APPENDIX 6B
Storm Drain Investigation History

Table of Contents

TABLE

FIGURE

ATTACHMENTS

APPENDIX 6B STORM DRAIN INVESTIGATION HISTORY

1.1. Storm Drain Investigation History

Past investigations have evaluated the need for potential source control measures to protect a future sediment remedy. Focusing on storm drains, studies to evaluate potential recontamination have been conducted since 2007. Impacts to surface sediment are emphasized because storm drains are a source of "top-down" recontamination. On-site stormwater sources are currently being evaluated (see FS Appendix 14A), those lines and drains with potential to act as a source will be maintained or upgraded (i.e., the pathway will be addressed).

The City of Seattle (City) initiated a Joint Source Control Evaluation (JSCE) in 2007 (Attachment 6B-1). Its purpose was to evaluate the possibility that both off-site and on-site sources could recontaminate sediment with polycyclic aromatic hydrocarbons (PAHs). The objectives of the JSCE were as follows:

- Identify and evaluate sources of total PAH (TPAH) that could potentially recontaminate (future) remediated surface sediment.
- Evaluate waterfront facilities, operations and stormwater outfalls, and their potential to recontaminate future remediated sediment with contaminants of concern (COCs), other than TPAH, that could adversely affect sediment toxicity.
- Identify issues relating to potential sources of recontamination in the context of long-term sediment compliance monitoring.

Washington State Department of Ecology's (Ecology's) review of the JSCE (Attachment 6B-1) led to a series of on-site storm drain source control evaluations. The storm drain system in the Area of Investigation includes outfalls that discharge from the park and Harbor Patrol and outfalls in Waterway 19 and Waterway 20 that capture stormwater from small portions of the park. The layout of catch basins, storm drains, and outfalls is presented in Figure 6B-1. Source control evaluations addressed the following subject matter:

- TPAH and other contaminant concentrations in solids within the storm drains and associated catch basins.
- Present condition of the storm drains.
- Potential sources of impacted solids in the storm drain system.

As an initial step in 2008, the City conducted a screening investigation of the storm drains. The investigation consisted of sampling and chemical analysis of accumulated solids within the storm drains, and a video inspection of readily accessible portions of the storm drains within the Site. Results (Attachment 6B-2) showed that TPAH concentrations in solids from a catch basin in the northeast corner of Gas Works Park may have the potential to recontaminate sediment. Cracks, fractures and the presence of perforated storm drains in portions of the system were also documented.

Based on results from the initial screening, additional investigations were completed in October 2009 to further characterize the solids (including adjacent soil) in the catch basins and storm drains in the northeast corner of Gas Works Park (Attachment 6B-3).

Additional fieldwork was conducted between 2009 and 2011 (Attachments 6B-4 and 6B-5) to evaluate other areas of the park:

- Characterize solids within the storm drains and adjacent soil (where present) in the Harbor Patrol facility and the parking area.
- Characterize surface soil in the stormwater drainage ditch from the upland to Waterway 19.
- Perform a video survey inspection to assess the condition of the storm drain lines associated with Harbor Patrol, the parking lot, Kite Hill and Outfall F.

The City summarized the work performed as part of the source control evaluation in several documents (Attachments 6B-6 and 6B-7). Since 2012, the City has inspected catch basins and storm drains annually. Catch basins are cleaned on an as-needed basis. The storm drain line associated with Outfall C was inspected in 2014 as part of the planned Play Area renovation project; results are shown in Attachment 6B-8.

The City sampled the Harbor Patrol catch basins in January 2015 and storm drain solids in the northeast corner of the park (leading to Outfall A and Waterway 19 ditch) in January and December 2017. The data from the 2015 and 2017 catch basin/storm drain solids sampling events are included in the RI; however, no formal reports are available.

The results of source control investigations are presented in Section 6 (data are included in Appendix 5B); the current status of storm drains is discussed in FS Appendix 14A. Copies of the key source control reports related to stormwater are provided in Attachments 6B-1 through 6B-8.

REFERENCES

Seattle Parks & Recreation. 2018. Gas Works Play Area Renovation As-Builts. November 16, 2018.

Table 6B-1

Analytical Data Summary – Catch Basin Solids

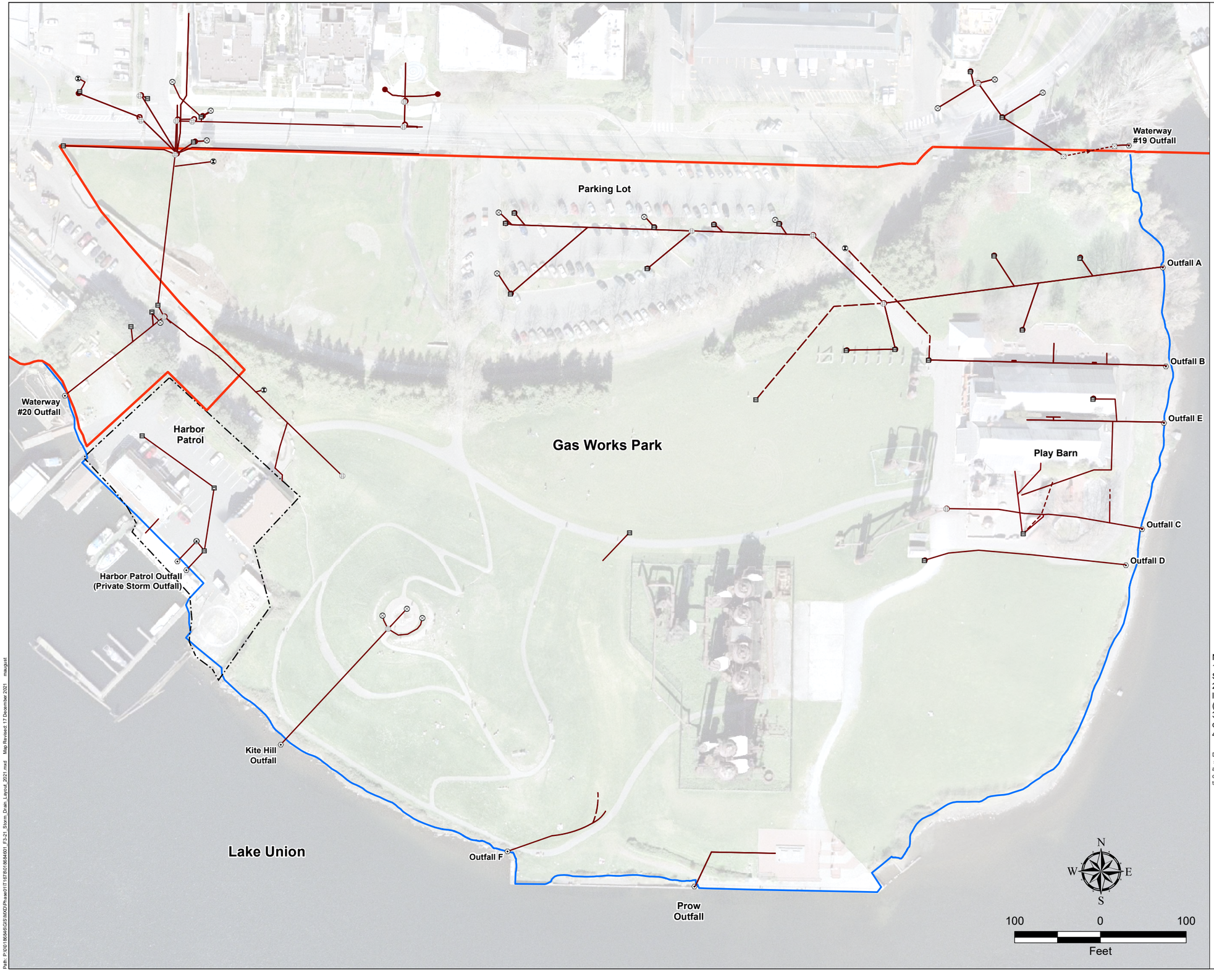
Gas Works Park Site
Seattle, Washington

Analyte	Total No. Samples	Frequency of Detection	Reporting Limit for Nondetected Values		Detected Concentrations			
			Minimum	Maximum	Minimum	Median	Mean	Maximum
PAHs		%	mg/kg		mg/kg			
cPAH TEQ (Calculated) using 1/2 the RL	24	100	n/a	n/a	0.12	0.92	1.9	6.5
HPAH	24	100	n/a	n/a	0.93	7.6	15	53
TPAH	24	100	n/a	n/a	1.0	9.1	18	73
Benzo(a)anthracene	24	83	0.20	0.64	0.084	0.64	1.1	3.4
Benzo(a)pyrene	24	88	0.20	0.64	0.087	0.71	1.6	5.1
Benzofluoranthenes	24	100	n/a	n/a	0.20	1.4	2.5	9.7
Chrysene	24	100	n/a	n/a	0.096	0.91	1.5	5.0
Dibenzo(a,h)anthracene	24	29	0.064	0.64	0.078	0.58	0.50	0.83
Fluoranthene	24	100	n/a	n/a	0.20	1.6	2.7	11
Indeno(1,2,3-cd)pyrene	24	67	0.064	0.64	0.20	0.54	1.4	4.1
Pyrene	24	100	n/a	n/a	0.26	2.0	3.4	13
Naphthalene	24	54	0.064	0.64	0.081	0.48	1.1	3.1
Metals		%	mg/kg		mg/kg			
Arsenic	23	48	9.0	30	10	19	22	53

Notes:

n/a = not applicable

See text for full acronym and abbreviation list.



Legend

- Area of Investigation
- Shoreline (OHWM)
- Storm Drain
- Perforated Storm Drain
- Drainage Ditch
- Oil/Water Separator
- Drain
- Catch Basin
- Inlet
- Maintenance Hole or Manhole
- Unknown Sewer/Lateral Point
- Storm Drain Outfall Location

Notes:
1. Reference: Attachments 6B-1 through attachments 6B-8, and Seattle Parks & Recreation As-Builts from November 2018.
2. Former outfall C perforated laterals not shown. Perforated laterals were lined during the Play Area 2018 renovation (Seattle Parks & Recreation As-Builts, November 16, 2018).
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Catch Basin, Storm Drain, and Outfall Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers | Figure 6B-1

Path: P:\0018634\GIS\MXD\Phase01\T078\0018634001_F3-21_Storm_Drain_Layout_2021.mxd Map Revised: 17 December 2021 maugust

ATTACHMENT 6B-1
Joint Source Control Evaluation

Gas Works Sediment Area

Joint Source Control Evaluation

Prepared for

City of Seattle

Seattle Public Utilities

February 27, 2007

ECOLOGY REVIEW DRAFT

FLOYD | SNIDER

strategy ▪ science ▪ engineering

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10 YEARS 1996-2006

Table of Contents

List of Figures

List of Appendices

List of Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AB	Area Boundary
AO	Agreed Order
AOI	Area of investigation
BMP	Best management practices
BIP	Business Inspection Program
City	City of Seattle
CSO	Combined sewer overflow
CD	Consent decree
COC	Contaminant of concern
DNAPL	Dense non-aqueous phase liquid
DOT	Department of Transportation
DO	Dissolved oxygen
DW	Dry weight
Emerald Landing	Emerald Landing LLC
Park	Gas Works Park
GWSA	Gas Works Sediment Area
HMC	Honda Marine Center
HRPG	High-risk pollution-generating activities
Jeff's	Jeff's Diesel Works
JSCE	Joint Source Control Evaluation
LUYC	Lake Union Yacht Center
LNAPL	Light non-aqueous phase liquid
NOAA	National Oceanic and Atmospheric Administration
NLSY	Northlake Shipyard, Inc.
NPDES	National Pollutant Discharge Elimination System
NWSS	Northwest Schooner Society
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PSE	Puget Sound Energy
PVC	Poly vinyl chloride

Acronym/Abbreviation	Definition
RI/FS	Remedial investigation and feasibility study
SCSL	Site-specific cleanup screening level
Harbor Patrol	Seattle Police Department Harbor Patrol facility
SPU	Seattle Public Utilities
SQS	Sediment quality standards
SSQL	Site-specific sediment quality level
TOC	Total organic carbon
TSS	Total suspended solids
TPAH	Total polycyclic aromatic hydrocarbons
TPH	Total petroleum hydrocarbons
USEPA	U.S. Environmental Protection Agency
Ecology	Washington State Department of Ecology

1.0 Introduction

The City of Seattle (City) and Puget Sound Energy (PSE) are conducting this Joint Source Control Evaluation (JSCE) for the Gas Works Sediment Area (GWSA), offshore of Gas Works Park (Park) in order to evaluate the potential for post-remedial sediment recontamination from both uplands and in-water off-site sources. The City conducted the evaluation and preparation of this report and consulted with PSE during planning and implementation of the evaluation and report development.

The approach and geographic extent of the JSCE was developed with oversight and input by the Washington State Department of Ecology (Ecology). The final approved approach and geographic extent document was submitted to Ecology on November 14, 2006 (Floyd|Snider 2006).

1.1 PURPOSE AND SCOPE

The JSCE is being conducted as a component of the remedial investigation and feasibility studies (RI/FS) for both the Gas Work Sediments Eastern and Western Study Areas (GWS-ESA and -WSA), as required by the Agreed Order (AO) No. DE2008. In this AO, Exhibits B and C specify that the RI/FS for each study area include an "evaluation of the possibility of post-remedial sediment recontamination (e.g., source control) from both uplands and in-water sources" (State of Washington 2005). During RI/FS scope development, the City and PSE recommended to Ecology that the JSCE be prepared as a joint document to better address certain pathways with potential site-wide impacts on a site-wide basis. The focus of the JSCE is ongoing off-site sources, as well as active outfalls at the park; this JSCE does not address historical sources of contamination. Because the sediment recontamination potential from soil, groundwater, and overland flow at the Gas Works Uplands is unique to each study area, recontamination potential from these pathways are addressed separately in the respective RI/FS documents prepared for each study area. The intent is not to separate the source control evaluation from the RI/FS process, but rather to ensure that recontamination risks which are site wide are considered in a thorough and coordinated manner. This JSCE document, in combination with the GWS-ESA RI/FS and GWS-WSA RI/FS, complete the AO requirement for source control.

The Cleanup Action Plan (CAP) for the Gas Works Uplands states that "Full analysis of any Gas Works Park upland to sediment pathways (including groundwater and shoreline erosion pathways) will be reserved for the next phase of cleanup analysis and action, under a separate decree or order" (Parametrix 1999). Thus, whether Uplands sources posed a risk of sediment recontamination was not evaluated as part of the Uplands remedial action. Instead, these sources and pathways are being evaluated as part of the subsequent AO for the GWSA sediments, with groundwater, soil, and overland flow evaluations included in each respective study area RI/FS.

The goals of the JSCE are to:

1. Identify and evaluate North Lake Union sources of total polycyclic aromatic hydrocarbons (TPAH) that could potentially recontaminate post-remedial surface

sediments in the GWSA to unacceptable levels based on the site-specific cleanup standards.

2. Evaluate North Lake Union waterfront facilities, operations, and stormwater outfalls, and their potential to recontaminate the remediated GWSA with constituents other than TPAH that could affect sediment toxicity.
3. Provide recommendations regarding potential additional data collection and actions for source control and to identify long-term sediment compliance monitoring implications for specific potential sources of recontamination.

1.2 SUMMARY OF EVALUATION APPROACH AND DOCUMENT ORGANIZATION

Several sources of information were evaluated as part of this JSCE regarding North Lake Union shoreline facilities, stormwater drainage basins including on-site and municipal outfalls, and ambient lake conditions. North Lake Union shoreline facilities within the geographic area of interest were evaluated based on reports developed by Seattle Public Utilities' (SPU) Business Inspection Program (BIP) that identify potential stormwater code compliance concerns at these facilities. Other lines of evidence for facility evaluations include Ecology file reviews for facilities that were known MTCA sites or had known National Pollutant Discharge Elimination System (NPDES) violations, and finally, a review of existing data about sediment quality in the vicinity of the site. For on-site outfall and municipal stormwater outfall evaluations, existing piping information (predominantly from City sources) and drainage basin size and uses were evaluated, as well as any information related to sediment quality in the vicinity of the outfall discharge. Finally, ambient lake quality was evaluated qualitatively, including known adjacent areas of sediment TPAH contamination above the site-specific cleanup level for the GWSA. Although a reasonable effort was made to identify sources of sediment recontamination, unknown off-site sources and possible future discharges of TPAH and other constituents could result in sediment toxicity.

The JSCE is organized as follows:

- Section 2.0 provides a general description of the contaminant of interest, polycyclic aromatic hydrocarbons (PAHs), site-specific cleanup levels, and geographic extent of the JSCE.
- Section 3.0 contains a description of the shoreline facilities evaluation process and highlights key findings within the JSCE Geographic Extent.
- Section 4.0 contains the stormwater drainage basin evaluation for both Park outfalls and municipal outfalls within the JSCE Geographic Extent.
- Section 5.0 contains a description of combined sewer overflow (CSO) #146 discharge frequency and known high-risk activities within this CSO basin.
- Section 6.0 contains an overview of North Lake Union ambient conditions.

- Section 7.0 contains the results of the recontamination evaluation, and lists several facilities, marinas, outfalls, and adjacent sediment areas that may pose a recontamination concern to post-remedial GWSA sediments.

- Section 8.0 contains a description of recommended actions for these facilities, outfalls, and adjacent sediment areas. These recommended actions include continued monitoring, specific recommendations for Ecology involvement, and in some cases, data collection to determine if sources pose a recontamination risk.

- Appendices A through D contain relevant backup materials, the text of the individual shoreline facility evaluations, selected site and facility photos, and a map of bioassay passes and failures.

2.0 Background and Site Description

Gas Works Park is situated on the northern shore of Lake Union, a heavily developed urban lake located north of downtown Seattle, Washington (Figure 2.1). Historical operations at the site have resulted in environmental contamination. The Gas Works Uplands have been investigated and remediation has been implemented. Remediation consisted of a vegetative cap, air sparging/soil vapor extraction, and groundwater monitoring, as documented in a formal Model Toxics Control Act (MTCA) Consent Decree (CD) between Ecology, PSE, and the City (State of Washington 1999).

The investigation and remediation of Lake Union sediments offshore from the Gas Works Uplands are being addressed in a second phase of work. Ecology, the City, and PSE have entered into an AO to conduct an RI/FS and associated planning for the Gas Works Sediment Area, as delineated by the Area of Investigation (AOI) (State of Washington 2005). The AO defines two study areas, the Western Study Area and the Eastern Study Area. The Eastern Study Area RI/FS process is being led by PSE. The City is leading the RI/FS process for the Western Study Area. Both RI/FS processes are currently underway.

This JSCE is a component of the RI/FS and addresses both the Eastern and Western Study Areas. The JSCE, in combination with the ESA RI/FS and WSA RI/FS, meets the AO requirements to "evaluate the possibility of post-remedial sediment recontamination from both uplands and in-water sources."

2.1 CONTAMINATION OF INTEREST

The focus of the JSCE is to evaluate the potential for off-site sources as well as active on-site outfalls to recontaminate post-remedial GWSA sediments at levels exceeding the site-specific cleanup standards established for the GWSA. Extensive bioassay testing in the GWSA vicinity (as part of the cleanup standard derivation process) suggests two classes of contaminants are of primary concern: total polycyclic aromatic hydrocarbons (TPAHs), which are addressed by using the TPAH SSQL as a screening tool, and metals, which are correlated with bioassay failures in areas adjacent to the GWSA containing very high metals concentrations. No promulgated metals freshwater cleanup standards exist for Washington State; however, these metals-related toxicity failures occurred at very elevated concentrations of metals and did not appear to be related to elevated ambient Lake Union concentrations of metals.

Aromatic hydrocarbons, such as PAHs, are present in a wide-range of materials, including many of the products and by-products from manufactured gas plants and tar refineries (e.g., lamp black and tar) as well as the majority of petroleum products, including both crude oil and refined products from gasoline to heavy fuel oils. PAHs formed from the combustion of organic matter are referred to as pyrogenic PAHs. These PAHs are associated with fires, the burning of fossil fuels and coal, the gasification of coal and oil, and soots. PAHs present in petroleum products, like those handled at many waterfront facilities, are petrogenic. Heavier oils, such as fuel oils and lubricating oils, have a higher percentage of PAHs than lighter products, such as gasoline (Potter et al 1998).

Overall, many sources of PAHs exist in Lake Union and contribute to an elevated ambient Lake Union concentrations of TPAH.

In the absence of promulgated freshwater sediment quality standards (SQS) and cleanup levels for Washington State, a GWSA or site-specific cleanup level for TPAH was developed in collaboration with Ecology and documented in the "Gas Works Sediment Area Cleanup Standard Determination" (RETEC 2005). This document, along with the GWS-ESA RI/FS and the GWS-WSA RI/FS, will go to public comment simultaneously.

As part of this GWSA site-specific cleanup standard determination, TPAH was determined to be the contaminant of concern (COC) for the GWSA after extensive bioassay testing within and adjacent to the GWSA. Correlation and regression analyses indicated that observed bioassay responses in the nearshore area of the AOI were primarily related to TPAH concentrations. TPAH presence is related to historic sources on the Gas Works Uplands, and therefore focusing on TPAH as a COC addresses historical impacts from Gas Works Uplands activities. TPAH is also associated with other historic and ongoing industrial activities adjacent to Gas Works Park. Additionally, observed bioassay responses were related to TPAH and shipyard-associated metals in the far western portion of the GWSA, and marina associated contaminants in the far northeast edge of the GWSA (RETEC 2005). Metals are not considered a COC for the GWSA, but instead relate predominantly to activities at adjacent sites such as Northlake Shipyard, Inc. (NLSY) and therefore will be addressed as part of those MTCA cleanup(s).

These analyses resulted in two cleanup standards for the GWSA: a site-specific cleanup screening level (SCSL) of 290 mg/kg dry weight (dw) TPAH and a GWSA site-specific sediment quality level (SSQL) of 170 mg/kg dw TPAH (RETEC 2005). Both levels are based on actual bioassay testing results, which concluded that a biological response (or indication of sediment toxicity) at concentrations less than the range of 170 to 290 mg/kg dw TPAH is unlikely. Long-term compliance of the sediment remedy will be assessed primarily based on measured concentrations of TPAH in surface sediments.

Therefore, the JSCE focuses on potential sources of PAHs to the surface sediments of the GWSA that could cause recontamination greater than the SSQL of 170 mg/kg TPAH.

Evaluation of off-site sources and their potential to contaminate sediments with other chemicals are also addressed in the JSCE. Both the GWS-ESA and -WSA remedial investigations indicate that chemicals not attributable to historic Uplands activities are present in the GWSA; however, as fresh-water standards for these other chemicals are not promulgated, and these other chemicals are not identified as COCs for the GWSA, the scope of this evaluation is limited to information from the City of Seattle's Business Inspection Program (BIP), Ecology inspections and files, NPDES Permits, City records, and field evaluation, as well as existing information concerning sediment quality in the North Lake Union vicinity.

2.2 RELATIONSHIP TO OTHER NORTH LAKE UNION CONTAMINATION

The purpose of the GWSA cleanup is to achieve substantial environmental benefit by remediating the sediments impacted from historical operations on the Uplands in an expeditious manner. Specifically, the cleanup will focus on remediating TPAH contamination that resulted from these historic operations.

It is assumed that the post-remedial surface sediments in the GWSA will likely equilibrate over time to Lake Union ambient sediment quality. The JSCE does not address sources that may cause low to moderate-level GWSA surface sediment recontamination to ambient Lake Union concentrations of TPAH (which are less than the SSQL), or other constituents that may affect sediment quality. For example, sources such as atmospheric deposition will not be addressed. General Lake Union water and sediment quality is addressed under regulatory programs (e.g., Clean Water Act programs such as NPDES) other than those governing the cleanup of sediments in the GWSA.

Existing information regarding ambient lake sediment quality and known sediment contamination in the vicinity of GWSA is summarized in this report, and evaluated relative to the potential for recontamination of the GWSA through sediment transport. This evaluation addresses multiple chemicals present in area sediments, as well as other factors that influence toxicity, such as dissolved oxygen (DO) and total organic carbon (TOC).

2.3 GEOGRAPHIC EXTENT OF THE JOINT SOURCE CONTROL EVALUATION

To define the geographic area for the JSCE, an initial screening was performed using existing surface sediment concentrations of TPAH relative to the SSQL. The initial screening, described below, evaluates the pattern of surface sediment TPAH concentrations. Potential Lake Union shoreline sources that are separated from the GWSA by documented areas of cleaner sediments less than the SSQL were screened out and are not evaluated in this report. Figure 2.2 shows the TPAH-distribution basis for the initial screening step and provides a comparison of surface sediment TPAH concentrations at locations along and outside of the AOI, relative to the SSQL. The geographical extent of the JSCE is shown in Figure 2.3 and described further below. This geographic area was discussed and agreed to by the City of Seattle, PSE and Ecology prior to development of this JSCE document.

2.3.1 Southern Extent

TPAH data south of the GWSA AOI indicates that contamination sources located to the south are not causing surface sediment TPAH concentrations in excess of the SSQL to occur within the GWSA. In other words, there are cleaner sediments (less than 170 mg/kg) in between the GWSA and potential southerly sources. Similarly, the existing sediment data to the southeast of the GWSA (Figure 2.2) show surface TPAH concentrations at levels less than the SSQL separating these areas from the GWSA, indicating that potential sources in these shoreline areas are not contributing to TPAH concentrations in the GWSA at levels greater than the SSQL. To the southwest, areas of impacted sediments are mostly bounded by cleaner sediments, with a few exceptions.

2.3.2 Western Extent

Additionally, while sediment data west of NLSY is relatively sparse compared to the data density in the GWSA, the existing data (Figure 2.2) does show that cleaner sediments (less than 170 mg/kg TPAH) are present just west of the NLSY facility. This supports the conclusion that potential TPAH sources much farther west than the NLSY site would not likely cause recontamination of GWSA sediments at TPAH concentrations greater than the SSQL. However, for the sake of defining a conservative western extent for the JSCE that addresses

potential sources other than NLSY, sources in Waterway #21, and the adjacent westerly shoreline facility (Lake Union Yacht Center [LUYC]) were included.

2.3.3 Eastern Extent

Surface sediment TPAH concentrations east of the AOI are less than 170 mg/kg and suggest that there are not any sources located east of the GWSA that would contribute TPAHs at concentrations greater than the SSQL. For the JSCE, the eastern extent is proposed to include the Gas Works Park Marina and the adjacent easterly shoreline facility (Emerald Landing).

2.3.4 Geographic Extent Summary

Based on this evaluation of existing surface sediment data, the geographic extent of the JSCE for GWSA sediment source control is defined as follows:

- East on the North Lake Union shore, encompassing the Gasworks Park Marina and the Emerald Landing facility.
- West on the North Lake Union shore to, and including, the LUYC.
- No evaluation on the east and west shores of Lake Union (east/southeast and west/southwest of the AOI), or south of the AOI.

The sediment data evaluation concludes that facilities and outfalls outside of this geographic extent are unlikely to recontaminate GWSA sediments at TPAH concentrations greater than the SSQL. The proposed geographic extent of the JSCE is shown in Figure 2.3.

3.0 Shoreline Facilities Evaluation

Numerous shoreline facilities drain stormwater directly to Lake Union. This section evaluates those overwater and shoreline facilities that could directly discharge to the portion of Lake Union within the JSCE geographical extent (i.e., west of and including LUYC, and east of and including Emerald Landing). This evaluation addresses discharges occurring through normal business activities and does not address potential discharges from catastrophic events such as equipment failures, spills, fires, earthquakes, etc. or contributions from groundwater. Stormwater runoff from the Gas Works Park Uplands that is conveyed to the lake via overland flow and not through a conveyance system will be evaluated in the respective RI/FS documents for the two study areas.

Shoreline facilities were evaluated in fall 2006 using the procedures described in Sections 3.1 and 3.2 below. A detailed evaluation of each facility, including a summary of the facility, inspection results, and potential discharges to Lake Union is included in Appendix A.

A general discussion of the findings of the shoreline facilities is in Section 3.3. A more detailed discussion of specific facilities that pose a concern for GWSA sediment recontamination can be found in Section 7.0

3.1 FACILITIES EVALUATED AND METHODOLOGY

Within the JSCE Geographic Extent there are shipyards, light industrial, marina, and commercial facilities. Shoreline facilities that could potentially contribute discharges to North Lake Union were evaluated for the potential of recontamination of the post-remedial Lake Union sediment within the GWSA. The overwater and shoreline facilities within the JSCE Geographic Extent are listed in an east to west direction below, and are shown on Figure 3.1. Aerial photographs of each facility are included in Appendix B.

- Emerald Landing
    - Emerald Landing, LLC
    - BlueView Technologies
    - Union Bay Fabrication
    - Matt Pontius, Inc.
    - Seattle Shipwrights
    - Tuckerman's Fine Woodwork
    - Susan Neff
    - Seattle Canvas Inc.
    - Bernstein Woodworking
- Gasworks Park Marina
- Gas Works Park
- Seattle Police Department Harbor Patrol

- Metro Lake Union South Yard
    - Northwest Schooner Society
- Northlake Shipyard
    - Northlake Shipyards, Inc.
    - Jeff's Diesel Works
    - Isotron
    - Ehler Marine and Industrial Service Co.
    - Western Industrial
    - The Signmaster
    - All Ocean Service, LLC
- Lake Union Yacht Center
- Honda Marine Center

Each facility was evaluated using material drawn from multiple sources including the findings from the Seattle Public Utilities (SPU) Business Inspection Program (BIP); described in further detail in Section 3.2), Ecology inspections and files, NPDES Permits, City records, facility websites, and additional field evaluation, when necessary. These multiple sources were used to assist the authors of this report to draw conclusions regarding the potential discharges to Lake Union and the potential of post-remedial sediment recontamination.

Briefly, the BIP inspects facilities to assess their compliance with the stormwater pollutant source control requirements of the City's Stormwater, Grading and Drainage Code (Stormwater Code). Several of the facilities addressed in this JSCE have individual surface water or sanitary sewer discharge permits under NPDES and/or King County Industrial Waste programs. Due to these regulatory overlaps, BIP inspections were occasionally conducted with Ecology and/or King County Hazardous Waste staff. When inspection reports from these agencies were available, information from those reports is included in the evaluation. These agencies also track and enforce compliance with permit requirements.

A general discussion of the results of the shoreline facility evaluation is in Section 3.3.

3.2 SEATTLE PUBLIC UTILITIES BUSINESS INSPECTION PROGRAM

The BIP program has its origin in the City's NPDES municipal stormwater permit, which is regulated by Ecology. As a condition of the City's NPDES permit and through the Seattle Municipal Code Chapter 22.800, Stormwater, Grading and Drainage Control Code, (Stormwater Code), the City regulates development and land use activities that impact the quality and quantity of stormwater runoff.

The Stormwater Code regulates source control in two ways:

- **Requirements for all Discharges.** All businesses that drain to the public storm drain system are required to maintain their drainage control systems (such as catch basins, detention systems, etc.), identify and eliminate illicit connections to storm

drains; and maintain street, driveway, parking lot, and sidewalks. Related technical specifications are identified in the Stormwater Code.

- **Requirements for High-risk Pollution-generating (HRPG) Activities.** The Stormwater Code identifies eight HRPG activities, consisting of fueling operations; vehicle, equipment, and building washing and cleaning operations; truck or rail loading and unloading of liquid and solid materials; liquid storage in stationary above ground tanks; outside portable container storage of liquids, food wastes, or dangerous wastes; outside storage of non-containerized materials, by-products or finished products; outside manufacturing activity; and landscape construction and maintenance. All businesses engaged in one or more of these activities must obtain a spill kit and develop a spill plan, as well as implement operational source controls specific to their activities. Technical specifications are identified in the Stormwater Code for all of these types of activities.

In addition, the City recently revised the Stormwater Code to clarify that it has the authority to regulate direct discharges to surface waters (i.e., stormwater or other discharges to surface water that are not conveyed via a constructed conveyance [e.g., stormwater runoff from a dock or other overwater structure]).

The first step in implementation of the Stormwater Code via the BIP involves inspections of commercial and industrial properties. In accordance with the Stormwater Code, businesses are required to implement source controls to reduce the amount of pollutants discharged directly to surface water or to the storm drains in Seattle. The BIP inspects properties to evaluate whether these actions are occurring.

Typically, initial inspections are unannounced visits by one to two members of a trained inspection team and are guided by a site representative. During the inspection the facility is notified of corrective actions that are identified for the facility to be in compliance and a letter is later sent documenting these corrective actions. The letter also defines a deadline by which the corrective actions must be implemented, usually 30 to 60 days from the date of the letter, and identifies potential consequences of non-compliance, including a Notice of Violation and daily fines.

A follow up inspection is conducted by the BIP to determine the facility's compliance. If the facility has implemented the corrective actions, a letter of compliance with the City's stormwater pollutant source control requirements will be sent to the facility. If not, further action may be necessary, as described above. Additional technical and financial assistance information is usually provided to the facility if corrective actions are required. For facilities that do not conduct any of the high risk pollution generating activities, a screening visit is conducted by SPU in lieu of a full site inspection.

The BIP does not specifically evaluate the potential for facility discharges to affect sediment quality. Rather, the purpose of the BIP is solely to address stormwater code compliance. Information from the BIP inspection provided useful information regarding individual shoreline businesses and provided corrective action recommendations relative to stormwater compliance at each inspected facility. This information is useful for the evaluation of potential sediment recontamination as discharges affecting water quality frequently have effects on sediment quality. For the JSCE, the effect of business operations on potential sediment recontamination

is evaluated based on the assumption that the corrective actions required by SPU for stormwater code compliance will be implemented by the shoreline facilities.

3.3 GENERAL DISCUSSION OF FINDINGS

In general, routine activities at shoreline facilities are not of concern relative to sediment recontamination potential if they comply with the appropriate source control measures required by existing NPDES permits and the City's Stormwater Code, and implement corrective actions identified by the BIP. These corrective action requirements typically include the development and implementation of a spill control plan, provision of an adequate amount of appropriate materials for spill prevention and containment, routine maintenance of catch basins, proper storage and disposal of hazardous wastes and the on-going education of employees. In general, if the shoreline facilities within the JSCE Geographic Extent comply with Ecology and City stormwater regulations and on-going City and Ecology inspections, the majority of facilities are expected to pose a limited potential of recontaminating post-remedial sediment.

While the routine operations of most of these shoreline facilities are not expected to pose a significant source of recontamination, there are several specific facilities that are of concern regarding their potential to recontaminate post-remedial sediments. The identified facilities include NLSY, the South Yard of King County Metro, Harbor Patrol, and in general, boat repair facilities and marinas. These facilities and the associated recontamination issues are discussed in greater detail in Section 7.1.

4.0 Stormwater Drainage Basins Evaluation

This section evaluates the stormwater drainage basins that contribute to North Lake Union through outfalls located within the JSCE Geographic Extent. Stormwater from Gas Works Park is conveyed to the lake through seven outfalls. Three other public stormwater outfalls that collect stormwater runoff from the local neighborhood are located within the JSCE Geographic Extent, at Waterways #19, #20 and #21. Public stormwater outfalls and their respective drainage basins are shown in Figure 4.1

Each drainage basin was evaluated for this JSCE based on field observations, City information, recent environmental reports, and Business Inspection Program (BIP) reports, if appropriate. The basins were evaluated to identify the land use and size of the contributing area, best management practices (BMPs) administered in each basin, and the potential for the contribution of constituents of concern to the water and sediments of North Lake Union.

Section 7.2 describes conclusions regarding the potential that individual stormwater outfalls pose a GWSA sediment recontamination potential.

4.1 GAS WORKS PARK STORMWATER OUTFALLS

Gas Works Park (the Park) is a 19.1 acre park situated on the northern shore of Lake Union, a heavily developed urban lake located north of downtown Seattle, Washington. The Park is located at 1901 North Northlake Way with approximately 1,900 feet of shoreline. The Park's facilities include: grassy areas, paved trails, a concession stand, a covered play barn, a parking lot, and restrooms. Cracking towers and other features from the former Gas Works facility still remain on-site. The Park is owned by the City and is operated and maintained by the City of Seattle Parks Department. An aerial photo of the Park is included in Appendix B.

Historical operations at the site resulted in environmental contamination and the site is listed on Ecology's Hazardous Sites and Confirmed and Suspected Contaminated Sites lists with a ranking of 1. As described in Section 2.0, the Gas Works Uplands have been investigated, remediation has been implemented, and on-going groundwater monitoring is being conducted, as documented in a formal MTCA CD between Ecology, PSE, and the City.

There are seven active park outfalls that convey stormwater from small sub-basins within the park (including the parking lot) for discharge directly to the lake. These outfalls are shown on Figure 4.1 and Figure 4.2, and are discussed in further detail in the following sections.

Maintenance of the stormwater conveyance system at the Park includes vacuuming of the catch basins and inlets, and removal of debris from the system.

This section evaluates the drainage basins and conveyance systems that contribute to each outfall, potential ongoing releases to surface water and lake sediment from these systems, and the method of discharge to the lake. The evaluation draws on findings from an inspection by the BIP of Gas Works Park that addresses the facilities operation and its compliance with the Stormwater Code. Sediment recontamination potential from the outfalls is addressed in Section 7.2.

4.1.1 Outfall A

Outfall A, shown on Figure 4.2 is the largest sub-basin within the Park that contributes to a park outfall discharging into Waterway #19. This system drains the Park parking lot, a lawn area to the west of the restrooms, and the lawn and vegetated area located north of the play barn and paved picnic area. Approximately 200 feet of this basin's conveyance system is perforated pipe, which functions as an underdrain for the shallow area located west of the play barn and south of the parking lot. The perforated pipe is located in the soil below the cap placed in 2001 as part of the Uplands remediation project and in an area of the park that was not capped during the Uplands remediation project, shown on Figure 4.2.

Based on the information available regarding the configuration of the drainage conveyance system, it is possible that some of the system piping and related structures may be in direct contact with soil impacted by PAH from historical releases. The quality of the water discharging from Outfall A could be impacted by soil particles containing PAHs or impacted water entering the system through perforations, or at pipe joints and cracks. Thus, potential PAH-impacted soil or water discharges from Outfall A could impact sediment quality in Waterway #19. Nevertheless, sheens have not been identified at any of the Park outfalls or in the water at the shoreline, indicating that it is unlikely that free oils are entering the pipes and discharging to Lake Union.

The outfall for Outfall A is a concrete box outlet structure with a 10-inch diameter outlet located on the eastern side of the park approximately 150 feet from the head of Waterway #19. A photo of the outfall flowing during substantial November 2006 rainfall is included in Appendix C.

The basin that contributes to Outfall A is approximately 5 acres and contains approximately 14 catch basins. The catch basins are equipped with a PVC elbow that limits oils, greases, and debris from entering the conveyance system via the catch basins. The PVC elbow is attached to the discharge pipe in the catch basin and is turned downwards so the inlet to the discharge pipe is at a lower elevation than that of the discharge pipe. This system prevents floatable materials, including oils and greases, from entering the discharge pipe and promotes settling of material to the base of the catch basin. During the BIP, SPU inspected the catch basins in the parking lot and reported that they were in good condition and that no additional maintenance was necessary.

SPU also inspected the catch basins within the Park and determined that a few of the catch basins that contributed to this outfall are beginning to fill up with material and that additional maintenance (material removal) was necessary. The Park subsequently performed the maintenance and is now in compliance with the City's Stormwater Code requirements.

4.1.2 Outfalls B, C, D, and E

Outfalls B, C, D, and E, shown on Figure 4.2 are combined into this section due to their smaller sub-basin size, close proximity to one another, and the similar land uses that contribute to each one. All four outfalls discharge into or near Waterway #19 on the east side of Gas Works Park. Discharge from or in the vicinity of Outfalls B, C, and D were observed during the significant rain events in November 2006. Discharge from Outfall E was not observed during this event as its location was unknown at that time. Photos of the discharge in the vicinity of Outfalls B and C are included in Appendix C.

Outfall B is located approximately 250 feet from the head of Waterway #19. The system drains a portion of the paved area west of the restrooms, the picnic area north of the play barn, and may also drain a portion of the main paved path that links the parking lot and the play barn/paved picnic area. Approximately 160 feet of this basin's conveyance system is perforated pipe that collects runoff in the shallow area adjacent to the walkway from the parking lot to the play barn, shown on Figure 4.2. This piping is in an area of the park that was not capped during the Uplands remediation project. Like the piping connected to Outfall A, this piping may be a conduit for contaminated soil particles or impacted groundwater and may have similar potential to impact sediment quality in Waterway #19. According to available drawings, the diameter of Outfall B is 6 inches. The outfall itself was not observed during a recent field visit, as it was hidden beneath shoreline vegetation; however concentrated runoff was observed in the vicinity of the outfall.

Outfall C is located approximately 450 feet from the head of Waterway #19 and drawings indicate it discharges at the shoreline. This system contains one catch basin which drains a portion of the paved pathway that is located west of the sand play area and adjacent unpaved areas. This Outfall also discharges stormwater that is collected through a network of perforated pipes located under the sand play area. This piping is in an area of the park that was not capped during the Uplands remediation project, but the majority of the piping is likely within clean sand that is used for the play area and not in the soil below. However, outside of the sandy area, a portion of the piping may be within the native soil. Similar to the piping connected to Outfall A, this piping may be a conduit for contaminated soil particles or impacted groundwater and may have similar potential to impact sediment quality in Waterway #19. The outfall is 10 inches in diameter and was observed discharging during a recent field visit.

Outfall D is located approximately 50 feet south of Outfall C and 500 feet from the head of Waterway #19. Drawings indicate that it discharges at the shoreline. The outfall was not observed during a recent field visit and may be hidden beneath shoreline vegetation, however concentrated runoff was observed in the vicinity of the outfall. The outfall location was determined by available City GIS information. The system is relatively small in length and appears to drain a portion of the paved pathway that is located west of the sand play area, adjacent unpaved areas, and a portion of the lawn to the south of the sand play area.

Outfall E is located approximately 75 feet south of Outfall B and 325 feet from the head of Waterway #19. Drawings indicate that it discharges at the shoreline and is 6 inches in diameter. The outfall was not observed during a recent field visit as its location was unknown. This system is composed of a series of catch basins and a floor drain that collects runoff from the roofs and impervious areas of the play barn and picnic shelter.

The sub-basins for each of these outfalls are relatively small, as they are used to collect runoff from areas that, without these conveyance systems, would not be able to otherwise drain, due to the higher surrounding elevations. The land use for the sub-basins is primarily unpaved grassy areas and impervious portions of the play barn and picnic shelter and the nearby uncovered play area.

4.1.3 Outfall F

Outfall F is located at the west end of the prow along the southern portion of the Park. Outfall F discharges runoff from a system that consists of a solid pipe which conveys runoff collected in an upgradient perforated pipe. The perforated pipe is 6 inches in diameter and is located in a low elevation area just north of a paved path and is approximately 40 feet long. Stormwater runoff from a northern area of the Park that is between the main east-west path and the parking lot is conveyed to this area through an inlet and short pipe that conveys the runoff to the south underneath the paved path. This runoff then travels overland to the low area where the perforated pipe is located. Additional runoff from the eastern side of Kite Hill and the grassy area west of the cracking towers is also collected by the perforated pipe.

Runoff from this Outfall was not observed during a recent storm event, as its location was unknown at the time. The location of this Outfall and perforated pipe was based on as-built drawings provided by the Parks Department. The perforated pipe is in area of the park that was not capped during the Uplands remediation project, Similar to the piping connected to Outfall A, this piping may be a conduit for contaminated soil particles or impacted groundwater.

4.1.4 Kite Hill Outfall

A series of inlets is incorporated into the calendar sculpture at the summit of Kite Hill. Each direction marker in the sculpture is used as a stormwater inlet. A photo of one of the inlets is included in Appendix C. The outfall for this sub-basin is a 6-inch pipe that discharges into Lake Union on the western end of the Park.

The sub-basin for this outfall is very small and includes only the sculpture on the summit of Kite Hill and the small grass berm that surrounds it.

4.1.5 Stormwater Code Compliance

Gas Works Park was inspected by the BIP and park stormwater features identified by SPU, including 14 catch basins with PVC elbow outlet traps. The only required corrective action identified was the cleaning of several catch basins. A letter was supplied to the City of Seattle Parks Department identifying this action. A re-inspection of the site verified that the City of Seattle Parks Department had complied with the letter of corrective action and the site is now in compliance with the Stormwater Code. A letter was sent to representatives of the Park identifying this compliance.

4.2 MUNICIPAL STORMWATER OUTFALLS

As required by the USEPA and the Clean Water Act, publicly owned stormwater systems in the City are required to operate with a NPDES permit. The City's municipal separate storm sewer system (MS4) is permitted under the Phase I MS4 NPDES program (NPDES Permit No. WASM23003). Parts of that MS4 drain to North Lake Union. The Phase I MS4 NPDES permit was issued in 1995 and has been administratively extended, pending programmatic and state legislative processes. A reissue of the Phase I MS4 permit is anticipated in early 2007.

Three City-owned stormwater outfalls are located within the JSCE Geographic Extent. The eastern outfall discharges into Waterway #19, directly east of Gas Works Park at 2119 North Northlake Way. The second outfall discharges into Waterway #20 located in the western portion of the Harbor Patrol facility at 1717 North Northlake Way. The western outfall discharges into Waterway #21, just west of NLSY at the base of Carr Place North (approximately 300 feet east of the JSCE western boundary). These stormwater outfalls and portions of their collection and conveyance systems that are located on public property are maintained by SPU. Maintenance conducted on such systems by SPU includes: cleaning of the catch basins and inlets, removing debris, video inspection of the pipes, and verifying proper operation of the features. Additional maintenance for stormwater features that are not on City property (drains from the nearby buildings and the Metro Lake Union North Yard) is conducted by the respective owners.

In the sections below, these outfalls and their contributing basins are evaluated to identify their potential impacts to water and sediment quality in Lake Union from current and anticipated future activities.

4.2.1 Waterway #19 Stormwater Outfall

Waterway #19 is located between the northeastern edge of Gas Works Park and Gas Works Park Marina. The Waterway is approximately 100 feet wide and has at its northern end a 1.87-acre city park called Waterway 19, a habitat demonstration project that was jointly developed by the Washington State Department of Wildlife, the City of Seattle Department of Parks and Recreation, and the Washington State Department of Natural Resources.

Within the Waterway 19 Park, a stormwater outfall is a 6-inch PVC pipe that discharges approximately 80 feet inland from the shoreline and two-thirds up the slope from the shoreline towards N. Northlake Way. The discharge from this pipe flows down a small partially armored channel into a depression near the shoreline, where it enters another 6-inch PVC culvert that discharges on the other side of a foot path near the shore and flows into Waterway #19. Pictures of these pipes taken during a substantial rainfall event in November 2006 are included in Appendix C.

The basin associated with this outfall is estimated to be 1.2 acres and is composed of a portion of Meridian Avenue North and North Northlake Way, the Burke Gilman Trail, a patio, a landscaped area, and a portion of roof drainage from a building complex, which includes condominiums and commercial facilities. The exact area of the roof that drains into this basin is unknown, but is not expected to significantly affect the quality of the runoff. The basin for this outfall is shown in Figure 4.3 and is based on field observations, City GIS information, and BIP reports, where appropriate.

The City-owned catch basins in this basin have outlet traps that prevent oils, greases, and debris from entering the conveyance system. The land uses of the basin are primarily roadways and commercial facilities without industrial contributions. Potential impacts are discussed in Section 7.2

4.2.2 Waterway #20 Stormwater Outfall

Waterway #20 is the waterbody located in between Harbor Patrol and the South Yard of King County Metro and at the foot of Densmore Avenue North. An 8-inch stormwater outfall is located near the shoreline of this waterway. This outfall and its conveyance system was built prior to 1919, and discharges stormwater into Waterway #20 at the western end of the Harbor Patrol facility. The drainage basin for this outfall is small, contributing stormwater from approximately 7.0 acres, with inputs primarily from street right-of-ways, the Park, a condominium complex, and the majority of the Metro Lake Union North Yard. The location and size of this basin was developed using available maps and field verification conducted by SPU and is shown on Figure 4.3.

This basin encompasses the majority of the North Yard of the King County Metro Lake Union Facility, but does not include the South Yard. The remainder of the North Yard stormwater runoff is part of the CSO #146 basin. The North Yard has been inspected by the BIP and is currently in compliance with the City's stormwater pollutant source control requirements. Metro is currently using the North yard for office and shop space, parking, vehicle fueling, and storage (SAIC 2006). The BIP identified four catch basins on the site that discharge to the Waterway #20 outfall. All the catch basins are equipped with PVC elbow outlet traps to prevent debris, oils, and greases from entering the stormwater drainage. In addition, there are two oil/water separators on-site that treat stormwater and washwater prior to discharge to the stormwater system.

Historically the basin has contributed stormwater discharges from the manufactured gas plant, tar refinery, Nortar Site, and the North Yard of the Metro Lake Union Facility (formerly the Chevron Bulk Fueling Terminal) (Floyd|Snider 2005a). An RI/FS conducted at the North Yard of the Metro Lake Union Facility identified both soil and groundwater contamination at the site. Contaminants in the soil included metals, total petroleum hydrocarbons (TPH), benzene, and PAHs. Cleanup work was conducted at the site in two phases. The first phase focused on the removal and disposal of above ground storage tanks and associated piping, and the excavation and disposal of shallow metals-contaminated soils. The second phase focused on the cleanup of petroleum contamination in deeper soils and groundwater underlying both the North and South yards and is 90 percent complete. This latter cleanup was successful in removing most of the petroleum; however, pockets of petroleum contamination remain at the site and groundwater compliance monitoring continues. Future use of the site is limited by the restrictive covenants applied to the property by the Consent Decree (Ecology 2004).

Future activities within this basin likely include significant redevelopment and soil cleanup (e.g. excavation) of the North Yard of the Metro Lake Union facility sometime within the next few years. This work could potentially affect the quality of surface water within the basin and is discussed further in Section 8.1.4.

This basin also discharges stormwater collected in a series of catch basins and inlets within the public right-of-way. Water quality from this basin is typical of small urban stormwater basins and potential impacts are discussed in Section 7.2.

Due to the basin's proximity to contaminated sub-surface soils described above and the age of the conveyance system, the stormwater conveyance system might act as a conduit for

contaminated groundwater and soil particles. Further evaluation of this sediment recontamination potential is discussed in Section 7.2.

4.2.3 Waterway #21 Outfall

Located in Waterway #21, the outfall that discharges into Waterway #21 performs two functions, firstly, it is an emergency overflow for water and sewage collected in the CSO #146 basin, discussed in further detail in Section 5.0. Secondly it acts as a municipal stormwater outfall for stormwater collected in the Waterway #21 stormwater basin shown on Figure 4.3. This section discusses the second function of this outfall.

This outfall is located at the Waterway #21 shoreline just west of NLSY at the base of Carr Place North (approximately 300 feet east of the JSCE western boundary). The overflow structure for the CSO #146 emergency overflow is located at the intersection of Carr Place North and North Northlake Way. Stormwater collected in this basin is conveyed to this outfall through a pipe that is connected to the overflow pipe just downgradient of the lift station.

The basin associated with this outfall is estimated to be 1.8 acres and is composed of a portion of Woodlawn Avenue North in between North 34th Street and North Northlake Place, a portion of roof drainage from a building complex, and a portion of the North Yard of the King County Metro facility. The basin for this outfall is shown in Figure 4.3 and is based on field observations, City GIS information, and BIP reports, where appropriate.

The North Yard has been inspected by the BIP and is currently in compliance with the City's stormwater pollutant source control requirements and is discussed in Section 4.2.2. Stormwater collected from the parking lot in the northern section of the Metro Lake Union North Yard is treated in an oil/water separator. The City-owned catch basins in this basin have outlet traps that prevent oils, greases, and debris from entering the conveyance system. The land uses of the basin are primarily roadways and commercial facilities without industrial contributions. Potential impacts are discussed in Section 7.2

5.0 CSO #146 Evaluation

The City of Seattle, under NPDES Permit No. WA-003168-2, is responsible for the operation and maintenance of approximately 92 CSOs within the City of Seattle. One CSO, #146, has an outfall to North Lake Union within the JSCE boundary shown in Figure 4.1. CSO #146 is an emergency overflow that discharges into Waterway #21 through the Waterway #21 Outfall, as discussed in Section 4.2.3.

During normal operation, water and sewage collected in the combined sewer system from the basin is pumped by lift station No. 58 to a sewer line that feeds into the King County trunk sewer at 34th Ave N. and Woodlawn Park Ave N. and is then conveyed to the West Point Treatment Plant (CTE Engineers 2001). During emergency situations, such as a line blockage or during periods in which the sanitary sewer system does not have sufficient capacity, overflow could discharge to Lake Union through CSO #146.

CSO discharge from this outfall due to an emergency overflow has not occurred since at least 1998 and is not considered to have a significant impact to Lake Union sediment and water quality (SPU 2005; Ecology 2005). During the JSCE scoping process, the intent was to evaluate the potential effects on water and sediment quality of Lake Union from this outfall. However, given that this outfall is an emergency overflow outfall only, without any documented history of actual discharge, this evaluation is largely irrelevant for this recontamination evaluation. The next section provides a description of the basin and businesses within the basin that could have negative impacts to water and sediment quality (in the event of a future emergency overflow).

5.1 BASIN DESCRIPTION

The basin for CSO #146 is 29.4 acres and is bounded to the north by approximately North Northlake Way and to the south by North Lake Union. This basin extends from the west to approximately the Fremont Bridge to pick up the sanitary discharge, but not the stormwater, from the Adobe facility at 901 North 34th Street and the facility just to the west of the Fremont Bridge. To the east, the basin includes a portion of Gas Works Park (including the sanitary discharge from the restrooms). The basin also includes a small portion of stormwater from the North Yard of the King County Metro facility and a portion of the sanitary discharge from the building complexes just north of North Northlake Way in between Woodlawn Avenue North and Meridian Avenue North. The basin is comprised of 25 percent commercial facilities, 5 percent industrial, and 70 percent park use (CTE Engineers 2001). Additionally, the basin includes associated roadways and sidewalks.

This section addresses contributions to the combined sewer line within the CSO #146 basin. Discharges directly to the lake from business and Park activities and stormwater runoff have been addressed in Sections 3.0 and 4.0.

In order to evaluate the potential contributions of this basin, the businesses within the basin were identified and then evaluated to determine which of those businesses had activities that could potentially have negative impacts on water and sediment quality if their discharges to the CSO were released to Lake Union. The portion of the basin that contained the identified businesses is shown on Figure 4.1, facilities west of this were not included since they only

contribute sanitary discharge to CSO #146 Identified businesses were researched and, when available, inspected by the City of Seattle's Business Inspection Program (BIP). In general, flow in the CSO #146 basin is comprised of sanitary sewage and gray water from the various businesses along the North Lake Union shoreline, including the Park and the Adobe facility. Marinas are typically not connected to the City's sanitary system and are not included in the potential CSO #146 discharge evaluation.

Based on the results of the BIP inspections, the types of facilities within this basin, and Ecology and City records, it appears unlikely that hazardous or dangerous wastes generated or managed at facilities within the CSO #146 basin will be discharged to the sanitary sewer system. In addition, as a result of some of the inspections, King County Hazardous Waste provided technical and financial assistance information to facilities to help facilitate proper disposal of these wastes.

Facilities identified that may negatively impact sediment and water quality by discharging material besides sewage and gray water to the CSO #146 are identified below along with their potential contribution.

- Seattle Sensor Systems located at 1341 North Northlake Way has an industrial permit. The BIP inspection report has not been reviewed for this facility, and it is a potential that they are no longer in operation at this location.
- Northlake Shipyards located at 1441 North Northlake Way has a King County Industrial Waste permit (#172) that allows the shipyard to discharge its vessel washwater to the sanitary sewer system. This does not include wastewater from dry docks, which is pumped into holding tanks and disposed of by an off-site disposal company. The shipyard has verbally communicated to King County that they are planning to terminate the permit because their current off-site disposal approach.

Potential impacts to sediment quality from this CSO #146 emergency overflow discharge are discussed further in Section 7.0.

6.0 Ambient Lake Conditions

After the GWSA undergoes remedial action, a long term source control concern is the recontamination of the post-remedial surface sediments by transport of surrounding off-site contaminated sediments to the GWSA. Transport of off-site sediments to the GWSA could occur due to natural current-induced resuspension and deposition or transport via localized vessel-generated currents. A qualitative sediment transport evaluation below discusses these concerns to post-remedial GWSA sediments.

Additionally, post-remedial evaluation of the GWSA sediments could be affected by ambient lake conditions. This is also discussed below. This document does not offer any project-specific recommendations related to ambient lake conditions, but they should be acknowledged as a confounding factor that can influence evaluations of post-remedial sediment quality at the GWSA, particularly given known seasonal effects.

6.1 OVERVIEW AND DESCRIPTION

6.1.1 Ambient Conditions

Lake Union historically was a slow-flushing, quiescent lake with extensive marsh habitat at the south end. Therefore, the sediments likely always have been enriched in organic carbon, originally from natural sources such as macrophytic decay. Anthropogenic inputs (e.g., industrial discharge and raw sewage) further enhanced this enrichment by providing excess organic carbon. Because the sediments and overlying water contain a large amount of organic carbon and nutrients are not rate-limiting, microbial breakdown of this carbon can rapidly deplete available dissolved oxygen (DO), particularly during periods of lake surface water stratification during summer months. Furthermore, the lake historically has been subject to periodic significant saltwater intrusion via the Hiram M. Chittenden Locks operations. Both low DO and saltwater intrusion have historically had significant impacts on the biological community and have been the focus, directly or indirectly, of a number of studies and/or mitigation actions. Whereas saline intrusion is under better control, low summer DO in the deeper waters of the lake continues to be problematic (King County 2005). This problem of elevated TOC and depressed DO are lake wide issues and will continue to be issues even after the GWSA remedial action. Both can contribute to toxicity in surface sediments. These effects, particularly seasonal effects, should be taken into consideration as confounding factors during future compliance monitoring.

6.1.2 Navigation and Fires

There is an inherent risk of boat collisions or groundings that could result in a fuel release and/or fire in the GWSA vicinity. Given the heavy boat traffic in this area, and history of vessel fires on Lake Union, fuel release and fires are likely to occur in the future. These potential impacts are difficult to quantify, but these events would presumably negatively affect water quality short-term, and possibly sediments in the vicinity longer term. Lake Union also has a history of marina and/or pier fires (most recently, the July fire at the National Oceanic and Atmospheric Administration's [NOAA] Pacific Marine Operations Center docks at 1801 Fairview

Ave.). Both fires and fuels contain or produce PAHs. If either occurred immediately adjacent to (or over) the post-remedial GWSA surface, sediments could become elevated in TPAHs.

6.1.3 Ambient Sediment Quality

Because Lake Union is a "working lake" with an industrial history, lakewide ambient concentrations in sediment appear to be elevated for many contaminants. During the AOI derivation process, historical lake-wide sediment data were compiled and analyzed. An area-wide ambient concentration of approximately 100 mg/kg TPAHs was calculated. This TPAH value, in addition to several other lines of evidence, was used to develop the AOI line, which delineates impacts from the Gas Work Park Uplands sources from background ambient Lake Union conditions.

Importantly, given the SSQL of 170 mg/kg, the fact that the ambient Lake Union TPAH concentration is 100 mg/kg indicates a generally low potential that the remediated GWSA will be recontaminated by adjacent sediments above the 170 mg/kg SSQL. Areas of off-site sediment TPAH contamination greater than the 170 mg/kg SSQL are relatively sparse (Figure 6.1). With one significant exception, discussed in Section 7.3, these off-site sediment areas are typically very distant from the GWSA (i.e. South Lake Union) or intervening sample locations indicate low TPAH concentrations, suggesting a lack of transport to the GWSA.

7.0 Recontamination Evaluation

The goals of this recontamination evaluation are to identify the potential for TPAH recontamination to post-remedial surface sediments, particularly those sources that could exceed the 170 mg/kg SSQL. Additionally, facilities, stormwater outfalls, and ambient lake conditions are identified that appear to have the greatest potential to recontaminate the post-remedial GWSA surface with contaminants that could affect sediment toxicity.

Presuming that shoreline businesses within the geographic extent of the JSCE institute the corrective actions required under applicable regulatory programs and maintain compliance with existing NPDES permits and the Stormwater Code, the majority of these facilities will likely not recontaminate GWSA sediments above the site-specific SSQL of 170 mg/kg TPAHs. Many of the materials handled by these businesses, (e.g., solvents) do not accumulate on sediment particles due to their volatility and/or hydrophilicity. Additionally, in areas with sufficient data coverage, including bioassay testing, existing surface sediment data suggests that many of these facilities can be eliminated as likely ongoing sources based on lower levels of surface sediment contaminants. Of note, some of these facilities use creosote-treated timber piles which can leach PAHs to adjacent sediments over time; however, given the localized scale of these impacts, these are not considered a source of PAHs capable of causing substantial recontamination.

However, surface sediment data in several locations suggests that a few facilities have ongoing contributions that could persist at levels of concern, even if corrective actions are taken. Additional information is also needed for several stormwater outfalls to evaluate the potential for recontamination. In addition, there are several areas of existing off-site sediment contamination that pose a recontamination concern. Based on these concerns and information gaps, there are a subset of facilities, outfalls, and ambient lake conditions that warrant further consideration and/or possible source control actions to be taken to protect post-remedial GWSA sediments. These are discussed individually in the sections below, along with the rationale for their inclusion as locations of concern.

7.1 SHORELINE FACILITIES

7.1.1 Northlake Shipyard, Inc.

Northlake Shipyard, Inc. (NLSY) has been identified as a facility of particular concern. At the NLSY site, releases of diesel fuels, tars, solvents, greases, oils, and metals have been associated with the dry dock operations. These are documented via multiple complaints in the Ecology site files and releases summarized in the Prospective Purchaser CD. Sediment investigations performed at the time of this Prospective Purchaser CD documented substantial sandblast grit accumulations on sediments in the vicinity (GeoEngineers 1991).

Presuming that corrective actions identified by the City of Seattle's Business Inspection Program (BIP) and Ecology NPDES inspections are implemented and the shipyard remains in compliance, the remaining sediment recontamination concern regarding shipyard operations is related to operation and maintenance of the dry docks and BMPs surrounding the use and handling of unused and spent sandblast grit. Neither program (BIP or NPDES) is focused on

the handling and monitoring of sandblast grit releases to prevent sediment recontamination: a MTCA-required source control process at the NLSY (see Section 7.1.1.2) must address this issue. In addition, there is a sediment recontamination risk from existing adjacent NLSY-impacted sediments; this is discussed further in Section 7.3.1.

7.1.1.1 Materials and Processes of Concern

The BIP process identified a number of concerns regarding stormwater code compliance which also relate to possible sources of both PAHs and metals at the NLSY. The facility operates adjacent to and directly over GWSA sediments at the far western portion of the Area Boundary (AB). Additionally, Ecology's NLSY files identify some sources of concern and documented releases.

PAH sources handled at the shipyard include: greases, oils, and fuels. Metals sources include ship repair activities, metals fabrications, and the application and maintenance of hull and above-water infrastructure surface paints and the use of sandblast grit (also known as abrasive grit blast). Paints used to coat ship hulls typically contain anti-fouling additives including copper, zinc, and other metals. Other metals and organotins (e.g., mercury, lead, and tributyltin) were used in antifoulant coatings historically.

Sandblasting is used for paint removal and metal surface preparation at shipyards such as NLSY. This is typically performed within drydocks. This sandblast, or abrasive grit blast, can lead to elevated levels of turbidity, suspended solids, and metals in untreated stormwater runoff and drydock discharge. Vitreous copper smelter slag grit is commonly used in the Pacific Northwest as grit under various brand names. A variety of sandblasting materials (e.g., river sand, silica sand, and metal slag sandblasting grit) were used at NLSY (GeoEngineers 1991). Even unused grit contains elevated metals (i.e., copper slag will be elevated in copper and other metals, reflecting its smelter origins). Spent grit becomes further elevated in metals after it is used to blast paint, because it becomes co-mingled with paint chips and associated metals dislodged from hull surfaces during blasting.

Hydroblasting is also used for paint removal at NLSY. Although hydroblasting eliminates the use of grit containing metals, the wastewater from hydroblasting activities becomes entrained with paint chips and associated metals dislodged from hull and other ship surfaces during blasting. Because even small amounts of paint chips can contain very elevated metals, preventing grit and washwater releases to Lake Union is a critical source control need.

Sandblasting and hydroblasting are performed on the dry docks at NLSY. Direct discharge of paint or sandblast grit to Lake Union could occur if the dry docks at NLSY are not properly tarped and secured during painting and sandblasting operations. In May and August 2006, two complaints were filed with Ecology against NLSY. Both complaints were related to inadequate tarping during sandblasting and painting operations. Inadequate tarping has been the source of NLSY NPDES Notice of Violations in the past (Ecology 2000).

NLSY's NPDES requirements specify a number of general BMPs, such as removing large debris from the dry dock prior to submergence, tarping during abrasive blasting and spray painting, and cleaning drydocks to remove spent sandblast grit and debris prior to submerging the dock to launch a vessel. Photographs are used to document the condition of the drydock floor prior to submergence. The permit requires monitoring for oil and grease quarterly via grab

sampling, but no monitoring for metals or total suspended solids (TSS; Ecology 2000). It is unknown whether NLSY has been submitting monitoring results or whether these results are in compliance. Importantly, NLSY's NPDES permit expired in June 2002. NLSY submitted a permit renewal in November 2001; Ecology has not issued a new permit yet, so the existing permit has been administratively extended through June 30, 2007.

A major source of spent grit release is likely from dry dock submergence. Because NLSY's dry docks are lowered and flooded with Lake Union water for ship launching and docking operations, incremental releases of spent grit from the dock surface could accumulate on the adjacent sediments. As mentioned above, spent grit can be extremely high in metals such as copper, and even small amounts can contribute, over time, to metal concentrations in sediment that exceed standards and/or causes bioassay failures. Currently the dry docks at NLSY have sumps and pumps that discharge hydroblast wastewater to a 4,000 gallon holding tank on-site, which is pumped for off-site disposal, as necessary, typically once per month. In addition, the dry docks are required to be cleaned of grit with manual sweeping or with washing (if hydroblasting was used) according to the NLSY NPDES permit. It is unclear, without a review of shipyard BMPs, whether stormwater from the docks is collected in the holding tanks, where the spent grit is stored, and how NLSY evaluates if the dry dock surface is sufficiently clean to submerge.

Other shipyard operations, such as overwater fuel handling, may also contribute PAHs via releases. Recently, for instance, NLSY operations were the apparent source of an oil sheen reported in North Lake Union (Ecology 2006). Additionally, surface sediments in the NLSY vicinity are elevated in TPAHs greater than the 170 mg/kg SSQL. Testing performed as part of the WSA RI/FS investigation, indicates petrogenic PAH sources in the vicinity, which would include PAHs associated with fuels (Floyd|Snider 2005b).

Overall, because ongoing NPDES-required water quality monitoring of dry dock discharges does not provide PAH or metals data, it is difficult to evaluate the magnitude of possible ongoing dry dock PAH and metals releases to the sediments offshore of the facility. Thus, even if NLSY is in compliance with their administratively-extended NPDES monitoring requirements, they are not measuring COC levels indicative of spent sandblast grit discharge from the dry docks. Furthermore, although NLSY submitted NPDES permit renewal materials in November 2001, Ecology has not apparently issued a new NPDES permit. Thus, the recontamination potential from NLSY's operations to post-remedial GWSA sediments can not be fully evaluated, and should be performed as part of an Ecology-led MTCA cleanup process at the NLSY site.

7.1.1.2 Future Model Toxics Control Act Source Control Requirement at Northlake Shipyard, Inc.

It is anticipated that, the NLSY site, while addressing MTCA sediment cleanup requirements analogous to the GWSA site, will undergo a source control process as part of its RI/FS evaluations. This source control process should be focused on addressing ongoing releases that could cause recontamination of NLSY post-remedial sediments, as well as adjacent sediments including the GWSA. Likely COCs for the shipyard include metals such as copper and zinc, as well as PAHs.

Specifically, the NLSY source control process should address at a minimum the following key issues:

- Abrasive grit blast use, storage, and disposal.
- Prevention of PAH releases to North Lake Union.
- Review of drydock cleaning procedures with a focus on BMPs that minimize releases.
- Spill prevention and spill cleanup.
- Prevention of paint spray releases during painting operations.
- Prevention of gray water and septic water discharge from vessels undergoing repair.

Key issues would likely involved the handling of sandblast grit (particularly spent grit) and how dry docks operations should be managed to prevent spent grit and PAH releases to Lake Union

7.1.1.3 Recommendations

Releases from NLSY must be controlled prior to sediment cleanup implementation at the GWSA, and there must be compliance with BIP corrective actions, the Stormwater Code, and the NLSY NPDES permit requirements. Compliance will require consistent housekeeping, BMPs, and spill response systems to be in place. Unfortunately, the current business structure at NLSY, involving customer-implemented ship repair, is not conducive to compliance or to consistent implementation of BMPs. Ecology, King County, and SPU will need to perform frequent inspections and follow-up regarding identified concerns.

A detailed source control evaluation should be part of the separate MTCA sediment RI/FS process focused on the cleanup of NLSY sediments. Sediments at NLSY that pose a high potential for recontaminating GWSA sediments through sediment transport should be addressed prior to GWSA sediment cleanup. This is discussed further in Section 7.3.

An awareness of concerns and potential sources at NLSY should be incorporated into the design of an appropriate long-term monitoring program for the remediated GWSA.

7.1.2 Other Boat Repair Facilities

Several adjacent boat repair facilities have notable issues that were identified during the BIP process. East of the GWSA, these facilities include Emerald Landing and Union Bay Fabrication (a tenant of Emerald Landing). West of the GWSA they include LUYC. These businesses perform vessel work and some overwater work, but none have dry docks. Therefore, the likely magnitude of potential releases is lower than NLSY. All three areas/facilities were noted as having inadequate spill prevention and/or poor housekeeping practices, and all three have the potential for releases to the sediments. Sediment data in the vicinity of Emerald Landing and Gasworks Park Marina (discussed in Section 7.3) indicates the potential for elevated metals and toxicity concerns. Limited sediment data exists to the west of the NLSY and adjacent to LUYC, but the data that does exist suggest the presence of elevated metals.

7.1.2.1 Recommendations

In the future, it will be important that these facilities maintain compliance with BIP-recommended corrective actions, NPDES permit requirements (if required), institute good housekeeping practices and maintain adequate spill prevention and control planning. As noted for the marinas below, an awareness of concerns and potential sources at these adjacent boat repair facilities should be incorporated into the design of an appropriate long-term monitoring program for the remediated GWSA.

7.1.3 Marinas, including Gasworks Park Marina

Gasworks Park Marina overlaps with the GWSA in the far northeastern corner of the site, as shown in Figure 3.1. The BIP did not identify serious issues with this facility, and corrective actions were minor and involved mostly cleaning of stormwater collection features and implementation of a comprehensive spill plan. However, surface sediment in the marina vicinity has several bioassay failures. An SQS-level bioassay failure occurred adjacent to the marina (Station NLU02; RETEC 2005). In addition, a station northeast of the marina (NLU01) had a bioassay failure. Cluster analyses performed as part of cleanup standard determination indicated these stations (and possibly, the general area) more closely resemble the shipyard-related metals impacted stations than Gas Works related stations (RETEC 2005). This area is characterized by low to moderate levels of PAHs; however, metals are present at moderate levels (generally higher than concentrations within the GWSA). A detailed site history would be required to determine whether these metals and PAHs are related to marina operations, operations at adjacent facilities (such as Emerald Landing), or are from historical sources.

In general, marina impacts may be of concern. This is not necessarily due to a lack of business BMPs at the marinas, but rather the cumulative effect of ongoing vessel maintenance—particularly if vessels are painted with soft, ablative anti-fouling paints. These paints typically contain metals as anti-fouling agents. Marinas were identified as contributors of PAHs, tributyltin, and selected metals during a study conducted in 1989 by Battelle at two marinas located in Port Townsend and Anacortes, Washington (Crecelius et al 1989). Other marinas are currently under investigation or have been investigated by Ecology (Norton 2001). Other potential discharges of concern at marinas include gray water and possible sewage discharges (i.e. holding tank overflow or spills). Of note, none of the marinas in the JSCE geographic extent offer fueling services.

Ecology restricts in-water hull scraping and cleaning by divers on hulls painted with soft paints. However, state water quality law allows minor repairs to be conducted while boats are in the water. This cleaning and painting is restricted to less than one-quarter of a vessel's hull—anything more extensive must be done out of the water at a boatyard or dry dock that has a permit and facilities for proper handling of painting and cleaning wastes. It is unknown whether this level of allowed hull work poses a recontamination risk, particularly over time.

The Clean Marina program may provide an extra level of source control assurance. The Clean Marina program represents a 3-way partnership between the recreational boating industry (represented by the Northwest Marine Trade Association), Puget Soundkeeper Alliance, and the EnviroStars Cooperative. A Clean Marina Designation indicates that a marina is in full compliance with environmental regulations, has voluntarily adopted additional environmental

management practices, and has passed certification through an inspection process. A Clean Marina certification indicates that the facility has also been certified as an EnviroStars business and is thus committed to pollution prevention and hazardous waste material reduction.

7.1.3.1 Recommendations

Ecology is encouraged to promote education of marina tenants at Gas Works Park Marina by providing information about BMPs to marina tenants and by offering technical assistance on implementation of BMPs. This could include supplying tenants with copies of Ecology's "Resource Manual for Preventing Pollution in Marinas," and encouraging marinas to pursue a "Clean Marina" designation through the EnviroStars program.

An awareness of concerns and potential sources at adjacent marinas should be incorporated into the design of an appropriate long-term monitoring program for the remediated GWSA.

7.1.4 Derelict Vessel Storage at Seattle Police Department Harbor Patrol Facility

Discharges to Lake Union could occur from abandoned vessels and objects that are taken to the Harbor Patrol facility. Vessels brought to the facility that are sea-worthy are stored at the dock, before being auctioned or disposed of in other ways. Potential discharges from these vessels may occur, as the structural and mechanical integrity of the vessels is typically unknown. Potential leakage from derelict vessels at this location would be of direct concern to GWSA sediment quality.

7.1.4.1 Recommendations

Proper equipment including booms, used fuel and oil containers, and secondary storage equipment is currently kept on-site and should minimize potential negative effects of any derelict vessel discharges. Harbor Patrol also avoids taking obviously leaking derelict vessels to the facility, and drains and containerizes fluids within derelict vessels. It is recommended that Harbor Patrol continue these current practices.

7.1.5 Future Tenant Operations at the Metro South Yard

Metro Lake Union South Yard Facility (Metro South Yard) currently has the Northwest Schooner Society (NWSS) as a tenant. As noted above, the future use of the property is uncertain and it is subject to King County master planning. The Maritime Heritage Task Force identified it as a possible location for a working wooden boatyard.

7.1.5.1 Recommendations

As King County moves forward with final decisions about future land use at Metro South Yard, an awareness of its location adjacent to and partially over the GWSA should be considered. If future tenants perform boat repair or any similar activities, proper source controls (BMPs, spill prevention, etc.) and proper permitting (NPDES, etc.) will be necessary.

7.2 STORMWATER OUTFALLS

In general, typical urban street runoff from residential and commercial areas does contain TPAHs, as PAHs are present in fuels and as by-products of incomplete combustion of fuel in vehicles, as well as other sources. However, urban stormwater runoff PAH contributions for the commercial and residential neighborhoods tributary to outfalls at Waterways #19, #20, and #21 are not expected to contribute TPAH at levels greater than 170 mg/kg SSQL due to the land use characteristics and small size of drainage basins.

The stormwater draining to these outfalls is not expected to contribute TPAH at levels greater than 170 mg/kg. However, the stormwater conveyance systems with older piping that were placed in contaminated areas are a potential concern due to their potential to provide preferential pathways for contaminated soil particles and/or groundwater to infiltrate into these pipes and discharge to sediments. Several outfalls within the JSCE boundary—Outfalls A, B, C, D, E, and F within the Park, and the Waterway #20 outfall—are identified as being of potential concern as sources of contamination to the remediated GWSA. They are discussed individually below. Importantly, for all six of these outfalls, there are no records of sheen or odor complaints, suggesting that light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL) infiltration and discharge is not an issue.

As discussed in Section 5.0, CSO #146 has not discharged to Lake Union for at least nine years. Therefore, it is not considered a source control concern.

7.2.1 Outfall A

As discussed in Section 4.1.1, this is the largest drainage basin within the Park. This system drains the Park parking lot, a lawn area to the west of the restrooms, the main park pathway, and the lawn and vegetated area located north of the play barn and paved picnic area.

There are several possible issues with discharge quality. The system as a whole dates from the Park's creation in the 1970s. The Park runoff that drains from the parking lot and paved picnic area to this outfall is not expected to contain TPAH at levels of concern. However, a portion of the system (roughly 200 feet of perforated piping) is under an area capped during the Uplands remedy. This section is likely under, not in, the clean cap material, as there is not any available documentation concerning encountering or rebuilding this system during the Uplands Remedial Action. The perforated portions of the piping may provide a preferential pathway for contaminated soils and/or groundwater present below the cap. Furthermore, piping tributary to Outfall A drains a portion of the northeast corner of the Park that was not capped during the Uplands remedy. Due to the age of the system, segments other than the perforated pipe (e.g., joints) may also have cracks or joints where infiltration of soils and/or groundwater may occur. Finally, TPAH sediment concentrations in the vicinity of the discharge from this outfall in Waterway #19 are greater than the GWSA SSQL of 170 mg/kg. While there are multiple historical and current sources in the area, the outfall can not be ruled out as a contributing source of elevated TPAHs to surface sediments.

7.2.1.1 Recommendations

Further investigation of Outfall A is recommended to evaluate the outfall as a potential ongoing source of TPAHs that could cause sediment recontamination at levels exceeding the project SSQL. Possible options for this investigation include (singly or in combination): 1) measure TPAH concentrations in stormwater exiting the outfall, 2) measure concentrations of TPAH in solids present in the conveyance system or exiting the outfall, and 3) assess (via video surveys or other methods) conveyance system condition and areas of primary infiltration.

7.2.2 Outfall B, C, D, E

Outfalls B, C, D, and E, shown in Figure 4.2, have smaller sub-basins than Outfall A with similar land uses. All four outfalls discharge in or near Waterway #19 or on the east side of Gas Works Park. For Outfall B, approximately 160 feet of this basin's conveyance system is perforated pipe in an area that was not capped during the Uplands remediation project. Outfall C also contains a section of perforated piping that drains the sand play area adjacent to the Play Barn. Outfall D is south of Outfall C and appears to be a relatively small system. Outfall E is located in between Outfall B and Outfall C and drains the roofs of the play barn and picnic shelter and other impervious areas. All of these sub-basins for each outfall are relatively small. The land uses are primarily unpaved grassy areas and impervious portions of the play barn and picnic shelter and play area.

However, the surface sediments in the vicinity of these outfalls are elevated in TPAH and therefore, the outfalls can not be eliminated as possible sources. Furthermore, similar to Outfall A, the piping likely passes through areas of unknown soil and groundwater quality.

7.2.2.1 Recommendations

Given Outfall A's larger drainage basin, it is recommended that these four outfall investigations (which would include the same recommendations listed above for Outfall A) be "tiered" behind Outfall A's investigation. If Outfall A is determined to not pose a sediment recontamination concern, than these outfalls are highly unlikely to pose a concern. However, if Outfall A results indicate a possible concern, Outfall B, C, D, and E's investigations could then proceed.

7.2.3 Outfall F

Outfall F is located at the west end of the promenade (or Prow) along the southern portion of the Park and contains a short stretch of perforated pipe to intercept stormwater runoff from a fairly substantial area of the western and northern sides of the Park. This area includes the eastern portion of Kite Hill and the grassy area west of the cracking towers. Similar to the above outfalls, surface sediments in the likely vicinity of the assumed point of discharge are elevated in TPAH and therefore, the outfall can not be eliminated as a source. Furthermore, the condition of the piping—and whether it is providing a conduit—is unknown.

7.2.3.1 Recommendations

Again, like the above outfalls, an investigation of this outfall is recommended. Recommended options for investigation would include those listed for Outfall A. Again, it would be prudent to tier this investigation behind Outfall A's.

7.2.4 Waterway #20

Waterway #20's drainage basin is relatively small, contributing stormwater from approximately 6.4 acres, with inputs primarily from street right-of-ways, the Park, a condominium complex, and a portion of the Metro Lake Union North Yard. In general, given current and likely future uses (i.e., commercial and residential) in the area, the surface water quality runoff is not expected to be of concern relative to the GWSA SSQL. Of concern, however, is the age of the system (built prior to 1919) and the fact that the system borders two properties with significant subsurface historical contamination (Harbor Patrol and the Metro Lake Union North and South Yards).

There is no record of sheen complaints associated with the outfall, indicating that NAPL infiltration is not likely an issue. However, given the age of the system and the proximity of possible subsurface contamination, it would be prudent to investigate the system integrity to ensure that it is not providing a preferential pathway for subsurface contamination.

7.2.4.1 Recommendations

Possible options, like those for Park Outfalls A and B, include (singly or in combination): 1) determine TPAH concentrations in stormwater exiting the outfall, 2) determine concentrations of TPAH in solids in the conveyance system or exiting the outfall, and 3) determine (via video surveys or other methods) the system integrity. Additionally, since this outfall discharges at or below the water line, a fourth option, which may be a more direct test of impacts, could involve taking surface sediment samples immediately adjacent to the point of outfall discharge.

7.3 EXISTING SEDIMENT CONTAMINATION

In general, current speeds in Lake Union are low. As part of the Eastern Study Area RI/FS process, a North Lake Union hydrodynamics study was performed (RETEC 2006). As part of this study, current meters were deployed at various locations in the GWSA within the Eastern Study Area. The results indicate that the expected maximum bottom current in North Lake Union (due to vessels transiting overhead) decreases with depth. In the shoreline area, a greater current velocity and modeled wave action was documented, indicating this area could be subject to more resuspension. This agrees with the apparent lack of deposition (and associated lack of natural recovery) in this area. Offshore, the lake bottom area is more quiescent. Because spikes in current speeds appear to be correlated with vessel passage, vessel-induced currents could provide a localized mechanism to transport contaminated sediments from off-site onto the clean, post-remedial GWSA surface. These results, in general, support the focus on areas immediately adjacent to the GWSA.

7.3.1 Northlake Shipyards

The extent of metals-impacted sediments at NLSY is likely large. Samples taken within the GWSA indicate an area of overlap with the Western Study Area (Figure 7.2). Metals with elevated concentrations include copper and zinc, which are clearly associated with the shipyard, not with Gas Works Uplands sources. A study conducted for UNIMAR estimated that 6,500 cubic yards of spent sandblasting material was present in sediments offshore of the facility (GeoEngineers 1991). The mapped spent sandblast grit, as documented in 1991, extends beyond the existing administrative boundary established in the Northlake Shipyard Prospective Purchaser CD. The CD boundary was based on property ownership and the state-owned aquatic land leasehold area, and thus is purely administrative in nature. Thus, this boundary did not—even at the time it was developed in 1991—encompass impacts from NLSY operations.

Aside from these data collected in 1991 by GeoEngineers, metals and other chemical concentrations within the sediments at the NLSY site have not been recently measured nor has sediment bioassay testing been performed within the current site boundaries. Therefore, the mapping of spent sandblast grit does not adequately portray the actual lateral extent of sediment contamination associated with the NLSY site. Even small amounts of spent sandblast grit intermixed with sediments can elevate metals concentrations to levels of potential concern. Furthermore, the contaminant sources present at the NLSY site are not adequately characterized, and other types of releases beyond sandblast grit likely have occurred. Contaminants of concern for the NLSY site will have to be determined as part of that site's MTCA RI/FS process.

Extensive bioassay testing has been performed as part of the GWSA RI/FS processes (RETEC 2005) within the AOI but outside of the NLSY site. Correlation analysis demonstrates that bioassay failures adjacent to NLSY are related more to metals, and less to organics. Specifically, at the Stations NLU16 and NLU17 (located immediately west of the far western AB line, Figure 2.2), metals are more significant contributors to bioassay failures than TPAHs. Bioassay failures within the far western AB line, in contrast, are related more to TPAH than to metals. Therefore, these NLSY-impacted sediments, if resuspended and transported onto the post-remedial GWSA surface, could cause bioassay failures during compliance monitoring. Appendix D shows the pattern of bioassay passes and failures within and adjacent to the GWSA.

Additionally, the far western AB line roughly bisects an area of surface TPAH contamination greater than the SSQL of 170 mg/kg dw. A second area of elevated TPAH (greater than the 170 mg/Kg SSQL) also occurs to the southwest of the NLSY dry docks (see Figure 7.1). Both of these areas are immediately adjacent to the GWSA and pose a sediment recontamination concern. Supplemental PAH analyses performed as part of the Western Study Area sediment investigation (Floyd|Snider 2005b) examined possible sources for these PAHs. The goal of these analyses was to identify whether the PAHs present in surface samples in the GWSA are associated with pyrogenic (combusted) sources only, or whether they are also associated with petrogenic (petroleum-related) sources, such as diesel fuel, gasoline, oil, and other fuel products. Petrogenic signatures were found at several locations to the west of the GWSA and are likely associated with historic and current operations of the NLSY, or historic operations at the Metro North and South Yards (Floyd|Snider 2006). Thus, NLSY is likely an ongoing source of PAHs to surface sediments, and this adjacent area of TPAH-impacted sediments, if

resuspended, could recontaminate the post-remedial GWSA sediments due to its close proximity.

7.3.1.1 Recommendations

The NLSY/UNIMAR MTCA site has been listed on Ecology's Hazardous Sites List as "awaiting remedial action" for several years. Recently, Ecology has recognized the significant potential risk that contaminated sediments at the NLSY site pose to a remediated sediment surface at the GWSA. In the fall of 2006, Ecology decided to commence an Ecology-led RI/FS process which should allow characterization and remediation of sediments at NLSY posing high-risk of recontamination to GWSA. In early 2007, Ecology will engage a consulting firm to perform an RI/FS investigation of NLSY sediments.

As part of the RI/FS investigation, it is anticipated that an interim source control action to remediate sediments that pose a high risk of recontamination to the GWSA will be conducted. The interim source control action would be conducted prior to, or concurrent with, the GWSA remediation.

If an interim source control action to remove the sediments and materials that pose the highest risk of recontamination to the GWSA can not be conducted prior to, or concurrent with the GWSA remedy, Ecology could consider delaying implementation of that portion of the GWSA remedy that is in jeopardy of recontamination from NLSY sediments, until the NLSY source is under control.

7.3.2 Gasworks Park Marina and Adjacent Area

There is a second area of potential concern associated with the Gasworks Park Marina and adjacent areas, which are located immediately adjacent to the GWSA. This area does not contain any measured exceedance of the 170 mg/kg TPAH SSQL. This area has somewhat elevated metals. However, there are two stations with bioassay failures located adjacent to the marina, as well as north of the marina. These failures are shown in Appendix D. During the cleanup standard derivation process, three stations were identified as the "marina area" based on metal concentrations and surrounding bioassay passes (RETEC 2005). It is unclear what the source(s) are for these sediments, and whether the sources are current or historical. However, due to the proximity of these sediments to the GWSA, they are of concern from a recontamination perspective, most likely from vessel traffic-induced contaminated sediment transport. While these sediments may not contribute to a failure of the 170 mg/kg TPAH SSQL, these sediments could contribute to sediment toxicity.

7.3.2.1 Recommendations

This "marina area" has not been identified by Ecology as a separate site, and current concern is based on bioassay failures in the area, not on an exceedance of the 170 mg/kg TPAH SSQL. Compliance monitoring for the GWSA, which will be developed in conjunction with Ecology, the City, and PSE, should incorporate an awareness of this impacted area and be designed in such a way as to separate any GWSA-TPAH effects from possible metals or other COC effects from these adjacent sediments.

8.0 Conclusions

Overall, the goals of this JSCE performed by the City of Seattle in collaboration with Puget Sound Energy were to:

1. Identify and evaluate North Lake Union sources of TPAH that could recontaminate post-remedial surface sediments in the GWSA to unacceptable levels based on the site-specific cleanup standards.
2. Evaluate North Lake Union waterfront facilities, operations, and stormwater outfalls, and their potential to recontaminate the remediated GWSA with discharged chemicals that could affect sediment quality.
3. Provide recommendations to Ecology regarding potential additional data collection and actions for source control and to identify long-term sediment compliance monitoring implications for identified specific potential sources of recontamination.

These goals have been addressed in detail in this document and are summarized here. Source control recommendations are summarized for each potential source identified below.

8.1 OPERATING FACILITIES EVALUATION AND RECOMMENDED ACTIONS

In general, the majority of businesses within the JSCE Geographic Extent are not suspected of contributing TPAHs to North Lake Union at levels that would cause recontamination above the GWSA SSQL. Within the JSCE Geographic Extent, facilities that operate over the water or on the shoreline were inspected by the BIP and corrective actions were identified to bring the facilities into compliance with the City's Stormwater, Grading, and Drainage Code and the associated stormwater pollutant source control requirements. These inspections and follow-up inspections to verify compliance will reduce the potential for business activities in the GWSA vicinity to impact water and sediment quality.

Within the facilities evaluated, select facilities were identified as having the potential to impact water and sediment quality even after implementing the BIP-required corrective actions for stormwater code compliance. These were identified and specific recommendations were provided, as summarized below.

8.1.1 Northlake Shipyard, Inc.

NLSY was identified due to its sandblasting and hydroblasting practices which may contribute spent grit and associated paint, debris, and PAHs to North Lake Union. NLSY's general poor housekeeping, consistent violations, and historical practices indicate that they have been and could continue to be a key contributor to sediment bioassay failures observed in the western vicinity of the GWSA. Sandblast grit residuals on the drydocks are a significant potential source of sediment contamination. Recommendations include completing the NLSY source control process that will satisfy the NLSY MTCA cleanup requirements for an RI/FS. Coordinating an Ecology-led interim action at the NLSY with the GWSA remedial action is also a crucial step.

Northlake Shipyard Recommendations

- Ecology, King County and the City should perform frequent inspections and follow-up regarding BIP- and NPDES-identified concerns.
- Ecology should lead a detailed source control evaluation as part of a separate MTCA sediment RI/FS process focused on the cleanup of NLSY sediments.
- An awareness of concerns and potential sources at NLSY should be incorporated into the design of an appropriate long-term monitoring program for the remediated GWSA.

8.1.2 Other Boat Repair Facilities

In addition to NLSY, the general nature of boat repair facilities and the results of the BIP process caused boat repair facilities to be carried forward as a potential contributor of contaminants for future consideration. Adjacent boat repair facilities, including: Emerald Landing, Union Bay Fabrication, and LUYC, have notable issues identified as part of the BIP process. All of these perform vessel work, some overwater, but none have dry docks and therefore, the likely magnitude of releases is lower than NLSY. All three areas/facilities were noted as having inadequate spill prevention and/or poor housekeeping practices. Based on these activities and the information identified in the BIP reports, Ecology inspections and files, NPDES Permits, City records, and field evaluation, all four have the potential for releases to the sediments. The limited sediment data available in the vicinity of these sources indicate that they could be potential sources. It will be important to ensure that these facilities are in compliance with BIP-recommended corrective actions and are maintaining good housekeeping practices and adequate spill prevention and control planning. As noted for the marinas below, an awareness of concerns and potential sources at these adjacent boat repair facilities should be incorporated into the design of an appropriate long-term monitoring program for the remediated GWSA.

Other Boat Repair Facilities Recommendations

- Ecology, King County, and the City should perform inspections and verify that these facilities are in compliance with BIP-required corrective actions for stormwater code compliance, are maintaining good housekeeping practices, adequate spill prevention and control planning, and are in compliance with NPDES permit conditions, if required.
- A long-term monitoring program for the remediated GWSA should incorporate an awareness of concerns and potential sources at these adjacent boat repair facilities.

8.1.3 Marinas (including Gasworks Park Marina)

The general nature of marinas, including Gasworks Park Marina, caused marinas to be carried forward as a potential contributor of contaminants and evaluated further. Typical work at marinas, including minor repair work and in-water washing of vessels, has the potential to contribute PAHs, tributyltin, and associated metals. Additionally, although not attributed to a direct source, there is evidence of impacted sediment in the vicinity of Gasworks Park Marina. This document recommends the continued education of marinas on the potential impacts of

their operations, implementing Clean Marina programs, and supplying the marina and their tenants with technical assistance on how to prevent pollution at marinas.

Marina Recommendations

- Ecology, King County and the City are encouraged to promote BMP education and provide technical assistance to marina tenants including supplying them with copies of Ecology's "Resource Manual for Preventing Pollution in Marinas."
- Ecology is encouraged to work with marina owners to secure "Clean Marina" designation through the EnviroStars program.
- An awareness of concerns and potential sources at adjacent marinas should be incorporated into the design of an appropriate long-term monitoring program for the remediated GWSA.

8.1.4 Other Miscellaneous Facility Issues—Harbor Patrol Derelict Vessel Storage, Future Metro South Yard Tenants

Two other miscellaneous facility issues were identified. Both are minor but important given the proximity of the facilities to the GWSA. One involves Harbor Patrol's storage of derelict vessels at the facility adjacent to Waterway #20, and the possibility that the stored vessels could leak fluids and/or take on water and sink within the GWSA. The second involves future operations at Metro South Yard's facility. If future land use at the Metro South Yard involves boat repair, tenants must use proper control and seek the appropriate permitting.

Derelict Vessel Storage Recommendations

- Proper equipment including booms, used fuel and oil containers, and secondary storage equipment is currently kept on-site and should minimize potential negative effects of any derelict vessel discharges. Harbor Patrol also avoids taking obviously leaking derelict vessels to the facility, and drains and containerizes fluids within derelict vessels. It is recommended that Harbor Patrol continue these current practices.

Future Tenant Operations at Metro South Yard Recommendations

- As King County moves forward with final decisions about future land use at Metro South Yard, King County should ensure that tenants (if performing boat repair or any similar activities), use proper controls (BMPs, spill prevention, etc.) and seek proper permitting (such as seeking a Boatyard NPDES permit).

8.2 STORMWATER OUTFALLS

Stormwater outfalls that discharge within the JSCE Geographic Extent were evaluated in this document. Several were identified as potential sources.

8.2.1 Gas Works Park Outfalls

Outfalls A, B, C, D, E, and F within the park convey runoff from an area that was not capped in the Uplands cleanup action. This area may contain soils with elevated TPAH concentrations that may collect in the stormwater conveyance system. In addition, some outfalls contain sections of perforated pipe that may contact potentially contaminated material lying beneath the cap that was constructed as part of the Uplands remedial action. The age of these systems may result in gaps in the joints and cracks in the pipes and may provide a preferential path of contamination to the sediments in the GWSA. It has been noted that no sheen or odor has been detected at the Park outfalls, so NAPL is most likely not being discharged from these outfalls.

Outfall A Recommendations

- Further investigation of Outfall A is recommended to determine if the outfall is a potential ongoing source of TPAHs that may cause sediment recontamination at levels exceeding the project SSQL.
- Possible options for this investigation include (singly or in combination): a) determine TPAH concentrations in stormwater exiting the outfall, b) determine TPAH concentrations of solids in the system, and c) determine (via video surveys or other methods) the condition of the system and areas of primary infiltration.

Outfalls B, C, D, E and F Recommendations

- It is recommended that these outfalls' investigations (which would include the same recommendations listed above for Outfall A) be "tiered" behind Outfall A's investigation.

8.2.2 Waterway #20

The stormwater conveyance system that discharges into Waterway #20 also runs through areas where contamination could be present. Due to the age of the system, there may be cracks and gaps in joints in the system that could provide a pathway for infiltration and contaminated groundwater to enter the conveyance system and discharge to Waterway #20. It has been noted that no sheen or odor has been detected at either the Park outfalls or the Waterway #20 outfall, so NAPL is most likely not an issue at these outfalls.

Waterway #20 Recommendations

- Possible options include (singly or in combination): a) determine TPAH concentrations in stormwater exiting the outfall, b) determine TPAH concentrations of solids in the system, c) verify (via video surveys or other methods) system integrity, or d) take surface sediment samples immediately adjacent to the point of outfall discharge.

8.3 SEDIMENT TRANSPORT

Additionally, recontamination of post-remedial GWSA from off-site contaminated sediments was evaluated. Three areas are of concern. Two of these areas are associated with the NLSY Shipyard site.

8.3.1 Northlake Shipyard, Inc.

NLSY is known to have contributed significant amounts of sandblast grit to North Lake Union—up to 6,500 cubic yards was estimated in 1991 (GeoEngineers 1991). Sediment sampling at Northlake has identified elevated concentrations of metals and therefore, these NLSY-impacted sediments, if resuspended and transported onto the post-remedial GWSA surface, could cause sediment toxicity.

Additionally, the far western AB line roughly bisects an area of surface TPAH contamination greater than the SSQL of 170 mg/kg dw. A second area of elevated TPAH (greater than the 170 mg/kg SSQL) also occurs to the southwest of the NLSY dry docks. Both of these areas are immediately adjacent to the GWSA and pose a sediment recontamination concern.

Northlake Shipyard Sediment Area Recommendation

- Sediments at NLSY that pose a high-risk of recontamination to GWSA sediments through sediment transport should be addressed via an interim action prior to or in coordination with the GWSA sediment cleanup.

8.3.2 Gasworks Park Marina and Adjacent Area

An additional area of concern for sediment transport is in the Waterway #19 area adjacent to the eastern side of the Park and Gasworks Park Marina. This area has somewhat elevated metals and there are two stations with bioassay failures located adjacent to the marina, as well as another station north of the marina.

Gasworks Park Marina Area Sediments Recommendation

- Compliance monitoring for the GWSA should incorporate an awareness of this impacted area and be designed in such a way as to separate any GWSA-TPAH effects from possible metals (or other COC) effects from these adjacent sediments.

8.4 SUMMARY

In order to identify and reduce the potential recontamination of remediated GWSA sediments, facilities and outfalls that may pose a source control concern have been identified, and recommendations for follow-up have been developed. Some of the identified concerns will be addressed by remedial action and source control evaluation at NLSY, some will be addressed by SPU and Ecology inspections and follow-up relative to compliance with the City's Stormwater Code, and some could be addressed through voluntary programs. Small, localized outfalls need further evaluation before their potential contributions can be ascertained. Successfully addressing these North Lake Union source control issues will help ensure the success of the

remedial action in the GWSA. The compliance monitoring program should also recognize that future evaluation of the remediated GWSA sediments could be affected by ambient lake conditions that are characterized by low DO and high TOC, and possibly influenced by seasonal effects.

Assuming that the corrective actions required under applicable regulatory programs are instituted at the shoreline facilities discussed in Section 3.0, and that the facilities maintain compliance with any NPDES permits and the Stormwater Code, the majority of these facilities will likely not pose a sediment recontamination exceedance of the site-specific cleanup level, although they may contribute other non-COCs which could contribute to and/or cause sediment toxicity issues.

Urban stormwater runoff from commercial and residential neighborhoods to outfalls within the geographic extent of the JSCE is not expected to contribute TPAH at levels greater than lake-wide ambient concentrations. Therefore, the runoff carried by these outfalls is not of concern relative to potential recontamination of the remediated GWSA in concentrations greater than TPAH SSQL. Additional evaluation is recommended for the potential for recontamination from infiltration of historically contaminated soils and groundwater into perforated or older conveyance pipes connected to active outfalls within the study area, such as Waterway #20 and Park outfalls. The sole CSO within the JSCE geographic extent is an emergency overflow that has not experienced an overflow discharge for almost a decade and is not considered a source control concern or potential concern for recontamination.

With the important exception of the Northlake Shipyard sediment area and an area to the northeast of the GWSA in Waterway #19, sediment transport from Lake-wide ambient sediments does not pose a threat of recontamination because ambient Lake Union TPAH concentrations are generally below the GWSA TPAH SSQL and sediment transport is not significant. The sediment area northeast of the GWSA has some observed bioassay failures that should be considered during compliance monitoring design for the GWSA. However, the NLSY site poses the greatest recontamination potential to the GWSA from current and future operations, as well as from adjacent contaminated sediments associated with the NLSY site. As part of its MTCA cleanup requirements, it is anticipated that Ecology will direct a NLSY source control evaluation aimed at eliminating sediment recontamination risks from NLSY operations. Furthermore, sediments at NLSY that pose a high-risk of recontamination to GWSA sediments through sediment transport should be addressed via an interim action prior to or in coordination with the GWSA sediment cleanup.

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Gas Works Sediment Area

Joint Source Control Evaluation

Figures

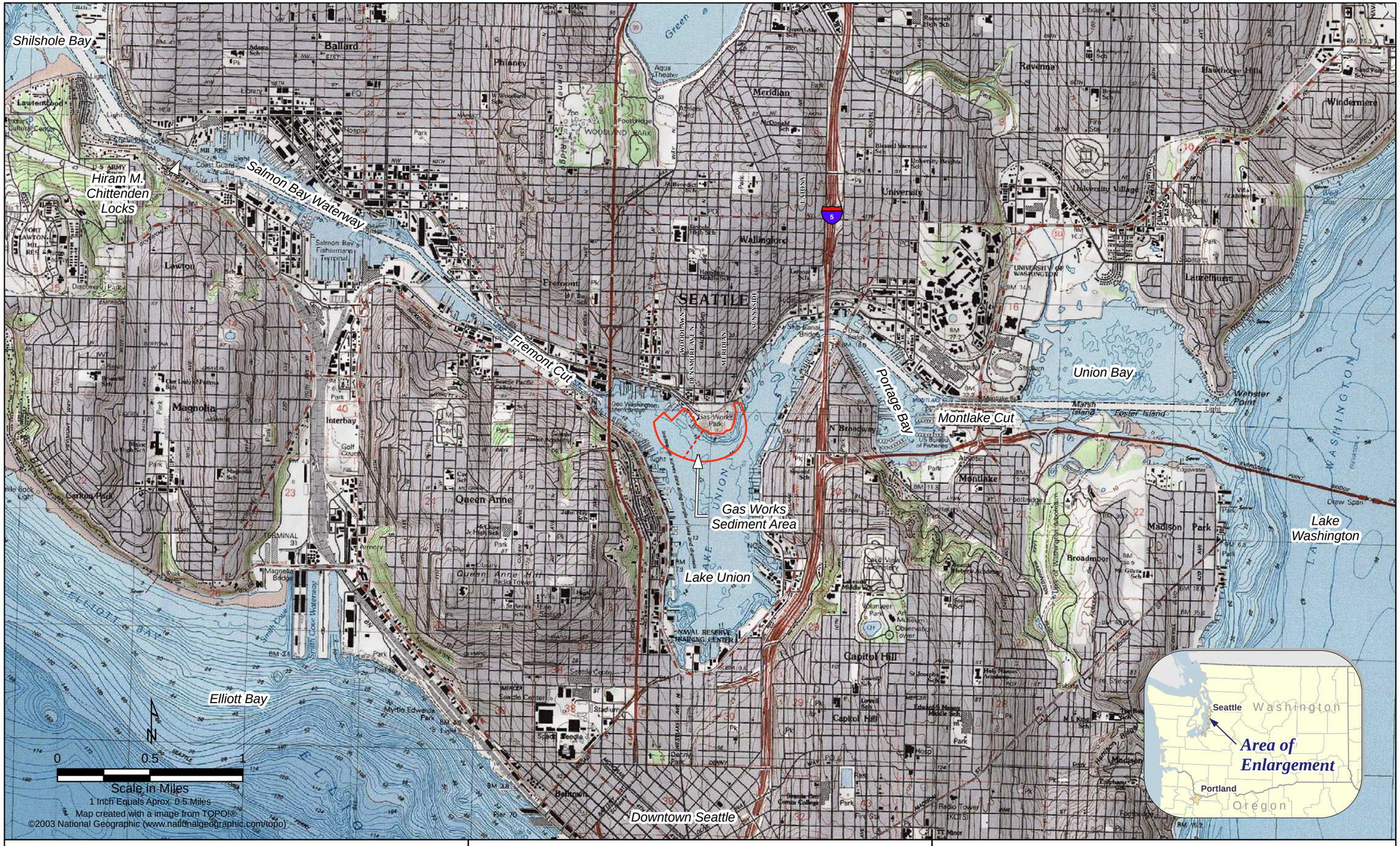

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Figure 2.1
Site Vicinity Map

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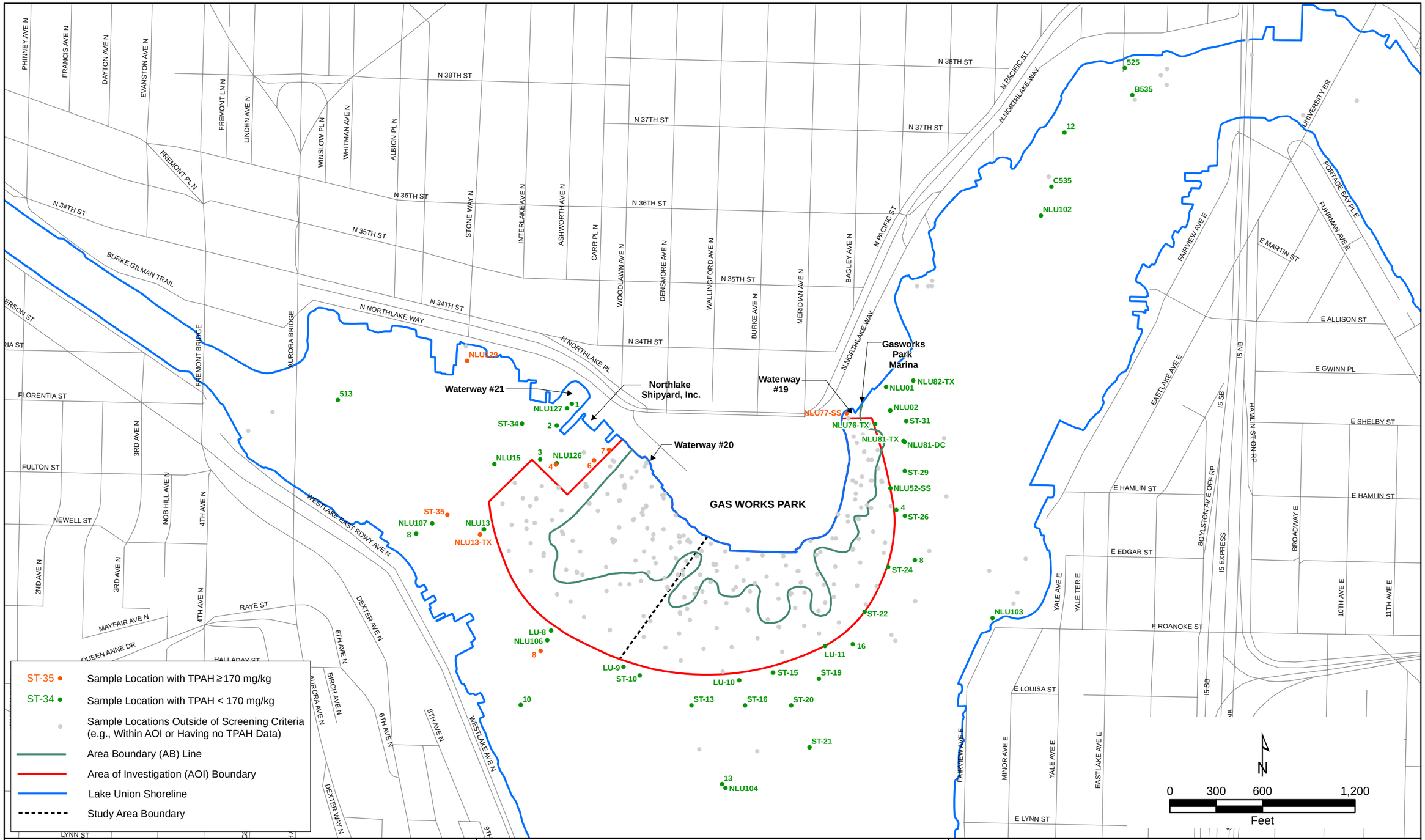

ST-35 ● Sample Location with TPAH ≥170 mg/kg

ST-34 ● Sample Location with TPAH < 170 mg/kg

Sample Locations Outside of Screening Criteria (e.g., Within AOI or Having no TPAH Data)

Area Boundary (AB) Line

Area of Investigation (AOI) Boundary

Lake Union Shoreline

Study Area Boundary

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Figure 2.2
Initial Screening - Surface Sediment Quality

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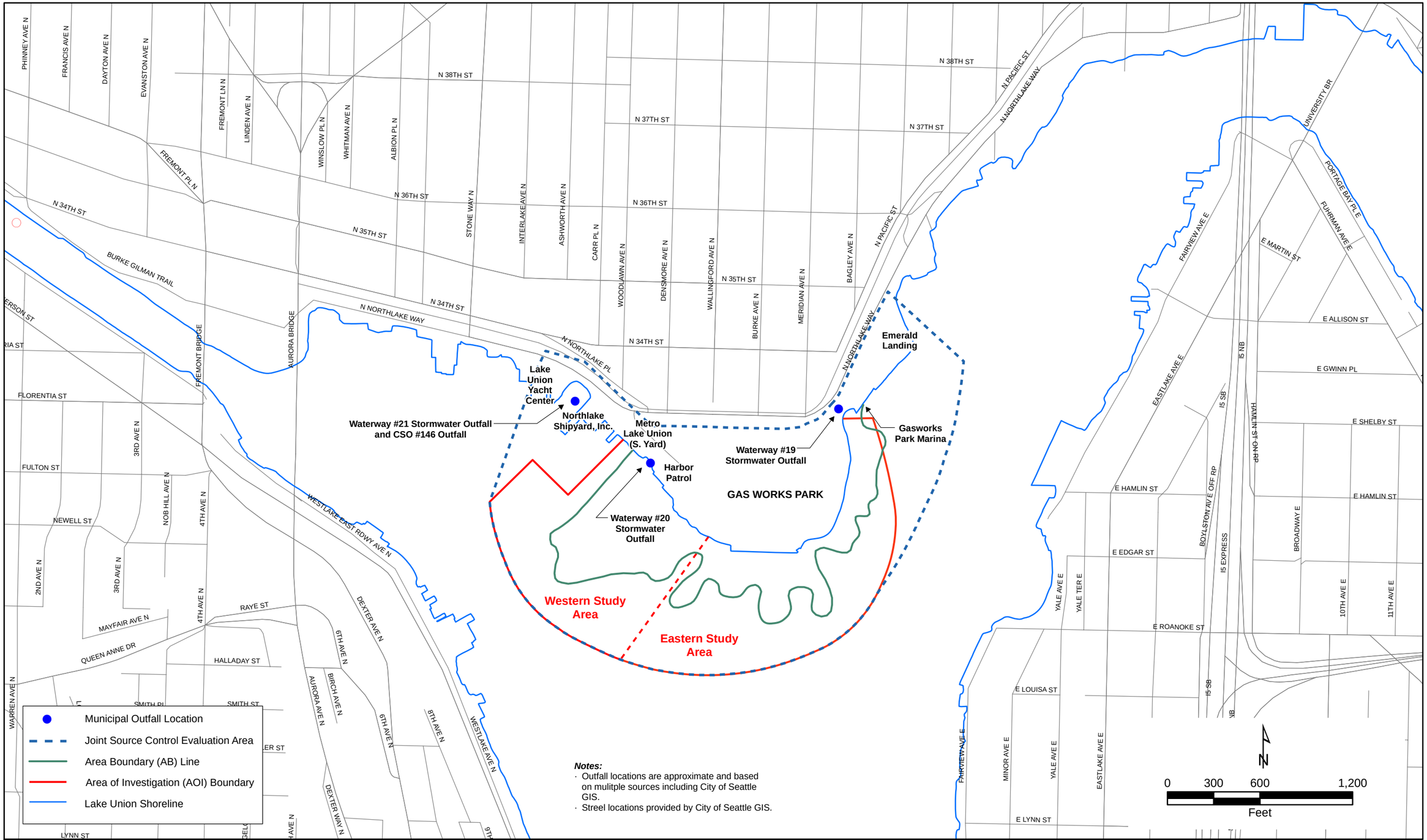

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Figure 2.3
Joint Source Control Evaluation
Geographic Extent

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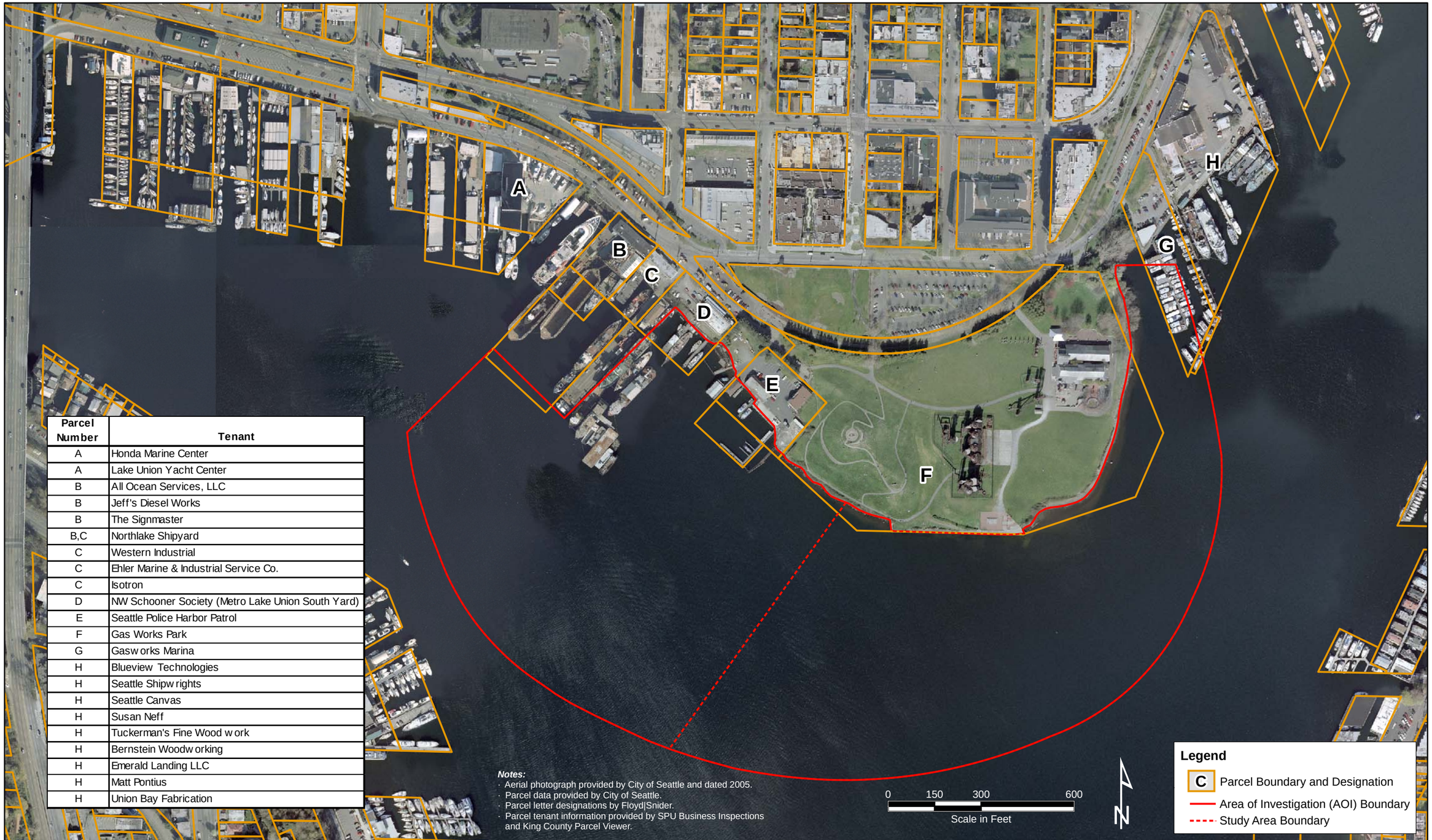

Parcel Number	Tenant
A	Honda Marine Center
A	Lake Union Yacht Center
B	All Ocean Services, LLC
B	Jeff's Diesel Works
B	The Signmaster
B,C	Northlake Shipyard
C	Western Industrial
C	Ehler Marine & Industrial Service Co.
C	Isotron
D	NW Schooner Society (Metro Lake Union South Yard)
E	Seattle Police Harbor Patrol
F	Gas Works Park
G	Gasw orks Marina
H	Blueview Technologies
H	Seattle Shipw rights
H	Seattle Canvas
H	Susan Neff
H	Tuckerman's Fine Wood w ork
H	Bernstein Woodw orking
H	Emerald Landing LLC
H	Matt Pontius
H	Union Bay Fabrication

Notes:
- Aerial photograph provided by City of Seattle and dated 2005.
- Parcel data provided by City of Seattle.
- Parcel letter designations by Floyd|Snider.
- Parcel tenant information provided by SPU Business Inspections and King County Parcel Viewer.

0 150 300 600
Scale in Feet

N

Legend
- C — Parcel Boundary and Designation
- Area of Investigation (AOI) Boundary
- Study Area Boundary

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Figure 3.1
Business Facility Map

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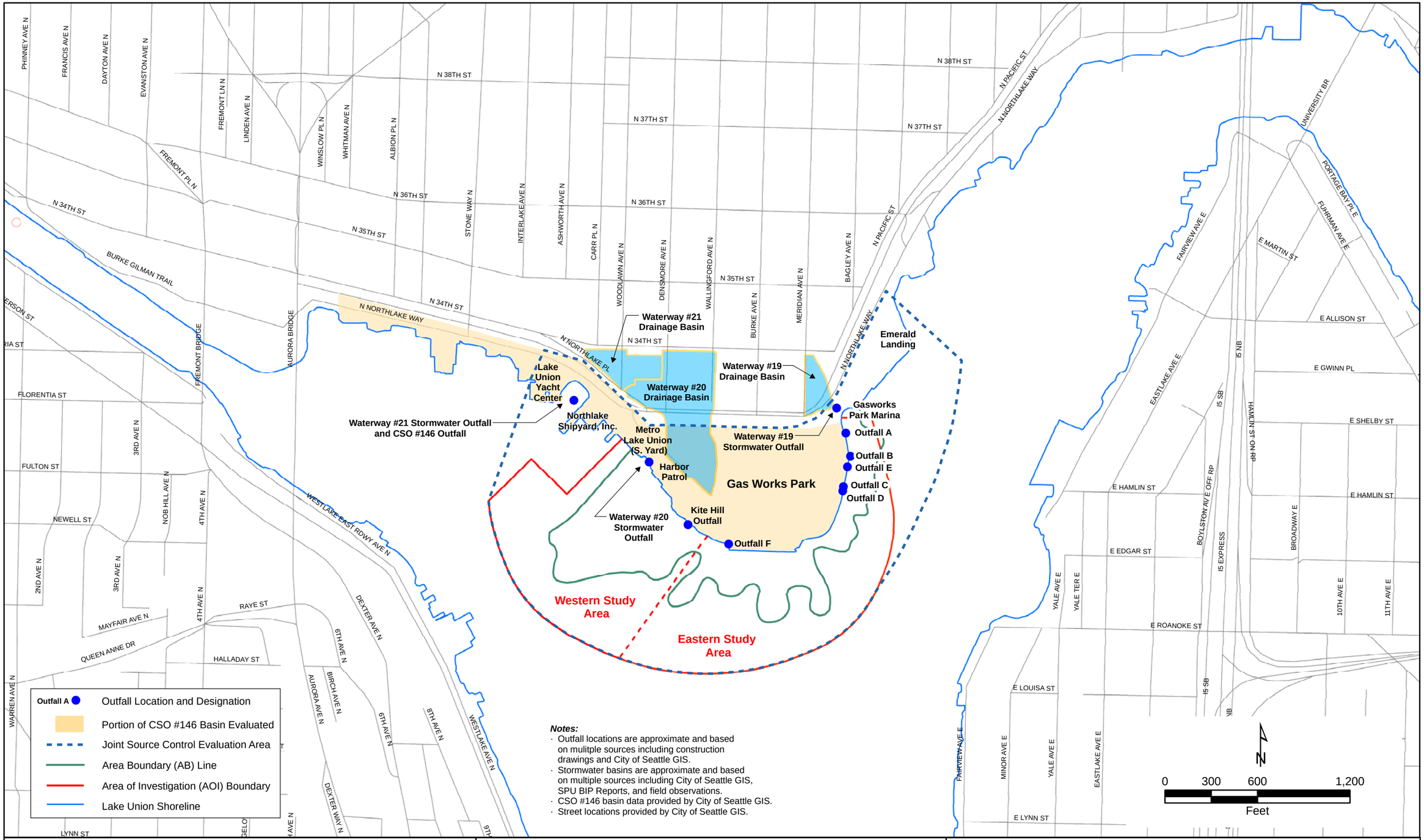

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Figure 4.1
Municipal and Park Stormwater Outfalls

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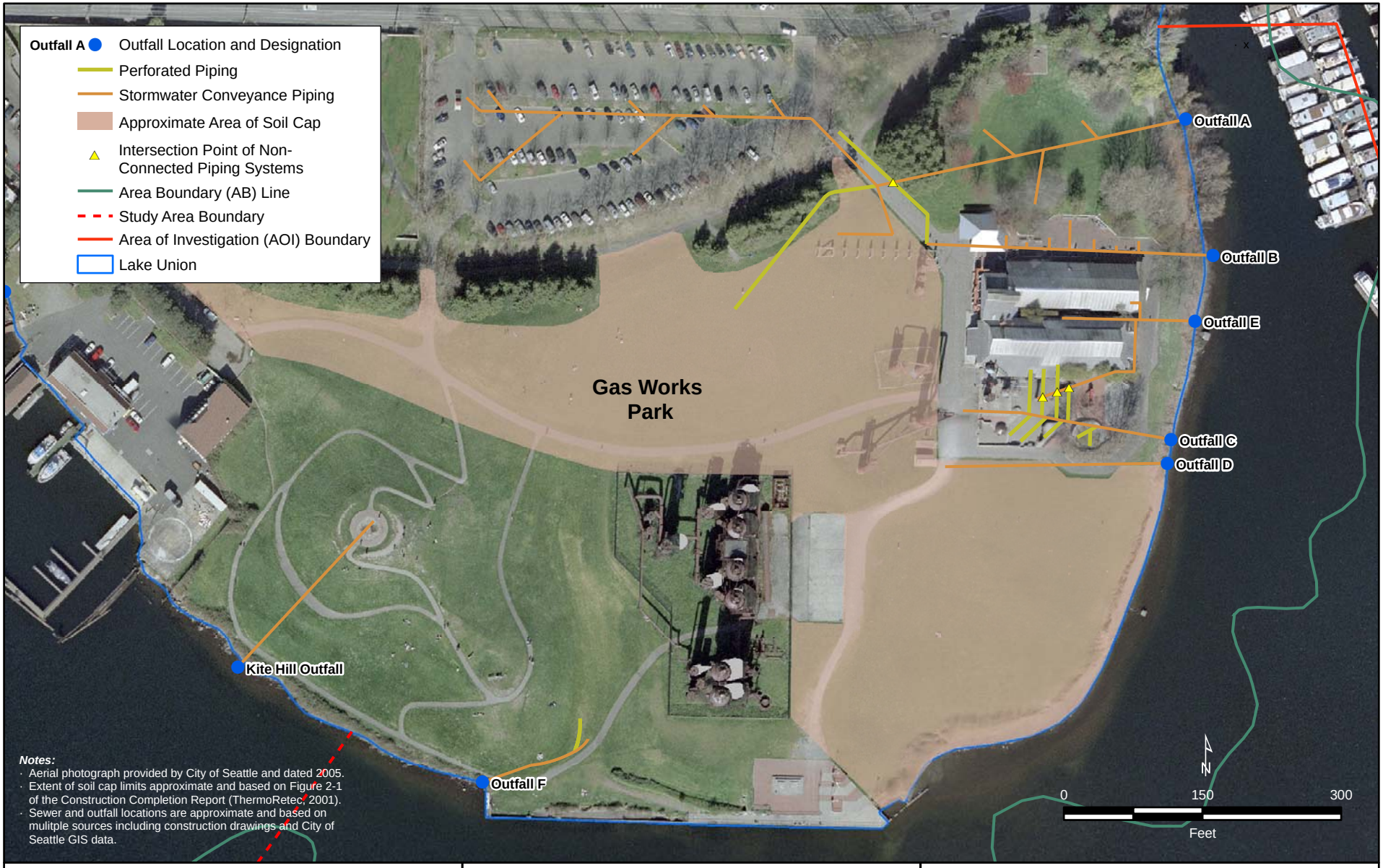

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Figure 4.2
Gas Works Park
Stormwater System and Soil Cap Limits

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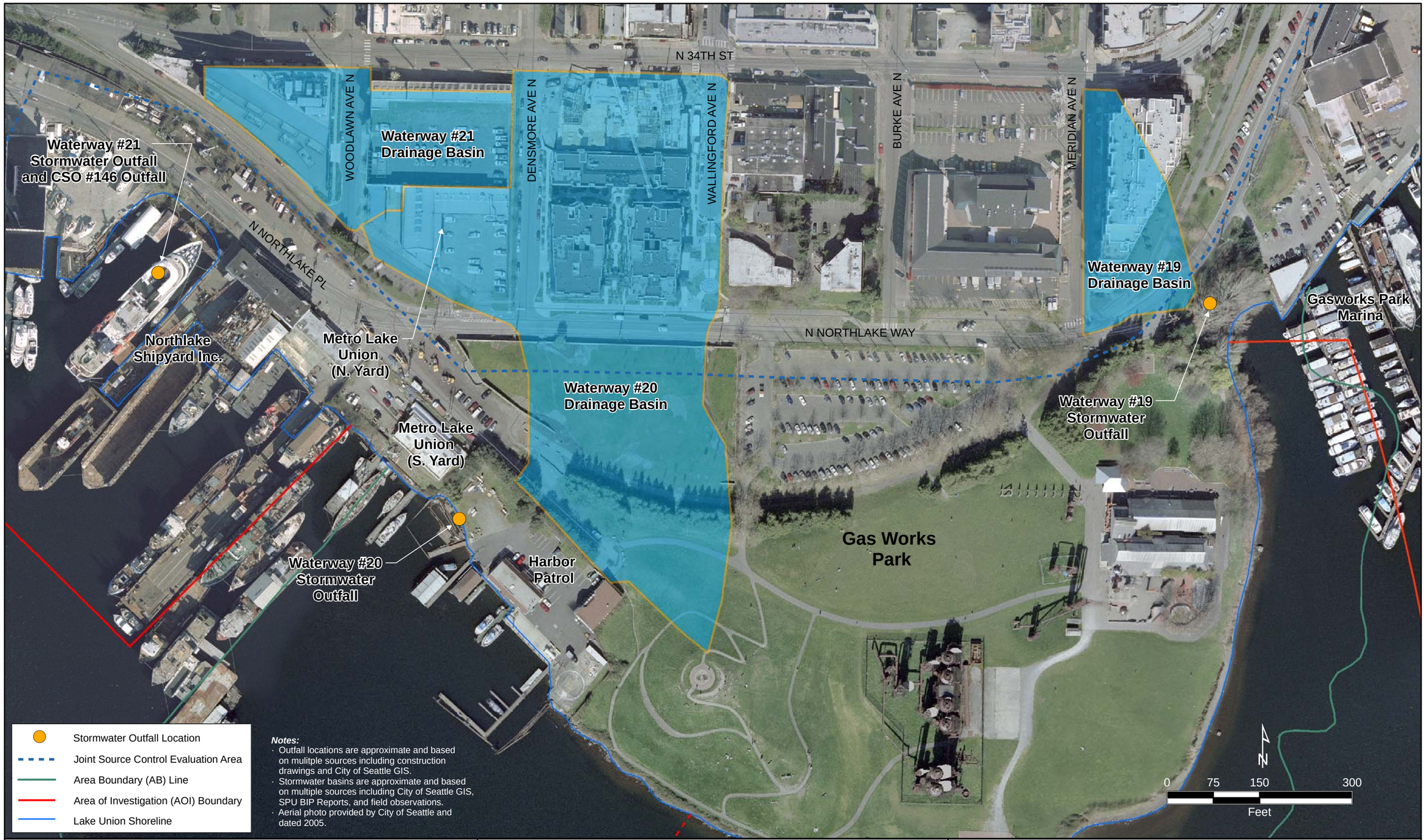

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Figure 4.3
Drainage Basins for Waterways #19, #20, and #21 Outfalls

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Legend

Lake Union Sediment Samples with TPAH Concentration > 170 mg/kg SSQL

- 170 - 500
- 500 - 2,500
- 2,500 - 5,000
- 5,000 - 10,000
- 10,000 - 63,500

Lake Union Sediment Sample Locations with TPAH Concentrations < 170 mg/kg SSQL

Area of Investigation (AOI) Boundary

Study Area Boundary

Area Boundary (AB) Line

Lake Union

Parcel Boundary

Notes:

- TPAH data and sample location data compiled from SEDQUAL Release 5.0 (October 2004) and other project-specific data sources.
- Aerial photograph provided by City of Seattle and Dated 2005.
- Parcel data provided by City of Seattle GIS.

N

0 800 1,600

Scale in Feet

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Figure 6.1
TPAH Concentrations in
Lake Union Sediment Samples

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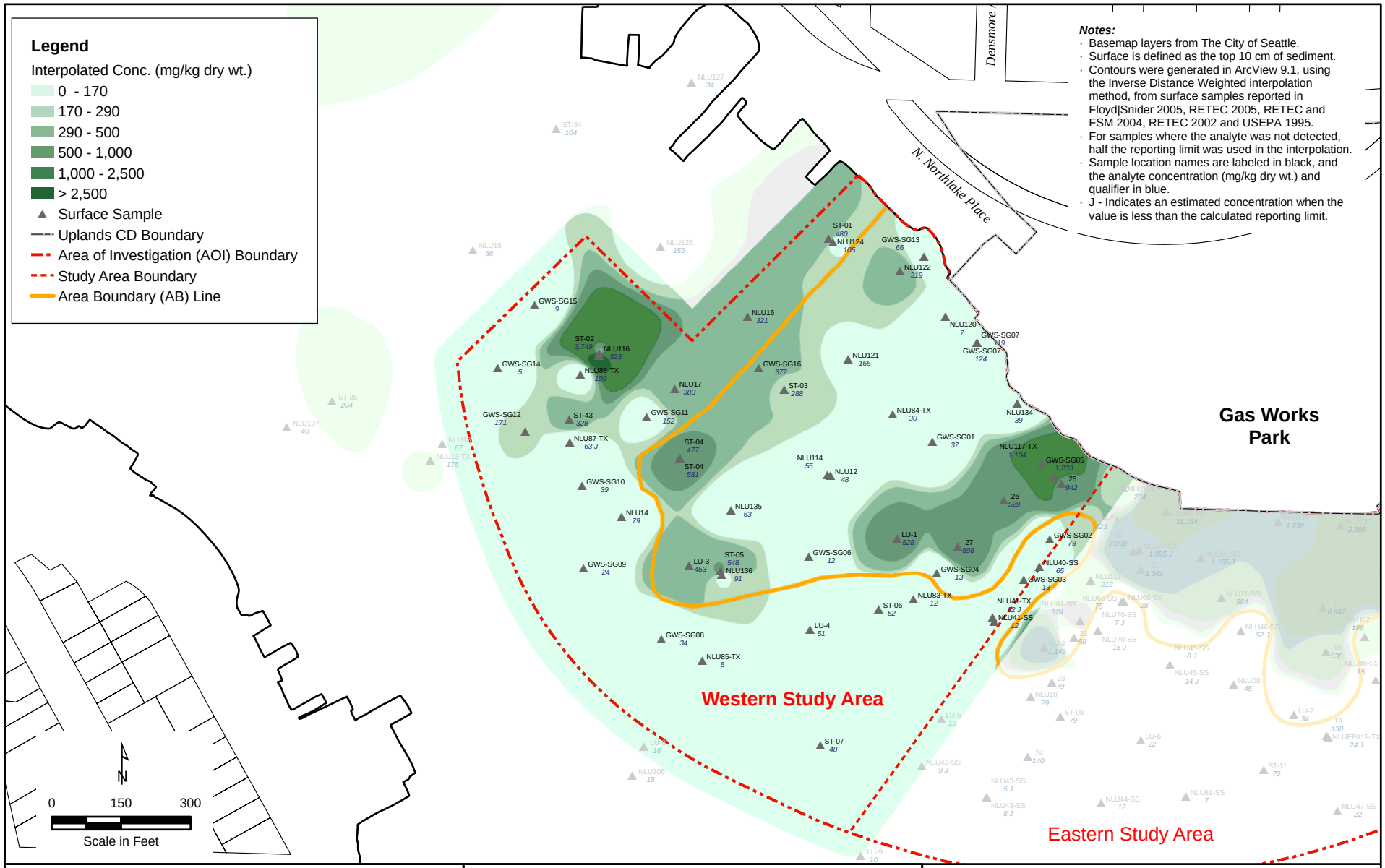

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Figure 7.1
Surface Chemistry—TPAH

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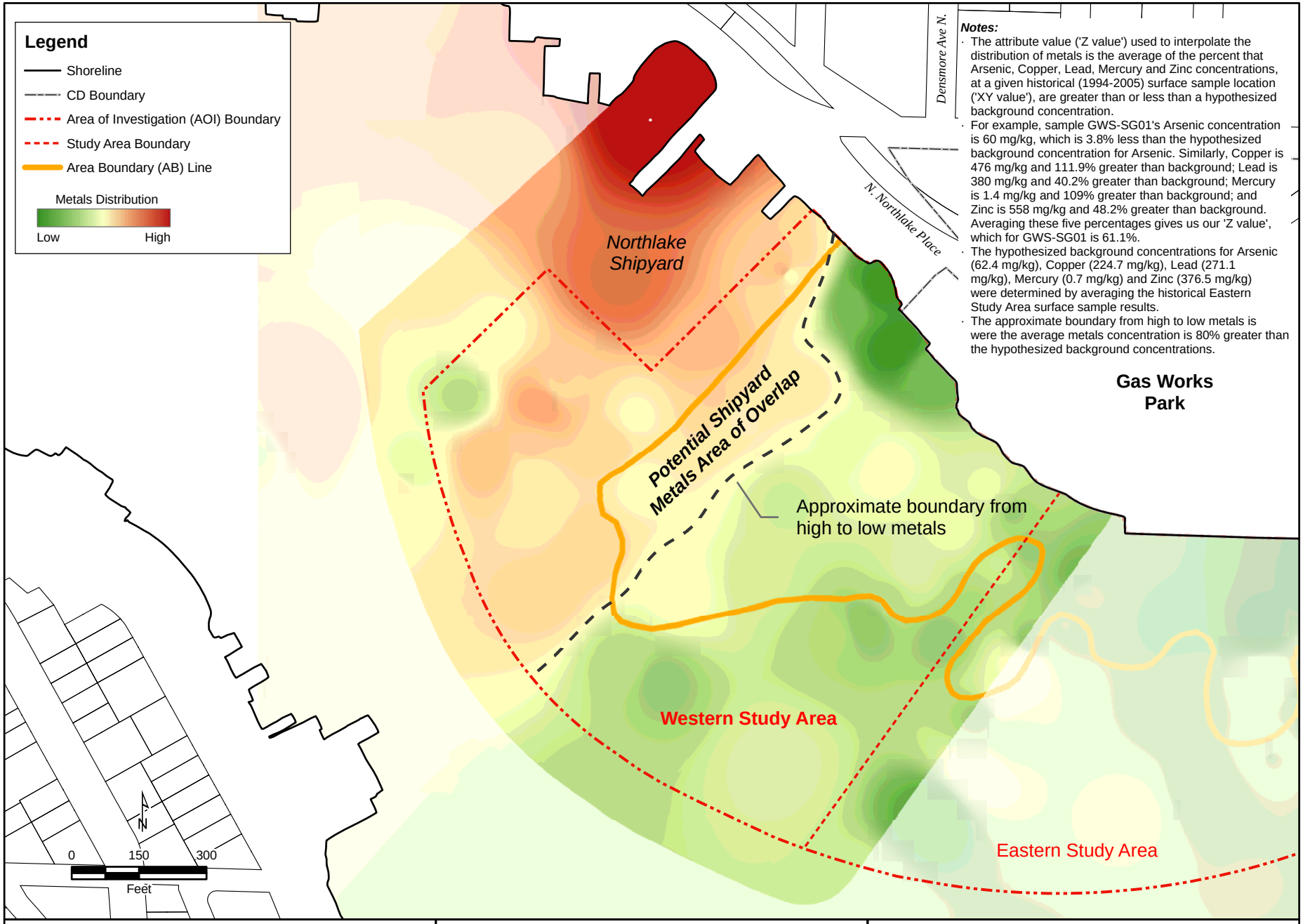

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Figure 7.2
Potential Shipyard Metals Extent within the Western Study Area

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