ft TOC)	Depth to DNAPL (ft TOC)	Total Depth of Well (ft bTOC)	Bottom of Well: Soft/Silty/ Hard	Water in Monument (Y/N)? Below or Above Cap?	Lock on Cap (Y/N)?	Field Notes	Repairs Needed? (Y/N)	TOC Elevation (Ft)	GW Elevation
		Lake Union Gauge	--	--	--		--	--	--	--	--		--	--	--
North East		MW-26	--											32.81	
		MW-27	--											35.26	
		MW-36D	--											29.55	
		MW-36S	--											29.62	
		MW-37S	--											26.85	
		MW-38S	--											25.42	
		MW-39D	--											26.74	
		MW-39S	--											26.61	
		MW-40S	--											25.18	
		MW-41D	--											32.44	
		MW-41S	--											32.27	
		MW-42S	--											31.07	
		MW-43S	--											32.28	
		MW-44S												33.54	
		MW-45D	--											32.25	
		MW-45S												33.99	
		MW-46D	--											28.17	
		MW-46S	--											28.09	
		MW-47S	--											33.05	
		MW-48D												30.05	
		MW-49D	--											29.4	
		AW-49D	--											29.4	

Area	Time of Gauging	Well	Depth to LNAPL (ft TOC)	PID (ppm)	Depth to LNAPL (ft TOC)	Depth to Water (ft TOC)	Depth to DNAPL (ft TOC)	Total Depth of Well (ft bTOC)	Bottom of Well: Soft/Silty/ Hard	Water in Monument (Y/N)? Below or Above Cap?	Lock on Cap (Y/N)?	Field Notes	Repairs Needed? (Y/N)	TOC Elevation (Ft)	GW Elevation
North East		MW-50D	--											29.55	
		AW-50D	--											29.55	
		MW-51S	--											28.62	
		MW-52D												28.31	
		AW-52D												28.31	
		MW-9												33.97	
		OBS-1	--											23.59	
		OBS-2	--											26.21	
		OBS-3	--											29.385	
South Shoreline		MW-10	--											32.99	
		MW-13	--											32.72	
		MW-14	--											27.53	
		MW-15	--											38.25	
		MW-22	--											25.07	
		MW-23	--											23.92	
		MW-24	--											24.87	
		MW-25	--											23.39	
		MW-28	--											37.49	
		MW-29	--											32.3	
		MW-30	--											32.95	
		MW-32D	--											31.35	
		MW-32S												31.12	
		MW-33S	--											39.08	
		MW-34S	--											28.05	
		MW-35S	--											24.15	
		TDW-2	--											25.11	
		TDW-3	--											26.46	
		TSW-2	--											28.14	
		TSW-3	--											27.82	

Area	Time of Gauging	Well	Depth to LNAPL (ft TOC)	PID (ppm)	Depth to LNAPL (ft TOC)	Depth to Water (ft TOC)	Depth to DNAPL (ft TOC)	Total Depth of Well (ft bTOC)	Bottom of Well: Soft/Silty/ Hard	Water in Monument (Y/N)? Below or Above Cap?	Lock on Cap (Y/N)?	Field Notes	Repairs Needed? (Y/N)	TOC Elevation (Ft)	GW Elevation
Harbor Patrol		TDW-1												24.57	
		TSW-1												25.40	
		PZ-1	--											25.09	
		PZ-5	--											27.83	
		PZ-6	--											27.13	
		CMP-1												24.97	
		DW-7												24.99	
		DW-5												25.12	
		DW-4												25.33	
		PZ-8	--											25.30	
Park Inland Wells		MW-03D	--											38.42	
		MW-03S	--											38.23	
		MW-17	--											32.66	
		MW-18												38.21	
		MW-19	--											39.14	
		MW-31	--											40.90	
		PZ-10	--											34.52	
		PZ-3												38.81	
		PZ-9	--											38.48	
		RW-1	--											39.02	

Notes:

[1] To convert elevation to USACE elevation, 19.05 feet is added to the lake gauge measurement.

[2] Green shading indicates wells with previous observations of LNAPL. An interface probe should be used.

ATTACHMENT A-5
Arsenic Speciation Groundwater Sampling Technique

ATTACHMENT A-5
ARSENIC SPECIATION - ANOXIC FIELD SAMPLE TECHNIQUE

Safety

This method uses a surgical steel needle. Use caution to avoid injury with the needle.

Materials (see Figure 1)

15 mL Syringe barrel with Luer-lock fitting
Luer-lock 25-gauge surgical steel needle
Luer-lock 0.45 µm filter
Evacuated sample vial with septum – non-preserved or EDTA-coated
Sharps container

Method

Water samples collected for arsenic speciation analysis are sensitive to redox changes. The purpose of this groundwater sampling technique is to mimic anoxic conditions—minimizing the exposure to oxygen. Follow these procedures after low flow purging is complete, groundwater parameters are stabilized and the monitoring flow through cell (YSI) has been disconnected.

1. Label the sample vial before sampling.
2. Allow for a segment of silicon (Tygon, Masterflex, or equivalent) tubing, approximately 6-inches long, on the discharge end of the peristaltic or submersible pump.
3. Remove any air within the syringe barrel. Attach the surgical needle to the barrel.
4. Point the needle against the current of the groundwater, insert the needle into the silicon tubing. Puncture tube about 3 inches from the end, this punctured segment will need to be cut to minimize spillage when filling subsequent bottle ware.
5. Draw approximately 15 milliliters (mL) of water into the barrel. To minimize the amount of oxygen in the barrel, draw water slowly. Water may flow into the barrel by itself, displacing the small amount of air in the barrel. Be careful not to pull the plunger out of the barrel.
6. Extract the syringe from the tubing. Detach the needle from the barrel. Hold the syringe needle side up, gently flick the barrel to dislodge bubbles from the walls within, and slowly depress the syringe plunger to expel any air pockets.
7. Attach the Luer-lock 0.45 micrometer (µm) filter onto the barrel (fits only in one direction). Attach the needle on the filter.
8. Gently depress the plunger to expel a small amount of water through the filter and needle, this will hydrate the filter and the needle. Be sure to retain approximately 6 mL to fill each vial.
9. Insert the needle through the septum of the evacuated sample vial. Gently depress the plunger to fill the vial with water. Note it is normal for the vacuum in the vial to pull some water into the vial. Do not fill the vial completely, instead try to “balance” the vial without over pressurizing it, the plunger will resist. The vial will contain a small amount of headspace.
10. Remove the needle from the evacuated sample vial.

11. Place the vial in a plastic bag, seal the bag, and place the sample in a cooler with ice.

12. Discard the syringe into an appropriate “sharps” disposal container when finished.

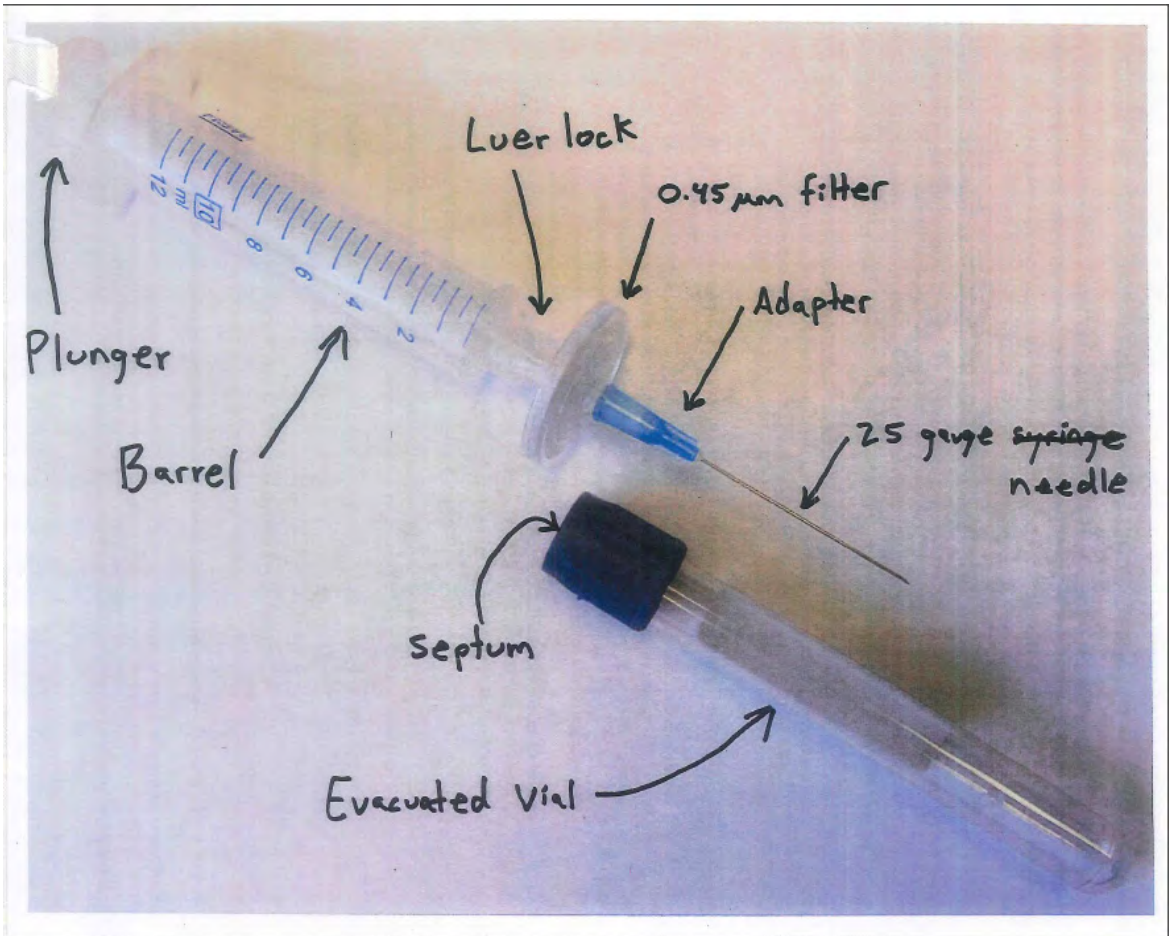


Figure 1. Groundwater Arsenic Speciation Sample Collection Materials

GeoEngineers

APPENDIX B
Health and Safety Plan

Appendix B
Pre-Remedial Design Investigation

Health and Safety Plan

Gas Works Park Site
Seattle, Washington

for
Puget Sound Energy and the City of Seattle

February 26, 2024

GeoEngineers
Earth Science + Technology

Appendix B
Pre-Remedial Design Investigation

Health and Safety Plan

Gas Works Park Site
Seattle, Washington

for
Puget Sound Energy and the City of Seattle

February 26, 2024

GeoEngineers

2101 4th Avenue, Suite 950
Seattle, Washington 98121
206.728.2674

Table of Contents

GEOENGINEERS, INC.
HEALTH AND SAFETY PLAN
GAS WORKS PARK SITE – PRDI INVESTIGATION

FILE NO. 0186-846-04

This HASP is to be used in conjunction with GeoEngineers, Inc. (GeoEngineers) Safety Programs. Together, the written safety programs and this HASP constitute the site safety plan for this site. This plan is to be used by GeoEngineers personnel on this site and must be available on-site. If the work entails potential exposure to other substances or unanticipated conditions, additional safety and health information will be included, and the updated plan made available to project participants. This HASP is to be used in conjunction with current standards and policies outlined in the GeoEngineers Health and Safety Program Manual.

Liability Clause: If requested by subcontractors, this site safety plan may be provided for informational purposes only. In this case, Form 3 shall be signed by the subcontractor. Please be advised that this Site Safety Plan is intended for use by GeoEngineers Employees only. Nothing herein shall be construed as granting rights to GeoEngineers' subcontractors or any other contractors working on this site to use or legally rely on this Site Safety Plan. GeoEngineers specifically disclaims any responsibility for the health and safety of any person not employed by them.

1.0 GENERAL PROJECT INFORMATION

Project Name:	Gas Works Park Site - PRDI Work Plan
Project Number:	00186-846-04
Type of Project:	PRDI Work Plan – Health and Safety Plan
Site Address	Gas Works Park – 2101 N. Northlake Way, Seattle, Washington 98103
Start/Completion:	2023/2024
Subcontractors:	Drillers, Private Utility Locators, Habitat Surveyors, Structural Engineers, Surveyors and Vessel Operators

1.1. Project Responsibilities

Chain of Command	Title	Name	Telephone Numbers
1	Project Manager (PM)	Neil Morton	206.239.3238
2	HAZWOPER Supervisor	TBD	
3	Field Engineer/Geologist	TBD	
4	Site Safety Officer (SSO)*	TBD	
5	Client Assigned Site Supervisor	TBD	
6	Health and Safety Manager (HSM)	Lucas Miller	509.209.2830
7	Client	Puget Sound Energy	
8	Subcontractors	TBD	

* **Site Safety and Health Supervisor** – The individual present at a hazardous waste site responsible to the employer and who has the authority and knowledge necessary to establish the site-specific health and safety plan and verify compliance with applicable safety and health requirements.

1.2. List of Field Personnel and Training

Anticipated field personnel include the following:

- Nate Solomon
- Katy Atakturk
- Paul Robinette
- Jason Sanford

Field personnel will have appropriate training and up to date health and safety certifications, including initial 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) course, annual 8-hour HAZWOPER refresher, and First Aid/cardiopulmonary resuscitation (CPR) training.

2.0 WORK PLAN

GeoEngineers will conduct field activities to investigate air, soil, groundwater, and sediment at the Gas Works Park Site (GWPS). The purpose of the Pre-Remedial Design Investigation (PRDI) Work Plan is to collect additional upland and sediment data to support the engineering analysis and design of the GWPS cleanup action.

As part of the PRDI Work Plan, our scope includes:

- Locating utilities prior to any earth disturbing activities.
- Indoor and outdoor air sampling and sub-slab soil vapor sampling.
- Groundwater investigation in the upland cleanup unit include drilling, monitoring well installation and shoreline groundwater sampling. New monitoring wells will be completed using Sonic drilling equipment. Collection of groundwater samples and submitting samples to laboratory for analysis.
- Soil sampling from the shoreline area and submitting samples to laboratory.
- Surface sediment sampling activities using a grab sampler deployed from a marine vessel and submitting samples to laboratory for analysis.
- Subsurface sediment sampling activities utilizing vibracore or similar method deployed from a marine vessel and submitting samples to laboratory for analysis.
- Geotechnical and structural investigations in nearshore and offshore areas utilizing mud rotary or sonic drill rig or similar methods deployed from a marine vessel. Field activities include subsurface sediment explorations, field vane shear tests, cone penetration tests (CPT) and sample collection for laboratory analysis.
- Detailed existing structure, topographic, bathymetric and debris survey of the GWPS to support future remedial design and construction work.
- Focused habitat survey in nearshore and riparian zones.

2.1. Site Description

The GWPS is in Seattle, Washington, at Gas Works Park, north of the downtown business district. The GWPS is divided into an upland unit and sediment unit, separated by the ordinary high-water mark (OHWM). The upland portion is approximately 21 acres landward of the OHWM and includes Gas Works Park, portions of Waterways 19 and 20, and Seattle Police Harbor Patrol. The 56-acre sediment portion is waterward of the OHWM and incorporates most of the aquatic portion of Waterway 19, all the aquatic portion of Waterway 20 and the lake bottom adjacent to Metro's Lake Union South Yard, Harbor Patrol, and Gas Works Park.

2.2. Site History

From the early 1900s until 1956, gas companies operated a plant at the GPWS that converted coal and oil into manufactured gas. The American Tar Company operated nearby, manufacturing tar from coal by-products. Releases and wastes from the historical gas works and tar production facilities contaminated the soil and groundwater as well as sediments in Lake Union. Contaminated soil capping, an in-situ cleanup of a benzene-impacted area in the NE portion of the park and in-situ groundwater treatment of groundwater beneath the Play Area have been completed since 2000.

A Remedial Investigation and Feasibility Study (RI/FS) report was prepared for GWPS and approved by Washington State Department of Ecology (Ecology) in 2023. A Cleanup Action Plan (CAP) describing the cleanup actions at GWPS was completed in 2023. The Ecology-approved CAP presents details of the cleanup action proposed for implementation at GWPS.

2.3. List of Field Activities

Check the activities to be completed during the project:

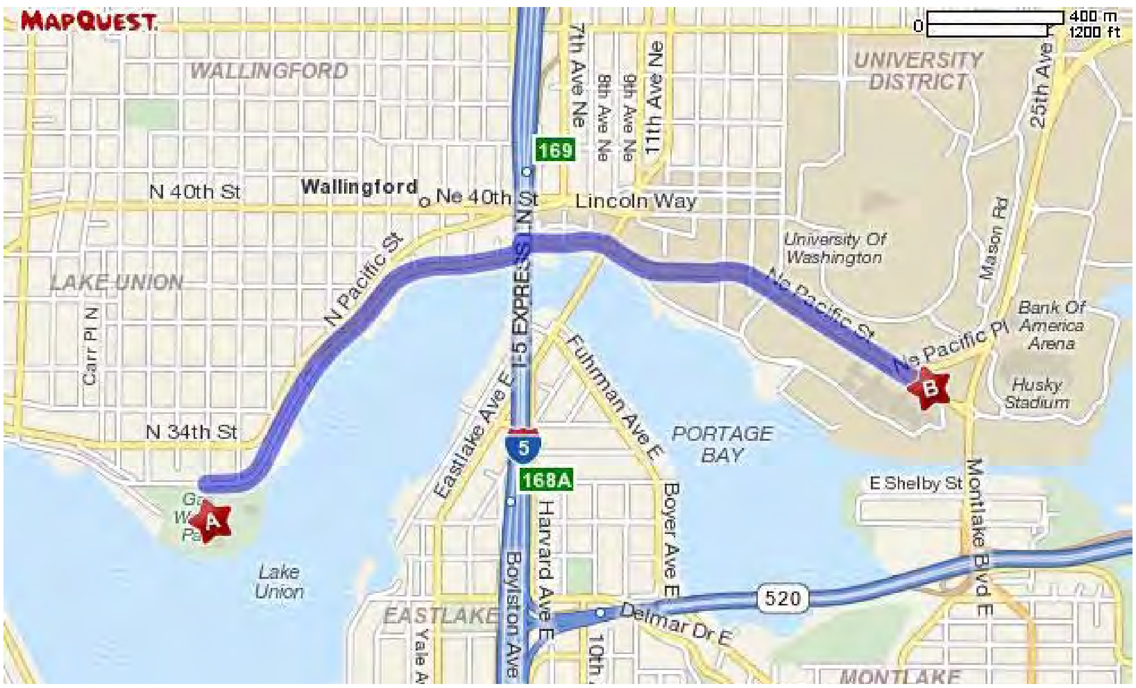
X	Site reconnaissance	X	Field Screening of Soil Samples
X	Exploratory Borings	X	Vapor Measurements
	Construction Monitoring	X	Groundwater Sampling
X	Surveying	X	Groundwater Depth and Free Product Measurement
	Test Pit Exploration	X	Air and Sub-Slab Soil Vapor Sampling
X	Monitoring Well Installation		Soil Stockpile Testing
X	Monitoring Well Development		Remedial Excavation
X	Soil Sample Collection		Underground Storage Tank (UST) Removal Monitoring
	Remediation System Monitoring	X	Sediment and Porewater Sampling

3.0 EMERGENCY INFORMATION

Hospital Name and Address:	University of Washington Medical Center 1959 NE Pacific Street Seattle, WA 98195
Phone Numbers (Hospital ER):	ER: 206.598.3300

Route to Hospital:
Distance: miles
Time: 7 minutes

1. Head east on N Northlake Way toward Meridian Avenue N
2. Continue onto NE Pacific Street
3. The hospital will be on your right.



Ambulance:	9-1-1
Poison Control:	Seattle (206) 253-2121; Other (800) 732-6985
Police:	9-1-1
Fire:	9-1-1
Location of Nearest Telephone:	Cell phones are carried by field personnel.
Nearest Fire Extinguisher:	Located in the GeoEngineers vehicle on-site.
Nearest First-Aid Kit:	Located in the GeoEngineers vehicle on-site.

3.1. Standard Emergency Procedures

Get help

- Send another worker to phone 9-1-1 (if necessary)
- As soon as feasible, notify GeoEngineers' Project Manager

Reduce risk to injured person

- Turn off equipment
- Move person from injury location (if in life-threatening situation only)
- Keep person warm or cool as necessary
- Perform CPR (if necessary)

Transport injured person to medical treatment facility (if necessary)

- By ambulance (if necessary) or GeoEngineers vehicle
- Stay with person at medical facility
- Keep GeoEngineers manager apprised of situation and notify Human Resources Manager of situation

4.0 HAZARD ANALYSIS

A hazard analysis has been completed as part of preparation of this HASP. The hazard analysis was performed taking into account the known and potential hazards at the GWPS and surrounding areas, as well as the planned work activities. The results of the hazard analysis are presented in this section. The hazard assessment will be evaluated each day before beginning work. Updates will be made as necessary and documented in the Job Hazard Analyses (JHA) Form 3 or daily field log.

4.1. Physical Hazards

X	Drill rigs
X	Sediment coring
	Trackhoe
	Excavations/trenching (1:1 slopes for Type B soil)
	Shored/braced excavation if greater than 4 feet of depth
	Overhead hazards/power lines
X	Tripping/puncture hazards (debris on site, steep slopes)
X	Traffic hazard – Boat traffic
X	Handling of heavy equipment and materials
X	Heat/Cold, Humidity
X	Utilities/utility locate
X	Overwater work on a vessel (see attached boat, over-water and near water safety program)
X	Other: Large equipment and operations associated with nearby Harbor Patrol, Shipyard and Gas Works Park Marina

General

- High-visibility vests will be worn by on-site personnel to ensure they can be seen by vehicle and equipment operators.
- Safety glasses will be worn during sample collection and decontamination activities, and other instances when appropriate. Face shields should be worn over safety glasses during sample collection and decontamination activities when splashing is a concern.
- Use traffic cones, candles, and caution tape to delineate active work areas to prevent the public from entering the work area during construction activities.
- Use proper lifting techniques.
- Work will proceed during daylight hours, or under sufficient artificial light.
- Care should be used to avoid falling accidents and to maintain good housekeeping. By keeping tools and equipment picked up and out of working area walkways, Personnel will take care when walking on slippery park surfaces, such as wet grass, and on sloped ground surfaces and embankments.
- Personnel will avoid tripping hazards, steep slopes, pits and other hazardous encumbrances. If it becomes necessary to work within 6 feet of the edge of a pit, slope or other potentially hazardous area, appropriate fall protection measures will be implemented by the Site Safety and Health Supervisor in accordance with Occupational Safety and Health Administration (OSHA)/Division of Occupational Safety and Health (DOSH) regulations and the GeoEngineers Health and Safety Program.
- Cold stress control measures will be implemented according to the GeoEngineers Health and Safety Program to prevent frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature). Heated break areas and warm beverages shall be available during periods of cold weather.
- Heat stress control measures required for this site will be implemented according to GeoEngineers Health and Safety Program with water provided on-site.
- Excessive levels of noise (exceeding 85 decibels [dBA]) are anticipated during drilling. Personnel that are potentially exposed to excessive levels of noise will wear ear plugs or muffs with a noise reduction rating (NRR) of at least 25 dB whenever it becomes difficult to carry on a conversation 3 feet away from a co-worker or whenever noise levels become bothersome. (Increasing the distance from the source will decrease the noise level noticeably.)

Heavy Equipment

- Heavy equipment and/or vehicles used on this GWPS will not work within 20 feet of overhead utility lines without first ensuring that the lines are not energized. This distance may be reduced to 10 feet based on acceptable electrical engineering controls or the use of a safety watch.
- Caution will be taken near the drill rig to avoid moving parts of the drill rig, as well as falling or flying objects.
- Field personnel will minimize time spent near drill rig; will not wear loose clothing; will use safety glasses, hard hat, and steel-toed boots.
- Field personnel will be aware at all times of the location and motion of heavy equipment in the area of work to ensure a safe distance between personnel and the equipment. Personnel will be visible to the operator at all times and will remain out of the swing and/or direction of the equipment apparatus.

Personnel will approach operating heavy equipment only when they are certain the operator has indicated that it is safe to do so through hand signal or other acceptable means.

Work Over or Near Water

- Approved floatation devices will be worn while aboard a vessel. Personnel will become familiar with safety aboard vessel at captain's direction.
- A change of dry clothes will be kept either on the vessel in a dry bag, or on shore during workdays involving on or near water work.
- Emergency evacuation routes will be identified for tsunami or earthquake events.

4.2. Engineering Controls

_____ Trench shoring (1:1 slope for Type B Soils)
__X__ Perform wind direction monitoring and locate workspaces upwind when possible
__X__ Other: soil covers (temporary covering of soil stockpiles, as needed)
__X__ Dust Control (as needed)

4.3. Chemical Hazards

CHEMICAL HAZARDS (POTENTIALLY PRESENT AT SITE)

Substance	Pathways
Benzene, ethylbenzene, and toluene	Groundwater/Porewater
Total Petroleum Hydrocarbons (diesel-range hydrocarbons)	Sediment
Polycyclic aromatic hydrocarbons, including cPAHs and naphthalene	Soil/Groundwater/Porewater/Sediment
Metals (arsenic)	Soil/Groundwater/Porewater/Sediment

SPECIFIC CHEMICAL HAZARDS AND EXPOSURES (POTENTIALLY PRESENT AT SITE)

Compound/ Description	Exposure Limits/IDLH	Exposure Routes	Symptoms/Health Effects
Benzene Colorless to light-yellow liquid with an aromatic odor.	PEL 1 ppm TWA TLV 0.5 ppm TWA REL 0.1 ppm TWA IDLH 500 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritated eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude; dermatitis; bone marrow depression; confirmed human carcinogen
Ethyl benzene Highly flammable, colorless liquid with an odor similar to that of gasoline.	PEL 100 ppm IDLH 800 ppm	Inhalation, ingestion, direct contact, skin absorption and eye contact	Irritation to eyes, skin, respiratory system, burning

Compound/ Description	Exposure Limits/IDLH	Exposure Routes	Symptoms/Health Effects
Toluene Colorless, water-insoluble liquid with the smell associated with the paint thinners.	PEL 200 ppm IDLH 500 ppm	Inhalation, absorption, ingestion, direct contact	Irritation to eyes, nose, exhaustion, confusion, dizziness, headaches, dilated pupils, euphoria, anxiety, teary eyes, muscle fatigue, insomnia, paresthesia, dermatitis, liver and kidney damage.
Polycyclic aromatic hydrocarbons (PAHs) (Coal tar pitch volatiles)	WA L&I/ACGIH: PEL 0.2 mg/m³ STEL 0.6 mg/m³ TLV 0.2 mg/m³ NIOSH: REL 0.1 mg/m³ IDLH 80 mg/m³	Inhalation, ingestion, skin and/or eye contact	Dermatitis, bronchitis, potential carcinogen
Benzo(a)pyrene Faint aromatic odor, pale yellow, crystalline solid or powder	PEL-TWA 0.2 mg/m³ NIOSH: REL 0.1 mg/m³ IDLH 80 mg/m³ (as coal tar pitch volatiles)	Inhalation, ingestion, skin and/or eye contact	Skin rash or eye irritation with redness and/or burning sensation, potential carcinogen
Naphthalene	PEL 10 ppm (50 mg/m³) REL 10 ppm (50 mg/m³) STEL 15 ppm (75 mg/m³) IDLH 250 ppm MTCA B Air 7.35E-05 mg/m³	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage, potential carcinogen
Arsenic (inorganic metal, as As) Metal: Silver-gray or tin-white, brittle, odorless solid.	WA L&I: PEL 0.01 mg/m³ ACGIH: TLV 0.01 mg/m³ OSHA: PEL 0.5 mg/m³ NIOSH: ND	Inhalation, ingestion, skin and/or eye contact.	Inorganic Arsenic: Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin [potential occupational carcinogen]

Notes:

ACGIH = American Conference of Governmental Industrial Hygienists
IDLH = immediately dangerous to life or health
µg/m³ = micrograms per cubic meter
mg/m³ = milligrams per cubic meter
OSHA = Occupational Safety and Health Administration
PEL = permissible exposure limit
ppm = parts per million
REL = recommended exposure limit
STEL = short-term exposure limit (15 min)
TLV = threshold limit value (over 10 hrs.)
TWA = time-weighted average (Over 8 hrs.)

4.3.1. Benzene

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities. Benzene is also a natural part of gasoline. The odor threshold for benzene in air is approximately 60 ppm and is recognizable as benzene at 100 ppm. Benzene may be present in the air, groundwater, soil sediment, and porewater. OSHA maximum allowable exposure limit of benzene in air during an 8-hour workday of a 40-hour workweek is 1 ppm. Benzene is a known carcinogen; therefore, National Institute for Occupational Safety and Health (NIOSH) recommends that all workers wear respirators when they are likely to be exposed to benzene at levels exceeding the recommended (8-hour) exposure limit of 0.1 ppm.

4.3.2. Ethylbenzene

Ethylbenzene is an aromatic hydrocarbon that occurs naturally in petroleum and coal tar and also found in manufactured products such as inks, insecticides and paints. Ethylbenzene is a colorless, volatile liquid with an aromatic odor. It is a flammable and combustible liquid. Ethylbenzene is less dense than water and insoluble in water. Vapors are heavier than air and may travel to a source of ignition and flash back. Ethylbenzene may be present in the air, groundwater, soil sediment, and porewater.

Ethylbenzene has low acute and chronic toxicity for humans. It is toxic to the central nervous system and is an irritant of mucous membranes and eyes. The central nervous system is the primary target organ for toluene toxicity in both humans and animals for acute and chronic exposures.

4.3.3. Toluene

Toluene is a clear colorless liquid with a characteristic aromatic odor. Toluene is used in aviation and automotive fuel, as a solvent and to make other chemicals. It is less dense than water and insoluble in water. Toluene vapors are heavier than air. It is a flammable and combustible liquid.

Toluene vapors irritate eyes and upper respiratory tract, cause dizziness, headache and respiratory arrest. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested, causes vomiting, griping, diarrhea, and depressed respiration.

4.3.4. Polycyclic Aromatic Hydrocarbons (PAHs), Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs) as coal tar pitch volatiles

Carcinogenicity: PAHs are classifiable as human carcinogens.

Toxicity: Exposure routes include inhalation and skin and/or eye contact. Symptoms may include dermatitis and bronchitis. Short-term exposure to large amounts of benzo(a)pyrene, naphthalene and other PAHs can cause mild symptoms, or serious illness. Mild symptoms may include skin or eye irritation, headache, confusion, and blurry vision. Serious effects may include degenerative changes in the kidneys, liver, thymus, or spleen, dermatitis, or conjunctivitis. Several of the PAHs and some specific mixtures of PAHs are considered to be cancer-causing chemicals.

Environmental Fate and Transport: If released to air, PAHs can attach to dust particles. PAHs can be broken down by sunlight and other chemicals in the air over a period of days to weeks. PAHs do not dissolve easily in water and tend to stick to solid particles and settle to the bottoms of lakes and rivers where microorganisms can break them down over a period of weeks to months.

Odor Threshold: N/A

4.3.5. Benzo(a)

4.3.6. Arsenic (Inorganic)

Carcinogenicity: Arsenic is classified as a human carcinogen.

Toxicity: Exposure routes include inhalation, skin absorption, ingestion and skin and/or eye contact. Ingesting a large amount of arsenic may cause death. Exposure to lower levels can cause nausea, vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels and a sensation of 'pins and needles' in hands and feet. Skin contact with inorganic arsenic may cause redness and swelling.

Environmental Fate and Transport: If released to air, arsenic may get into water from runoff and leaching, ultimately ending up in soil or sediment. Rain and snow will remove arsenic dust particles from the air. Arsenic cannot be destroyed in the environment; it can only change in form.

Odor Threshold: N/A

Arsenic is a naturally occurring element. It is released into the air by volcanoes, the weathering of arsenic-containing minerals and ores, and by commercial or industrial processes. For most people, diet is the largest source of arsenic exposure, with usually smaller intakes from drinking water and air. Among foods, some of the highest levels are found in fish and shellfish; however, this arsenic exists primarily as organic compounds, which are essentially nontoxic. Inorganic arsenic compounds are the predominant forms in drinking water. Elevated levels of inorganic arsenic may be present in soil, either from natural mineral deposits or contamination from human activities, which may lead to dermal or ingestion exposure. Workers in metal smelters and nearby residents may be exposed to above-average inorganic arsenic levels from arsenic released into the air. Other sources of inorganic arsenic exposure include burning plywood treated with an arsenical wood preservative or dermal contact with wood treated with arsenic.

4.3.7. Historical Sampling

In general, site soil, sediment and groundwater have been characterized during multiple phases of environmental studies. The chemicals of concern for the GWPS include cPAHs, arsenic, naphthalene, total PAHs, benzene, ethylbenzene, toluene. Short-term exposure to large amounts of naphthalene and TPAH can cause mild symptoms, or serious illness. Mild symptoms may include skin or eye irritation, headache, confusion, and blurry vision. Serious effects may include degenerative changes in the kidneys, liver, thymus, or spleen; dermatitis; or conjunctivitis.

4.4. Biological Hazards and Procedures

Y/N	Hazard	Procedures
	Covid-19 virus	
	Poison Ivy or other vegetation	
Y	Insects	Work gloves and long sleeve shirt
Y	Hypodermic needles or other blood borne infectious disease transmission hazards	Do not pick up or contact, wear leather gloves and work boots in areas where needles may be present.
Y	Others: Blackberry bushes	Hard hat, gloves, and long sleeve shirt

4.5. Additional Hazards

Update in Daily Report. Include evaluation of:

- *Physical Hazards* (equipment hazards, tripping hazards, and others)
- *Chemical Hazards* (odors, spills, free product, airborne particulates, and others present)
- *Biological Hazards* (discarded needles, pollen, bees/wasps, and others present)

5.0 AIR MONITORING PLAN

Work upwind if possible.

Air monitoring will be performed during drilling and sampling activities (groundwater, soil, and sediment) using a photoionization detector (PID) before performing work at each area to measure background conditions. Air monitoring will be performed as necessary in the breathing zone during groundwater sampling activities. The PID will be used to measure parts per million (ppm) of organic vapors. If the PID registers a measurable concentration in the breathing zone, air monitoring frequencies and personal protection shall be modified per the "Air Monitoring Action Levels" table below.

Check instrumentation to be used:

__X__ Photoionization Detector ([PID] MiniRAE 3000 with 10.6 eV lamp or equivalent).

X Other (i.e., detector tubes): Benzene pre-filter tube_______________________________

______ ____________________

Check monitoring frequency/locations and type (specify: work space, borehole, breathing zone):

______ Continuous during sample collection

______ 15 minutes

______ 30 minutes

__X__ As needed in breathing zone during drilling and sampling activities

Additional personal air monitoring for specific chemical exposure:

5.1. Dust

Dust is not expected since the uplands are covered with grass, paving, or buildings. Dust is not expected to be generated during sediment sampling and handling activities. However, if activities generate visible dust, the Site Safety and Health Supervisor will be notified immediately to assess the need for air monitoring and lab analysis for inhalable and respirable particulates.

5.2. Action Levels

- The workspace (drilling and sampling activities (groundwater, soil, and sediment) will be monitored using a photoionization detector (PID) and lower-explosive-limit meter (LEL). These instruments must be properly maintained, calibrated, and charged (refer to the instrument manuals for details). Zero this meter in the same relative humidity as the area in which it will be used and allow at least a 10-minute warm-up prior to zeroing. Do not zero in a contaminated area. The PID can be tuned to read chemicals specifically if there are not multiple contaminants on-site. It can be tuned to detect one chemical with the response factor entered into the equipment, but the PID picks up all volatile organic compounds (VOCs) present. The ionization potential (IP) of the chemical must be less than the PID lamp (11.7 / 10.6eV), and the PID does not detect methane. The LEL meter will detect if explosive gases such as methane are present at concentrations approaching the LEL.

- If vapor concentrations exceed 1 ppm above background continuously for a 5 minute period as measured in the breathing zone, upgrade to Level C personal protective equipment (PPE) or move to a non-contaminated area.
- Note: Standard industrial hygiene/safety procedure is to require that action be taken to reduce worker exposure to organic vapors when vapor concentrations exceed one-half the threshold limit value (TLV). Because of the variety of chemicals, the PID will not indicate exposure to a specific PEL and is therefore not a preferred tool for determining worker exposure to chemicals. If odors are detected, then employees shall upgrade to respirators with Organic Vapor cartridges and will contact the Health and Safety Program Manager for other sampling options.

ACTION LEVEL TABLE FOR CHEMICAL MONITORING

Contaminant	Activity	Monitoring Device	Frequency of Monitoring Breathing Zone	Action Level	Action
Organic Vapors	Environmental and Geotechnical Investigations	PID	Start of shift; every 30 minutes during field activities. in event of odors, continuous monitoring will occur until a reading of 0.1 ppm or lower is held over 1 minute.	Background to 1 ppm in breathing zone	Use Level D or Modified Level D PPE
			Start of shift; every 30 minutes during field activities and in event of odors. In the event of a reading above 1ppm, continuous monitoring will occur to determine if levels have been raised consistently.	1 to 2 ppm in breathing zone inconsistently	Upgrade to Level C PPE
			Start of shift; every 30 minutes during field activities and in event of odors	> 2 ppm in breathing zone consistently over 1 minute of reading	Stop work and evacuate the area. Contact Health and Safety Manager for guidance.

Contaminant	Activity	Monitoring Device	Frequency of Monitoring Breathing Zone	Action Level	Action
Benzene	Environmental and Geotechnical Investigations	PID	Start of shift; hourly if necessary	Background to 0.5 ppm in breathing zone	Use Level D PPE
		PID	3 minutes sustained	0.5 ppm – 2.5 ppm in breathing zone	Use Level C PPE
		PID	3 minutes sustained	> 2.5 ppm in breathing zone	Stop work and evacuate the Site. Contact Health and Safety Manager for guidance.
Dust	Environmental and Geotechnical Investigations	NA	Continuous visual observation during soil disturbance activities	Visual observation of cloud dust	Implement dust control measures (approved wetting agents) and continue operations

6.0 SITE CONTROL PLAN

This section provides a Control Plan to minimize employee exposure to hazardous substances. In addition, this section addresses methods to delineate work zones and exclude non-site personnel, including pedestrians and park users.

6.1. Traffic or Vehicle Access Control Plans

Roads or parking areas are not present in the portions of the GWPS where the investigations will take place. No unauthorized vehicles will be allowed in the work area.

Sediment explorations will be completed on board a marine vessel. Outside personnel will not be allowed on the vessel.

6.2. Site Work Zones

As part of site control measures to protect the public and restrict access to drilling and hand auger operations and contaminated media in upland work area, exclusion zones will be established using traffic cones/candles and caution tape within a minimum of 10 feet around each boring or well during drilling/sampling. Only people with the appropriate training will enter this perimeter while work is being conducted there. The contractor will be responsible for providing and installing temporary site security measures including fencing, barricades etc. as necessary to maintain the exclusion zone for cordoning off the work area from the public.

Exclusion zones will be set up on the marine vessels and within 10 feet of the sample processing area during investigations in the sediment work areas.

Method of delineation / excluding non-site personnel (including pedestrians/park users)

X	Fence (secure IDW area only)
	Survey Tape
X	Traffic Cones
X	Other: Caution Tape

A contamination reduction zone will be established just outside the exclusion zone for the decontamination of sampling equipment. Care will be taken to prevent the spread of contamination.

6.3. Buddy System

Personnel on-site should use the buddy system (pairs), particularly whenever communication is restricted. If only one GeoEngineers employee is on-site, a buddy system can be arranged with subcontractor/ contractor personnel.

6.4. Site Communication Plan

Positive communications (within sight and hearing distance or via radio) should be maintained between pairs on-site, with the pair remaining in proximity to assist each other in case of emergencies. The team should prearrange hand signals or other emergency signals for communication when voice communication becomes impaired (including cases of lack of radios or radio breakdown). In these instances, you should consider suspending work until communication can be restored; if not, the following are some examples for communication:

1. Hand gripping throat: Out of air, can't breathe.
2. Gripping partner's wrist or placing both hands around waist: Leave area immediately, no debate.
3. Hands on top of head: Need assistance.
4. Thumbs up: Okay, I'm all right: or I understand.
5. Thumbs down: No, negative.

6.5. Emergency Action

In the event of an emergency, employees with convene in a designated area Identified on the Job Hazard Analyses Form (JHA) Form 4. Employees should communicate with others working on site and the PM to determine the Emergency Action Plan for each site. All personnel from GeoEngineers and subcontractor(s) should be made aware of the Emergency Action for the site at each morning's safety tailgate meeting (drill rig shutoff switch, location of fire extinguishers, cell phone numbers, etc.). For medical assistance, see Section 3.0 above.

6.6. Decontamination Procedures

Decontamination, at a minimum, should include removing and disposing of PPE when exiting the exclusion zone and washing your hands. Decontamination may also consist of removing outer protective gloves and washing soiled boots and gloves using bucket and brush provided on-site in the contamination reduction zone. If needed, inner gloves will then be removed, and respirator, hands and face will be washed in either a portable wash station or a bathroom facility at the site. Employees will perform decontamination procedures and wash before eating, drinking, or leaving the site. Equipment that comes in contact with contaminated material will be decontaminated prior to leaving the Site.

The following types of equipment will be available to perform decontamination activities:

- Scrub brushes;
- Spray rinse applicator;
- Plastic garbage bags; and
- Container of Alconox/water solution and Alconox powder.

6.7. Waste Disposal or Storage

Incidental waste including used PPE is to be placed in a plastic bag for disposal. Investigation derived waste (IDW) will be placed in 35/55-gallon drums and stored on site in a secure location pending characterization and disposal.

7.0 PERSONAL PROTECTIVE EQUIPMENT

PPE will consist of standard Level D equipment.

- Level D PPE unless a higher level of protection is required will be worn at all times on the site. Level D PPE includes steel-toed boots, outdoor work clothing, hard hat, safety glasses, safety vest, gloves, and hearing protection as needed. Potentially exposed personnel will wash gloves, hands, face and other pertinent items to prevent hand-to-mouth contact. This will be done prior to hand-to-mouth activities including eating, smoking, etc.
- Adequate personnel and equipment decontamination will be used to decrease potential ingestion and inhalation.

Air monitoring will be conducted to determine the level of respiratory protection.

- Half-face combination organic vapor/high efficiency particulate air (HEPA) or P100 cartridge respirators will be available on-site to be used as necessary. P100 cartridges are to be used only if PID measurements are below the site action limit. P100 cartridges are used for protection against dust, metals and asbestos, while the combination organic vapor/HEPA cartridges are protective against both dust and vapor. Ensure that the PID or TLV will detect the chemicals of concern on-site.

Check applicable personal protection gear to be used:

X	Hardhat (if overhead hazards, or client requests)
X	Steel-toed boots (if crushing hazards are a potential or if client requests)
X	Safety glasses (if dust, particles, or other hazards are present or client requests)
X	Hearing protection (if it is difficult to carry on a conversation 3 feet away)
	Chemical resistant boots or boot covers
X	Life Jackets (for work near/over water)

Gloves (specify):

X	Nitrile
X	Latex
	Liners
X	Leather (if working near hypodermic needles)

Protective clothing:

	Tyvek (if dry conditions are encountered, Tyvek is sufficient) (modified Level D or Level C)
	Saranex (personnel shall use Saranex if liquids are handled, or splash may be an issue) (modified Level D or Level C)
X	Cotton (Level D)
X	Rain gear (as needed) (Level D)
X	Layered warm clothing (as needed) (Level D)

Inhalation hazard protection:

X	Level D (no respirator)
X	Level C (respirators with organic vapor/HEPA or P100 filters) – only if needed as indicated by air monitoring)

7.1. Personal Protective Equipment Inspections

PPE clothing ensembles designated for use during site activities shall be selected to provide protection against known or anticipated hazards. However, no protective garment, glove or boot is entirely chemical-resistant, nor does any PPE provide protection against all types of hazards. To obtain optimum performance from PPE, site personnel shall be trained in the proper use and inspection of PPE. This training shall include the following:

- Inspect PPE before and during use for imperfect seams, non-uniform coatings, tears, poorly functioning closures or other defects. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone and replace the PPE.
- Inspect PPE during use for visible signs of chemical permeation such as swelling, discoloration, stiffness, brittleness, cracks, tears, or other signs of punctures. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone, and replace the PPE.
- Disposable PPE should not be reused after breaks unless it has been properly decontaminated.

7.2. Respirator Selection, Use and Maintenance

If respirators are required, site personnel shall be trained before use on the proper use, maintenance, and limitations of respirators. Additionally, they must be medically qualified to wear respiratory protection in accordance with 29 CFR 1910.134. Site personnel who will use a tight-fitting respirator must have passed a qualitative or quantitative fit test conducted in accordance with an OSHA-accepted fit test protocol. Fit testing must be repeated annually or whenever a new type of respirator is used. Respirators will be stored in a protective container.

7.2.1. Respirator Cartridges

If the action levels identified in the Air Monitoring Action Levels Table in Section 5.0, are exceeded, Site personnel should don respiratory protection appropriate for the known or suspected chemical of concern.

For most sites, a half-face or full-face air purifying respirator with a National Institute for Occupational Safety and Health (NIOSH)-approved organic vapor/HEPA P100 combination cartridge (Level C), will be appropriate for the known or suspected chemicals of concern. Monitoring frequency should be continuous while using Level C respiratory protection. The SSO closely monitor personnel using respiratory protection, including observing for signs of fatigue or respiratory distress, the potential for cartridge breakthrough or increased resistance to inhalation, and the need for changes in the level of respiratory protection based on air monitoring. The frequency and duration of breaks should be increased for personnel working in respiratory protection. If at any time on-Site air monitoring indicates Level B respiratory protection is warranted, personnel should leave the exclusion zone and consult with the HSM.

If site personnel are required to wear air-purifying respirators, the appropriate cartridges shall be selected to protect personnel from known or anticipated site contaminants. The respirator/cartridge combination shall be certified and approved by NIOSH. A cartridge change-out schedule shall be developed based on known site contaminants, anticipated contaminant concentrations and data supplied by the cartridge manufacturer related to the absorption capacity of the cartridge for specific contaminants. Site personnel shall be made aware of the cartridge change-out schedule prior to the initiation of site activities. Site personnel shall also be instructed to change respirator cartridges if they detect increased resistance during inhalation or detect vapor breakthrough by smell, taste or feel, although breakthrough is not an acceptable method of determining the change-out schedule.

7.2.2. Respirator Inspection and Cleaning

The Site Safety and Health Supervisor shall periodically (weekly) inspect respirators at the project site. Site personnel shall inspect respirators prior to each use in accordance with the manufacturer's instructions. In addition, site personnel wearing a tight-fitting respirator shall perform a positive and negative pressure user seal check each time the respirator is put on, to ensure proper fit and function. User seal checks shall be performed in accordance with the GeoEngineers respiratory protection program or the respirator manufacturer's instructions.

7.2.3. Facial Hair and Corrective Lenses

Site personnel with facial hair that interferes with the sealing surface of a respirator shall not be permitted to wear respiratory protection or work in areas where respiratory protection is required. Normal eyeglasses cannot be worn under full-face respirators because the temple bars interfere with the sealing surface of the respirator. Site personnel requiring corrective lenses will be provided with spectacle inserts designed for use with full-face respirators. Contact lenses should not be worn with respiratory protection.

8.0 BOAT, OVER WATER AND NEAR WATER SAFETY PROGRAM

Use of a boat for work requires safe boating practices, good equipment, and training. These procedures are not meant to replace the safety manuals that are provided by the U.S. Coast Guard. Instead, they should highlight some of the areas of concern and address specific GeoEngineers, Inc. work procedures. While working near water that is over waist deep or while on a boat, use a Coast Guard approved flotation device. Remember that being submerged in water increases the chance of hypothermia. Have a dry set of clothes and work with a buddy if you are working around water. If an employee is required to work in the water, they will wear appropriate gear including a wet suit or dry suit, if necessary, for safe accomplishment of the task.

The U.S. Coast Guard's Federal Requirements state, “All recreational boats must carry one wearable personal floatation device (PFD) (Type I, II, II, or Type V) for each person aboard… [and that] any boat 16 feet and longer (except canoes and kayaks) must also carry one throwable Type IV PFD.”

GeoEngineers’ Insurance for working over water is covered under the United States Longshore and Harbor Workers Compensation Act (USL&H) policy (worker’s comp over water) and is not specific to the individuals participating.

For work on barges or boats or areas near water that have an OSHA standard height and strength guardrail, PFDs are not required while working behind the guardrail. The access to the barge or near water area also requires that the gangway be protected by guardrails. Fall protection rules can be utilized on projects where employees are not within 6 feet of a leading edge and there is no risk of falling in the water.

8.1. Regulatory References

When working near water, over water or on a barge, OSHA has authority. The U.S. Coast Guard has authority 12 miles offshore and until international waters.

Life Jackets ~ Employees wear Coast Guard Approved vests that meet the water conditions (see Section 9.4.2.5). Employees can wear the self-inflating vests.

This safety program is based on the following state and federal regulations:

- OSHA 1926.106 Working over or near water; 1926.605 Marine operations and equipment; Access to vessels 1915.74 and Access to barges and river towboats 1918.26 (Idaho, Missouri)
- WAC 296-800-160 Personal Protective Equipment for PFD (Washington)
- OR-OSHA 1926 (Oregon)
- AAC Title 8 (Alaska)
- HIOSH Title 12 (Hawaii)
- Cal/OSHA Title 8 (California)

8.2. Procedures for Using Boats

Two people will be involved with the use of the boat. The boat operator should always plan a course of travel that is the safest and minimizes the distance to the shore. As a general courtesy, the boat should be cleaned up by the user after each day. Note that for this project the research vessel used for sediment sampling will be subcontracted and the subcontractor shall operate the boat and sampling device(s).

8.2.1. Maneuvering a Boat

- To move boat from dock, move stern away then bow (but not into waves or wind)
- Try not to depend on fendering, slow down
- Communicate with other person in boat when:
    - increase or decrease speed
    - dramatically change direction
    - approach pilings so hands can come inside boat

8.2.2. Right-of-Way

- Watch out for ferry traffic-- large vessels have right of way and cannot stop
  - Don't cut them off, they move much faster than they appear to. If the boat breaks down in a ferry lane, use radio, flares, and wave and make sure they see you until help arrives.
- Larger vessels have right of way over smaller vessels.
- With boats of similar size, sailboats have right of way.
- When lights are visible, green has the right of way over red.

8.2.3. Load Limits

Cargo should be evenly distributed and there should be a safe amount of freeboard which depends on water conditions. When loading up the boat for travel that goes beyond the protection of the pier, the employee should drive to the end of the pier and check wave conditions before entering.

8.2.4. Engine Use

When using an outboard motor, the boat operator will use the tether kill switch. This will hook to the employee's wrist and turn off the engine if the employee were to be launched into the water.

8.2.5. Personal Floatation Device (PFD)

Type 1 PFDs will be worn in the boats at all times. PFD will be the correct size for the wearer and will be securely fastened. The PFD should be inspected for damage prior to each use.

In water with PFD -- to reduce water from lowering body temperature:

- One person: cross arms pull knees up
- Two persons: huddle together

The ability to swim more than 100 yards is not very good, so the best strategy is to stay with the boat. The boat should always be closer to shore than this distance during transport if allowable, where the employee would be close enough to swim to shore, if able.

8.2.6. Throwing Lines Off the Vessel

- Make first two coils larger
- Kneel in boat
- Shoulder pointed to victim
- Throw over their head

8.2.7. Water on Board

- A 5-gallon bucket will always be available on the boat to bale water that comes inside the boat.

8.2.8. Towing

- Take time to set up

- Look at lines
- Stay in step with waves
- Don’t overstress lines
- Don’t shock load lines
- Sea anchor – can use to slow down tow, make it more controllable. For some situations, a sea anchor is not necessary and could make things worse.

8.2.9. Safety and Signals

- Horn blasts: 5 short signals danger
- Lights: Employees will not be traveling at the work area in the dark. If it becomes dark while working, the operator will moor the boat at the work area for the night. A flashlight will be available in the waterproof box stored in the workboat.

8.3. Barge or Platform Procedures

Any work within 6 feet of a leading edge will require a life jacket if water is below the leading edge. Railings must be present if a leading edge is above a hard surface. Refer to GeoEngineers’ Fall Protection Program for additional details.

Employees shall not be permitted to walk along the sides of covered lighters or barges with coamings more than 5 feet high, unless there is a 3-foot clear walkway, or a grab rail, or a taut hand line is provided. (Coaming is any vertical surface on a ship designed to deflect or prevent entry of water. It usually refers to raised section of deck plating around an opening, such as a hatch. Coamings also provide a frame onto which to fit a hatch cover.)

Employees shall not be permitted to walk over deck loads from rail to coaming unless there is a safe passage. If it is necessary to stand at the outboard or inboard edge of the deck load where less than 24 inches of bulwark, rail, coaming, or other protection exists, all employees shall be provided with a suitable means of protection against falling from the deck load.

The SSO shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch life ring with not less than 90 feet of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that the employee is working the barge.

Whenever practicable, a gangway of not less than 20 inches walking surface of adequate strength, maintained in safe repair and safely secured shall be used. If a gangway is not practicable, a substantial straight ladder, extending at least 36 inches above the upper landing surface and adequately secured against shifting or slipping shall be provided. When conditions are such that neither a gangway nor a straight ladder can be used, a Jacob's ladder meeting the requirements of paragraphs (d)(1) and (2) of this section may be used.

8.3.1. Cranes/Hoists/Cables

Employees need to use caution when working in areas where cranes, hoists and cables are in use. Refer to the GeoEngineers' Drilling and Rigging Safety Program.

8.4. Working Near Water Procedures

GeoEngineers' employees working over or near water, where the danger of drowning exists, shall be provided with U.S. Coast Guard-approved life jacket or buoyant work vests.

Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.

Ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.

At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.

8.5. Emergency Procedures

The following topics are items that are important for handling an emergency. The boat operator should know these procedures and follow them at all times.

8.5.1. Communication

A Marine Radio will be with the boat operator at all times. Before entering the boat, the operator will call in to the Dispatcher and notify them of the location and destination of the boat. Each time an employee enters or exits the boat, this will be recorded by the Dispatcher. This contact should occur at departure and arrival for long transits.

8.5.2. Engine Problems

In the event of engine problems, contact the Dispatcher and notify them of the situation immediately. Depending on the situation, a rescue could be dispatched by the Coast Guard, another employee or a contractor. If a repair is made in the interim while waiting for the tow, call the Dispatcher again and notify them of the situation.

Spare plugs will be in the waterproof kit for offshore engine problems only. The boat operator will be required to take a spare tank and line for fuel, thus eliminating the need for spare line.

8.5.3. Distress Flares

Are located in the waterproof boxes that the boat operator needs to ensure are on the boat before each travel session. Boat operators should also make sure that they are familiar with the operation of these flares.

8.5.4. Person Overboard/Rescue

Boat operators should be familiar with in-water rescue techniques. The Coast Guard recommends that people not try to swim long distances to shore but wait for a rescue. This is because of hypothermia. Please see the section on "Personal Floatation Devices." Access back into the boat will be from the stern. The engine will be turned off while the employee re-enters the boat.

8.5.5. Fire

Each workboat will be equipped with a 5 lb. ABC fire extinguisher located near the bow. The fire extinguisher should be checked each time the boat is used to ensure that it is ready to operate.

8.5.6. Work Related Injuries

Work-related injuries that are not threatening to the safety of the persons on board should be reported to the Supervisor as soon as possible. Any work-related injury that impairs operation of the boat should be called in to the GeoEngineers' office immediately. The office will call for the Coast Guard and or the Fire Department in the event of a serious injury.

8.6. Weather/Tides

8.6.1. Fog

If the visibility is very low due to fog, the operator will not take the boat out. In fog, employees will stay within sight of the shoreline and/or head in and tie up.

8.6.2. Rough Water

- Look for protection from oncoming wind/waves. Can be the leeward side of a boat, dock, or pier
- Head into swells, throttle up when approaching, throttle down when dropping down
- Check wave conditions before taking the boat out
- Head in at 45-degree angle at times, depending on wave size

8.7. List of Supplies

In addition to the list of supplies generated in the training at the MTC, the U.S. Coast Guard identified the following items to be critical for safe boating (applicable if small boats are necessary for completing the work activities).

<u>Items to be stored with the boat at all times:</u>

- Oars and oarlocks
- Anchor
- Bucket for baling water
- Fire Extinguisher
- One spare fuel tank and line

<u>Items that will be brought onto the boat when in use</u>:

- Marine radio
- Watertight box with first aid kit, flashlight, flares
- Personal Floatation Device(s)
- Carry a knife with serrated edge
- Tide book
- Spare plugs and wrench

8.8. Personal Floatation Device Specifications

PFD use applies to terminals and piers and employees working near other bodies of water. It also applies to all activities conducted by GeoEngineers employees at these facilities, including construction, maintenance, inspections, tours, and operations. Type 1 PFDs will be worn in the boats at all times. PFD will be the correct size for the wearer and will be securely fastened. The PFD should be inspected for damage prior to each use. Boats longer than 16 feet must carry at least one Type I, II, III, or V PFD for each person on board.

In addition, at least one Type IV (throwable device) must be carried. This is important, you may not use a Type IV "flotation cushion" as your sole PFD in your small rowboat or sailing dingy. Note: If a Type V device is used to count toward requirements, it must be worn. Federal regulations require PFDs on canoes and kayaks of any size; they are not required on racing shells, rowing skulls, or racing kayaks. State laws may vary.

PFDs are required for:

- Any employee in a boat/skiff/barge,
- Any employee is working on top of, or beyond the bull rail (a railing for docking the boat), or
- Employees working near water where the danger of drowning exists.

PFDs are not specifically required when:

- Employees are working behind standard height and strength guardrails.
- Employees are working inside operating cabs or stations that eliminate the possibility of accidentally falling into the water.
- Employees are wearing an approved safety harness with a lifeline attached that prevents the possibility of accidentally falling into the water.
- Working behind a guardrail of standard height and strength or other stable restraint.
- A single person is working more than 6 feet from the edge.
- Working over shallow water (less than chest deep) where floatation would not be achieved (other protective measures required).

Provide your employees with PFDs approved by the U.S. Coast Guard for use on commercial or merchant vessels. The following are appropriate or allowable United States Coast Guard-approved PFDs:

Type of PFD	General Description
Type I	Off-Shore Life Jacket-effective for all waters or where rescue may be delayed.
Type II	Near-Shore Buoyant Vest- intended for calm, inland water or where there is a good chance of quick rescue.
Type III	Flotation aid- good for calm, inland water, or where there is a good chance of rescue.
Type V	Flotation aids such as boardsailing vests, deck suits, work vests and inflatable PFDs marked for commercial use.

8.8.1. Off-Shore Life Jacket (Type I PFD)

Best for open, rough, or remote water, where rescue may be slow coming.

- Advantages
  - Floats person the best.
  - Turns most unconscious wearers face-up in water.
  - Highly visible color.
- Disadvantages
  - Bulky.

8.8.2. Near-Shore Buoyant Vest (Type II PFD)

Good for calm, inland water, or where there is good chance for fast rescue.

- Advantages
  - Turns some unconscious wearers face-up in water.
  - Less bulky, more comfortable than Off-Shore Life Jacket (Type I PFD).
  - Compromise between Type I PFD performance and wearer comfort.
- Disadvantages
  - May be uncomfortable wearing for extended periods.
  - Will not turn as many people face-up as a Type I PFD will.
  - In rough water, a wearer's face may often be covered by waves.
  - Not for extended survival in rough water.

8.8.3. Flotation Aid (Type III PFD)

Good for calm, inland water, or where there is good chance of fast rescue.

- Advantages
  - Generally, the most comfortable type for continuous wear.
  - Freedom of movement for water skiing, small boat sailing, fishing, etc.
  - Available in many styles, including vests and flotation coats.
- Disadvantages
  - Not for rough water.
  - Wearers may have to tilt head back to avoid face-down position in water.

Inflatable PFDs come in Types I, II, and III. Although the different “Types” of inflatable PFDs are intended for use in the same areas as inherently buoyant types of PFDs, the characteristics of inflatable PFDs are different. Inflatable PFDs are not inherently buoyant and will not float without inflation. For Types I, II, and III inflatables, the lower the Type number, the better the PFDs performance (e.g., Type I is better than Type II).

Although inflatable PFDs are considered one of the most comfortable PFDs to wear when it is hot, inflatable PFDs require regular maintenance and are not recommended for children or individuals who can't swim. Inflatable PFDs are not for use where water impact is expected as when waterskiing, riding personal watercraft, or whitewater paddling.

8.9. Training

8.9.1. Personnel Using Boats

Each state has specific boat training requirements. In addition, the U.S. Coast Guard can also be contacted for local training opportunities. All GeoEngineers employees operating a boat should have documented training.

The topics are copied from the Basic Use section of these Policy and Procedure Training materials provided by MTC are available from the Health and Safety Program Manager to use as a guide for additional training.

- Boat safety
- Boat operations, maneuvering (hands on)
- Towing
- Communications
- Emergency situations
- Rescue (hands on)
- Use of ropes (hands on)

8.9.2. Personnel Working Over or Near Water

GeoEngineers employees working over or near water should be trained in the contents of the Boat, Over Water and Near Water Safety Program. At the start of each project in which working over or near water presents a danger of drowning employees should have a tailgate safety meeting and discuss the following:

- The danger of drowning where it exists.
- Use of U.S. Coast Guard-approved life jacket or buoyant work vests.
- Life jacket or buoyant work vests inspections.
- Location of ring buoys for emergency rescue operations.
- Location of a lifesaving skiff for rescue if needed.

9.0 ADDITIONAL ELEMENTS

9.1. Cold Stress Prevention

Working in cold environments presents many hazards to site personnel and can result in frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature).

The combination of wind and cold temperatures increases the degree of cold stress experienced by site personnel. Site personnel shall be trained on the signs and symptoms of cold-related illnesses, how the human body adapts to cold environments, and how to prevent the onset of cold-related illnesses. Heated break areas and warm beverages shall be provided during periods of cold weather.

9.2. Heat Stress Prevention

State and federal OSHA regulations provide specific requirements for handling employee exposure to heat stress. GeoEngineers' program complies with these requirements and will be implemented in all areas where heat stress is identified as a potential health issue.

General requirements for preventing heat stress apply to outdoor work environments from May 1 through September 30, annually, only when employees are exposed to outdoor heat at or above an applicable temperature listed in the table below. To determine which temperature applies to each worksite, select the temperature associated with the general type of clothing or personal protective equipment (PPE) each employee is required to wear.

HEAT STRESS

Type of Clothing	Outdoor Temperature Action Levels (Degrees Fahrenheit)
Nonbreathing clothes including vapor barrier clothing or PPE such as chemical resistant suits	52°
Double-layer woven clothes including coveralls, jackets and sweatshirts	77°
All other clothing	89°

9.2.1. Minimize Exposure to Extreme Temperatures

Where acceptable temperatures cannot be maintained, all outdoor work should be scheduled so as to minimize exposure to extreme temperatures.

9.2.2. Monitoring

The temperature and conditions in the work area should be monitored by supervisory personnel.

9.2.3. Appropriate Dress

Employees are required to dress appropriately for the relevant working conditions, including normal weather extremes. Limiting the time of exposure and wearing protective clothing will reduce the dangers of exposure to heat. Clothing should:

- Be constructed of an absorbent, close-weave material that doesn't allow penetration of sunlight; and
- Be worn in light layers that can be adjusted for comfort.

9.2.4. Preventive Measures for Working Outdoors

The following measures are to be implemented to protect employees working outdoors:

- Use of a range of sunscreens (with high protection factor) that are persistent on the skin irrespective of humidity and perspiration.
- Encouragement of the application of sunscreen 15 minutes prior to exposure.
- Encouragement of regular re-application of sunscreen throughout the day.
- Use of safety sunglasses (where lighting is not an issue).

9.2.5. Rest Breaks

When cooling down is required, employees shall take rest breaks in a shaded or cooled area.

9.2.6. Drinking Water

Ensure an adequate supply of cool drinking water for the employees to replace water lost through perspiration. It is essential that water intake be approximately equal to the amount of sweat produced to avoid dehydration. Most workers exposed to hot conditions drink fewer fluids than needed because of an insufficient thirst drive. A worker, therefore, should not depend on thirst to signal when and how much to drink.

- Fluids shall be replaced approximately every 20 minutes in amounts of at least one gallon per day.
- Water shall be kept cool throughout the operation.
- Electrolyte replacement shall be in the form of a commercial electrolyte replacement drink (that is, Gatorade or equivalent).
- Avoid alcohol and caffeine (including coffee and tea), which contribute to dehydration.

9.2.7. Air Conditioning

Minimize humidity in the work environment to improve sweat evaporation from the surface of the skin. This can be accomplished by air conditioning or dehumidification. Cooling by the evaporation of sweat lets the body reduce its temperature; evaporation proceeds more quickly, and the cooling effect is more pronounced within increasing air speed and low relative humidity. When possible, vehicle and work areas should be equipped with air conditioning.

9.2.8. Reduce Physical Demands

Increasing work during high temperatures can add stress to the body. Reduce physical demands of work task when possible, through mechanical means such as hoists, hand trucks, lift-tables etc.

9.2.9. Steps to Prevent Heat Stress

Steps to help prevent heat stress include:

- Consider a worker's physical condition when determining fitness to work in hot environments. Obesity, lack of conditioning, pregnancy and inadequate rest can increase susceptibility to heat stress.
- Certain medical conditions (such as heart conditions) or treatments (such as low-sodium diets and some medications) increase the risk from heat exposure.
- Seek medical advice when symptoms of heat stress appear.

- Schedule strenuous physical activity at the beginning and end of the day when external temperatures may be cooler.
- Provide portable water sprayers so that employees can cool down skin surfaces.
- Provide whole-body cooling devices such as ice vests with frozen packs or recirculation systems.

10.0 MISCELLANEOUS

10.1. Emergency Response

Indicate what site-specific procedures you will implement.

- Personnel on-site should use the “buddy system” (pairs).
- Visual contact should be maintained between “pairs” on-site, with the team remaining in proximity to assist each other in case of emergencies.
- If any member of the field crew experiences any adverse exposure symptoms while on-site, the entire field crew should immediately halt work and act according to the instructions provided by the Site Safety and Health Supervisor.
- The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team, contact of the PM, and reevaluation of the hazard and the level of protection required.
- If an accident occurs, the Site Safety and Health Supervisor and the injured person are to complete, within 24 hours, an Accident Report for submittal to the PM, the Health and Safety Program Manager and Human Resources. The PM should ensure that follow-up action is taken to correct the situation that caused the accident or exposure.

10.2. Personnel Medical Surveillance

GeoEngineers employees are not in a medical surveillance program because they do not fall into the category of “Employees Covered” in OSHA 1910.120(f)(2), which states a medical surveillance program is required for the following employees:

1. All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year;
2. All employees who wear a respirator for 30 days or more a year or as required by state and federal regulations;
3. All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and
4. Members of HAZMAT teams.

10.3. Spill Containment Plans (Drum and Container Handling)

Site topography in the upland investigation area is generally flat to the north and gently slopes towards the lake to the south. Within the upland work area, surface water may flow toward the south. If investigation-related fluids are spilled from upland and sediment areas, the area should be identified and noted in the field report. If a significant volume of fluid is spilled, absorbent should be used for the spill area and the project manager contacted. Spent absorbent material will need to be stored in suitable drums within the designated containment area, which will be enclosed by fencing.

10.4. Sampling, Managing and Handling Drums and Containers

Drums and containers used during the cleanup shall meet the appropriate Department of Transportation (DOT), OSHA and EPA regulations for the waste that they contain. Site operations shall be organized to minimize the amount of drum or container movement. When practicable, drums and containers shall be inspected, and their integrity shall be ensured before they are moved. Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled. Before the drums or containers are moved, all employees involved in the transfer operation shall be warned of the potential hazards associated with the contents.

Drums or containers and suitable quantities of proper absorbent should be kept available and used where spills, leaks or rupture may occur. Where major spills may occur, a spill containment program shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred. Fire extinguishing equipment shall be on hand and ready for use to control incipient fires.

10.5. Sanitation

Public washrooms are present in the northern portion of Gas Works Park (immediately northwest of the Play Barn). Water should be available in the decontamination area for washing.

10.6. Lighting

Investigation activities are expected to be conducted during daylight hours. However, in the event that work must occur early or late in the day, the contractor will be required to provide adequate artificial lighting to safely perform investigation activities.

11.0 DOCUMENTATION TO BE COMPLETED FOR HAZWOPER PROJECTS

- Daily Field Log
- FORM 1 - Health and Safety Briefing
- FORM 2 – Site Safety Plan – GeoEngineers' Employee Acknowledgement
- FORM 3 – Subcontractor and Site Visitor Site Safety From
- FORM 4 – Job Hazard Analyses (JHA) Form
- FORM 5 – Accident/Exposure Report Form

NOTE: The Field Report is to contain the following information:

- Updates on hazard assessments, field decisions, conversations with subcontractors, client or other parties, etc.;

- Air monitoring/calibration results, including personnel, locations monitored, activity at the time of monitoring, etc.;
- Actions taken;
- Action level for upgrading PPE and rationale; and
- Meteorological conditions (temperature, wind direction, wind speed, humidity, rain, snow, etc.).

12.0 APPROVALS

1. Plan Prepared	Shashi Shankar Preparer	February 26, 2024 Date
2. Plan Approval	Neil Morton Project Manager	February 26, 2024 Date
3. Health & Safety Officer	Connor Jordan Health & Safety Specialist	February 26, 2024 Date

HASP FORM 1
HEALTH AND SAFETY BRIEFING
GAS WORKS PARK SITE - PRDI INVESTIGATION
FILE NO. 0186-846-04

Inform employees, contractors and subcontractors or their representatives about:

- The nature, level, and degree of exposure to hazardous substances they're likely to encounter;
- Emergency response procedures; and
- Any identified potential fire, explosion, or other health or safety hazards, and associated safe work practices.

Conduct briefings for employees, contractors and subcontractors, or their representatives as follows:

- A pre-entry briefing before any Site activity is started.
- Additional briefings, as needed, to make sure that the Site-specific HASP is followed.
- Make sure that employees working on the Site are informed of any risks identified and trained on how to protect themselves and other workers against the Site hazards and risks.
- Update information to reflect current sight activities and hazards.
- Personnel participating in this project must receive initial health and safety orientation. Thereafter, brief tailgate safety meetings will be held as deemed necessary by the Site Safety Officer.
- The orientation and the tailgate safety meetings shall include a discussion of emergency response, Site communications and Site hazards.

Date	Topics	Attendee	Company Name	Employee Initials

HASP FORM 2
SITE SAFETY PLAN – GEOENGINEERS' EMPLOYEE ACKNOWLEDGMENT
GAS WORKS PARK SITE - PRDI INVESTIGATION
FILE NO. 0186-846-04

(All GeoEngineers' Site workers shall complete this form, which should remain attached to the Safety Plan and filed with other project documentation).

I hereby verify that a copy of the current Safety Plan has been provided by GeoEngineers, Inc., for my review and personal use. I have read the document completely and acknowledge an understanding of the safety procedures and protocol for my responsibilities on Site. I agree to comply with all required specified safety regulations and procedures.

Print Name	Signature	Date

HASP FORM 3
SUBCONTRACTOR AND SITE VISITOR SITE SAFETY FORM
GAS WORKS PARK SITE - PRDI INVESTIGATION
FILE NO. 0186-846-04

Please be advised that this Site-specific HASP is intended for use by GeoEngineers employees only. Nothing herein shall be construed as granting rights to GeoEngineers' subcontractors or any other contractors working on this Site to use or legally rely on this HASP. GeoEngineers specifically disclaims any responsibility for the health and safety of any person not employed by the company.

I verify that a copy of the current Site Safety Plan has been provided by GeoEngineers, Inc. to inform me of the hazardous substances on Site and to provide safety procedures and protocols that will be used by GeoEngineers' staff at the Site. By signing below, I agree that the safety of my employees is the responsibility of the undersigned company.

Print Name	Signature	Firm	Date

FORM 4
JOB HAZARD ANALYSES (JHA) FORM
GAS WORKS PARK SITE, PRDI INVESTIGATION
FILE NO. 0186-846-04

This form can be used for analyses of daily hazards where there are multiple tasks and ongoing projects and for record keeping purposes. Make copies as needed.

Project: PRDI Investigation, Gas Works Park Site **File No:** 0186-846-04	**Date:** date	**Site Location:** Seattle, WA

Development Team:	**Position/Title:**	**Reviewed by:**	**Position/Title:**
Name	Field Representative	Name	Project Manager
		Connor Jordan	Health and Safety Specialist

Minimum Required Protective Equipment: (see critical actions for task-specific requirements)

PPE	**Equipment**	**Tools**	**Actions**
☒ Hard Hat	☐ Safety Beacons	☒ Cell/Satellite Phone	☒ Stay Visible
☒ High Visibility Vest	☒ Safety Cones	☒ Digital Camera	☒ Equipment Inspection
☒ Safety Shoes/Waders	☒ First Aid Kit	☐ iPad	☒ Work in Pairs
☒ Gloves	☒ Fire Extinguisher	☐	☒ Safety Control/Traffic Plan
☒ Safety Glasses	☐ Eye Wash/ Drinking Water	☐	☐

Job Steps	**Potential Hazards**	**Critical Actions to Mitigate Hazards**
Pre-Job Activities	Example: Unfamiliar locations, congestion, unpaved roads, Mechanical Failure, Flat Tires Vehicle Fire, Exhaust Leaks, Vehicle Collision, Internal Projectiles	■ Inspect the vehicle before departure: ▪ Check for tire cuts, fluid leaks, flat tires, body damage, windshield cracks, and other damage. ▪ Check lights, wipers, fluid levels, and seat belts. ■ Study the area maps, photos and use GPS. ■ Identify the safest spot to park field vehicles.

Job Steps	Potential Hazards	Critical Actions to Mitigate Hazards
Driving to Site location (Highway Driving)	Unfamiliar road, Mechanical Failure, Flat Tires, Vehicle Fire, Vehicle Collision.	■ Use only vehicles appropriate for the work needs and the driving conditions expected. ■ Ensure the vehicle has a complete and current first aid kit and fire extinguisher. ■ Place heavy objects behind a secure safety cage if they must be carried in a passenger compartment. ■ Use parking brake, and don't leave vehicle unattended while it is running. ■ Ensure vehicle has fuel to get to and from your destinations. ■ Inform your Project Manager of your destination and estimated time of return. ■ Carry extra food, water, and clothing. ■ Drive defensively.
Familiarize crew with the task and location of Site	Crew does not notify site owner / manager. Unaware of the job site hazards and steps to prevent injury. Appropriate personnel protective equipment not worn.	■ Conduct a tailgate safety meeting discussing the jobs, the hazards and actions that will be taken to prevent injury. ■ Discuss "Stop Work Authority" as it applies to each Site member. ■ Discuss appropriate PPE including high visibility clothing such as reflective vest. ■ Notify attendant and/or Site owner/manager of work activities and location. ■ Set up exclusion zone surrounding work area.

Job Steps	Potential Hazards	Critical Actions to Mitigate Hazards
Heavy Equipment Movement	Pre-Job Activities	■ Conduct a tailgate safety meeting discussing the jobs, the hazards and actions that will be taken to prevent injury. ■ Discuss "Stop Work Authority" as it applies to each Site member. ■ Discuss appropriate PPE including high visibility clothing such as reflective vest. ■ Notify attendant and/or Site owner/manager of work activities and location. ■ Set up exclusion zone surrounding work area.
Travel on Foot	Falls, foot injuries, stress and impact injuries	■ Identify & use safe travel routes. Don't exceed physical abilities/equipment design. ■ Use pack equipment properly. Carry weight on hips, not back. ■ Test and use secure footing. Move cautiously and deliberately. Never run. ■ Take extra precautions when encountering steep, loose, wet conditions. ■ Take slow deliberate steps as conditions dictate. ■ Wear boots with good, non-skid soles that are tall enough to support ankles. ■ Know basic First Aid. Completion of a basic First Aid course is required. ■ Use footwear appropriate to the terrain and load being carried. ■ Know how to fall. Roll, protect the head and neck, and do not extend arms to break the fall. ■ Travel after dark only in an emergency.
Biological Hazards	Insects, Snakes, Wildlife, Vegetation,	■ Inspect work areas when arriving at site to identify hazard(s). ■ Use insect repellant as necessary. ■ If an employee has bee sting allergy, carry epi-pen. ■ Wear appropriate PPE including gloves, long sleeves and pants, mosquito hats and waders if there is a probability of encountering biting or stinging insects. ■ Wear required PPE for job – thick soled boots with lug tread, leather work gloves, long pants & long-sleeved shirt.

Job Steps	Potential Hazards	Critical Actions to Mitigate Hazards
Hypodermic needles	Exposure to hypodermic needles	■ Wear heavy lug soled boots when working in the field (i.e. not soft soled office shoes). Around drill rigs, steel toed boots with high traction lug soles are typically required. ■ Do not pick up used needles. ■ Notify the property owner (SPR) of their presence, location and amount. They should initiate disposal or flag area off from pedestrian traffic.
Mobilize, set drill rig, drill to required depth and utilize sediment sampling devices	Caught between moving equipment. Lifting, pinch points and rotating equipment.	■ Stay clear of moving equipment and parts. ■ Use correct lifting techniques, and mechanical or physical assistance when needed. Be aware of all pinch points. ■ Do not trap yourself between equipment and stationary objects. Keep hand, feet and clothing clear of all rotating parts or equipment.
Cleaning soil cuttings from top of borehole	Rotating equipment, abrasions	■ Always use a shovel. Do not use feet or hands to clear cuttings away from drill string.
Groundwater Sampling	Back or muscle strain, contact with contaminated water, contact with sample preservatives, breathing fumes, cuts from broken glass sample jars	■ Use proper lifting techniques when lifting pumps and sampling equipment. ■ Wear appropriate PPE (safety boots, protective gloves, long pants, long-sleeved shirt, safety glasses and hard hat) for the job to avoid direct skin contact with contaminated water and sample preservatives. ■ Always work in a well-ventilated area to avoid breathing fumes from the sample preservatives. ■ If sample jars are broken, take extra precaution to dispose of preservative and broken glass by approved methods.
Use of Hand Augers	Lifting, pinch points, and muscle strain.	■ Wear appropriate PPE for the job – safety boots, leather work gloves, long pants and long-sleeved shirt, safety glasses and hard hat. ■ Use correct lifting techniques. Be aware of pinch points. ■ Remove excavated soil only after stopping the hand auger. ■ Check for underground utilities before starting hand augering operations. ■ Employ hand movements that exert minimum pressure on wrist.
Use of boats	Man overboard, sinking vessel, weather, currents, wet conditions, cold weather, fire, engine failure	■ Bring extra dry clothing and food for each person in a dry bag ■ Carry appropriate anchor to safely moor your vessel. ■ Know tides while out on beach to prevent accidental beaching. ■ Wear appropriate PPE and PFD at all times. ■ Carry a first aid kit. ■ Dress in layers and wear appropriate water repellent apparel. ■ Only operate during daylight hours.
Using SPT hammer, sampling, and tools, hoisting, core barrels	Moving equipment, pinch points, worn tools and equipment, wire ropes	■ Stay clear of moving equipment and parts. ■ Make sure all rod connections are flush and tight prior to using hammer. ■ When hoisting rods from borehole, stand clear of upper load until tension in soil has released. ■ Do not trap yourself between equipment and stationary objects. Be aware of all pinch points.

Job Steps	Potential Hazards	Critical Actions to Mitigate Hazards
Communication	Additional Hazards, i.e., No communication in case of emergency	■ Verify cell phone is working. ■ Maintain communication with Project Manager throughout job task. ■ Verify location and contact numbers for emergency medical assistance or 911.
	Additional Hazards, i.e., Emergency	■ **Dial 911.** ■ Hospital Route.

Required Control Measures: (check the box when complete)
☐ Perform a pre-work vehicle inspection (First Aid kit, fire extinguisher).
☐ Drive defensively looking out for the other guy.
☐ Conduct a pre-work safety meeting.
☐ Use a Safety Watch to monitor equipment Minimum Approach Distance (MAD) and to keep personnel clear if needed.
☐ Wear Personal Protective Equipment (PPE).
☐ Ensure training is current (First Aid, defensive driving, etc.).
☐ Conduct Task Safety Assessments throughout the job.
Additional Comments:

DAILY HAZARD ASSESSMENT RECORD OF SAFETY MEETINGS

Signature	Date	Signature	Date

FORM 5
ACCIDENT/EXPOSURE REPORT FORM
GAS WORKS PARK SITE, PRDI INVESTIGATION
FILE NO. 0186-8460-04

To (Supervisor): ______________________ From (Employee): ______________________

Telephone (with area code): ______________________

Name of injured or ill employee: ______________________

Date of accident: Time of accident: Exact location of accident:

Narrative description of accident/exposure (circle one):

Medical attention given on site:

Nature of illness or injury and part of body involved: Lost Time? Yes ☐ No ☐

Probably Disability (check one):

Fatal	Lost work day with days away from work	Lost work day with days of restricted activity	No lost work day	First Aid only
☐	☐	☐	☐	☐

Corrective action taken by reporting unit and corrective action that remains to be taken (by whom and when):

Employee Signature: Date:

Name of Supervisor:

APPENDIX C
Geotechnical Field and Laboratory Investigation Plan

Appendix C
Pre-Remedial Design Investigation – Geotechnical Field and Laboratory Investigation Plan

Gas Works Park Site
Seattle, Washington

for

Puget Sound Energy and the City of Seattle

February 26, 2024

GeoEngineers
Earth Science + Technology

Appendix C
Pre-Remedial Design Investigation –
Geotechnical Field and Laboratory
Investigation Plan

Gas Works Park Site
Seattle, Washington

for
Puget Sound Energy and the City of Seattle

February 26, 2024

GeoEngineers

2101 4th Avenue, Suite 950
Seattle, Washington 98121
206.728.2674

Pre-Remedial Design Investigation--
Geotechnical Field and Laboratory Investigation Plan

Gas Works Park Site
Seattle, Washington

File No. 0186-846-04

February 26, 2024

Prepared for:

Puget Sound Energy
PO Box 97034 BEL11
Bellevue, Washington 98009-9734

Attention: Sara Leverette and Suzanne Dolberg

Seattle Public Utilities
PO Box 34018
700 5th Avenue, Suite 4900
Seattle, Washington 98124-4018

Attention: Pete Rude

Seattle Parks and Recreation
300 Elliott Avenue West, Suite 100
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Attention: David Graves

Prepared by:

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Feng Li, PE
Senior Geotechnical Engineer

King Chin, PE
Principal

FL:KC:leh

GeoEngineers

Table of Contents

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

1D	one-dimensional
2D	two-dimensional
ASTM	ASTM International
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
COC	chain of custody
CPTs	Cone Penetration Tests
CPTu	CPT with porewater pressure measurement
CRS	Controlled Rate of Strain
CyDSS	cyclic direct simple shear
DSS	direct simple shear tests
ER	electrical resistivity
GeoEngineers	GeoEngineers, Inc.
GPS	global positioning system
GWPS	Gas Works Park Site
HASP	health and safety plan
IDW	investigation derived waste
LM	linear microtremor
MASW	multi-channel analysis of surface waves
MGP	manufactured gas plant
MTCA	Model Toxics Cleanup Act
OSHA	Occupational Safety and Health Act
PRDI	Pre-Remedial Design Investigation
psf	per square foot
RCW	Revised Code of Washington
SASW	spectral analysis of surface waves
SMS	Sediment Management Standards
SOP	Standard Operating Procedure
SPTs	Standard Penetration Tests
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
Vs	shear-wave velocity
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act

APPENDIX C
PRE-REMEDIAL DESIGN INVESTIGATION–GEOTECHNICAL FIELD AND LABORATORY INVESTIGATION PLAN

1.0 INTRODUCTION

A Pre-Remedial Design Investigation (PRDI) will be completed at the Gas Works Park Site (GWPS) in Seattle, Washington to obtain additional data to support design of the cleanup action (Figure C-1). The GWPS encompasses contamination associated with the former manufactured gas plant (MGP) and tar refinery, and other historical industrial activities (Figure C-2). The Ecology-approved Cleanup Action Plan (CAP) for the Site (Ecology 2023) presents the details on the cleanup action that will be completed pursuant to requirements of the Washington State Model Toxics Control Act (MTCA) (Chapter 70.105D of the Revised Code of Washington [RCW] and Chapter 173-340 of the Washington State Administrative Code [WAC]) and Sediment Management Standards (SMS) (Chapter 173-204 WAC).

This geotechnical investigation plan serves as the primary guide for geotechnical sampling and analysis that will be completed as part of this PRDI.

2.0 FIELD INVESTIGATION EQUIPMENT AND PROCEDURES

The following sections summarize the geotechnical sample collection and testing for the GWPS PRDI.

The objectives of the geotechnical field and laboratory testing program are to:

- Characterize the key soil units, i.e., fluid mud (also referred to as soft sediments), lakebed deposits, and glacial outwash materials, and

- Develop baseline geotechnical design parameters for use in the engineering analyses to support the execution of the planned clean up actions that consist primarily of dredging, including cofferdam design, and capping.

2.1. Standard Penetration Tests (SPTs) and Field Vane Shear Tests

SPTs will be completed using the mud rotary method to collect soils and soil strength data from the mudline to target depths of approximately 40 feet below mudline. The proposed geotechnical exploration will be completed at 10 of 22 locations shown on Figure C-3. These are proposed exploration locations and subject to adjustments based on field conditions.

2.1.1. SPT Equipment

A truck-mounted or track-mounted drilling rig that is capable of mud rotary drilling will be utilized. The drilling rig will be mounted on a floating barge that is sufficiently large to provide stable support and work areas.

2.1.2. SPT Procedure

Standard Penetration Tests (SPTs) will be performed in accordance with ASTM International (ASTM) D1586-11. In the SPT, typically a 2-inch outside-diameter, 1.375-inch inner-diameter, split-spoon sampler is driven with a 140-pound hammer, falling freely from a height of 30 inches. The number of blows required to achieve each of three 6-inch increments of sampler penetration is recorded. When penetration resistance exceeds 50 blows for 6 inches or less of penetration, the test will be terminated, and the number of blows and the penetration length will be recorded on the field log. The recovered sample from the SPT test will be collected, logged, labeled, described, and placed in plastic bags to minimize moisture loss for transport to a geotechnical laboratory.

The number of blows required for the last 12 inches of penetration is termed the penetration resistance. In the SPT, this number is called the Standard Penetration Resistance or N-value. The SPT N-value is a useful parameter for determining the relative density or consistency of soil. However, it should also be noted that the presence of gravels or cobbles larger than the sampler may affect measured penetration resistances and result in artificially high values. The energy transferred to the drill rods and sampler during the penetration test can vary depending on the hammer type and the drill rig configuration.

The drilling contractor will provide calibration data for their auto hammers. Hammer efficiencies will be presented on the boring logs.

Either undisturbed soil samples using Shelby tube samplers or Piston samplers or disturbed soil samples using split-spoon samplers will be collected from the SPT borings. Soil samples will be collected as continuously as practical within the fluid mud or for the top 10 feet using Piston sampling (also known as Osterberg sampling) per ASTM D 6519, at 2.5-foot intervals using Shelby tube samplers per ASTM D 1587 within the lakebed deposits, and then at 5-foot intervals using split spoon or Shelby tube samples below or within the glacial outwash materials. One Shelby tube sample of the undisturbed glacial outwash materials will be taken per each SPT borehole.

Borings will be continuously observed by a field representative, who will examine and classify the soils encountered, obtain representative soil samples, observe water conditions, and prepare a detailed log of each boring. Sample material will be visually classified in accordance with ASTM D 2488 methods and the Unified Soil Classification System (USCS) per ASTM D 2487 and recorded on a field log and the material will be photographed. The field classifications will be further evaluated in the laboratory. Observations of surface and/or groundwater conditions will be made during drilling and noted on the boring logs.

A portable GPS unit will be utilized to collect the coordinates of the soil boring location.

2.1.3. Field Vane Shear Tests

Alternating field vane shear tests and Piston sampling of undisturbed soils will be performed in the fluid mud as continuously as practically feasible. Field vane shear tests and Shelby tube sampling of undisturbed soils will be carried out alternatingly at approximately 2.5-foot intervals in the lakebed deposits. In the field, once the drilling rod touches the mudline, a field vane shear test will be set up and carried out, then the drilling rod will be pushed down, and Piston or Shelby tube samples of undisturbed soils will be taken.

The field vane shear tests will be completed following ASTM D 2573.

2.1.4. Soil Sample Designation

The soil samples will be assigned a unique sample identifier. The sample designator will include the sampling location number followed by the sampling method. The sample interval depth in feet below mudline will be added following the sampling method.

For example, a soil sample collected from a depth of 0 to 2.5 feet below mudline at location B-1 using the SPT method would be designated as B-1-SPT_0-2.5. The sample identification will be placed on the sample label, field report form, and chain-of-custody form.

2.2. Cone Penetration Tests (CPTs) with Porewater Measurements

All 22 boring locations presented in Figure C-3 will be completed using CPTs. The CPTs will be completed to depths of the top of the dense glacially consolidated soils or practical refusal to characterize the sediments and define the bearing layer elevation. The top of the dense glacially consolidated soils is anticipated to be at depths of about 40 to 60 feet below mudline or practical refusal based on limited existing CPT data.

Ten of the CPTs are paired with SPTs in adjacent locations so that the soil data collected can be cross-checked.

2.2.1. CPT Equipment

The equipment that will be needed for performing the CPTs in the GWPS sediment area include:

- A floating barge that is sufficiently large to provide stable support to the CPT rig and has a moonpool allowing lowering the rig rods from the center of the barge.
- Drilling Equipment:
  - Multi-drill rotary track/truck rig.
  - 6-inch conductor casing.
  - CPT support casing.
  - Other operational support equipment (tooling, tool handling, pumps, generators, etc.).
- CPTu (CPT with porewater pressure measurement) Equipment:
  - CPTu is typically comprised of an electronic piezocone penetrometer and a data acquisition system. A high resolution, low-capacity piezocone is used for the fluid mud materials. The probe has independent load cells for both the tip and sleeve. The penetrometers are designed with equal end area friction sleeves and a net end area ratio of 0.8 following typical industrial standard.
  - Redundant and multiple back-up equipment, e.g., spare CPT probes.
  - 20-ton, 1-meter stroke integrated ramset for CPTu deployment.
- Full-flow penetrometer:
  - o Full-flow penetrometer (a T-bar or ball) has been increasingly used in obtaining accurate undrained strengths of soft sediments.
- 20-ton Direct Push CPTu Ramset
  - 5- to 25-ton thrust capacity.

Full 1-meter CPT rod stroke.

2.2.2. CPT Procedure

The general CPT procedure includes the following steps:

- Position the barge at the target sampling location.
- Measure the mudline elevation using a weighted tape and record the time.
- Take initial baseline readings before advancing the penetrometer. The baseline readings represent the relative conditions when there are no forces on the load cells and transducers.
- Lower the drilling rod to the mudline.
- Perform soft CPT push from approximately 0 to 10 feet below mudline (optional) and then extract CPT rods.
- Set the 6-inch conductor casing to approximately 10 feet below mudline.
- Hang the CPT support casing inside 6-inch casing.
- Push the CPT using either drill head or hydraulic ramset.
- Upon completion, remove the CPT rods, support casing and 6-inch conductor casing.
- Decontaminate equipment and reposition the barge to the next sampling location.

The zero load readings will be monitored during the cone pushing process.

2.3. Laboratory Tests

Laboratory tests will be conducted to characterize the fluid mud, lakebed deposits, and glacial outwash materials and develop baseline geotechnical design parameters for use in the engineering analyses to support the execution of the planned clean up actions (i.e., primarily dredging and capping). The primary goal of laboratory testing is to characterize the soil classification, density, shear strength, compressibility, and dynamic properties to inform the design and construction of the sediment caps.

The majority of laboratory testing will be completed following ASTM standards as outlined in the Work Plan. A project-specific laboratory testing program, however, has been developed to characterize the fluid mud as no existing standard is available.

2.3.1. Laboratory Testing on Lakebed and Glacial Soils

The laboratory testing program will include testing samples that represent the identified major soils units based on visual observation on index testing (e.g., grain-size distribution and hydrometer per ASTM D422, specific gravity per ASTM D854, and Atterberg limits per ASTM D4318) as well as direct simple shear tests (DSS) per ASTM D6528 and/or triaxial shear tests (per ASTM D2850, D4767, or U.S. Army Corps of Engineers [USACE] EM 1110-2-1906). This testing will be used to characterize material types (i.e., USCS classification) and properties, such as density and strength, to support analyses such as estimating the stable slope cuts for dredging.

Conventional consolidation laboratory tests per ASTM standard D2435 or D4186 and/or low-stress consolidation laboratory tests based on USACE EM 1110-2-5027 will be performed on representative samples of the lakebed deposits and/or glacial outwash materials to evaluate the time rate of settlement and strength increase due to consolidation.

Consolidated-undrained cyclic direct simple shear (CyDSS) testing per ASTM D8296 will be performed on representative samples for each soil unit (e.g., fluid mud, lakebed deposits and glacial outwash materials) to characterize the engineering properties under cyclic seismic loading.

2.3.2. Project-specific Laboratory Testing Program and Procedure for Fluid Mud

A project-specific laboratory testing program has been developed to characterize the fluid mud with a specific focus on time rate and magnitude of sedimentation or settling under the proposed capping material thickness, and the bearing capacity of the fluid mud to support the weight of the capping material during and post-construction. The laboratory testing program will include the following:

- Self-weight sedimentation/settling tests for vertical stresses less than 10 pounds-force per square foot (psf) based on USACE EM 1110-2-5027 and EM 1110-2-5025.
- Low-stress oedometer testing for vertical stresses from 10 up to 100 psf based on USACE EM 1110-2-5027.
- Conventional consolidation tests under vertical stresses greater than 100 psf (up to 1,000 psf depending on maximum sample strain) by performing either 1D consolidation using incremental loading per ASTM D2435 or 1D Controlled Rate of Strain (CRS) consolidation per ASTM D4186.
- ‘Bench Scale’ testing of a sediment column to assess sedimentation/settling and consolidation of the fluid mud when a sand cap is added. The bench scale testing would help understand the potential losses and settlement of sand cap materials into the fluid mud found at the site, which will be key considerations in project construction.

The ‘Bench Scale’ testing will include the following:

- Construct a clear sedimentation column/tube with a diameter up to 12 inches and length of 6 feet.
- Mix and deposit slurry of sampled materials at base of column, add water (while minimizing disturbance to the slurry), allow fine-grained material to self-settle and then add sand cap material and allow to consolidate again.
- Document observations with photos of sand infiltration into the fluid mud during sedimentation/ settling and the consolidated sand/fine-grained material.
- Measure consolidation of slurry under self-weight and then with the influence of the sand cap.
- Collect ringed samples from the consolidated slurry materials for 1D consolidation, DSS, and/or CyDSS.

The project-specific laboratory testing procedure for the fluid mud will include:

- Develop a project-specific Standard Operating Procedure (SOP).
- Construct/fabricate specialty testing device(s) and equipment for planned sedimentation and consolidation laboratory testing.
- Completion of a ‘test sample’ following the SOP to troubleshoot testing challenges and identify solutions prior to production testing.

- Complete project-specific and conventional laboratory testing.
- Reduce data, complete quality review process, summarize laboratory results in a report.
- GeoEngineers recognizes unique considerations with sample preparation, relative consistency, and handling on the project. Attention will be paid to incorporating testing procedures in line with the referenced standards and where needed judgement will be incorporated from our previous experience to complete testing and report results.

2.3.3. Testing Considerations

Testing considerations by anticipated material type include:

- Fluid mud, also referred to as the soft sediment
  - Details on the project-specific testing procedure will be developed and included in a SOP.
  - Given practical constraints the sedimentation devices/columns will be of smaller diameter than those referenced for full scale testing by USACE.
  - Samples for settling or sedimentation (under less than 10 psf vertical stress) will be provided as collected in the field (e.g., a slurry consistency if Shelby tube sampling is not feasible in the very soft deposits) or a void ratio will be defined for sample preparation and testing.
  - Planned 1D consolidation testing (greater than 10 psf) anticipates that sample sediment will have a consistency that allows for placement in a consolidation ring with a spatula.
  - Where possible, test sample thicknesses will be minimized (e.g., less than 1-inch) to reduce consolidation times and satisfy project schedule constraints.
- Sand cap bench scale testing of fluid mud
  - This testing approach is experimental and there is a risk that recovery of an undisturbed sample for 1D consolidation and CyDSS may not be practicable.
  - GeoEngineers will identify which samples are planned for bench scale testing and will be provided with the preferred sand cap materials for testing.
  - GeoEngineers will provide CyDSS testing parameters.
- Lakebed deposits
  - The planned testing, besides index (e.g., density), of Lakebed deposits will be completed on recovered Shelby tube samples in the stiffer fine-grained materials.
- Glacial outwash materials
  - If Shelby tube samples cannot be recovered in these sandier materials, GeoEngineers will provide sample preparation parameters (e.g., density/unit weight) for disturbed samples.

GeoEngineers recognizes unique considerations with sample preparation, relative consistency, and handling for the GWPS project. Attention will be paid to incorporating testing procedures in line with the referenced standards and where needed judgement will be incorporated to complete testing and report results.

2.4. In-water Geophysical Testing (Optional)

An in-water geophysical survey can be performed along multiple lines within the sediment area of the GWPS to characterize both the nearshore and offshore soil conditions. The geophysical survey will include two methods: electrical resistivity (ER) tomography and linear microtremor (LM). These methods complement each other to collect subsurface geophysical property measurements via remote sensing techniques. Two-dimensional (2D) shear-wave velocity (Vs) profiles will be developed from the geophysical survey, which will be used to distinguish different geological unit boundaries and be used as direct measures of soil stiffness.

2.4.1. Electrical Resistivity (ER) Tomography

ER tomography is a geophysical surveying technique that measures the conduction/resistance of electricity through subsurface materials. It operates on the electrical conductance principle of voltage (V) = current (I) × resistance (R). A current is induced between two electrodes along a sensor array, which passes through the subsurface sediment before returning to the remaining electrodes within the array. The resulting voltage variance at each subsequent electrode is measured, from which the resistivity of subsurface layers can be deduced. The amount of resistivity determined through the data processing (inversion) process can be used to draw correlations to types of subsurface materials.

The proposed equipment comprises a cable array of up to 56 electrodes at 12-foot spacing. The cable will be deployed from a work vessel and placed on the sediment surface at the desired survey location. The cable will be slid axially in both directions until seated well to the mudline. Care will be taken to not suspend surface sediments. Following collection of ER measurements, the cable will be slid axially to a predetermined distance, yet still overlapping with the position of the previous measurement. This process will continue until the survey is completed. On completion of the survey, the cable will be retrieved onto the work vessel and decontaminated.

The ER survey will be completed by a qualified contractor. GeoEngineers will be on site to observe the geophysical survey data collection.

2.4.2. Linear Microtremor (LM)

LM is a passive seismic refraction surface-performed geophysical survey method based on previously existing principles of evaluating surface wave propagations (e.g., spectral analysis of surface waves [SASW] and multi-channel analysis of surface waves [MASW]). LM techniques measure Rayleigh wave dispersion along a linear seismic array and evaluate the phase differences of the incoming refracted waves emitted from ambient ground noise. Due to the dispersive characteristics of higher frequency waves traveling through the shallower conditions, and lower frequency waves passing through deeper materials, one-dimensional (1D) (and 2D) subsurface profile(s) with depth can be generated of the subsurface acoustic velocities of the sound source.

The LM equipment consists of a seismograph and hydrophones (e.g., a cable of 48 hydrophones equally spaced). Similar to the ER measurement methodology, the hydrophone cable will be placed on the bottom from a work vessel and slid axially in both directions until seated well to the mudline. Care will be taken to not suspend surface sediments. Following collection of LM measurements, the cable will be slid axially a predetermined distance, yet still overlapping with the position of the previous measurement. This process will continue until the survey is completed. On completion of the survey, the cable will be retrieved onto the work vessel and decontaminated.

3.0 GENERAL FIELD PROCEDURES

This section provides general field procedures and standard practices that apply to soil sample collection and analysis.

3.1. Field Logging

The stratigraphy encountered in soil borings will be logged by the field representative. Information on the boring logs will include the exploration location; general information about the drilling equipment; sampling information such as sample intervals/depths, sample recoveries, stratigraphy, and field screening results. The stratigraphy encountered will generally be described in accordance with ASTM D 2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). In addition, identification of the USCS group symbol will be recorded on the field logs.

As applicable, additional information will be recorded on field logs during soil boring drilling including depth to groundwater/saturated soil, heaving conditions, changes in drilling rate, and other noteworthy observations or conditions such as the presence or absence of stratification, depth of apparent stratigraphic contacts and the type and occurrence of anthropogenic materials. The visual absence or presence of wood debris in the surface and subsurface sediment sample will be recorded on the field form.

A photograph will be taken of the soil or sediment samples.

3.2. Decontamination Procedures

To prevent cross-contamination of collected samples, reusable sampling equipment will be decontaminated prior to collecting each sample using the following procedures.

3.2.1. Drilling and Geophysical Survey Equipment

For large pieces of drilling equipment (such as augers, drill rods, drill bits, and those portions of the drill rig that may be positioned directly over a boring location), the following procedure will be used to decontaminate the equipment between borings and upon completion of drilling activities. The equipment will be pressure-washed and, if necessary, scrubbed to remove visible dirt, grime, grease, oil, loose paint, rust flakes, etc. The equipment will then be rinsed with water.

3.2.2. Reusable Sampling Equipment

When possible, disposable sampling equipment will be used to minimize the need for decontaminating equipment. Prior to and between sample collection, reusable sampling equipment will be decontaminated. Reusable sampling equipment may include split spoon soil samplers, Piston soil samplers, and other hand tools or sampling/measuring devices.

For soil sampling equipment, excess soil will first be removed from the equipment and the equipment will then be rinsed with water. Decontaminated equipment will be temporarily stored on clean plastic sheeting and/or stored in a clean, dry place.

Penetration probes used for CPTs will be decontaminated before and after use at each location. Decontamination will be performed as follows:

1. Wipe off any visible liquid and dirt with disposable towels.

2. Rinse with water.

3.2.3. Sample Containers

Pre-cleaned sample bottles and jars will be used. Sample containers will not be reused.

3.2.4. Used Decontamination Water

Used decontamination water will be stored in labeled 55-gallon drums for subsequent characterization and disposal at a permitted facility.

3.3. Field Documentation

Three primary types of field documentation will be used for this project: field reports, sample container labels, and chain of custody (COC) forms. A description of each of these documentation methods is provided in the following sections.

3.3.1. Field Reports

Field reports will be used to document the field and sampling activities performed at the project site for each day of field work. Field reports will include the date, time, description of field activities performed, names of personnel and site visitors, weather conditions, areas where photographs were taken (if applicable), and other data pertinent to the project. Field reports will also contain sample collection and identification information, and if appropriate, a drawing of each area sampled, along with the locations (coordinates) where samples were collected.

Sample data recorded in field reports will include the sample date, time, location, identification number, collection method, and any comments. Field reports will also document identified safety issues; field measurements; and investigation derived waste (IDW) disposition (e.g., number of drums generated and their contents and location).

Soil boring information will be recorded on boring logs and delivered as part of the geotechnical data report.

Following review by the Project Manager, the original field records will be kept in the project file.

3.3.2. Sample Labels

Sample containers will be clearly labeled with waterproof black ink at the time of sampling. Sample labels will include the following information:

- Project/site name,
- Sampling date,
- Sampling time, and
- Sample identification number.

The same information entered on the sample label will be recorded on the chain of custody form and in the field report.

3.3.3. Chain of Custody Forms

After samples have been collected and labeled, they will be maintained under COC procedures. These procedures document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a COC form.

The COC form documents sample names, dates, times, and analyses to be performed for each sample, as well as all transfers of sample custody from the field to the laboratory. The COC form will be completed using waterproof ink. Any corrections will be made by drawing a line through and initialing and dating the change, then entering the correct information.

When transferring custody of samples, the individuals relinquishing and receiving them will sign, date, and note the time on the COC form. Sample coolers shipped by common carrier will have the COC form enclosed in a resealable plastic bag and placed in the sample cooler prior to sealing the cooler for shipping. Custody seals will be used on sample coolers that are shipped by common carrier or delivered by courier to the laboratory. The sample shipping receipt will be retained in the project files as part of the COC documentation. The shipping company will not sign the COC forms as a receiver; instead, the laboratory will sign as a receiver when the samples are received. Internal laboratory records will document custody of the samples from the time they are received through final disposition.

3.4. Exploration Location

For geotechnical exploration locations collected over-water from a barge, the barge will be equipped with global positioning system (GPS) equipment and the operator will provide GPS coordinates for each sampling location. GeoEngineers field personnel will log the exploration location names and coordinates.

3.5. Investigation Derived Waste

IDW typically includes soil cuttings and wastewater used to decontaminate field equipment. It will be placed in labeled storage containers and stored on Site in a designated containment area. Each waste container will be labeled (with the contents, date, and contact information), secured, stored, and disposed of according to applicable local, State, and Federal regulations.

4.0 HEALTH AND SAFETY

Field activities will be performed in accordance with the requirements of the Washington Industrial Safety and Health Act (WISHA; RCW 49.17) and the Federal Occupational Safety and Health Act (OSHA; 29 Code of Federal Regulations [CFR] 1910, 1926). These regulations include requirements that workers are to be protected from exposure to contaminants. A site-specific health and safety plan (HASP) describing actions that will be taken to protect the health and safety of GeoEngineers personnel is presented in Appendix B. Companies providing services for this project on a subcontracted basis (if applicable) will be responsible for developing and implementing their own HASP.

5.0 REPORTING AND DELIVERABLES

Upon completion of the field and laboratory investigation, two deliverables will be prepared including a geotechnical data report and a geotechnical baseline and interpretative report.

5.1. Geotechnical Data Report

The Geotechnical Data Report is a data package that contains:

- A brief summary of local geology,
- A brief summary of regional tectonics and seismicity,
- Lake water level data,
- Field investigation outputs including field logs from both SPTs and CPTs and field vane shear test results,
- Laboratory results, and
- Electronic data appendices

The SPT boring logs presented in the Geotechnical Data Report will include:

- Date, GPS location, and surface elevation of the boring, drilling equipment, method and contractor, hole diameter, hammer type and specifications, name of the field logger,
- A graphic log and description of materials along the depth, as well as sample number, sample type, blow count, blow count per foot (also known as N-value), comments and field notes,
- Laboratory test results including moisture content, fines content, liquid limit and plastic limit, and
- Observations of surface and/or groundwater conditions.

The penetration resistances (i.e., N-values) shown in the boring logs are the measured field values and have not been corrected for hammer efficiency.

The description of the materials generally includes a USCS classification, a list of key components as well as their shape, color and grain size, material density, and other observations, e.g., wood/shell fragments. The density descriptors on the logs are generally based on the uncorrected N-value but occasionally we adjust the density descriptor to consider the effect of the hammer efficiency on the N-value (particularly for samples with N-values at borderline values between density descriptors).

Sample material will be visually classified in accordance with USCS in the field and be adjusted if needed based on laboratory data.

Observations of surface water conditions will be made during drilling and noted on the boring logs. These observations represent a short-term condition that may not be representative of the long-term water conditions at the site.

The field logs reflect interpretation of the field conditions and the results of laboratory testing and evaluation of samples. They also indicate the depths at which the soil types or their characteristics change; although, the change might be gradual.

5.2. Geotechnical Baseline and Interpretative Report

The geotechnical baseline and interpretative report will document the following:

- Interpretation of the subsurface conditions under the mudline, including identified geologic units, lake/surface water levels, and baseline assumptions (e.g., the uncertainty/variation in the elevation of contacts between different geologic units),
- Recommended baseline parameters, primarily soil strength, compressibility, and rate of consolidation parameters, for each geologic unit,
- Preliminary geotechnical analyses, including slope stability analysis, liquefaction analysis, and settlement analysis, and analysis results, such as the range of settlement the sand cap may be anticipated to settle at the end of construction, and
- Identified anticipated key geotechnical challenges for detailed design and construction based on preliminary analyses. The challenges may include constructability considerations associated with capping and dredging activities, the post-construction offshore slope stability under both static and seismic conditions and potential ground improvement methods that may be needed as part of the remediation and construction process.

The geotechnical baseline and interpretative report will not include detailed design of the capping and construction process or detailed construction sequence or drawings. These will be covered during the formal design process.

6.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The key PRDI personnel and responsibilities are identified below. These key personnel are responsible for ensuring that the field investigation and analysis activities are conducted in a manner sufficient to meet the PRDI objectives.

The names of the key personnel will be confirmed before beginning the fieldwork.

6.1. Principal-in-Charge

John Herzog is the Principal-in-Charge who has overall responsibility for seeing that the project is implemented in accordance with the PRDI and related requirements.

6.2. Project Manager

Neil Morton is the Project Manager and will work with the Task Manager to coordinate and schedule field and laboratory testing activities, assign project team members, coordinate subcontractors, and track budgets and schedules. Neil will also verify that Geotechnical Field and Laboratory Plan objectives are achieved. Additionally, he will coordinate production and review of the PRDI geotechnical deliverables.

6.3. Task Manager

King Chin is the Task Manager for the geotechnical component of the PRDI who will coordinate and schedule field and laboratory testing activities, assign project team members, coordinate subcontractors, and track budgets and schedules. The task manager will also verify that potential changes to the geotechnical investigation plan are documented if such changes are needed based on conditions at the time of the work. Additionally, he will provide technical oversight of geotechnical PRDI deliverables.

- Provide technical direction to the geotechnical field staff.

- Develop schedules and allocate resources for geotechnical field tasks.
- Supervise the compilation of geotechnical field data and laboratory results.
- Review data for correct and complete geotechnical reporting.

6.4. Field Coordinator

The Field Coordinator is responsible for the daily management of activities in the field. Specific responsibilities include:

- Implement and oversee field sampling in accordance with the PRDI Project Plans.
- Supervise field personnel.
- Coordinate work with on-site subcontractors.
- Schedule sample shipments with the laboratory.
- Monitor that appropriate sampling, testing, and measurement procedures are followed.
- Coordinate the transfer of field data to the Task Manager.
- Identify whether deviations from the procedures presented in the appendix are appropriate to achieve the investigation goals and discuss these changes with the Task Manager.

The Field Coordinator will be confirmed before beginning the fieldwork.

6.5. Project Geotechnical Engineer

The Project Engineer is responsible for the analysis and interpretation of the field and laboratory data. Specific responsibilities include:

- Assemble and review field and laboratory data.
- Perform relevant analysis.
- Draft geotechnical data report and baseline report for senior review.

The Project Geotechnical Engineer will be confirmed before beginning the fieldwork.

7.0 LIMITATIONS

This work plan has been prepared for the exclusive use of Puget Sound Energy and the City of Seattle, their authorized agents and regulatory agencies in their evaluation of the Gas Works Park Site. No other party may rely on the product of our services unless we agree in advance and in writing to such reliance.

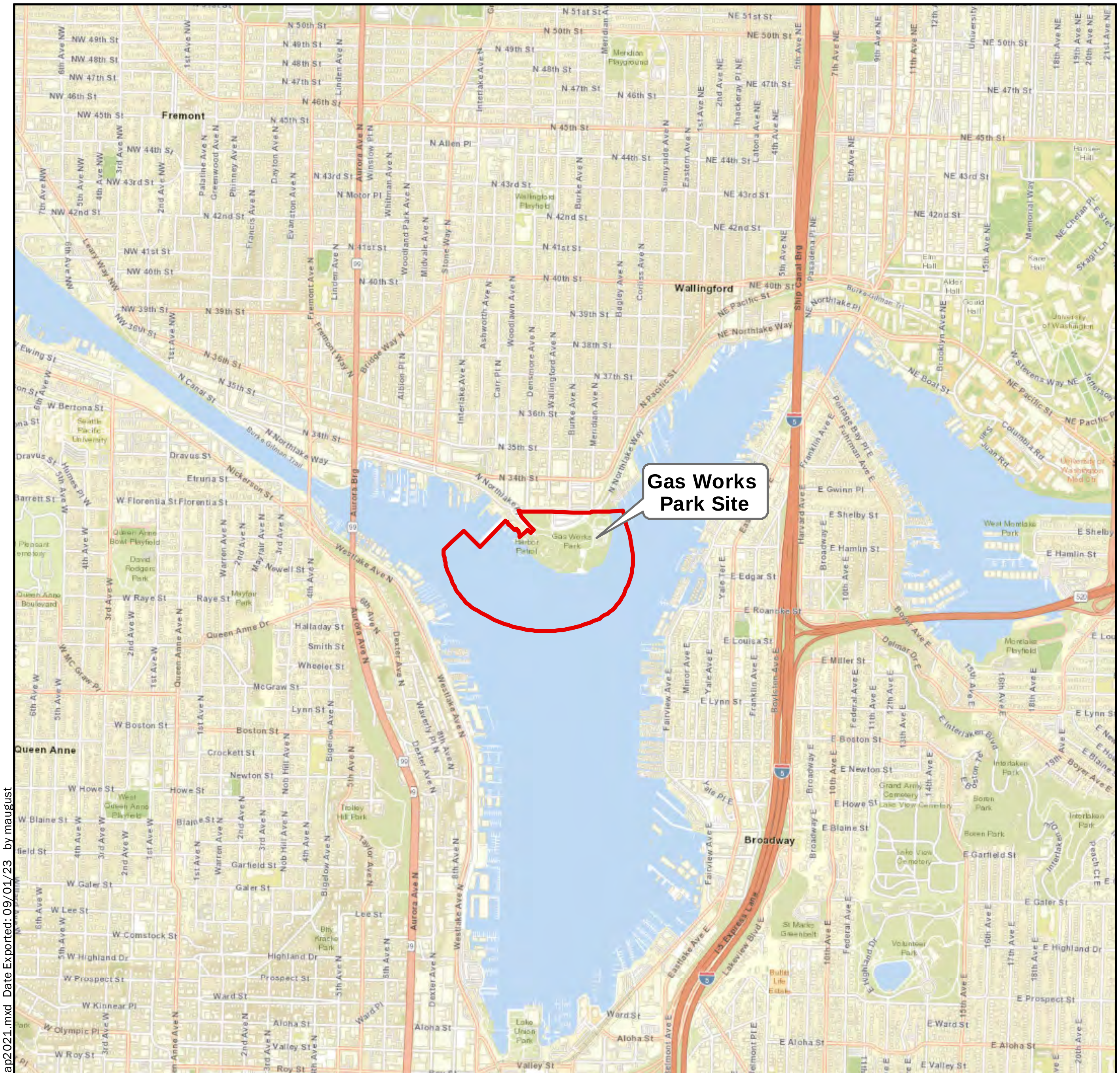
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted geotechnical engineering practices in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

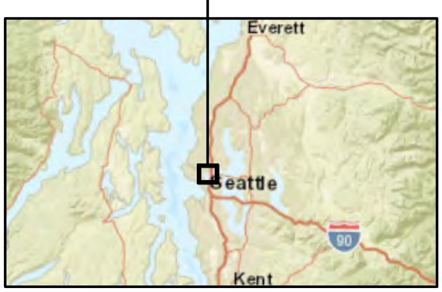
Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

8.0 REFERENCES

Ecology 2023. Cleanup Action Plan, Gas Works Park Site, Seattle, Washington. July 24, 2023.

FIGURES





Gas Works Park Site

N
W
E
S

2,000 0 2,000

Feet

Notes:

1. Basemap - ESRI, 2021.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Vicinity Map

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure C-1

P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F01_VicinityMap2021.mxd Date Exported: 09/01/23 by maugust

Legend

- Gas Works Park Site
- Shoreline (OHWM)
- Impervious (Paved or Structures)
- Gravel

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

N / E / S / W

200 0 200
Feet

Site Plan

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure C-2

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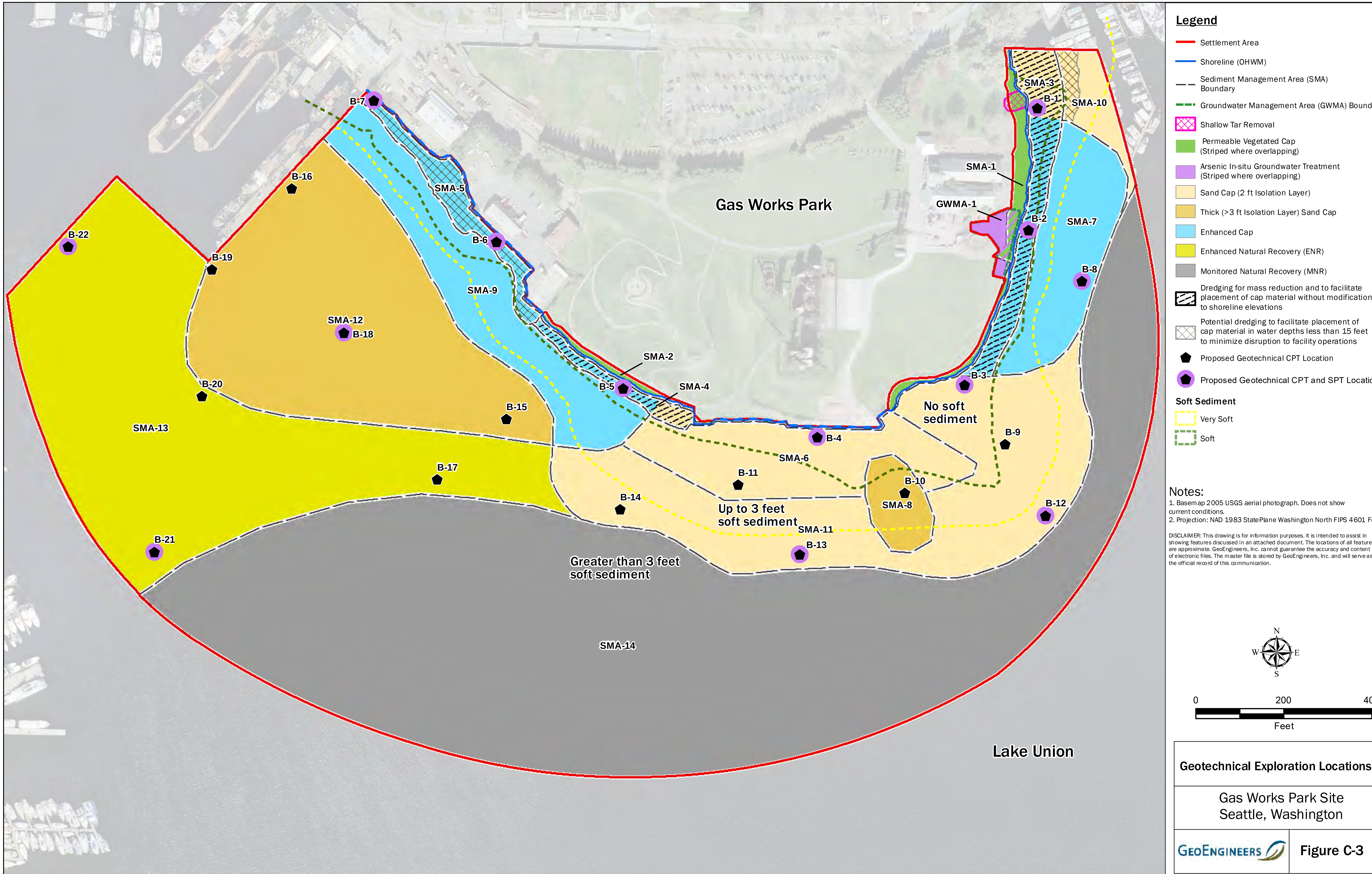


Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Geotechnical Exploration Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure C-3

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F12_GeotechnicalExplorations.mxd Map Revised: 19 December 2023 maugust

GeoEngineers

APPENDIX D
Inadvertent Discovery Plan

INADVERTENT DISCOVERY PLAN

PLAN AND PROCEDURES FOR THE DISCOVERY OF CULTURAL RESOURCES AND HUMAN SKELETAL REMAINS

To request ADA accommodation, including materials in a format for the visually impaired, call Ecology at 360-407-6000 or visit https://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with a speech disability may call TTY at 877-833-6341.

Site Name(s): Gas Works Park Site	Location: Seattle, WA
Project Lead/Organization: Puget Sound Energy	County: King

If this Inadvertent Discovery Plan (IDP) is for multiple (batched) projects, ensure the location information covers all project areas.

1. INTRODUCTION

The IDP outlines procedures to perform in the event of a discovery of archaeological materials or human remains, in accordance with applicable state and federal laws. An IDP is required, as part of Agency Terms and Conditions for all grants and loans, for any project that creates disturbance above or below the ground. An IDP is not a substitute for a formal cultural resource review (Executive 21-02 or Section 106).

Once completed, **the IDP shall always be kept at the project site** during all project activities. All staff, contractors, and volunteers shall be familiar with its contents and know where to find it.

2. CULTURAL RESOURCE DISCOVERIES

A cultural resource discovery could be prehistoric or historic artifacts. Examples include (see images for further examples):

- An accumulation of shell, burned rocks, or other food related materials.
- Bones, intact or in small pieces.
- An area of charcoal or very dark stained soil with artifacts.
- Stone tools or waste flakes (for example, an arrowhead or stone chips).
- Modified or stripped trees, often cedar or aspen, or other modified natural features, such as rock drawings.
- Agricultural or logging materials that appear older than 50 years. These could include equipment, fencing, canals, spillways, chutes, derelict sawmills, tools, and many other items.
- Clusters of tin cans or bottles, or other debris that appear older than 50 years.
- Old munitions casings. ***Always assume these are live and never touch or move.***
- Buried railroad tracks, decking, foundations, or other industrial materials.
- Remnants of homesteading. These could include bricks, nails, household items, toys, food containers, and other items associated with homes or farming sites.

The above list does not cover every possible cultural resource. When in doubt, assume the material is a cultural resource.

3. ON-SITE RESPONSIBILITIES

If any employee, contractor, or subcontractor believes that they have uncovered cultural resources or human remains at any point in the project, take the following steps to ***Stop-Protect-Notify***. **If you suspect that the discovery includes human remains, also follow Sections 5 and 6.**

STEP A: Stop Work.

All work must stop immediately in the vicinity of the discovery.

STEP B: Protect the Discovery.

Leave the discovery and the surrounding area untouched and create a clear, identifiable, and wide boundary (30 feet or larger) with temporary fencing, flagging, stakes, or other clear markings. Provide protection and ensure integrity of the discovery until cleared by the Department of Archaeological and Historical Preservation (DAHP) or a licensed, professional archaeologist.

Do not permit vehicles, equipment, or unauthorized personnel to traverse the discovery site. Do not allow work to resume within the boundary until the requirements of this IDP are met.

STEP C: Notify Project Archaeologist (if applicable).

If the project has an archaeologist, notify that person. If there is a monitoring plan in place, the archaeologist will follow the outlined procedure.

STEP D: Notify Project and Washington Department of Ecology (Ecology) contacts.

Project Lead Contacts

Primary Contact		Alternate Contact	
Name:	Suzanne Dolberg	Name:	John Herzog
Organization:	Puget Sound Energy	Organization:	GeoEngineers
Phone:	425.229.0172	Phone:	206.239.3252
Email:	suzanne.dolberg@pse.com	Email:	jherzog@geoengineers.com

Ecology Contacts (completed by Ecology Project Manager)

Ecology Project Manager		Alternate or Cultural Resource Contact	
Name:	Lucy McInerney	Name:	Jon Klem
Program:	TCP-NWRO	Program:	TCP-NWRO
Phone:	425.410.1400	Phone:	206.556.5584
Email:	lucy.mcinerney@ecy.wa.gov	Email:	jon.klem@ecy.wa.gov

STEP E: Ecology will notify DAHP.

Once notified, the Ecology Cultural Resource Contact or the Ecology Project Manager will contact DAHP to report and confirm the discovery. To avoid delay, the Project Lead/Organization will contact DAHP if they are not able to reach Ecology.

DAHP will provide the steps to assist with identification. DAHP, Ecology, and Tribal representatives may coordinate a site visit following any necessary safety protocols. DAHP may also inform the Project Lead/Organization and Ecology of additional steps to further protect the site.

Do not continue work until DAHP has issued an approval for work to proceed in the area of, or near, the discovery.

DAHP Contacts:

Name:	Rob Whitlam, PhD
Title:	State Archaeologist
Cell:	360-890-2615
Email:	Rob.Whitlam@dahp.wa.gov
Main Office:	360-586-3065

Human Remains/Bones:

Name:	Guy Tasa, PhD
Title:	State Anthropologist
Cell:	360-790-1633 (24/7)
Email:	Guy.Tasa@dahp.wa.gov

4. TRIBAL CONTACTS

In the event cultural resources are discovered, the following tribes will be contacted. See Section 10 for Additional Resources.

Tribe: Duwamish Tribe
Name: Nancy Sackman
Title: Cultural Preservation Officer
Phone: 206.856.2564
Email: preservationdept@duwamishtribe.org

Tribe: Muckleshoot Indian Tribe
Name: Laura Murphy
Title: Archaeologist
Phone: 253-876-3272
Email: laura.murphy@muckleshoot.nsn.us

Tribe: Snoqualmie Indian Tribe
Name: Adam Osbekoff
Title: Cultural Resource Compliance Manager
Phone: 425-753-0388
Email: adam@snoqualmietribe.us

Tribe: Squaxin Island Tribe
Name: Shaun Dinubilo
Title: Archaeologist
Phone: 360-432-3998
Email: sdinubilo@squaxin.us

Tribe: Stillaguamish Tribe of Indians
Name: Kerry Lyste
Title: THPO
Phone: 360-652-7362 ext. 226
Email: klyste@stillaguamish.com

Tribe: Suquamish Tribe
Name: Stephanie Trudel
Title: THPO
Phone: 360-394-8533
Email: strudel@suquamish.nsn.us

Tribe: Tulalip Tribes
Name: Richard Young
Title: Cultural Resources Director
Phone: 360-716-2652
Email: ryoung@tulaliptribes-nsn.gov

Please provide contact information for additional tribes within your project area, if needed, in Section 11.

5. FURTHER CONTACTS (if applicable)

If the discovery is confirmed by DAHP as a cultural or archaeological resource, or as human remains, and there is a partnering federal or state agency, Ecology or the Project Lead/Organization will ensure the partnering agency is immediately notified.

Federal Agency:

Agency:
Name:
Title:
Phone:
Email:

State Agency:

Agency:
Name:
Title:
Phone:
Email:

6. SPECIAL PROCEDURES FOR THE DISCOVERY OF HUMAN SKELETAL REMAINS

Any human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect. Follow the steps under ***Stop-Protect-Notify.*** For specific instructions on how to handle a human remains discovery, see: *RCW 68.50.645: Skeletal human remains—Duty to notify—Ground disturbing activities—Coroner determination—Definitions*.

Suggestion: If you are unsure whether the discovery is human bone or not, contact Guy Tasa with DAHP, for identification and next steps. Do not pick up the discovery.

Guy Tasa, PhD State Physical Anthropologist
Guy.Tasa@dahp.wa.gov
(360) 790-1633 (Cell/Office)

For discoveries that are confirmed or suspected human remains, follow these steps:

1. Notify law enforcement and the Medical Examiner/Coroner using the contacts below. **Do not call 911** unless it is the only number available to you.

   Enter contact information below (required):

   - Local Medical Examiner or Coroner name and phone: King County Medical Examiner (206-731-3232, ext 4)
   - Local Law Enforcement main name and phone: Seattle Police Department (206-625-5011)
   - Local Non-Emergency phone number (911 if without a non-emergency number): 206-625-5011

2. The Medical Examiner/Coroner (with assistance of law enforcement personnel) will determine if the remains are human or if the discovery site constitutes a crime scene and will notify DAHP.

3. **DO NOT speak with the media, allow photography or disturbance of the remains, or release any information about the discovery on social media.**
4. If the remains are determined to be non-forensic, cover the remains with a tarp or other materials (not soil or rocks) for temporary protection and to shield them from being photographed by others or disturbed.

Further activities:

- Per RCW 27.44.055, RCW 68.50, and RCW 68.60, DAHP will have jurisdiction over non-forensic human remains. Ecology staff will participate in consultation. The Project Lead/Organization may also participate in consultation.
- Documentation of human skeletal remains and funerary objects will be agreed upon through the consultation process described in RCW 27.44.055, RCW 68.50, and RCW 68.60.
- When consultation and documentation activities are complete, work in the discovery area may resume as described in Section 8.

If the project occurs on federal lands (such as a national forest or park or a military reservation) the provisions of the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) apply and the responsible federal agency will follow its provisions. Note that state highways that cross federal lands are on an easement and are not owned by the state.

If the project occurs on non-federal lands, the Project Lead/Organization will comply with applicable state and federal laws, and the above protocol.

7. DOCUMENTATION OF ARCHAEOLOGICAL MATERIALS

Archaeological resources discovered during construction are protected by state law RCW 27.53 and assumed eligible for inclusion in the National Register of Historic Places under Criterion D until a formal Determination of Eligibility is made.

The Project Lead/Organization must ensure that proper documentation and field assessments are made of all discovered cultural resources in cooperation with all parties: the federal agencies (if any), DAHP, Ecology, affected tribes, and the archaeologist.

An archaeologist will record all prehistoric and historic cultural material discovered during project construction on a standard DAHP archaeological site or isolate inventory form. They will photograph site overviews, features, and artifacts and prepare stratigraphic profiles and soil/sediment descriptions for minimal subsurface exposures. They will document discovery locations on scaled site plans and site location maps.

Cultural features, horizons, and artifacts detected in buried sediments may require the archaeologist to conduct further evaluation using hand-dug test units. They will excavate units in a controlled fashion to expose features, collect samples from undisturbed contexts, or to interpret complex stratigraphy. They may also use a test unit or trench excavation to determine if an intact occupation surface is present. They will only use test units when necessary to gather information on the nature, extent, and integrity of subsurface cultural deposits to evaluate the site’s significance. They will conduct excavations using standard archaeological techniques to precisely document the location of cultural deposits, artifacts, and features.

The archaeologist will record spatial information, depth of excavation levels, natural and cultural stratigraphy, presence or absence of cultural material, and depth to sterile soil, regolith, or bedrock for each unit on a standard form. They will complete test excavation unit level forms, which will include plan maps for each excavation level and artifact counts and material types, number, and vertical provenience (depth below surface and stratum association where applicable) for all recovered artifacts. They will draw a stratigraphic profile for at least one wall of each test excavation unit.

The archaeologist will screen sediments excavated for purposes of cultural resources investigation through 1/8-inch mesh, unless soil conditions warrant 1/4-inch mesh.

The archaeologist will analyze, catalogue, and temporarily curate all prehistoric and historic artifacts collected from the surface and from probes and excavation units. The ultimate disposition of cultural materials will be determined in consultation with the federal agencies (if any), DAHP, Ecology, and the affected tribe(s).

Within 90 days of concluding fieldwork, the archaeologist will provide a technical report describing any and all monitoring and resultant archaeological excavations to the Project Lead/Organization, who will forward the report to Ecology, the federal agencies (if any), DAHP, and the affected tribe(s) for review and comment.

If assessment activities expose human remains (burials, isolated teeth, or bones), the archaeologist and Project Lead/Organization will follow the process described in **Section 6**.

8. PROCEEDING WITH WORK

The Project Lead/Organization shall work with the archaeologist, DAHP, and affected tribe(s) to determine the appropriate discovery boundary and where work can continue.

Work may continue at the discovery location only after the process outlined in this plan is followed and the Project Lead/Organization, DAHP, any affected tribe(s), Ecology, and the federal agencies (if any) determine that compliance with state and federal laws is complete.

9. ORGANIZATION RESPONSIBILITY

The Project Lead/Organization is responsible for ensuring:

- This IDP has complete and accurate information.
- This IDP is immediately available to all field staff at the site and available by request to any party.
- This IDP is implemented to address any discovery at the site.
- That all field staff, contractors, and volunteers are instructed on how to implement this IDP.

10. ADDITIONAL RESOURCES

Informative Video

Ecology recommends that all project staff, contractors, and volunteers view this informative video explaining the value of IDP protocol and what to do in the event of a discovery. The target audience is anyone working on the project who could unexpectedly find cultural resources or human remains while excavating or digging. The video is also posted on DAHP's inadvertent discovery language website.

Ecology's IDP Video (https://www.youtube.com/watch?v=ioX-4cXfbDY)

Informational Resources

DAHP (https://dahp.wa.gov)

Washington State Archeology (DAHP 2003) (https://dahp.wa.gov/sites/default/files/Field%20Guide%20to%20WA%20Arch_0.pdf)

Association of Washington Archaeologists (https://www.archaeologyinwashington.com)

Potentially Interested Tribes

Tribal Contacts: Interactive Map of Tribes by Area (https://dahp.wa.gov/archaeology/tribal-consultation-information)

Tribal Contacts - WSDOT Tribal Contact Website (https://wsdot.wa.gov/tribal/TribalContacts.htm)

11. ADDITIONAL INFORMATION

Please add any additional contact information or other information needed within this IDP.

Implement the IDP if you see…

Chipped stone artifacts.

Examples are:

- Glass-like material.
- Angular material.
- “Unusual” material or shape for the area.
- Regularity of flaking.
- Variability of size.

Stone artifacts from Oregon.

Stone artifacts from Washington.

Biface-knife, scraper, or pre-form found in NE Washington. Thought to be a well knapped object of great antiquity. Courtesy of Methow Salmon Rec. Foundation.

Implement the IDP if you see…

Ground stone artifacts.

Examples are:

- Unusual or unnatural shapes or unusual stone.
- Striations or scratching.
- Etching, perforations, or pecking.
- Regularity in modifications.
- Variability of size, function, or complexity.

Above: Fishing Weight - credit CRITFC Treaty Fishing Rights website.

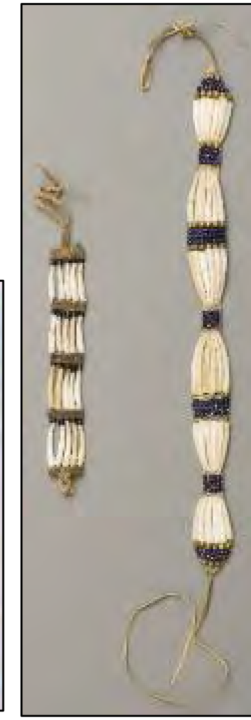
Artifacts from unknown locations (left and right images).

Implement the IDP if you see…

Bone or shell artifacts, tools, or beads.

Examples are:

- Smooth or carved materials.
- Unusual shape.
- Pointed as if used as a tool.
- Wedge shaped like a "shoehorn".
- Variability of size.
- Beads from shell (dentalium) or tusk.



Upper Left: *Bone Awls from Oregon.*

Upper Center: *Bone Wedge from California.*

Upper Right: *Plateau dentalium choker and bracelet, from Nez Perce National Historical Park, 19th century, made using Antalis pretiosa shells Credit: Nez Perce - Nez Perce National Historical Park, NEPE 8762, Public Domain.*

Above: *Tooth Pendants.*

Right: Bone Pendants. Both from Oregon and Washington.

Implement the IDP if you see…

Culturally modified trees, fiber, or wood artifacts.

Examples are:

- Trees with bark stripped or peeled, carvings, axe cuts, de-limbing, wood removal, and other human modifications.
- Fiber or wood artifacts in a wet environment.
- Variability of size, function, and complexity.

Left and Below: *Culturally modified tree and an old carving on an aspen (Courtesy of DAHP). These are examples of above ground cultural resources.*

Right, Top to Bottom: *Artifacts from Mud Bay, Olympia: Toy war club, two strand cedar rope, wet basketry*.

Implement the IDP if you see…

Strange, different, or interesting looking dirt, rocks, or shells.

Human activities leave traces in the ground that may or may not have artifacts associated with them. Examples are:

- “Unusual” accumulations of rock (especially fire-cracked rock).
- “Unusual” shaped accumulations of rock (such as a shape similar to a fire ring).
- Charcoal or charcoal-stained soils, burnt-looking soils, or soil that has a “layer cake” appearance.
- Accumulations of shell, bones, or artifacts. Shells may be crushed.
- Look for the “unusual” or out of place (for example, rock piles in areas with otherwise few rocks).

Shell Midden pocket in modern fill discovered in sewer trench.

Underground oven. Courtesy of DAHP.

Shell Midden with fire cracked rock.

Hearth excavated near Hamilton, WA.

Implement the IDP if you see…

Historic period artifacts (historic archaeology considered older than 50 years).

Examples are:

- Agricultural or logging equipment. May include equipment, fencing, canals, spillways, chutes, derelict sawmills, tools, etc.
- Domestic items including square or wire nails, amethyst colored glass, or painted stoneware.

Left: Top to Bottom: *Willow pattern serving bowl and slip joint pocket knife discovered during Seattle Smith Cove shantytown (45-KI-1200) excavation.*

Right: *Collections of historic artifacts discovered during excavations in eastern Washington cities.*

Implement the IDP if you see…

Historic period artifacts (historic archaeology considered older than 50 years).

Examples are:

- Railway tokens, coins, and buttons.
- Spectacles, toys, clothing, and personal items.
- Items helping to understand a culture or identity.
- Food containers and dishware.

Main Image: *Dishes, bottles, work boot found at the North Shore Japanese bath house (ofuro) site, Courtesy Bob Muckle, Archaeologist, Capilano University, B.C. This is an example of an above ground resource.*

Right, from Top to Bottom: *Coins, token, spectacles and Montgomery Ward pitchfork toy discovered during Seattle Smith Cove shantytown (45-KI-1200) excavation.*

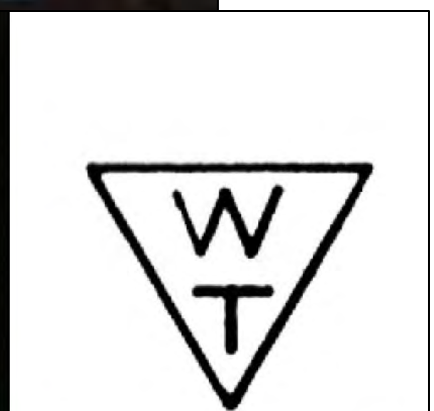
Implement the IDP if you see…

- Old munition casings – if you see ammunition of any type – ***always assume they are live and never touch or move!***
- Tin cans or glass bottles with an older manufacturer's technique – maker's mark, distinct colors such as turquoise, or an older method of opening the container.

Far Left: *.303 British cartridge found by a WCC planting crew on Skagit River.* ***Don't ever touch something like this!***

Left: *Maker's mark on bottom of old bottle.*

Right: *Old beer can found in Oregon. ACME was owned by Olympia Brewery. Courtesy of Heather Simmons.*



Logo employed by Whithall Tatum & Co. between 1924 to 1938 (Lockhart et al. 2016).

Can opening dates, courtesy of W.M. Schroeder.

Implement the IDP if you see…

Historic foundations or buried structures.

Examples are:

- Foundations.
- Railroad and trolley tracks.
- Remnants of structures.

Counter Clockwise, Left to Right: *Historic structure 45KI924, in WSDOT right of way for SR99 tunnel. Remnants of Smith Cove shantytown (45-KI-1200) discovered during Ecology CSO excavation, City of Spokane historic trolley tracks (above ground historic resources) uncovered during stormwater project, intact foundation of historic home that survived the Great Ellensburg Fire of July 4, 1889, uncovered beneath parking lot in Ellensburg.*

Implement the IDP if you see…

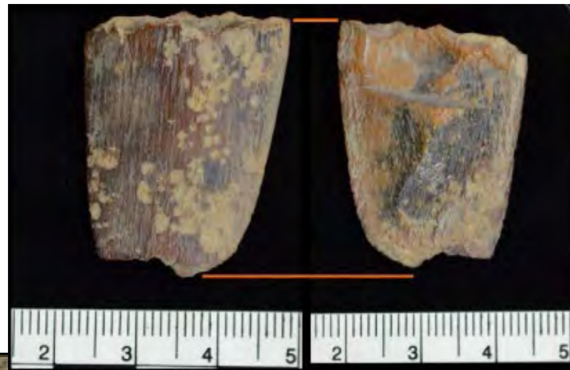
Potential human remains.

Examples are:

- Grave headstones that appear to be older than 50 years.
- Bones or bone tools--intact or in small pieces. It can be difficult to differentiate animal from human so they must be identified by an expert.
- These are all examples of animal bones and are not human.

Center: *Bone wedge tool, courtesy of Smith Cove Shantytown excavation (45KI1200).*

Other images (Top Right, Bottom Left, and Bottom) Center: Courtesy of DAHP.



Directly Above: *This is a real discovery at an Ecology sewer project site.*

What would you do if you found these items at a site? Who would be the first person you would call?

Hint: *Read the plan!*