Remedial Investigation and Feasibility Study

Gas Works Park Site
Seattle, Washington

for
Puget Sound Energy and the City of Seattle

January 2023

GeoEngineers
Earth Science + Technology

FIGURES

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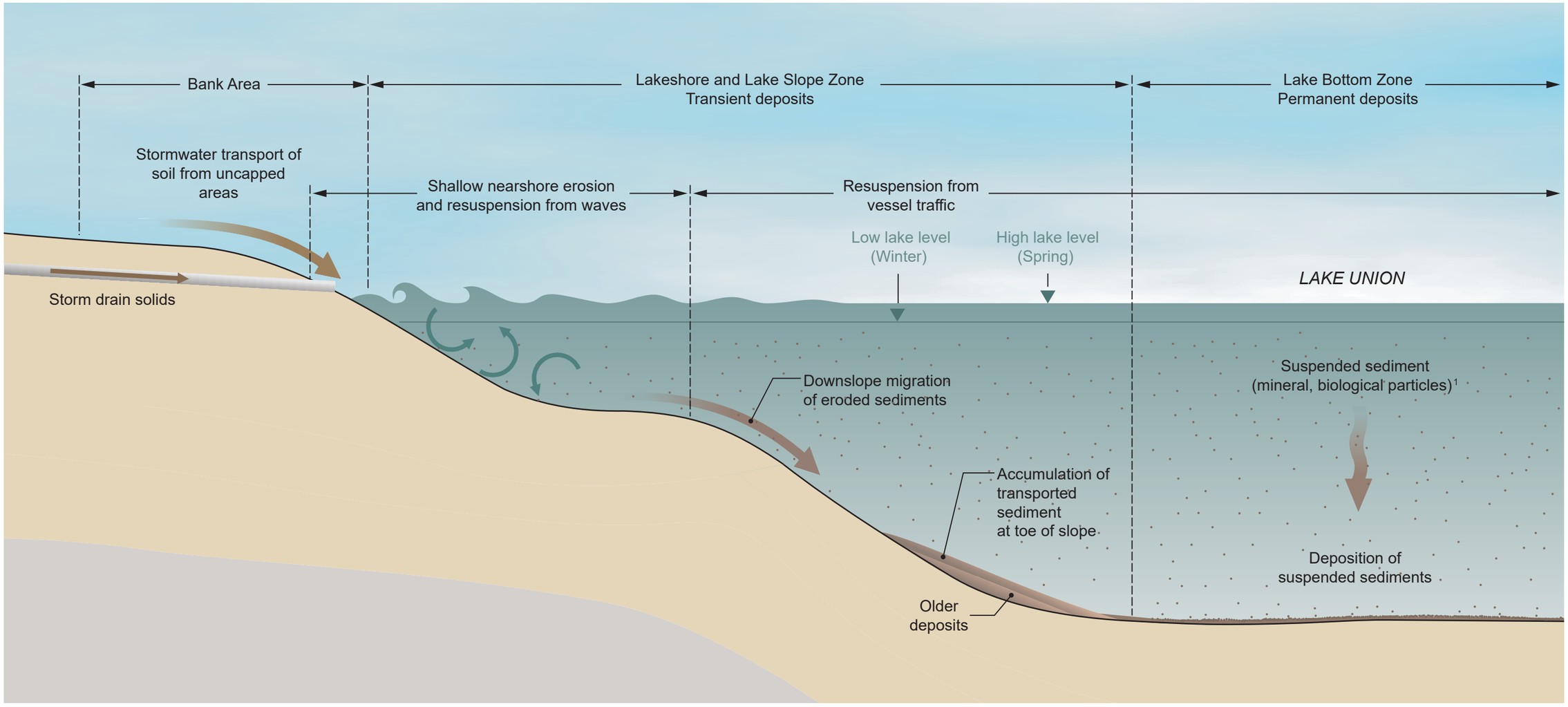

Notes:

1. Mineral particles are sourced from suspended solids transported from Lake Washington and Union Bays, storm drain and combined sewer overflow discharges, erosion of Lake Washington shoreline, and sediment resuspended in nearshore areas. Biological particles are from plankton, diatoms and decaying terrestrial and aquatic plant material.

Physical Processes Affecting Sediment Transport

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Seattle, Washington

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Figure 6-1

P:\0\0186846\Graphics_Misc\Figure 6-8 - Physical Processes Affecting Natural Recovery in Lake Bottom.ai Exported 4/29/21 by spride

GAS WORKS
PARK SITE

Sediment
erosion/resuspension

Downslope sediment
migration and some
resuspension

LAKE UNION

Less
resuspension

BANK

LAKESHORE

Bank erosion

LAKE SLOPE

Fill

Glacial Till

Outwash

More groundwater
discharge

Less
groundwater
discharge

Suspended
particle
deposition

LAKE BOTTOM

Lake
Sediment

Groundwater Flow

Resuspension

Deposition

Downslope Transport

Physical Transport Mechanisms (Block Diagram)

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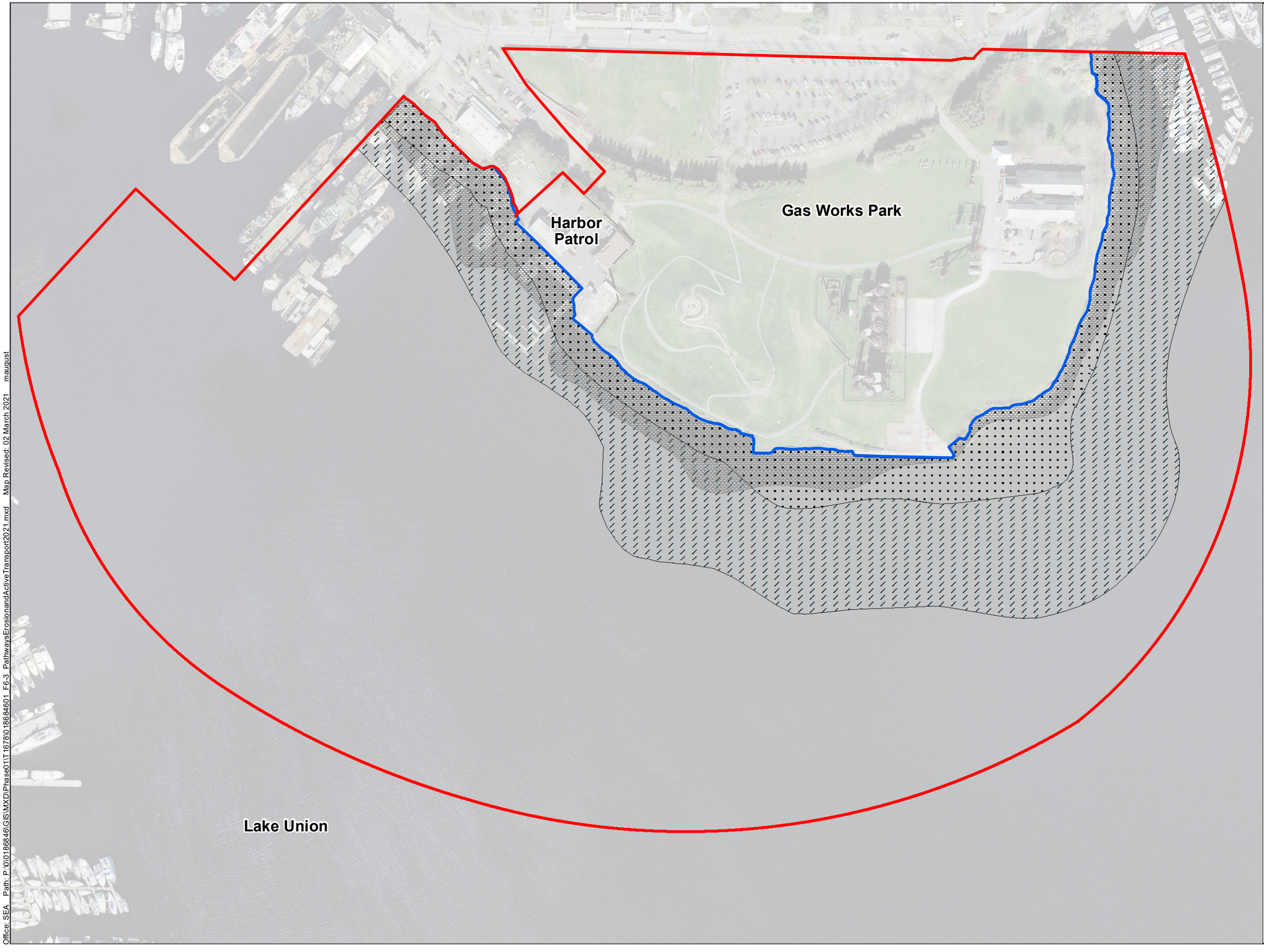
Figure 6-2

P:\O\0186846\Graphics_Misc\Figure 6-1 - Physical Transport Mechanisms.ai Exported 3/3/21 by spride



Legend

- Area of Investigation
- Shoreline (OHWM)

Transport Mechanisms

- Sediment Transport: Resuspension, Downslope Transport & (Transient) Deposition
- Erosion and Downslope Transport
- Groundwater Discharge Zone (>0.001 feet/day)

Notes:

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

N W E S

200 0 200

Feet

Physical Transport Mechanisms

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Seattle, Washington

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Figure 6-3

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\T1678\0186846_F6-3_PathwaysErosionandActiveTransport2021.mxd Map Revised: 02 March 2021 maugust

GAS WORKS
PARK SITE

Fill

Natural
attenuation

Glacial Till

Outwash

BANK

LAKESHORE

Dissolved contaminants
moving into lake

LAKE SLOPE

LAKE UNION

Groundwater becomes
recontaminated

Recontamination
followed by attenuation

LAKE BOTTOM

Lake
Sediment

Contaminant
Concentration

Higher

Lower

Groundwater
Flow

Contaminant
Source Material
(e.g. NAPL)

Chemical Transport Mechanisms (Block Diagram)

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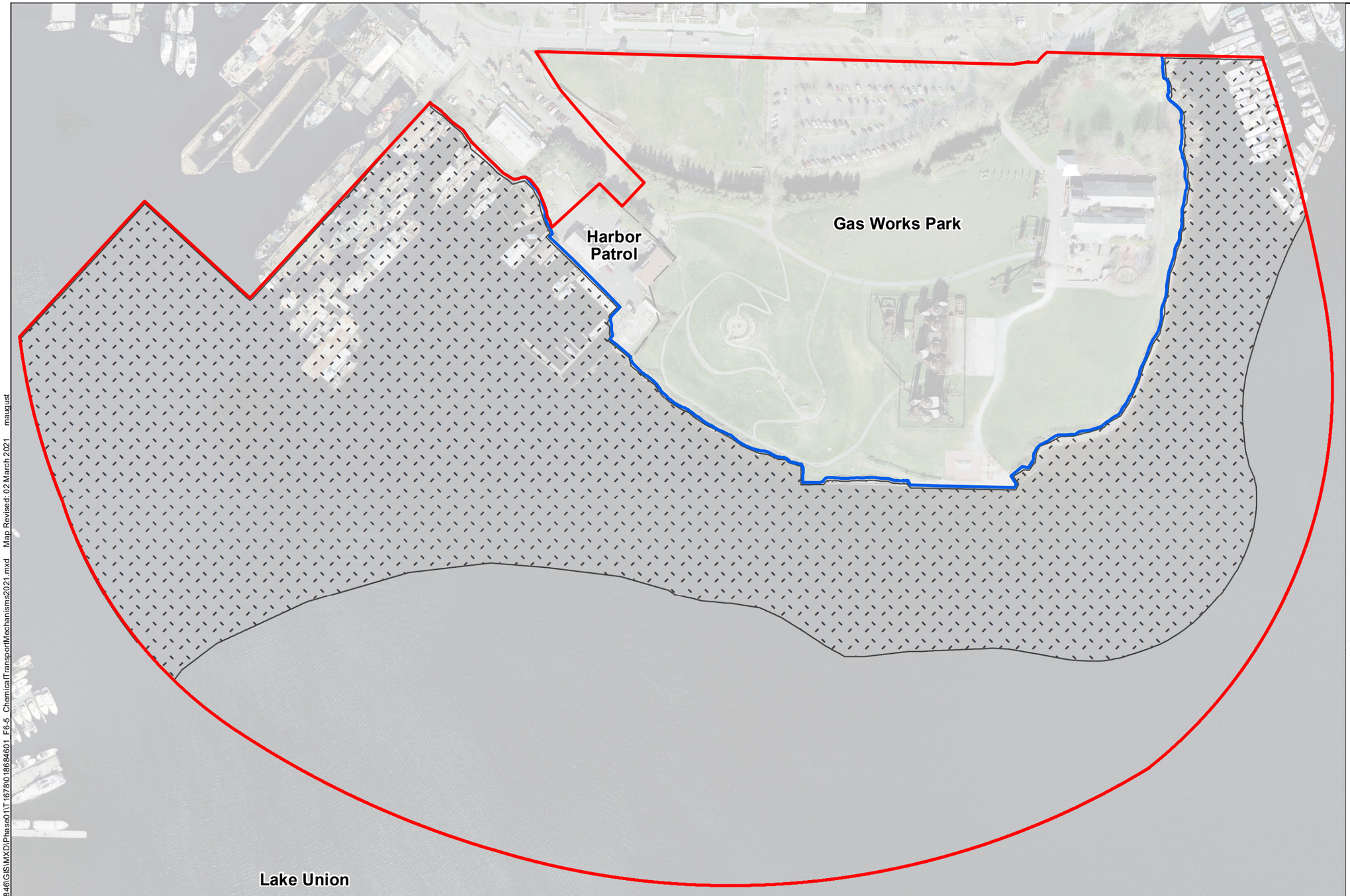
Figure 6-4

P:\0\0186846\Graphics_Misc\Figure 6-3 - Chemical Transport Mechanisms.ai Exported 3/5/21 by spride



Legend

- Area of Investigation
- Shoreline (OHWM)

Transport Mechanisms

- Partitioning to Porewater > Ambient

Notes:

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

N W E S

200 0 200

Feet

Chemical Transport Mechanisms

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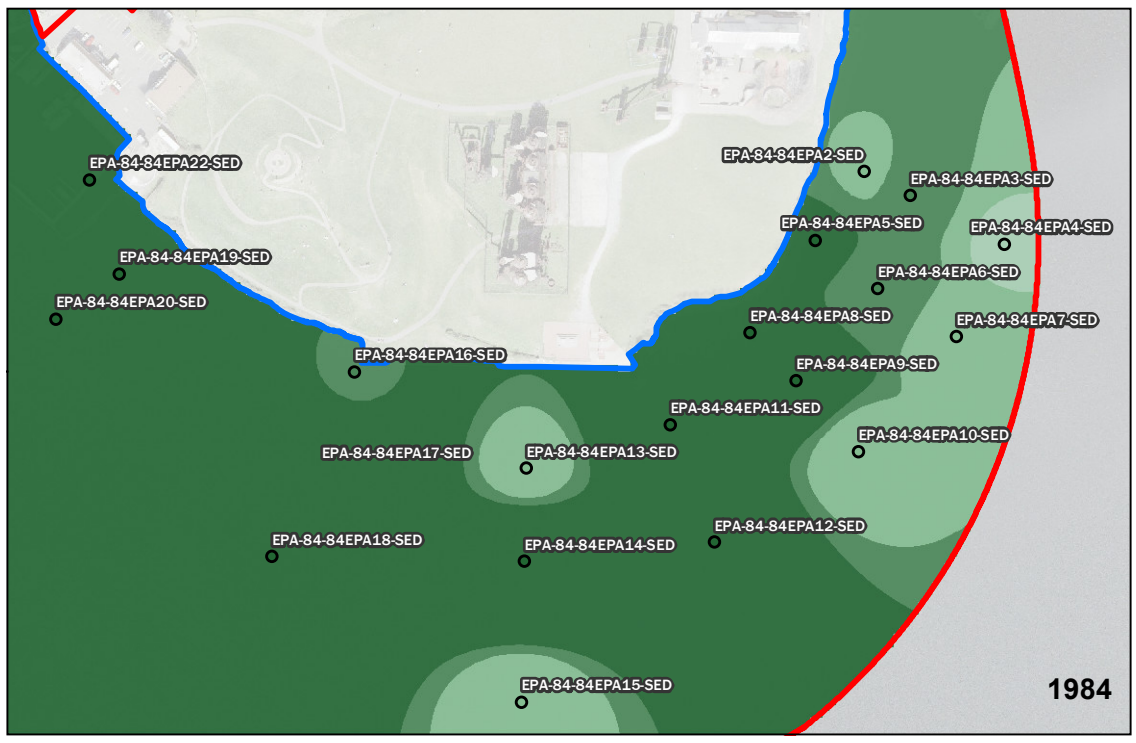
Figure 6-5

Office: SEA Path: P:\0\0186846\GIS\MXD\Phase01\T1678\0186846 01_F6-5_ChemicalTransportMechanisms2021.mxd Map Revised: 02 March 2021 maugust

P:\0\0186846\GIS\MXD\Phase01\T1678\018684601_F6-6_tpah_IDW_4up2021.mxd Date Exported: 03/02/21 by maugust



Legend

TPAH Concentration (mg/kg)

- ≤17 (SCO)
- >17 to ≤30 (CSL)
- >30 to ≤170
- >170 to ≤500
- >500

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

N W E S

300 0 300

Feet

Notes:

1. TPAH sediment screening level = 17 mg/kg (SCO) and 30 mg/kg (CSL).
2. For mappng purposes surface sediment is defined as the top 6 inches of sediment.
3. ArcGIS Inverse Distance Weighted (IDW) interpolation settings: Power = 6, Neighbors = 8, Radius = 1,000 feet.
4. Where TPAH was not detected, 1/2 the reporting limit was used in the interpolation.
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Temporal TPAH Trends in Surface Sediment 1984-2005

Gas Works Park Site
Seattle, Washington

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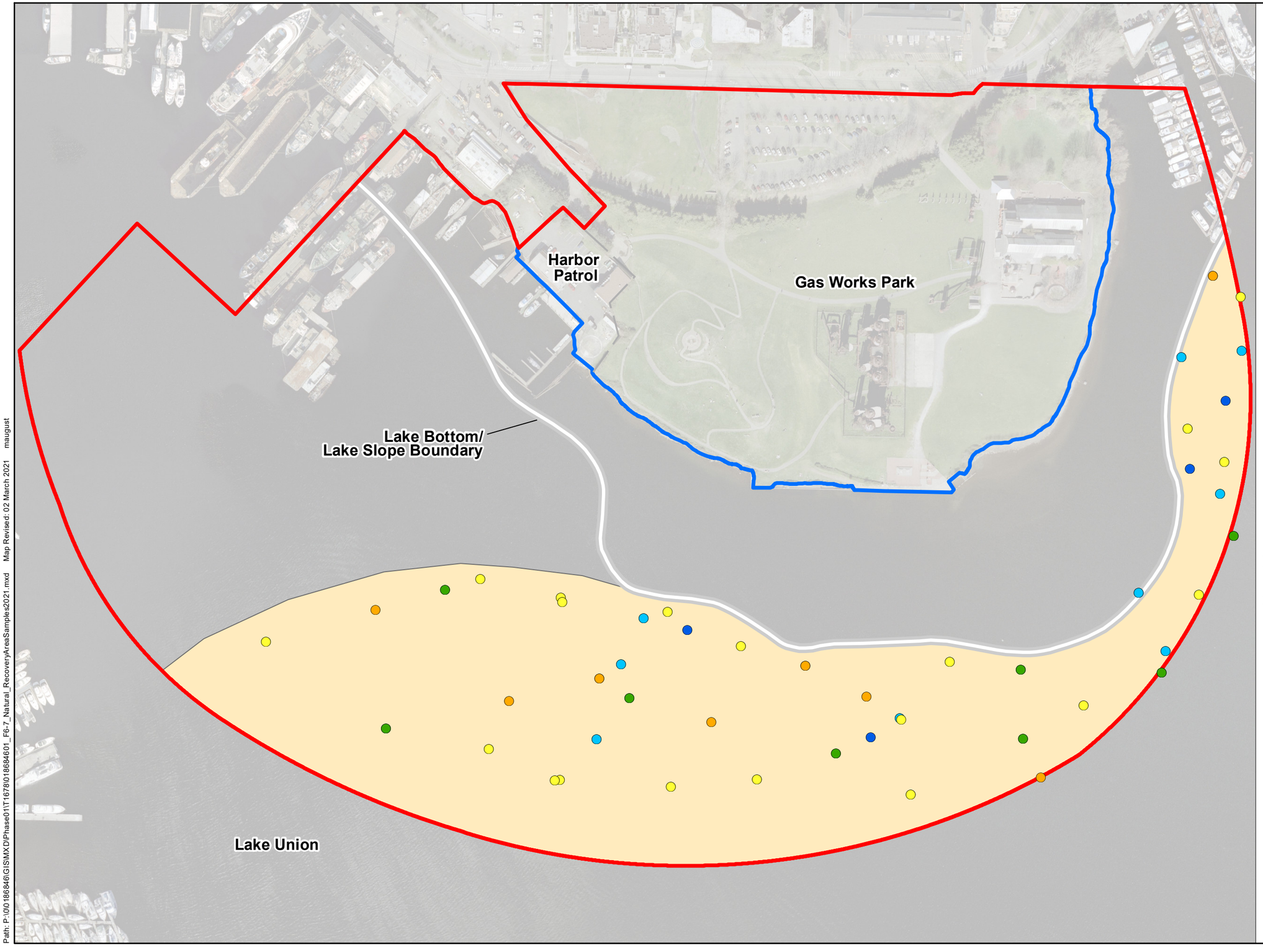
Figure 6-6



Legend

- Area of Investigation
- Shoreline (OHWM)
- Natural Recovery Area

Samples Collected from:

- 1984 - 1985
- 1987-1998
- 1999 - 2001
- 2002 - 2003
- 2004 - 2005

Notes:

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

N W E S

200 0 200

Feet

Surface Sediment Samples in Natural Recovery Area

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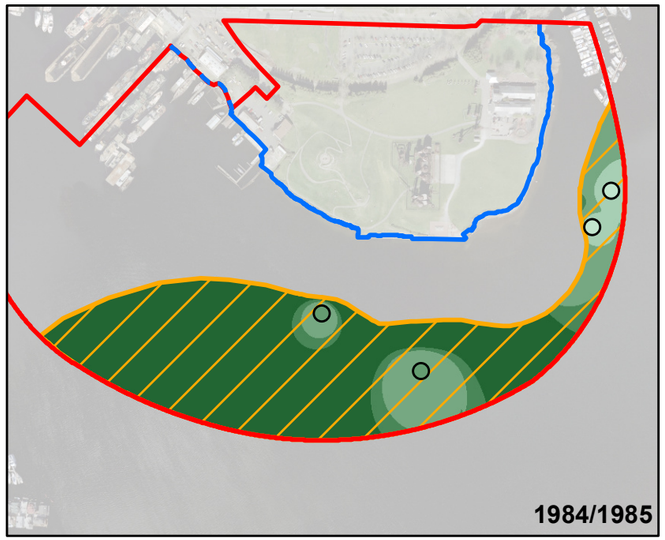
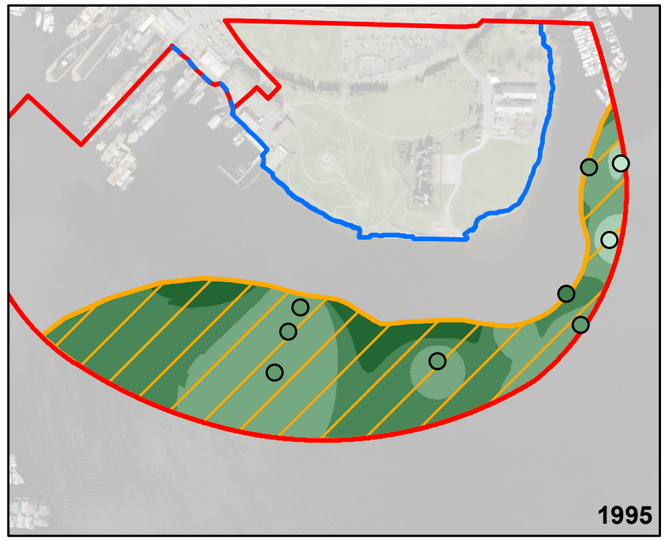
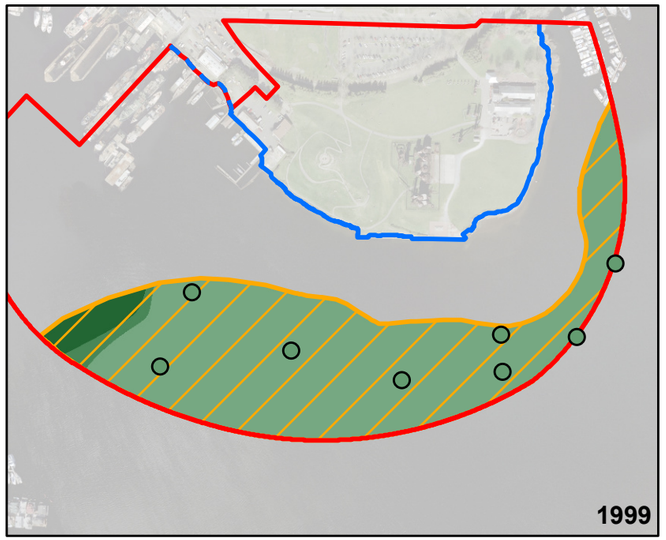
Figure 6-7

Path: P:\00\186846\GIS\MXD\Phase01\T1678\0186846 01_F6-7_Natural_RecoveryAreaSamples2021.mxd Map Revised: 02 March 2021 maugust 2021





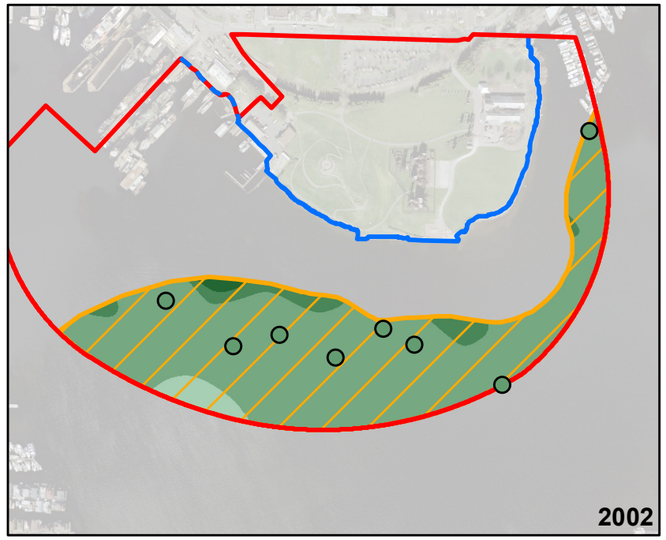


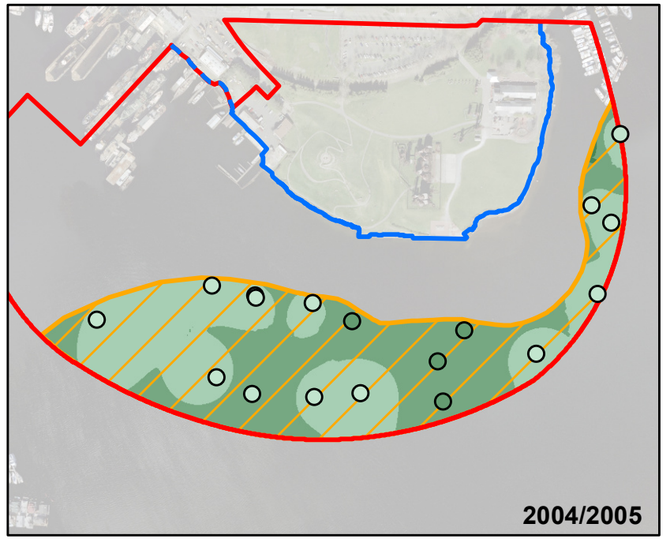
Legend

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

cPAH TEQ (mg/kg)

- ≤0.21 CSL
- >0.21 ≤ 2
- >2 ≤ 20
- >20 ≤ 50
- >50





Notes:

1. cPAH sediment screening level = 0.21 mg/kg (CSL).
2. For mappng purposes surface sediment is defined as the top 6 inches of sediment.
3. ArcGIS Inverse Distance Weighted (IDW) interpolation settings: Power = 6, Neighbors = 8, Radius = 1,000 feet.2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

Feet

Temporal cPAH TEQ Trends in Natural Recovery Area Surface Sediment 1984-2005

Gas Works Park Site
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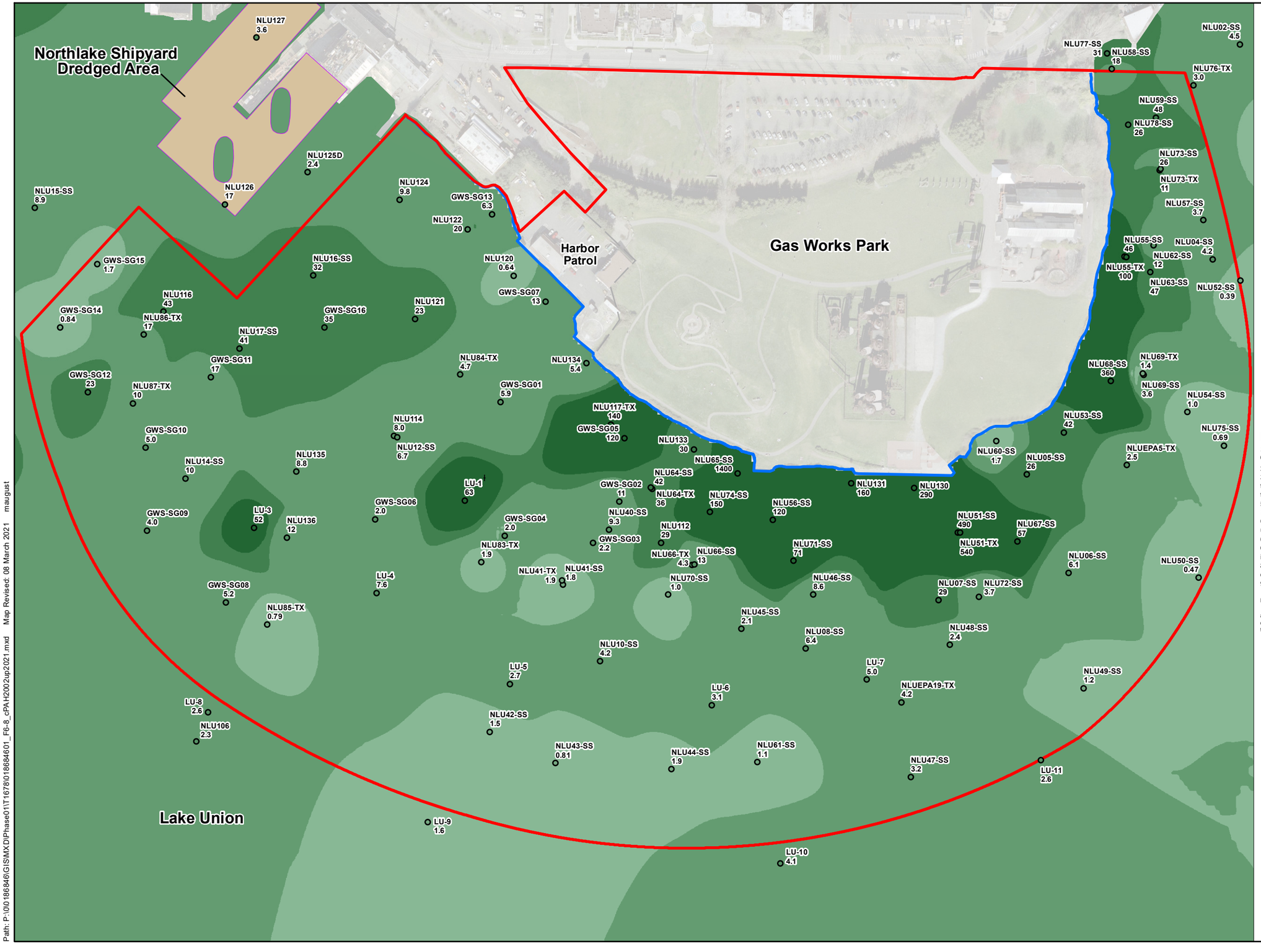
Figure 6-8

Path: P:\0186846\GIS\MXD\Phase01\T1678\0186846_F11C-4_cPAH_timeseries.mxd Map Revised: 17 May 2022 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Sample Location
- Area represents the dredge footprint and is not contoured.

cPAH TEQ Concentration (mg/kg)

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

Notes:

1. 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.
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 = Variable). Contoured interval may differ from actual data shown due to influence of neighboring values.
8. Basemap 2005 USGS aerial photograph. Does not show current conditions.
9. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

Feet

cPAH Concentrations in Surface Sediment 2002-2005

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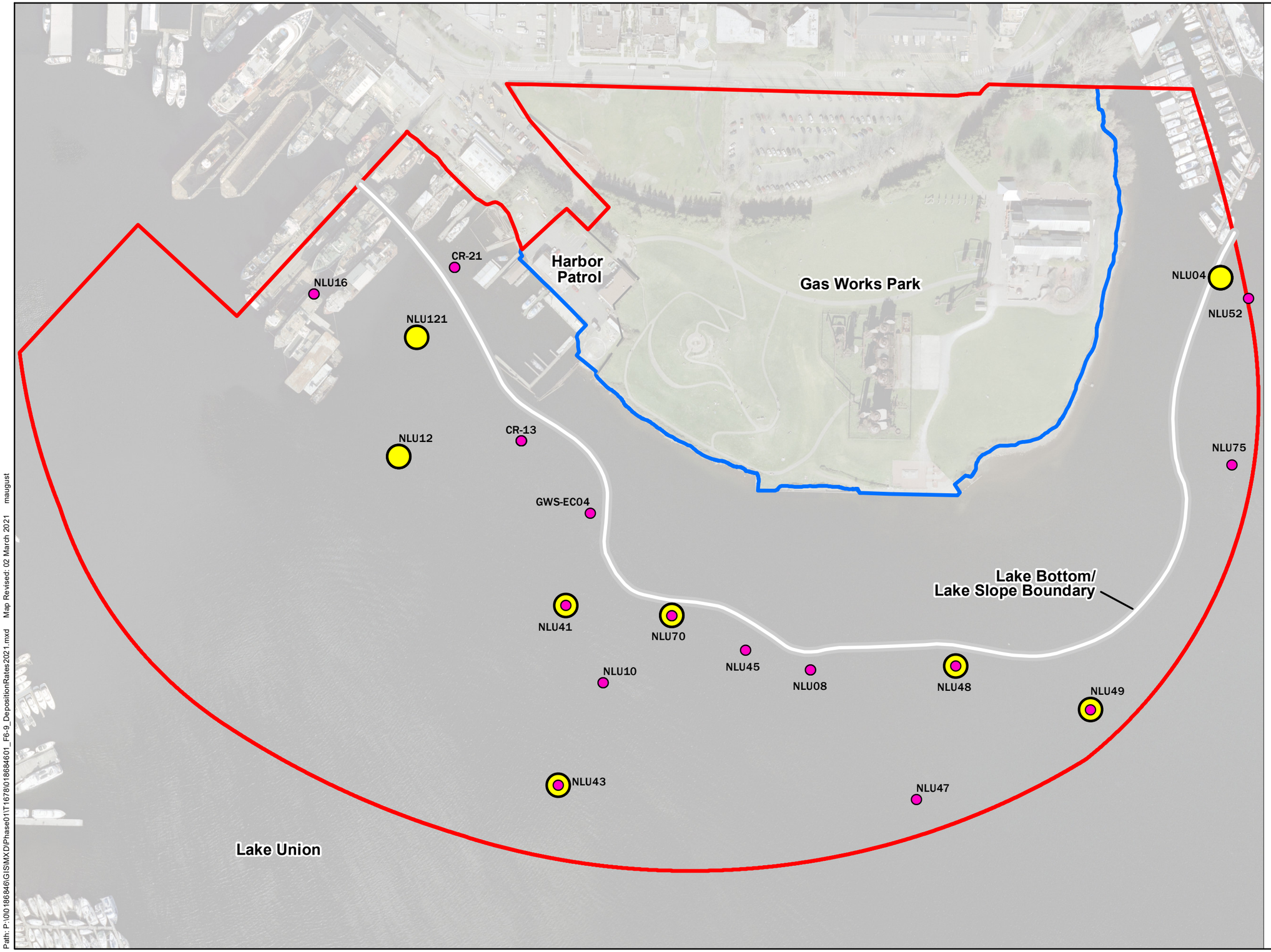
Figure 6-9

Path: P:\0018684\6\GISMXD\Phase01\T1678\0018684601_F6-8_cPAH2002up2021.mxd Map Revised: 08 March 2021 maugust



Path: P:\00\186846\GIS\MXD\Phase01\T1678\01868601_F6-9_DepositionRates2021.mxd Map Revised: 02 March 2021 maugust 2021

Legend

- Area of Investigation
- Shoreline (OHWM)
- Sample Used to Estimate Deposition Rate
- Sample Used to Evaluate Vertical cPAH TEQ Concentration Trends

Notes:

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

N W E S

200 0 200

Feet

Samples Used to Estimate Deposition Rates and cPAH TEQ Vertical Trends

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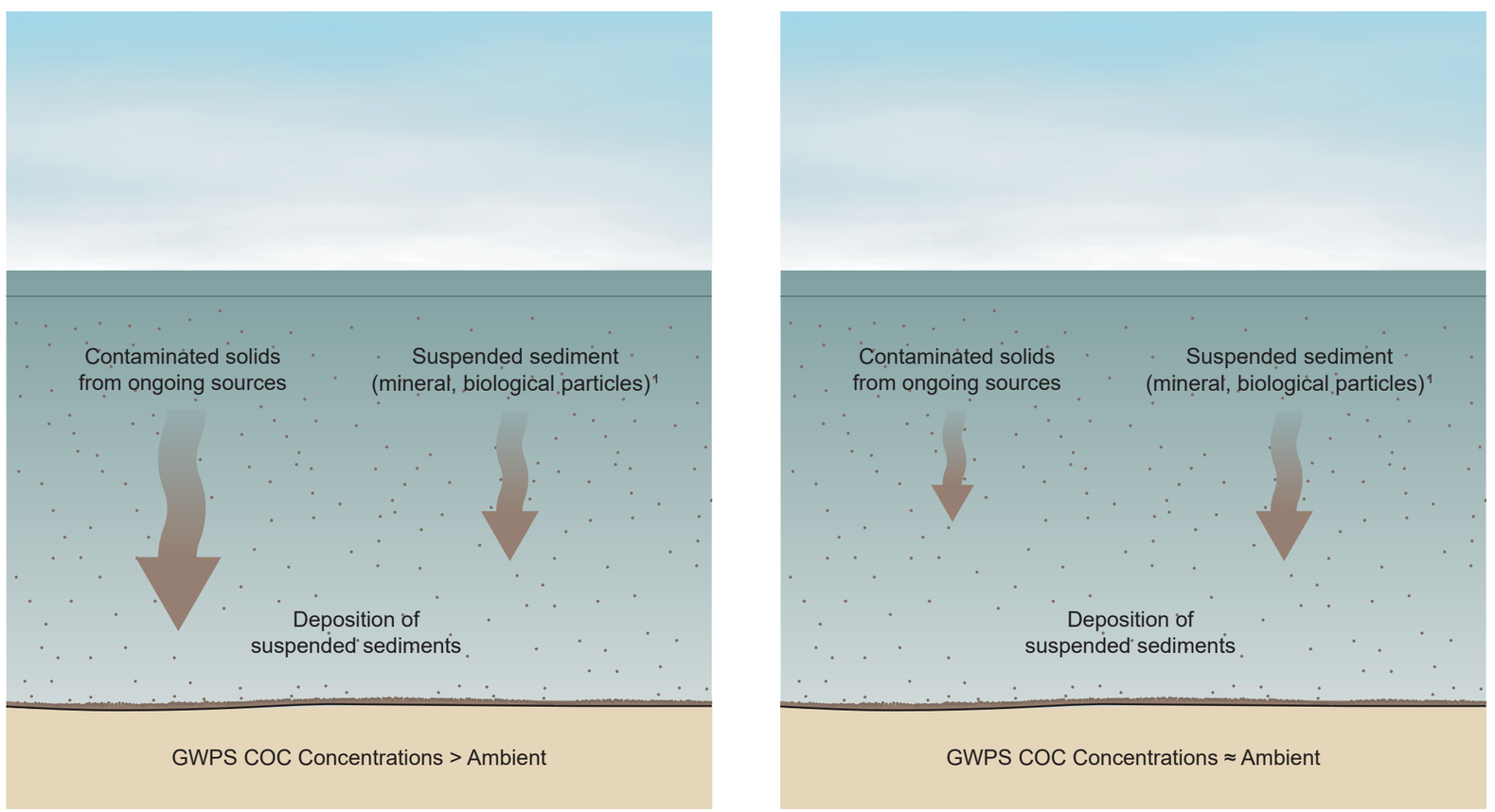
Figure 6-10

Lake Bottom Zone
Ongoing Deposition and Burial



Notes:

1. Mineral particles are sourced from suspended solids transported from Lake Washington and Union Bays, storm drain and combined sewer overflow discharges, erosion of Lake Washington shoreline, and sediment resuspended in nearshore areas. Biological particles are from plankton, diatoms and decaying terrestrial and aquatic plant material.

Factors Affecting Natural Recovery in Lake Bottom

Gas Works Park Site
Seattle, Washington

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Figure 6-11

P:\0\0186846\Graphics_Misc\Figure 6-10 Factors Affecting Natural Recovery in Lake Bottom.ai Exported 6/10/20 by spride

SL 3
As = 9 U
TPAH = 6.5
cPAH = 0.70

SL 2
As = 10 U
TPAH = 2.8
cPAH = 0.23

SL 5
As = 20
TPAH = 19
cPAH = 2.1

Waterway
#20 Outfall

HP-CB-03
As = 10 U
TPAH = 8.2
cPAH = 0.60 U

HP-CB-123
As = 10
TPAH = 11
cPAH = 0.89

Harbor Patrol Outfall
(Private Storm Outfall)

HP-CB-02
As = 10
TPAH = 16
cPAH = 1.3

HP-CB-01
As = 13
TPAH = 11
cPAH = 0.96

Kite Hill
Outfall

PA-CB-01
As = 30 U
TPAH = 5.0
cPAH = 0.51

PA-CB-02
As = 20 U
TPAH = 3.9
cPAH = 0.40

PA-CB-03
As = 20 U
TPAH = 5.8
cPAH = 0.54

PA-CB-04
As = 10 U
TPAH = 4.9
cPAH = 0.6

PA-CB-05
As = 20 U
TPAH = 2.9
cPAH = 0.32

Parking Lot

SL 6
No As
TPAH = 9.9
cPAH = 1.3

SL-6.1
As = 44
TPAH = 73
cPAH = 6.3

SL-6.2
As = 53
TPAH = 6.2
cPAH = 0.57

SL 12
As = 10 U
TPAH = 1.0
cPAH = 0.12

SL 9
As = 20 U
TPAH = 17
cPAH = 1.8

SL 10
As = 26
TPAH = 55
cPAH = 6.5

SL 11
As = 20
TPAH = 7.9
cPAH = 0.95

SL 7
As = 17
TPAH = 42
cPAH = 3.8

SL 13
As = 9 U
TPAH = 2.1
cPAH = 0.20

SL 14
As = 19
TPAH = 51
cPAH = 5.5

SL 8
As = 15
TPAH = 32
cPAH = 3.8

Waterway
#19 Outfall

Outfall A

Outfall B

Outfall E

Outfall C [3]

Outfall D

Outfall F

Gas Works Park

Lake Union

Legend

- Area of Investigation
- Shoreline (OHWM)
- Harbor Patrol Property
- Storm Drain
- Perforated Storm Drain
- Drainage Ditch
- Drain
- Catch Basin
- Inlet
- Maintenance Hole or Manhole
- Storm Drain Outfall Location
- Plugged Pipe

- Indicates catch basin sample taken September 2008 (Phase 1 Report).
- Indicates catch basin sample taken June 2010 (Phase 3 Report).
- Indicates composite catch basin sample taken January 2015.
- Indicates catch basin sample taken January 2017.
- Indicates catch basin sample taken December 2017.

Solid Sample Results
Sample ID
Arsenic
TPAH
cPAH

Screening Results
TPAH = 2.9 Concentration < SCO
cPAH = 0.12 Concentration > SCO
cPAH = 0.57 Concentration > CSL

Notes:

1. Sediment Screening Levels in mg/kg

	SCO	CSL
As	11	24
cPAH	0.021	0.21
TPAH	17	30

The screening levels used for cPAH and arsenic are conservative and well below Lake Union ambient conditions for those COCs.
2. Reference: Attachments 6B-1 through attachments 6B-8, and Seattle Parks & Recreation As-Builts from November 2018.
3.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).
4. No flow was observed from Outfall F, Prow Outfall, or Kite Hill Outfall during several storm events.
5. Perforated underdrain pipes connected to Outfall C were installed during the Play Area renovation. These pipes were installed in a layer of clean material above a vapor barrier and do not come in contact with underlying, potentially contaminated soils.
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
S

120 0 120
Feet

Storm Drain System and Catch Basin Solids Samples

Gas Works Park Site
Seattle, Washington

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Figure 6-12

Path: P:\0018684\GIS\MXD\Phase01\T167801868601_F6-12_ExistingSubsurfaceUtilities2022.mxd Map Revised: 22 April 2022 maugust