APPENDIX 5E
Identification of GWPS and ALU Contaminants of Concern in AOI Surface Sediment

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APPENDIX 5E
IDENTIFICATION OF GWPS AND ALU CONTAMINANTS OF CONCERN IN AOI SURFACE SEDIMENT

1.1. Introduction

Given the urban/industrial setting of Lake Union, sediment contaminants of concern (COCs) were evaluated further to identify site-related COCs, referred to as Gas Works Park Site (GWPS) COCs, associated with historical manufactured gas plant (MGP) and other upland industrial activities and widespread co-located COCs primarily associated with diffuse or other point sources affecting sediment quality throughout the lake (referred to as ambient Lake Union [ALU] COCs). The process to identify GWPS COCs and ALU COCs in surface sediment involved three steps:

- Statistical comparison of average chemical concentrations in the sediment portion of the area of investigation (AOI) with the remainder of the lake.
- Interpolating chemical concentrations in Lake Union to identify potential gradients.
- Evaluation of potential sources of COCs.

These three steps are described further in the following sections.

1.2. Statistical Evaluation Approach

The statistical evaluation compared chemical concentrations within the sediment portion of the AOI with the ALU area to determine if there were statistically significant differences. This evaluation relied upon the current conditions data set used in this remedial investigation (RI) for the sediment portion of the AOI; the ALU area data were represented by a broader data set that spanned from 1981 to 2008 (see Appendix 5A for a description of data sets). Sampling locations in the ALU area within 300 feet of the shoreline were not included in the statistical comparison to remove the potential effect of other point sources along the lake shore; however, nearshore sediment samples within the AOI were included in the AOI data set. The location of the samples used in this evaluation are shown in Figure 5E-1.

A non-parametric pair-wise test (Gehan two-sample test) using ProUCL version 5.1 was conducted. This test does not assume any underlying distribution (e.g., normality) of the data and is not affected by the presence of outliers (extreme values) and/or multiple detection limit values. The final statistical outcome (significantly different or not) of the pair-wise testing was based on a significance threshold of $p < 0.05$. Statistical outcomes included:

- The two data sets were similar and no statistical differences could be detected.
- The two data sets were significantly different with two further outcomes:
    - The sediment portion of the AOI had significantly higher concentrations than the ALU area, and
    - The ALU area had significantly higher concentrations than the sediment portion of the AOI.

Table 5E-1 presents summary statistics and pair-wise testing results for COCs in the ALU area compared to the sediment portion of the AOI. Summary statistics include sample size, number of detected concentrations, mean and median values for each data set. ProUCL statistical outputs are provided in Attachment 5E-1. Of the 27 COCs evaluated, 10 had significantly different concentrations between the two areas. Three COCs were significantly higher in the sediment portion of the AOI (carcinogenic polycyclic

aromatic hydrocarbons [cPAH], total polycyclic aromatic hydrocarbons [TPAH], and dibenzofuran) and seven COCs were significantly higher in the ALU area [bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, phenol, 4,4-DDE, total polychlorinated biphenyls [PCBs], lead, and mercury]. Other COC statistical results were not significantly different or were not tested because of a small sample size.

In addition, mercury was used as a surrogate for methylmercury because methylmercury was only analyzed in five samples in Lake Union (one sample in the AOI). Mercury is an appropriate surrogate as methylmercury can only form where mercury is present. Mercury is widespread in the lake, with the highest concentrations outside of the AOI; statistically, the ALU has a significantly higher average concentration. Therefore, methylmercury is classified as an ALU COC based on the distribution of mercury.

1.3. Lake-Wide Mapping of Concentration Gradients

Where no difference could be identified by the statistical pair-wise testing, COC concentrations were mapped to evaluate the distribution of elevated COC concentrations and to identify concentration gradients. Map contours were based on the sediment cleanup objective (SCO) and cleanup screening level (CSL) for each chemical. If there were too few data for statistical evaluation, there was also insufficient detected data for interpolation. For these COCs, data were posted on maps, but concentrations were not interpolated. Figures 5E-2 to 5E-16 display concentrations in Lake Union for those chemicals where a difference between the sediment portion of the AOI and the ALU area could not be detected statistically or where there were too few detected concentrations in either the ALU area or sediment portion of the AOI for statistical comparison.

Figure 5E-2 shows lake-wide sulfide concentrations. The CSL is exceeded throughout lake-bottom soft sediment. Lower sulfide concentrations are present in some lakeshore areas including within the AOI. Sulfide is associated with lake-wide sediment processes and has multiple lake-wide sources and is classified as an ALU COC.

The lake-wide distribution of carbazole is shown in Figure 5E-3. Carbazole exhibits an offshore gradient; concentrations are highest near the GWPS upland and are lower in the lake bottom. Carbazole is classified as an GWPS COC. Carbazole co-occurs with PAHs; SCO exceedances are within the footprint of PAHs.

Three of the organic COCs, 4-methylphenol, benzoic acid, and pentachlorophenol, have similar distributions (Figures 5E-4 to 5E-6). The highest concentrations are typically in depositional areas. Most higher concentration areas are driven by non-detects with elevated reporting limits. These anomalies (likely artifacts) are especially prominent in the lake bottom outside of the AOI but also present within the AOI. Highest detected concentrations in sediment are mostly in the western portion of the AOI and the adjacent area outside of the AOI. As there is no clear association with historical MGP operations, 4-methylphenol, benzoic acid, and pentachlorophenol are classified as ALU COCs.

Tributyltin and four metals, cadmium, chromium, copper, and silver do not appear to be associated with historical MGP operations. These COCs have similar distributions (Figures 5E-7 to 5E-11). Concentrations in sediment are generally elevated in much of the lake bottom area with some of the lowest concentrations in the nearshore area in the eastern portion of the AOI. The highest concentrations in sediment are in the western portion of the AOI, part of the shipyard metals area. Concentration gradients are from the shipyard area to the east and from the center of Lake Union to the north toward the AOI shoreline. These five metals are classified ALU COCs.

Nickel exceeds the SCO in most of Lake Union; however, the distribution of nickel is unlike other COCs (Figure 5E-12). The highest nickel concentrations are outside of the AOI but nickel was also elevated near the eastern and southeastern shoreline. Nickel was not classified based on mapping but was evaluated further to determine the potential relationship with historical MGP operations (see Section 5.2.3.4.3 of the RI).

There are five COCs with limited detections: diesel-range hydrocarbons, chlordane, di-n-octyl phthalate, and hexachlorobenzene. Data are posted in Figures 5E-13 to 5E-16; there were insufficient data for interpolation. Three of these are classified as ALU COCs based on the mapped distribution.

- Diesel-range hydrocarbons exceeded the SCO at three locations—one in the lake bottom depositional area in the southwestern portion of the AOI and two outside of the AOI (Figure 5E-13). All three locations are distant from historical MGP operations.
- The only sample analyzed for chlordane within the sediment portion of the AOI was non-detect. The highest concentrations of chlordane were measured outside of the AOI (Figure 5E-14).
- Di-n-octyl phthalate exceeded the SCO at one location in the lake bottom depositional area in the southwestern portion of the AOI; concentrations are lower closer to the AOI shoreline indicating an onshore gradient. In contrast, there were 13 exceedances of the SCO outside of the AOI (Figure 5E-15).

Hexachlorobenzene was detected in two out of 82 samples analyzed within the sediment portion of the AOI; one sample exceeded the screening level at a location adjacent to the Prow. Hexachlorobenzene is also elevated outside of the AOI (Figure 5E-16). Hexachlorobenzene was not classified based on mapping but was evaluated further to examine the relationship of this chemical to historical MGP operations (see Section 5.2.3.4.3 of the RI).

1.4. Source Considerations

Two chemicals could not be categorized as GPWS or ALU COCs through statistical analysis or mapping: nickel and hexachlorobenzene. Neither of these chemicals are upland COCs. There are many potential sources of nickel. Primary sources are related to transportation and fabrication or use of metal alloys (Ecology 1992, CHRIS database 1988, Technical Resources, Inc. 1989); nickel is also found in lubricants and marine diesel oil. Nickel is not a primary MGP-related chemical but was classified as a GWPS COC because this metal is a minor component of coal and petroleum. Hexachlorobenzene does not have a known association with MGPs, rather its biggest known historical source is pesticides. This COC is classified as an ALU COC.

1.5. References

CHRIS database. 1988. Fein-Marquart Associates, Inc. 7215 York Rd. Baltimore, MD; and OHM/TADS (Oil and Hazardous Materials/Technical Assistance Data System) database. 1988. Fein-Marquart Associates, Inc. 72112 York Rd, Baltimore, Maryland.

Technical Resources, Inc. 1989. Fifth Annual Report on Carcinogenicity. Rockville, Maryland.

Washington State Department of Ecology (Ecology). 1992. Washington State Department of Ecology. Chemicals of Special Concern in Washington State, by Ellen Atkinson. Publication 92-66. July 1992

Table 5E-1

ALU Area and Sediment Portion of the AOI Summary Statistics and Pair-Wise Testing Results

Gas Works Park Site

Seattle, Washington

	Units	Area	Number of Samples	Number Detected	Mean[a]	Median	Compare ALU Area vs AOI Sediment (Pair-Wise Testing Results)
Conventionals							
Sulfide	mg/kg	ALU	21	20	1,330	1,150	Not significantly different
		AOI Sediment	82	80	1,400	725	
PAHs							
cPAH TEQ[b]	mg/kg	ALU	61	59	5.4	3.3	Significantly different; ALU Area<AOI Sediment
		AOI Sediment	110	110	54	10.5	
Total PAH	mg/kg	ALU	62	60	47	27	Significantly different; ALU Area<AOI Sediment
		AOI Sediment	110	110	474	73	
TPH							
Diesel Range Hydrocarbons	mg/kg	ALU	8	2	360	970	Too few detects to test
		AOI Sediment	1	1	--	2,400	
SVOCs							
4-Methylphenol	mg/kg	ALU	45	20	0.19	0.19	Not significantly different
		AOI Sediment	79	22	0.20	0.41	
Benzoic Acid	mg/kg	ALU	42	23	1.3	1.6	Not significantly different
		AOI Sediment	79	17	0.9	2.3	
Bis(2-ethylhexyl)phthalate	mg/kg	ALU	48	42	6.8	2.8	Significantly different; ALU Area>AOI Sediment
		AOI Sediment	79	69	1.7	1.2	
Carbazole	mg/kg	ALU	20	11	0.18	0.13	Not significantly different
		AOI Sediment	66	33	0.65	0.57	
Dibenzofuran	mg/kg	ALU	47	23	0.11	0.09	Significantly different; ALU Area<AOI Sediment
		AOI Sediment	109	56	0.9	0.65	
Hexachlorobenzene	mg/kg	ALU	37	3	0.003	0.001	Too few detects to test
		AOI Sediment	82	2	0.07	2.3	
Pentachlorophenol	mg/kg	ALU	41	18	0.11	0.12	Not significantly different
		AOI Sediment	79	8	0.17	0.18	
Di-n-butyl phthalate	mg/kg	ALU	48	26	0.22	0.17	Significantly different; ALU Area>AOI Sediment
		AOI Sediment	79	9	0.07	0.35	
Di-n-octyl phthalate	mg/kg	ALU	42	3	0.1	0.02	Too few detects to test
		AOI Sediment	79	1	--	0.48	
Phenol	mg/kg	ALU	41	14	0.21	0.27	Significantly different; ALU Area > AOI Sediment
		AOI Sediment	102	9	0.08	0.49	
Pesticides							
Chlordane	ug/kg	ALU	5	3	62	10	Too few detects to test
		AOI Sediment	1	0	--	--	
4,4'-DDE	ug/kg	ALU	15	11	13	11	Significantly different; ALU Area>AOI Sediment
		AOI Sediment	28	1	3.2	35	
PCBs							
Total PCBs	mg/kg	ALU	23	20	0.69	0.34	Significantly different; ALU Area>AOI Sediment
		AOI Sediment	54	28	0.11	0.10	
Butyltins							
Tributyltin	mg/kg	ALU	17	17	1.5	1.4	Not significantly different
		AOI Sediment	52	50	1.0	0.50	
Metals							
Arsenic	mg/kg	ALU	50	42	53	47	Not significantly different
		AOI Sediment	94	57	77	60	
Cadmium	mg/kg	ALU	47	42	1.9	2.0	Not significantly different
		AOI Sediment	72	54	1.7	2.0	
Chromium	mg/kg	ALU	47	43	73	60	Not significantly different
		AOI Sediment	54	54	56	54	
Copper	mg/kg	ALU	47	47	358	298	Not significantly different
		AOI Sediment	73	73	365	303	
Lead	mg/kg	ALU	47	47	504	317	Significantly different; ALU Area>AOI Sediment
		AOI Sediment	73	73	337	280	
Mercury	mg/kg	ALU	53	50	1.7	1.80	Significantly different; ALU Area>AOI Sediment
		AOI Sediment	81	67	0.83	0.77	
Methylmercury	mg/kg	ALU	0	--	--	--	Too few detects to test
		AOI Sediment	1	1	--	0.001	
Nickel	mg/kg	ALU	33	33	85	58	Not significantly different
		AOI Sediment	44	44	66	58	
Silver	mg/kg	ALU	33	21	2.2	2.0	Not significantly different
		AOI Sediment	55	18	1.3	2.0	

Notes:

[a] The arithmetic mean is used when all values are detected; otherwise the Kaplan-Meier mean is used

ALU = Ambient Lake Union

AOI = Area of Investigation

KM = Kaplan-Meier

Red text indicates significantly different

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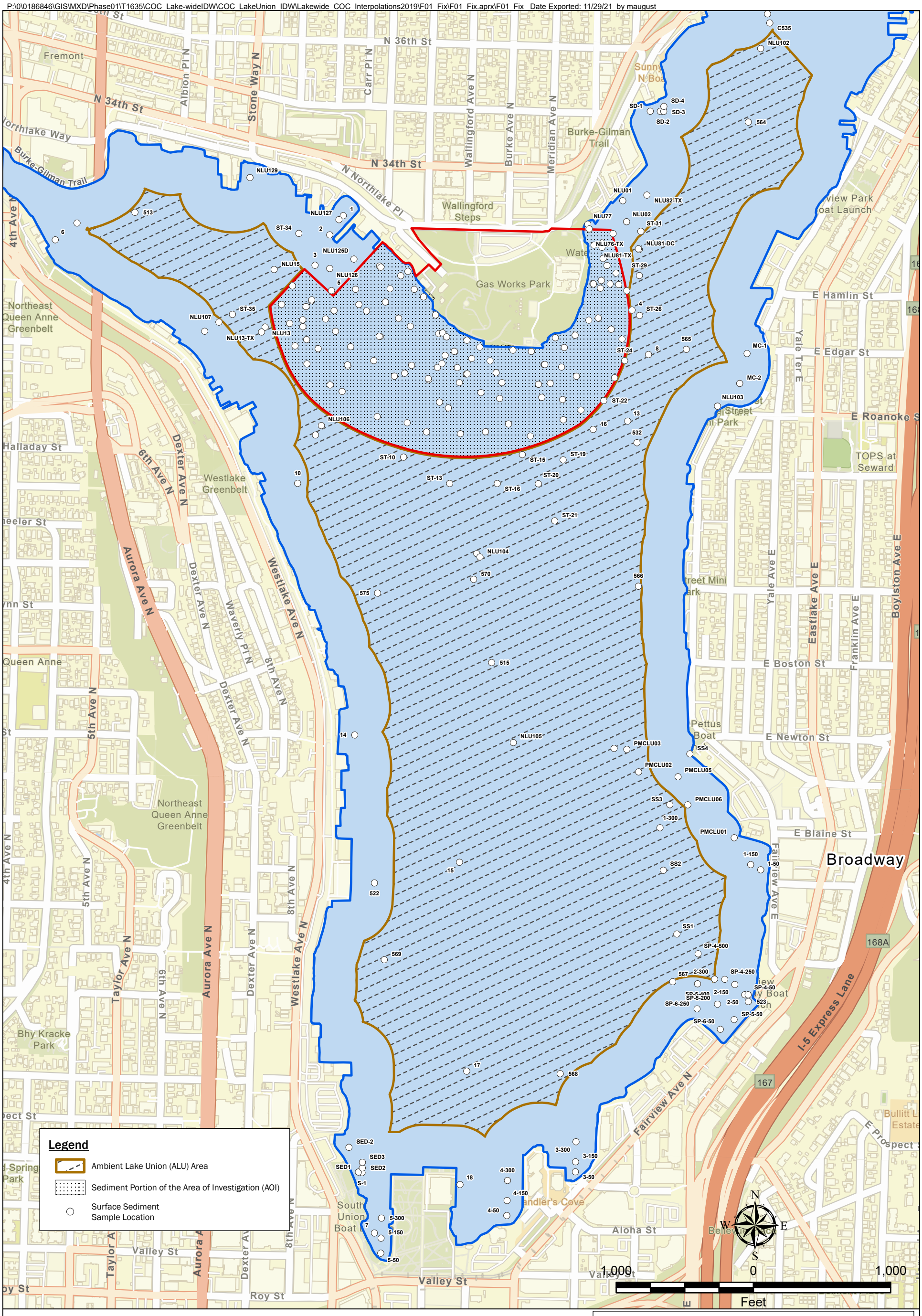

Notes:

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.

Areas Used For Statistical Comparison of Average Sediment Concentrations

Gas Works Park Site
Seattle, Washington

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Figure 5E-1

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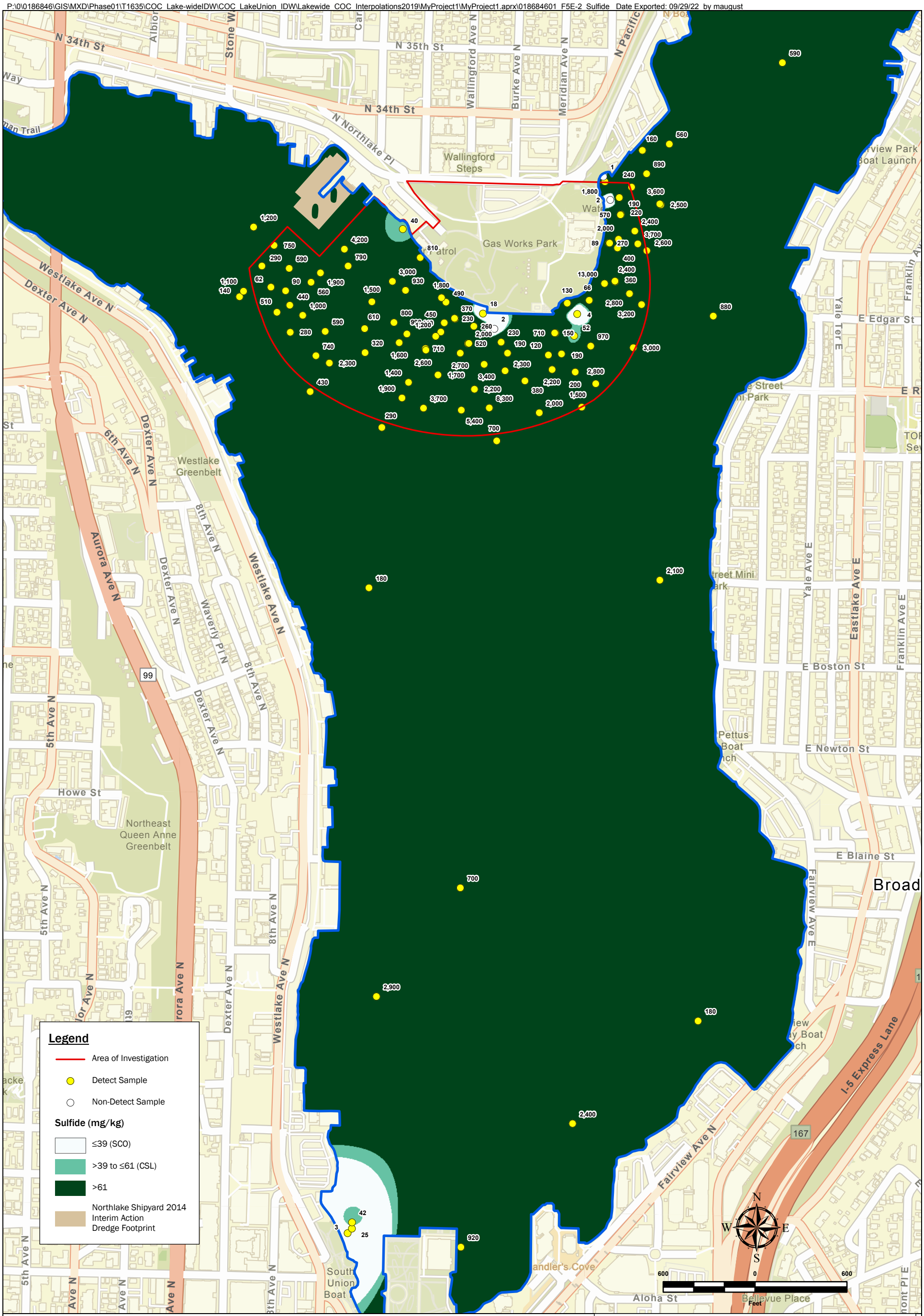

Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable).
4. Basemap - ESRI, 2021
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Sulfide Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-2

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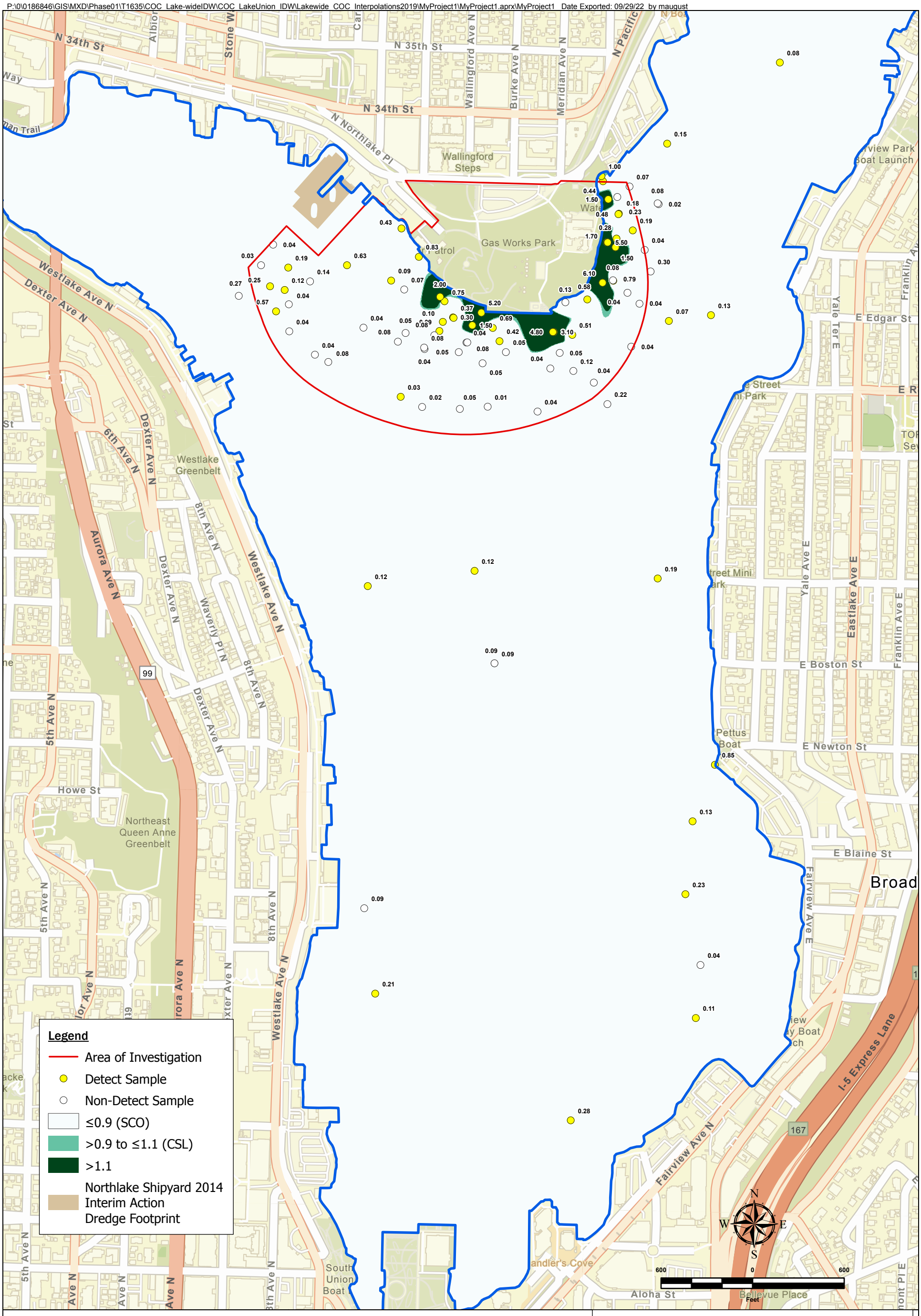

Legend

- Area of Investigation
- Detect Sample
- Non-Detect Sample
- ≤0.9 (SCO)
- >0.9 to ≤1.1 (CSL)
- >1.1
- Northlake Shipyard 2014 Interim Action Dredge Footprint

Notes:

1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
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

Carbazole Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-3

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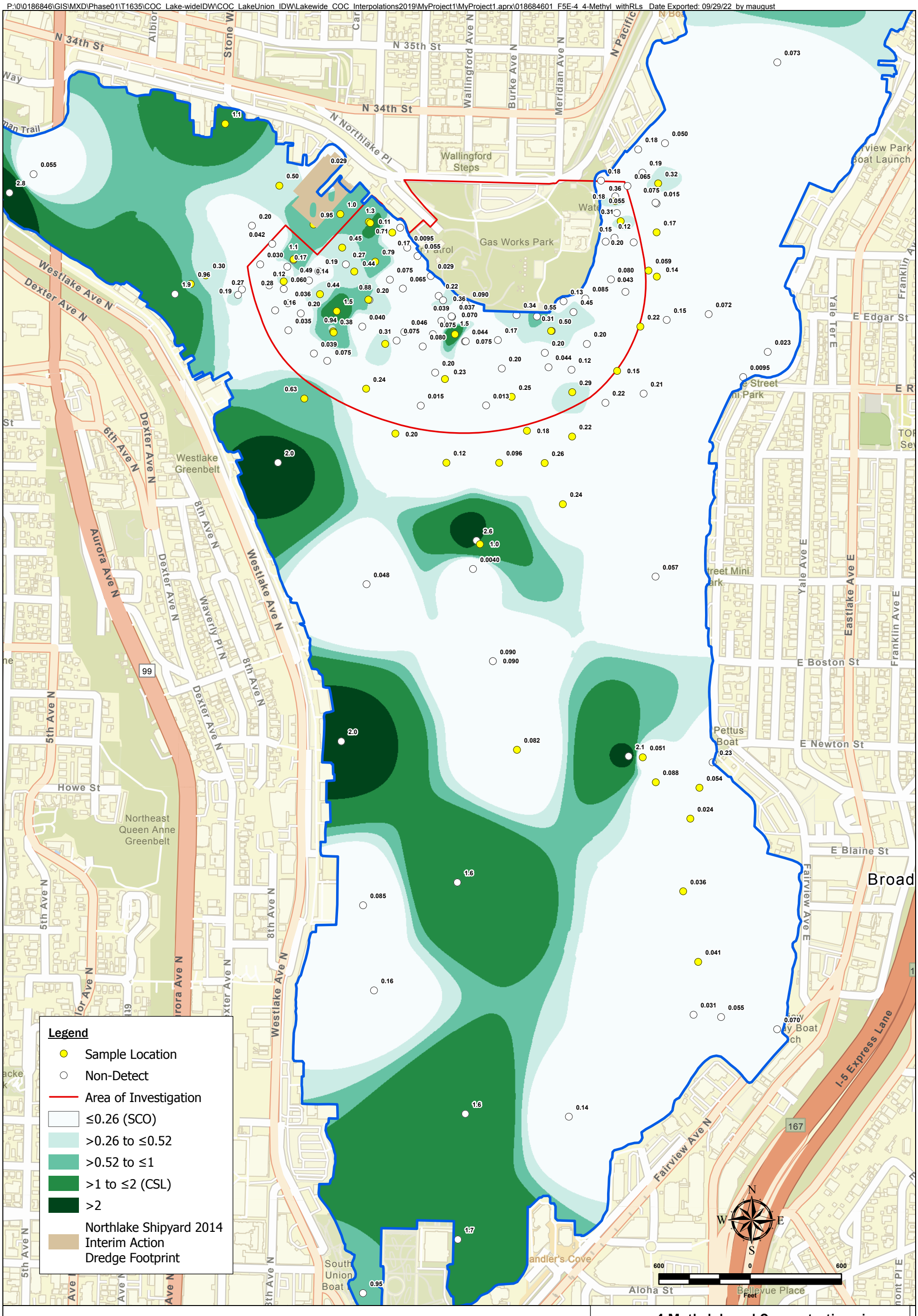

Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable).
4. Basemap - ESRI, 2021
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

4-Methylphenol Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-4

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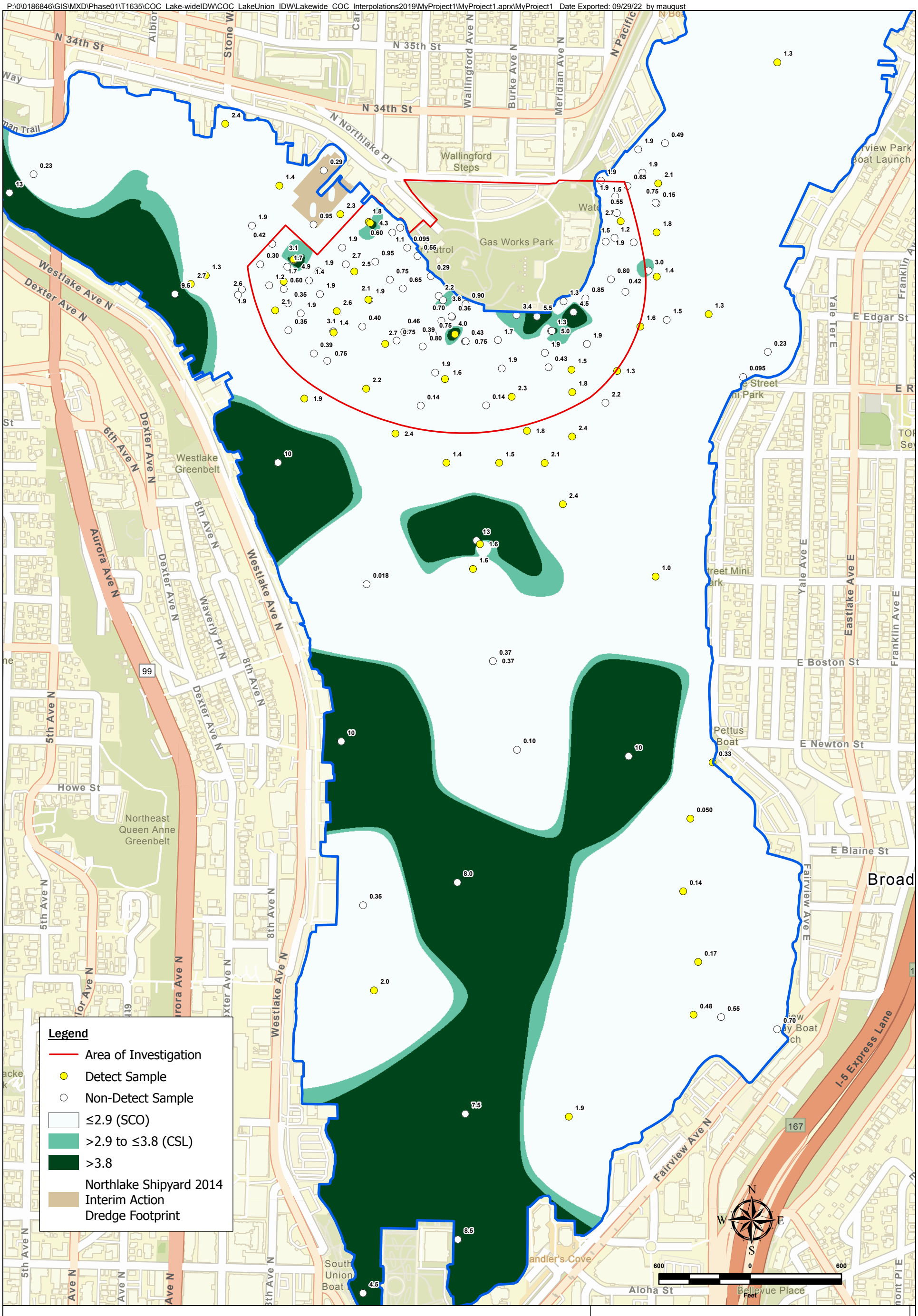

Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable).
4. Basemap - ESRI, 2021
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Benzoic Acid Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

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Figure 5E-5

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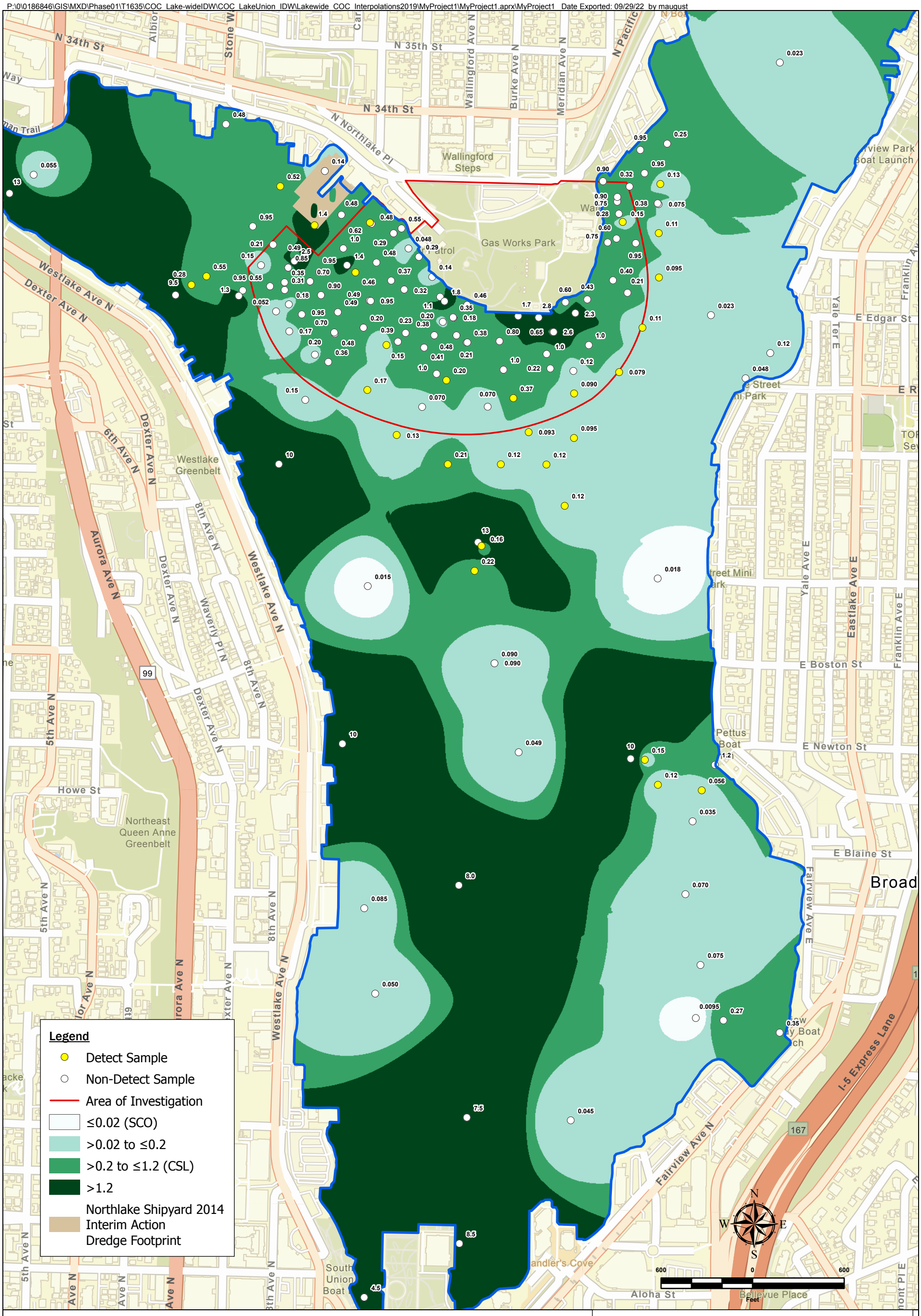

Notes:

1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
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

Pentachlorophenol Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-6

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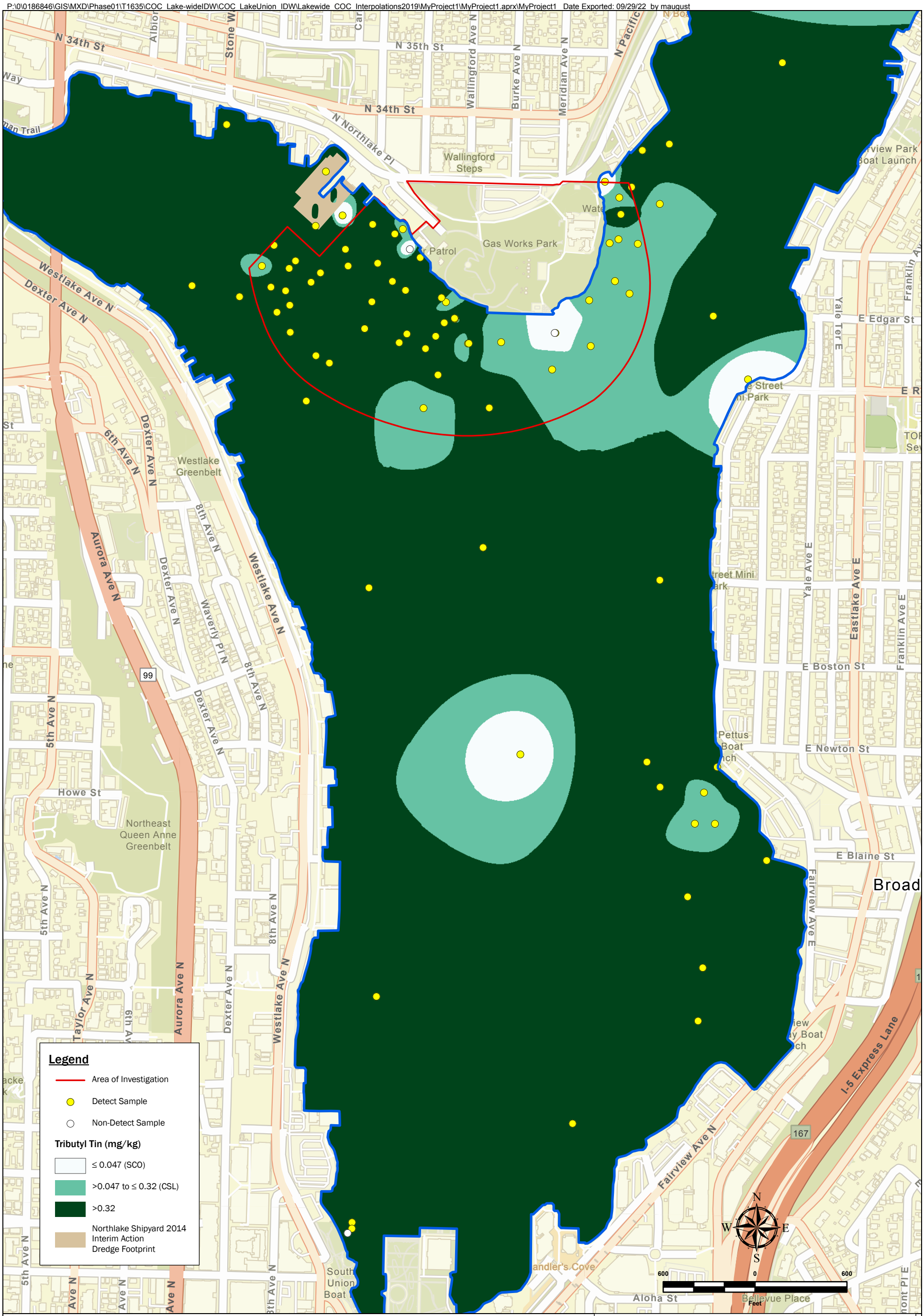

Notes:

1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
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

Tributyl Tin Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-7

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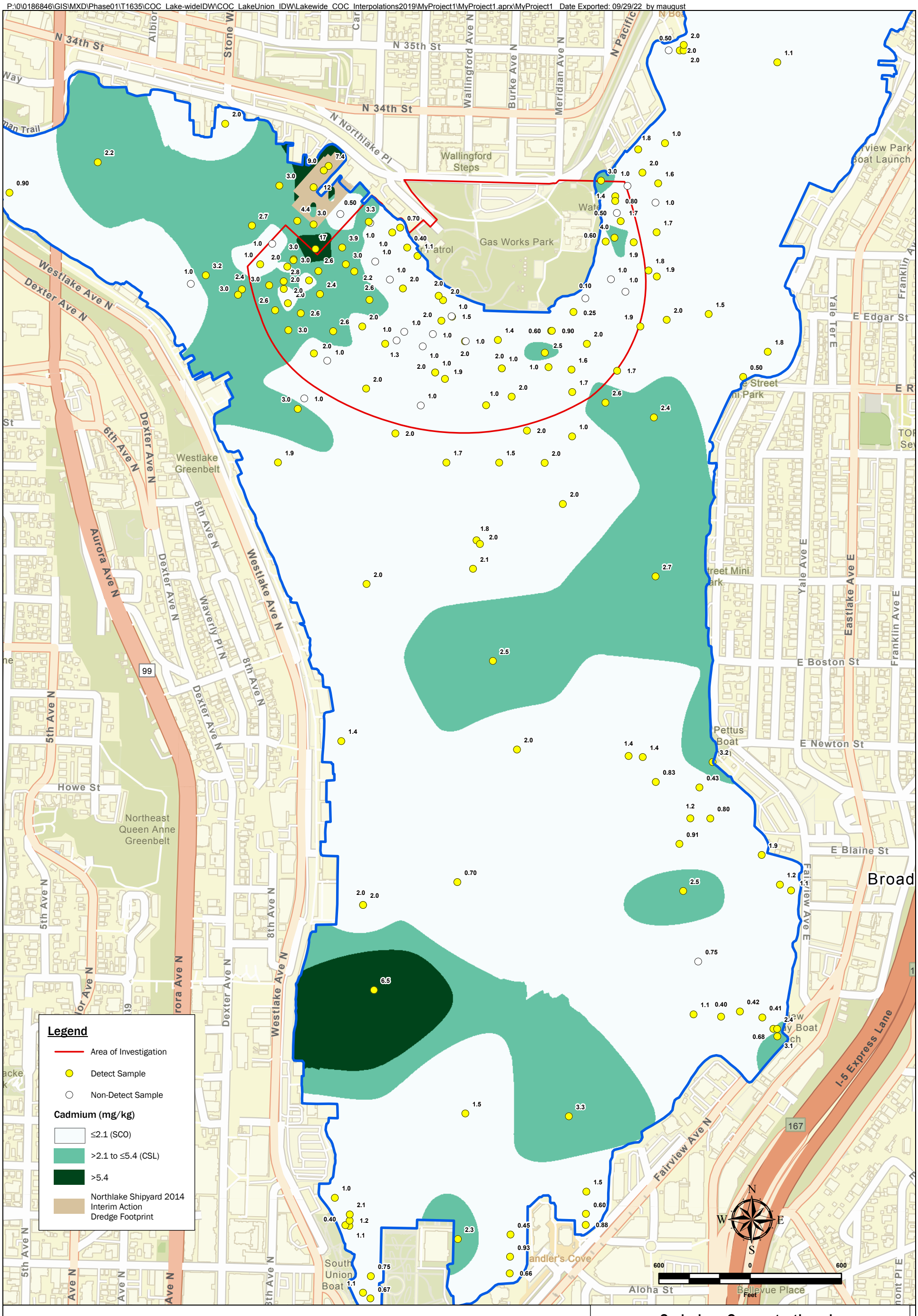

Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable).
4. Basemap - ESRI, 2021
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Cadmium Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-8

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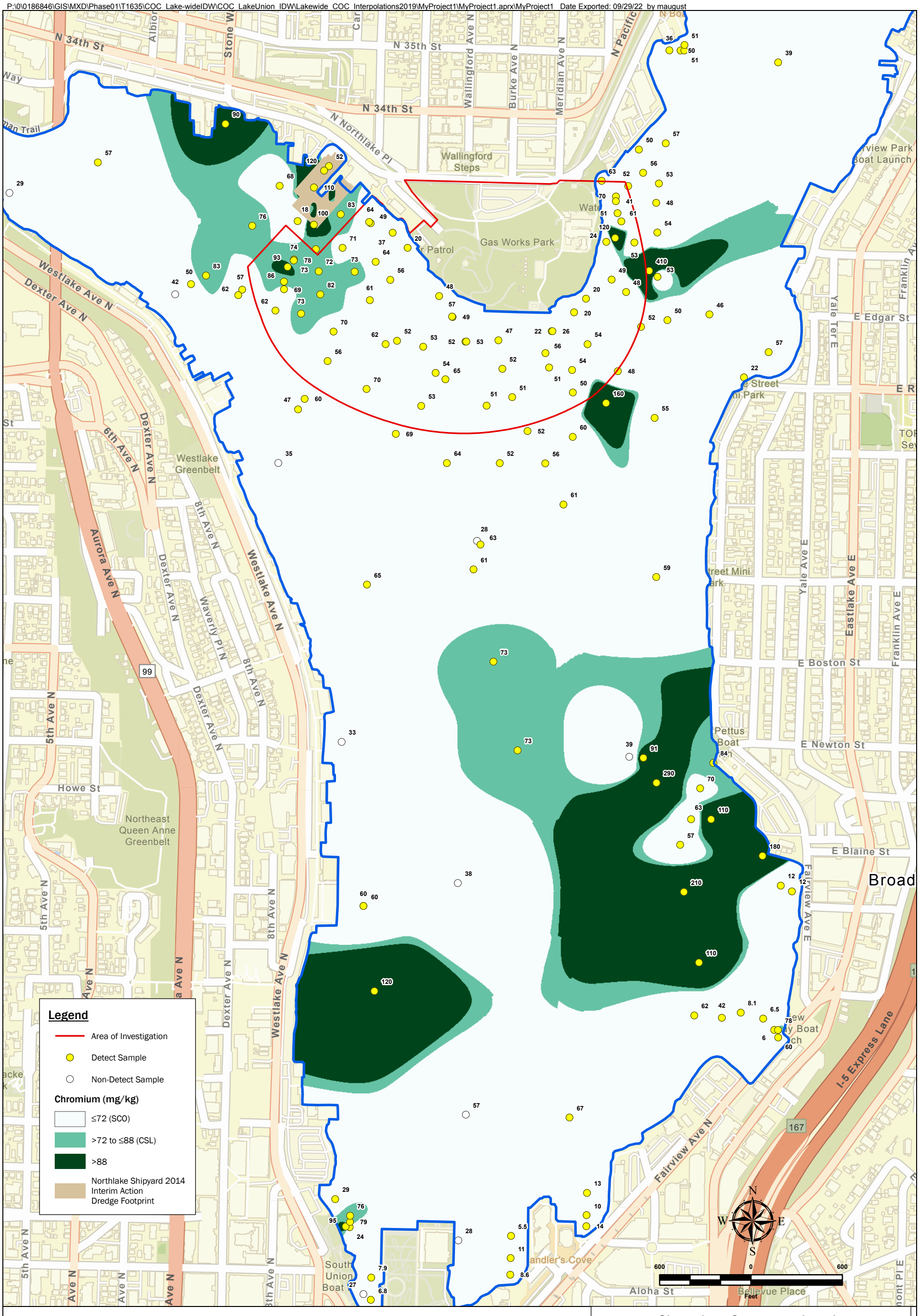

Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. For non-detects, 1/2 the reporting limit is used for interpolations. Interpolations include detects and non-detects.
3. Concentration contour map generated through interpolation using the Inverse Distance Weighted scheme (Power = 6, Neighbors = 8, Reach = Variable).
4. Basemap - ESRI, 2021
5. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Chromium Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-9

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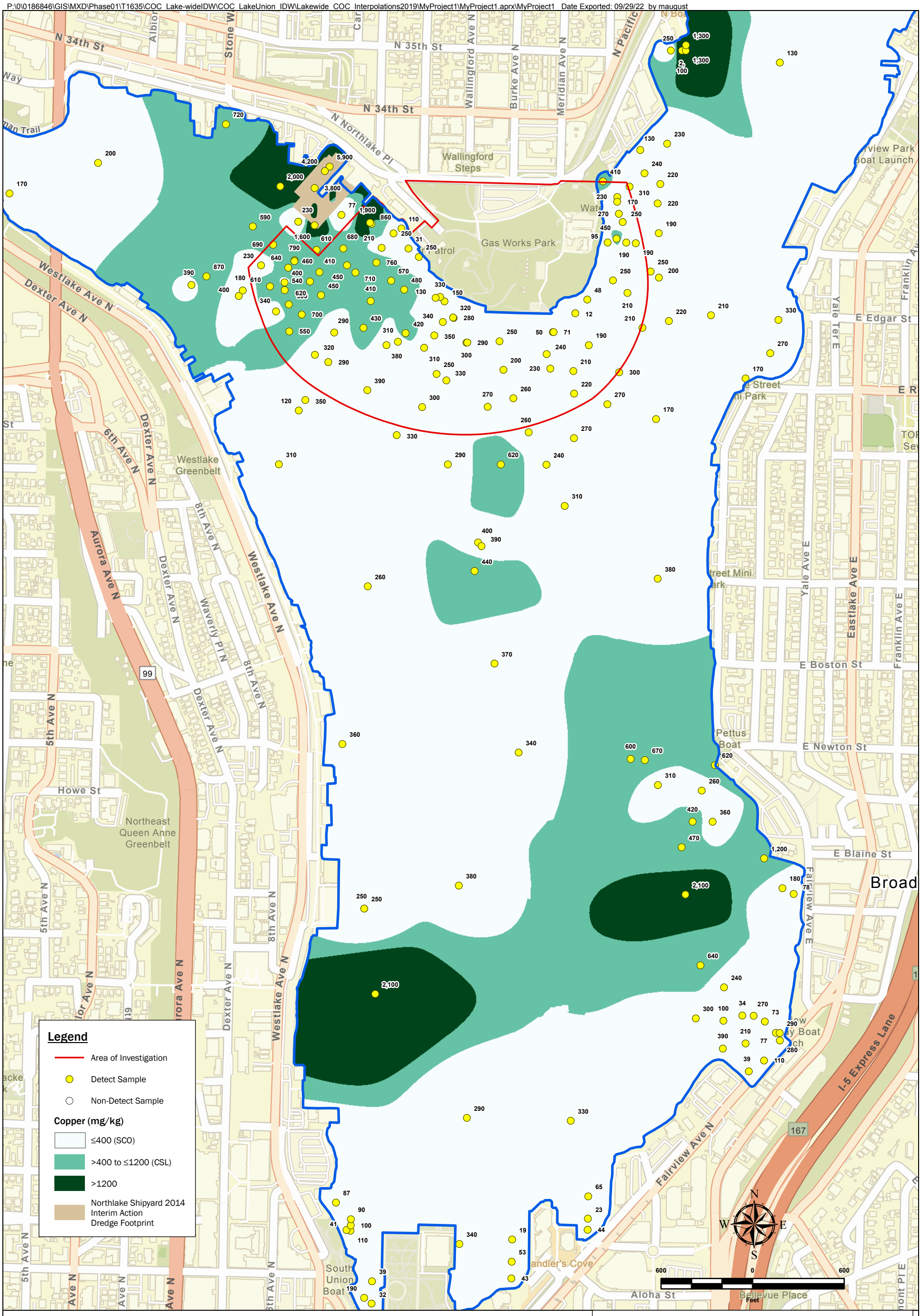


Legend

- Area of Investigation
- Detect Sample
- Non-Detect Sample

Copper (mg/kg)

- ≤400 (SCO)
- >400 to ≤1200 (CSL)
- >1200
- Northlake Shipyard 2014 Interim Action Dredge Footprint

Notes:

1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
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

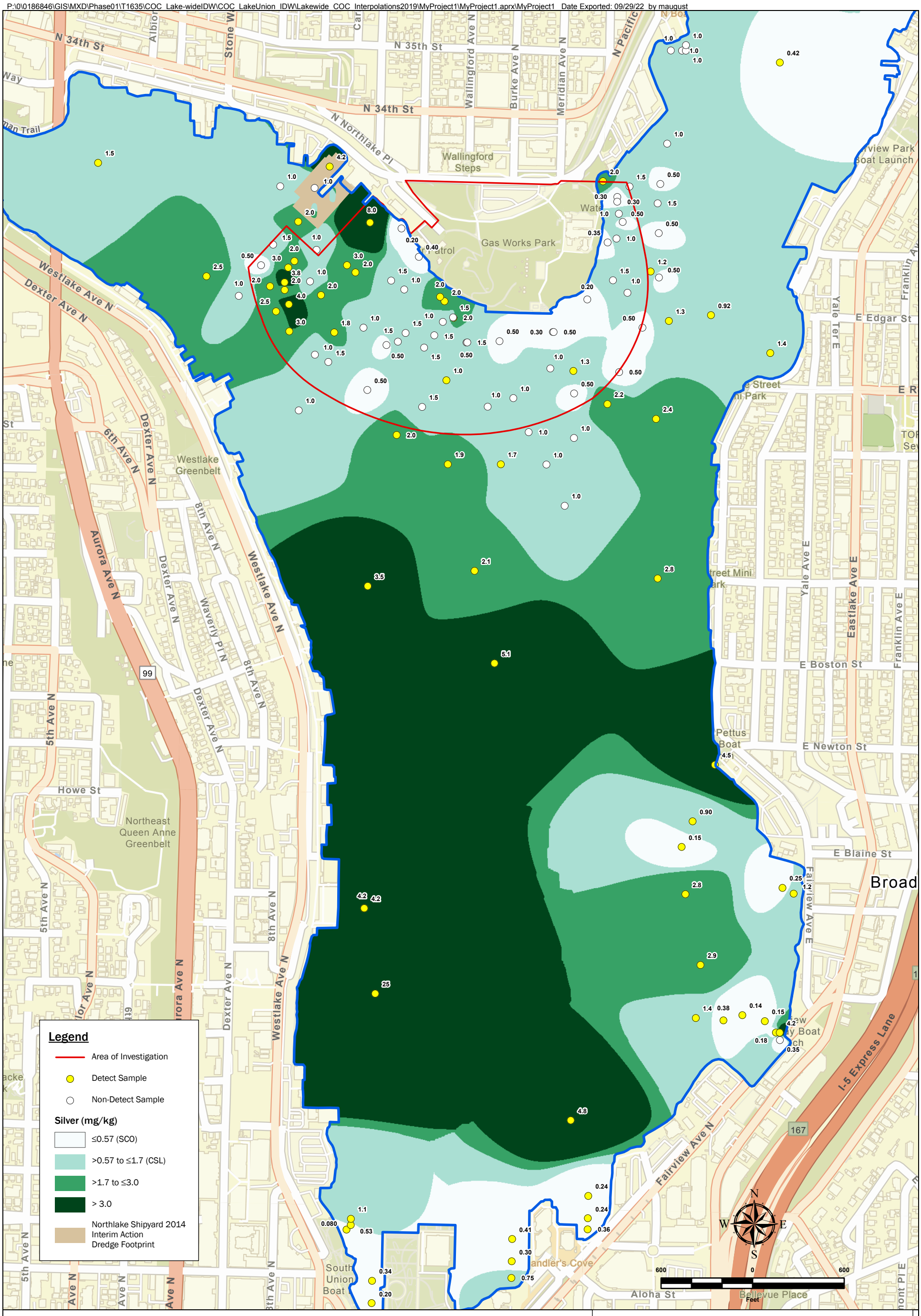
Copper Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-10

P:\0\0186846\GIS\MXD\Phase01\T1635\COC_Lake-wideIDW\COC_LakeUnion_IDW\Lakewide_COC_Interpolations2019\MyProject1\MyProject1.aprx\MyProject1 Date Exported: 09/29/22 by maugust



Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
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

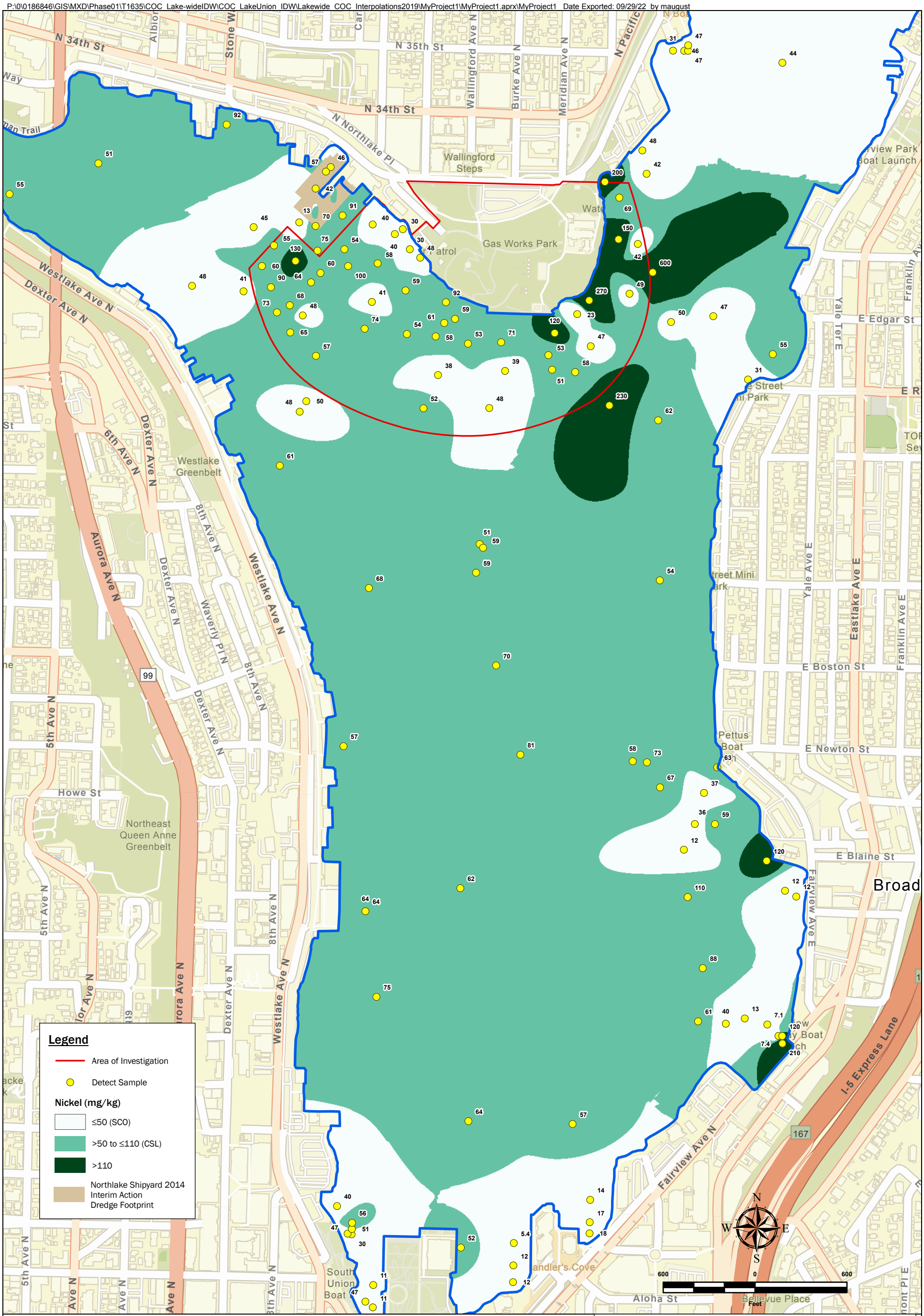
Silver Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-11

P:\0\0186846\GIS\MXD\Phase01\T1635\COC_Lake-wideIDW\COC_LakeUnion_IDW\Lakewide_COC_Interpolations2019\MyProject1\MyProject1.aprx\MyProject1 Date Exported: 09/29/22 by maugust



Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
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

Nickel Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-12

P:\0\0186846\GIS\MXD\Phase01\T1635\COC_Lake-wideIDW\COC_LakeUnion_IDW\Lakewide_COC_Interpolations2019\MyProject1\MyProject1.aprx\MyProject1 Date Exported: 09/29/22 by maugust

Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. Posting 1/2 the detection limit for non-detects.
3. Basemap - ESRI, 2021
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

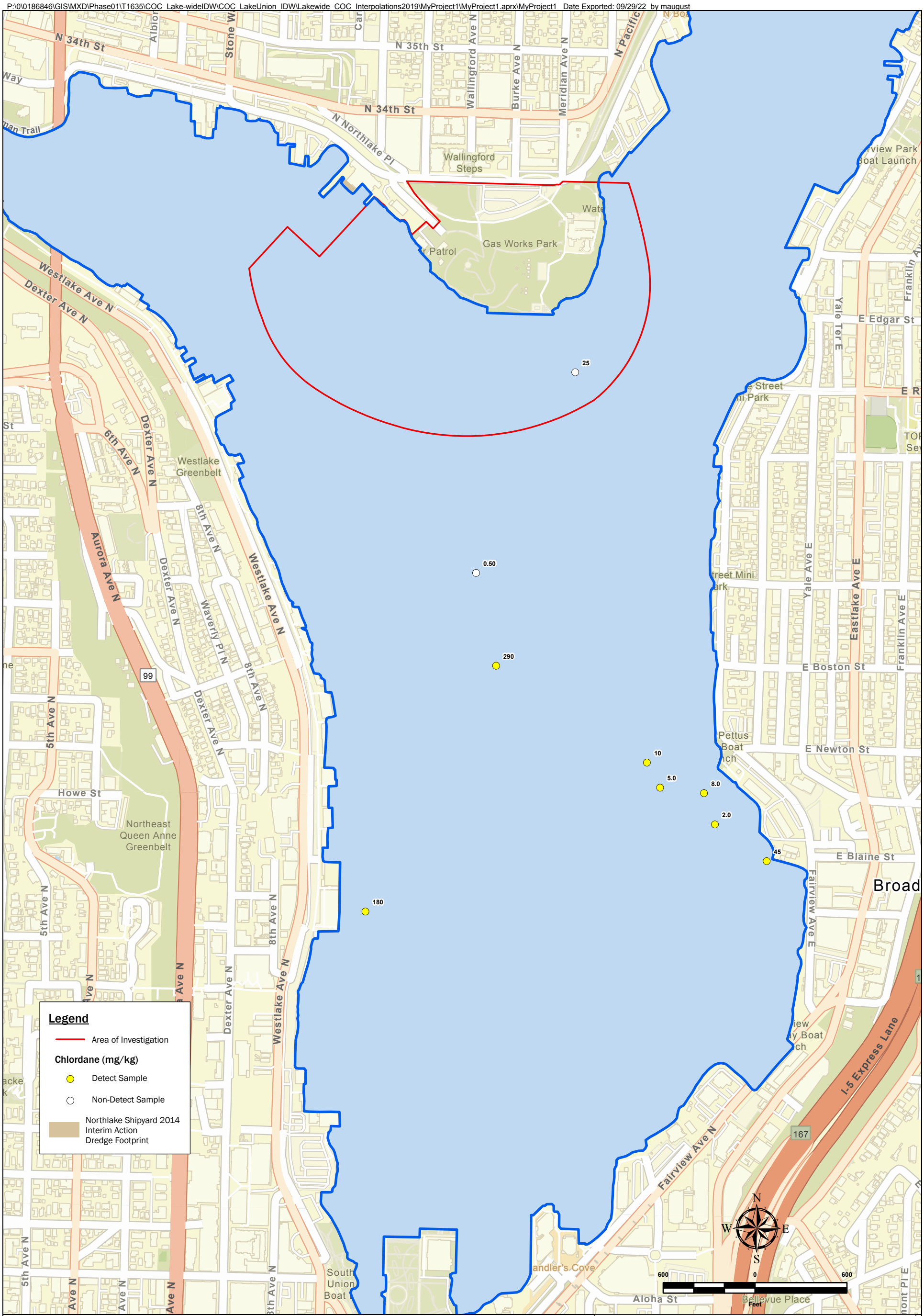
Diesel Range Hydrocarbon Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-13

P:\0\0186846\GIS\MXD\Phase01\T1635\COC_Lake-wideIDW\COC_LakeUnion_IDW\Lakewide_COC_Interpolations2019\MyProject1\MyProject1.aprx\MyProject1 Date Exported: 09/29/22 by maugust



Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. Posting 1/2 the detection limit for non-detects.
3. Basemap - ESRI, 2021
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

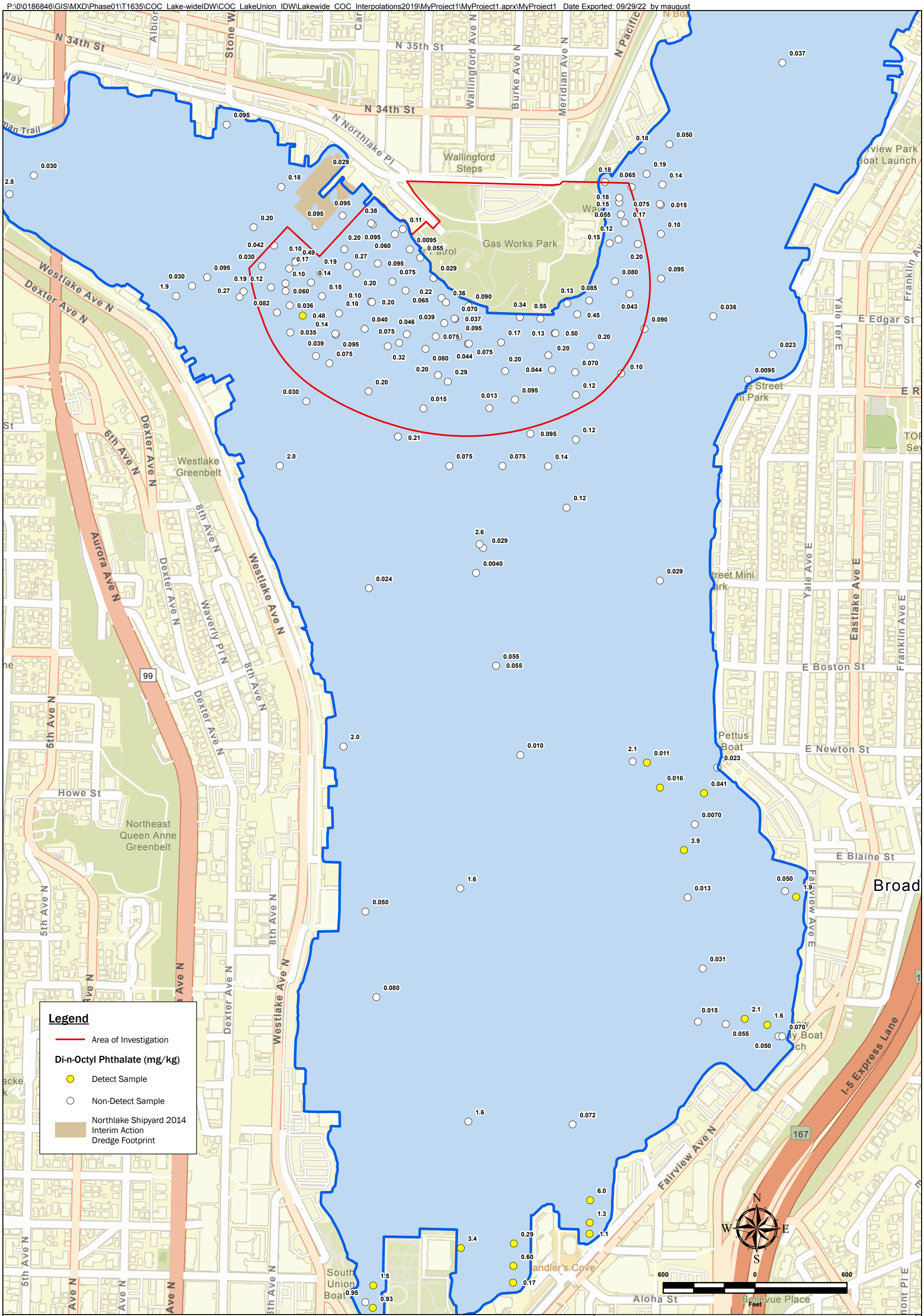
Chlordane Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-14

P:\0\0186846\GIS\MXD\Phase01\T1635\COC_Lake-wideIDW\COC_LakeUnion_IDW\Lakewide_COC_Interpolations2019\MyProject1\MyProject1.aprx\MyProject1 Date Exported: 09/29/22 by maugust



Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. Posting 1/2 the detection limit for non-detects.
3. Basemap - ESRI, 2021
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

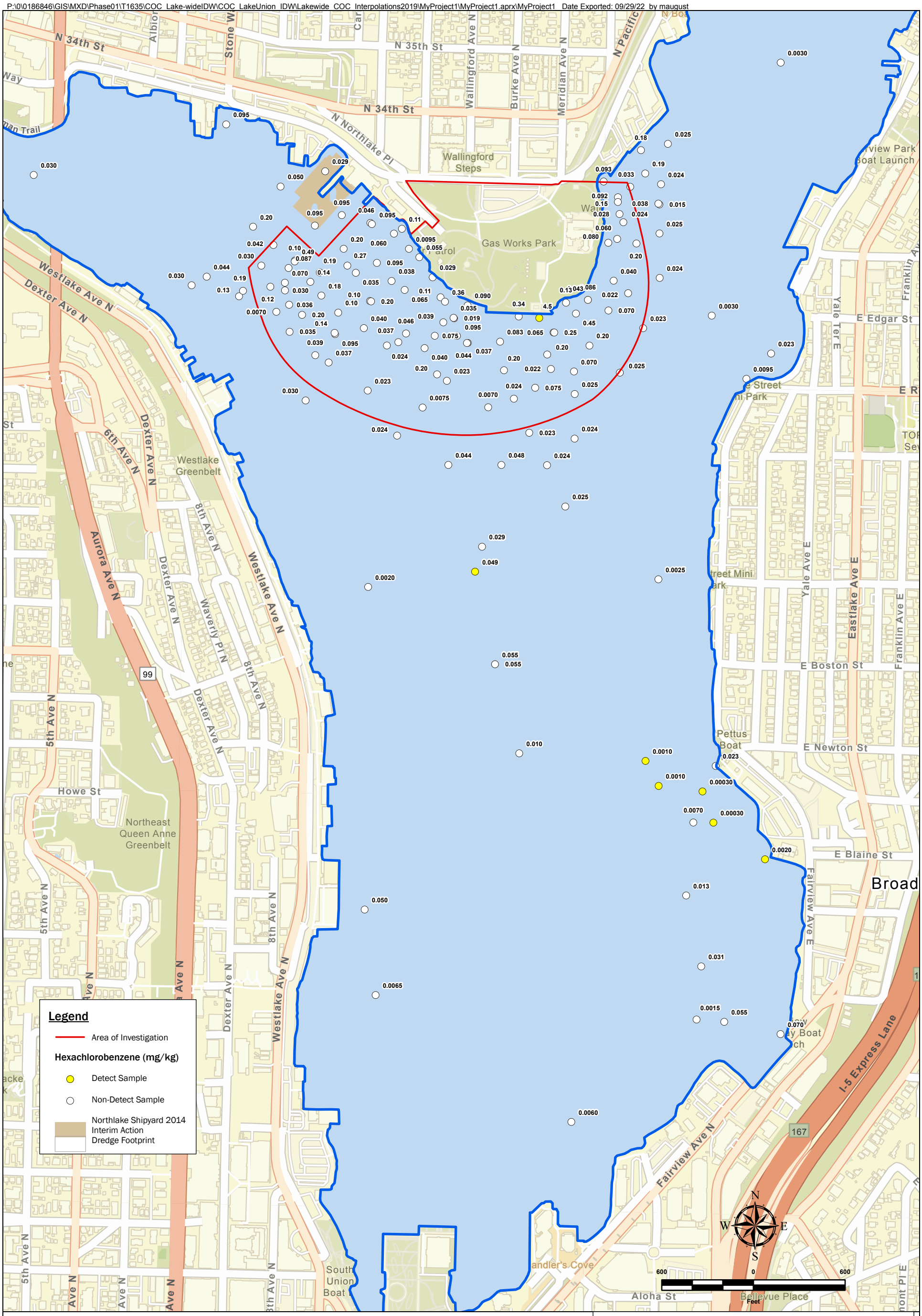
Di-n-Octyl Phthalate Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-15

P:\0\0186846\GIS\MXD\Phase01\T1635\COC_Lake-wideIDW\COC_LakeUnion_IDW\Lakewide_COC_Interpolations2019\MyProject1\MyProject1.aprx\MyProject1 Date Exported: 09/29/22 by maugust



Notes:
1. For mapping purposes, surface sediment is defined as the top 6 inches of sediment.
2. Posting 1/2 the detection limit for non-detects.
3. Basemap - ESRI, 2021
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Hexachlorobenzene Concentrations in Lake-Wide Surface Sediment

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 5E-16

ATTACHMENT 5E-1
ProUCL Statistical Test Results

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 1:33:43 PM
From File	Sulfide_data set.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Sulfide(n=ALU)

Sample 2 Data: Sulfide(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	21	82
Number of Non-Detects	1	2
Number of Detect Data	20	80
Minimum Non-Detect	2.5	4.3
Maximum Non-Detect	2.5	4.4
Percent Non-detects	4.76%	2.44%
Minimum Detect	140	4.1
Maximum Detect	3600	13000
Mean of Detects	1394	1435
Median of Detects	1150	725
SD of Detects	1045	1931
KM Mean	1328	1400
KM SD	1037	1908

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	0.647
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.518

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 1:48:00 PM
From File	cPAH data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: cPAH(n=ALU)

Sample 2 Data: cPAH(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	61	110
Number of Non-Detects	2	0
Number of Detect Data	59	110
Minimum Non-Detect	0.461	N/A
Maximum Non-Detect	1.18	N/A
Percent Non-detects	3.28%	0.00%
Minimum Detect	0.186	0.467
Maximum Detect	31.1	1400
Mean of Detects	5.565	54.05
Median of Detects	3.33	10.45
SD of Detects	7.15	157.4
KM Mean	5.399	54.05
KM SD	7.03	157.4

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	-5.202
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	1.9720E-7

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 1:53:28 PM
From File	TPAH data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: TPAH(n=ALU)

Sample 2 Data: TPAH(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	62	110
Number of Non-Detects	2	0
Number of Detect Data	60	110
Minimum Non-Detect	0.68	N/A
Maximum Non-Detect	20.5	N/A
Percent Non-detects	3.23%	0.00%
Minimum Detect	1.38	3.37
Maximum Detect	316	11200
Mean of Detects	48.61	473.9
Median of Detects	27.45	72.95
SD of Detects	63.32	1324
KM Mean	47.24	473.9
KM SD	62.24	1324

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	-4.434
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	9.2327E-6

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

1				**General Statistics on Uncensored Data**									
2			Date/Time of Computation	ProUCL 5.12/25/2020 12:24:48 PM									
3			**User Selected Options**										
4			From File	DRPH data.xls									
5			Full Precision	OFF									
6													
7	**From File: DRPH data.xls**												
8													
9	**General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method**												
10													
11	**Variable**		**NumObs**	**# Missing**	**Num Ds**	**NumNDs**	**% NDs**	**Min ND**	**Max ND**	**KM Mean**	**KM Var**	**KM SD**	**KM CV**
12	DRPH (n)		8	0	2	6	75.00%	50	5470	357.3	189389	435.2	1.218
13	DRPH (y)		1	0	1	0	0.00%	N/A	N/A	N/A	N/A	N/A	N/A
14													
15	**General Statistics for Raw Data Sets using Detected Data Only**												
16													
17	**Variable**		**NumObs**	**# Missing**	**Minimum**	**Maximum**	**Mean**	**Median**	**Var**	**SD**	**MAD/0.675**	**Skewness**	**CV**
18	DRPH (n)		2	0	934	1010	972	972	2888	53.74	56.34	N/A	0.0553
19	DRPH (y)		1	0	2420	2420	2420	2420	N/A	N/A	0	N/A	N/A
20													
21	**Percentiles using all Detects (Ds) and Non-Detects (NDs)**												
22													
23	**Variable**		**NumObs**	**# Missing**	**10%ile**	**20%ile**	**25%ile(Q1)**	**50%ile(Q2)**	**75%ile(Q3)**	**80%ile**	**90%ile**	**95%ile**	**99%ile**
24	DRPH (n)		8	0	263.5	391.4	423.3	696.5	1273	1640	3083	4277	5231
25	DRPH (y)		1	0	2420	2420	2420	2420	2420	2420	2420	2420	2420

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 1:59:10 PM
From File	4-MPhenol data_rev2.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: 4-MTHPNL(n=ALU)

Sample 2 Data: 4-MTHPNL(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	45	79
Number of Non-Detects	25	57
Number of Detect Data	20	22
Minimum Non-Detect	0.008	0.019
Maximum Non-Detect	5.1	1.1
Percent Non-detects	55.56%	72.15%
Minimum Detect	0.051	0.17
Maximum Detect	1	1.5
Mean of Detects	0.307	0.599
Median of Detects	0.19	0.41
SD of Detects	0.315	0.426
KM Mean	0.188	0.201
KM SD	0.249	0.34

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	-0.221
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.825

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 2:29:07 PM
From File	Benzoic Acid data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Benzoic Acid(n=ALU)

Sample 2 Data: Benzoic Acid(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	42	79
Number of Non-Detects	19	62
Number of Detect Data	23	17
Minimum Non-Detect	0.036	0.19
Maximum Non-Detect	25	11
Percent Non-detects	45.24%	78.48%
Minimum Detect	0.483	1.5
Maximum Detect	2.7	4.3
Mean of Detects	1.724	2.476
Median of Detects	1.6	2.3
SD of Detects	0.535	0.798
KM Mean	1.313	0.915
KM SD	0.844	1.107

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	1.29
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.197

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 2:34:12 PM
From File	BEHP data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: BEHP(n=ALU)

Sample 2 Data: BEHP(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	48	79
Number of Non-Detects	6	10
Number of Detect Data	42	69
Minimum Non-Detect	0.06	0.019
Maximum Non-Detect	2.33	1.1
Percent Non-detects	12.50%	12.66%
Minimum Detect	0.2	0.24
Maximum Detect	190	10
Mean of Detects	7.762	1.885
Median of Detects	2.8	1.2
SD of Detects	28.97	1.773
KM Mean	6.849	1.675
KM SD	26.89	1.738

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	3.412
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	6.4518E-4

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 2:39:01 PM
From File	Carbazole data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Carbazole(n=ALU)

Sample 2 Data: Carbazole(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	20	66
Number of Non-Detects	9	33
Number of Detect Data	11	33
Minimum Non-Detect	0.031	0.027
Maximum Non-Detect	0.601	0.37
Percent Non-detects	45.00%	50.00%
Minimum Detect	0.069	0.034
Maximum Detect	1	6.1
Mean of Detects	0.25	1.268
Median of Detects	0.133	0.574
SD of Detects	0.271	1.701
KM Mean	0.178	0.652
KM SD	0.213	1.335

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	-1.068
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.286

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 2:43:50 PM
From File	Dibenzofuran data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Dibenzofuran(n=ALU)

Sample 2 Data: Dibenzofuran(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	47	109
Number of Non-Detects	24	53
Number of Detect Data	23	56
Minimum Non-Detect	0.02	0.027
Maximum Non-Detect	5.1	0.9
Percent Non-detects	51.06%	48.62%
Minimum Detect	0.036	0.033
Maximum Detect	1	14
Mean of Detects	0.158	1.786
Median of Detects	0.09	0.65
SD of Detects	0.228	2.464
KM Mean	0.109	0.942
KM SD	0.174	1.954

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	-3.401
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	6.7216E-4

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

1				**General Statistics on Uncensored Data**									
2			Date/Time of Computation	ProUCL 5.13/9/2020 3:14:38 PM									
3			**User Selected Options**										
4			From File	HCB data.xls									
5			Full Precision	OFF									
6													
7	**From File: HCB data.xls**												
8													
9						**General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method**								
10													
11	**Variable**		**NumObs**	**# Missing**	**Num Ds**	**NumNDs**	**% NDs**	**Min ND**	**Max ND**	**KM Mean**	**KM Var**	**KM SD**	**KM CV**
12	HCB (n)		37	0	3	34	91.89%	0.003	0.39	0.00329	1.0449E-4	0.0102	3.111
13	HCB (y)		82	0	2	80	97.56%	0.014	0.98	0.0709	0.242	0.492	6.947
14													
15						**General Statistics for Raw Data Sets using Detected Data Only**								
16													
17	**Variable**		**NumObs**	**# Missing**	**Minimum**	**Maximum**	**Mean**	**Median**	**Var**	**SD**	**MAD/0.675**	**Skewness**	**CV**
18	HCB (n)		3	0	0.001	0.049	0.017	0.001	7.6800E-4	0.0277	0	1.732	1.63
19	HCB (y)		2	0	0.086	4.5	2.293	2.293	9.742	3.121	3.272	N/A	1.361
20													
21						**Percentiles using all Detects (Ds) and Non-Detects (NDs)**								
22													
23	**Variable**		**NumObs**	**# Missing**	**10%ile**	**20%ile**	**25%ile(Q1)**	**50%ile(Q2)**	**75%ile(Q3)**	**80%ile**	**90%ile**	**95%ile**	**99%ile**
24	HCB (n)		37	0	0.0046	0.0122	0.02	0.049	0.076	0.088	0.14	0.288	0.386
25	HCB (y)		82	0	0.0461	0.0618	0.072	0.135	0.245	0.356	0.39	0.673	1.649

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 2:52:44 PM
From File	PCP data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: PCP(n=ALU)

Sample 2 Data: PCP(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	41	79
Number of Non-Detects	23	71
Number of Detect Data	18	8
Minimum Non-Detect	0.019	0.096
Maximum Non-Detect	25	5.5
Percent Non-detects	56.10%	89.87%
Minimum Detect	0.079	0.09
Maximum Detect	0.55	0.62
Mean of Detects	0.164	0.276
Median of Detects	0.12	0.185
SD of Detects	0.11	0.187
KM Mean	0.112	0.168
KM SD	0.104	0.125

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	-1.243
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.214

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 11:55:10 AM
From File	DNBP data set.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: DNBP(n=ALU)

Sample 2 Data: DNBP(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	48	79
Number of Non-Detects	22	70
Number of Detect Data	26	9
Minimum Non-Detect	0.02	0.019
Maximum Non-Detect	17.3	1.1
Percent Non-detects	45.83%	88.61%
Minimum Detect	0.03	0.13
Maximum Detect	1	0.66
Mean of Detects	0.299	0.339
Median of Detects	0.167	0.35
SD of Detects	0.271	0.174
KM Mean	0.216	0.067
KM SD	0.237	0.124

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	3.734
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	1.8826E-4

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

1				**General Statistics on Uncensored Data**								
2			Date/Time of Computation	ProUCL 5.13/9/2020 3:11:13 PM								
3			**User Selected Options**									
4			From File	DNOP Data.xls								
5			Full Precision	OFF								
6												
7	**From File: DNOP Data.xls**											
8												
9						**General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method**							
10												
11	**Variable**		**NumObs**	**# Missing**	**Num Ds**	**NumNDs**	**% NDs**	**Min ND**	**Max ND**	**KM Mean**	**KM Var**	**KM SD**	**KM CV**
12	DNOP (n)		42	0	3	39	92.86%	0.008	5.1	0.108	0.359	0.599	5.568
13	DNOP (y)		79	0	1	78	98.73%	0.019	1.1	0.0257	0.00304	0.0551	2.145
14													
15						**General Statistics for Raw Data Sets using Detected Data Only**							
16													
17	**Variable**		**NumObs**	**# Missing**	**Minimum**	**Maximum**	**Mean**	**Median**	**Var**	**SD**	**MAD/0.675**	**Skewness**	**CV**
18	DNOP (n)		3	0	0.011	3.85	1.292	0.016	4.906	2.215	0.00741	1.732	1.714
19	DNOP (y)		1	0	0.48	0.48	0.48	0.48	N/A	N/A	0	N/A	N/A
20													
21						**Percentiles using all Detects (Ds) and Non-Detects (NDs)**							
22													
23	**Variable**		**NumObs**	**# Missing**	**10%ile**	**20%ile**	**25%ile(Q1)**	**50%ile(Q2)**	**75%ile(Q3)**	**80%ile**	**90%ile**	**95%ile**	**99%ile**
24	DNOP (n)		42	0	0.031	0.057	0.06	0.15	0.263	0.378	2.843	3.818	4.711
25	DNOP (y)		79	0	0.077	0.103	0.125	0.2	0.39	0.39	0.598	0.765	1.022

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 11:58:50 AM
From File	Phenol data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Phenol(n=ALU)

Sample 2 Data: Phenol(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	41	102
Number of Non-Detects	27	93
Number of Detect Data	14	9
Minimum Non-Detect	0.008	0.019
Maximum Non-Detect	0.733	1.1
Percent Non-detects	65.85%	91.18%
Minimum Detect	0.03	0.27
Maximum Detect	1.9	1.9
Mean of Detects	0.549	0.62
Median of Detects	0.265	0.49
SD of Detects	0.639	0.502
KM Mean	0.213	0.0785
KM SD	0.437	0.225

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	2.293
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.0218

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

1				**General Statistics on Uncensored Data**									
2			Date/Time of Computation	ProUCL 5.12/25/2020 12:09:12 PM									
3			**User Selected Options**										
4			From File	Chlordane data.xls									
5			Full Precision	OFF									
6													
7	**From File: Chlordane data.xls**												
8													
9	**General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method**												
10													
11	**Variable**		**NumObs**	**# Missing**	**Num Ds**	**NumNDs**	**% NDs**	**Min ND**	**Max ND**	**KM Mean**	**KM Var**	**KM SD**	**KM CV**
12	Chlordane (n)		5	0	3	2	40.00%	1	20	62.29	12974	113.9	1.828
13	Chlordane (y)		1	0	0	1	100.00%	50	50	N/A	N/A	N/A	N/A
14													
15	**General Statistics for Raw Data Sets using Detected Data Only**												
16													
17	**Variable**		**NumObs**	**# Missing**	**Minimum**	**Maximum**	**Mean**	**Median**	**Var**	**SD**	**MAD/0.675**	**Skewness**	**CV**
18	Chlordane (n)		3	0	5	290	101.7	10.1	26599	163.1	7.561	1.73	1.604
19	Chlordane (y)		0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20													
21	**Percentiles using all Detects (Ds) and Non-Detects (NDs)**												
22													
23	**Variable**		**NumObs**	**# Missing**	**10%ile**	**20%ile**	**25%ile(Q1)**	**50%ile(Q2)**	**75%ile(Q3)**	**80%ile**	**90%ile**	**95%ile**	**99%ile**
24	Chlordane (n)		5	0	2.6	4.2	5	10.1	20	74	182	236	279.2
25	Chlordane (y)		1	0	50	50	50	50	50	50	50	50	50

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 1:02:28 PM
From File	DDE data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: DDE(n=ALU)

Sample 2 Data: DDE(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	28
Number of Non-Detects	4	27
Number of Detect Data	11	1
Minimum Non-Detect	2	1.9
Maximum Non-Detect	19.3	40
Percent Non-detects	26.67%	96.43%
Minimum Detect	5.02	35.3
Maximum Detect	34.2	35.3
Mean of Detects	16.3	35.3
Median of Detects	11	35.3
SD of Detects	9.915	N/A
KM Mean	12.86	3.185
KM SD	10.05	6.423

Sample 1 vs Sample 2 Gehan Test

H0: Mean/Median of Sample 1 <= Mean/Median of background

Gehan z Test Value	4.055
Critical z (0.05)	1.645
P-Value	2.5118E-5

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 > Sample 2

P-Value < alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 1:12:09 PM
From File	TPCBs data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: TPCBs(n=ALU)

Sample 2 Data: TPCBs(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	23	54
Number of Non-Detects	3	26
Number of Detect Data	20	28
Minimum Non-Detect	0.02	0.02
Maximum Non-Detect	2.4	0.94
Percent Non-detects	13.04%	48.15%
Minimum Detect	0.041	0.02
Maximum Detect	6.37	0.73
Mean of Detects	0.757	0.158
Median of Detects	0.335	0.102
SD of Detects	1.384	0.173
KM Mean	0.686	0.109
KM SD	1.276	0.138

Sample 1 vs Sample 2 Gehan Test

H0: Mean/Median of Sample 1 <= Mean/Median of background

Gehan z Test Value	4.789
Critical z (0.05)	1.645
P-Value	8.3945E-7

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 > Sample 2

P-Value < alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 10:33:22 AM
From File	TBT Data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: TBT(n=ALU)

Sample 2 Data: TBT(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	17	52
Number of Non-Detects	0	2
Number of Detect Data	17	50
Minimum Non-Detect	N/A	0.004
Maximum Non-Detect	N/A	0.005
Percent Non-detects	0.00%	3.85%
Minimum Detect	0.02	0.01
Maximum Detect	4.14	8.46
Mean of Detects	1.527	1.05
Median of Detects	1.38	0.531
SD of Detects	1.273	1.576
KM Mean	1.527	1.01
KM SD	1.273	1.543

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	1.922
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.0546

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 12:07:37 PM
From File	As data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: As(n=ALU)

Sample 2 Data: As(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	50	94
Number of Non-Detects	8	37
Number of Detect Data	42	57
Minimum Non-Detect	5	6
Maximum Non-Detect	50	60
Percent Non-detects	16.00%	39.36%
Minimum Detect	10	6
Maximum Detect	270	2390
Mean of Detects	60.27	115.6
Median of Detects	47	60
SD of Detects	55.11	313.2
KM Mean	53.08	76.54
KM SD	52.74	246.6

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	0.331
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.74

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 12:09:23 PM
From File	Cd data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Cd(n=ALU)

Sample 2 Data: Cd(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	47	72
Number of Non-Detects	5	18
Number of Detect Data	42	54
Minimum Non-Detect	1	0.2
Maximum Non-Detect	2	2
Percent Non-detects	10.64%	25.00%
Minimum Detect	0.599	0.25
Maximum Detect	6.47	4
Mean of Detects	2.025	1.938
Median of Detects	2	2
SD of Detects	0.985	0.839
KM Mean	1.939	1.7
KM SD	0.964	0.87

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	0.371
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.711

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 12:11:27 PM
From File	Cr data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Cr(n=ALU)

Sample 2 Data: Cr(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	47	54
Number of Non-Detects	4	0
Number of Detect Data	43	54
Minimum Non-Detect	56.1	N/A
Maximum Non-Detect	113	N/A
Percent Non-detects	8.51%	0.00%
Minimum Detect	24	19.6
Maximum Detect	411	121
Mean of Detects	74.59	56.37
Median of Detects	60	53.95
SD of Detects	66.6	18.49
KM Mean	72.77	56.37
KM SD	63.34	18.49

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	0.947
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.344

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 12:13:43 PM
From File	Cu data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Cu(n=ALU)

Sample 2 Data: Cu(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	47	73
Number of Non-Detects	0	0
Number of Detect Data	47	73
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non-detects	0.00%	0.00%
Minimum Detect	68.9	12.4
Maximum Detect	2140	1890
Mean of Detects	358.3	365
Median of Detects	298	303
SD of Detects	308.2	262.6
KM Mean	358.3	365
KM SD	308.2	262.6

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	-0.497
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.619

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 12:24:14 PM
From File	Pb data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Pb(n=ALU)

Sample 2 Data: Pb(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	47	73
Number of Non-Detects	0	0
Number of Detect Data	47	73
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non-detects	0.00%	0.00%
Minimum Detect	157	15
Maximum Detect	3930	1120
Mean of Detects	503.6	337.3
Median of Detects	317	280
SD of Detects	565.8	199.2
KM Mean	503.6	337.3
KM SD	565.8	199.2

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	2.067
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.0387

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 12:27:20 PM
From File	Hg data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Hg(n=ALU)

Sample 2 Data: Hg(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	53	81
Number of Non-Detects	3	14
Number of Detect Data	50	67
Minimum Non-Detect	0.5	0.05
Maximum Non-Detect	0.865	0.97
Percent Non-detects	5.66%	17.28%
Minimum Detect	0.37	0.078
Maximum Detect	27.3	3.3
Mean of Detects	1.774	0.957
Median of Detects	0.922	0.77
SD of Detects	3.811	0.66
KM Mean	1.702	0.832
KM SD	3.676	0.66

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	2.614
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.00896

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/27/2020 11:08:45 AM
From File	Ni data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Ni(n)

Sample 2 Data: Ni(y)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	33	44
Number of Non-Detects	0	0
Number of Detect Data	33	44
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non-detects	0.00%	0.00%
Minimum Detect	11.5	23
Maximum Detect	597	268
Mean of Detects	84.61	65.87
Median of Detects	58.3	57.5
SD of Detects	104.2	40.17
KM Mean	84.61	65.87
KM SD	104.2	40.17

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	0.0721
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.943

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/24/2020 12:31:26 PM
From File	Ag data.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Ag(n=ALU)

Sample 2 Data: Ag(y=AOI)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	33	55
Number of Non-Detects	12	37
Number of Detect Data	21	18
Minimum Non-Detect	0.7	0.4
Maximum Non-Detect	3	3
Percent Non-detects	36.36%	67.27%
Minimum Detect	0.149	1
Maximum Detect	24.9	8
Mean of Detects	3.103	2.634
Median of Detects	2	2
SD of Detects	5.153	1.548
KM Mean	2.212	1.267
KM SD	4.194	1.348

Sample 1 vs Sample 2 Gehan Test

H0: Mean of Sample 1 = Mean of background

Gehan z Test Value	0.817
Lower Critical z (0.025)	-1.96
Upper Critical z (0.975)	1.96
P-Value	0.414

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)