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Gas Works Park Site

Exhibit B
Cleanup Action Plan

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Washington State Department of Ecology
Toxics Cleanup Program
Northwest Regional Office
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ABBREVIATIONS

3D	three-dimensional
ALU	ambient Lake Union
AOI	Area of Investigation
ATCO	American Tar Company
BMPs	best management practices
C1	commercial-zoned
CAP	Cleanup Action Plan
City	City of Seattle
CM	Conservancy Management
cm	centimeters
CMCRP	compliance monitoring and contingency response plan
COCs	contaminants of concern
COPC	contaminants of potential concern
cPAH	carcinogenic PAHs
CPOC	conditional point of compliance
CSEM	conceptual site exposure model
CSL	cleanup screening level
CSM	conceptual site model
CSOs	combined sewer/stormwater overflows
CW	Conservancy Waterway
CWA	Clean Water Act
DCA	disproportionate cost analysis
Ecology/ECY	Washington State Department of Ecology
EDR	Engineering Design Report
ENR	Enhanced Natural Recovery
EPA	United States Environmental Protection Agency
FAS	Department of Finance and Administrative Services
FS	feasibility study
GWMAs	groundwater management areas
GWPS	Gas Works Park Site
Harbor Patrol	Seattle Police Harbor Patrol

HPA	hydraulic project approval
IB	Industrial Buffer
IC	Industrial Commercial
JARPA	Joint Aquatic Resource Permit Application
µg/L	micrograms per liter
Metro	Municipality of Metropolitan Seattle
MGP	manufactured gas plant
MNR	Monitored Natural Recovery
MTCA	Model Toxics Control Act
NAPL	nonaqueous phase liquid
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OHWM	ordinary high water mark
PAHs	polycyclic aromatic hydrocarbons
PCP	pentachlorophenol
PLPs	potentially liable parties
PSE	Puget Sound Energy
QC	quality control
RCW	Revised Code of Washington
RI	remedial investigation
RSLs	Regional Screening Levels
SCO	sediment cleanup objective
SCU	sediment cleanup unit
SCUM	Sediment Cleanup User's Manual
SEPA	State Environmental Policy Act
Ship Canal	Lake Washington Ship Canal
SLs	screening levels
SMA	sediment management area
SMS	Sediment Management Standards
South Yard	Lake Union South Yard
State	State of Washington

SWAC	surface area-weighted average concentration
TarGOST®	Tar-specific Green Optical Screening Tool
TEQ	toxic equivalent concentrations
TPAH	total polycyclic aromatic hydrocarbons
UM	Urban Maritime
USACE	United States Army Corps of Engineers
UV	ultraviolet
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources

1.0 INTRODUCTION

This Cleanup Action Plan (CAP) describes the cleanup action proposed by the Washington State Department of Ecology (Ecology) to address contamination at the Gas Works Park Site (GWPS) in Seattle, Washington. The CAP, prepared by Puget Sound Energy (PSE) and the City of Seattle (City) under Agreed Order DE 2008 (AO; Ecology 2005, 2013, 2017a, b and 2022a), was developed using information in the final *Remedial Investigation and Feasibility Study Report, Gas Works Park Site, Seattle, Washington* (RI/FS; GeoEngineers 2023). The proposed cleanup action addresses contamination from a former manufactured gas plant (MGP) and tar refinery, and other historical industrial activities (Figure 1-1).

This CAP has been prepared to satisfy the requirements of the Model Toxics Control Cleanup Act (MTCA), Chapter 70A.305 Revised Code of Washington (RCW) which is administered by Ecology under the MTCA Cleanup Regulation, Chapter 173-340 of the Washington Administrative Code (WAC).

The GWPS was evaluated for inclusion on the United States Environmental Protection Agency (EPA) National Priorities List (NPL) in the 1980s. In 1996, Ecology and EPA signed a Deferral Agreement that deferred consideration of the GWPS for listing on the NPL while Ecology oversees cleanup activities under its state MTCA regulatory authority.

1.1. Site Description

The GWPS area of investigation (AOI) (Figure 1-2) was developed to encompass areas of elevated contamination associated with the former MGP and tar refinery, and other historical industrial activities. The AOI is defined in the AO, and combines the upland portion of the GWPS defined in a 1999 Consent Decree (Ecology 1999) with the contaminated sediment area associated with the historical upland industrial activities. The upland and sediment portions of the AOI are separated by the ordinary high-water mark (OHWM[1]).

The upland portion of the AOI is approximately 21 acres landward of the OHWM and includes Gas Works Park, portions of Waterways 19 and 20, and Seattle Police Harbor Patrol (Harbor Patrol) (Figure 1-2). It is bordered by industrial, commercial, and residential properties to the east, west and north and Lake Union to the south. The Gas Works Park property is owned by the City and managed by Seattle Parks and Recreation. The park consists of open grassy areas, a high grassy knoll known as Kite Hill, landscaping, historical industrial structures, and more than 2,000 feet of shoreline. Features of the shoreline include riprap, a concrete bulkhead along the southern shoreline known as the Prow, and low shoreline banks covered with blackberry and other invasive or opportunistic plants. A narrow gravel and mud beach is seasonally present at the base of the shoreline bank except in the riprap and bulkheaded areas. The Harbor Patrol upland property west of the park is fenced, with two buildings, a storage building, a fueling station, and a paved parking lot (Figure 1-2). The property is owned by the City and managed by the Department of Facilities and Administrative Services (FAS). The shoreline at Harbor Patrol includes a sheet pile bulkhead. Contamination in the upland portion of the AOI has been addressed through a variety of previous cleanup actions described in the RI/FS. A small area of uncapped contaminated shoreline bank soil and an area of shoreline arsenic-impacted groundwater will be addressed as part of the proposed cleanup action.

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

The 56-acre sediment portion of the AOI is waterward of the OHWM and incorporates most of the aquatic portion of Waterway 19, all of the aquatic portion of Waterway 20 and the lake bottom adjacent to Metro's[2] Lake Union South Yard (South Yard), Harbor Patrol, and Gas Works Park (Figure 1-3). This area of Lake Union is part of the Lake Washington Ship Canal (Ship Canal), which links Puget Sound with Lake Washington. Over-water features such as active and remnant docks are associated with the eastern-most portion of the Northlake Shipyard, Metro's South Yard, the Harbor Patrol property, and the western portion of Gas Works Park Marina that extends into Waterway 19

The current property ownership of the AOI is shown in Figure 1-3. The City owns the upland portion of the AOI, except for an area of Waterway 19 that is owned by the State of Washington (State) and managed by the Washington State Department of Natural Resources (WDNR). The State owns most of the sediment portion of the AOI, except for the following:

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

Figure 1-3 also shows the boundaries of WDNR aquatic leases and current waterway use permits within the AOI.

1.2. Purpose and Scope

The state law that governs the cleanup of contamination is the MTCA (Revised Code of Washington 70A.305 and implementing regulations in Chapter 173-340 WAC). When contaminated sediment is involved, the cleanup levels and other procedures are also regulated by the SMS (Chapter 173-204 WAC). MTCA regulations specify criteria for the evaluation and conduct of a state cleanup action. SMS regulations dictate the standards for cleanup of sediment. Under both rules, a cleanup must protect human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, and provide for monitoring to confirm compliance with cleanup standards.

The previously completed RI/FS (GeoEngineers 2023) identified and screened the applicability of potential cleanup technologies for the conditions at the GWPS and evaluated a range of cleanup action alternatives comprised of the retained technologies. The evaluation revealed the cleanup action alternative that meets the minimum requirements in WAC 173-340-360 and 173-204-570 and identified it as the preferred cleanup action alternative. The preferred cleanup action alternative is Ecology's proposed cleanup action for the GWPS.

The purpose of this CAP is to describe Ecology's proposed cleanup action for the GWPS. In accordance with the provisions for development of a CAP (WAC 173-340-380), this document provides the following information:

- Summary of project background and current environmental conditions (Section 2),

[2] Metro is the former Municipality of Metropolitan Seattle, a multi-jurisdictional sewerage and transportation agency that became part of King County in 1993.

- Cleanup requirements applicable to the site, including cleanup standards and other federal, state, and local laws applicable to the cleanup action (Section 3),
- Summary description of the cleanup action alternatives evaluated in the RI/FS (Section 4),
- Rationale for selection of the proposed cleanup action (Section 5),
- A description of the proposed cleanup action (Section 6), including a description of the types, levels, and amounts of hazardous substances and/or other deleterious substances that will remain on site as part of the cleanup, the measures that will be used to prevent migration and contact with those substances, compliance monitoring, potential contingency actions, and institutional controls, and
- Description of the schedule for implementation of the cleanup action (Section 7).

The upland portion of the AOI has been largely remediated through a variety of previous cleanup actions described in the RI/FS, including cleanup under a 1999 Consent Decree (Ecology 1999). This CAP focuses on the remaining areas of contamination: uncapped shoreline bank soil, arsenic in shoreline groundwater, sediment, and NAPL/tar areas.

2.0 SITE DESCRIPTION

This section provides a description of the GWPS and other background information relevant to the cleanup.

2.1. GWPS History and Background

Formerly territory occupied by three indigenous communities (the Duwamish, Hachooabsh, and Shilsholes), the area surrounding north Lake Union was settled by non-natives in the mid- to late-1800s. The first industries in the general area were associated with sawmills and forest products production that supported local small farms and homesteads. In 1891, Wallingford and other communities on the north side of Lake Union were annexed by the City. In 1907, construction of an MGP was completed in the upland areas of the GWPS to supply fuel for the growing population of Seattle. Other industries (e.g., tar refining, bulk fuel storage, shipbuilding) were developed along Lake Union shoreline adjacent to the MGP. Descriptions of the historical industrial activities associated with the GWPS are presented in the following sections.

Before natural gas was widely available, combustible gas was produced from coke, coal, and oil at MGPs throughout the United States (EPA 1988). MGPs, often called gasworks or town gas plants, provided fuel to the towns in which they operated and were instrumental in the early development of many communities. The MGP constructed by the Seattle Gas Light Company on the eastern side of what was then known as Brown's Point operated from 1907 to 1956 and was known as the Lake Station MGP. The Trans Mountain Pipeline began providing natural gas to the Seattle area in 1954, thus decreasing demand for manufactured gas, which led to the plant closure in 1956 (Sabol et al. 1988). The MGP was placed in standby mode in 1956; tanks were added to the facility for storage of natural gas until the property transferred to the City in 1973.

Many types of non-MGP industrial activities have historically occurred in the upland areas of the GWPS, including tar refining, boatbuilding and boat repair, municipal waste incineration, municipal landfilling, light oil refining, chemical manufacturing, briquetting operations, fuel storage and sales, shingle milling, coal and gravel storage, and barge and tug operations. Most of these activities took place in the western portion of the AOI upland. Tar-refining operations took place over the longest period (1907 until the mid-1960s at ATCO) and had a significant impact on conditions in the western portion of the AOI (both upland and sediment).

Other areas of Lake Union were industrialized during the same period as the MGP operation and contributed to the level of contamination found in Lake Union. Marine commerce, which began in 1911, was significantly expanded by the completion of the Ship Canal in 1916. By the 1920s, urbanization and industrial production established Lake Union as a "working lake," with over half the shoreline acreage used for manufacturing operations and industries, including boat works and maritime-related industries, engine repair facilities, machine shops, asphalt companies, oil storage and fueling operations, lumber and plywood mills, log rafting, and bulk materials storage and transport. Many facilities discharged wastes to the lake (Foster 1943; WPCC 1946; WPCC 1958).

A summary of the MGP operations from 1907 onward, along with historical information about other industrial activities that occurred on or adjacent to the upland portion of AOI, are discussed in the RI/FS (GeoEngineers 2023).

2.2. Current Land Use

Properties surrounding the upland portion of the AOI have been developed to support industrial, commercial, and residential uses. Land use planning designations support the variety of uses, as shown on Figure 2-1 (Seattle DPD 2012).

Gas Works Park is located within an Industrial Buffer (IB) zone. The park will remain in its current land use as a public park for the foreseeable future.

Properties north and adjacent to the upland portion of the AOI lie within the Wallingford neighborhood. Property uses within this commercial-zoned (C1) area include warehouses, office buildings, light industry, apartments, and condominiums (mixed-use). The C1 zone is generally defined as an automobile-oriented, primarily retail and service commercial area that serves surrounding neighborhoods as well as, a citywide or regional clientele (Seattle DPD 2012).

Zoning along the lake shoreline within the AOI allows for a variety of public and private commercial and residential land uses. Shoreline properties to the east of Gas Works Park, including Gas Works Park Marina and Waterway 19, are also zoned IB. Gas Works Park Marina provides moorage for residential houseboats.

Nearby shoreline properties to the west, including Harbor Patrol, the King County parcel that is currently leased to the Center for Wooden Boats, and the Northlake Shipyard, are zoned Industrial Commercial (IC) as shown on Figure 2-1 (Seattle DPD 2012). The intent of the IC zone is to promote development of businesses that incorporate a mix of industrial and commercial activities, including light manufacturing, research and development, while accommodating a wide range of other employment activities (Seattle DPD 2012).

Lake Union and its shoreline are regulated under Seattle's Shoreline Master Program and are subject to shoreline overlay designations (King County 2011), three of which exist within the AOI (Figure 2-1) and include:

- **Conservancy Management (CM) –** to conserve and manage areas for public purposes, recreational activities, and fish migration routes; it need not be maintained in a pure state.
- **Conservancy Waterway (CW)** – to preserve waterways for navigation and commerce, including public access to and from the water. All waterways are designated CW to provide navigational access to adjacent properties and for the loading, unloading, and temporary moorage of watercraft.
- **Urban Maritime (UM) –** to preserve areas for water-dependent and water-related uses while still providing some views of the water.

2.3. Summary of Previous Investigations

The previous investigations completed at and near the GWPS include site-wide environmental investigations, groundwater characterization, geological studies, physical conditions mapping and source characterizations. The details on the investigations conducted within the AOI are presented in the RI/FS (GeoEngineers 2023).

Investigations into the extent of site-related contamination included over 390 explorations in the upland and over 420 explorations in the sediment. Observational (e.g., sheen, odor, soil, or sediment characteristic) and quantitative non-chemical measurements (e.g., groundwater elevations, topography, bathymetry) were made as part of explorations supporting nonaqueous phase liquid (NAPL), geologic, hydrogeologic, geotechnical, and source evaluations. The quantitative non-chemical data were used to support development of the conceptual site models in the RI and development of cleanup action alternatives in the FS. Field observations from the upland and sediment explorations were used to map areas impacted by NAPL or tar. NAPL mapping and characterization techniques also included thickness gauging, laser-induced fluorescence probing (Tar-specific Green Optical Screening Tool [TarGOST®]), ultraviolet (UV) photography and petrophysical testing of soil cores, and NAPL recovery testing. Site-specific surveys to identify potential NAPL or tar seeps and characterize tar occurrences in sediment have also been conducted.

Analytical data was collected from soil (over 400 samples), groundwater (over 400 samples), sediment (over 700 samples), offshore groundwater, porewater, air, NAPL, tar, and catch basin solids. These data supported evaluations of the nature and extent of contamination, geologic and hydrogeologic conditions, risks to people and ecological receptors, fate and transport of contaminants, natural attenuation of groundwater contamination, and the potential for natural recovery of sediment. Analytical and physical data from more than 80 groundwater monitoring wells (deep, shallow, and multi-depth) were collected from 1986 to December 2020. Multiple rounds of slug tests, pump tests, and water level measurements in select wells were completed to characterize the upland groundwater and support development of a three-dimensional (3D) model of hydrogeologic conditions.

A geologic conceptual site model (CSM) was developed using data obtained from the upland and sediment explorations. Physical properties of soil and sediment were established based on the results of vane shear tests, cone penetrometer tests, triaxial tests, bearing plate tests, sieve analyses, and standard penetration tests.

Site-specific surveys to map bathymetry, evaluate substrate debris distribution, and estimate sedimentation rates were also completed.

Multiple data types (e.g., geophysical, petrophysical, UV photography, fluorescence, historical maps, and photos) were used to determine if the original contaminant sources remain (e.g., subsurface piping, tanks) and to identify areas impacted by historical sources. The City has also conducted investigations, including storm drain evaluations, to evaluate the need for source control measures to protect the sediment remedy. The GWPS storm drain system (underground pipes, catch basins and outfalls) includes outfalls that discharge 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.

2.4. Nearby MTCA Cleanup Sites

Several MTCA cleanup sites are in the general vicinity of the GWPS as shown on Figure 2-2 and described below.

The Northlake Shipyard is located north and west of the AOI boundary and has been operating since at least 1956. The shipyard entered into an agreement with the 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 at the site. Ecology conducted an interim action in early 2014 to remove sandblast grit that had been released to the lake bottom (Hart Crowser 2014). The interim action 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 on Figure 2-2.

West and northwest of the AOI upland is the former Chevron Bulk Fueling Terminal that is composed of two separate parcels formerly referred to as the North and South Yards of the Metro Lake Union facility. The South Yard parcel is owned by King County and the upland portion is leased to the Center for Wooden Boats. The South Yard parcel borders the AOI west of Waterway 20. Overwater structures related to the South Yard are located within the sediment portion of the AOI. 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 aboveground tanks. Although not immediately adjacent to the AOI, 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 AOI. Separate cleanup actions were implemented in the former North and South Yards between 1988 and 2015 to address contaminated soil and groundwater.

The former ATCO facility was located immediately north of Gas Works Park on North Northlake Way in the mid-1960s (Figure 2-2). Renamed Nortar in the late 1990s, the company continued to manufacture roofing products and formulated wood preservatives for about 20 years until the late 1980s (Equipoise Corporation 1999). After conducting a MTCA-compliant site hazard assessment in 1997, Ecology added the site to the list of Hazardous Sites and Confirmed and Suspected Contaminated Sites because soil and groundwater had been impacted by releases of petroleum hydrocarbons, pentachlorophenol (PCP) and polycyclic aromatic hydrocarbons (PAHs). Although the site does not border the shoreline, stormwater from the property is discharged to Lake Union through a municipal outfall located in 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 FAS in 2016 (Herrera 2016). 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 mg/kg for industrial properties.

The City of Seattle FAS, as licensee (WDNR Aquatic Waterway User Permit No. 20-089981), is investigating the upland portion of Waterway 20 with WDNR oversight.

2.5. Human Health and Environmental Concerns

This section summarizes potential sources of historical releases at the GWPS, remaining areas of contamination, and current complete exposure pathways and potentially affected receptors. Further details regarding human health and environmental concerns and the conceptual site exposure model (CSEM), including the fate and transport of contaminants, are presented in the RI/FS (GeoEngineers 2023).

In the RI, screening levels for each site media (soil, groundwater, and sediment) and risk evaluations (upland and sediment) were used to identify potential human health and environmental concerns and to help identify areas of the GWPS that need to be remediated to address these concerns (GeoEngineers 2023). An important part of identifying human health and environmental concerns in the RI was the development of the CSEM (see

Figure 2-3). The CSEM presents the contaminant sources, transport mechanisms, exposure routes for each media, and potential human health and ecological receptors (Figure 2-4). In addition, the CSEM identifies complete exposure pathways.

To be considered complete, an exposure pathway in the CSEM must include each of the following four elements:

- An identified source of contaminants,
- A mechanism of release and transport from the source,
- At least one exposure medium, and
- An exposure route or mechanism where a receptor can contact contaminated media.

2.5.1. Sources of Contamination to the GWPS

Given the urban/industrial setting of Lake Union, sources of contamination within the AOI include GWPS sources associated with the historical MGP facility, tar refinery, and other industrial activities. Additionally, off-site sources to Lake Union that are primarily associated with other non-point or point sources (e.g., combined sewer/stormwater overflows [CSOs], storm drains, marinas, houseboats, fueling docks, recreational and commercial boat traffic, etc.) can impact sediment quality throughout the lake.

The MGP and a tar refinery were the two main industries operating in the AOI upland for much of its history and are the primary GWPS sources. The MGP was initially constructed in 1907 and expanded over time until it was closed in 1956. West of the MGP, the tar refinery that later became ATCO operated during the same period (1907 to the mid-1960s) and was one of the historical sources of contamination found in the western portion of the AOI.

During regular operation of both the MGP and tar refinery, raw materials, wastes, and commercial products and byproducts leaked or overflowed from tanks, pipelines, and process areas or were spilled to the ground or to the water during shipping and handling. MGP bulk fuels (e.g., coal) and commercial byproducts (e.g., lampblack) were stored in open areas near points of use or loading/offloading in the southern portion of the upland.

Thylox solution that contained arsenic was used in gas purification at the MGP and, when spilled or leaked, during regular plant operations, sank downward through soil and groundwater because it was denser than water. The Thylox process area was located near the present-day Play Area. Some discharges of Thylox solution might have also occurred through the outfalls along the eastern shoreline.

Other historical industrial operations within the upland portion of the AOI included boatbuilding and repair; municipal waste incineration and landfilling; light oil refining; chemical manufacturing; briquetting operations; fuel storage and sales; shingle milling; coal and gravel storage; and barge and tug operations. The historical release of fuels, chemicals, wastes and other contaminated materials from these operations may have contributed to contamination in the AOI, primarily in the western portion.

Lake Union has long supported industrial and marine commerce typified by the storage and transport of coal, timber, and petroleum; shipbuilding; metal fabrication; product manufacturing and assembly; and lumber milling. Over the years, contaminants ultimately entered the lake sediment through direct discharge, spills, leaks, runoff, erosion, and disposal. Most industrial operations along the Lake Union shoreline have ceased

and related historical sources of contamination have been eliminated. Potential ongoing sources to the lake are generally limited to permitted discharges from CSOs and storm drains, releases from existing industries such as marinas and shipyards, and low-level contributions from non-point sources. Ambient Lake Union (ALU) sediment quality conditions reflect both the historical and remaining potential sources of contamination.

2.5.2. Remaining Areas of Contamination

Most of the upland portion of the AOI has been remediated through a variety of previous cleanup actions described in the RI/FS (GeoEngineers 2023), including cleanup under a 1999 Consent Decree (Ecology 1999). Remaining areas of contamination include uncapped shoreline bank soil, arsenic in shoreline groundwater, sediment, and NAPL/tar areas. The remaining areas of contamination are shown in Figures 2-5 through 2-13, and described below:

- **Uncapped Shoreline Bank Soil**: A human health risk assessment was conducted in the RI for areas of the upland (including shoreline banks) that remain uncapped and cPAHs were identified as the primary contaminants of concern (COCs). This area contributes to unacceptable human health risks for cPAHs in the upland portion of the AOI and is a potential source of contamination to sediment via erosion. Figure 2-5 shows the uncapped shoreline bank soil.
- **Arsenic in Shoreline Groundwater**: Other than arsenic, upland groundwater contaminants have been addressed by the cleanup actions associated with the 1999 Consent Decree. However, the 1999 Consent Decree predates the discovery of historical arsenic releases from the Thylox process at the Play Area. Arsenic was detected in groundwater at elevated concentrations near the Play Area in April 2013. An interim action was completed between 2016 and 2020 and resulted in a significant reduction of dissolved arsenic within the Play Area, but dissolved arsenic remains at elevated concentrations in groundwater within the Play Area and downgradient of the Play Area outside the limits of the interim action. The remaining arsenic in upland groundwater is not expected to impact sediment or surface water; however, it will be further addressed to meet regulatory source control requirements for establishing a conditional point of compliance, see Section 3.2.3.2, Figure 2-6 shows the extent of arsenic in shoreline groundwater with concentrations greater than the natural background groundwater cleanup level.
- **Sediment**: One or more sediment COCs have been detected in sediment at concentrations greater than sediment cleanup levels (for GWPS COCs) and sediment screening levels (for ALU COCs) throughout the sediment portion of the AOI. Figures 2-7 and 2-8 show chemical and biological exceedances of benthic criteria. Figures 2-9 and 2-10 show exceedances of human health criteria for direct contact (net fishing) and direct contact (beach play/wading). Figure 2-11 shows exceedances of human health and ecological criteria for bioaccumulation. Based on these data, the entire sediment portion of the AOI is an area of human health or environmental concern.
- **NAPL/Tar**: NAPL and tar areas were not evaluated relative to human health or ecological criteria in the RI/FS. Rather, the focus is to prevent human health or ecological exposure to the NAPL and tar areas and to reduce the potential for vertical migration of NAPL and dissolved contaminants in groundwater associated with the NAPL to the sediment surface. Figure 2-12 shows the extent of shallow NAPL and tar areas.

2.5.3. Current Exposure Pathways and Potentially Affected Receptors

Exposure pathways are the ways people or ecological receptors can be exposed either directly or indirectly to contaminants. Exposure may involve direct contact or ingesting contaminated soil or sediment or eating food that has become contaminated due to exposure to contaminated media. The receptors for the GWPS are park

visitors, park workers, recreational fishers, Tribal fishers, the benthic invertebrate community, fish, and aquatic-dependent wildlife (e.g., otters, heron, ducks, etc.), as identified in Figure 2-4. These receptors may be exposed to contaminated media by several key pathways.

The following exposure pathways represent the current risk of exposure to contaminants for receptors at the GWPS:

- Human contact with or incidental ingestion of:
  - Uncapped surface soil during park visits,
  - Seasonal beach surface sediment during beach play and wading, and
  - Offshore surface sediment while net fishing.
- Human ingestion of contaminated fish and shellfish,
- Benthic invertebrate contact with or ingestion of contaminated surface sediment,
- Fish consumption of contaminated prey, and
- Aquatic-dependent wildlife consumption of contaminated prey.

Previous cleanup actions, including upland soil capping, installation, and operation of the groundwater treatment system in the southeast area, ongoing removal of tar, groundwater treatment for arsenic near the Play Area, and fencing around the historical MGP Cracking Towers have significantly reduced risks from exposure of receptors to contaminated media.

Exposure can currently occur in the following areas of the GWPS (Figure 2-4):

- Tar- and cPAH-contaminated surface soil and sediment along the shoreline banks where people might play and wade in the water,
- In the lakeshore, lake slope, and lake bottom zones, where Tribal net fishers, crayfish, and finfish might contact surface sediment contaminated with cPAHs and arsenic,
- In the lakeshore, lake slope, and lake bottom zones, where crayfish and finfish might be caught and ingested by wildlife and people, and
- PAH-contaminated surface sediment in the lakeshore and lake slope zones, where the benthic invertebrate community might be present.

3.0 CLEANUP REQUIREMENTS

This section presents applicable regulatory requirements for the cleanup action, identifies cleanup standards based on these regulatory requirements, and summarizes applicable local, state, and federal laws.

3.1. Contaminants of Concern

COCs were identified for each GWPS media according to MTCA and SMS requirements. COCs are contaminants identified as posing a potential risk to human health or the environment. The following sections detail the identification of COCs for soil, upland groundwater, offshore groundwater, and sediment at the GWPS. The COCs that are identified for each GWPS media are listed in Table 3-1.

Groundwater is differentiated in the RI as either upland groundwater or offshore groundwater. Upland groundwater is defined as the groundwater located landward of the OHWM within the upland portion of the AOI. Offshore groundwater is defined as the groundwater located waterward of the OHWM within the sediment portion of the AOI, below the biologically active zone (top 10 centimeters [cm] of sediment). In accordance with Ecology guidance, water within the sediment biologically active zone is porewater.

3.1.1. Soil and Upland Groundwater COCs

COCs for soil and upland groundwater were established in the 1999 Consent Decree (see Table 3-1).

3.1.2. Offshore Groundwater COCs

Offshore groundwater COCs were identified by comparing the offshore groundwater concentrations for contaminants of potential concern (COPCs) to the RI/FS offshore groundwater screening levels. An offshore groundwater COPC was identified as a COC if the maximum detected concentration is greater than the offshore groundwater screening levels.

3.1.3. Sediment COCs

Consistent with SMS, sediment COCs were identified based on protection of benthic organisms (benthic COCs), people contacting sediment during beach play, wading, or net fishing (direct contact COCs), and people and wildlife (birds, mammals, and other fish) who eat finfish and crayfish from the AOI (bioaccumulative COCs). The following subsections describe how benthic, human health direct contact, and bioaccumulation COCs were identified.

Given the urban/industrial setting of Lake Union, the sediment COCs identified in this section were evaluated in the RI to identify which are site-related COCs (referred to as GWPS COCs) associated with historical MGP, tar refinery, and other upland industrial activities and which are widespread co-located COCs primarily associated with other non-point or point sources (e.g., CSOs, storm drains, marinas, houseboats, fueling docks, recreational and commercial boat traffic, etc.) affecting sediment quality throughout the lake (referred to as ALU COCs). GWPS and ALU sediment COCs are discussed further in Section 3.2.1.

3.1.3.1. Benthic COCs

Benthic COCs were identified by comparing sediment COPC concentrations in surface sediment to SMS benthic sediment cleanup objective (SCO) criteria. An SCO exceedance in any sample resulted in that contaminant being included as a benthic COC.

3.1.3.2. Human Health Direct Contact COCs

The process for identifying human health direct contact COCs is discussed in detail in Appendix 4E of the RI. The direct contact COCs are based on the exposure scenario of people encountering contaminated sediment during beach play, wading, or net fishing.

Human health direct contact COCs are identified using MTCA Method B soil cleanup levels, EPA Regional Screening Levels (RSLs), and information from the human health risk evaluation presented in Appendix 4C of the RI.

3.1.3.3. Bioaccumulative COCs

The process for identifying bioaccumulative COCs is discussed in detail in Appendix 4E of the RI. The bioaccumulative COCs are based on exposure scenario of people and wildlife (birds, mammals, and other fish) ingesting finfish and crayfish from the AOI.

Bioaccumulative COCs are identified using regulatory lists of potentially bioaccumulative contaminants and information from the human health and ecological risk evaluation presented in Appendix 4D of the RI.

3.2. Cleanup Standards

The following sections describe the cleanup standards that must be achieved by the cleanup action.

Under SMS and MTCA cleanup standards consist of:

- **Cleanup levels** – chemical concentrations (or levels) in environmental media or biological effect thresholds that are protective of human health and the environment.
- **Points of compliance** – the location(s) where the cleanup levels must be met. Typically established with a depth component on either a point or area basis.

The 1999 Consent Decree (Ecology 1999) includes soil and groundwater cleanup standards. The groundwater addressed by the cleanup actions required in the 1999 Consent Decree is equivalent to the "upland groundwater" discussed in the RI. The remaining pathways to sediment and surface water that were not addressed in the 1999 Consent Decree are erosion of shoreline bank soil and potential transport of COCs in groundwater to surface water and sediment.

3.2.1. Shoreline Bank Soil

The areas of shoreline bank soil presenting a risk of exposure to cPAH contamination and with the potential for erosion to sediment will be addressed as an element of the sediment cleanup and a cleanup level is not proposed. Uncapped shoreline bank soil will be excavated as part of the cleanup action to transition from the existing upland ground surface to the in-water sediment remedy and will include additional excavation for mass removal. Following excavation, a vegetated soil cap will be placed on the surface of the excavation to prevent direct exposure to park users and to prevent erosion into Lake Union.

Addressing the shoreline bank soil as part of the sediment cleanup will also reduce the risks from exposure to cPAH-contaminated surface soil across the upland portion of the AOI to meet regulatory requirements, see the upland risk evaluation presented in the RI/FS (GeoEngineers 2023).

3.2.2. Sediment

As described in Section 3.1.3, GWPS COCs and ALU COCs are present within the sediment portion of the AOI. Sediment cleanup standards were developed for GWPS COCs associated with historical MGP, tar refinery, and other upland industrial activities. Sediment cleanup standards were not developed for co-located ALU COCs because they are not associated with historical GWPS sources. However, screening levels were developed (see Table 3-3).

Sediment cleanup levels and points of compliance address multiple exposure pathways and receptors. The sediment cleanup levels for GWPS COCs are based on protection of benthic organisms (direct contact and ingestion), protection of people that may contact sediment during beach play/wading (i.e., direct contact comprising incidental ingestion and dermal contact), and protection of people and ecological receptors that may consume fish and shellfish foraged from the sediment portion of the AOI (bioaccumulation).

In general, the sediment cleanup levels are set as the highest of the following levels:

- The lowest risk-based concentration protective of benthic organisms (multiple pathways), human health (direct contact and bioaccumulation) or ecological receptors (bioaccumulation),
- Background (natural or regional) levels, or
- Practical quantitation limits (the lowest concentration that can be reliably measured by analytical laboratories).

Sediment cleanup standards for GWPS COCs are presented in Table 3-2. Sediment screening levels applicable to ALU COCs are presented in Table 3-3.

3.2.2.1. Sediment Cleanup Level

In accordance with the SMS, the SCO is the sediment quality goal. Sediment cleanup levels are initially established at the SCO and may be adjusted up to, but not higher than, the cleanup screening level (CSL) based on an evaluation of technical possibility and net adverse environmental impact (WAC 173-204-560[2][a][ii]). The Sediment Cleanup User's Manual (Chapter 7 Section 7.2.3.2; Ecology 2021) details how to determine whether it is technically possible to attain the SCO based on site-specific factors, including, but not limited to, the ability to:

- Achieve the SCO using available cleanup technologies, and
- Maintain the SCO after cleanup construction.

The sediment cleanup levels for carbazole and dibenzofuran are set at the SCO based on the protection of benthic organisms. The sediment cleanup level for nickel is set at the SCO based on Puget Sound natural background.

For cPAH toxic equivalent concentrations (TEQ), total PAHs (TPAH), and arsenic, the technical possibility to attain SCO was evaluated against the site-specific factors described above. While the SCO can be achieved using available cleanup technologies, it cannot be maintained after cleanup construction due to numerous ongoing diffuse sources to Lake Union that are not under the authority or responsibility of the potentially liable parties (PLPs). Therefore, the sediment cleanup levels for cPAH TEQ, TPAH, and arsenic are adjusted upward from the SCO to the CSL. The TPAH CSL is based on the protection of benthic organisms. The cPAH TEQ and arsenic CSLs are based on regional and preliminary regional background values, respectively.

3.2.2.2. Sediment Point of Compliance

In accordance with the SMS, different points of compliance are applied to sediment based on the exposure pathways and receptors associated with each cleanup level. Contaminants including TPAH, carbazole, dibenzofuran, arsenic, and nickel are benthic COCs whereas, cPAHs and arsenic are direct contact and bioaccumulative COCs.

The benthic, direct contact and bioaccumulation points of compliance for the GWPS are as follows:

- **Benthic** – TPAH, carbazole, dibenzofuran, arsenic, and nickel. The point of compliance depth for protection of benthic invertebrates is the biologically active zone, which is the upper 10 cm of sediment (i.e., surface to 0.33 feet below mudline). This point of compliance depth addresses direct toxicity to benthic organisms caused by ingestion of or contact with contaminated sediment and associated porewater. The associated

point of compliance area is identified as the "Benthic Toxicity Area" on Figure 3-1. Compliance will be evaluated on a point-by-point basis.

- **Direct contact** – cPAHs and arsenic. The direct contact exposure areas extend from the OHWM to a lake bottom elevation of 15 feet. This corresponds to a range of maximum water depth between 5 and 7 feet, depending on the time of year and lake level. The point of compliance depth for nearshore sediment that is seasonally exposed by United States Army Corps of Engineers (USACE)-managed lake levels is the upper 45 cm (i.e., 0 to 1.5 feet below mudline) based on beach play exposure potential. The point of compliance depth for sediment that is always covered by water is the upper 10 cm based on wading exposure. The associated points of compliance areas are identified as the "Direct Contact Beach Play and Wading Exposure Area" and the "Direct Contact Wading Exposure Area" on Figure 3-1. Compliance will be evaluated on a surface area-weighted average concentration (SWAC) basis.
- **Bioaccumulation** – cPAHs and arsenic. The exposure area for bioaccumulative compounds is the sediment portion of the AOI. The point of compliance depth is the upper 10 cm; this point of compliance is intended to protect exposure during net fishing and the bioaccumulation exposure pathway for both people and ecological receptors consuming fish and shellfish. The associated point of compliance area is identified as the "Bioaccumulation Exposure Area" on Figure 3-1. Compliance will be evaluated on a SWAC basis.

3.2.3. Groundwater

Groundwater is differentiated as either upland groundwater or offshore groundwater as described in Section 3.1. The RI included groundwater screening levels (SLs) for both. Transport of COCs in upland groundwater was identified to not result in exceedances of sediment and surface water criteria at the respective points of compliance. Rather, the concern is transport of COCs by offshore groundwater that is flowing through contaminated sediment. Therefore, the cleanup action uses a groundwater cleanup standard, applicable only to offshore groundwater, based on protection of surface water and sediment.

Groundwater cleanup standards applicable to offshore groundwater are presented in Table 3-4 along with the basis for each value.

3.2.3.1. Groundwater Cleanup Level

The groundwater cleanup level for each COC is the same as the offshore groundwater screening levels presented in Section 4 of the RI. The arsenic groundwater cleanup level is 8 micrograms per liter (µg/L), which is the natural background concentration for the Puget Sound Basin (Ecology 2022b).

3.2.3.2. Groundwater Point of Compliance

The 1999 Consent Decree established a conditional point of compliance (CPOC) as close as technically possible to the location where groundwater flows into Lake Union for the upland groundwater COCs. In addition, the RI established that the MTCA conditions for use of a COPC also apply to arsenic, which was not identified as an upland groundwater COC in the 1999 Consent Decree (GeoEngineers 2023). Therefore, in accordance with MTCA and Ecology guidance, the CPOC is set at 10 cm below the sediment mudline, at the base of the biologically active zone within the Groundwater Compliance Area (see Figure 3-2).

3.3. Potentially Applicable Laws

Cleanup actions conducted under MTCA and SMS must comply with the local, state and federal laws (WAC 173-340-710) that have jurisdiction over the cleanup or that Ecology otherwise determines may apply to the cleanup. The potentially applicable laws identified for cleanup and regulatory requirements that may impact project permitting and implementation are listed in Table 3-5. The procedures, standards and other

requirements specified in MTCA and SMS are the primary laws governing cleanup actions for the sediment portion of the AOI. Additional laws regulate specific components of the cleanup, such as waste disposal, management of stormwater during construction, and worker safety during implementation. In addition, MTCA requires that the parties conducting the cleanup obtain all required permits and/or approvals, and where a cleanup action is exempt from obtaining permits that the substantive requirements of the exempt permits are met. The sections below outline the permits to be obtained and the additional substantive requirements that must be met as part of the cleanup.

3.3.1. Permits to be Obtained

Federal and state permitting for in-water construction is addressed through the Joint Aquatic Resource Permit Application (JARPA). The JARPA coordinates information applicable to the USACE-issued CWA Section 10 and Section 404 permits. It is anticipated that the proposed cleanup action will qualify for a Nationwide Permit 38 which is for the specific purpose of cleanup of hazardous and toxic waste as ordered, or sponsored by a government agency with established legal or regulatory authority. The JARPA also coordinates information applicable to an Ecology-issued CWA Section 401 Water Quality Certification that will be required if the proposed cleanup action does not qualify for a Nationwide Permit 38 and the WDNR Use Authorization for State-Owned Aquatic Lands, among others. The federal permitting process includes review of issues relating to waters of the United States (including wetlands), Tribal resources and treaty rights, threatened and endangered species, habitat impacts and other factors. As part of the federal permitting process, the USACE will consult with the following:

- Tribes;
- Natural resource trustees regarding potential project impacts on species and habitats protected under the ESA and related requirements; and
- State Department of Archaeology and Historic Preservation to determine the effects of the cleanup action under Section 106 of the National Historic Preservation Act (Gas Works Park was listed in the National Register of Historic Places in 2013).

The USACE's CWA review will also require ESA consultation with the federal wildlife agencies, and completion of Ecology's 401 water quality certification review.

The following describes several permitting considerations:

- Endangered Species Act Review: Cleanup actions conducted where there is potential to affect threatened and/or endangered species or critical habitat will be subject to Endangered Species Act Section 7 review. USACE will consult (either formally or informally) with National Marine Fisheries Service and the U.S. Fish and Wildlife Service will perform the review as part of the permit process. Aquatic species identified as threatened under the Endangered Species Act include Chinook Salmon, Steelhead, and Bull trout. Critical habitats have been identified for Chinook salmon and bull trout.
- Historical/Archaeological Review: The permit process will involve review of the cleanup action by USACE to evaluate the potential to disturb historical or archaeological resources.
- State and National Environmental Policy Act Review: This cleanup is subject to environmental impact review under State Environmental Policy Act (SEPA) and/or National Environmental Policy Act (NEPA) regulations. Ecology has completed SEPA review for the proposed cleanup action and has determined that

the cleanup action will not have a probable significant impact on the environment. NEPA review will be completed by the USACE prior to completing the Section 404/10 permitting.

- Water Quality Certification: As part of the USACE Section 404 permitting process, a Section 401 water quality certification must be obtained from Ecology. Certification ensures that any dredge or fill in waters of the U.S. will comply with State water quality standards and other aquatic resource protection requirements under Ecology's authority.
- National Pollutant Discharge Elimination System (NPDES) Permit for the discharge of pollutants to waters of the United States pursuant to CWA Section 402: To the extent that the cleanup action requires discharges to the local sanitary sewer system or to surface water, any necessary permitting, including under CWA Section 402, will be obtained to ensure compliance with state water quality standards. The NPDES is a federal regulation that is administered by individual states. Therefore, NPDES permits will be obtained from Ecology.

3.3.2. Permit Exemption Substantive Requirements

Cleanup actions conducted under a MTCA Agreed Order or Consent Decree are exempt from the procedural requirements of the following state and local permits: Washington State Clean Air Act, Solid and Hazardous Waste Management Act, Hydraulic Code Rules, Water Pollution Control Act, Shoreline Management Act, and local regulations. However, the cleanup action must meet the substantive requirements of the permits or approvals that are procedurally exempt under RCW 70A.305.090. The JARPA may be provided to state and local agencies to obtain permit exemption confirmation letters.

Projects involving in-water construction activities typically require a Hydraulic Project Approval (HPA). HPAs are issued by the Washington Department of Fish and Wildlife (WDFW) and define state requirements for construction activities that could adversely affect fisheries and water resources. The cleanup action is exempt from obtaining an HPA, but WDFW will review the project for adherence with the substantive requirements of the HPA.

Shoreline Master Programs are local land-use policies under the State Shoreline Management Act that guide use of Washington shorelines. Ecology conducts site-specific review of cleanup actions conducted under MTCA, to evaluate whether those actions are consistent with the substantive requirements of the Shoreline Master Program. In addition, the City of Seattle Shoreline Master Program regulates development in the shoreline environment within the City and typically requires a shoreline substantial development permit or a shoreline exemption for shoreline development construction. The cleanup action will involve grading of more than 250 cubic yards of soil within the shoreline environment, which typically would trigger the need for a City of Seattle shoreline substantial development permit. The cleanup action is exempt from obtaining the actual permit, but the City will review the project for adherence with the substantive requirements of the shoreline substantial development permit.

Many of the permits likely to be associated with construction activities occurring in the upland, outside the jurisdiction of federal permitting for in water construction, including excavating, stabilizing, and capping shoreline bank soil; excavating the tar mound on the eastern shoreline, and treating arsenic in upland groundwater, are either exempt from the corresponding procedural requirements per MTCA (although substantive requirements must be met) or will be coordinated as part of City land use permit requirements. Other permits for which substantive requirements may need to be met include a Puget Sound Clean Air Agency operating permit, King County Wastewater Discharge Authorization permit, City Street Use permit, City building and grading permits, and a City Parks Revocable Use permit.

4.0 CLEANUP ACTION ALTERNATIVES CONSIDERED

This section describes the cleanup action alternatives that were evaluated in the RI/FS. The process of developing cleanup action alternatives included dividing the GWPS into several management areas with unique characteristics that require consideration for cleanup action, evaluating applicable remediation technologies for the various physical and chemical conditions present, screening the list of technologies against conditions present in the individual management units, and assembling a set of cleanup action alternatives that are expected meet MTCA and SMS minimum requirements.

4.1. Delineation of Management Areas

Two cleanup units have been defined within the AOI: an Upland Cleanup Unit and a Sediment Cleanup Unit (SCU). The SCU is waterward of the OHWM. As described in prior sections of this CAP, contamination in the upland unit has been largely addressed through a variety of previous cleanup actions. Remaining areas of contamination within the AOI are divided into management areas based on the guidance provided in the Sediment Cleanup User's Manual (SCUM).

The delineation of management areas considered environmental conditions and other factors that affect the applicability of specific remediation technologies and the feasibility of their implementation.

Factors considered in developing the management areas, included:

- COC distribution and magnitude of concentrations,
- Physical attributes of the sediment, sediment bed, and the area in which the sediments are located,
- Chemical migration or transport pathways, and
- Property ownership and associated land use.

The result of this evaluation was the development of one groundwater management area (GWMA) and fourteen sediment management areas (SMAs), as shown on Figure 4-1., shoreline areas of the upland cleanup unit are divided into three management areas (GWMA-1, SMA-1, and SMA-2) and the SCU is divided into multiple management areas (SMA-3 to SMA-14). Table 4-1 presents a description of each management unit, along with the environmental conditions for each management unit.

4.2. Identification and Screening of Remedial Technologies and Institutional Controls

A remedial technology screening process was used to ensure that the cleanup action alternatives assembled were based on a set of remedial technologies that are effective and implementable for the various conditions present. Remediation technologies were evaluated independently, as well as relative to other similar technologies with respect to the three primary screening criteria—effectiveness, implementability, and relative cost. For the technology screening process, effectiveness considered the ability to protect human health and the environment during and following construction and to meet preliminary cleanup levels. The evaluation of technology implementability included both technical and administrative feasibility – including the availability of products, services, and equipment needed to implement the technology safely and effectively, the ability to obtain necessary permits and regulatory and public acceptance. Cost is also considered at the technology screening level, but initially to a lower degree than effectiveness and implementability in favor of deferring the consideration of cost to the evaluation of alternatives. However, when multiple similar technologies are being evaluated, cost is considered to reduce the number of similar technologies used to develop alternatives.

The process to develop cleanup action alternatives included the step of identifying and evaluating potentially applicable remediation technologies for the various contaminants, media, and conditions present within the management units identified. Because of the range of conditions across the SCU and resulting range of applicable of technologies, the technology screening process considered the applicability of remediation technologies to the specific conditions within each of the identified management areas rather than for broad application of the technologies across the SCU. The results of the technology screening process, as applied to individual management units, is presented in Table 4-1. These selected technologies were assembled into a series of cleanup action alternatives, as described in the sections that follow.

Institutional controls were also evaluated for inclusion in cleanup action alternatives. Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the integrity of the cleanup action or may result in exposure to contamination. Institutional controls are required by MTCA when cleanup actions leave contamination in place. The following potentially applicable institutional controls were included as a common element of all cleanup action alternatives:

- Physical measures – fencing,
- Use restrictions – legal restrictions limiting the use of the property or resources (e.g., environmental covenants prohibiting cap disturbance without prior written approval from Ecology),
- Maintenance requirements – requirements for inspection, monitoring, and repairs,
- Educational programs – measures to provide information about the presence of contamination and ways to limit exposure, and
- Financial assurances – mechanisms that provide funds to cover all costs associated with the operation and maintenance of the cleanup action.

4.3. Cleanup Action Alternatives

Eight cleanup action alternatives were developed from the retained remediation technologies that were determined to be applicable to the conditions at the GWPS. The cleanup action alternatives were created to meet MTCA and SMS minimum requirements. As is common in the cleanup process, permit requirements and pre-design investigation data may modify the cleanup action alternatives from descriptions presented below to meet site-specific regulatory requirements. The key cleanup approach concepts for each of the alternatives are shown in the matrix below.

CLEANUP ACTION ALTERNATIVES CONCEPTS

Key Concepts of the Cleanup Action Alternatives	Alt-1	Alt-2	Alt-3	Alt-4	Alt-5	Alt-6	Alt-7	Alt-8
Treat arsenic in upland groundwater between the Play Area and the shoreline	•	•	•	•	•	•	•	•
Excavate and cap exposed upland shoreline bank soil to prevent direct-contact exposure and erosion	•	•	•	•	•	•	•	•
Dredge nearshore contaminated sediment to the degree necessary to maintain lake surface area after capping	•	•	•					

Key Concepts of the Cleanup Action Alternatives	Alt-1	Alt-2	Alt-3	Alt-4	Alt-5	Alt-6	Alt-7	Alt-8
Dredge nearshore contaminated sediment to a greater degree to increase mass removal in nearshore areas				•	•	•	•	•
Dredge offshore areas for the purpose of removing contaminant mass							•	•
Contain sediment contaminants by capping	•	•	•	•	•	•	•	•
Use enhanced capping methods, including low-permeability and/or amended capping to increase containment and provide in-situ treatment		•	•	•	•	•	•	•
Utilize natural recovery where contaminant concentrations are moderate to low and sediment deposition is occurring	•	•	•	•	•	•	•	•

The specific remedial technologies utilized for each of the cleanup action alternatives as applied to each SMA are summarized in Table 4-2.

The cleanup action alternatives share several common elements. These elements were consistent across the eight alternatives and therefore, did not affect the comparative evaluation of the alternatives. However, to more completely estimate the cost[3] for each alternative, the costs for the common elements are included in the total estimated cost for each alternative. The following elements are common to the alternatives evaluated.

- Excavate, stabilize, and cap exposed shoreline bank soil (SMAs-1 and -2).
- Excavate the tar mound on the eastern shoreline (SMA-1).
- Treat arsenic in upland groundwater (GWMA-1).
- Monitor groundwater (GWMA-1).
- Dispose excavated/dredged material offsite.
- Restore shoreline habitat to existing conditions.
- Complete a pre-design investigation to collect supplemental data that will be used to refine the design of the cleanup action.
- Apply institutional controls.
- Complete storm drain modifications.
- Long-term monitoring and maintenance.

[3] The cost estimates for each alternative, minus the applied contingency, are order-of-magnitude costs within a range of -30 to +50 percent.

The sections below present a general summary of each cleanup action alternative. Figure 4-2 presents a comparison of the eight cleanup action alternatives.

4.3.1. Cleanup Action Alternative 1

Cleanup Action Alternative 1 consists of conventional sand capping, nearshore dredging, and natural recovery processes in combination with the common elements described in Section 4.1 to achieve cleanup standards in the SCU. As shown in Table 4-2 and Figure 4-3, in addition to the common components described above, Alternative 1 includes the following cleanup components.

- Conventional sand capping in both nearshore and offshore areas (SMA-3 through SMA-12) to address direct contact with sediments. The cap is thickened in nearshore areas with potential for advective transport and offshore areas with shallow NAPL.
- Dredging in nearshore areas (SMA-3 and SMA-4) where feasible, using land-based methods to prevent loss of aquatic lands due to capping.
- Partial dredging in nearshore areas (SMA-5 and SMA-10), where necessary, to facilitate placement of cap material in water depths less than 15 feet to minimize disruptions to facility operations.
- Natural recovery processes (Enhanced Natural Recovery [ENR] and Monitored Natural Recovery [MNR]) in depositional lake bottom areas with relatively low contaminant concentrations (SMA-13 and SMA-14).

4.3.2. Cleanup Action Alternative 2

Cleanup Action Alternative 2 consists of conventional and enhanced capping methods, nearshore dredging, and natural recovery processes in combination with the common elements described in Section 4.1 to achieve cleanup standards in the SCU. As shown in Table 4-2 and Figure 4-4, in addition to the common components described above, Alternative 2 includes the following cleanup components.

- Enhanced capping in nearshore areas (SMA-3 through SMA-5) with highest groundwater flux to increase the reliability of contaminant attenuation.
- Other cleanup components for Alternative 2 are equivalent to Alternative 1.

4.3.3. Cleanup Action Alternative 3

Cleanup Action Alternative 3 consists of conventional and enhanced capping methods, nearshore dredging, and natural recovery processes in combination with the common elements described in Section 4.1 to achieve cleanup standards in the SCU. Alternative 3 includes an extensive application of enhanced capping methods to increase reliability or containment and attenuation of mobile contaminants. As shown in Table 4-2 and Figure 4-5, in addition to the common components described above, Alternative 3 includes the following cleanup components.

- Enhanced capping in adjacent offshore SMAs (SMA-7 through SMA-9 and SMA-12) with the potential for contaminant transport to surface water and areas of shallow NAPL are addressed by enhanced capping methods.
- Similar to Alternative 2, enhanced capping in nearshore areas (SMAs 3 through 5) with highest groundwater flux to increase the reliability of contaminant attenuation.
- Other cleanup components for Alternative 3 are equivalent to Alternative 1.

4.3.4. Cleanup Action Alternative 4

Cleanup Action Alternative 4 consists of conventional and enhanced capping methods, nearshore dredging, and natural recovery processes in combination with the common elements described in Section 4.1 to achieve cleanup standards in the SCU. Alternative 4 utilizes components from previous alternatives in nearshore and offshore areas with the addition of expanded nearshore dredging for greater contaminant mass reduction. As shown in Table 4-2 and Figure 4-6, in addition to the common components described above, Alternative 4 includes the following cleanup components.

- Enhanced capping in nearshore areas (SMA-3 and portions of SMA-4 and SMA-5) with highest groundwater flux to increase the reliability of contaminant attenuation and in a portion of adjacent offshore SMA-9 with the potential for contaminant transport to surface water.
- Expanded nearshore dredging in SMAs adjacent to the park (SMA-3 and SMA-4) where feasible to remove additional contaminant mass, reduce potential for contaminant transport in the nearshore zone of greatest groundwater flux, and to prevent loss of aquatic lands due to capping.
- Other components of Alternative 4 are equivalent to Alternative 1.

4.3.5. Cleanup Action Alternative 5

Cleanup Action Alternative 5 consists of conventional and enhanced capping methods, nearshore dredging, and natural recovery processes in combination with the common elements described in Section 4.1 to achieve cleanup standards in the SCU. Alternative 5 utilizes components from previous alternatives in nearshore and offshore areas with the addition of expanded nearshore dredging for greater contaminant mass reduction and expands the scope of enhanced capping used in Alternative 4. As shown in Table 4-2 and Figure 4-7, in addition to the common components described above, Alternative 5 includes the following cleanup components.

- Enhanced capping in offshore areas (SMA-7 and SMA-8) of shallow NAPL and high sediment contaminant concentrations, which may be susceptible to migration, to increase the reliability of containment.
- Other cleanup components of Alternative 5 are equivalent to Alternative 4.

4.3.6. Cleanup Action Alternative 6

Cleanup Action Alternative 6 consists of conventional and enhanced capping methods, nearshore dredging, and natural recovery processes in combination with the common elements described in Section 4.1 to achieve cleanup standards in the SCU. Alternative 6 utilizes components from previous alternatives in nearshore and offshore areas with the addition of expanded nearshore dredging for contaminant mass reduction and modifies the scope of enhanced capping used in Alternative 4. As shown in Table 4-2 and Figure 4-8, in addition to the common components described above, Alternative 6 includes the following cleanup components.

- Enhanced capping in nearshore areas (SMAs 3 through 5) with highest groundwater flux to increase the reliability of contaminant attenuation.
- Enhanced capping in offshore areas (SMA-7 and SMA-9) of shallow NAPL and high sediment contaminant concentrations, which may be susceptible to migration, to increase the reliability of containment.
- Other cleanup components of Alternative 6 are equivalent to Alternative 4.

4.3.7. Cleanup Action Alternative 7

Cleanup Action Alternative 7 builds upon the components of other alternatives by incorporating offshore mass removal of contaminated sediment to the maximum extent feasible along with broad application of enhanced capping methods. By contrast, the other alternatives include removal only as necessary to accommodate a cap, maintain water depths to minimize disruptions to facilities or to achieve additional mass reduction of contaminated sediment in nearshore areas. As shown in Table 4-2 and Figure 4-9, in addition to the common components described above, Alternative 7 includes the following cleanup components.

- Dredging a broad area off the southern shoreline of Gas Works Park (SMA-6) consisting of primarily lakeshore sediment for mass removal of contaminated sediment.
- Similar to Alternative 3, the most extensive application of enhanced capping to increase reliability or containment and attenuation of mobile contaminants (SMA-3 through SMA-5, SMA-7 through SMA-9, and SMA-12).
- Other cleanup components of Alternative 7 are equivalent to Alternative 4.

4.3.8. Cleanup Action Alternative 8

Cleanup Action Alternative 8 builds upon Alternative 7 by increasing the application of capping and enhanced natural recovery methods in the offshore, lake bottom areas of SMA-13 and SMA-14. Under Alternative 8, conventional sand capping and ENR are included in offshore areas SMA-13 and SMA-14 respectively (Table 4-2 and Figure 4-10). By contrast, Alternatives 1 through 7 include ENR for SMA-13 and MNR for SMA-14. SMA-1 through SMA-12 are addressed by the same methods and to the same degree as described for Alternative 7.

5.0 BASIS FOR THE SELECTION OF THE CLEANUP ACTION

The RI/FS evaluated the eight cleanup action alternatives against the minimum requirements and procedures in WAC 173-340-360 and WAC 173-204-570. This section presents the evaluation criteria and evaluation results for the selection of the proposed cleanup action.

5.1. MTCA/SMS Minimum Requirements

Cleanup actions performed under the SMS are evaluated based on the minimum requirements specified in WAC 173-204-570[3]. SMS requires evaluation of cleanup action alternatives relative to improvement in overall environmental quality, known as net environmental benefit, and for adverse environmental impacts. Net environmental benefit includes restoration of water quality, sediment quality, habitat, fisheries, public access, and recreation aesthetics. Adverse environmental impacts to be considered include construction-related water and sediment quality degradation, habitat value or acreage loss, and land use or access restrictions. The evaluation of alternatives for net environmental benefit and for adverse environmental impacts is addressed through the following SMS evaluation criteria (minimum requirements):

- Protect human health and the environment.
- Comply with all applicable laws, as defined in WAC 173-204-505(2).
- Comply with sediment cleanup standards specified in WAC 173-204-560 through 173-204-564.
- Use permanent solutions to the maximum extent practicable, as specified in WAC 173-204-570(4).
- Provide a reasonable restoration timeframe with preference for alternatives that provide for a shorter restoration timeframe.

- Implement effective source controls where needed, with preference for source control measures more effective at minimizing future accumulation of contaminants in sediment caused by discharges.
- Meet the requirements for implementation of a sediment recovery zone (WAC 173-204-590), if cleanup standards cannot be achieved within 10 years.
- Provide for permanent cleanup action where technically feasible instead of relying exclusively on MNR or institutional controls and monitoring. Where institutional controls are used, they must comply with WAC 173-340-440 to include measures that control exposures and ensure the integrity of the cleanup action.
- Provide an opportunity for review and comment by affected landowners and the general public consistent with the public participation plan, and consider concerns identified in these comments.
- Include long-term monitoring to ensure remedy effectiveness.
- Provide periodic review of remedy effectiveness where elements of a cleanup action include containment, enhanced or natural recovery, institutional controls, sediment cleanup levels based on practical quantitation limits, or sediment recovery zones.

In addition to the above minimum requirements, SMS stipulates that the evaluation of sediment cleanup actions shall provide sufficient information to fulfill the SEPA requirements (Chapter 43.21C RCW) for the proposed preferred remedy. This information includes discussion of significant short- and long-term environmental impacts; significant irrevocable commitments of natural resources; significant alternatives, including mitigation measures; and significant environmental impacts that cannot be mitigated. .

Regarding the minimum requirement that cleanup actions use permanent solutions to the maximum extent practicable, this is determined by a disproportionate cost analysis as described in the following section.

5.2. Disproportionate Cost Analysis

MTCA and SMS require use of the DCA as a tool to compare benefits and costs of alternatives for the purpose of determining which alternative uses permanent solutions to the maximum extent practicable. The DCA process in the RI/FS evaluated benefits and costs to make a relative comparison of cleanup action alternatives and identified the alternative whose incremental costs are not disproportionate to its incremental benefits (the preferred alternative).

The following criteria defined in WAC 173-340-360(3)(f) and WAC 173-204-570(4) were used in the RI/FS to evaluate and compare cleanup action alternatives in the DCA. Except for cost, each alternative was assigned a score for each of the criteria on a scale from 1 (low benefit) to 10 (high benefit). The raw scores and rationale for the scores for each alternative are presented in Table 5-1.

The scores for each alternative were adjusted using the following weighting factors recommended by Ecology (Ecology 2021):

- Protectiveness (30 percent of total benefit score)
- Permanence (20 percent of total benefit score)
- Long-term effectiveness (20 percent of total benefit score)
- Management of short-term risks (10 percent of total benefit score)
- Technical and administrative implementability (10 percent of total benefit score)
- Consideration of public concerns (10 percent of total benefit score)
- Cost (compared to total benefits)

The weighted benefit scores for each alternative were summed to create a total weighted benefit score for each alternative. A relative benefit-to-cost ratio (the total weighted benefit score divided by the cost for each alternative) was used to compare the cleanup action alternatives to determine whether costs are disproportionate to benefits. The cleanup action alternative with the highest benefit-to-cost ratio was determined to be permanent to the maximum extent practicable and identified as the preferred alternative. The weighted benefit scores, total weighted relative benefit scores, costs and the benefit/cost ratio for each alternative are summarized in Table 5-2 and on Figure 5-1.

In accordance with MTCA, "Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the lower cost alternative" (WAC 173-340-360(3)(e)(i)). This concept was illustrated graphically by comparing the benefit-to-cost ratios (Figure 5-1). Alternative 6 has the highest benefit-to-cost ratio (5.2) and Alternative 1 has the lowest (3.7). Alternatives 7 and 8 have higher overall benefit scores relative to Alternative 6, but with incremental cost increases that are greater than the incremental benefit increase. Therefore, Alternatives 7 and 8 are disproportionately costly relative to Alternative 6 and not considered to be practicable. Alternatives 1 through 5 provided lower benefits than Alternative 6, but also have lower benefit-to-cost ratios (range of 3.7 to 4.6), indicating that Alternative 6 is not disproportionately costly relative to these alternatives. Therefore, Alternative 6 was determined to be permanent to the maximum extent practicable.

6.0 PROPOSED CLEANUP ACTION

Based on the evaluation performed in the RI/FS, Alternative 6 meets the minimum requirements for cleanup actions under WAC 173-340-360 and 173-204-570 and is Ecology's proposed cleanup action for remaining contaminated areas of the GWPS. As part of the future design process, further sampling will be completed to refine the cleanup action to ensure it meets cleanup standards as expected. Monitoring will confirm remedy effectiveness following completion of construction.

6.1. Elements of the Proposed Cleanup Action

Elements of the proposed cleanup action are described below and shown in Figure 6-1. The proposed cleanup action generally includes upland groundwater treatment, shoreline bank soil excavation and capping, nearshore sediment excavation and dredging, sediment capping, including enhanced capping using cap amendments and low permeability methods, enhanced natural recovery, and monitored natural recovery at an estimated cost of $73,000,000.

The proposed cleanup action, by management area, is summarized below.

- **GWMA-1**
  - 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.
- **SMA-1**
  - Excavate the exposed tar mound in the northeast shoreline.
  - 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-2**
  - 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-3**
  - 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.
  - Install an enhanced cap (low-permeability multi-layer cap) throughout most of the SMA to contain contaminated sediment and to direct groundwater discharge away from nearshore sediment containing higher concentrations of contaminants and NAPL.
  - Place a conventional sand cap (2 feet thick, plus armor), in the northern portion of the SMA to contain sediment exceeding cleanup levels for arsenic and PAHs.
- **SMA-4**
  - 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.
  - Install an enhanced cap (low-permeability multi-layer cap) throughout most of the SMA to contain contaminated sediment and to direct groundwater discharge away from nearshore sediment containing higher concentrations of contaminants and NAPL.
  - Place a conventional sand cap (2 feet thick, plus armor), in the eastern portion of the SMA to contain sediment exceeding cleanup levels for arsenic and PAHs.
- **SMA-5**
  - Dredge shallow sediment using mechanical or hydraulic methods where necessary and feasible prior to capping to avoid shallowing water depths at the Harbor Patrol facility, Metro Lake Union South Yard, and Waterway 20.
  - Install an enhanced cap (low-permeability multi-layer cap) to contain contaminated sediment and to direct groundwater discharge away from sediment containing higher concentrations of contaminants and NAPL.
- **SMA-6**
  - Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels for PAHs.
- **SMA-7**
  - 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 cap used in SMA-3 and in areas where there is shallow NAPL.
  - Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels for PAHs in limited portions of SMA-7 that do not require an enhanced cap.

- **SMA-8**
  - Place a thick sand cap (minimum of 3 feet thick, plus armor) to contain shallow NAPL and to increase attenuation.
- **SMA-9**
  - Place an enhanced cap (amended sand cap) to attenuate contaminants where increased groundwater discharge and mass flux is anticipated at the toe of the low-permeability cap used in SMA-4 and in areas where there is shallow NAPL.
  - Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels for PAHs in limited portions of SMA-9 that do not require an enhanced cap.
- **SMA-10**
  - Dredge shallow sediment using mechanical or hydraulic methods where necessary and feasible prior to capping to avoid shallowing water depths at the Gasworks Park Marina.
  - Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels for PAHs.
- **SMA-11**
  - Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels for PAHs.
- **SMA-12**
  - Place a conventional sand cap (2 feet thick, plus armor) to contain sediment exceeding cleanup levels for arsenic, PAHs and co-located ALU contaminants.
  - Place a thick sand cap (minimum of 3 feet, plus armor) in portions of the SMA to contain shallow NAPL and to increase attenuation.
- **SMA-13**
  - Place a thin sand layer in SMA-13 to accelerate natural recovery (i.e., ENR).
- **SMA-14**
  - Monitor sediment to assess natural recovery (i.e., MNR).

The proposed 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.
- Performing long-term monitoring and maintenance.

6.2. Restoration Timeframe

The proposed cleanup action is expected to meet cleanup standards for GWPS COCs immediately following completion of construction and is assumed to achieve screening levels for co-located ALU COCs within 10 years following completion of construction. The PRDI data will be used to refine the estimated restoration timeframes.

6.3. Types, Levels and Amounts of Contamination Remaining On Site

Contaminated media will remain on-site at concentrations exceeding cleanup levels following construction of the proposed cleanup action[4]. While the proposed cleanup action primarily utilizes containment technologies, soil and sediment removal will be used in the bank and nearshore areas in addition to shoreline groundwater treatment Collectively, components of the proposed cleanup action will reduce the volume of hazardous substances, reduce contaminant mobility and toxicity, and cut off exposure pathways to reduce risks to human health and the environment.

6.3.1. Groundwater

Based on groundwater samples from monitoring wells in the Play Area interim action groundwater treatment area, arsenic concentrations following the interim action (in-situ chemical fixation) range from 32.6 to 25,600 µg/L. In-situ chemical fixation will be used in GWMA-1, downgradient of the Play Area, to treat dissolved arsenic in shoreline groundwater to the extent feasible using in-situ treatment. The effectiveness of in-situ chemical fixation in GWMA-1 is expected to be similar to the effectiveness observed during the Play Area interim action.

6.3.2. Soil and Sediment

Based on soil samples from explorations completed within the shoreline bank and from surface and subsurface sediment samples collected within the SCU, GWPS COC concentrations that will remain in place include TPAH (0.015 to 69,000 mg/kg), cPAHs (0.005 to 2,900 mg/kg), carbazole (0.24 to 150 µg/kg), dibenzofuran (0.12 to 830 mg/kg), arsenic (1.30 to 2,400 mg/kg), and nickel (10 to 270 mg/kg).

Contaminated shoreline bank soil will be contained beneath approximately 0.75 acres of vegetated cap. Contaminated sediment will be contained by approximately 33 acres of capping and ENR. In addition to the capping and ENR areas, approximately 23 acres of sediment with lower contaminant concentrations will be addressed by MNR.

An estimated volume of 25,000 cubic yards of soil and 425,000 cubic yards of sediment with GWPS COCs concentrations exceeding cleanup levels will remain in place beneath the proposed soil and sediment caps and in the sediment MNR and ENR areas following construction of the proposed cleanup action.

6.4. Compliance Monitoring and Contingency Responses

Compliance monitoring and contingency responses (as necessary) will be implemented consistent with MTCA (WAC 173-340-410) and SMS (WAC 173-204-560[7]). Three types of compliance monitoring will be performed: protection, performance and confirmational:

- Protection monitoring will be conducted during construction to assure that permit requirements are met, and that human and environmental health is protected.

[4] When a cleanup action involves on-site containment, which the proposed cleanup action does, WAC 173-340-380(1)(a)(ix) requires that the CAP specifies "the types, levels, and amounts of hazardous substances remaining on site."

- Performance monitoring will be conducted at the end of the construction period to confirm that design specifications (e.g., final slopes, grades, cap thickness, areal coverage) and cleanup standards have been achieved.
- Confirmational monitoring collects information that allows the performance of the remedy to be evaluated over-time and ensures that the efficacy and integrity of the remedy is maintained. Confirmational monitoring is also used to assess rates of recovery in ENR and MNR areas, and to assess recontamination, if any.

Elements of monitoring will be documented in a compliance monitoring and contingency response plan (CMCRP) submitted for Ecology review and approval as a part of the Engineering Design Report (EDR). The CMCRP will include site-specific objectives, scope, quality assurance, duration, and timing for all monitoring activities as well as an overall framework for contingency actions and adaptive management.

Compliance monitoring activities are described in the sections that follow.

6.4.1. Protection Monitoring

Protection monitoring is conducted during implementation of the remedy to assure that permit and contract requirements are met and to provide intermittent quality control checks. It is specific to the work area and adjacent areas potentially subject to construction impacts. Protection monitoring will occur throughout the construction period and may include the following elements:

- Air quality monitoring in, upwind of, and downwind of the immediate work area during construction to protect workers, park visitors, and local residents.
- Water quality monitoring in the vicinity of shoreline bank and in-water construction activities (e.g., removal of debris, excavation and dredging, placement of cap material, dewatering of dredged material) to address requirements of CWA Section 401 water quality certification.
- Visual inspection of physical best management practices (BMPs) (e.g., silt curtain) and construction stormwater management facilities (e.g., for retention, control, or treatment) on a regular basis for as long as the BMPs are in place, or the temporary stormwater facility is in operation.
- Quality control (QC) checks to confirm that location, areal extent, depth, elevation, thickness, design elements and other performance requirements are being met; details on type and frequency of the QC checks will depend on the technology.

6.4.2. Performance Monitoring

Performance monitoring will be conducted to confirm that the design specifications and cleanup standards are met. Similar to QC checks conducted during construction, performance monitoring will include final location, areal extent, depth, elevation and thickness of various remedy components following construction. Bathymetric and topographic surveys will be used to establish final elevations and slopes.

Additional sampling will be conducted at the end of construction to determine compliance with the cleanup standards and to describe baseline conditions for areas where ENR and MNR are elements of the remedy.

- Surface and subsurface samples (e.g., coring) will be collected within the SMAs for chemical and physical testing. Testing will focus on GWPS and ALU COCs, organic carbon and grain size. However, compliance with the cleanup standards will be based only on GWPS COCs.

- Surface and subsurface samples (e.g., coring) will be collected within the areas of various cap types for observation and/or physical testing to evaluate cap placement effectiveness and that cap specifications are met.
- Surface sediment samples will be collected adjacent to the SCU for chemical and physical testing immediately outside areas of cleanup action.
- Groundwater samples will be collected within and downgradient of the area of in-situ treatment of arsenic to evaluate treatment performance. Samples will be collected during and after the active treatment period. An Operation, Maintenance, and Monitoring Plan (OMMP) will be prepared specific to the in-situ groundwater treatment to direct performance monitoring.
- Offshore groundwater samples will be collected within the completed sediment caps in the Groundwater Compliance Area to evaluate the performance of the capping methods.

6.4.3. Confirmational Monitoring

Confirmational monitoring assesses three general areas of the cleanup action performance over time:

- Physical integrity of the remedy elements such as the caps
- Performance of the natural recovery
- Compliance with the cleanup standards and goals, including screening levels for ALU COCs. Sediment and groundwater samples will be analyzed for GWPS and ALU COCs

Bathymetric surveys will be repeated periodically to monitor the degree of post-construction elevation change that may adversely affect cap performance. Visual inspections (actual or remote) will be conducted to assess the integrity of remedy elements over a broader area (e.g., video surveys to identify areas of scour).

Areas of the SCU utilizing ENR and MNR to achieve cleanup levels will be subject to periodic monitoring to evaluate the rate of contaminant reduction. Natural recovery monitoring will consist of sediment sampling and chemical testing and is assumed to be conducted at years 1, 3, and 5 following completion of cleanup action construction. Longer term monitoring is proposed to be conducted at 5-year increments, but this frequency may be modified based on earlier monitoring results.

In areas where contaminants will be left in place beneath caps, long-term monitoring will be conducted to evaluate continued compliance with cleanup standards. Monitoring will include continued physical and chemical monitoring of sediment at sampling frequencies sufficient to evaluate continued performance trends. Monitoring will initially be conducted Site-wide; however, the focus may change over-time depending on results. Depending on results of the initial monitoring, frequency could diminish over time. Special monitoring could be undertaken after severe storms or other events that could damage a cap.

6.4.4. Contingency Response Actions

In addition to the monitoring information described above, the CMCRP will include contingency actions and adaptive management strategies that may be applicable in response to monitoring observations. The EDR will provide additional details regarding the contingency response actions for the proposed cleanup action.

6.5. Institutional Controls

Institutional controls are included as a component of the proposed cleanup action to ensure its long-term protectiveness under anticipated land and navigation uses; these controls will limit or prohibit activities that may interfere with or impair the integrity of a cleanup action and provide notification of these limitations. As noted in WAC 173-340-440(4), institutional controls are required where contamination is left in place or conditional points of compliance are used. Following construction of the proposed cleanup action, institutional controls will be implemented and are expected to include:

- Use restrictions - For parceled properties, use restrictions will be described in environmental covenants and recorded with King County. For unparcelled state-owned property managed by WDNR, Ecology and WDNR are currently developing an alternative system to environmental covenants to be used by WDNR.

  The environmental covenants, or alternative system for state-owned property, will protect the cleanup action by limiting incompatible uses and activities that may affect the integrity of the cleanup action, and by requiring coordination with Ecology for proposed actions that may impact the cleanup action.
- Maintenance requirements - The CMCRP will provide direction for the requirements and schedule for post-cleanup monitoring and maintenance, including long-term inspection, monitoring, and maintenance of the soil and sediment caps and long-term groundwater monitoring. The CMCRP will also include guidance for conducting contingent actions or otherwise modifying the cleanup action in the future if elements of the cleanup become damaged or are not performing as designed.
- Financial assurances - The CD to which this CAP is an exhibit, requires PSE and the City to maintain sufficient and adequate financial assurance mechanisms to fund all costs associated with the operation and maintenance of the cleanup action.

Institutional controls for the proposed cleanup action will be refined as part of the remedial design activities and confirmed by Ecology following completion of construction.

6.6. Periodic Review

Because the proposed cleanup action includes institutional controls, due to the containment of hazardous substances, and the cleanup level for one or more COCs is based on a practical quantitation limit, Ecology will review the selected cleanup action described in this CAP at least every 5 years to ensure protection of human health and the environment. Consistent with the requirements of WAC 173-340-420, the periodic review shall include the following:

- A review of the title of the real property subject to the environmental covenant to verify that the covenant is properly recorded.
- A review of available monitoring data to verify the effectiveness of completed cleanup actions, including engineered caps and institutional controls, in limiting exposure to hazardous substances remaining at the GWPS.
- A review of new scientific information for COCs present at the GWPS.
- A review of new applicable state and federal laws for hazardous substances present at the GWPS.
- A review of current and projected future land and resource uses at the GWPS.
- A review of the availability and practicability of more permanent remedies.
- A review of the availability of improved analytical techniques to evaluate compliance with cleanup levels.

Ecology will publish a notice of all periodic reviews in the Site Register and will provide an opportunity for review and comment by the potentially liable persons and the public.

A similar periodic review process may also be applied to state-owned WDNR-managed properties addressed by the alternative system for environmental covenants currently under development by WDNR and Ecology.

7.0 IMPLEMENTATION OF THE PROPOSED CLEANUP ACTION

This section describes how the proposed cleanup action will be implemented. Section 7.1 discusses coordination with other projects, Section 7.2 discusses coordination with property owners and operators, and Section 7.2 describes the anticipated schedule for implementation of the cleanup action.

7.1. Coordination with Other Projects

Projects occurring, or planned to occur, within or adjacent to the cleanup action are described below. Coordination with these projects is key to ensuring an effective cleanup.

7.1.1. MTCA Cleanup Sites

As discussed in Section 2.4 and shown on Figure 2-2, there are several nearby MTCA cleanup sites. At this time no cleanup activities are on-going or planned that would affect the proposed cleanup action, except for the upland portion of Waterway 20. Ecology is currently providing technical assistance to WDNR as they oversee City of Seattle investigation of contaminated soil in the upland portion of Waterway 20. As design of the cleanup action progresses, the design team will coordinate with WDNR regarding this project.

7.1.2. Center for Wooden Boats

The Center for Wooden Boats currently leases the upland portion of the Metro Lake Union South Yard parcel shown on Figure 1-3 from King County. The Center for Wooden Boats is currently planning to develop a small boat facility along the shoreline of Lake Union that consists of in-water and upland facilities and includes a portion of Waterway 20. In-water elements of the Center for Wooden Boats facility are expected to overlap with the in-water elements of the proposed cleanup action. As design of the cleanup action progresses, the design team will coordinate with King County/Center for Wooden Boats regarding this project.

7.2. Coordination with Property Owners and Operators

Coordination will occur with owners and operators of property within and adjacent to the proposed cleanup action, including WDNR, Northlake Shipyard, King County, Harbor Patrol, and Gasworks Park Marina, regarding current and future uses and cleanup construction activities.

7.3. Schedule for Implementation

7.3.1. Remedial Design

Pre-design, design and permitting activities will begin in 2023 and are expected to require approximately 4 years to complete.

Pre-remedial design investigation (PRDI) work will be performed to document current conditions (e.g., bathymetric data, groundwater data, supplemental surface sediment sampling and coring, and geotechnical data) and support the refinement and design of the cleanup action. The pre-remedial design investigation will be described in a work plan that is approved by Ecology prior to data collection.

Based on the PRDI work, design details will be described in an EDR, that will be subject to Ecology review and approval. Once approved, the EDR will serve as the basis for developing permit applications, construction plans and specifications, and final compliance monitoring plans. The plans and specifications will be developed to guide construction of the cleanup action and to serve as the basis for bidding the work to contractors.

7.3.2. Pre-Construction Documents

Pre-construction documents will be prepared prior to starting construction activities including bid documents, contractor submittals required by the specifications and submittals required by permitting agencies. If requested, these documents will be provided to Ecology for review and project records.

7.3.3. Construction

Construction of the cleanup action is anticipated to begin during the second half of 2027. The timing of in-water work will be restricted by permit-specified work windows to minimize the effects to migrating juvenile salmonids and other aquatic species. Based on the in-water work limitations for Lake Union, in-water cleanup activities are expected to be completed over two construction seasons (Fall 2027 to Spring 2028 and Fall 2028 to Spring 2029).

Shoreline cleanup activities not subject to in-water work windows can be completed anytime within the anticipated 2027 to 2029 construction period.

8.0 REFERENCES

Equipoise Corporation. 1999. Prospective Purchaser Agreement Cleanup Action Plan, Nortar/Former ATCO Facility at 1700 North Northlake Way, Seattle, Washington.

Foster, Richard. 1943. Sources of Pollution in Lake Washington Canal and Lake Union. State of Washington Pollution Commission.

GeoEngineers, Inc. 2023. Remedial Investigation and Feasibility Study Report, Gas Works Park Site, Seattle, Washington. January 2023.

Hart Crowser, Inc. 2014. Construction Completion Report, Sandblast Grit Removal, Interim Remedial Action, Northlake Shipyard Site.

Herrera 2016. Technical Memorandum. Waterway #20 Upland Soil Sampling. June 30, 2016.

King County. 2011. 2011 Annual Revalue Report, Commercial Waterfront Specialty Area 12, King County Department of Assessments Accounting Division, Lloyd Hara, Assessor.

Sabol, MA, GL Turney, and GN Ryals. 1988. Evaluation of Available Data on the Geohydrology, Soil Chemistry, and Ground-Water Chemistry of Gas Works Park and Surrounding Region, Seattle, Washington. Prepared in cooperation with the WA Department of Ecology.

Seattle Department of Planning and Development (DPD). 2012. DPD Map Books 76, 77, 90, and 91. City of Seattle, Department of Planning & Development.

U.S. Environmental Protection Agency (EPA). 1988. US Production of Manufactured Gasses: Assessment of Past Disposal Practices. Research Triangle Institute.

Washington Department of Ecology (Ecology). 1999. Department of Ecology, Plaintiff, v. The City of Seattle and Puget Sound Energy, Consent Decree—99-2-52532-952A. State of Washington Superior Court. December 28.

Washington Department of Ecology (Ecology). 2005. Agreed Order DE 2008—Gas Works Park Sediment Site issued to the City of Seattle and Puget Sound Energy. State of Washington Superior Court. March 18.

Washington Department of Ecology (Ecology). 2013. Approval of Request to Amend Agreed Order DE 2008-- Gas Works Park Sediment Site. March 15. Letter from Libby Goldstein, Ecology, to Ray Hoffman, City of Seattle, and Steve Secrist, Puget Sound Energy.

Washington Department of Ecology (Ecology). 2017a. Gas Works Park Second Amendment to Agreed Order no. DE 2008. Issued to City of Seattle and Puget Sound Energy. Effective April 26, 2017.

Washington Department of Ecology (Ecology). 2017b. Gas Works Park Third Amendment to Agreed Order No. DE 2008. Issued to City of Seattle and Puget Sound Energy. Effective October 16, 2017.

Washington Department of Ecology (Ecology). 2021. Sediment Cleanup Users Manual (SCUM): Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC. Publication No. 12-09-057. Revised December 2021.

Washington Department of Ecology (Ecology). 2022a. Gas Works Park Fourth Amendment to Agreed Order No. DE 2008. Issued to City of Seattle and Puget Sound Energy. Effective December 14, 2022.

Washington Department of Ecology. 2022b. Natural Background Groundwater Arsenic Concentrations in Washington State, Study Results. Publication No. 14-09-044. January 2022.

Washington Pollution Control Commission (WPCC). 1946. Memorandum Number 102, Oil Pollution of Lake Union by the American Tar Company.

Washington Pollution Control Commission (WPCC). 1958. Inter Office Memorandum, Subject Oil Spill in Lake Union.

Table 3-1

Summary of Contaminants of Concern

Gas Works Park Site

Seattle, Washington

Analyte Group	Contaminants of Concern (COCs)		Medium			
			Soil[a]	Upland Groundwater[a]	Offshore Groundwater[b]	Sediment[c]
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	–[d]	–
	Total cPAHs TEQ		–	–	X	X
TPH	Diesel Range Hyrdocarbons		–	–	–	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:

[a] Identified as COC in the upland Consent Decree (Ecology 1999).

[b] Identified as a COC based on offshore groundwater data.

[c] Identified as a COC based on the Sediment Management Standards (WAC 173-204) and Gas Works Sediment Area SCSD (RI Appendix 4C).

[d] Not identified as a COC. However, dibenzo(a,h)anthracene will be evaluated as part of Total cPAHs TEQ.

x = Chemical identified as a COC

– Chemical not identified as a COC

See text for full acronym and abbreviation list.

Table 3-2

Sediment Cleanup Levels for GWPS Contaminants of Concern

Gas Works Park Site

Seattle, Washington

Analyte Group	GWPS Contaminants of Concern		Sediment[a,b] mg/kg	Basis	Exposure Pathways and Receptors
PAHs	Total PAH		30	CSL (risk-based concentration)	Benthic
	cPAHs	Benzo(a)anthracene	Included in Total cPAHs TEQ Screening Level		
		Benzo(a)pyrene			
		Benzo(b)fluoranthene			
		Benzo(k)fluoranthene			
		Chrysene			
		Indeno(1,2,3-cd)pyrene			
		Dibenzo(a,h)anthracene			
	Total cPAHs TEQ		0.21	CSL (regional background concentration)	Human health direct contact, bioaccumulation
SVOCs	Carbazole		0.90	SCO (risk-based concentration)	Benthic
	Dibenzofuran		0.20	SCO (risk-based concentration)	Benthic
Metals	Arsenic		24	CSL (preliminary regional background concentration)	Benthic, human health direct contact, bioaccumulation
	Nickel		50	SCO (risk-based concentration)	Benthic

Notes:

[a] Preliminary sediment cleanup levels included for analytes identified as GWPS COCs only. Sediment screening levels for ALU COCs are presented in Table 3-3.

[b] Points of compliance are discussed in Section 3.2.1. Benthic COCs = upper 10 cm in the Benthic Toxicity Area. Direct Contact COCs = upper 45 cm in the Direct Contact Beach Play and Wading Exposure Area and upper 10 cm in the Direct Contact Wading Exposure Area. Bioaccumulation COCs - upper 10 cm in the Bioaccumulation Exposure Area. Sediment point of compliance areas are shown on Figure 3-1.

See text for full acronym and abbreviation list.

Table 3-3

Sediment Screening Levels for ALU Contaminants of Concern

Gas Works Park Site

Seattle, Washington

Analyte Group	ALU Contaminants of Concern	Sediment[a]	
		Sediment Cleanup Objective	Cleanup Screening Level
		mg/kg	mg/kg
Conventionals	Sulfide	39	61
TPH	Diesel Range Hyrdocarbons	340	510
SVOCs	4-Methylphenol	0.26	2.0
	Benzoic Acid	2.9	3.8
	Bis(2-ethylhexyl)phthalate	0.50	22
	Di-n-Butyl phthalate	0.38	1.0
	Di-n-Octyl phthalate	0.039	>1.1
	Hexachlorobenzene	0.005	0.005
	Pentachlorophenol	0.02	0.02
	Phenol	0.12	0.21
Pesticides	Chlordane	0.001	0.001
	4,4'-DDE	0.021	0.033
PCBs	Total PCBs (Aroclor)	0.02	0.02
Butyltins	Tributyltin	0.047	0.32
	Cadmium	2.1	5.4
	Chromium	62	62
	Copper	400	1,200
	Lead	360	>1,300
	Mercury	0.66	0.8
	Methylmercury	0.000058	0.000058
	Silver	0.57	1.7

Notes:

[a] Sediment screening levels for analytes identified as ALU COCs. Preliminary sediment cleanup levels for GWPS COCs are presented in Table 3-2.

See text for full acronym and abbreviation list.

Table 3-4

Groundwater Cleanup Levels

Gas Works Park Site

Seattle, Washington

			Preliminary Groundwater Cleanup Levels[a,b]	
			µg/L	Basis[c]
BTEX	Benzene		0.44	Protection of surface water (based on ingestion of water and organisms)
	Ethylbenzene		29	Protection of surface water (based on ingestion of water and organisms)
	Fluoranthene		6	Protection of surface water (based on ingestion of water and organisms)
	Naphthalene		160	Protection of surface water (based on ingestion of water and organisms)
	Pyrene		8	Protection of surface water (based on ingestion of water and organisms)
	cPAHs	Benzo(a)anthracene	0.01	Protection of surface water (based on ingestion of water and organisms), adjusted to PQL
		Benzo(a)pyrene	0.01	Protection of surface water (based on ingestion of water and organisms), adjusted to PQL
		Benzo(b)fluoranthene	0.01	Protection of surface water (based on ingestion of water and organisms), adjusted to PQL
		Benzo(k)fluoranthene	0.01	Protection of surface water (based on ingestion of water and organisms), adjusted to PQL
		Chrysene	0.016	Protection of surface water (based on ingestion of water and organisms)
		Indeno(1,2,3-cd)pyrene	0.01	Protection of surface water (based on ingestion of water and organisms), adjusted to PQL
	Total cPAHs TEQ		0.02	Protection of sediment, adjusted to PQL
	Bis(2-ethylhexyl)phthalate		3.0	Protection of sediment, adjusted to PQL
	Carbazole		2.0	Protection of sediment
	Dibenzofuran		16	Protection of surface water (based on drinking water ingestion)
Metals	Arsenic		8	Protection of surface water (based on ingestion of water and organisms), adjusted to background
	Cadmium		0.72	Protection of surface water (based on toxicity to aquatic organisms)
	Copper		11	Protection of surface water (based on toxicity to aquatic organisms)
	Lead		2.5	Protection of surface water (based on toxicity to aquatic organisms)
	Mercury		0.10	Protection of surface water (based on toxicity to aquatic organisms), adjusted to PQL
	Nickel		52	Protection of surface water (based on toxicity to aquatic organisms)
	Silver		3.2	Protection of surface water (based on toxicity to aquatic organisms)

Notes:

[a] Cleanup levels are only applicable to offshore groundwater.

[b] Groundwater conditional point of compliance is generally set at 10 centimeters below the mudline, at the base of the biologically active zone. For arsenic, the conditional point of compliance may be set farther upgradient, closer to the source, if conditions allow.

[c] Groundwater cleanup levels are based on protection of surface water and sediment. The basis refers to the media and pathways associated with the selected cleanup level.

See text for full acronym and abbreviation list.

Table 3-5

Potentially Applicable Laws Governing Cleanup

Gas Works Park Site

Seattle, Washington

Subject Regulated	State or Local Statutes and Implementing Regulations	Federal Statutes and Implementing Regulations	Notes
Cleanup Levels			
Groundwater	MTCA (WAC 173-340 Section 720)	--	State cleanup levels for groundwater.
Sediment	SMS (WAC 173-204)	--	Criteria used to identify sediments that have no adverse effects on biological resources and correspond to no significant health risk to humans. Site-specific cleanup levels developed per WAC 173-204-340(3) and in consultation with Ecology.
Surface Water	MTCA (WAC 173-340 Sections 720 and 730)	--	Requirements for establishing numeric or risk-based goals and selecting cleanup actions. Anticipated to be relevant and appropriate to Site remediation.
	--	CWA Section 304	National recommended water quality criteria for the protection of aquatic organisms and protection of human health based on consumption of organisms.
	Washington Water Pollution Control Act - State Water Quality Standards for Surface Water (RCW 90.48; WAC 173-201A-130)	CWA (33 USC 1251–1376; 40 CFR 100–149; 40 CFR 131)	Ambient water quality criteria for the protection of aquatic organisms and human health. MTCA requires the attainment of water quality criteria where relevant to the circumstances of the release. State water quality standards, conventional water quality parameters and toxic criteria. Narrative and quantitative limitations for surface water protection. Permitting for sediment cleanup action will define required measures for compliance with surface water standards during cleanup implementation.
	--	Safe Drinking Water Act (40 CFR 141)	Safe Drinking Water Act National Primary Drinking Water Standards: maximum contaminant levels, maximum contaminant level goals, proposed maximum contaminant levels and proposed maximum contaminant level goals. Anticipated to be relevant and appropriate to Site remediation. Permitting for sediment cleanup action will define measures to be taken to comply with standards during implementation.
Protection of Species and Habitats			
Habitat Impacts and Mitigation	Washington Department of Fisheries Habitat Management Policy (POL 410), Compensatory Mitigation Policy for Aquatic Resources (RCW 75.20 and 90.48)	Memorandum of Agreement between EPA and USACE (mitigation under CWA Section 404(b)(1); US Fish and Wildlife Mitigation Policy (46 Federal Register 7644); Fish and Wildlife Coordination Act (16 USC 661 et seq.)	Policies and procedures have been established by state and federal agencies to evaluate and mitigate habitat impacts. Mitigation requirements for projects are defined in project permitting and vary with the type of work conducted. The cleanup action alterrnatives have been designed to avoid net loss of sensitive or critical habitats. The need for significant mitigation over and above that already included in the cleanup action alternatives is considered unlikely. Project final design and permitting (e.g., as part of the Biological Assessment to be performed during project permitting) will include evaluation of project impacts and definition of any mitigation required or appropriate to the work being performed.
Protection of Essential Fish Habitat	No state equivalent	Magnuson-Stevens Fishery Conservation and Management Act (50 CFR 600.920)	Essential fish habitat has a specific definition under the Magnuson-Stevens Act. In practice, the state's hydraulic project approval addresses similar issues. Requirements for protection of essential fish habitat will be part of the USACE permit.
Protection of Migratory Birds	No state equivalent	Migratory Bird Treaty Act (16 USC 703; 50 CFR 10.12)	Species protected by the Migratory Bird Treaty Act use Lake Union on a seasonal basis; potential impacts will be addressed as part of the USACE permit.
Protection of Fish and Fish Habitat	Hydraulic Code Rules (WAC 77.55.100; WAC 220-110)	No federal equivalent	Rules designed to protect fish; substantive requirements apply to sediment remedy.
Critical Areas	SMC Critical Areas Requirements (SMC 25.09); Growth Management Act (RCW 36.70A)	No federal equivalent	This chapter implements the City of Seattle Comprehensive Plan to promote safe, stable and compatible development that avoids adverse environmental impacts and potential harm on the parcel and to adjacent property, the surrounding neighborhood and the drainage basin. MTCA remedial actions are exempt from the procedural requirements of this law, but must comply with the substantive requirements. May affect habitat goals in relation to portions of final remedy. An "environmentally critical area" exemption would likely be required.
Protection and Restoration of Endangered or Threatened Species and Critical Habitats	Fish and Wildlife or Natural Resource Conservation Areas (various RCW Titles 77 and 79; WAC 232-12)	Endangered Species Act of 1973 (16 USC 1531 et seq.; 50 CFR 200; 50 CFR 216; 50 CFR 402; 16 USC 1361 et seq.)	State rules primarily address salmon and their recovery along with general conservation strategies for state lands and state resources. GWPS is used by species protected under the ESA. Consultation with natural resource trustees will take place as part of the USACE permit. Actions must be performed so as to conserve endangered or threatened species, including consultation with the U.S. Department of Interior. Chinook salmon federally listed as a threatened species. Federal agencies must confer with National Oceanic and Atmospheric Administration Fisheries on any action that may impact listed species. Project permitting will include compliance with ESA requirements, as necessary, including consultation with state and federal permitting agencies, completion of a Biological Assessment, and incorporation of measures to avoid adverse impacts to endangered or threatened species.
Activities Within or Adjacent to Wetlands		Executive Order 11990, Protection of Wetlands (40 CFR 6, Appendix A); EPA (1989) Wetland Actions Plan	Actions must be performed so as to minimize the destruction, loss or degradation of wetlands as defined by Executive Order 11990 Section 7. Requirement for no net loss of remaining wetlands. Minor wetland fringe is present in cove at northeast corner of Site. Cleanup alternatives are not anticipated to negatively impact this wetland fringe.
Water Quality			
General	Water Pollution Control Act (RCW 90.48); Water Quality Standards for Surface Waters of Washington (WAC 173-201A)	CWA (33 USC 26 §1251 et seq.; 40 CFR 1, Subchapter D)	State implements most components of the CWA. Water quality is considered in the development of cleanup objectives, short-term performance during construction and long-term performance of the remedy.
Discharge of Dredge, Excavated or Fill Materials	No state equivalent	CWA Section 404	Applies to waters of the U.S.; affects sediment remedies that have a removal or capping component. Requires a USACE Nationwide 38 or Section 404 individual permit, which will be part of the Joint Aquatic Resources Permit Application permit.
Discharge of Return Water from Dredged Material	Water Pollution Control Act (RCW 90.48); Water Quality Standards for Surface Waters of Washington (WAC 173-201A)	CWA Section 401	State certifies consistency with CWA. Applies to sediment remedies; any requirements are typically specified in a Consent Decree or Cleanup Action Plan.

Subject Regulated	State or Local Statutes and Implementing Regulations	Federal Statutes and Implementing Regulations	Notes
Discharge of Stormwater	Water Pollution Control Act (RCW 90.48); National Pollutant Discharge Elimination System Program (WAC 173-220)	CWA Section 402	Applies to both sediment and upland remedies. Dewatering of sediment may, and upland construction would, require a state-issued NPDES permit.
Hazardous Waste Cleanup	MTCA Cleanup Regulation (RCW 70.105D; WAC 173-340)	Comprehensive Environmental Response, Compensation and Liability Act (42 USC 103; 40 CFR I, Subchapter J)	State law has precedence; primary regulations governing upland cleanup actions at the Site. Although most state and local permits are waived because the work will be conducted under a Consent Decree, MTCA requires compliance with substantive permit requirements. All federal permits governing the remedial action are still required.
Sediment Quality, Investigation and Cleanup	SMS (RCW 90.48 and 70.105D; WAC 173-204)	No federal equivalent	Primary regulations governing sediment cleanup actions at the Site. MTCA is one of the authorities defining the SMS; thus, waivers of state and local permits also apply to sediment cleanups.
Evaluation of Environmental Impacts	State Environmental Policy Act (RCW 43.21C; WAC 197-11; WAC 173-802)	National Environmental Policy Act (42 USC 55 § 4321 et seq.; 40 CFR V, Parts 1500-1508)	Evaluation of project environmental impacts and definition of appropriate measures for impact mitigation.
Impacts to Navigation	Hydraulic Code Rules (WAC 77.55.100; WAC 220-110)	Rivers and Harbors Act Section 10	Rules designed to protect navigation. No navigation channel designated in Lake Union. To be addressed as part of the JARPA process.
Shoreline Construction or Development within 200 Feet of Shoreline	Shoreline Management Act (RCW 90.48; RCW 90.58; WAC 173-16; WAC 173-14)	Coastal Zone Management Act (Public Law 92-583; 16 USC Chapter 33; 16 USC 1451 et seq.)	The state Shoreline Management Act is authorized under the federal Coastal Zone Management Act and establishes requirements for substantial development occurring within the waters of the State of Washington or within 200 feet of a shoreline. MTCA remedial actions are exempt from the procedural requirements of this law, but must comply with the substantive requirements.
	Shoreline Master Use Program (SMC 23.60)	--	Among the goals of the Shoreline Master Use Plan are to protect the ecosystems of the shoreline areas; encourage water-dependent uses; provide for maximum public use and enjoyment of the shorelines of the City; and preserve, enhance and increase views of the water and access to the water. MTCA remedial actions are exempt from the procedural requirements of this law, but must comply with the substantive requirements. A Seattle DPD Land Use Permit will be needed for shoreline substantial development (i.e., grading near Lake Union).
Treatment and Disposal			
Management, Transport and Disposal of Hazardous Wastes	Solid and Hazardous Waste Management Act (RCW 70.105); Dangerous Waste Regulations WAC 173-303)	Resource Conservation and Recovery Act (40 CFR 260 and 261; 49 USC 51, Transportation of Hazardous Material; 49 CFR 171-180)	Federal regulations are implemented by the state. Pertains to soil, sediment, water, and debris waste handling and landfill disposal. Management and disposal process is administered by the state and all substantive requirements must be met. Transportation is regulated by the US Department of Transportation. Federal regulation 40 CFR 261.24(a) states that the disposal of soil/sediments that contain manufactured gas plant wastes that fail the Toxicity Characteristic Leaching Procedure test are not regulated under RCRA Subtitle C at federally regulated sites, so no toxicity tests are required for disposal of manufactured gas plant wastes in nonhazardous waste landfills. Furthermore, the universal treatment standards required by RCRA's Land Ban Regulations for all regulated constituents that are contained in the waste will not be triggered.
Management, Transport and Disposal of Solid Wastes	Solid and Hazardous Waste Management Act (RCW 70.95; WAC 173-305, 173-350 and others)	RCRA (40 CFR 257 Subpart A)	Affects land disposal and transportation of dredged or excavated material and debris from the Site; process is administered by the state and all substantive requirements must be met.
In-water Sediment Disposal or Capping	--	USACE permitting requirements (CWA Sections 401 and 404) (40 CFR 230; 33 CFR 320, 323, 325 and 328)	Permitting requirements for discharges into waters of the U.S.
	--	USACE permitting requirements (Rivers & Harbors Act Section 10) (33 CFR 320 and 322)	Permitting requirements for dredging or disposal in navigable waters of the US. Project implementation will include USACE permitting.
	State HPA Permitting (Washington Hydraulics Code) (WAC 220-110)	--	Permitting for work that would use, divert, obstruct or change the natural flow or bed of any salt or fresh waters. Project implementation and permitting will include coordination with WDFW staff. This coordination will address all substantive requirements of the HPA permitting process, including evaluation of potential mitigation requirements and definition of work procedures and timing. Dredging, capping and other in-water work activities will be performed at appropriate times of the year to comply with fisheries protection requirements.
	State Aquatic Lands Management Laws (RCW 79.90 through 79.96; WAC 332-30)	--	Sediment capping on state-owned lands, if performed as part of the remedy, will comply with rules for management of state-owned aquatic lands.
	State Constitution (Articles XV, XVII, XXVII) Public Trust Doctrine		
Upland Disposal of Dredged Sediments	Washington Dangerous Waste Regulations Designation Procedures (WAC 173-303-070)	Federal hazardous waste criteria are less broad than state criteria for dangerous waste.	State and federal laws prohibit land disposal of certain hazardous or dangerous wastes. Sediments managed by upland disposal will comply with disposal site criteria. The need for additional waste profiling will be addressed as part of the engineering design for the project.
	Minimum Functional Standards for Solid Waste Handling (WAC 173-304); Solid Waste Handling Standards (WAC 173-350)	Solid Waste Disposal Act (42 USC Sec. 325103259, 6901-6991), as administered under 40 CFR 257, 258	Applicable to nonhazardous waste generated during remedial activities and disposed of off-site unless wastes meet recycling exemptions. Sediments managed by upland disposal will comply with disposal site criteria. The cleanup action alternatives are based on existing permitted facilities in compliance with these regulations and permitted to accept impacted dredged materials. Upland beneficial reuse of sediments, which would be regulated under WAC 173-350, is not contemplated under the cleanup action alternatives.
Wastewater	State Discharge Permit Program; NPDES Program (WAC 173-216, -220)	NPDES (40 CFR 122, 125)	Permitting and treatment requirements for direct discharges into surface water. Anticipated to be relevant only if collected waters are discharged to on-site water body. Discharges must comply with substantive requirements of the NPDES permit. Applicable for off-site discharges; a permit would be required. The cleanup action alternatives do not contemplate discharge of collected waters to on-site water body. Construction stormwater requirements will be satisfied for upland handling of sediment, including development of a Storm Water Pollution Prevention Plan and implementation of best management practices. NPDES program requirements will be reviewed as part of project final design. A Construction Stormwater General Permit will need to be issued by Ecology for discharge of stormwater as part of construction activity.
	City of Seattle Wastewater Treatment Requirements (Metro District Wastewater Discharge Ordinance), King County Industrial Waste Program	National Pretreatment Standards (40 CFR 403)	Permitting and pretreatment requirements for discharges to a POTW. Discharges to POTWs are considered off-site activities; pretreatment and permitting requirements would be applicable. Alternatives include water pretreatment and POTW discharge. Such work would be subject to POTW permitting and pretreatment standards. Project design and implementation must incorporate waste characterization, pretreatment and permitting. Permitting requirements will be reviewed as part of project final design. A City of Seattle DPD Side Sewer Permit will be needed for use of the sewer for construction dewatering (stormwater collected). A King County Industrial Waste Program Discharge Authorization will be needed for discharge of construction dewatering to the sewer system.
Underground Injection	UIC Program (WAC 173-218)	--	The Washington UIC Program manages the injection of materials below ground for waste disposal, remediation, etc. The UIC program is applicable to the GWPS for in situ remediation of groundwater. Permanent and temporary Injection wells used to inject solutions of remediation reagents are managed under UIC as Class V injection wells as defined in WAC 173-218-040(5)(a)(x). Existing injection wells at the GWPS installed for remediation of arsenic in the Play Area are registered under the UIC program. Additional injection wells or temporary injection points installed for the cleanup action will require registration with the UIC Program as Class V injection wells. Following the cleanup action, all injection wells will require decomissioning in accordance with UIC guidelines.

Subject Regulated	State or Local Statutes and Implementing Regulations	Federal Statutes and Implementing Regulations	Notes
Air Quality			
Ambient Air Quality and Emissions	Washington State Clean Air Act (70.94 RCW); Ambient Air Quality Standards (WAC 173-746); Northwest Air Pollution Agency ambient and emission standards; General Requirements for Air Pollution Sources (WAC 173-400); Regional Emission Standards for Toxic Air Pollutants	Clean Air Act (42 USC 85, Air Pollution, Prevention and Control)	Administered by the state and local authorities; substantive requirements apply to construction activities during implementation of the remedy. Potentially applicable to alternatives involving sediment treatment or upland handling. On-site treatment of dredged materials using methods that may require an air pollution control permit is not contemplated in the cleanup action alternatives. Off-site sediment handling and treatment and disposal facilities contemplated for use under the cleanup action alternatives comply with applicable air regulations and maintain appropriate permits. Permitting requirements and compliance of facilities used for dredged material management will be reviewed as part of project final design.
Toxic Air Contaminants	Source of toxic air contaminant requires a notice of construction (Puget Sound Air Pollution Control Agency Regulation III)	--	--
Fugitive Dust	Regional Emission Standards for fugitive dust; Best Available Control Technology to control dust (Puget Sound Air Pollution Control Agency Regulation I); Puget Sound Clean Air Agency regulations for fugitive dust emissions (Section 9.15 of Regulation I)	--	--
Other			
Health and Safety	Washington Industrial Safety and Health Act (RCW 49.17; WAC 296-62, 296-843 and others)	OSHA (29 USC 15; 29 CFR 1910, 1926)	Applicable to investigation and construction phases of a cleanup. Development of a Health and Safety Plan with appropriate controls, worker certifications and monitoring. Relevant requirement for environmental remediation operations. All work activities performed at the site will comply with OSHA and WISHA requirements. Project final design will include definition of contractor safety requirements, including preparation and compliance with a project Health and Safety Plan, worker training, record-keeping requirements and other applicable measures.
Objects, Landscapes or Structures of Historical or Archaeological Significance	Regulations regarding these resources are part of SEPA, the Governor's Executive Order 05-05, and Shoreline Management Act (i.e., no one single regulation or authority); RCW 27.53; WAC 365-196-450 and others also apply.	National Historic Preservation Act (16 USC 470 et seq. Section 106)	State laws govern local projects; federal law governs those requiring federal permits or funds. Protection of significant historical, archaeological and traditional cultural sites from damage or loss during development. Gas Works Park was listed in the National Register of Historical Places in 2013. Will require coordination with the state's Department of Archaeological and Historic Preservation (State Historic Preservation Office), and include evaluating compliance with Section 106 of the federal law.
Historical Character of Park and Aboveground Installations	Landmarks Preservation Board (SMC 22.901T)	--	Ensures that changes to protected characteristics of Gas Works Park are minimal and that the historical character of the property is preserved. Requires a Certificate of Approval before changes are made to landmark sites. Applicable only to permanent above-ground installations that may be included in remedial activities. Any changes to permanent above-ground installations will be designed to maintain protected characteristics.
Construction in State Waters	Construction in State Waters, Hydraulic Code Rules (RCW 75.20; WAC 220-1101)	Rivers and Harbors Appropriation Act (33 USC 401; 40 CFR 230; 33 CFR 320, 322, 323, 325)	Requirements for construction and development projects for the protection of fish and shellfish in state waters. State HPA permit required unless project implemented under MTCA Consent Decree or Order. Under Consent Decree, substantive requirements would still be addressed. Project implementation and permitting will include coordination with WDFW staff. This coordination will address all substantive requirements of the HPA permitting process, including information submittals, evaluation of potential mitigation requirements, and definition of work procedures and timing. Dredging, capping and other in-water work activities will be performed at appropriate times of the year to comply with fisheries protection requirements. USACE Section 404 permit or Nationwide 38 permit required.
Impacts to Tribal Treaty Rights	--	Treaty of Point Elliott (12 Stat. 927); Treaty of Medicine Creek (10 Stat. 1132)	U.S. treaties protect certain rights of recognized Tribes of Native Americans, including property rights, water rights and fish/shellfish gathering rights. Impacts to treaty rights are typically addressed during project permitting. Project alternatives evaluated in the FS protect environmental quality at the Site and result in no significant changes to Site features. Consultation with area Tribal nations will be conducted during project permitting to ensure that there are no adverse impacts to Tribal treaty rights.
Noise Control	Noise Control Act of 1974 (WAC 173-60); SMC Title 25.800	Noise Control Act of 1974 (RCW 70.107)	Maximum noise levels. Potentially relevant depending on remedial activities and equipment selected. Construction activities will be limited to normal working hours, to the extent possible, to minimize noise impacts.
Activities within 100-Year Floodplain	--	40 CFR 257; 40 CFR 264.18(b); 40 CFR 761.75	Not applicable; water levels are managed by USACE.
Earthwork and Grading Activities	SMC Title 22.804	--	For any upland grading activity that may need to be performed, a City of Seattle DPD Grading Permit will be needed.
Electrical Installations	Seattle Electric Code Supplement for Class 1 Division 2 Environments	National Electric Code (National Fire Protection Association 70)	Electrical installations to support remedial activities at the site. Potentially applicable to the site to support remedial activities. All electrical installations to be weatherized per National Electrical Manufacturers Association 4 standards.
Overall Remedial Design	Seattle Design Commission	--	Ensures that City investment enhances livability through design excellence. Potentially applicable if the cleanup is considered to be a City capital improvement project. Project design will be reviewed by the Design Commission, if necessary.
Investigation, Use and Modification of Park Property	Seattle Municipal Code 18.30	--	A Seattle Department of Parks and Recreation Revocable Use Permit will be needed to use, occupy and modify park property.
Traffic Control and Truck Haul Routes	Seattle Municipal Code (SMC Title 15)	--	A City of Seattle Department of Transportation Street Use Permit will be needed for traffic control and truck haul routes.

Notes:

See text for full acronym and abbreviation list.

TABLE 4-1 APPLICATION OF RETAINED TECHNOLOGIES TO MANAGEMENT AREAS

Management Area	Description	Environmental Conditions Informing Cleanup	Technologies Applicable to Management Area
GWMA-1	Deep groundwater in the uplands between the Play Area and Lake Union. The groundwater is below the park facility and is not subject to use.	▪ Arsenic in deep groundwater immediately upland of the Lake Union shoreline at concentrations greater than preliminary cleanup levels	▪ In situ chemical fixation of arsenic using proven ferrous sulfate treatment ▪ Monitored natural attenuation
SMA-1	Approximately 0.54 acre uncapped bank soil area along approximately 1,000 linear feet of the eastern park shoreline. Includes the upland portion of the tar mound in the northeast corner of the park.	▪ Uncapped bank soil impacted by tar and PAHs above preliminary levels ▪ Uncapped bank soil that can be eroded and transported to sediment	▪ Land-based excavation of exposed tar, including the tar mound ▪ Land-based excavation and capping as needed to integrate upland surface with adjacent sediment remedy
SMA-2	Approximately 0.16 acre uncapped bank soil area along approximately 400 linear feet of the shoreline adjacent to Kite Hill in the southwestern area of the park.	▪ Uncapped bank soil impacted by tar and PAHs above preliminary cleanup levels ▪ Uncapped bank soil that can be eroded and transported to sediment	▪ Land-based excavation and capping as needed to integrate upland surface with adjacent sediment remedy
SMA-3	Approximately 1.0 acre nearshore sediment area along the eastern shoreline north of the Till Ridge generally between elevations OHWM and +10' (USACE).	▪ PAH and arsenic concentrations in sediment greater than preliminary cleanup levels ▪ Advective transport of VOCs, PAHs, and arsenic ▪ Area of sediment benthic toxicity	▪ Land-based excavation ▪ Conventional sand capping ▪ Amended (enhanced) sand capping (ZVI, AC, OC) ▪ Low permeability (enhanced) capping
SMA-4	Approximately 0.28 acre nearshore sediment area between the Prow and Harbor Patrol generally between elevations OHWM and +10' (USACE).	▪ PAH concentrations in sediment greater than preliminary cleanup levels ▪ Advective transport of VOCs and PAHs ▪ Area of sediment benthic toxicity	▪ Land-based excavation ▪ Conventional sand capping ▪ Amended (enhanced) sand capping (AC, OC) ▪ Low permeability (enhanced) capping
SMA-5	Approximately 0.60 acre nearshore sediment area between Harbor Patrol and the northwest corner of the AOI generally between OHWM and +5' (USACE). Includes areas adjacent to Metro Lake Union South Yard and Harbor Patrol, as well as Waterway 20.	▪ PAH concentrations in sediment greater than preliminary cleanup levels ▪ Advective transport of VOCs and PAHs ▪ Area of sediment benthic toxicity	▪ Land-based excavation ▪ Small-scale hydraulic dredging in access restricted areas ▪ Mechanical dredging ▪ Conventional sand capping ▪ Amended (enhanced) sand capping (AC, OC) ▪ Low permeability (enhanced) capping
SMA-6	Approximately 2.3 acre shallow sediment area offshore of the Prow extending to approximately elevation -5' (USACE).	▪ PAH concentrations in sediment greater than preliminary cleanup levels ▪ Area of sediment benthic toxicity	▪ Land-based excavation (part) ▪ Mechanical dredging ▪ Conventional sand capping
SMA-7	Approximately 2.0 acre sediment area in the eastern offshore portion of the GWPS. Approximate elevations are between +10' and -17' (USACE). This area includes a portion of the Gas Works Park Marina.	▪ PAH and arsenic concentrations in sediment greater than preliminary cleanup levels ▪ Advective transport of VOCs, PAHs, and arsenic ▪ Area of sediment benthic toxicity ▪ Shallow subsurface NAPL	▪ Conventional sand capping ▪ Amended (enhanced) sand capping (ZVI, AC, OC) ▪ Low permeability (enhanced) capping
SMA-8	Approximately 0.59 acre sediment area associated with NAPL Area 8 offshore of the Prow generally between between +5' and -15' (USACE). This area can be accessed for net fishing and is used for vessel navigation.	▪ PAH concentrations in sediment greater than preliminary cleanup levels ▪ Area of sediment benthic toxicity ▪ Shallow subsurface NAPL ▪ Used for vessel navigation.	▪ Conventional sand capping ▪ Amended (enhanced) sand capping (OC)
SMA-9	Approximately 2.8 acre sediment area offshore of the western park shoreline including the area adjacent to the Harbor Patrol bulkhead. Approximate elevations are between +10' and -18' (USACE) where offshore of SMA 4 and between +5' and -18' (USACE) where offshore of SMA 5.	▪ Shallow subsurface NAPL ▪ PAH concentrations in sediment greater than preliminary cleanup levels ▪ Advective transport of VOCs and PAHs ▪ Areas of sediment benthic toxicity	▪ Conventional sand capping ▪ Amended (enhanced) sand capping (AC, OC) ▪ Low permeability (enhanced) capping ▪ Small-scale hydraulic dredging around structures
SMA-10	Approximately 0.55 acre sediment area in the northeastern area of the AOI generally at +10' on the nearshore side and between +0' and -16' (USACE) offshore. This area includes part of the Gasworks Park Marina.	▪ PAH concentrations in sediment greater than preliminary cleanup levels	▪ Conventional sand capping ▪ Small-scale hydraulic dredging around structures ▪ Mechanical dredging

Management Area	Description	Environmental Conditions Informing Cleanup	Technologies Applicable to Management Area
SMA-11	Approximately 6.2 acre sediment area in the south and eastern parts of the AOI generally between -5' and -20' (USACE) where offshore of SMA-6 and between the OHWM and elevation -23' (USACE) where offshore of the till ridge shoreline.	▪ PAH concentrations in sediment greater than preliminary cleanup levels	▪ Conventional sand capping
SMA-12	Approximately 7.2 acre sediment area along the western park shoreline between SMA-9 and SMA-13 and the western AOI boundary generally between elevations between -18' and -20' (USACE).	▪ Shallow subsurface NAPL ▪ PAH and arsenic concentrations in sediment greater than preliminary cleanup levels ▪ Co-located shipyard metals contamination ▪ Areas of sediment benthic toxicity	▪ Conventional sand capping ▪ Amended (enhanced) sand capping (ZVI, OC)
SMA-13	Approximately 10 acre sediment area at the western limits of the AOI.	▪ PAH and arsenic concentrations in sediment greater than preliminary cleanup levels ▪ Co-located shipyard metals contamination ▪ Areas of sediment benthic toxicity ▪ Lake Bottom soft sediment	▪ Conventional sand capping ▪ Enhanced natural recovery
SMA-14	Approximately 23 acre sediment area at the southern limits of the AOI.	▪ PAH concentrations in sediment greater than preliminary cleanup levels, but levels are lower than SMA-13. ▪ Lake Bottom soft sediment	▪ Monitored natural recovery ▪ Enhanced natural recovery

Notes:

GWMA = Groundwater management area
SMA = Sediment management area
PAH = polycyclic aromatic hydrocarbon
NAPL = nonaqueous phase liquid
AC = activated carbon
OC = organoclay
VOCs = volatile organic compounds
ZVI = zero-valent iron

TABLE 4-2. SUMMARY OF CLEANUP ACTION ALTERNATIVES

Management Areas	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
GWMA-1	• In-situ treatment of arsenic-impacted groundwater.	Same for all alternatives						
SMA-1, SMA-2	• Tar mound removal. • Shallow bank soil excavation • Permeable vegetated soil cap	Same for all alternatives						
SMA-3, SMA-4	• Dredge nearshore sediment • 2-foot sand cap • 3-foot or greater sand cap	• Dredge nearshore sediment • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment to a greater degree • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment to a greater • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment to a greater degree • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment to a greater degree • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment to a greater degree • 2-foot sand cap • Enhanced (amended sand) cap
SMA-5	• Dredge nearshore sediment • 2-foot sand cap • 3-foot or greater sand cap	• Dredge nearshore sediment • Enhanced (amended sand) cap	• Dredge nearshore sediment • Enhanced (amended sand) cap	• Dredge nearshore sediment • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment • 2-foot sand cap • Enhanced (amended sand) cap	• Dredge nearshore sediment • Enhanced (amended sand) cap	• Dredge nearshore sediment • Enhanced (amended sand) cap	• Dredge nearshore sediment • Enhanced (amended sand) cap
SMA-6	• Place conventional 2-foot sand cap.	• Place conventional 2-foot sand cap.	• Place conventional 2-foot sand cap.	• Place conventional 2-foot sand cap.	• Place conventional 2-foot sand cap.	• Place conventional 2-foot sand cap.	• Dredging to the maximum extent practicable to reduce contaminant mass. • Place conventional 2-foot sand cap.	• Dredging to the maximum extent practicable to reduce contaminant mass. • Place conventional 2-foot sand cap.
SMA-7	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • Enhanced (amended sand) cap
SMA-8	• 3-foot or greater sand cap	• 3-foot or greater sand cap	• Enhanced (amended sand) cap	• 3-foot or greater sand cap	• Enhanced (amended sand) cap	• 3-foot or greater sand cap	• Enhanced (amended sand) cap	• Enhanced (amended sand) cap
SMA-9	• 3-foot or greater sand cap	• 3-foot or greater sand cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 3-foot or greater sand cap • Enhanced (amended sand) cap	• 3-foot or greater sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • Enhanced (amended sand) cap
SMA-10	• Dredge sediment • 2-foot sand cap	Same for all alternatives						
SMA-11	• 2-foot sand cap	Same for all alternatives						
SMA-12	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • 3-foot or greater sand cap	• 2-foot sand cap • Enhanced (amended sand) cap	• 2-foot sand cap • Enhanced (amended sand) cap
SMA-13	• Enhanced natural recovery.	• Enhanced natural recovery.	• Enhanced natural recovery.	• Enhanced natural recovery.	• Enhanced natural recovery.	• Enhanced natural recovery.	• Enhanced natural recovery.	• 2-foot sand cap
SMA-14	• Monitored natural recovery.	• Monitored natural recovery.	• Monitored natural recovery.	• Monitored natural recovery.	• Monitored natural recovery.	• Monitored natural recovery.	• Monitored natural recovery.	• Enhanced natural recovery.

Notes:

Amendments for the sand cap to be determined based on results of cap modeling.

GWMA = Groundwater Management Area SMA = Sediment Management Area

TABLE 5-1. DISPROPORTIONATE COST ANALYSIS: CLEANUP ACTION ALTERNATIVES RELATIVE BENEFIT SCORING

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Disproportionate Cost Analysis Benefit Criteria				
	Relative Benefit Evaluation (Scored from 1 = Low to 10 = High)			
Protectiveness	Score = 4.0	Score = 5.0	Score = 6.0	Score = 6.0
	Achieves a moderate level of protectiveness (lowest score among all alternatives) as a result of extensive use of conventional sand capping of sediment contaminants to permanently reduce risk of exposure across SMAs 1 through 12, including strategic application of thick sand cap construction over nearshore areas of potential advective contaminant transport and offshore areas with shallow NAPL.	Achieves a moderate level of protectiveness as a result of the extensive capping of contaminated sediment, including strategic application of thick sand caps over offshore areas with shallow NAPL and enhanced capping in an expanded area of nearshore sediment with potential for advective contaminant transport. Use of enhanced capping in areas of highest potential for contaminant migration more reliably prevents exposure in the long term.	Achieves a moderate level of protectiveness as a result of the extensive capping of contaminated sediment and including the greatest use of enhanced capping to treat nearshore areas of potential advective contaminant transport and offshore areas with shallow NAPL. Expansive use of enhanced capping further increases reliability of preventing exposure relative to other alternatives.	Achieves a moderate level of overall protectiveness as a result of extensive capping of contaminated sediment, including strategic application of thick sand caps over offshore areas with shallow NAPL and enhanced capping in isolated nearshore areas of potential advective contaminant transport and an isolated offshore area with shallow NAPL. Use of enhanced capping in areas of highest potential for contaminant migration and select offshore areas with shallow NAPL more reliably prevents exposure in the long term.
Permanence	Score = 4.0	Score = 5.0	Score = 6.0	Score = 6.0
	Achieves a moderate level of permanence (lowest score among all alternatives) relative to other alternatives as a result of extensive use of conventional sand capping to contain sediment contaminants on site while permanently reduce risk of exposure across SMAs 1 through 12, including strategic application of thick sand caps in offshore areas with shallow NAPL.	Achieves a moderate level of permanence resulting from the use capping, including strategic application of thick sand caps in offshore areas with shallow NAPL and enhanced capping in an expanded area of nearshore sediment with potential for advective contaminant transport. Addition of enhanced capping, including in situ treatment using cap amendments will increase attenuation of mobile contaminants.	Achieves a moderate level of permanence as a result of the greatest use of enhanced capping to provide more reliable containment and treat contaminants that may migrate to the sediment/cap surface or surface water. Addition of enhanced capping, including in situ treatment using cap amendments will increase attenuation of mobile contaminants.	Achieves a moderate level of permanence through conventional sand capping, including strategic application of thick sand caps in offshore areas with shallow NAPL and the addition of enhanced capping in isolated nearshore areas of potential advective contaminant transport and an isolated offshore area with shallow NAPL.
Long-term Effectiveness	Score = 3.5	Score = 4.5	Score = 6.0	Score = 5.5
	Achieves a moderately low level of long-term effectiveness (lowest score among all alternatives) as a result of extensive use of conventional sand capping of sediment contaminants to permanently reduce risk of exposure across SMAs 1 through 12, including strategic application of thick sand caps in offshore areas with shallow NAPL.	Achieves a moderate level of long-term effectiveness through use of conventional sand capping, including strategic application of thick sand caps in offshore areas with shallow NAPL and enhanced cappingin an expanded area of nearshore sediment with potential for advective contaminant transport. The use of enhanced capping methods will increase the reliability of contaminant containment, particularly where applied to areas of groundwater flux.	Achieves a moderate level of long-term effectiveness through use of conventional sand capping and the greatest use of enhanced capping to increase reliability of containment and/or to treat contaminants that may migrate to the sediment/cap surface or surface water. Extensive use of enhanced capping will increase the predictability of performance of the remedy.	Achieves a moderate level of long-term effectiveness through use of conventional sand capping including strategic application of thick sand caps in offshore areas with shallow NAPL and enhanced capping in isolated nearshore areas of potential advective contaminant transport and an isolated offshore area with shallow NAPL. The use of enhanced capping methods will increase the reliability of contaminant containment, particularly where applied to areas of groundwater flux.
Management of Short-term Risks	Score = 6.0	Score = 6.5	Score = 7.5	Score = 6.0
	Manages short-term risks to a moderate degree through use of common construction methods for sediment remediation. Moderate risks can be mitigated by isolating the work zone and notifying the public, including commercial and recreational boat traffic.	Manages short-term risks to a moderate degree through use of common construction methods for sediment remediation. Moderate risks can be mitigated by isolating the work zone and notifying the public, including commercial and recreational boat traffic.	Manages short-term risks to a moderate degree through use of common construction methods for sediment remediation. Moderate risks can be mitigated by isolating the work zone and notifying the public, including commercial and recreational boat traffic.	Manages short-term risks to a moderate degree through common construction methods frequently used for sediment remediation, with moderate risks that can be mitigated by isolating the work zone and notifying the public, including commercial and recreational boat traffic.
Technical and Administrative Implementability	Score = 7.0	Score = 6.5	Score = 7.0	Score = 6.5
	Achieves a moderately high level of technical implementability using common capping and material removal methods.	Achieves a moderately high level of technical implementability using common capping and material removal methods.	Achieves a moderately high level of technical implementability using common capping and material removal methods.	Achieves a moderately high level of technical implementability using common capping and material removal methods.
Consideration of Public Concerns	Score = 4.0	Score = 5.0	Score = 6.0	Score = 6.0
	The score for this alternative is the same as the score under the protectiveness criterion.	The score for this alternative is the same as the score under the protectiveness criterion.	The score for this alternative is the same as the score under the protectiveness criterion.	The score for this alternative is the same as the score under the protectiveness criterion.

	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Disproportionate Cost Analysis Benefit Criteria				
	Relative Benefit Evaluation (Scored from 1 = Low to 10 = High)			
Protectiveness	Score = 7.0	Score = 8.0	Score = 8.5	Score = 9.0
	Achieves a moderately high level of overall protectiveness as a result of the extensive capping of contaminated sediment, including strategic application of thick sand caps over offshore areas with shallow NAPL and enhanced capping in isolated nearshore areas of potential advective contaminant transport and expanded offshore areas with shallow NAPL. Use of enhanced capping in areas of highest potential for contaminant migration and select offshore areas with shallow NAPL more reliably prevents exposure in the long term.	Achieves a high level of overall protectiveness as a result of the extensive capping of contaminated sediment, including strategic application of thick sand caps in offshore areas with shallow NAPL and enhanced capping in expanded nearshore and offshore areas to address potential advective contaminant transport and expanded offshore areas with shallow NAPL.	Achieves a high level of overall protectiveness as a result of the extensive capping of contaminated sediment, including enhanced capping in expanded nearshore and offshore areas to address potential advective contaminant transport and expanded offshore areas with shallow NAPL.	Achieves the highest level of overall protectiveness as a result of extensive capping of contaminated sediment, including enhanced capping in nearshore and offshore areas to address potential advective contaminant transport and offshore areas with shallow NAPL and ENR in SMA-14. Expanded use of capping and replacing MNR with ENR in SMA-14 increases protectiveness relative to Alternative 7.
Permanence	Score = 6.5	Score = 7.5	Score = 8.0	Score = 8.5
	Achieves a moderately high level of permanence through conventional sand capping, including strategic application of thick sand caps in offshore areas with shallow NAPL, and the addition of enhanced capping in isolated nearshore areas of potential advective contaminant transport and expanded offshore areas with shallow NAPL	Achieves a moderately high level of permanence through conventional capping, including strategic application of thick sand caps in offshore areas with shallow NAPL, and the use of enhanced capping in expanded nearshore and offshore areas to address potential advective contaminant transport and expanded offshore areas with shallow NAPL.	Achieves a high level of permanence as a result of extensive capping and material removal. Extensive capping includes conventional capping and the greatest use of enhanced capping in nearshore areas of potential advective contaminant transport and offshore areas with shallow NAPL.	Achieves the highest level of permanence among all alternatives, as a result of extensive conventional capping the use of enhanced capping, and ENR in SMA-14. Expanded use of capping and replacing MNR with ENR in SMA-14 increases permanence relative to Alternative 7.
Long-term Effectiveness	Score = 6.5	Score = 7.0	Score = 7.5	Score = 8
	Achieves a moderately high level of long-term effectiveness through use of conventional sand capping, including strategic application of thick sand caps in offshore areas with shallow NAPL, and enhanced capping in isolated nearshore areas of potential advective contaminant transport and expanded offshore areas with shallow NAPL. The use of enhanced capping methods will increase the reliability of contaminant containment, particularly where applied to areas of groundwater flux.	Achieves a moderately high level of long-term effectiveness through use of conventional sand capping, including strategic application of thick sand caps in offshore areas with shallow NAPL and enhanced capping in expanded nearshore areas to address potential advective contaminant transport and expanded offshore areas with shallow NAPL. The use of enhanced capping methods will increase the reliability of contaminant containment, particularly where applied to areas of groundwater flux.	Achieves a moderately high level of long-term effectiveness through use of conventional sand capping and enhanced capping to increase reliability of containment and/or to treat contaminants that may migrate to the sediment/cap surface or surface water.	Achieves the highest level of long-term effectiveness among all alternatives, through use of conventional sand capping and enhanced capping to increase reliability of containment and/or to treat contaminants that may migrate to the sediment/cap surface or surface water. Expanded capping and use of ENR rather than MNR in SMA-14 increases long-term effectiveness relative to Alternative 7.
Management of Short-term Risks	Score = 6.5	Score = 7.0	Score = 5.0	Score = 4.5
	Manages short-term risks to a moderate degree through common construction methods frequently used for sediment remediation. The large volume of cap material from conventional sand capping methods results in short-term impacts from transport of material to the GWPS.	Manages short-term risks to a moderate degree (highest score among all alternatives) through common construction methods frequently used for sediment remediation. The large volume of cap material from conventional sand capping methods results in short-term impacts from transport of material to the GWPS.	Manages short-term risks to a moderate degree relative to other alternatives due to the inclusion of offshore dredging increasing the potential to suspend sediment and mobilize contaminants to the water column. Larger dredging scope increases the risk of contaminant mobilization during construction.	Manages short-term risks to a moderately low degree (lowest score among all alternatives) relative to other alternatives due to the inclusion of offshore dredging and extensive capping and ENR in SMA-14.
Technical and Administrative Implementability	Score = 6.5	Score = 7.5	Score = 6.5	Score = 6.0
	Achieves a moderately high level of technical implementability using common capping and material removal methods.	Achieves a moderately high level of technical implementability (highest among all alternatives) using common capping and material removal methods.	Achieves a moderately high level of technical implementability using common capping and material removal methods.	Achieves a moderate level of technical implementability (lowest among all alternatives) using common capping and material removal methods.
Consideration of Public Concerns	Score = 7.0	Score = 8.0	Score = 8.5	Score = 9.0
	The score for this alternative is the same as the score under the protectiveness criterion.	The score for this alternative is the same as the score under the protectiveness criterion.	The score for this alternative is the same as the score under the protectiveness criterion.	The score for this alternative is the same as the score under the protectiveness criterion.

Notes:

Criteria in MTCA 173-340-360(3)(f) and SMS 173-204-570(4) (Scored from 1 =Low to 10 = High).

ARAR = applicable or relevant and appropriate requirement

CAP = cleanup action plan

CUL = cleanup level

CY = cubic yard

ENR = enhanced natural recovery

MNR = monitored natural recovery

MTCA = Model Toxics Control Act

NAPL = nonaqueous phase liquid

SMS = Sediment Management Standards

WAC = Washington Administrative Code

Scoring Range:

1 to 3.5 = Moderately Low

4 to 6 = Moderate

6.5 to 7.5 = Moderately High

8 to 10 = High

Table 5-2

Disproportionate Cost Analysis Summary

Gas Works Park Site

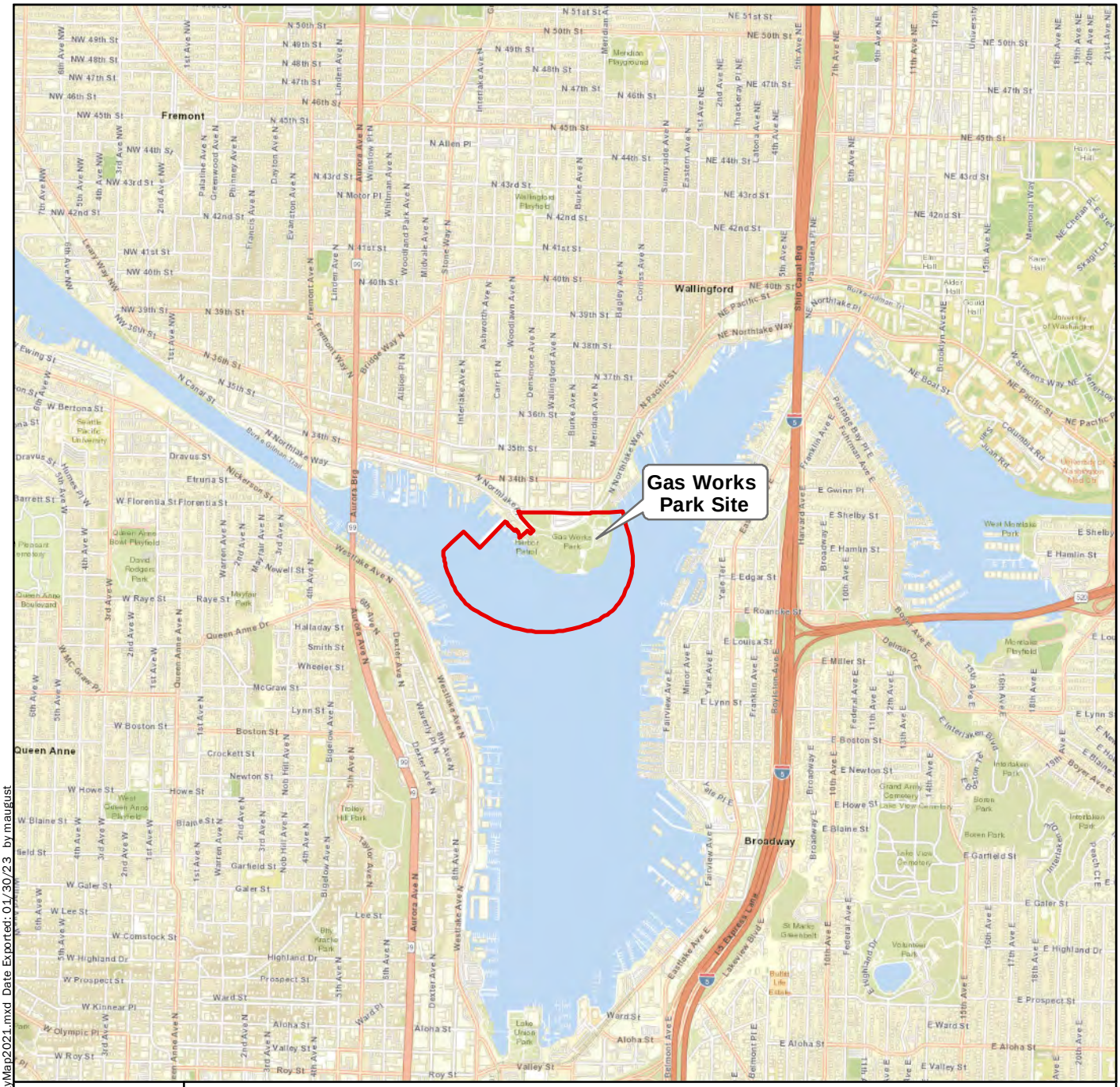
Seattle, Washington

Cleanup Action Alternative	1		2		3		4		5		6		7		8	
Relative Benefit Score																
Benefit Criteria (weighting factor)	**Score**	**Weighted**	**Score**	**Weighted**	**Score**	**Weighted**	**Score**	**Weighted**	**Score**	**Weighted**	**Score**	**Weighted**	**Score**	**Weighted**	**Score**	**Weighted**
Protectiveness (30%)	4	1.2	5	1.5	6	1.8	6	1.8	7	2.1	8	2.4	8.5	2.55	9	2.7
Permanence (20%)	4	0.8	5	1	6	1.2	6	1.2	6.5	1.3	7.5	1.5	8	1.6	8.5	1.7
Long-term Effectiveness (20%)	3.5	0.7	4.5	0.9	6	1.2	5.5	1.1	6.5	1.3	7	1.4	7.5	1.5	8	1.6
Management of Short-term Risks (10%)	6	0.6	6.5	0.65	7.5	0.75	6	0.6	6.5	0.65	7	0.7	5	0.5	4.5	0.45
Technical and Administrative Implementability (10%)	7	0.7	6.5	0.65	7	0.7	6.5	0.65	6.5	0.65	7.5	0.75	6.5	0.65	6	0.6
Consideration of Public Concern[a] (10%)	4	0.4	5	0.5	6	0.6	6	0.6	7	0.7	8	0.8	8.5	0.85	9	0.9
Total Weighted Relative Benefit Score	**4.4**		**5.2**		**6.3**		**6.0**		**6.7**		**7.6**		**7.7**		**8.0**	
Cost[b]	$60,160,000		$64,400,000		$73,940,000		$70,100,000		$73,080,000		$72,970,000		$82,290,000		$93,930,000	
Benefit/Cost Ratio = Total Weighted Relative Benefit Score ÷ (Cost ÷ $50,000,000)	3.7		4.0		4.2		4.2		4.6		5.2		4.6		4.2	

Notes

[a] Score for "Consideration of Public Concerns" is the same as the score for "Protectiveness".

[b] Estimated costs are at FS level, with a range of +50% and -30%.



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Notes:

1. Gas Works Park Site boundary is the Area of Investigation.
2. Basemap - ESRI, 2021.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Vicinity Map

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 1-1

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Legend

- Area of Investigation
- Shoreline (OHWM)
- Impervious (Paved or Structures)
- Gravel

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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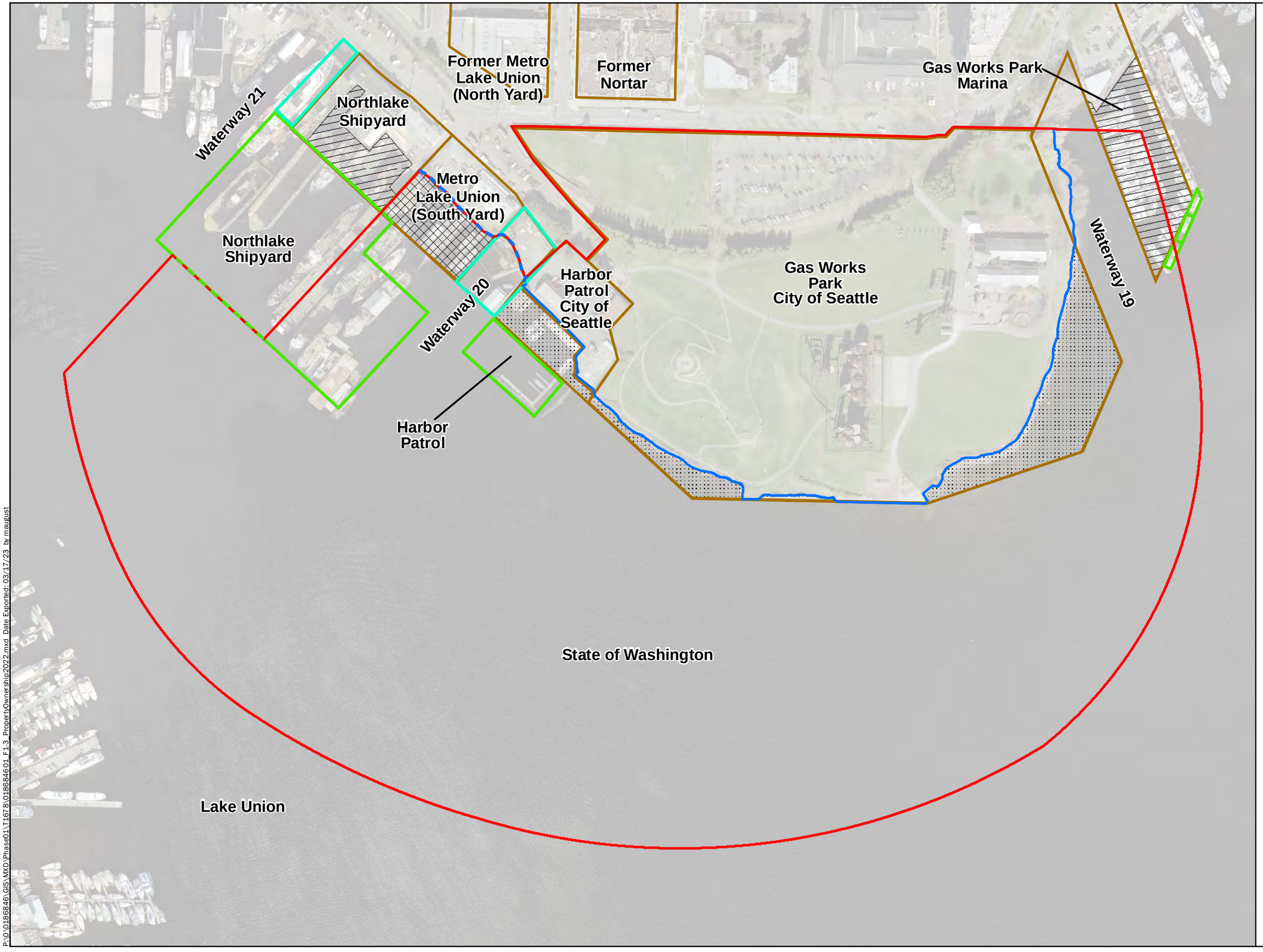
Site Plan

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 1-2



Legend

- Area of Investigation
- 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 1-3**

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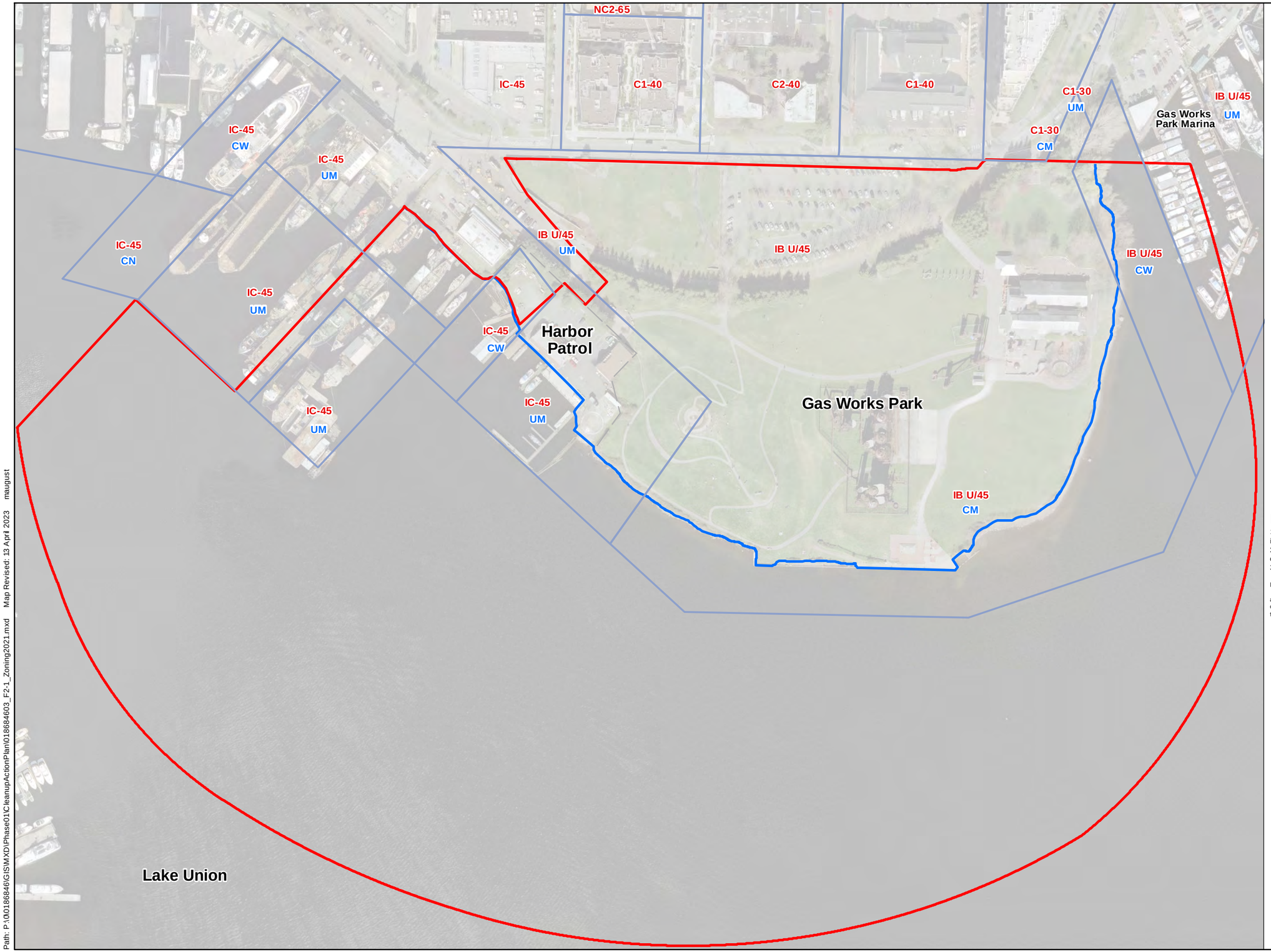

Legend

- Area of Investigation
- Shoreline (OHWM)

Zoning

IC-45 — 1C - Industrial Commercial
1B - Industrial Buffer
C1 - Commercial
C2 - Commercial

Shoreline Designations

UM — CN - Conservancy Navigation
CM - Conservancy Management
CW - Conservancy Waterway
UM - Urban Maritime

Notes:

1. Reference: King County Parcel Viewer (2013). King County iMap (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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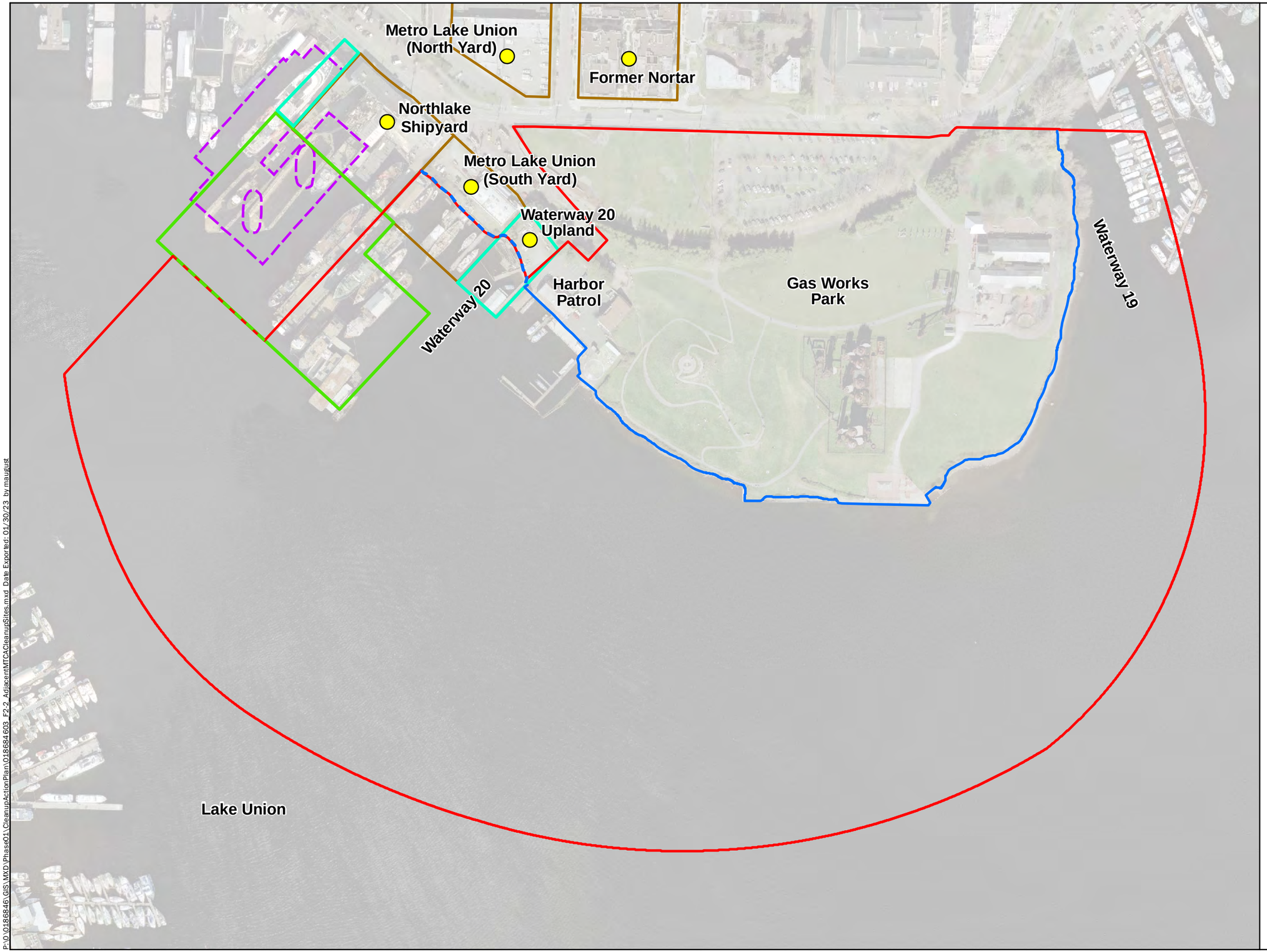
Zoning

Gas Works Park Site
Seattle, Washington

GeoEngineers **Figure 2-1**

Path: P:\00186846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F2-1_Zoning2021.mxd Map Revised: 13 April 2023 maugust



Legend

- Area of Investigation
- 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.

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Feet

Adjacent MTCA Cleanup Sites

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2-2

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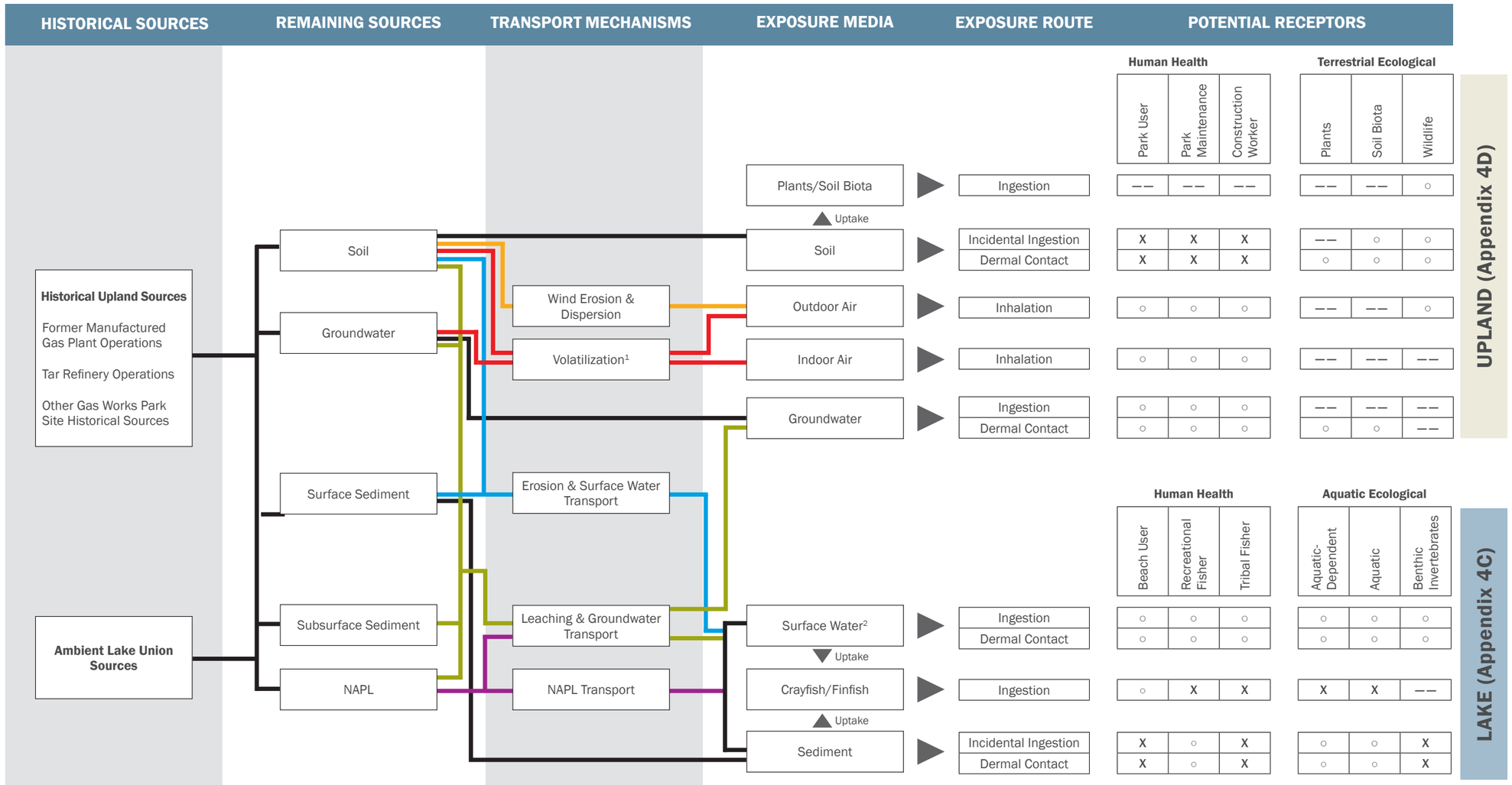


Legend

- Volatilization
- Wind Erosion & Dispersion
- Leaching & Groundwater Transport
- Mobile Non-Aqueous Phase Liquid (NAPL) Transport
- Erosion & Surface Water Transport
- X — Complete Pathway
- ○ — Incomplete or Minor Pathway
- –– — Not Applicable

Notes

1. Upland NAPL is a potential source to soil and groundwater; associated contaminants can volatilize to air.
2. The protection of surface water is addressed by the use of surface water screening levels in the evaluation of offshore groundwater.

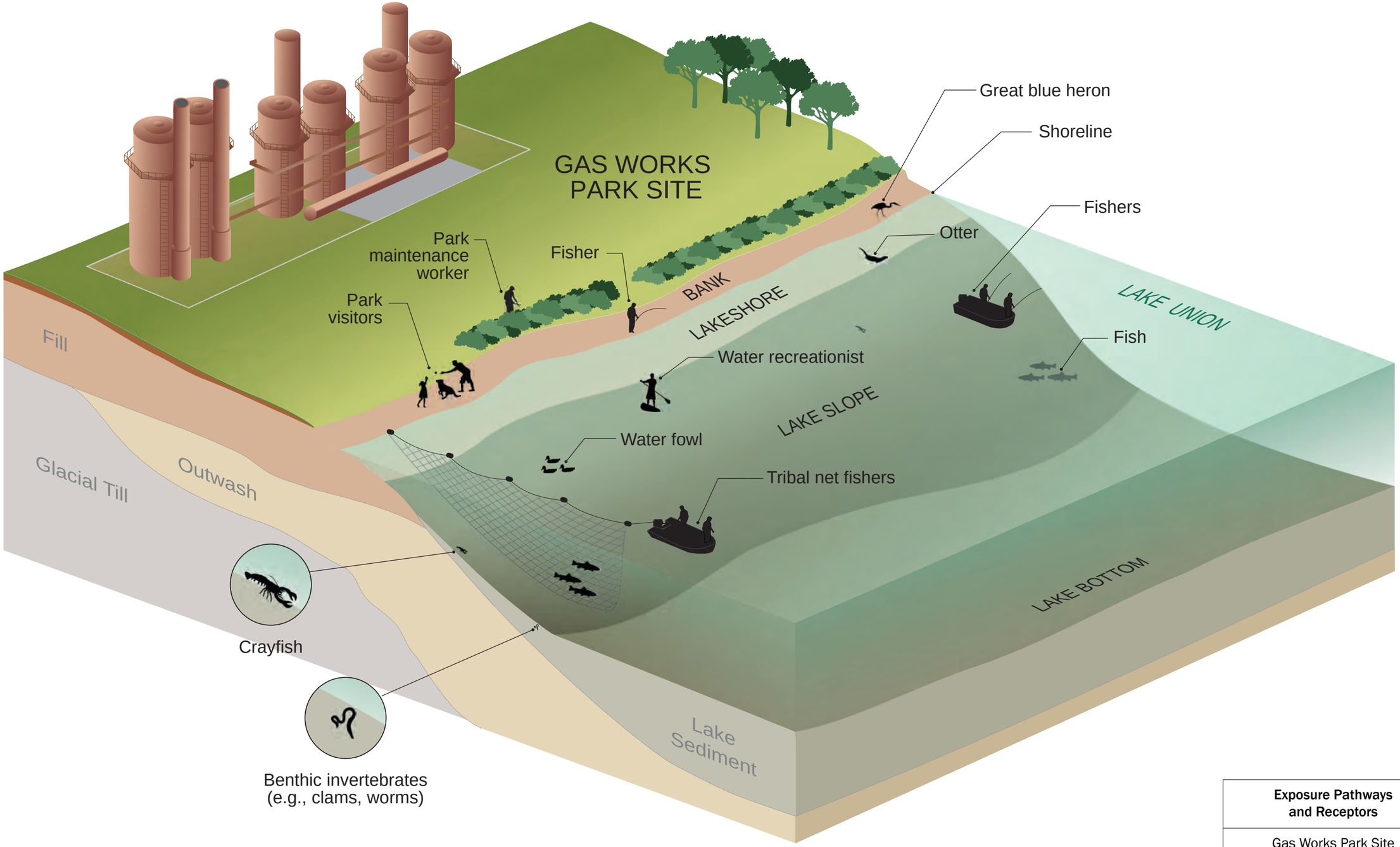
Conceptual Site Exposure Model

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2-3

Path: P:\0\0186846\Graphics_Misc\Figure 7-6_Conceptual-Site-Exposure-Model.indd Revised: 06 March 2020 sbracks



Exposure Pathways and Receptors

Gas Works Park Site
Seattle, Washington

GeoEngineers | **Figure 2-4**

Legend

- Area of Investigation
- Shoreline (OHWM)
- Security Fence
- Uncapped Shoreline Bank Soil

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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Uncapped Shoreline Bank Soil

Gas Works Park Site
Seattle, Washington

GeoEngineers **Figure 2-5**

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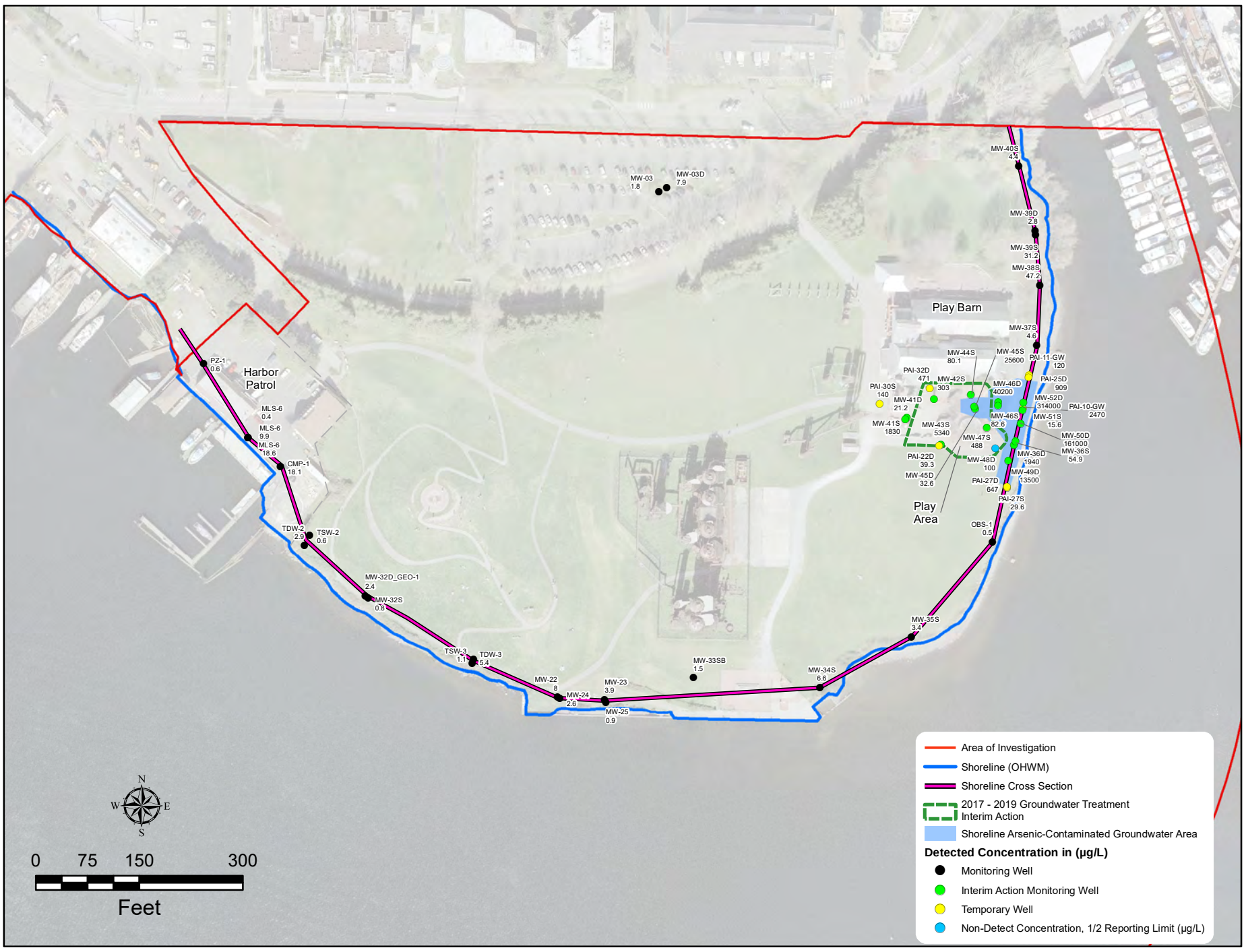
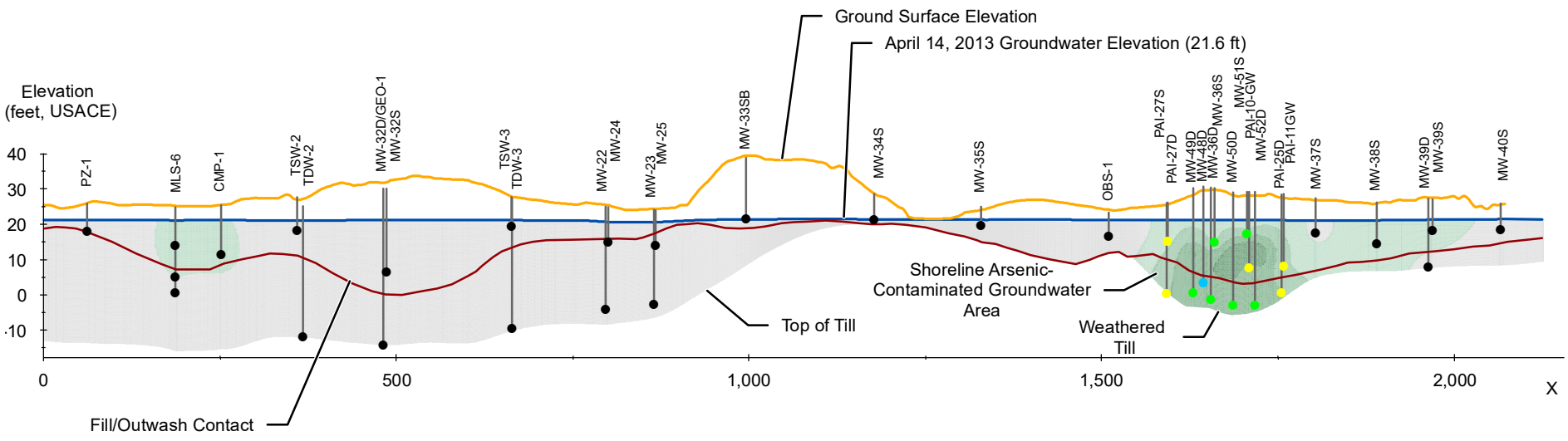
Map Revised: 31 January 2023 glohrmeyer





Shoreline Cross Section

Vertical Exaggeration 5:1

Maximum Arsenic Concentration (µg/L)

- < 8
- ≥ 8 to ≤ 80
- > 80 to ≤ 800
- > 800 to ≤ 8,000
- > 8,000

Notes:

1. Concentration contours reflect dissolved concentrations.
2. Concentration contours generated using CTech's Earth Volumetric Studio Kriging interpolation method. Reach=1000, Anisotropy=5, Nugget=0.
3. Groundwater results from: 2014 for PAI-10 and PAI-11; 2016 for PAI-22D, PAI-25D, PAI-27S, PAI-27D, PAI-30S and PAI-32D; 2020 for Play Area Interim Action Monitoring Wells; and October 2013 for the remaining wells. 2020 samples analyzed by method SW6010C lab filtered non-preserved.
   Previous samples analyzed by method SW6010C field filtered preserved with HNO_3.
   See Section 5 for a discussion of why these data sets were selected.
4. Areas not shaded in the shoreline cross section are interpreted to have arsenic concentrations below the screening level.
5. Although arsenic is not a groundwater contaminant of concern, concentrations were screened against 8 µg/L.
6. As of 2019, NAPL was observed in the same wells called out in this figure. MW-45S contained trace NAPL at the time it was sampled in 2018.
7. Shoreline Arsenic Contaminated Groundwater Area - see Play Area Interim Action Monitoring Report (GeoEngineers 2021).
8. Basemap: 2005 USGS aerial photograph. Does not show current conditions.
9. Non-detects are assumed to have concentrations of half the reporting limit(RL), for contouring purposes. Map posts non-detects as < 1/2RL.
10. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

Arsenic in Upland Groundwater

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2-6

Gas Works Park

Harbor Patrol

Lake Union

NLU58 NLU78 NLU59 ST-42 NLU73 NLU73 ST-28 NLU57 NLU62 NLU55 NLU04 NLU55 NLU63 NLU69 NLU68 NLU69 NLU54 NLU53 NLU75 NLU60 NLUEPA5 NLU05 NLU131 NLU130 NLU67 NLU51 NLU51 NLU06 NLU50 NLU07 NLU72 NLU48 527-LUUMON95 NLU49 NLUEPA19 ST-18 ST-11 NLU47 NLU61 NLU44 NLU43 ST-09 ST-12 NLU42 ST-07 LU-5 NLU10 ST-08 LU-7 NLU08 NLU45 LU-6 NLU46 NLU70 LU-2† NLU41 NLU41 NLU66 NLU66 NLU71 NLU74 NLU56 NLU64 NLU64 NLU65 NLU133 NLU11 NLU40 GWS-SG02 GWS-SG03 GWS-SG04 GWS-SG06 LU-1† NLU117-TX GWS-SG05 NLU84 GWS-SG01 NLU134 ST-01 NLU124 GWS-SG13 NLU122 NLU120 GWS-SG07 NLU121 GWS-SG16 ST-03 NLU123 NLU16 GWS-SG15 NLU116 GWS-SG14 ST-02 NLU86 NLU17 GWS-SG11 ST-43 GWS-SG12 NLU87 ST-04 NLU114 NLU12 GWS-SG10 572 NLU14 NLU135 LU-3 ST-05 NLU136 GWS-SG09 NLU83 ST-06 LU-4 GWS-SG08 NLU85

Legend

Area of

Shoreline (OHWM)

Benthic Chemical Criteria Screening Results

No Exceedance

Sediment Cleanup Objective Exceedance

Cleanup Screening Level Exceedance

Notes:

1. †LU-1 and LU-2 locations are uncertain.
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

250 0 250

Feet

SMS Benthic Chemical Criteria Screening Results

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2-7

Path: P:\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F2-7_Bioassay_benthic_counts2021.mxd Map Revised: 30 January 2023 maugust

Path: P:\0018684603\GIS\MXD\Phase01\CleanupActionPlan\0186846603_F2-8_BioassayInterpolations_Composite2021.mxd Map Revised: 30 January 2023 maugust

Harbor Patrol

Gas Works Park

Lake Union

NLU82
NLU01
NLU02
NLU76
NLU81
NLU73
NLU15
NLU16
NLU55
NLU04
NLU86
NLU17*
NLU84
NLU69
NLU13
NLU13
NLU87
NLU117
NLU12
NLUEPA5
NLU05
NLU14
NLU64
LU-1†
LU-3
NLU51
NLU83
NLU66
NLU06
LU-4
LU-2†
NLU07
NLU85
NLU08
NLU10
LU-5
LU-7
NLUEPA19
LU-6
LU-8
LU-9
LU-10

Legend

- Area of Investigation
- Shoreline (OHWM)

Biological Criteria Screening Results

- No Exceedance
- Sediment Cleanup Objective Exceedance
- Cleanup Screening Level Exceedance

Interpolated Biological Data

- Areas of Benthic Toxicity
- Location of Benthic Toxicity Area Uncertain

Notes:

1. †LU-1 and LU-2 locations are uncertain.
2. ArcGIS IDW interpolation settings:
   Power=6, Neighbors=8, Reach=500ft.
3. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
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250 0 250
Feet

Areas of Benthic Toxicity in Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2-8

Gas Works Park

Harbor Patrol

Lake Union

NLU58 NLU59 NLU78 ST-42 NLU73 NLU73 ST-28 NLU57 NLU62 NLU55 NLU04 NLU55 NLU63 NLU69 NLU68 NLU69 NLU54 NLU53 NLU75 NLU60 NLUEPA5 NLU05 NLU131 NLU130 NLU64 NLU64 NLU65 NLU133 NLU74 NLU56 NLU51 NLU51 NLU67 NLU06 NLU50 NLU71 NLU66 NLU66 NLU112 NLU40 NLU41 NLU41 NLU70 NLU46 NLU07 NLU72 NLU45 NLU08 NLU48 527-LUUMON95 NLU49 NLUEPA19 ST-18 ST-11 NLU61 NLU47 NLU44 NLU43 NLU42 ST-07 LU-5 ST-08 NLU10 LU-7 LU-6 ST-09 ST-12 LU-4 NLU85 GWS-SG08 ST-06 NLU83 LU-3 ST-05 NLU136 GWS-SG09 572 NLU14 NLU135 GWS-SG10 ST-04 NLU87 GWS-SG12 ST-43 GWS-SG11 NLU84 NLU134 GWS-SG01 NLU117-TX GWS-SG05 NLU114 NLU12 GWS-SG14 ST-02 NLU86 NLU116 GWS-SG15 NLU16 NLU123 NLU120 GWS-SG07 NLU121 GWS-SG16 NLU17 ST-03 ST-01 NLU124 GWS-SG13 NLU122 LU-1† GWS-SG02 GWS-SG06 GWS-SG04 GWS-SG03

Legend

- Area of Investigation
- Shoreline (OHWM)

Surface Sediment Screening Results

- No Exceedance
- Sediment Cleanup Objective Exceedance
- Cleanup Screening Level Exceedance
- Unknown, Sample Not Tested for Direct Contact COCs.

Notes:

1. †LU-1 location is uncertain.
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

250 0 250

Feet

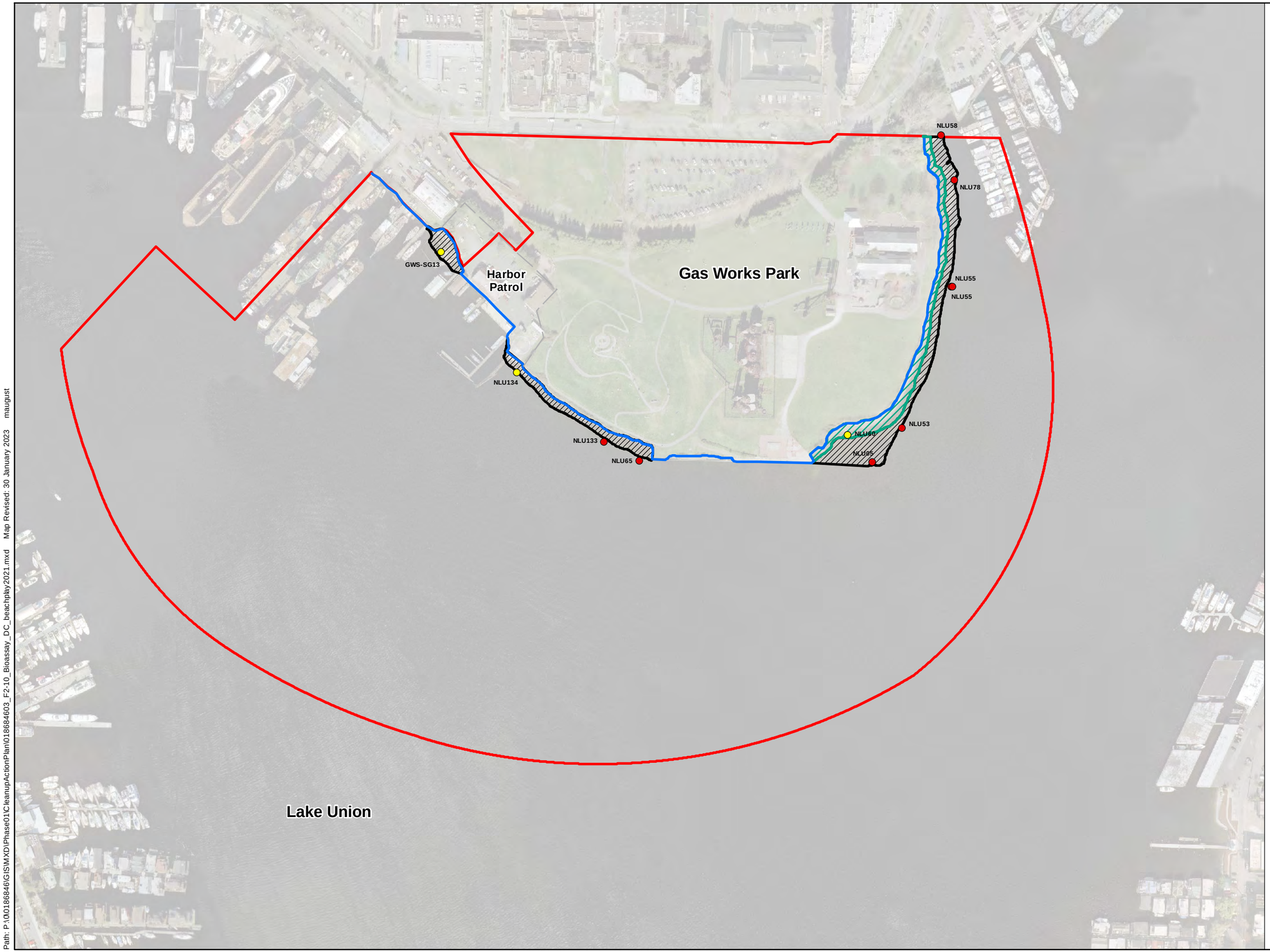
Direct Contact (Net Fishing) Surface Sediment Screening Results

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2-9

Path: P:\0018846\GIS\MXD\Phase01\CleanupActionPlan\018684603_F2-9_Bioassay_DC_netfish2021.mxd Map Revised: 30 January 2023 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Direct Contact Beach Play and Wading Exposure Area (point of compliance = upper 45 cm)
- Direct Contact Wading Exposure Area (point of compliance = upper 10 cm)

Surface Sediment Screening Results

- No Exceedance
- Sediment Cleanup Objective Exceedance
- Cleanup Screening Level Exceedance

Notes:

1. Elevation of 20 feet USACE generally defines the extent of the Direct Contact Beach Play and Wading Exposure Area. Elevation of 15 feet USACE generally defines the extent of the Direct Contact Wading Exposure Area.
2. Beach Play area is not included southwest of Kite Hill because the bank is steep, inaccessible, and armored.
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

250 0 250
Feet

Direct Contact (Beach Play/Wading) Surface Sediment Screening Results

Gas Works Park Site
Seattle, Washington

GeoEngineers **Figure 2-10**

Path: P:\0018684\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F2-10_Bioassay_DC_beachplay2021.mxd Map Revised: 30 January 2023 maugust

Legend

- Area of Investigation
- Shoreline (OHWM)

Surface Sediment Screening Results

- No Exceedance
- Sediment Cleanup Objective Exceedance
- Cleanup Screening Level Exceedance
- Unknown, Sample Not Tested for Bioaccumulation COCs.

Notes:

1. †LU-1 location is uncertain.
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

250 0 250

Feet

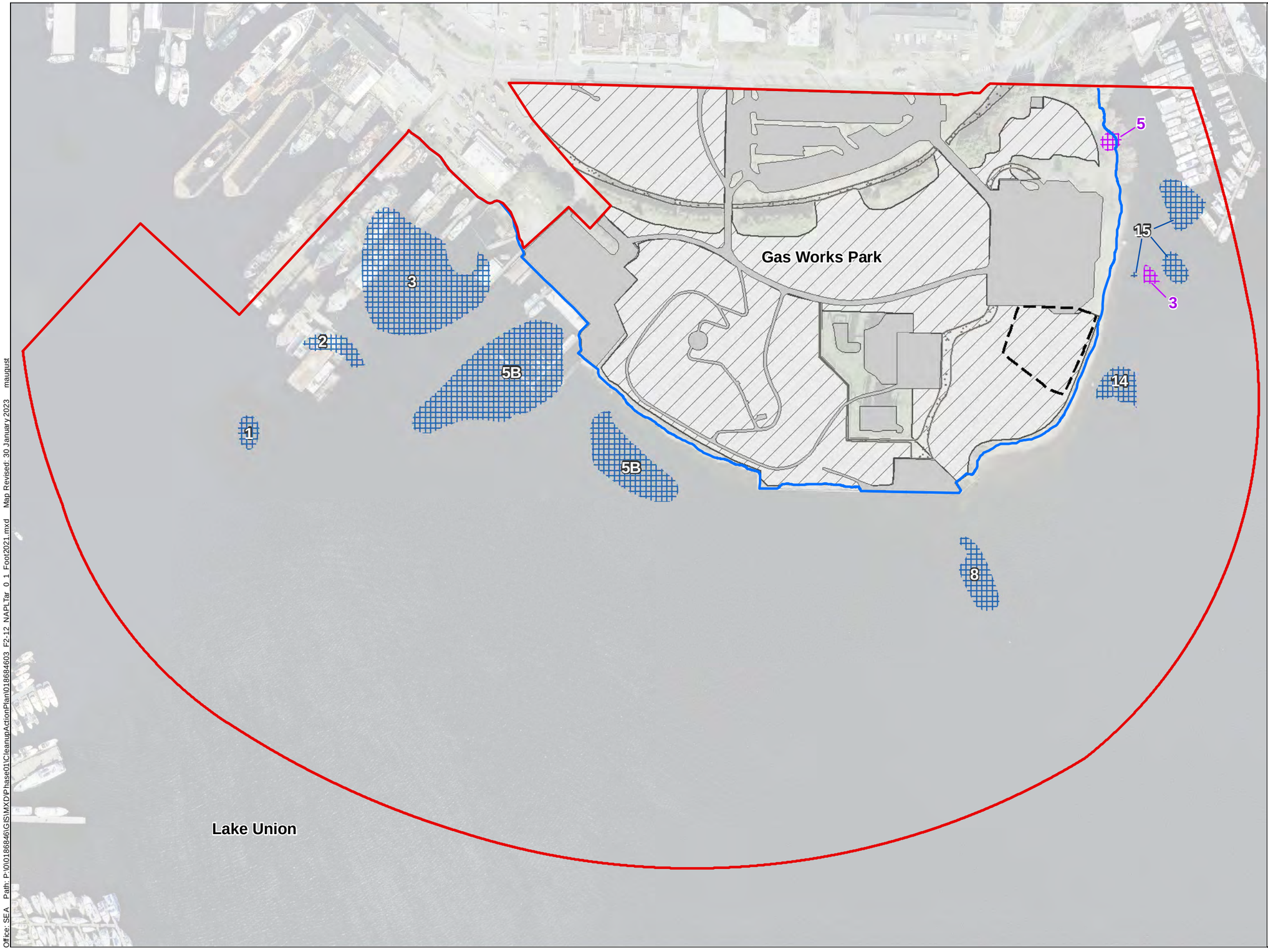
Bioaccumulation Surface Sediment Screening Results

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2-11

Path: P:\0018684\6\GIS\MXD\Phase01\CleanupActionPlan\018684603_F2-11_Bioassay_bioaccum2021.mxd Map Revised: 30 January 2023 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Impervious Area
- Areas with Clean Soil Caps
- Gravel

NAPL/Tar Areas - 0 to 1 Foot Depth

- 1 Tar Area
- 1 NAPL Area
- Tar
- DNAPL

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

200 0 200

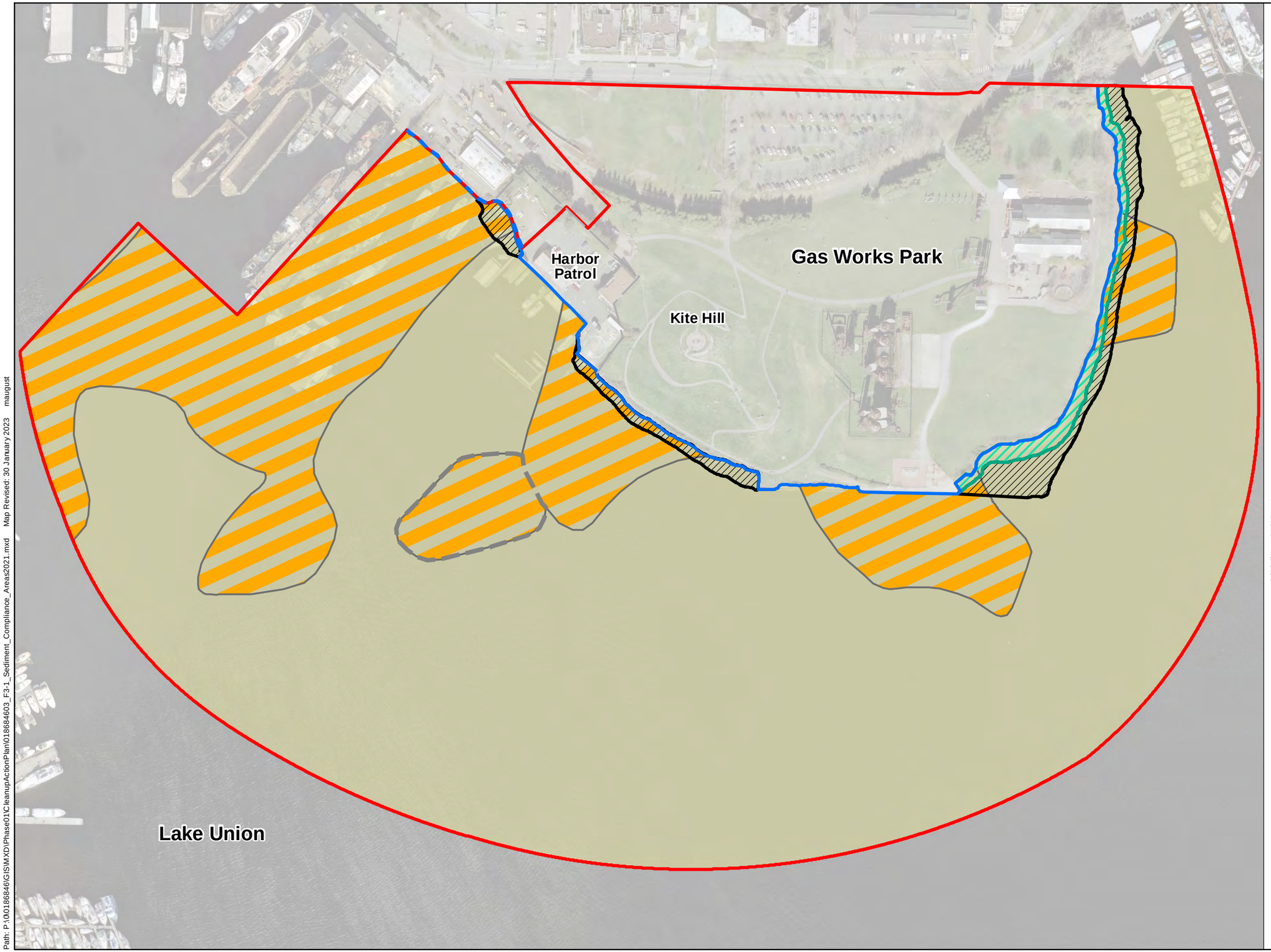
Feet

NAPL and Tar Areas - 0 to 1 Foot Depth

Gas Works Park Site
Seattle, Washington

GeoEngineers **Figure 2-12**

Office: SEA Path: P:\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846 03 F2-12 NAPLTar 0 1 Foot2021.mxd Map Revised: 30 January 2023 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Direct Contact Beach Play and Wading Exposure Area (point of compliance = upper 45 cm)
- Direct Contact Wading Exposure Area (point of compliance = upper 10 cm)
- Bioaccumulation Exposure Area (point of compliance = upper 10 cm)
- Benthic Toxicity Area (point of compliance = upper 10 cm)
- Location of Benthic Toxicity Area Uncertain

Notes:

1. Elevation of 20 feet USACE generally defines the extent of the Direct Contact Beach Play and Wading Exposure Area. Elevation of 15 feet USACE generally defines the extent of the Direct Contact Wading Exposure Area.
2. Beach Play area is not included southwest of Kite Hill because the bank is steep, inaccessible, and armored.
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

Sediment Point of Compliance Areas

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-1

Path: P:\0018684G\GIS\MXD\Phase01CleanupActionPlan\0186846603_F3-1_Sediment_Compliance_Areas2021.mxd Map Revised: 30 January 2023 maugust

P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846603_F3-2_GW_Compliance_Zone2021.mxd Date Exported: 03/17/23 by maugust

Legend

- Area of Investigation
- Shoreline (OHWM)
- 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

N
W E
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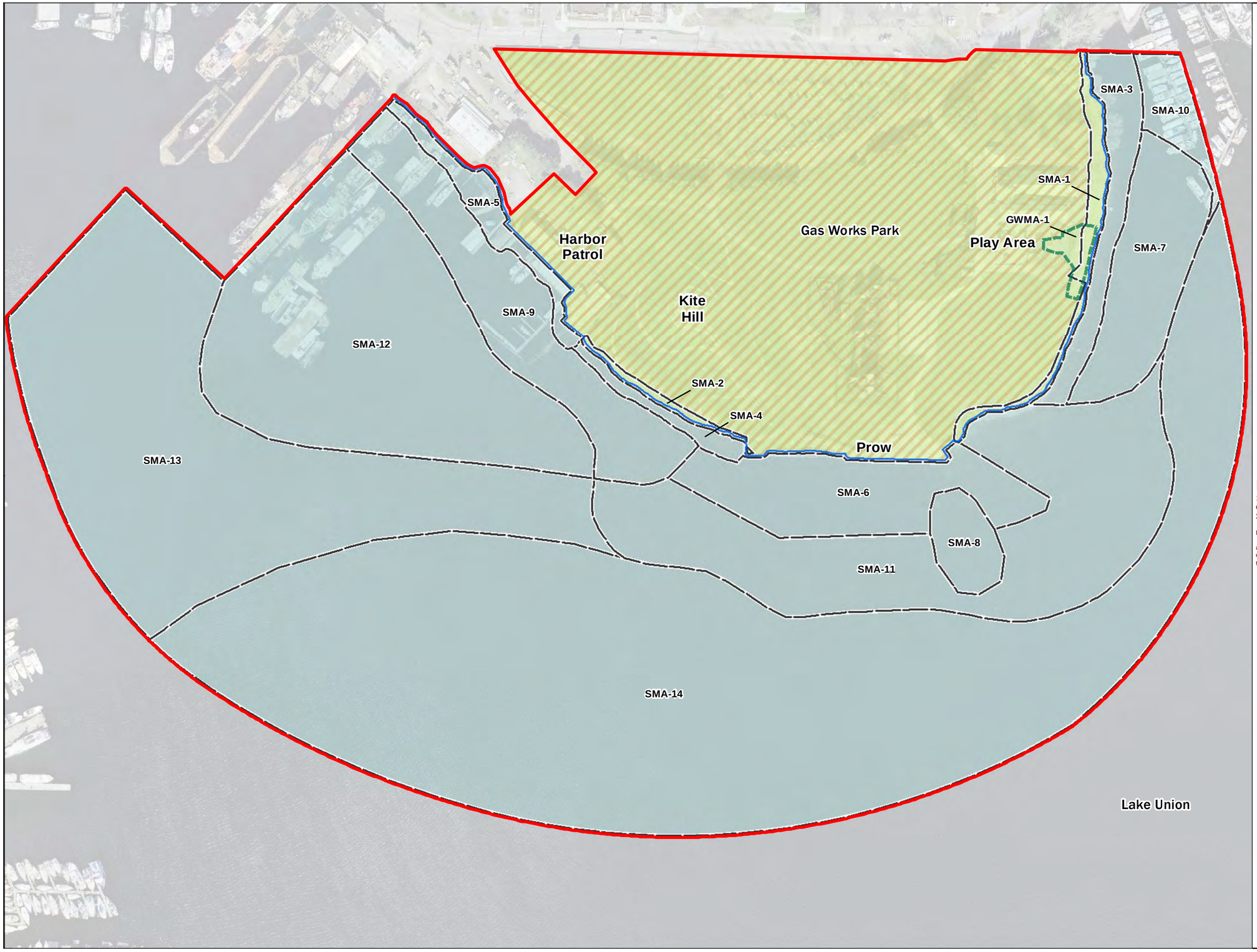
200 0 200
Feet

Groundwater Compliance Area

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-2



Legend

- Area of Investigation
- Shoreline (OHWM)
- Sediment Management Area (SMA) Boundary
- Groundwater Management Area (GWMA) Boundary
- Upland Cleanup Unit (UCU)
- Sediment Cleanup Unit (SCU)
- Area of UCU Previously Remediated

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

200 0 200

Feet

Cleanup Units and Management Areas

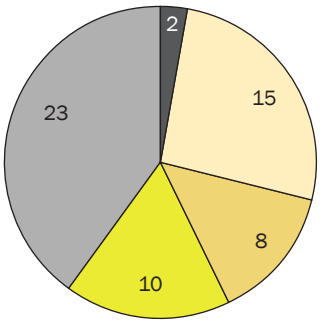
Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-1

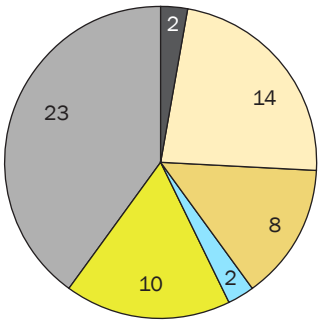
Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846603_F4-1_SMAs2021.mxd Map Revised: 17 March 2023 mauguste

Alternative 1



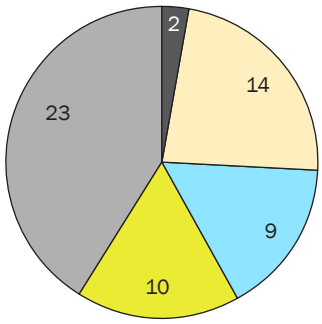
Dredge Volume (cy)	9,900
Placement Volume (cy)	142,000
Cost ($)	60M

Alternative 2



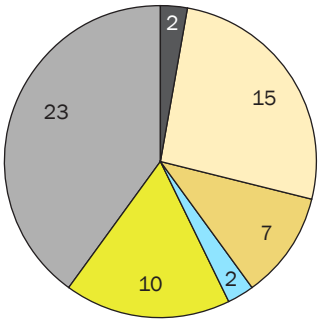
Dredge Volume (cy)	9,900
Placement Volume (cy)	136,000
Cost ($)	64M

Alternative 3



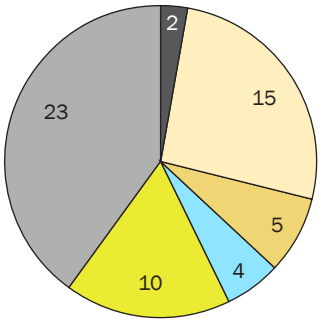
Dredge Volume (cy)	9,900
Placement Volume (cy)	110,000
Cost ($)	74M

Alternative 4



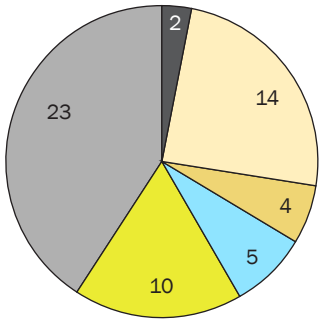
Dredge Volume (cy)	16,000
Placement Volume (cy)	135,000
Cost ($)	70M

Alternative 5



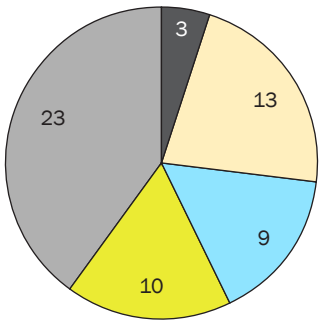
Dredge Volume (cy)	16,000
Placement Volume (cy)	131,000
Cost ($)	73M

Alternative 6



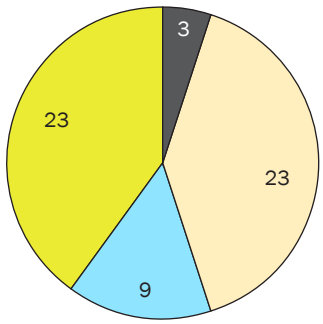
Dredge Volume (cy)	16,000
Placement Volume (cy)	124,000
Cost ($)	73M

Alternative 7



Dredge Volume (cy)	24,000
Placement Volume (cy)	105,000
Cost ($)	82M

Alternative 8



Dredge Volume (cy)	24,000
Placement Volume (cy)	161,000
Cost ($)	94M

Legend:

Dredging | Thick Sand Cap | ENR
Sand Cap | Enhanced Cap | MNR

a. Numbers in pie chart represent acres and are rounded for presentation.

b. Costs are net present value based on 2021 dollars.

cy - cubic yard

ENR - enhanced natural recovery

MNR - monitored natural recovery

Comparison of Cleanup Action Alternatives

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-2

P:\0\0186846\Graphics_Misc\Comparison of Cleanup Action Alternatives.indd Exported 2/17/2023 by spride

Gas Works Park

Lake Union

SMA-1
SMA-2
SMA-3
SMA-4
SMA-5
SMA-6
SMA-7
SMA-8
SMA-9
SMA-10
SMA-11
SMA-12
SMA-13
SMA-14
GWMA-1

Legend

- Area of Investigation
- 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 Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging 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

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

Cleanup Action Alternative 1

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-3

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846603_F4-2_Alt1_NearshoreDredge_ConventCap_2021.mxd Map Revised: 17 March 2023 maugust

Gas Works Park

SMA-1
SMA-2
SMA-3
SMA-4
SMA-5
SMA-6
SMA-7
SMA-8
SMA-9
SMA-10
SMA-11
SMA-12
SMA-13
SMA-14
GWMA-1

Lake Union

Legend

- Area of Investigation
- 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 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

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

Cleanup Action Alternative 2

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-4

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F4-3_Alt2_Nearshore_Enhanced_2021.mxd Map Revised: 17 March 2023 maugust

Gas Works Park

SMA-1
SMA-2
SMA-3
SMA-4
SMA-5
SMA-6
SMA-7
SMA-8
SMA-9
SMA-10
SMA-11
SMA-12
SMA-13
SMA-14
GWMA-1

Lake Union

Legend

- Area of Investigation
- 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)
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- Monitored Natural Recovery (MNR)
- Dredging 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

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

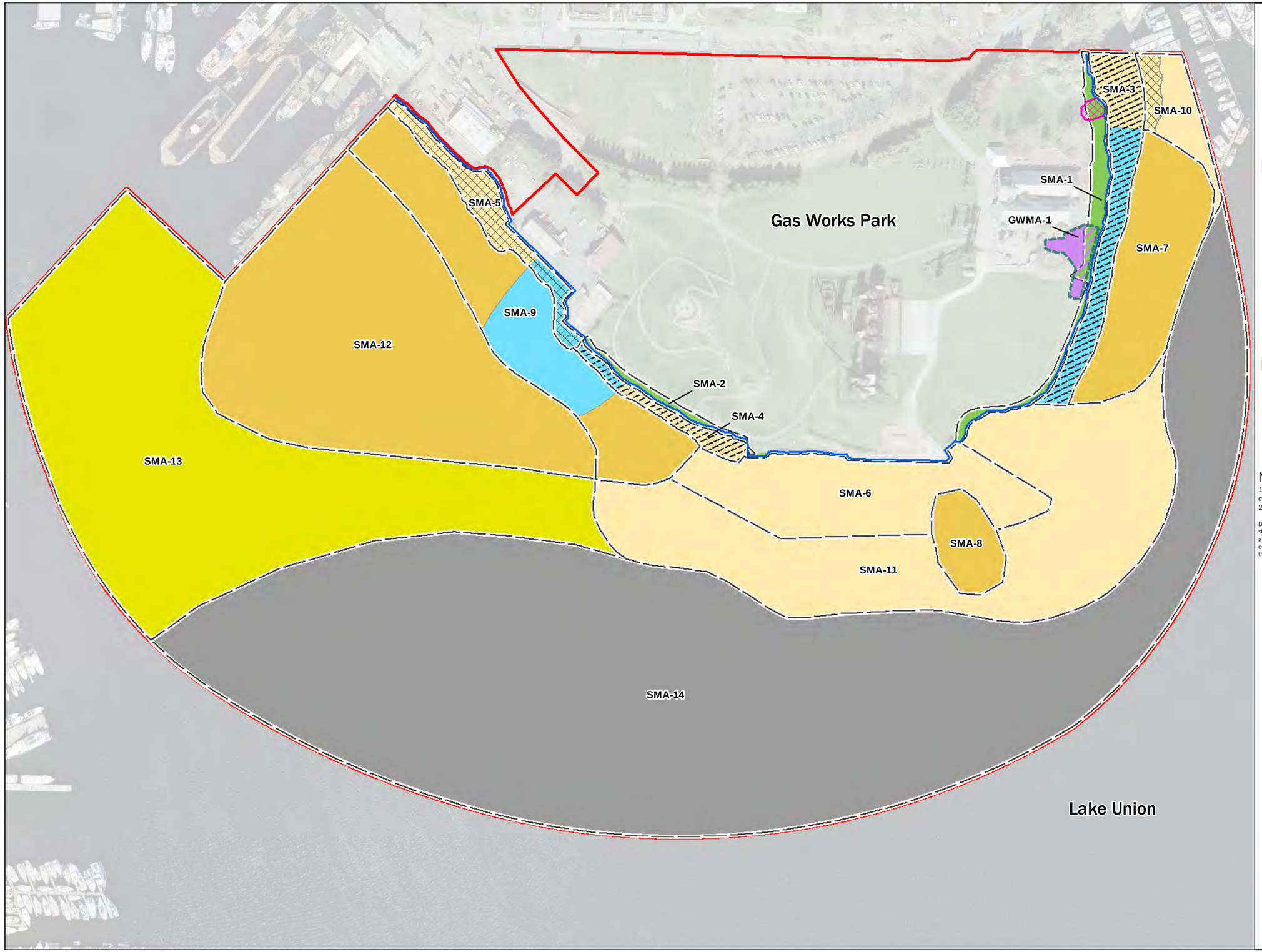
Cleanup Action Alternative 3

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-5

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F4-4_Alt3_NearshoreDredge_AmendedCap_2021.mxd Map Revised: 17 March 2023 maugust



Legend

- Area of Investigation
- 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

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

Cleanup Action Alternative 4

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-6

Office: SEA Path: P:\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F4-5_Alt4_ExpandedNearshore_Multicomponent_2021.mxd Map Revised: 17 March 2023 maugust

Gas Works Park

SMA-1
SMA-2
SMA-3
SMA-4
SMA-5
SMA-6
SMA-7
SMA-8
SMA-9
SMA-10
SMA-11
SMA-12
SMA-13
SMA-14
GWMA-1

Lake Union

Legend

- Area of Investigation
- 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

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

Cleanup Action Alternative 5

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-7

Office: SEA Path: P:\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F4-6_Alt5_ExpandedNearshore_MultiComponent.mxd Map Revised: 17 March 2023 maugust

Gas Works Park

SMA-1
SMA-2
SMA-3
SMA-4
SMA-5
SMA-6
SMA-7
SMA-8
SMA-9
SMA-10
SMA-11
SMA-12
SMA-13
SMA-14
GWMA-1

Lake Union

Legend

- Area of Investigation
- 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

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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Feet

Cleanup Action Alternative 6

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-8

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F4-7_Alt6_ExpandedNearshore_Multicomponent_2021.mxd Map Revised: 17 March 2023 maugust

Gas Works Park

SMA-1
SMA-2
SMA-3
SMA-4
SMA-5
SMA-6
SMA-7
SMA-8
SMA-9
SMA-10
SMA-11
SMA-12
SMA-13
SMA-14
GWMA-1

Lake Union

Legend

- Area of Investigation
- 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)
- 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
- Dredging for mass removal

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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Feet

Cleanup Action Alternative 7

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-9

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846603_F4-8_Alt7_ExpandedNearshoreDredge_Multi_2021.mxd Map Revised: 17 March 2023 maugust

Gas Works Park

SMA-1
SMA-2
SMA-3
SMA-4
SMA-5
SMA-6
SMA-7
SMA-8
SMA-9
SMA-10
SMA-11
SMA-12
SMA-13
SMA-14
GWMA-1

Lake Union

Legend

- Area of Investigation
- 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)
- Enhanced Cap
- Enhanced Natural Recovery (ENR)
- 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
- Dredging for mass removal

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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Feet

Cleanup Action Alternative 8

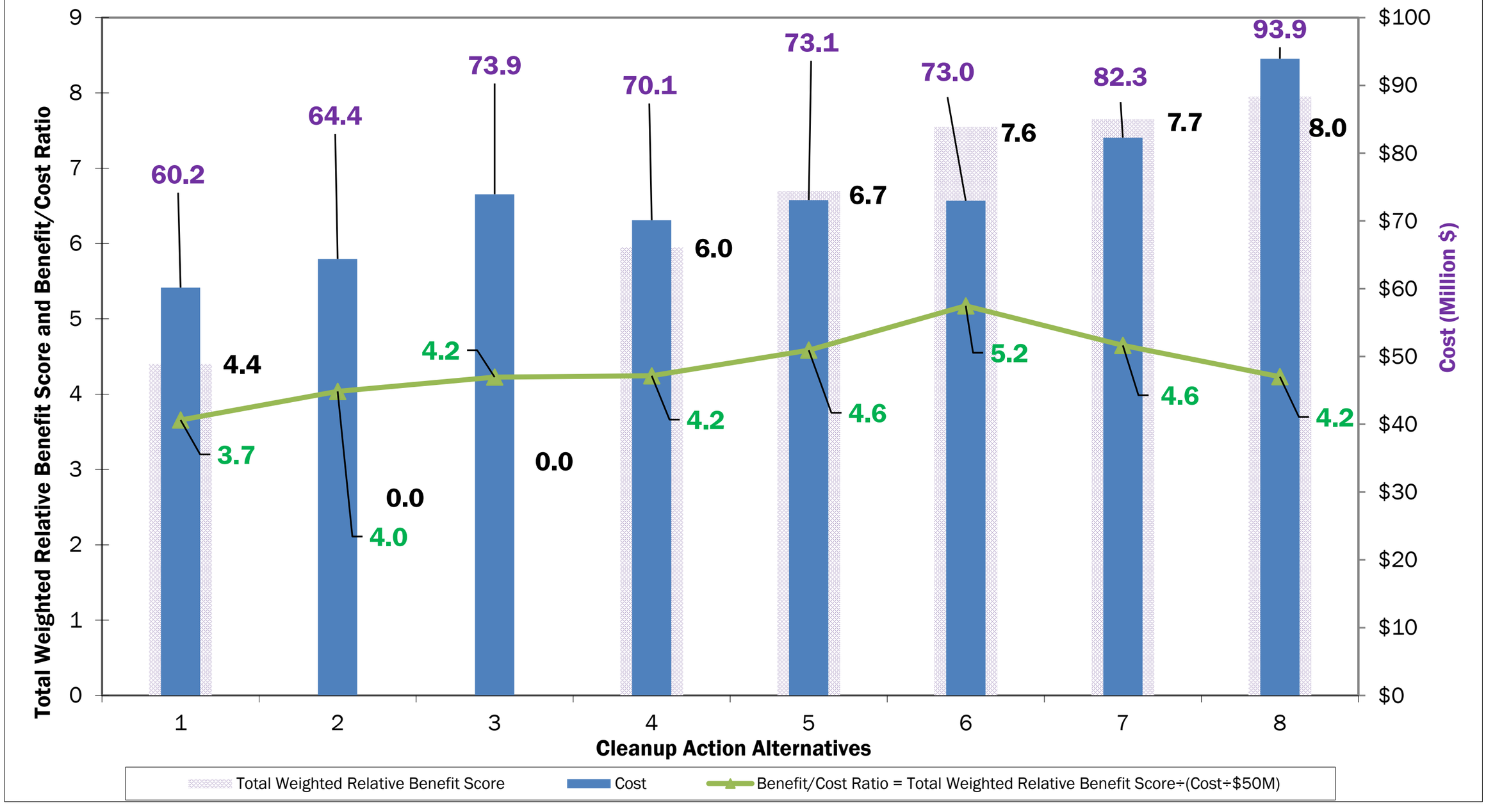
Gas Works Park Site
Seattle, Washington

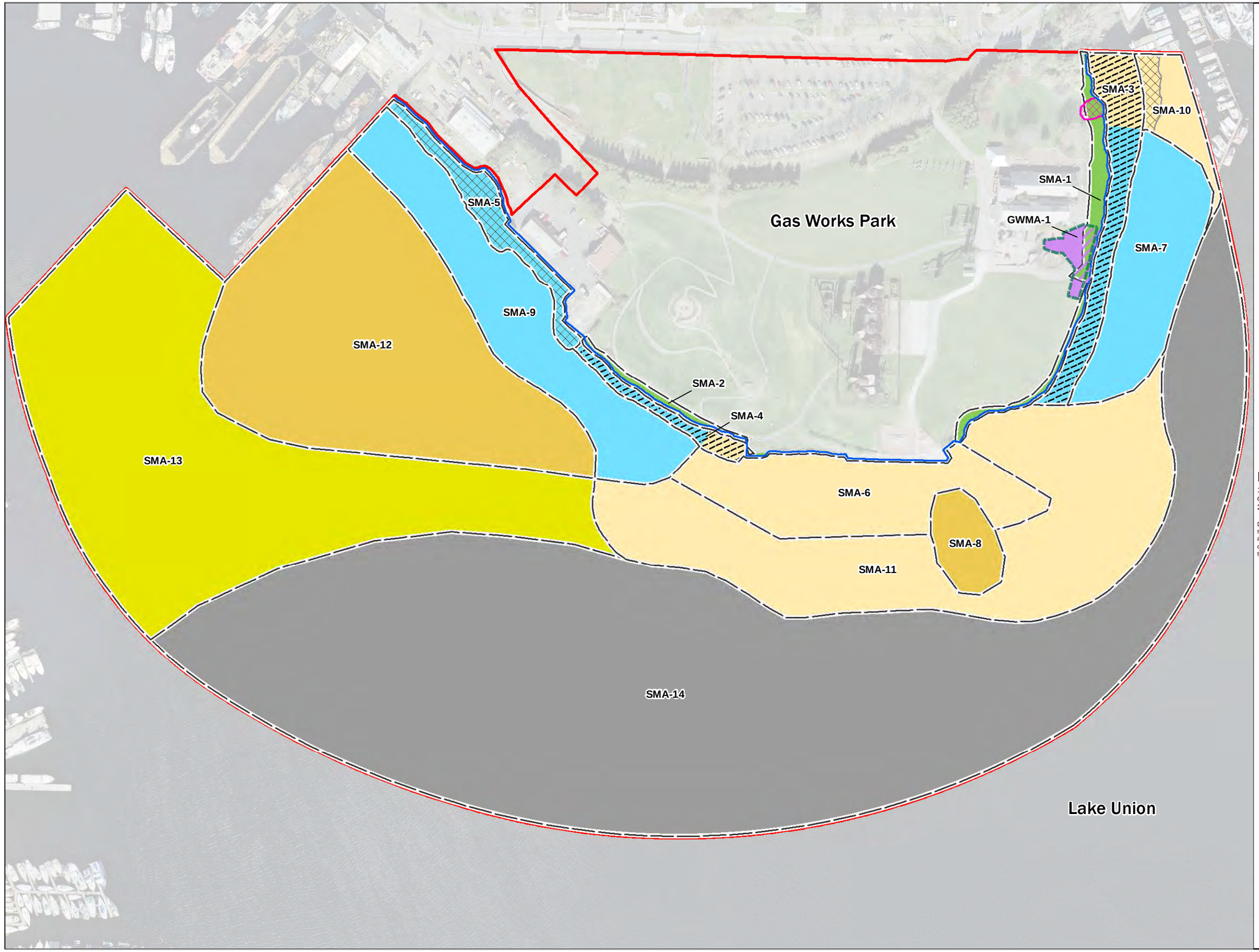
GeoEngineers

Figure 4-10

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\CleanupActionPlan\0186846003_F4-9_Alt8_ExpandedNearshoreDredge_Multi_2021.mxd Map Revised: 17 March 2023 maugust

Figure 5-1 Disproportionate Cost Analysis Summary





Legend

- Area of Investigation
- 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

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

Proposed Cleanup Action

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 6-1

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\T805\0186846000_F12-6_Alt6_ExpandedNearshore_Multicomponent_2021.mxd Map Revised: 21 September 2021 maugust