

Remedial Investigation and Feasibility Study

Gas Works Park Site
Seattle, Washington

for

Puget Sound Energy and the City of Seattle

January 2023





1. WW19-03 8.6
2. WW19-04 11
3. WW19-06 0.23
4. SL7-50-N 6.2
5. WW19-05 0.19
6. SL7-2-W 170
7. SL8-2-N 5.3
8. SL8-70-NW 8.5
9. SL7-2-S 110
10. SL7-20-SE 98
11. EPA23 39

Legend

- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Impervious Area
- Areas with Clean Soil Caps
- Gravel
- Cracking Towers Security Fence
- Sample Location

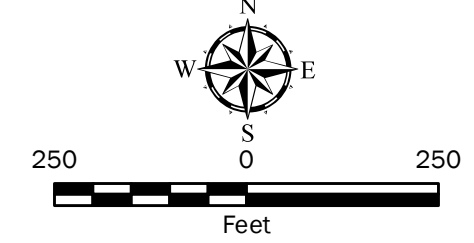
cPAH TEQ Concentration (mg/kg)

- <0.021 (SCO, Natural Background)
- >0.021 to ≤0.137
- >0.137 to ≤0.21 (CSL, Regional Background)
- >0.21 to ≤2
- >2 to ≤20
- >20 to ≤50
- >50

Notes:

1. cPAH TEQ soil screening level = 0.137 mg/kg, cPAH TEQ sediment screening levels = 0.021 mg/kg (SCO) and 0.21 mg/kg (CSL).
2. † LU-1 location is uncertain.
3. For mapping purposes, surface sediment is defined as the top 6 inches of sediment and surface soil is defined as the top 1 foot of soil.
4. Some surface soil chemical data reflect pre-capping or pre-grading conditions (not clean capping material). Given the extent of capping, surface soil concentrations depicted on this figure are not representative of the clean material currently at the surface soil interval.
5. For non-detects, 1/2 the reporting limit is posted and used for interpolations. Interpolations include detects and non-detects.
6. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = 1,000). Contoured interval may differ from actual data shown due to influence of neighboring values.
7. Basemap 2005 USGS aerial photograph. Does not show current conditions.
8. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

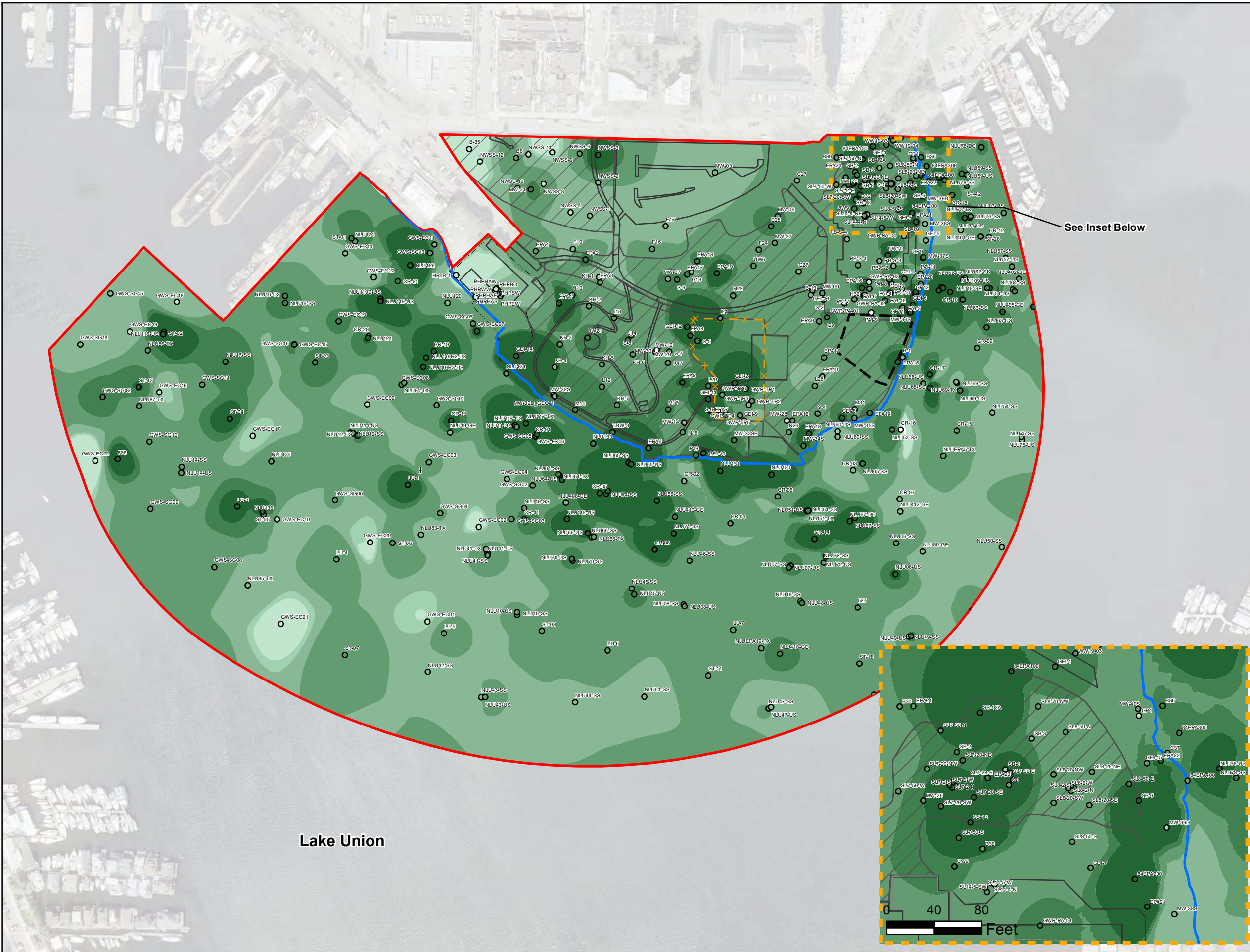
DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all attached features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.



cPAH TEQ Concentrations in Soil and Sediment - Surface

Gas Works Park Site
Seattle, Washington

GEOENGINEERS Figure 5-1A



Lake Union

See Inset Below

Legend

- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Impervious Area
- Areas with Clean Soil Caps
- Cracking Towers Security Fence
- Sample Location

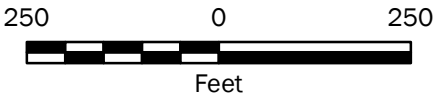
Maximum cPAH TEQ Concentration (mg/kg)

- < 0.021 (SCO)
- > 0.021 to ≤ 0.137
- > 0.137 to ≤ 0.21 (CSL)
- > 0.21 to ≤ 2
- > 2 to ≤ 20
- > 20 to ≤ 50
- > 50

Notes:

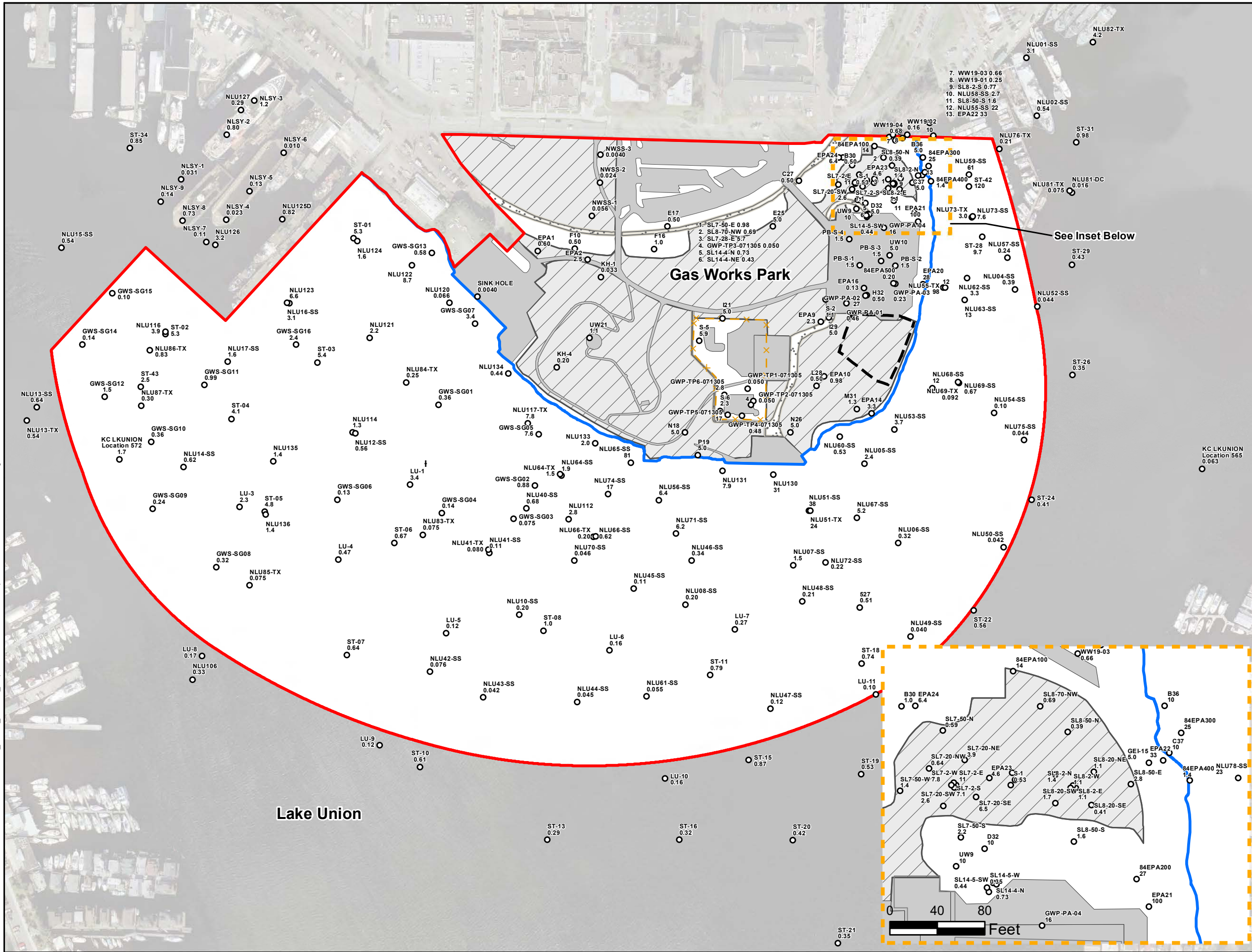
1. cPAH TEQ soil screening level = 0.137 mg/kg.
cPAH TEQ sediment screening levels = 0.021 (SCO) mg/kg and 0.21 mg/kg (CSL).
2. LU-1 location is uncertain.
3. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
4. Concentration contours do not represent surface conditions.
5. Concentration contours generated using CTech's Earth Volumetric Studio IDW (Shepard) method.
Reach = 500, Power = 6, Anisotropy = 10.
Contoured interval may differ from actual data shown due to influence of neighboring values.
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

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cPAH TEQ Concentrations in Soil and Sediment - Surface and Subsurface

Gas Works Park Site
Seattle, Washington



Legend

- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Impervious Area
- Areas with Clean Soil Caps
- Gravel
- Cracking Towers Security Fence
- Sample Location

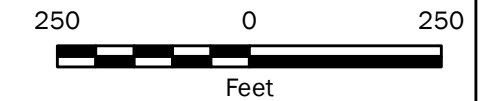
Naphthalene Concentration (mg/kg)

- ≤3,200
- >3,200 to ≤6,200
- >6,200 to ≤10,000
- >10,000

Notes:

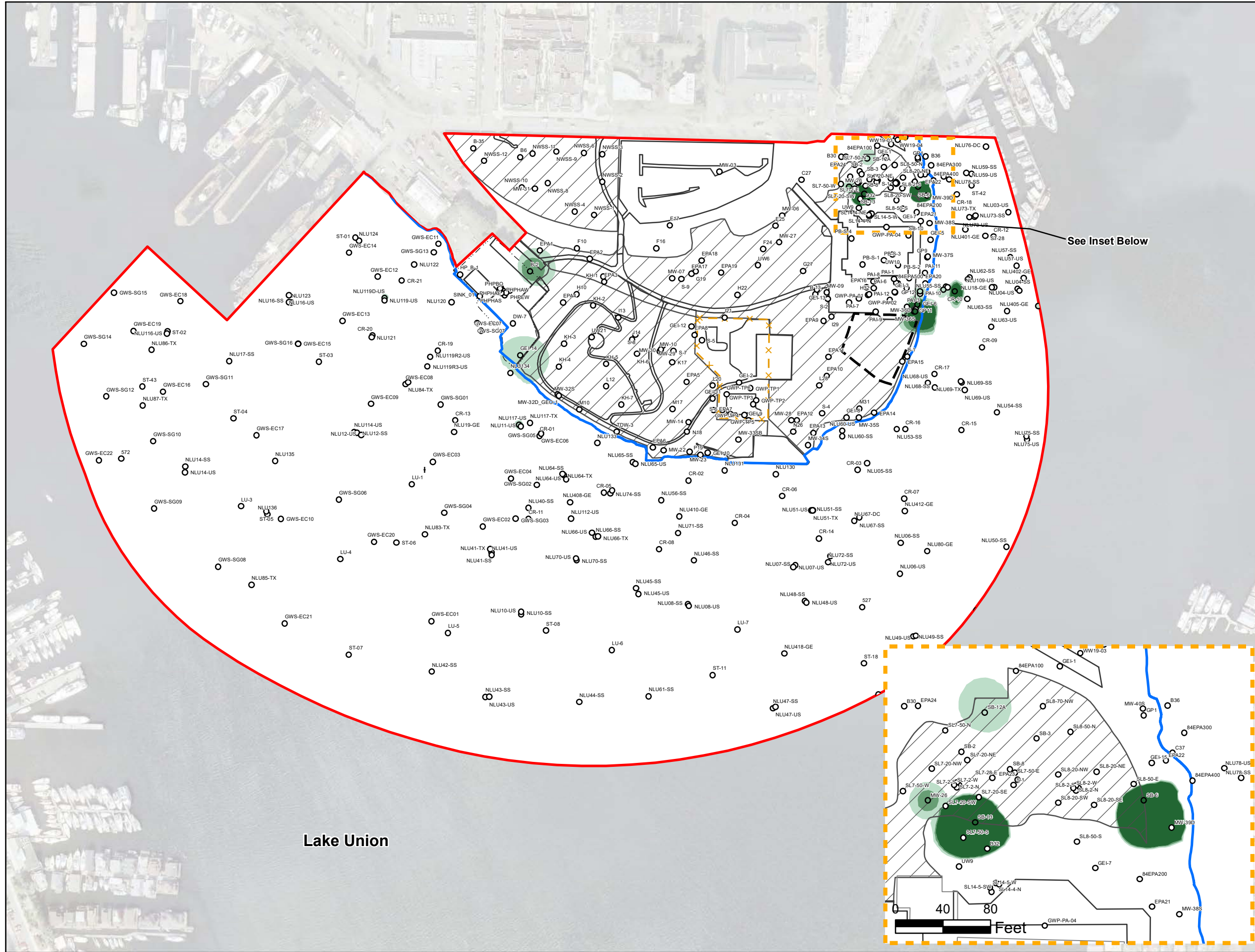
1. Naphthalene soil screening level = 3,200 mg/kg. Naphthalene is not a sediment COC. No naphthalene exceedances in surface soil/sediment.
2. † LU-1 location is uncertain.
3. For mapping purposes, surface sediment is defined as the top 6 inches of sediment and surface soil is defined as the top 1 foot of soil.
4. Some surface soil chemical data reflect pre-capping or pre-grading conditions (not clean capping material). Given the extent of capping, surface soil concentrations depicted on this figure are not representative of the clean material currently at the surface soil interval.
5. For non-detects, 1/2 the reporting limit is posted and used for interpolations. Interpolations include detects and non-detects.
6. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = 1,000). Contoured interval may differ from actual data shown due to influence of neighboring values.
7. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
8. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Naphthalene Concentrations in Soil and Sediment - Surface

Gas Works Park Site
Seattle, Washington



Legend

- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Impervious Area
- Areas with Clean Soil Caps
- Cracking Towers Security Fence
- Sample Location

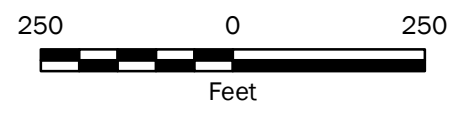
Maximum Naphthalene Concentration (mg/kg)

- ≤ 3,200
- > 3,200 to ≤ 6,200
- > 6,200 to ≤ 10,000
- > 10,000

Notes:

1. Naphthalene soil screening level = 3,200 mg/kg. Naphthalene sediment screening level = 6,180 mg/kg.
2. † LU-1 location is uncertain.
3. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
4. Concentration contours do not represent surface conditions.
5. Concentration contours generated using CTech's Earth Volumetric Studio IDW (Shepard) interpolation method. Reach = 500, Power = 6, Anisotropy = 10. Contoured interval may differ from actual data shown due to influence of neighboring values.
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

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Naphthalene Concentrations in Soil and Sediment - Surface and Subsurface

**Gas Works Park Site
Seattle, Washington**

GeoENGINEERS **Figure 5-2B**



Legend

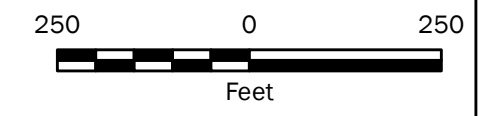
- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Impervious Area
- Areas with Clean Soil Caps
- Gravel
- Cracking Towers Security Fence
- Sample Location

Arsenic Concentration (mg/kg)

- ≤11 (SCO, Natural Background)
- >11 to ≤20
- >20 to ≤24 (CSL, Preliminary Regional Background)
- >24 to ≤200
- >200 to ≤2,000
- >2,000

- Notes:**
1. Arsenic soil screening level = 20 mg/kg. Arsenic sediment screening levels = 11 mg/kg (SCO) and 24 mg/kg (CSL).
 2. For mapping purposes, surface sediment is defined as the top 6 inches of sediment and surface soil is defined as the top 1 foot of soil.
 3. Some surface soil chemical data reflect pre-capping or pre-grading conditions (not clean capping material). Given the extent of capping, surface soil concentrations depicted on this figure are not representative of the clean material currently at the surface soil interval.
 4. For non-detects, 1/2 the reporting limit is posted and used for interpolations. Interpolations include detects and non-detects.
 5. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = 1,000). Contoured interval may differ from actual data shown due to influence of neighboring values.
 6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
 7. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Arsenic Concentrations in Soil and Sediment - Surface

Gas Works Park Site
Seattle, Washington

GEOENGINEERS **Figure 5-3A**

Path: P:\010186846\GIS\EV\AS\Asensic\MXD\018684600_RI_Rev_Arsenic_Soil_Sediment_SubSurface_Fig5-3B Map Revised: 08 March 2021 glotzmeyer



Legend

- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Impervious Area
- Areas with Clean Soil Caps
- Cracking Towers Security Fence
- Sample Location

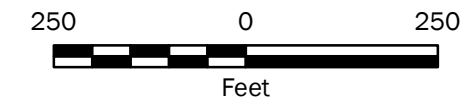
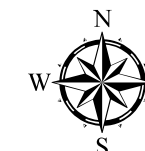
Maximum Arsenic Concentration (mg/kg)

- ≤ 11 (SCO)
- > 11 to ≤ 20
- > 20 to ≤ 24 (CSL)
- > 24 to ≤ 200
- > 200 to ≤ 2,000
- > 2,000

Notes:

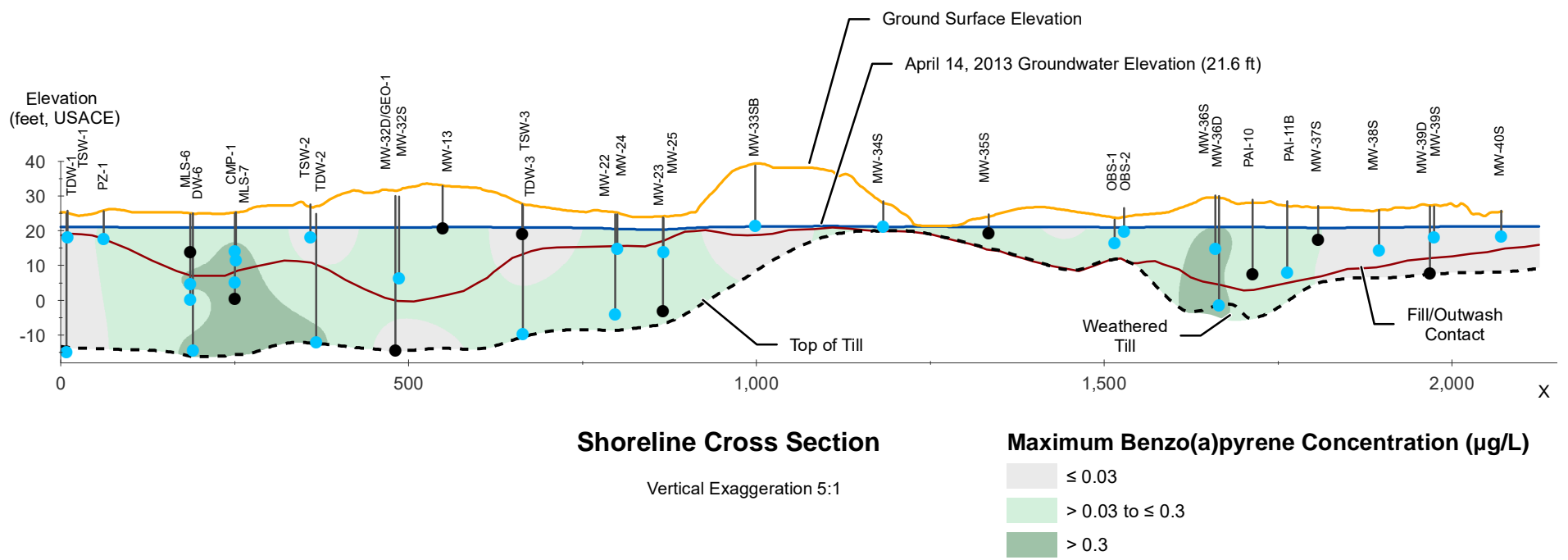
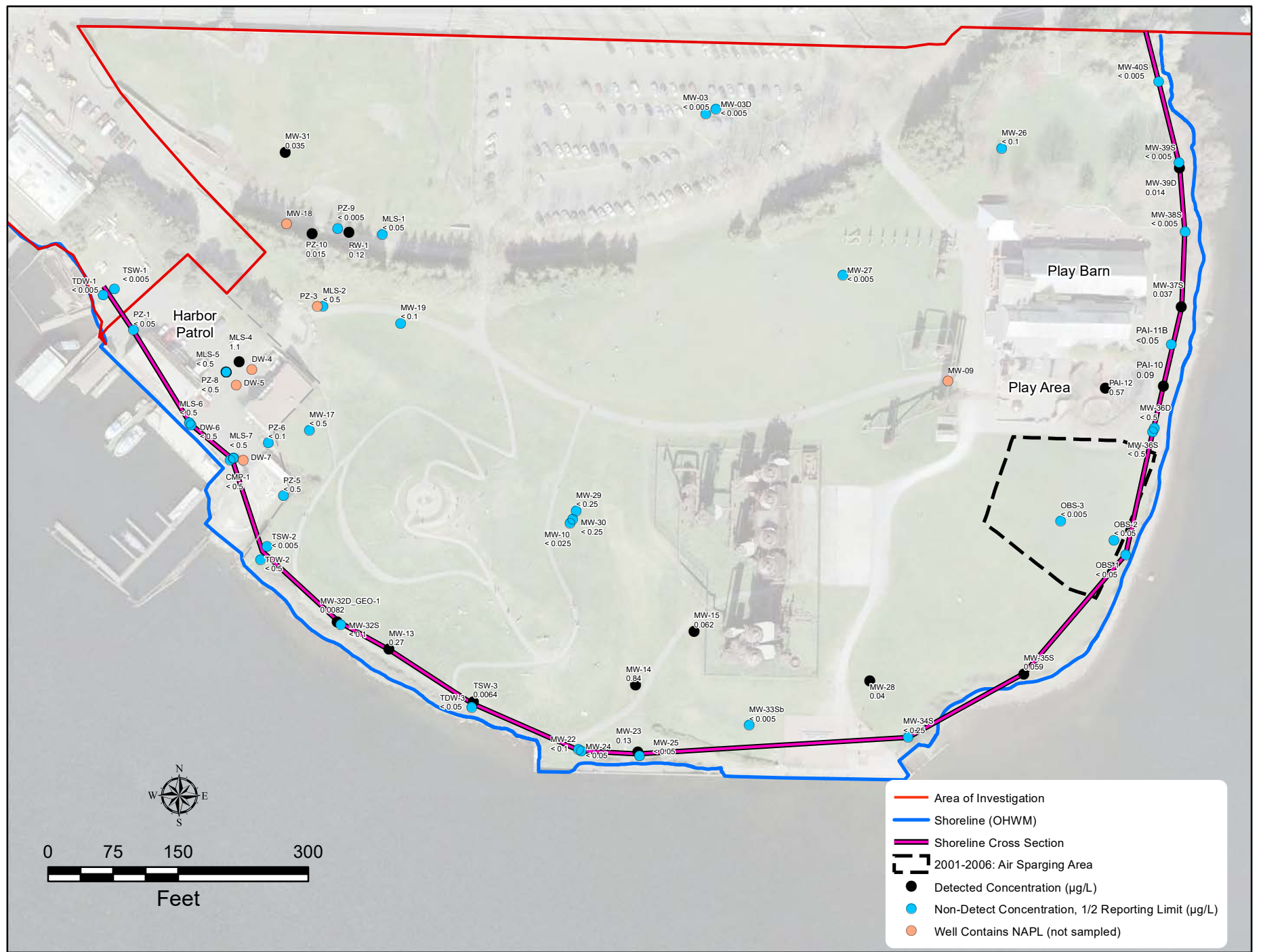
1. Arsenic soil screening level = 20 mg/kg. Arsenic sediment screening levels = 11 mg/kg (SCO) and 24 mg/kg (CSL).
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contours do not represent surface conditions.
4. Concentration contours generated using CTech's Earth Volumetric Studio IDW (Shepard) interpolation method. Reach= 500, Power =6, Anisotropy = 10. Contoured interval may differ from actual data shown due to influence of neighboring values.
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet

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Arsenic Concentrations in Soil and Sediment - Surface and Subsurface

Gas Works Park Site
Seattle, Washington

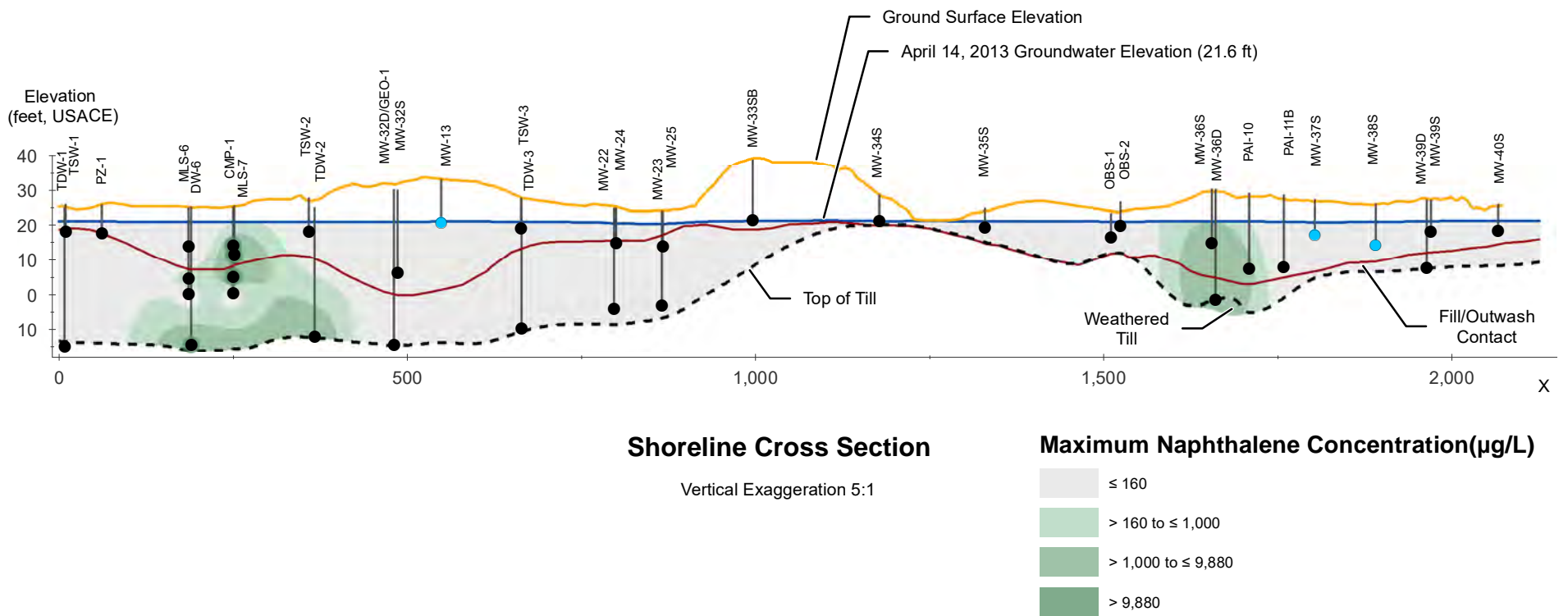
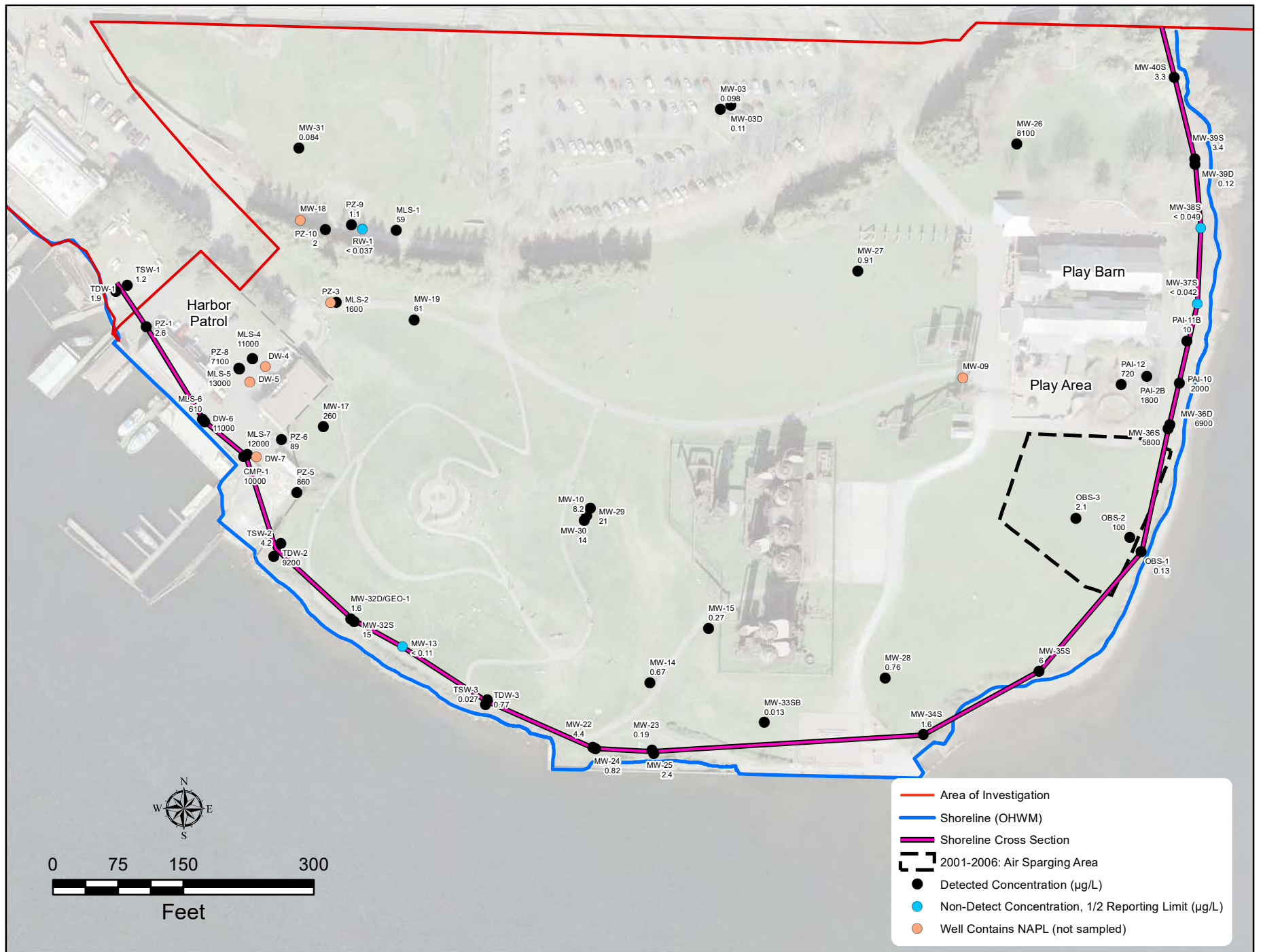


Notes:

- Concentration contours do not reflect dissolved concentrations. Results are non-filtered.
- Concentration contours generated using CTech's EVS Kriging interpolation method. Reach=1000, Anisotropy=5, Nugget=0.
- April 2013 groundwater results were chosen for mapping instead of the October 2013. The rationale is threefold:
 - (1) the suite of wells included all wells
 - (2) reporting limits tended to be more elevated in October and
 - (3) concentrations of COCs in groundwater were generally higher in April than in October.
- December 2014 results are MW-36D, MW-36S, PAI-10, PAI-11B and PAI-12. PAI-2B is not included because it was a non-detect and it had an elevated reporting limit of 10 µg/L.
- Non-detects are assumed to have concentrations of half the reporting limit (RL), for contouring purposes. Map posts non-detects as < 1/2RL.
- Areas not shaded in the shoreline cross section are interpreted to have benzo(a)pyrene concentrations below the screening level.
- Benzo(a)pyrene upland groundwater screening level = 0.03 µg/L.
- As of 2019, NAPL was observed in the same wells called out in this figure.
- Wells MW-41S through MW-52D are not shown because they were installed in 2017, several years after the sampling events presented in this figure. The new wells were installed for the groundwater treatment interim action and have not been sampled for benzo(a)pyrene.
- Basemap: 2005 USGS aerial photograph. Does not show current conditions.
- Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

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Benzo(a)pyrene in Upland Groundwater	
Gas Works Park Site Seattle, Washington	
GEOENGINEERS	Figure 5-4

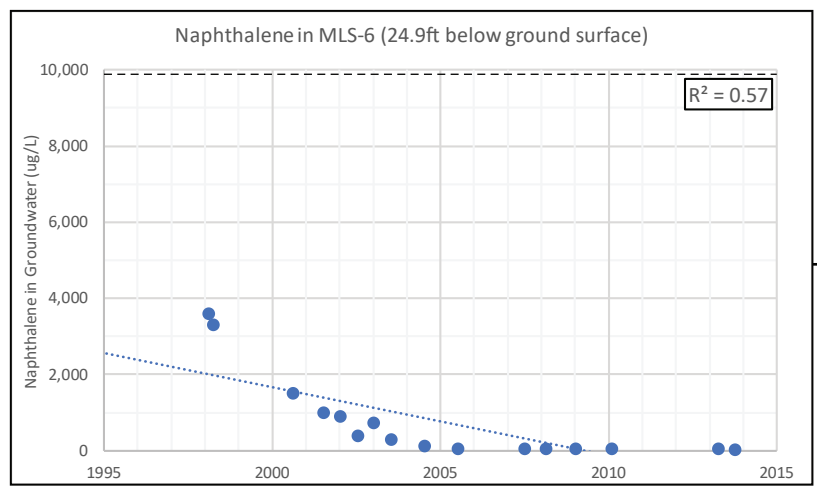
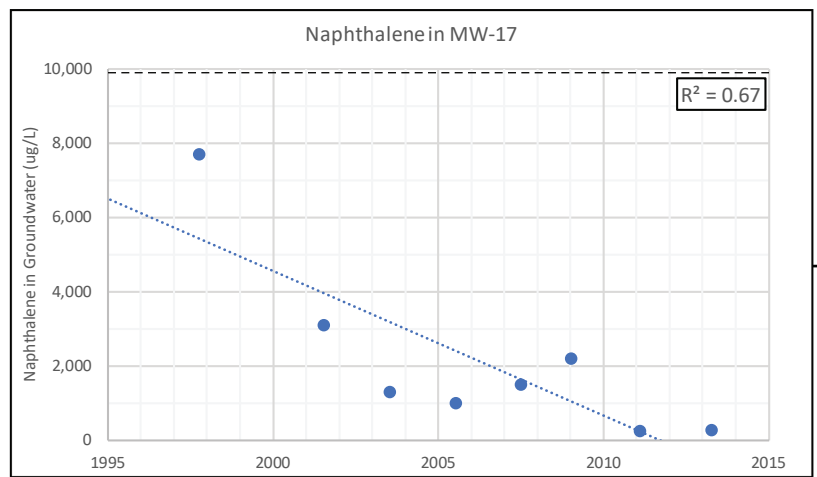
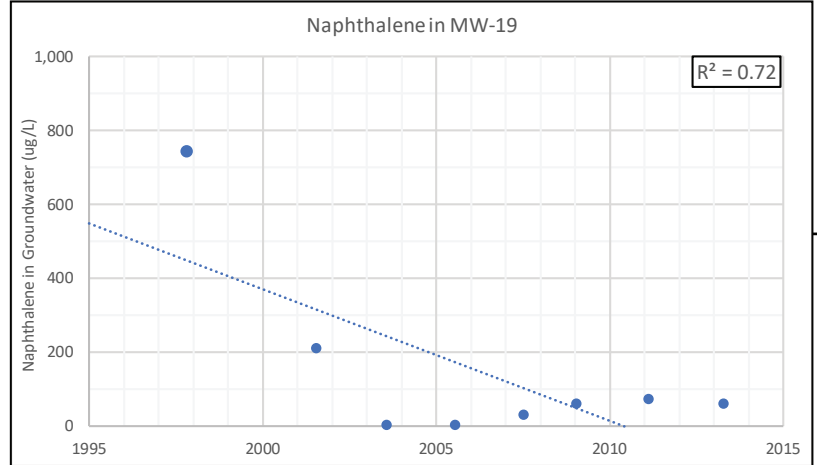


Notes:

1. Concentration contours generated using CTEch's EVS Kriging interpolation method. Reach=1000, Anisotropy=5, Nugget=0.
2. April 2013 groundwater results were chosen for mapping instead of the October 2013. The rationale is threefold:
 - (1) the suite of wells included all wells
 - (2) reporting limits tended to be more elevated in October and
 - (3) concentrations of COCs in groundwater were generally higher in April than in October.
3. December 2014 results are MW-36D, MW-36S, PAI-2B, PAI-10, PAI-11B and PAI-12
4. Non-detects are assumed to have concentrations of half the reporting limit (RL), for contouring purposes. Map posts non-detects as < 1/2RL.
5. Areas not shaded in the shoreline cross section are interpreted to have naphthalene concentrations below the screening level.
6. Naphthalene upland groundwater screening level = 9,880 µg/L
7. As of 2019, NAPL was observed in the same wells called out in this figure.
8. Wells MW-41S through MW-52D are not shown because they were installed in 2017, several years after the sampling events presented in this figure. The new wells were installed for the arsenic groundwater treatment interim action and have not been sampled for naphthalene.
9. Basemap: 2005 USGS aerial photograph. Does not show current conditions.
10. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

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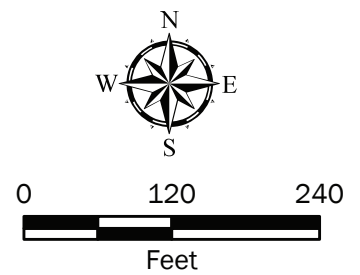
Naphthalene in Upland Groundwater	
Gas Works Park Site Seattle, Washington	
GEOENGINEERS	Figure 5-5



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

- Area of Investigation
- 2001-2006: Air Sparging Area
- Deep Monitoring Well
- Water Table Monitoring Well
- MW-40S** Monitoring Well Identifier
- ➔ Groundwater Flow Direction
- ⊕ Monitoring Wells Evaluated for Plume Stability
- Groundwater Sample
- ⋯ Linear Regression
- Upland Groundwater Screening Level 9,880 ug/L

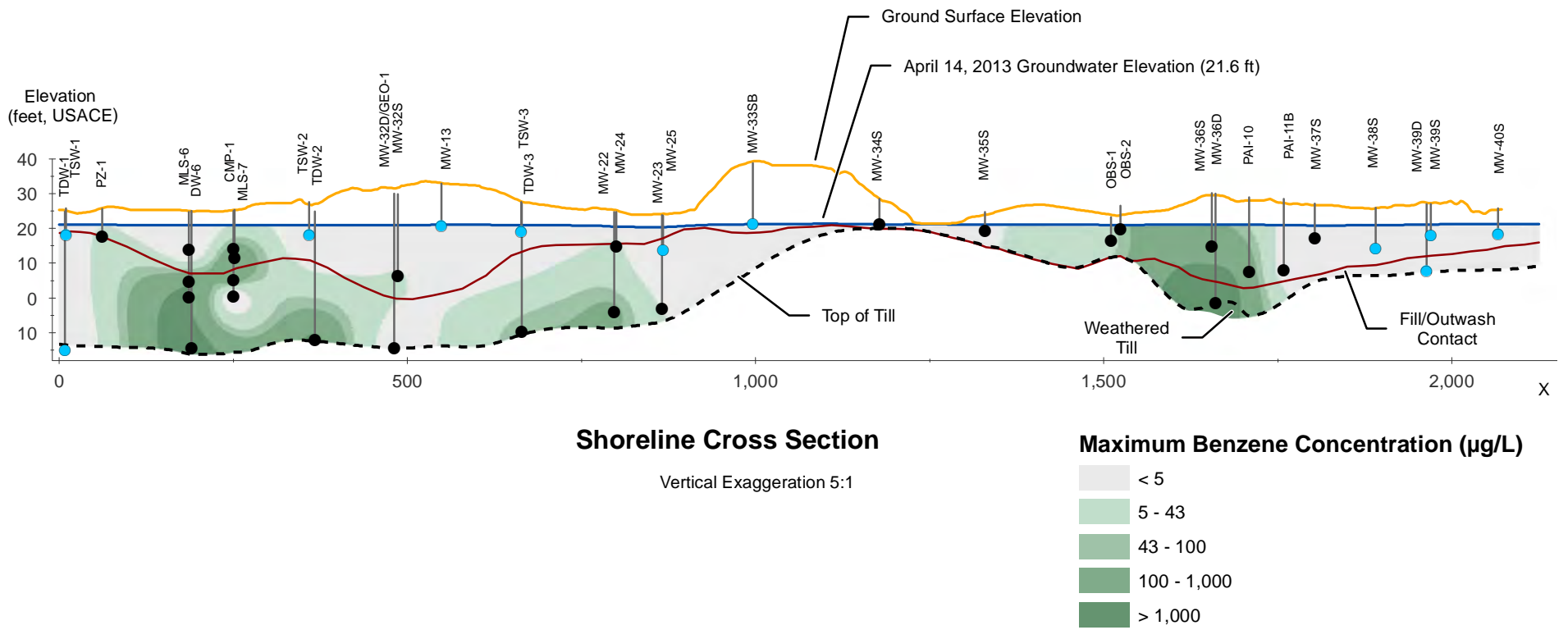
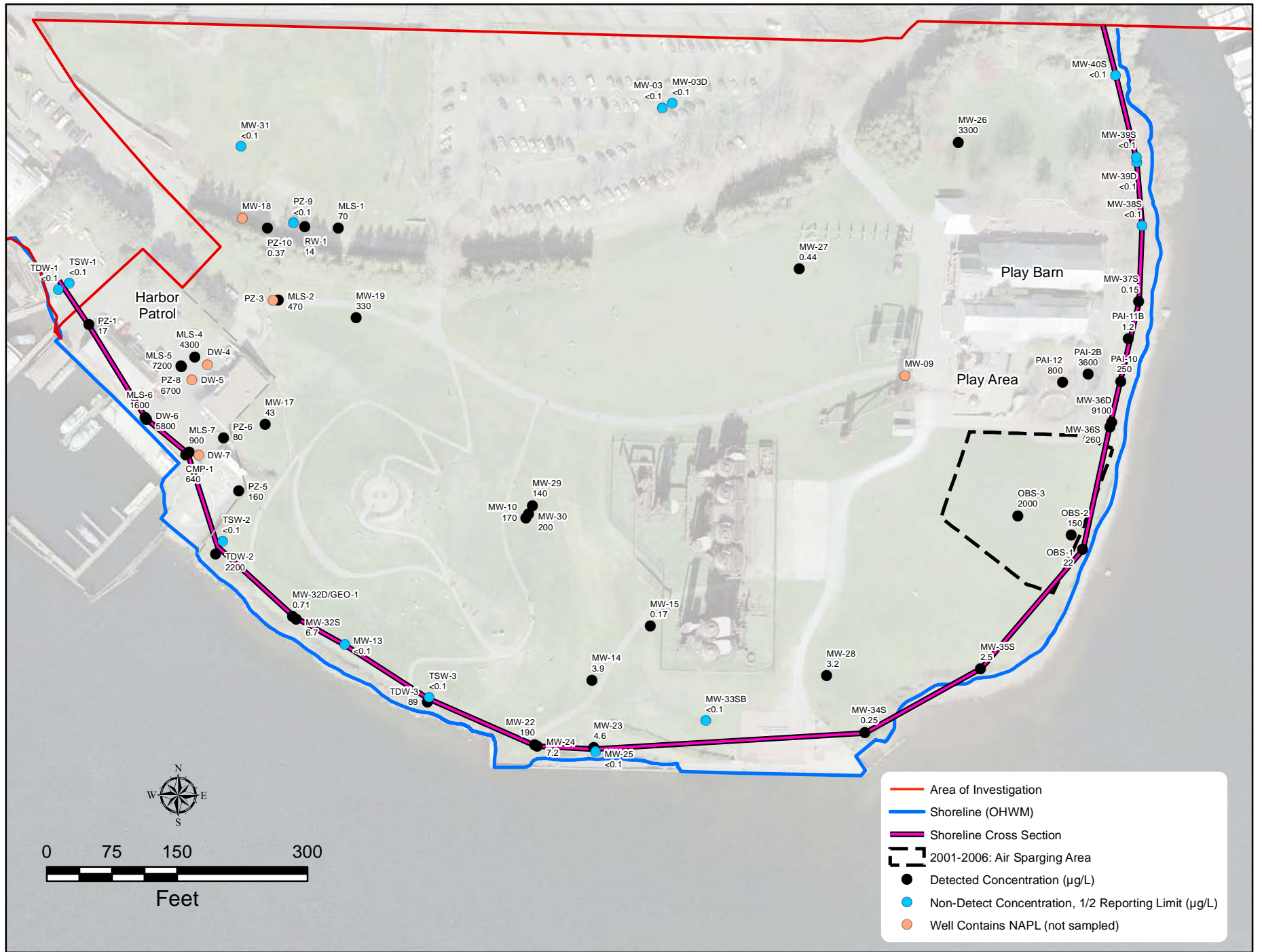


Naphthalene Concentration Trends in Monitoring Wells

Gas Works Park Site
Seattle, Washington

Figure 5-6

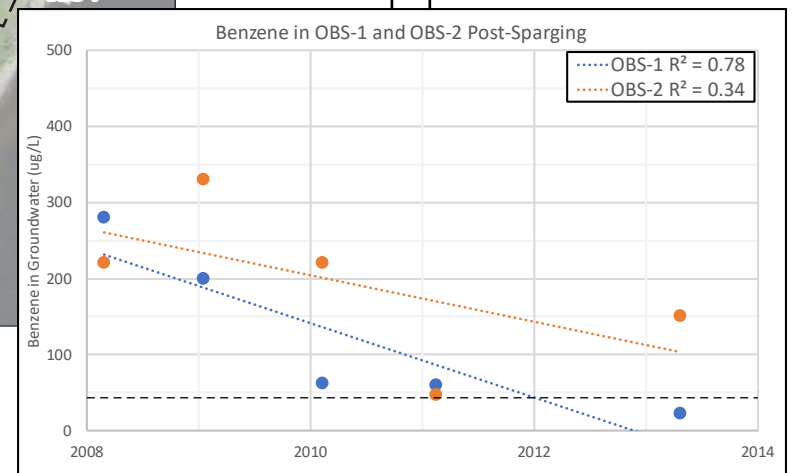
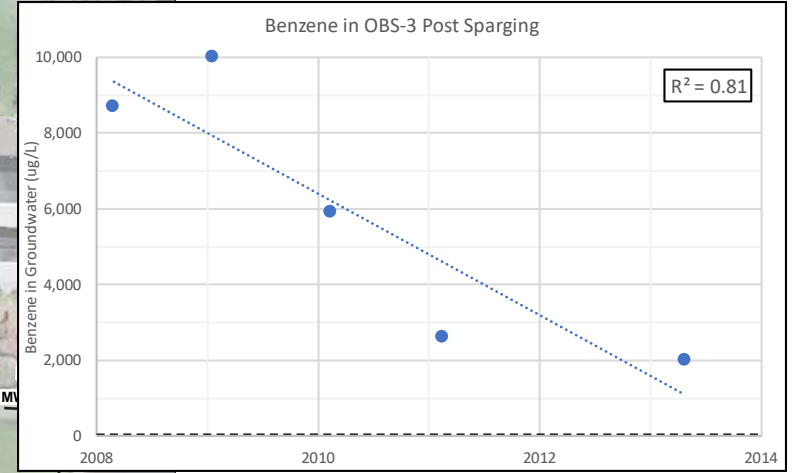
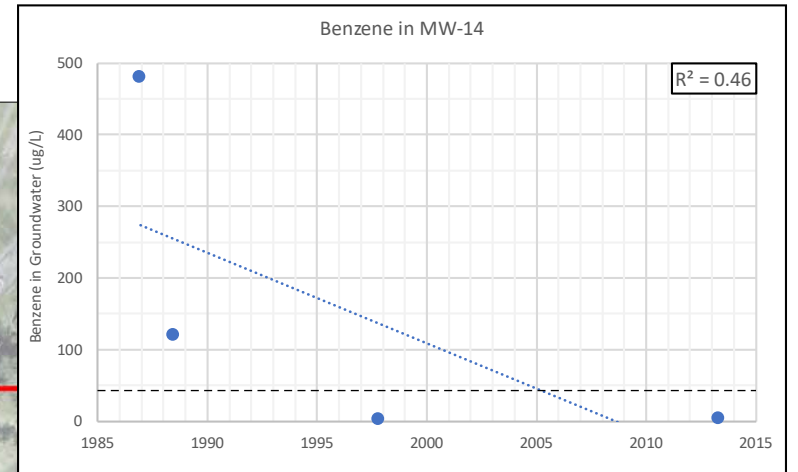
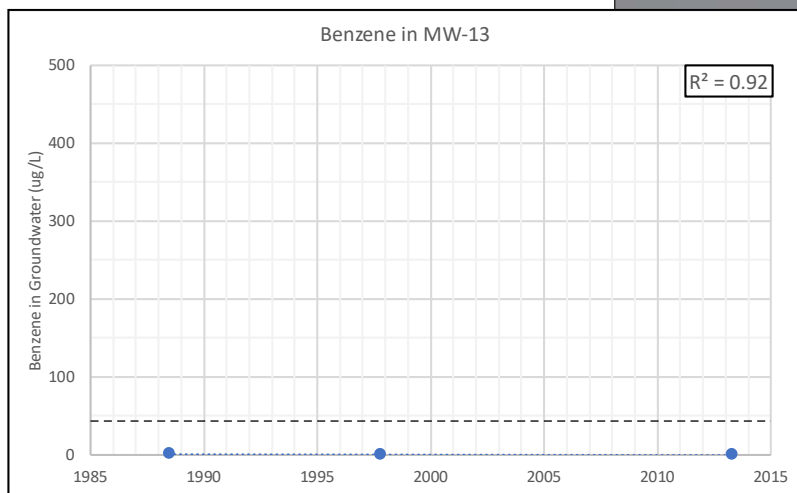
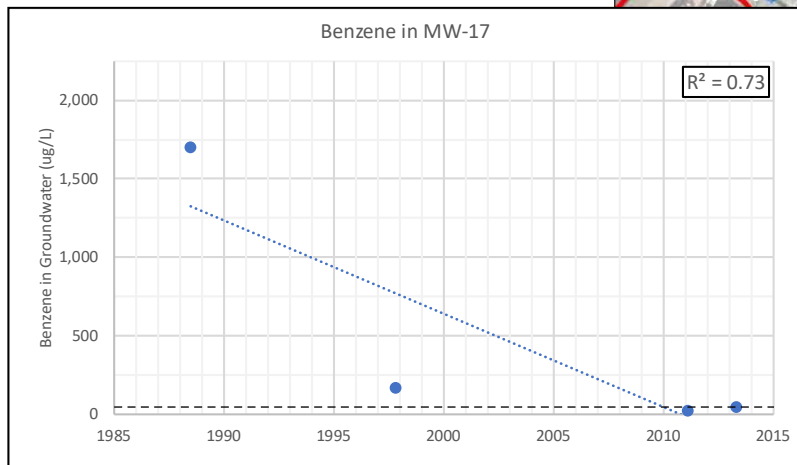
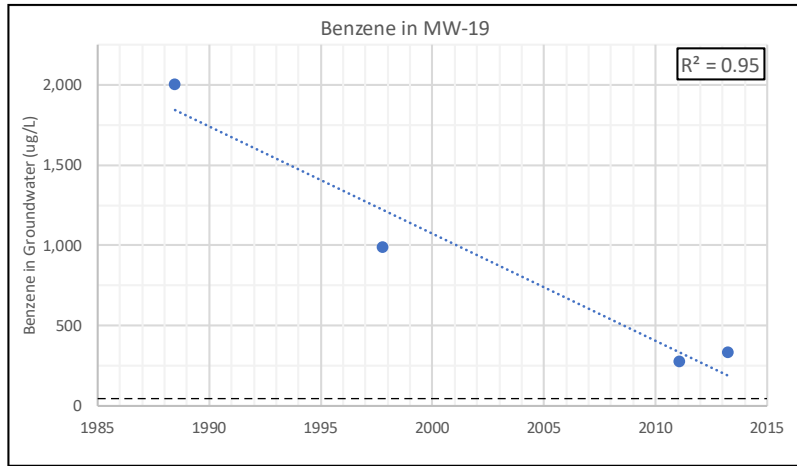
P:\0186846\Graphics_Misc\Naphthalene Concentration Trends in Monitoring Wells.ai Exported 3/1/21 by spride



- Notes:**
1. Concentration contours generated using CTech's EVS Kriging interpolation method. Reach=1000, Anisotropy=5, Nugget=0.
 2. April 2013 groundwater results were chosen for mapping instead of the October 2013. The rationale is threefold:
 - (1) the suite of wells included all wells
 - (2) reporting limits tended to be more elevated in October and
 - (3) concentrations of COCs in groundwater were generally higher in April than in October.
 3. December 2014 results are MW-36D, MW-36S, PAI-2B, PAI-10, PAI-11B and PAI-12
 4. Non-detects are assumed to have concentrations of half the reporting limit (RL), for contouring purposes. Map posts non-detects as < 1/2RL.
 5. Areas not shaded in the shoreline cross section are interpreted to have benzene concentrations below the screening level.
 6. Benzene upland groundwater screening level = 43 µg/L
 7. As of 2019, NAPL was observed in the same wells called out in this figure.
 8. Wells MW-41S through MW-52D are not shown because they were installed in 2017, several years after the sampling events presented in this figure. The new wells were installed for the arsenic groundwater treatment interim action and have not been sampled for benzene.
 9. Basemap: 2005 USGS aerial photograph. Does not show current conditions.
 10. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

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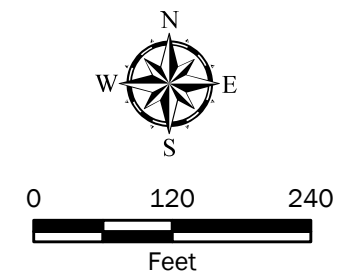
Benzene in Upland Groundwater	
Gas Works Park Site Seattle, Washington	
GEOENGINEERS	Figure 5-7



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

- Area of Investigation
- 2001-2006: Air Sparging Area
- Deep Monitoring Well
- Water Table Monitoring Well
- Monitoring Well Identifier
- Groundwater Flow Direction
- Monitoring Wells Evaluated for Plume Stability
- Groundwater Sample
- Linear Regression
- Upland Groundwater Screening Level 43 ug/L

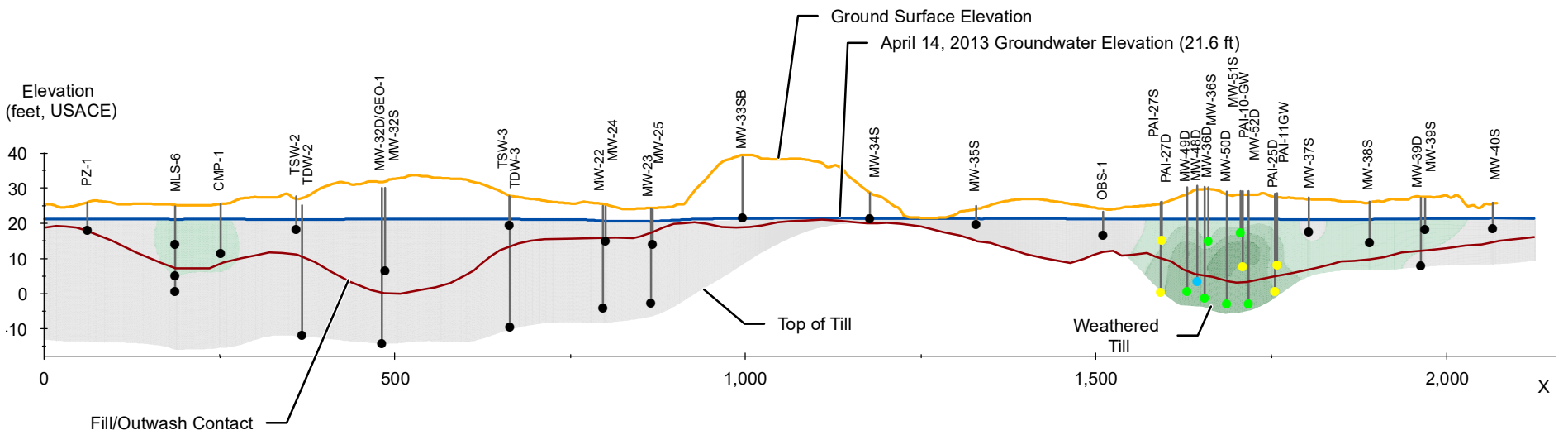
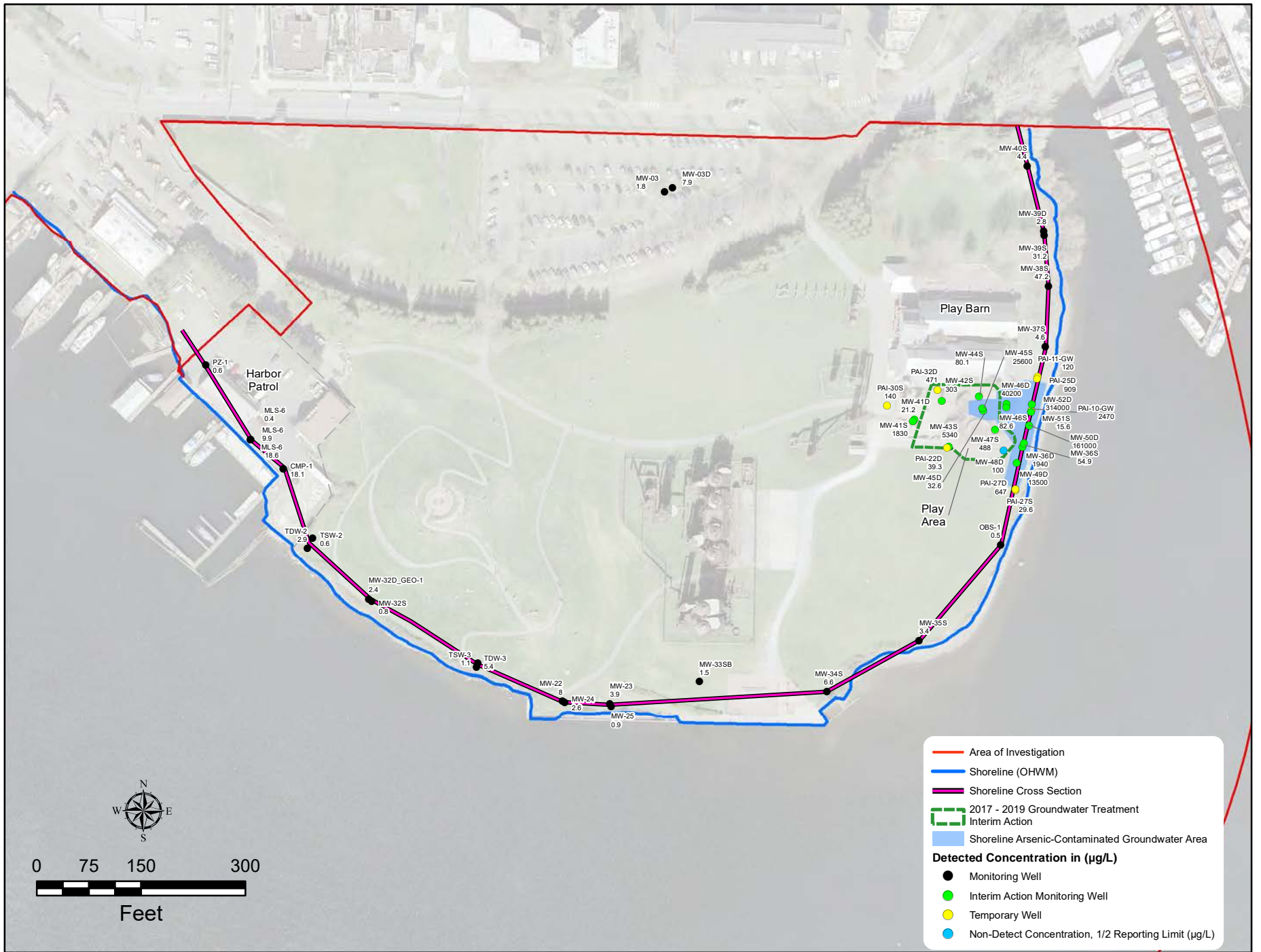


Benzene Concentration Trends in Monitoring Wells

Gas Works Park Site
 Seattle, Washington

GeoEngineers **Figure 5-8**

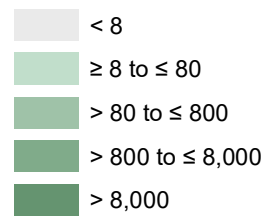
P:\0186846\Graphics_Misc\Benzene Concentration Trends in Monitoring Wells.ai Exported 3/1/21 by spride



Shoreline Cross Section

Vertical Exaggeration 5:1

Maximum Arsenic Concentration (µg/L)



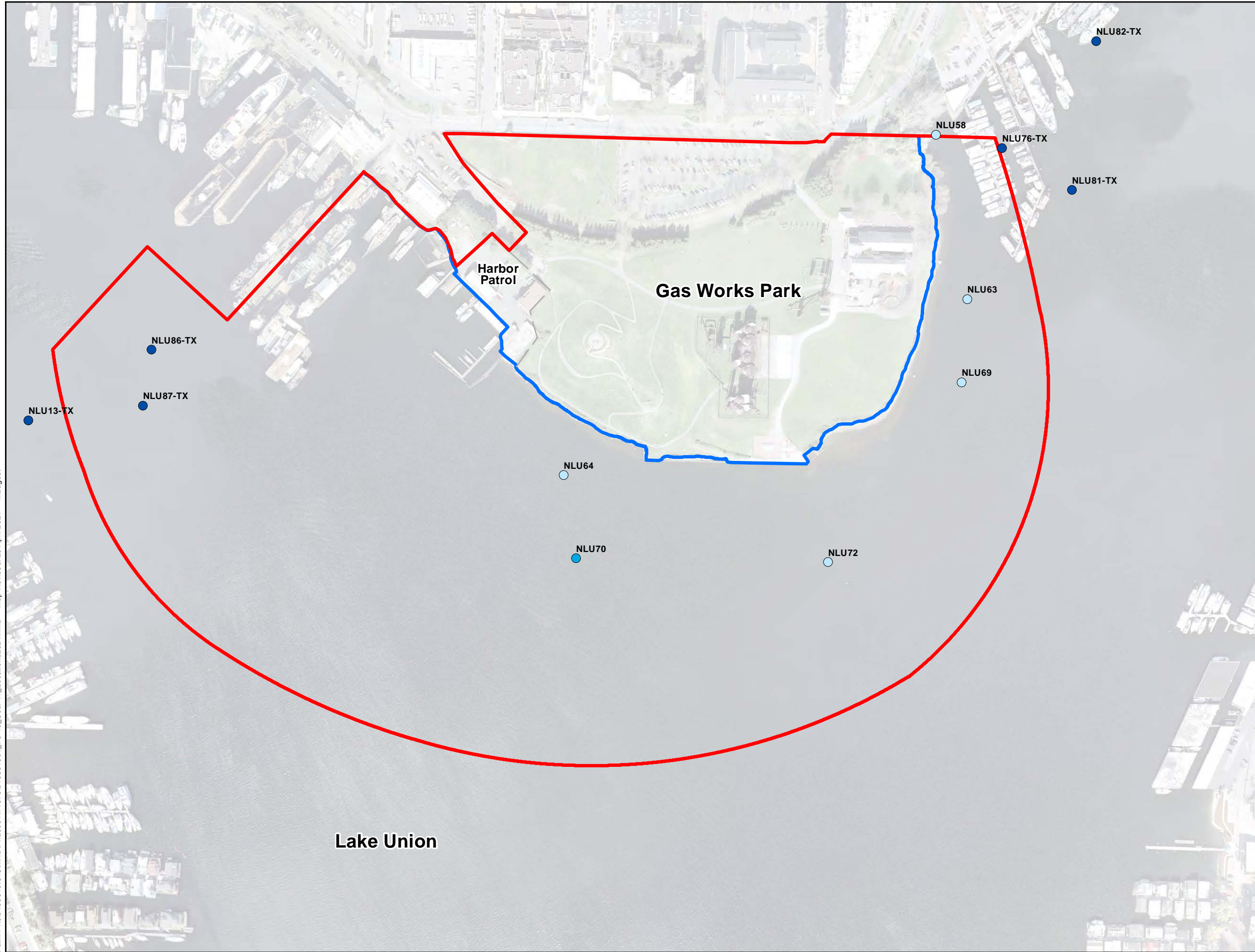
Notes:

1. Concentration contours reflect dissolved concentrations.
2. Concentration contours generated using CTech's Earth Volumetric Studio Kriging interpolation method. Reach=1000, Anisotropy=5, Nugget=0.
3. Groundwater results from: 2014 for PAI-10 and PAI-11; 2016 for PAI-22D, PAI-25D, PAI-27D, PAI-30S and PAI-32D; 2020 for Play Area Interim Action Monitoring Wells; and October 2013 for the remaining wells. 2020 samples analyzed by method SW6010C lab filtered non-preserved.
4. Previous samples analyzed by method SW6010C field filtered preserved with HNO₃.
5. See Section 5 for a discussion of why these data sets were selected.
6. Areas not shaded in the shoreline cross section are interpreted to have arsenic concentrations below the screening level.
7. Although arsenic is not a groundwater contaminant of concern, concentrations were screened against 8 µg/L.
8. As of 2019, NAPL was observed in the same wells called out in this figure. MW-45S contained trace NAPL at the time it was sampled in 2018.
9. Shoreline Arsenic Contaminated Groundwater Area - see Play Area Interim Action Monitoring Report (GeoEngineers 2021).
10. Basemap: 2005 USGS aerial photograph. Does not show current conditions.
11. Non-detects are assumed to have concentrations of half the reporting limit (RL), for contouring purposes.
12. Map posts non-detects as < 1/2RL.
13. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

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Arsenic in Upland Groundwater	
Gas Works Park Site Seattle, Washington	
	Figure 5-9

Path: P:\00186846\GIS\MXD\Phase01\1678\018684601_F5-10_SedPW_Locations2021.mxd Map Revised: 29 April 2021 maugust



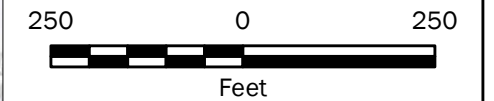
Legend

- Area of Investigation
- Shoreline (OHWM)
- Offshore Groundwater and Porewater Samples
- Offshore Groundwater Sample
- Porewater Sample

Notes:

1. Surface porewater collected from top 10 cm of sediment column. Offshore groundwater collected between 10 cm and 100 cm below mudline.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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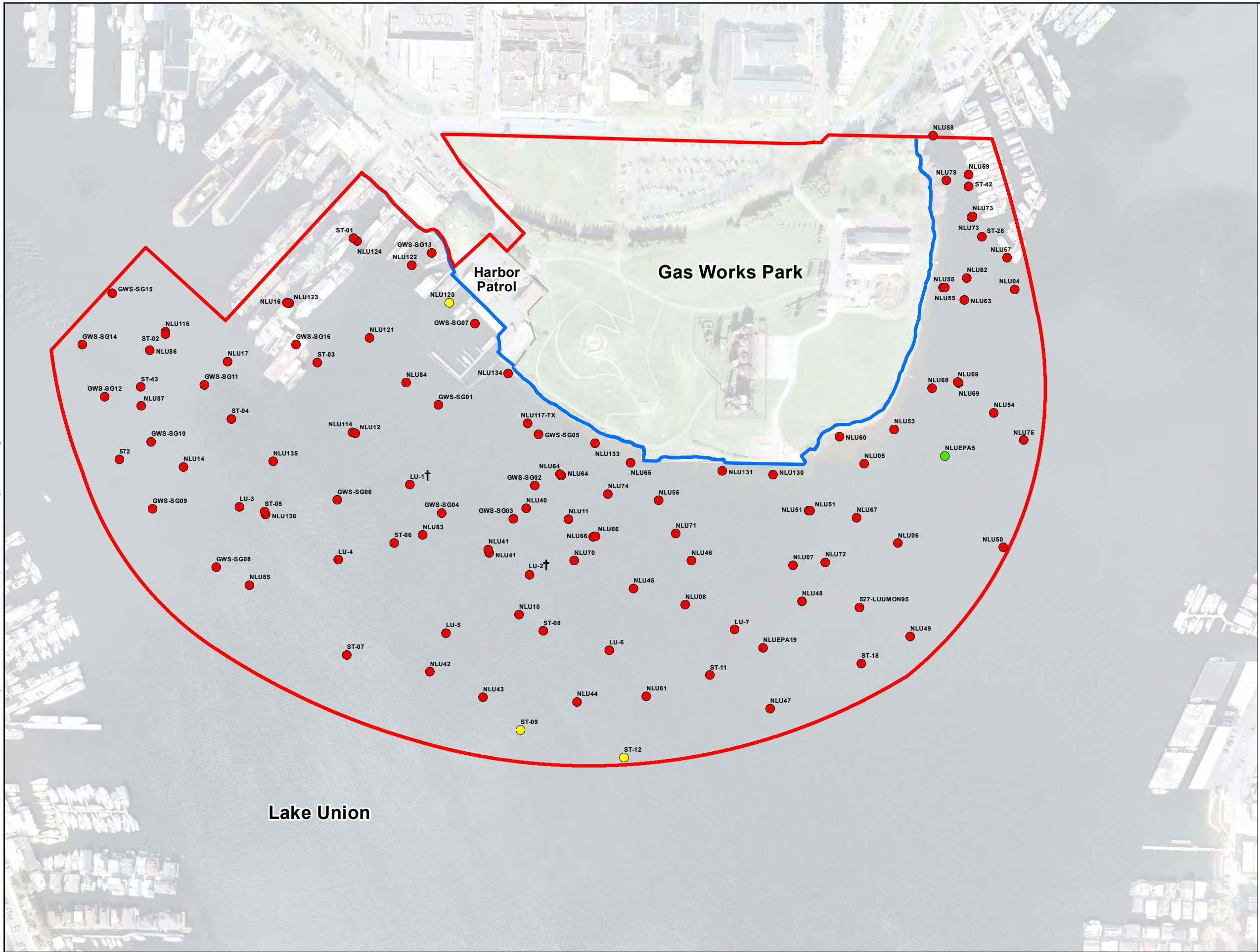


Offshore Groundwater and Porewater Sample Locations

Gas Works Park Site
Seattle, Washington



Figure 5-10



Legend

- Area of
- Shoreline (OHWM)

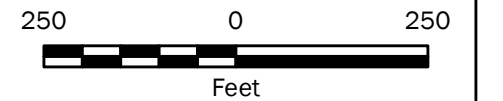
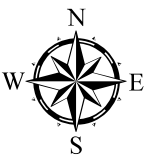
Benthic Chemical Criteria Screening Results

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

Notes:

- See Table 5B-2.1 for specific exceedances at each station.
- † LU-1 and LU-2 locations are uncertain.
- Basemap - 2005 USGS aerial photograph. Does not show current conditions.
- Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.



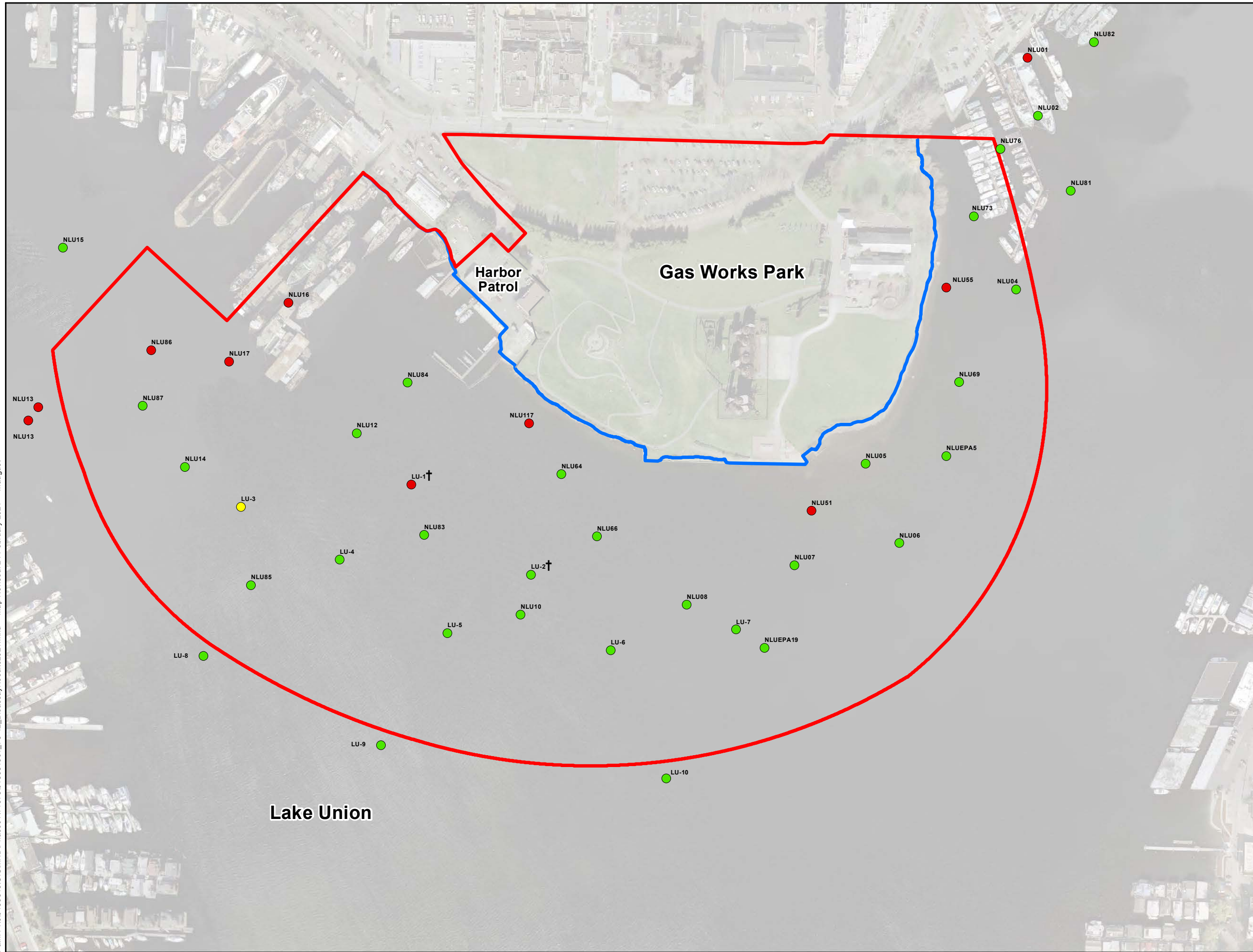
SMS Benthic Chemical Criteria Screening Results

Gas Works Park Site
Seattle, Washington



Figure 5-11

Path: P:\00186846\GIS\MXD\Phase0\111678\018684601_FS-12_BioassayResults2021.mxd Map Revised: 24 February 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)

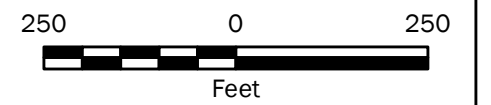
Biological Criteria Screening Results

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

Notes:

1. See Table 5D-1 for specific exceedances at each station.
2. †LU-1 and LU-2 locations are uncertain.
3. See Table 5-6 for bioassay testing results and Table 5-7 for exceedances of biological criteria.
4. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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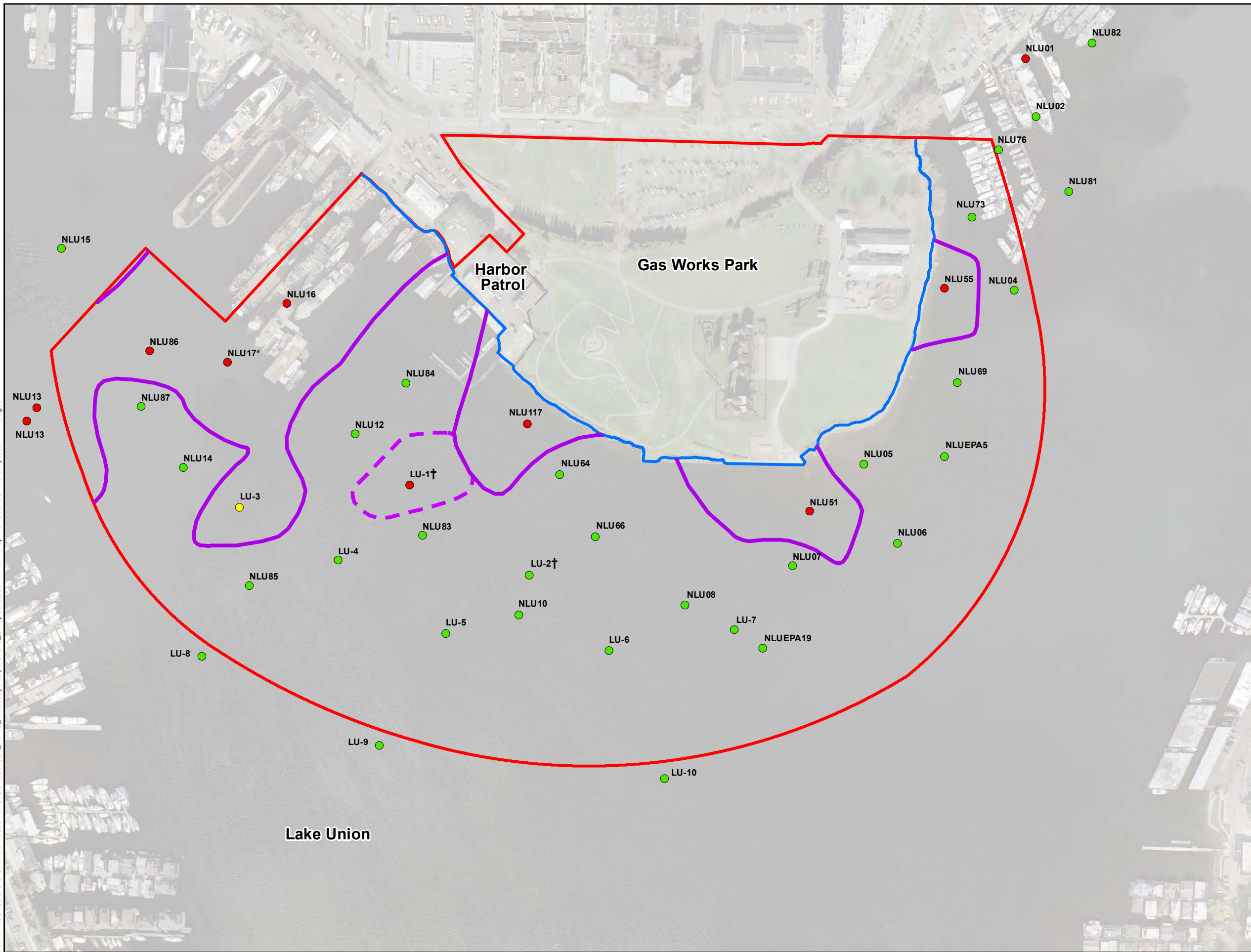
SMS Biological Criteria Screening Results

Gas Works Park Site
Seattle, Washington



Figure 5-12

Path: P:\00 186846\GIS\MapXDP\Phase01\11678\018684601_F5-13_Bioassay\Interpolations_Composite2021.mxd Map Revised: 28 February 2021 maugust



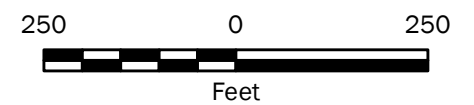
Legend

- Area of Investigation
- Shoreline (OHWM)
- Biological Criteria Screening Results**
- No Exceedance
- Sediment Cleanup Objective Exceedance
- Cleanup Screening Level Exceedance
- Interpolated Biological Data**
- ⬭ Areas of Benthic Toxicity
- ⬭ Location of Benthic Toxicity Area Uncertain

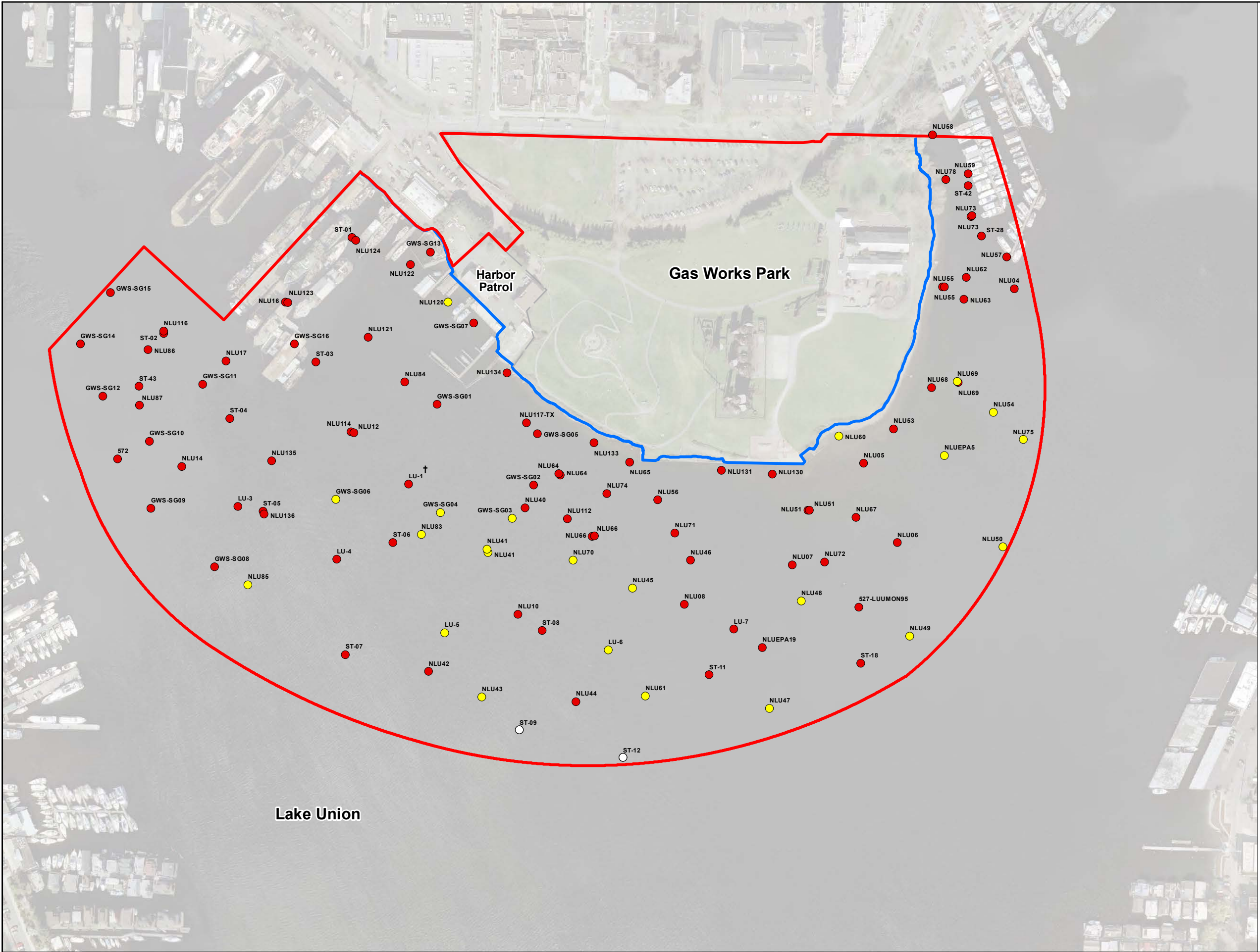
Notes:

1. See Table 5D-1 for specific exceedances at each station.
2. † LU-1 and LU-2 locations are uncertain.
3. See Appendix 5D for basis of benthic toxicity areas.
4. See Table 5-6 for bioassay testing results and Table 5-7 for exceedances of biological criteria.
5. ArcGIS IDW interpolation settings:
Power=6, Neighbors=8, Reach=500ft.
6. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Areas of Benthic Toxicity in Surface Sediment	
Gas Works Park Site Seattle, Washington	
	Figure 5-13



Legend

- Area of Investigation
- Shoreline (OHWM)

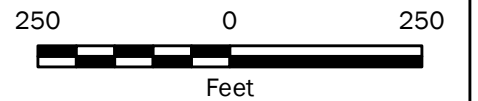
Surface Sediment Screening Results

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

Notes:

- 1. See Table 5B-2.2 for specific exceedances at each station.
- 2. † LU-1 location is uncertain.
- 3. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
- 4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Direct Contact (Net Fishing) Surface Sediment Screening Results

Gas Works Park Site
Seattle, Washington



Figure 5-14



Legend

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

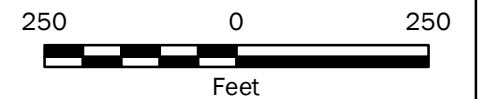
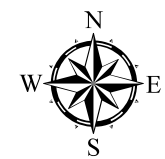
Surface Sediment Screening Results

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

Notes:

1. Elevation of 20 feet USACE generally defines the extent of the Direct Contact Beach Play and Wading Exposure Area. Elevation of 15 feet USACE generally defines the extent of the Direct Contact Wading Exposure Area.
2. Beach Play area is not included southwest of Kite Hill because the bank is steep, inaccessible, and armored.
3. See Table 5B-2.3 for specific exceedances at each station.
4. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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

Gas Works Park Site
Seattle, Washington



Figure 5-15

Path: P:\00186846\GIS\MXD\Phase01\1678\018684601_FS-16_Bioassay_bioaccum2021.mxd Map Revised: 24 February 2021 m August



Legend

- Area of Investigation
- Shoreline (OHWM)

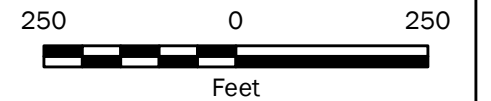
Surface Sediment Screening Results

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

Notes:

1. See Table 5B-2.4 for specific exceedances at each station.
2. † LU-1 location is uncertain.
3. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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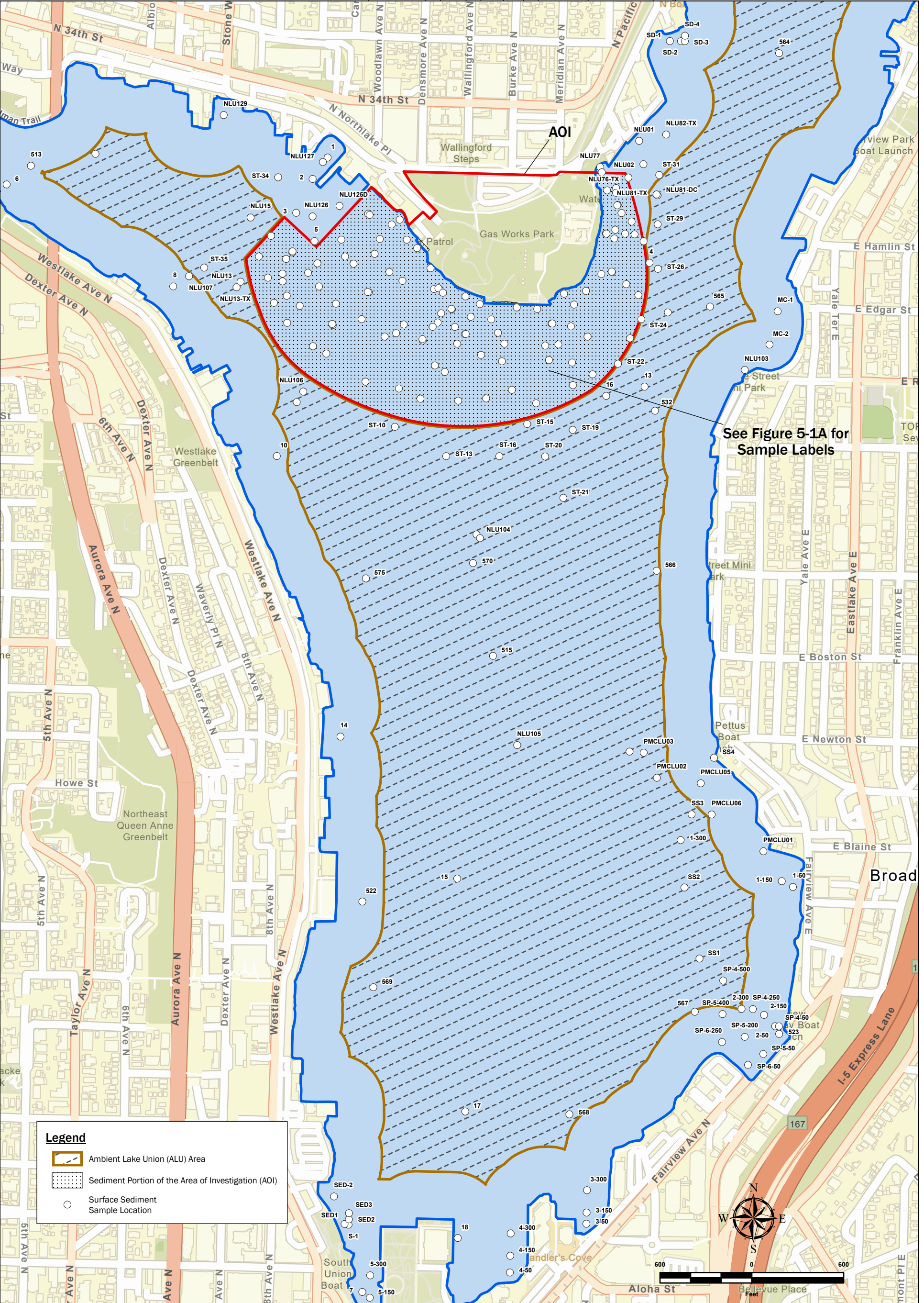


Bioaccumulation Surface Sediment Screening Results

Gas Works Park Site
Seattle, Washington






Figure 5-16



See Figure 5-1A for Sample Labels

Legend

-  Ambient Lake Union (ALU) Area
-  Sediment Portion of the Area of Investigation (AOI)
-  Surface Sediment Sample Location

Notes:

1. Map shows surface sediment sample locations, surface sediment defined as the top 6 inches of sediment.
2. Basemap - ESRI, 2021.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

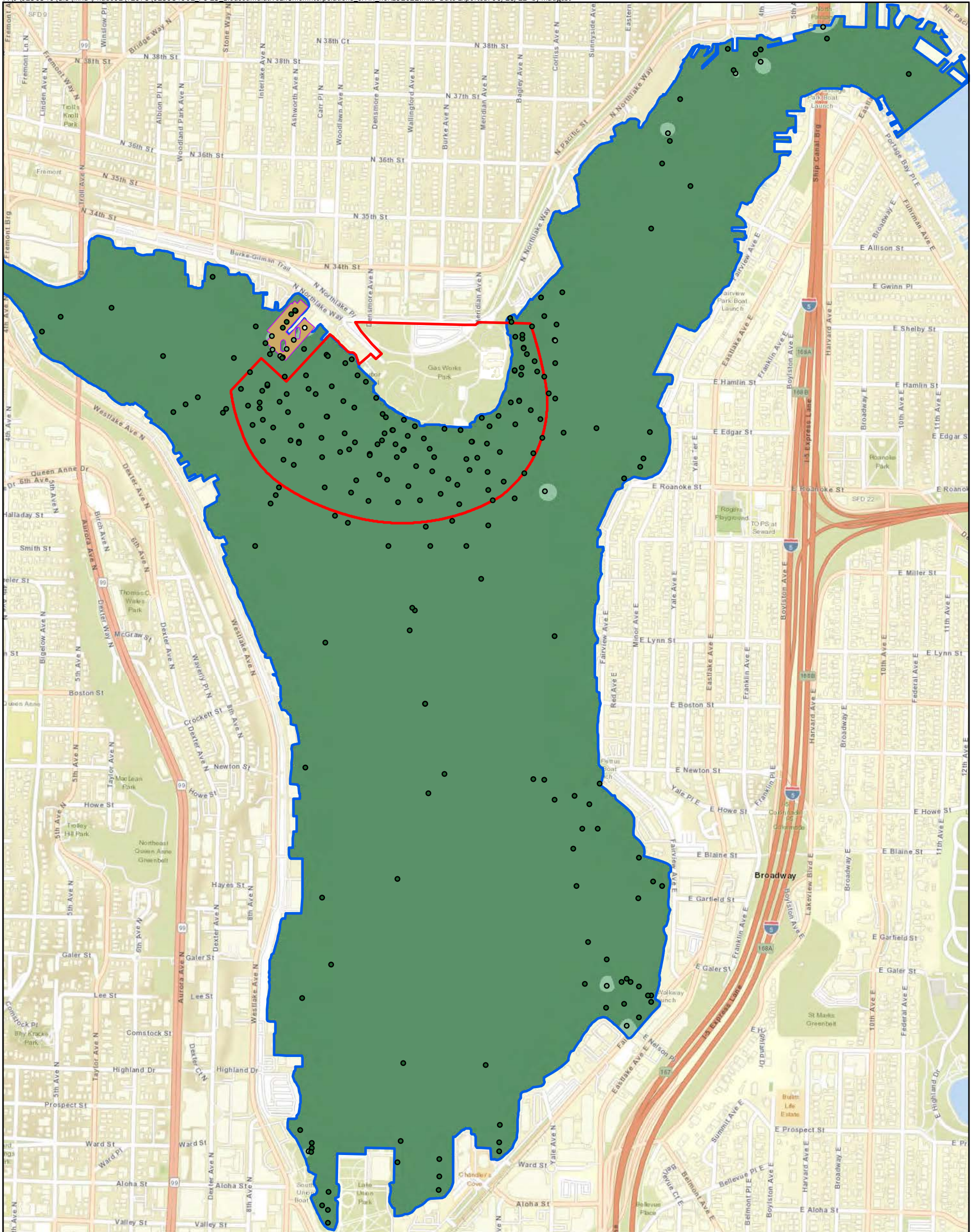
DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Areas Used For Statistical Comparison of Average Sediment Concentrations

Gas Works Park Site
Seattle, Washington



Figure 5-17



Legend

- Area of Investigation
- Sample Location
- Northlake Shipyard 2014 Interim Action Dredge Footprint

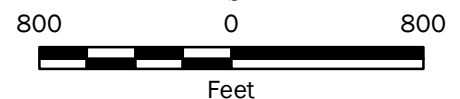
cPAH TEQ Concentration (mg/kg)

- <0.021 (SCO, Natural Background)
- >0.021 to <=0.21 (CSL, Regional Background)
- >0.21

Notes:

1. cPAH TEQ sediment screening levels = 0.021 mg/kg (SCO) and 0.21 mg/kg (CSL).
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable)
4. Basemap - ESRI, 2021.
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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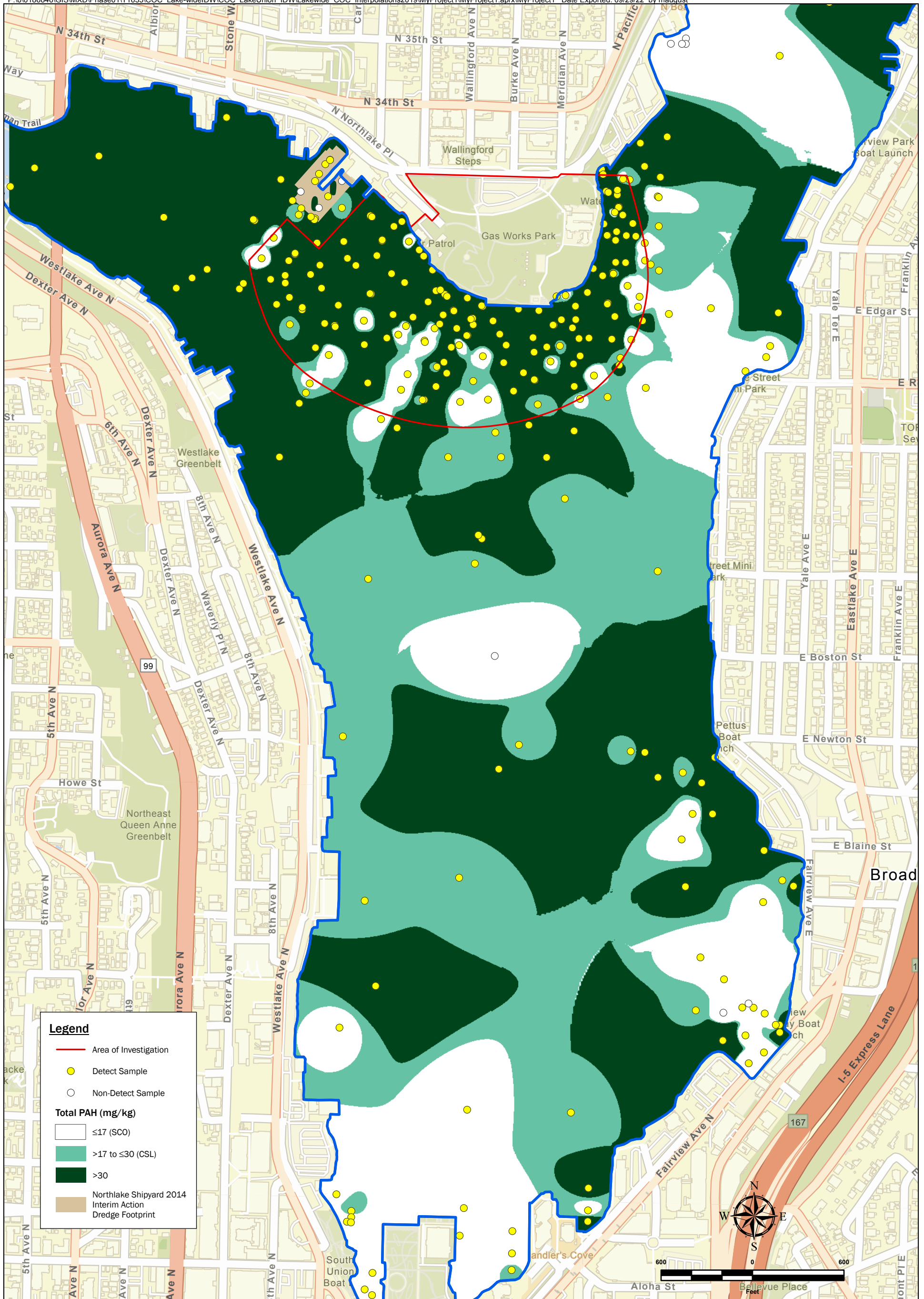


cPAH Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington



Figure 5-18



Legend

- Area of Investigation
 - Detect Sample
 - Non-Detect Sample
- Total PAH (mg/kg)**
- ≤17 (SCO)
 - >17 to ≤30 (CSL)
 - >30
- Northlake Shipyard 2014 Interim Action Dredge Footprint

Notes:

1. TPAH sediment screening levels = 17 mg/kg (SCO) and 30 mg/kg (CSL).
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable).
4. Basemap - ESRI, 2021.
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

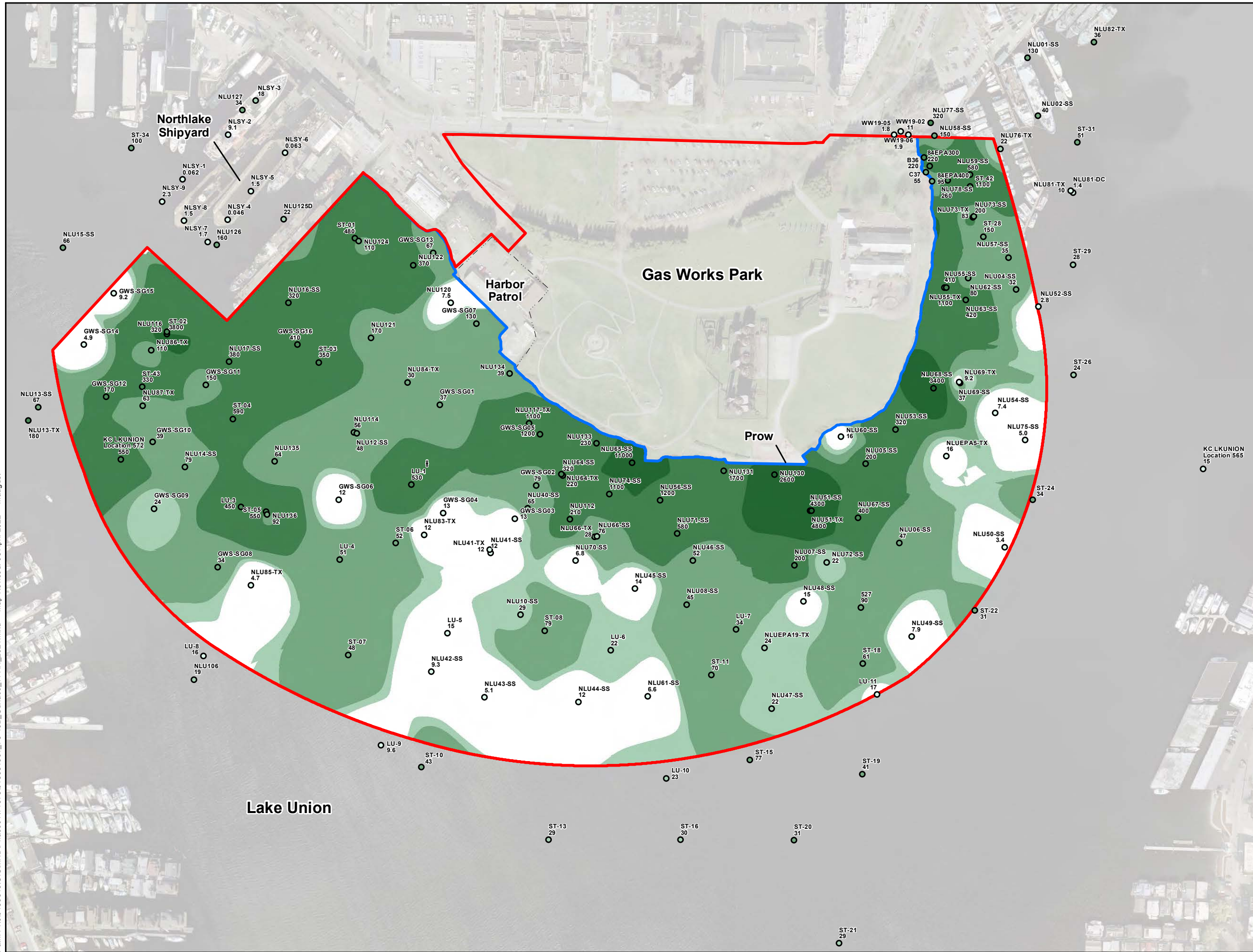
TPAH Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington



Figure 5-19A

Path: P:\00186846\GIS\MXD\Phase0\11678\018684601_F5-19B_Surface_TPAH_2021.mxd Map Revised: 08 April 2022 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Sample Location

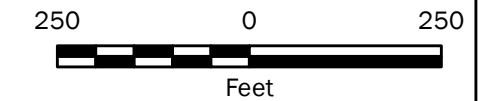
TPAH Concentration (mg/kg)

- ≤17 (SCO)
- >17 to ≤30 (CSL)
- >30 to ≤170
- >170 to ≤2,000
- >2,000

Notes:

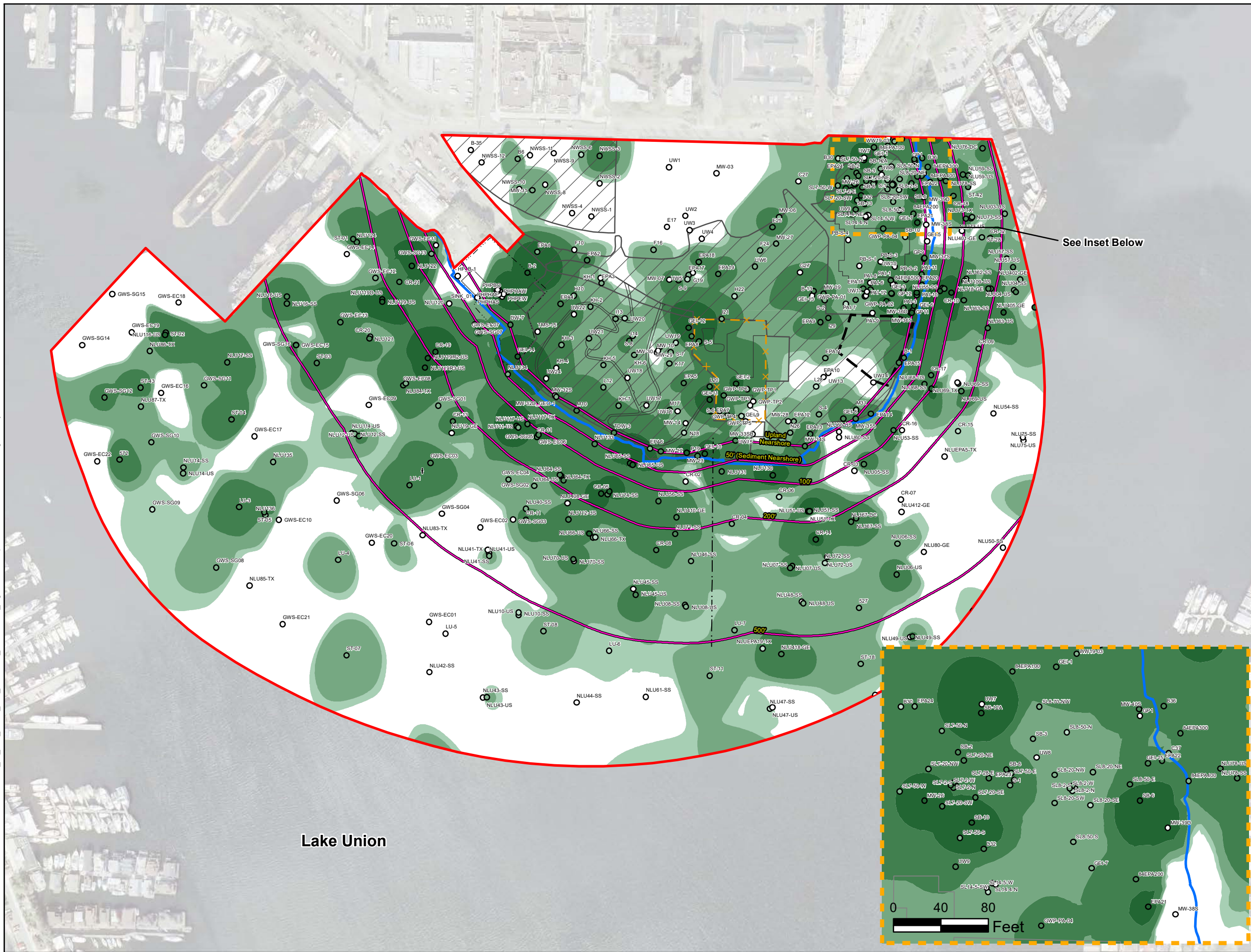
1. TPAH Sediment Screening levels = 17 mg/kg (SCO) and 30 mg/kg (CSL).
2. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
3. † LU-1 location is uncertain.
4. For non-detects, 1/2 the reporting limit is posted and used for interpolations. Interpolations include detects and non-detects.
5. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = 1,000). Contoured interval may differ from actual data shown due to influence of neighboring values.
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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TPAH Concentrations in Sediment - Surface

Gas Works Park Site
Seattle, Washington



Legend

- Area of Investigation
- Shoreline (OHWM)
- 2001-2006: Air Sparging Area
- Areas with Clean Soil Caps
- Cracking Towers Security Fence
- Sample Location
- Cross Section Alignment (See Figure 5-19C and 5-19D)
- - - Cross Section Reference Line

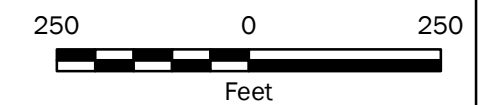
Maximum TPAH Concentration (mg/kg)

- ≤ 17 (SCO)
- > 17 to ≤ 30 (CSL)
- > 30 to ≤ 170
- > 170 to ≤ 2,000
- >2,000

Notes:

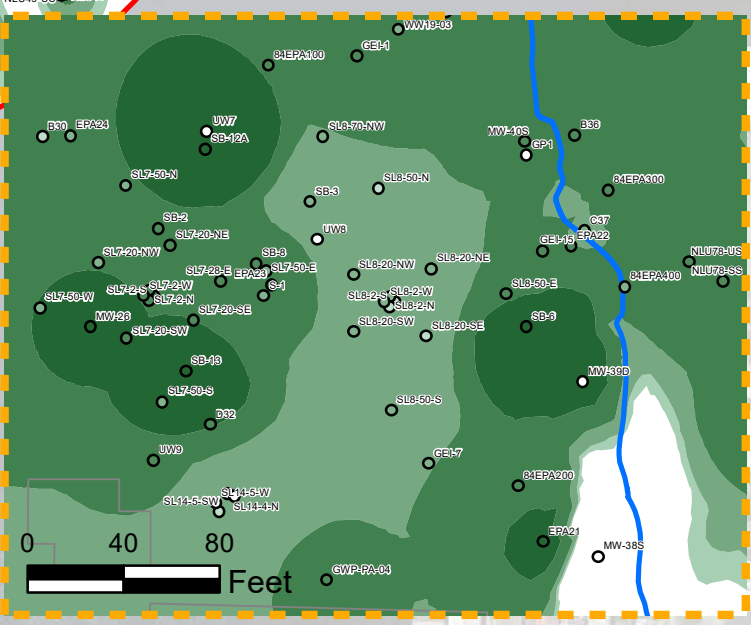
1. TPAH is not a COC for soil. TPAH sediment screening levels = 17 mg/kg (SCO) and 30 mg/kg (CSL).
2. U-1 location is uncertain.
3. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
4. Concentration contours do not represent surface conditions.
5. Concentration contours generated using CTech's Earth Volumetric Studio IDW (Shepard) interpolation method. Reach = 500, Power = 6, Anisotropy = 10. Contoured interval may differ from actual data shown due to influence of neighboring values.
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 State Plane Washington North FIPS 4601 Feet.

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TPAH Concentrations in Soil and Sediment - Surface and Subsurface

**Gas Works Park Site
Seattle, Washington**

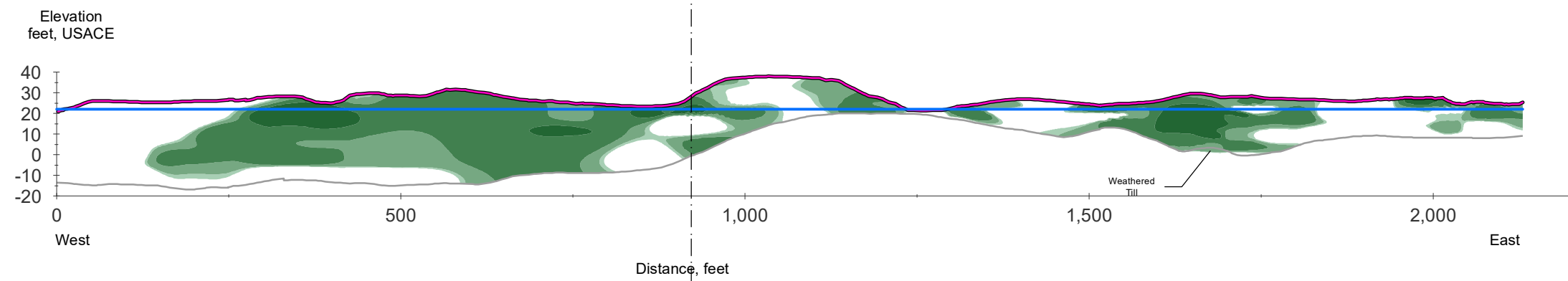


See Inset Below

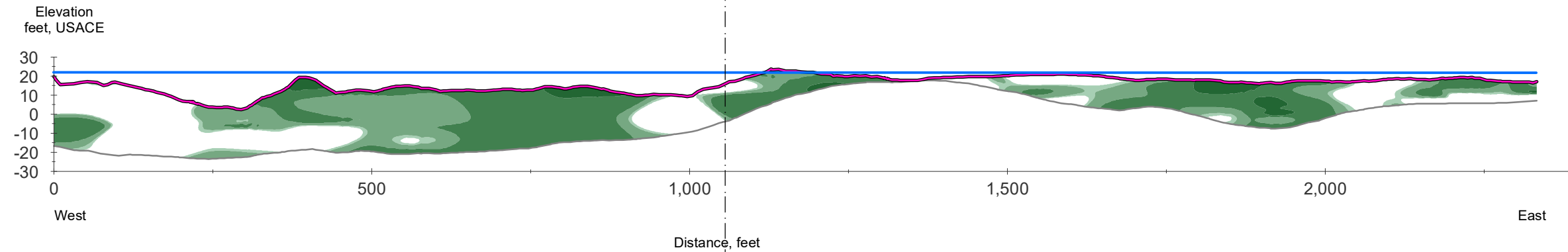
Lake Union

Path: P:\00186846\GIS\SE\VS\TPAH\MD\018684601_R1_Rev_TPAH_Soil_Sediment_SubSurface_CrossSections_Figs-19D Map Revised: 26 March 2021 glichmeyer

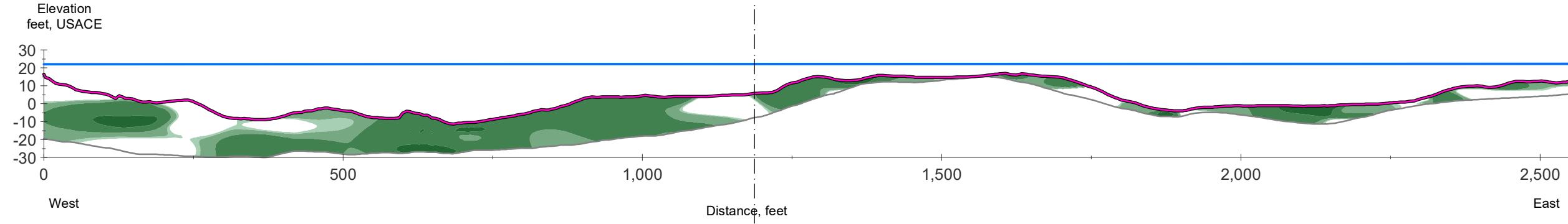
Upland Nearshore Cross Section



50' Cross Section (Nearshore Sediment)



100' Cross Section



Legend

- Cross Section Reference Line
- OOHWM (22 feet, USACE)
- Existing Ground Surface or Mudline
- Top of Till

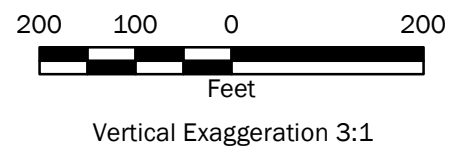
Maximum TPAH Concentration (mg/kg)

- ≤ 17 (SCO)
- > 17 to ≤ 30 (CSL)
- > 30 to ≤ 170
- > 170 to ≤ 2,000
- > 2,000

Notes:

1. TPAH is not a COC for soil. TPAH sediment screening levels = 17 mg/kg (SCO) and 30 mg/kg (CSL).
2. Vertical exaggeration is 3:1 for all cross sections.
3. Concentration contours do not represent surface conditions.
4. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
5. Concentration contours generated using CTech's Earth Volumetric Studio IDW (Shepard) interpolation method. Reach = 500, Power = 6, Anisotropy = 10. Contoured interval may differ from actual data shown due to influence of neighboring values.

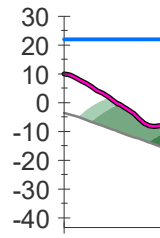
DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.



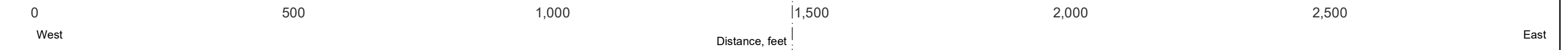
TPAH Concentrations in Soil and Sediment - Surface and Subsurface Cross Sections	
Gas Works Park Site Seattle, Washington	
GEOENGINEERS	Figure 5-19D

Path: P:\010186846\GIS\SE\TPAH\MD\018684601_R1_Rev_TPAH_Soil_Sediment_SubSurface_CrossSections_Fig5-19E_Map Revised: 26 March 2021 glohimeyer

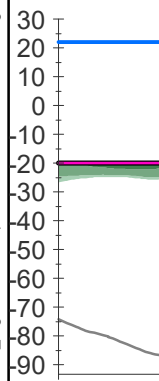
Elevation
feet, USACE



200' Cross Section



Elevation
feet, USACE



500' Cross Section



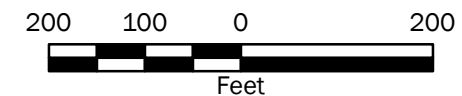
Notes:

1. TPAH is not a COC for soil. TPAH sediment screening levels = 17 mg/kg (SCO) and 30 mg/kg (CSL).
2. Vertical exaggeration is 3:1 for all cross sections.
3. Concentration contours do not represent surface conditions.
4. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
5. Concentration contours generated using CTEch's Earth Volumetric Studio IDW (Shepard) interpolation method. Reach = 500, Power = 6, Anisotropy = 10. Contoured interval may differ from actual data shown due to influence of neighboring values.

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Legend

- Cross Section Reference Line
 - OHWM (22 feet, USACE)
 - Existing Ground Surface or Mudline
 - Top of Till
- | Maximum TPAH Concentration (mg/kg) | |
|------------------------------------|--------------------|
| | ≤ 17 (SCO) |
| | > 17 to ≤ 30 (CSL) |
| | > 30 to ≤ 170 |
| | > 170 to ≤ 2,000 |
| | > 2,000 |



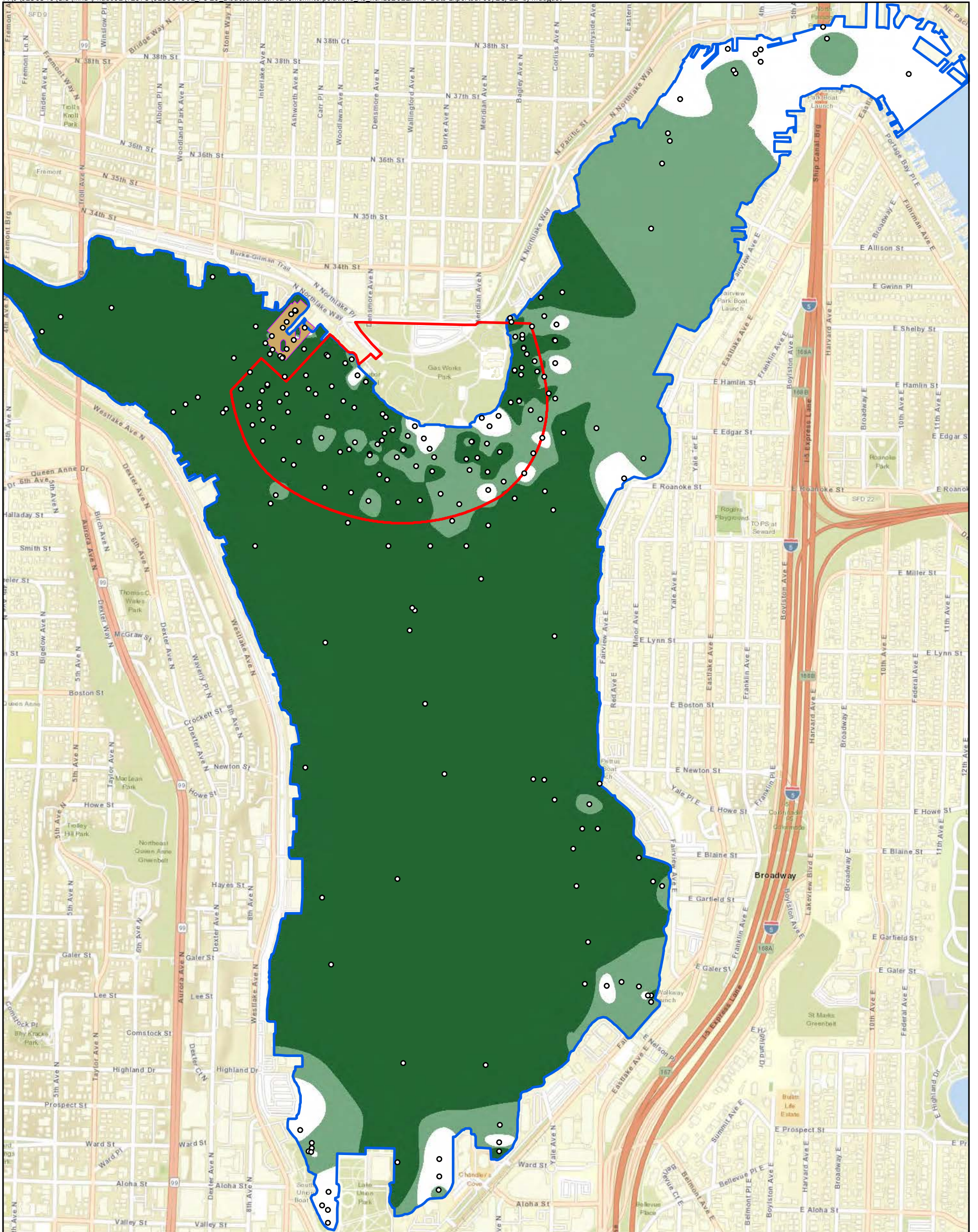
Vertical Exaggeration 3:1

TPAH Concentrations in Sediment - Surface and Subsurface Cross Sections

Gas Works Park Site
Seattle, Washington



Figure 5-19E



Legend

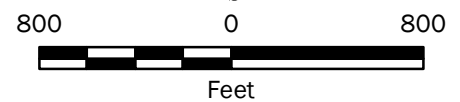
- Area of Investigation
- Northlake Shipyard 2014 Interim Action Dredge Footprint
- Sample Location

- Arsenic Concentration (mg/kg)**
- <11 (SCO, Natural Background)
 - 11 to ≤24 (CSL, Preliminary Regional Background)
 - >24

Notes:

1. Arsenic sediment screening levels = 11 mg/kg (SCO) and 24 mg/kg (CSL).
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable)
4. Basemap - ESRI, 2021
5. Projection - NAD 1983 StatePlane Washington North FIPS 4601 Feet.

DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

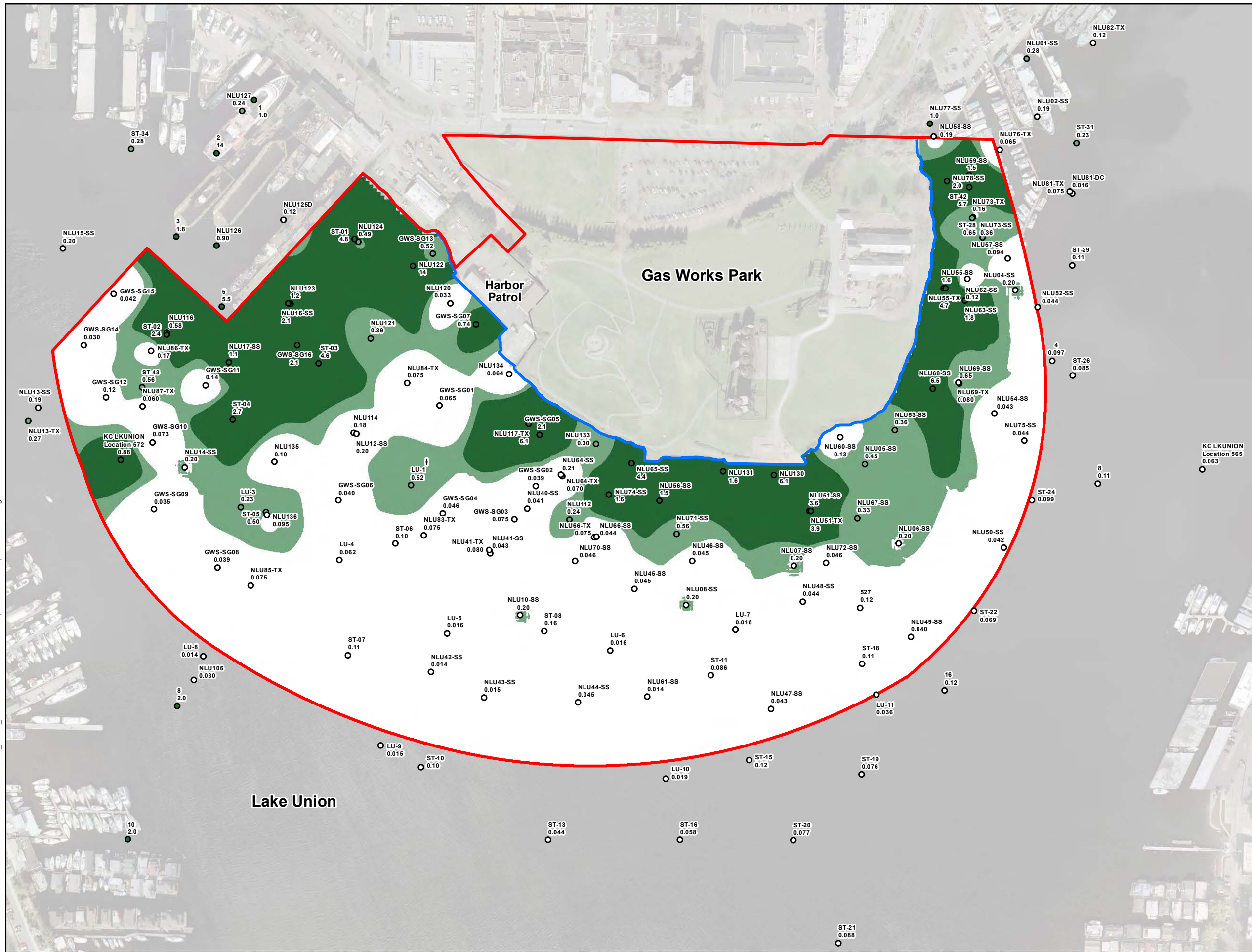


Arsenic Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington



Figure 5-20



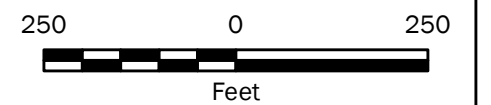
Legend

- Area of Investigation
 - Shoreline (OHWM)
 - Sample Location
- Dibenzofuran (mg/kg)**
- ≤0.2 (SCO)
 - >0.2 to ≤0.68 (CSL)
 - >0.68

Notes:

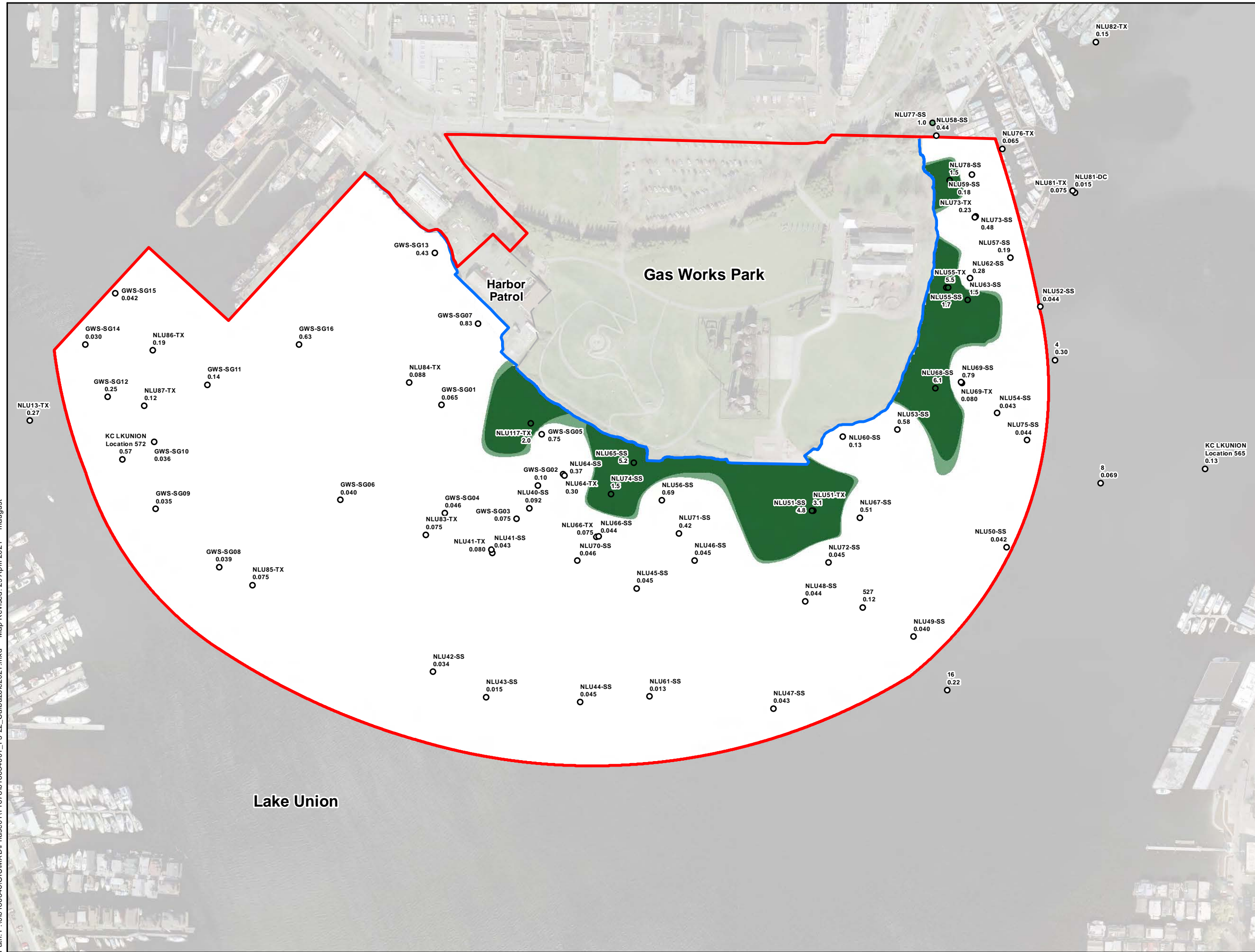
1. Dibenzofuran sediment screening levels = 0.2 mg/kg (SCO) and 0.68 mg/kg (CSL).
2. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
3. † LU-1 location is uncertain.
4. For non-detects, 1/2 the reporting limit is posted and used for interpolations. Interpolations include detects and non-detects.
5. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme. (Power = 6, Neighbors = 8, Reach = 1000).
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Dibenzofuran Concentrations in Surface Sediment	
Gas Works Park Site Seattle, Washington	
GEOENGINEERS	Figure 5-21

Path: P:\00186846\GIS\MapXDP\Phase01\1678\018684601_F5-22_Carbazole2021.mxd Map Revised: 29 April 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Sample Location

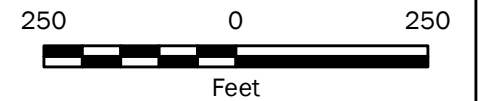
Carbazole (mg/kg)

- ≤0.9 (SCO)
- >0.9 to ≤1.1 (CSL)
- >1.1

Notes:

1. Carbazole sediment screening levels = 0.9 mg/kg (SCO) and 1.1 mg/kg (CSL).
2. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
3. For non-detects, 1/2 the reporting limit is posted and used for interpolations. Interpolations include detects and non-detects.
4. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme. (Power = 6, Neighbors = 8, Reach = 1000).
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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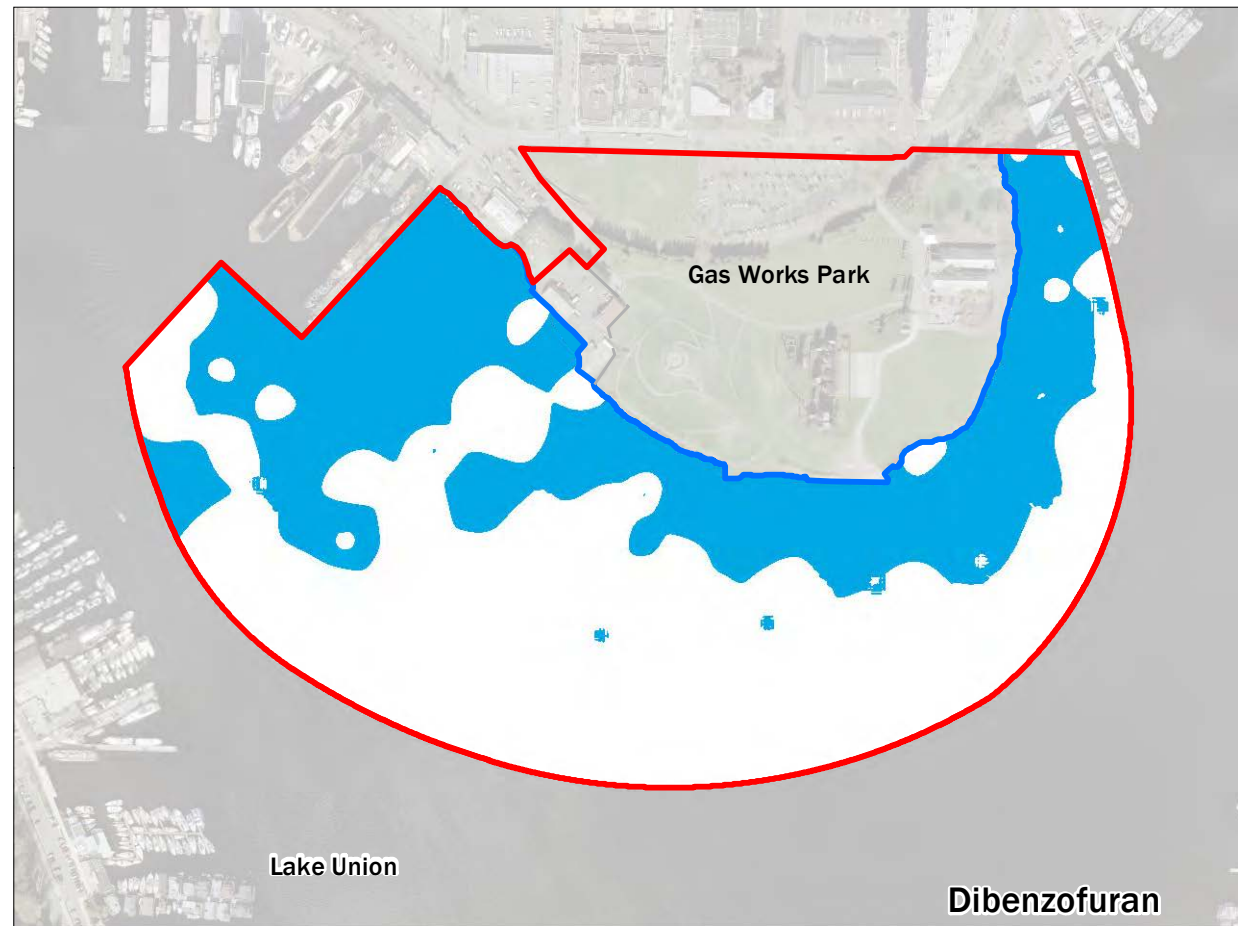


Carbazole Concentrations in Surface Sediment

Gas Works Park Site
Seattle, Washington



Figure 5-22



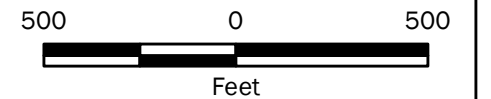
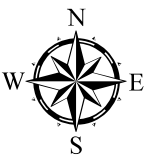
Legend

- Area of Investigation
- Shoreline (OHWM)
- COC ≤ SCO
- cPAH > 0.021 mg/kg (SCO)
- TPAH > 17 mg/kg (SCO)
- Dibenzofuran > 0.2 mg/kg (SCO)
- Carbazole > 0.9 mg/kg (SCO)

Notes:

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

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Limited Distribution of Dibenzofuran & Carbazole Relative to cPAH & TPAH in Surface Sediment (>SCO)

Gas Works Park Site
Seattle, Washington



Figure 5-23

Path: P:\00186846\GIS\MXD\Phase01\1678\018684601_F5-24_Nicke\2021.mxd Map Revised: 08 April 2022 mmaugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Sample Location

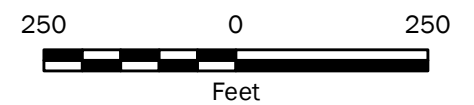
Nickel (mg/kg)

- ≤50 (SCO/Natural Background)
- >50 to ≤110 (CSL)
- >110

Notes:

1. Nickel sediment screening levels = 50 mg/kg (SCO) and 110 mg/kg (CSL).
2. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
3. Interpolating detects. All samples detected.
4. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme. (Power = 6, Neighbors = 8, Reach = 1000).
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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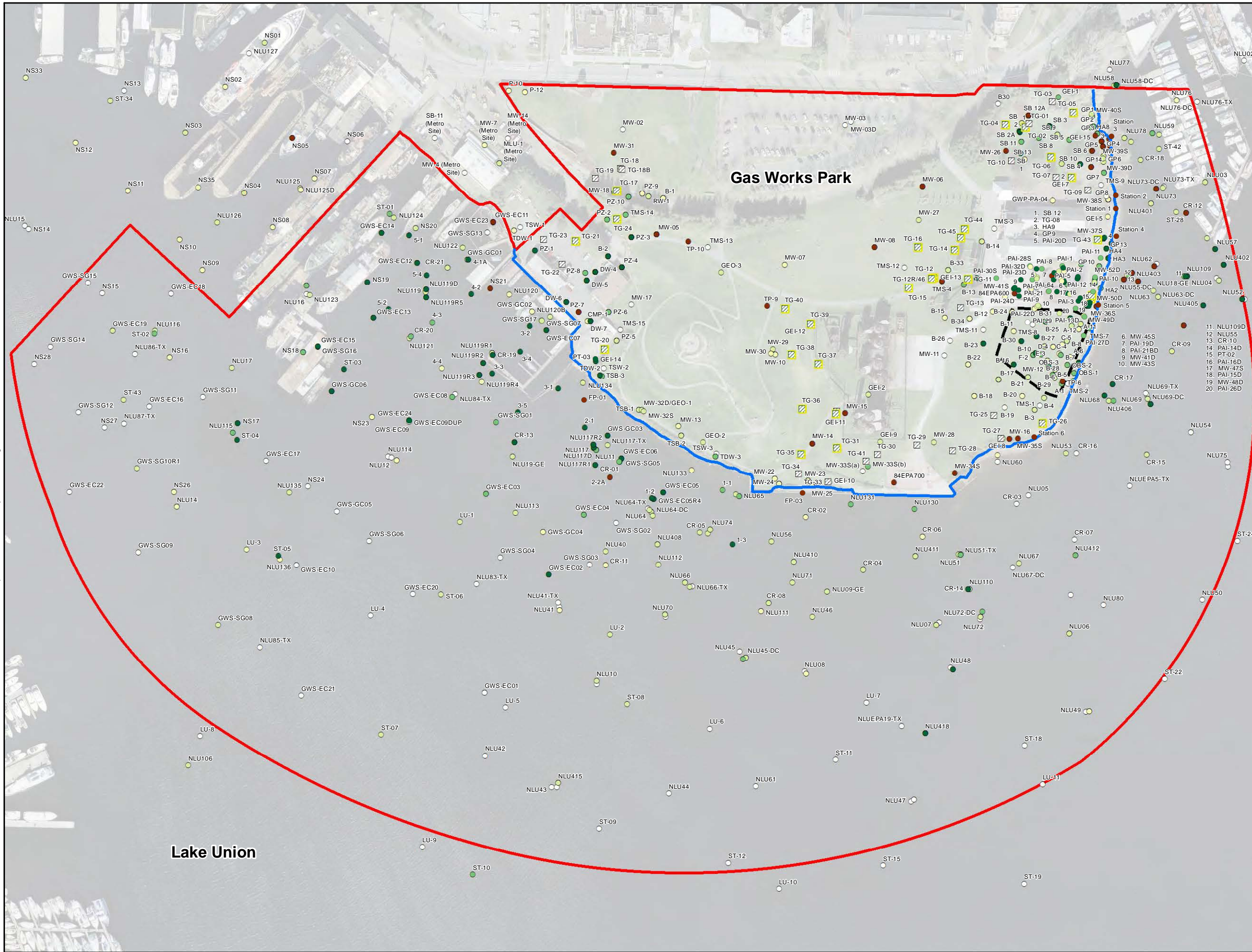
Nickel Concentrations in Surface Sediment

Gas Works Park Site
Seattle, Washington



Figure 5-24

Path: P:\00186846\GIS\MapXD\Phase0\11678\018684601_F5-25_NAPL_Tar_Occurrence2021.mxd Map Revised: 25 February 2021 maugust



Legend

- Area of Investigation
 - Shoreline (OHWM)
 - 2001-2006: Air Sparging Area
- NAPL and Tar Occurrences**
- Tar
 - Heavy Sheen with NAPL
 - Heavy Sheen and/or Trace NAPL
 - Slight to Moderate Sheen
 - Staining and/or Odor
 - No Impacts
- Interpreted TarGOST NAPL Occurrence**
- NAPL Impacts
 - No Impacts

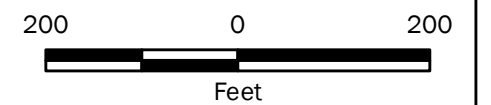
Mapping Rationale:

1. NAPL occurrence categories are defined in Appendix 5F.
2. Where both tar and heavy sheen with NAPL were observed in an exploration, the exploration is shown as tar-impacted.

Notes:

1. NAPL has been extracted/treated in the airsparging/soil vapor extraction area.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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NAPL and Tar Occurrences

Gas Works Park Site
Seattle, Washington

GEOENGINEERS **Figure 5-25**



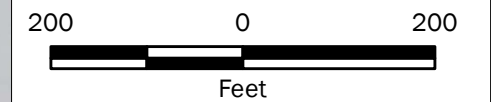
Legend

-  Area of Investigation
-  Shoreline (OHWM)
-  2001-2006: Air Sparging Area
-  Impervious Area
-  Areas with Clean Soil Caps
-  Gravel
- NAPL/Tar Areas - 0 to 1 Foot Depth**
-  1 Tar Area
-  1 NAPL Area
-  Tar
-  DNAPL

Notes:

1. Reference Appendix 5F.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601.

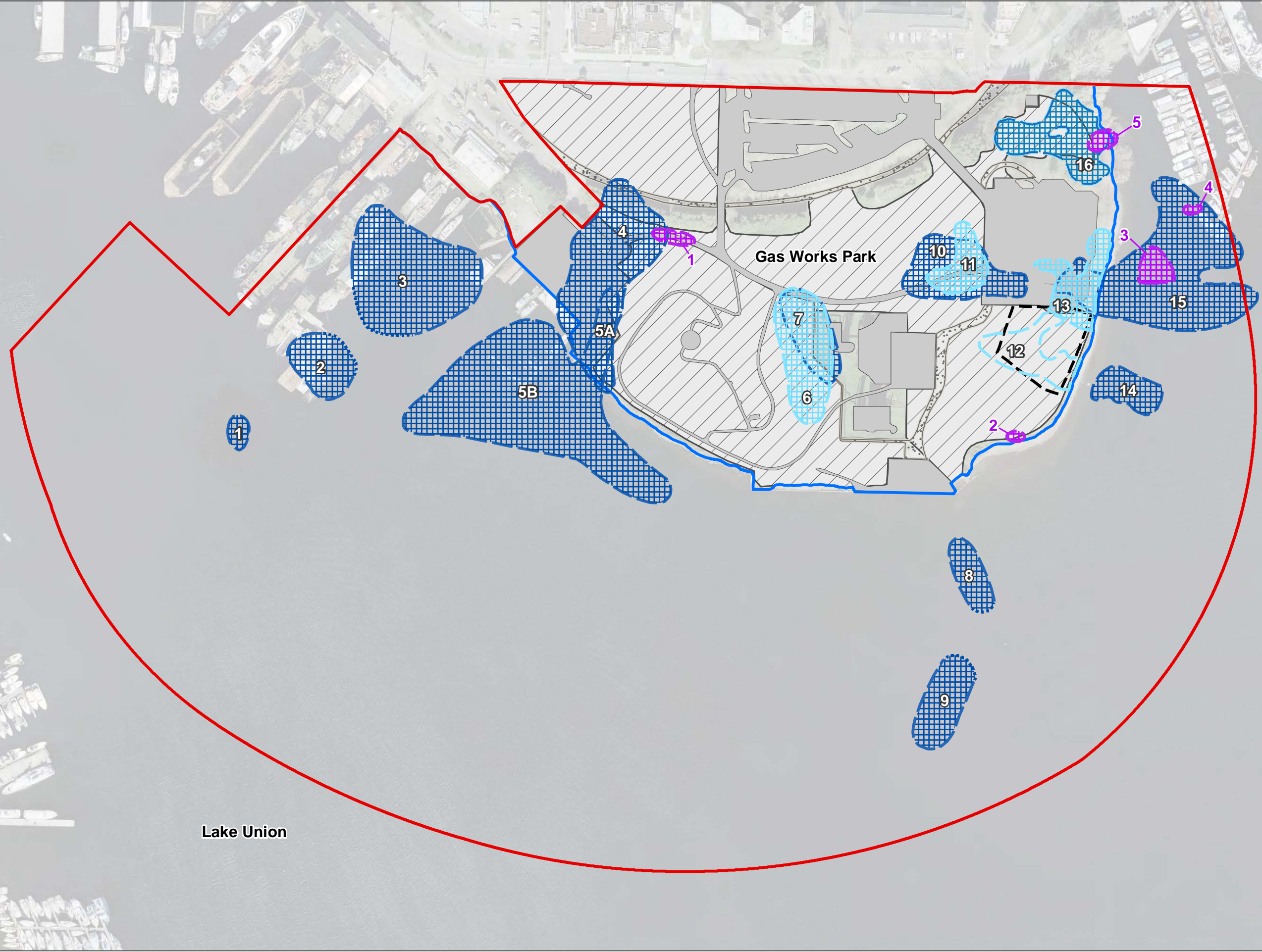
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**NAPL and Tar Areas -
0 to 1 Foot Depth**

**Gas Works Park Site
Seattle, Washington**

Office: SEA Path: P:\010186846\GIS\MXD\Phase01\1678018684601_F5-26B_Secondary_Sources_Release2021.mxd Map Revised: 29 April 2021 maugust



Legend

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

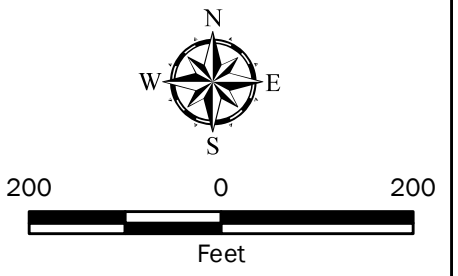
NAPL/Tar Areas - All Depths

- 1 Tar Area
- 1 NAPL Area
- Tar
- DNAPL
- LNAPL
- Mixed LNAPL/DNAPL
- Former Tar
- Former LNAPL
- Estimated Extent of NAPL—Greater Uncertainty

Notes:

1. *Tar area 1 partially removed in 1997.
2. Reference Appendix 5F.
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601.

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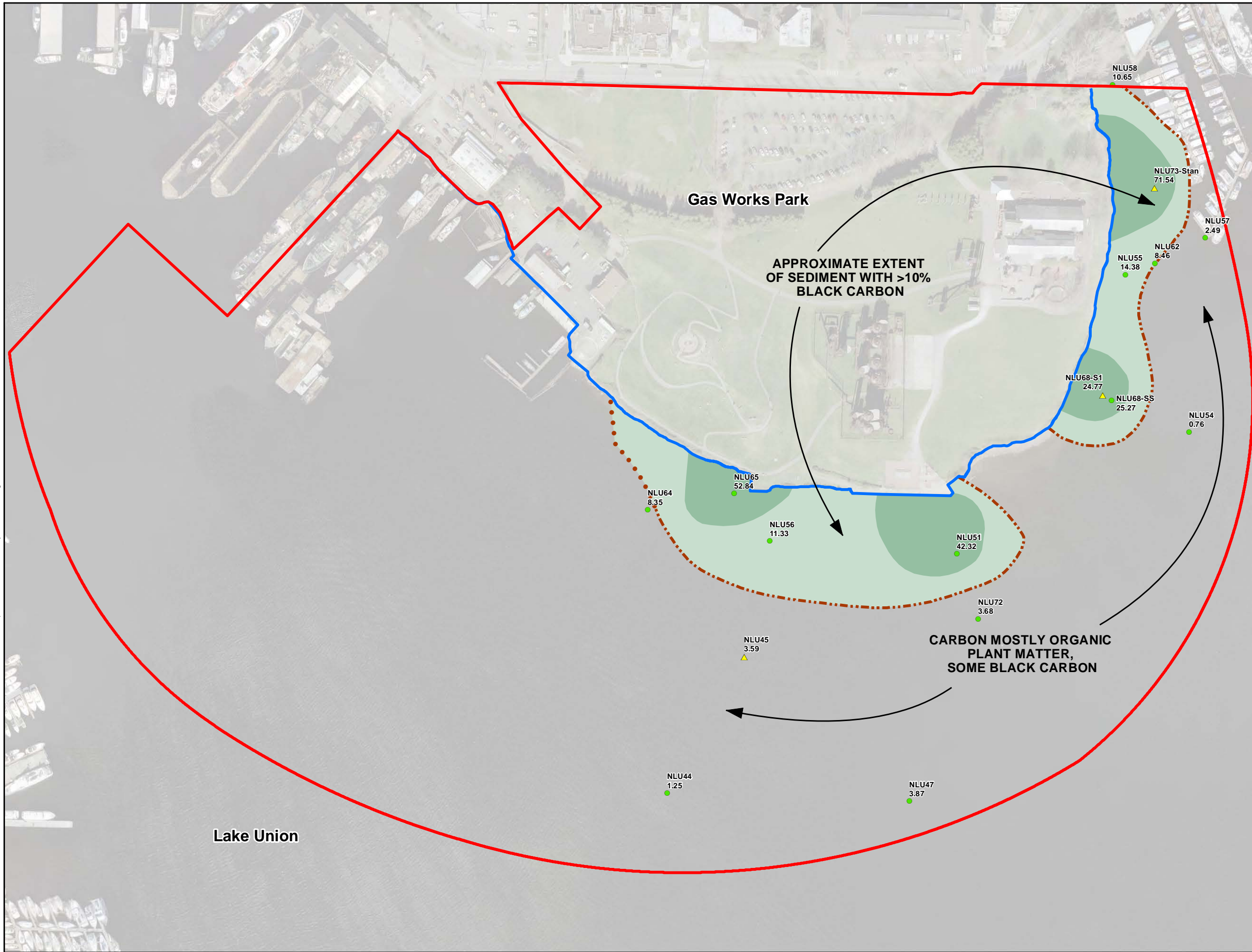


NAPL and Tar Areas - All Depths

Gas Works Park Site
Seattle, Washington

GEOENGINEERS **Figure 5-26B**

Path: P:\00186846\GIS\MapXDP\Phase01\1678\018684601_F5-27_BlackCarbon2021.mxd Map Revised: 25 February 2021 maugust



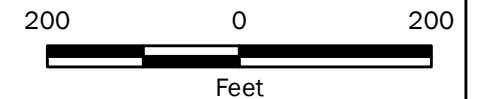
Legend

- Area of Investigation
 - Shoreline (OHWM)
 - Grab Sample
 - ▲ Core Sample
- Percent Black Carbon
(% by Volume of Whole Sample)**
- 10-20
 - >20
 - Extent of Black Carbon >10%
 - Extent of Black Carbon >10% Uncertain

Notes:

1. Black carbon defined in Section 5.3.5.
2. Depicted extent of black carbon is approximate.
3. Most samples are from 0 to 0.33 feet bml; some samples are up to 1.6 feet bml.
4. Basemap 2005 USGS aerial photograph. Does not show current conditions.
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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**Black Carbon in
Near-surface Sediment**

Gas Works Park Site
Seattle, Washington



Figure 5-27