Appendices

Urban Waters Initiative, 2007: Sediment Quality in Elliott Bay

Washington State Department of Ecology

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Appendices D-I and K are linked to this file on the Internet as a zip file.

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Appendix A. Previous Elliott Bay/Lower Duwamish Studies

Two sets of studies are summarized here. The first is an overview of sediment studies from 1990 through 2006. Data from those studies, extracted from Ecology databases, are available in Excel files in the electronic appendices of this report. The second is a summary of the NOAA MESA studies from 1979 to 1981.

1. Studies in EIM, SEDQUAL, and other sources

by Sandra Weakland

Ecology's Environmental Assessment Program Marine Monitoring Unit staff were given the task of identifying chemicals of concern for receiving sediments in Elliott Bay and the Lower Duwamish River. Chemical concentration data from sediment, water, and fish-tissue samples collected from this area were downloaded from Ecology's Environmental Information Management System (EIM) and Sediment Quality Information System (SEDQUAL) and compiled into a GIS-linked Urban Waters Initiative database. Other summarized results were compiled from various local, state, and national natural resource agency publications (WDFW, PSP, King County, NOAA, National Marine Fisheries Service), as well as from peer-reviewed journals.

These sediment chemical concentration data were examined, summarized, compared to Washington State Sediment Quality Standards and Puget Sound average ambient data. The data were then displayed on spatial distribution maps as indicated below. Summaries of the chemical concentrations in biota, taken from the literature, are also listed below.

Elliott Bay/Lower Duwamish database summary information (as of August 2007)

- Time span: 1990-2006.
- 187,623 records (sediment/water/fish tissue).
- Undetected data represented by reporting and detection limits.
- 96 studies represented (Tables A-1a, A-1b).
- 578 parameters sampled at least once (including "total" summary values) (Table A-2).
- 1,287 stations sampled at least once.
- Detection rates calculated for all data; metals and PAHs were highest (Table A-3).

Comparison with Washington State Sediment Management Standards

- 68,071 sediment records compared to criteria.
- 1,254 stations with at least one chemical compared to criteria.
- Undetected values represented by detection and/or reporting limits.
- 1,165 stations with at least one Marine Sediment Quality Standard (SQS) exceeded.
- All 47 SQS Chemical Criteria exceeded at least once.

    - Mercury, phthalates, PCBs, and PAHs exceeded SQS values most frequently (Table A-4).
- 619 stations with at least one Marine Sediment Cleanup Screening Level (CSL) exceeded.
- 45 of the 47 CSL Chemical Criteria exceeded at least once.

Comparison with Puget Sound average ambient levels

- Puget Sound sediment chemistry average ambient values calculated as the mean of all Puget Sound Assessment and Monitoring Program (PSAMP) sediment data from basin, passage, or rural strata (290 stations, all results including undetected values).
- Undetected data represented by reporting limit.
- 196 parameters compared (Table A-5).
- 160 parameters with a mean above the average ambient value.
- 38 parameters with a mean at least five times above the average ambient value and a detection rate above 50%.
- 29 parameters with a mean at least ten times above the average ambient value and a detection rate above 50%, including:
    - HPAHs and LPAHs
    - PCBs
    - Butyltin
    - Lead
    - Bis(2-ethylhexyl) phthalate

Spatial distribution maps of measured concentrations of selected chemicals

- Arsenic (Figure A-1)
- Bis(2-ethylhexyl) phthalate (Figure A-2)
- Cadmium (Figure A-3)
- Copper (Figure A-4)
- Dibenzofuran (Figure A-5)
- HPAH (Figure A-6)
- LPAH (Figure A-7)
- Mercury (Figure A-8)
- PCB Aroclor 1254 (Figure A-9)
- PCB Aroclor 1260 (Figure A-10)
- Zinc (Figure A-11)

Biota Summary

The following websites and reports include summaries of chemical concentrations in biota in Elliott Bay:

Geoducks:	King County Department of Natural Resources. 2002. Geoduck tissue physical characteristics, bacteria, and chemistry: Final report. King County Department of Natural Resources and Parks, Wastewater Treatment Division, Seattle, WA. http://dnr.metrokc.gov/Wlr/waterres/marine/reports/Geoduck-Tissue-Report-2002.htm.
Salmon:	Varanasi, U., E. Casillas, M.R. Arkoosh, T. Hom, D.A. Misitano, D.W. Brown, S.-L. Chan, T.K. Collier, B.B. McCain, and J.E. Stein. 1993. Contaminant exposure and associated biological effects in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from urban and nonurban estuaries of Puget Sound. NOAA Technical Memorandum NMFS-NWFSC-8. NOAA National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. www.nwfsc.noaa.gov/publications/techmemos/tm8/tm8.html.
Rockfish, Pacific herring, English sole:	Washington Department of Fish and Wildlife. 2002. Recent findings and numerous reports available at: www.wdfw.wa.gov/fish/psamp/findings.htm. www.wdfw.wa.gov/fish/psamp/reports.htm.

Tables

The table headings below contain only the lists of variables. The table contents are given in their entirety in the electronic appendix.

Table A-1a. Studies and references stored in Ecology's EIM System for Elliott Bay/Lower Duwamish.
Electronic table filename: Elliott Bay-Lower Duwamish data references - EIM Studies.xls.

Reference ID	User Study ID	Reference Title	Reference Year	Reference Library	Survey Description	Survey Begin Date	Survey End Date	Survey Project Name	Survey Program Name	Survey Chief Scientist	Survey Agency Name	Comment	Study Name	Study Implementation Status	Study Purpose	Study Type	Study QA Planning Level	Study QA Assessment Level	Responsible Ecology Program	Study Ecology Lead Contact	Study Area Description	Study Area Type	Study QA Project Plan Description	Study System ID

Table A-1b. Studies and references for Elliott Bay/Lower Duwamish not in EIM.
Electronic table filename: Elliott Bay-Lower Duwamish data references - non EIM References.xls.

Author	Reference Title	Reference Year	Survey Description	Survey Begin Date	Survey End Date	Survey Chief Scientist	Survey Agency Name	Comment	Study Name	Study Implementation Status	Study Purpose	Study Type	Study Area Description	Study Area Type

Table A-2. Number of EIM System records for surveys conducted in Elliott Bay/Lower Duwamish, 1990-2006.
Electronic table filename: Elliott Bay-Lower Duwamish parameters by matrix and study.xls.

Parameter	Sample Matrix	Total for Parameter	Environmental Information Management System Survey Identifier		
			Study 1	...	Study *n*

Table A-3. Number of samples taken, number detected, and % detection rate for Elliott Bay/Lower Duwamish data stored in Ecology's EIM System.
Electronic table filename: Elliott Bay-Lower Duwamish Percent detected.xls.

Parameter	Sample Matrix	N	Undetected	Detected	% Detected

Table A-4. Comparison of Elliott Bay/Lower Duwamish sediment chemistry data to Washington State Marine Sediment Quality Standards - Chemical Criteria.
Electronic table filename: Elliott Bay-Lower Duwamish Summary of previous studies.xls.

Parameter	Number of Samples	Number of Samples Below Detection Limit	Percent Detected	Number Exceeding SQS	Number Exceeding CSL

Table A-5. EIM Sediment chemistry summary statistics for Elliott Bay/Lower Duwamish and comparison of mean values to average ambient values.
Electronic table filename: Elliott Bay-Lower Duwamish values compared to average ambient concentrations.xls.

Chemical class	Chemical	N	Min	Max	% Detected	Mean	StDev	Ambient Mean	Ratio of Elliott Bay/Lower Duwamish mean to PSAMP ambient mean

Figures

The figures listed below are given on the pages following. They display spatial distribution maps of measured sediment concentrations of the listed contaminants in Elliott Bay/Lower Duwamish from 1990-2006 studies whose data are stored in Ecology's SEDQUAL and EIM databases.

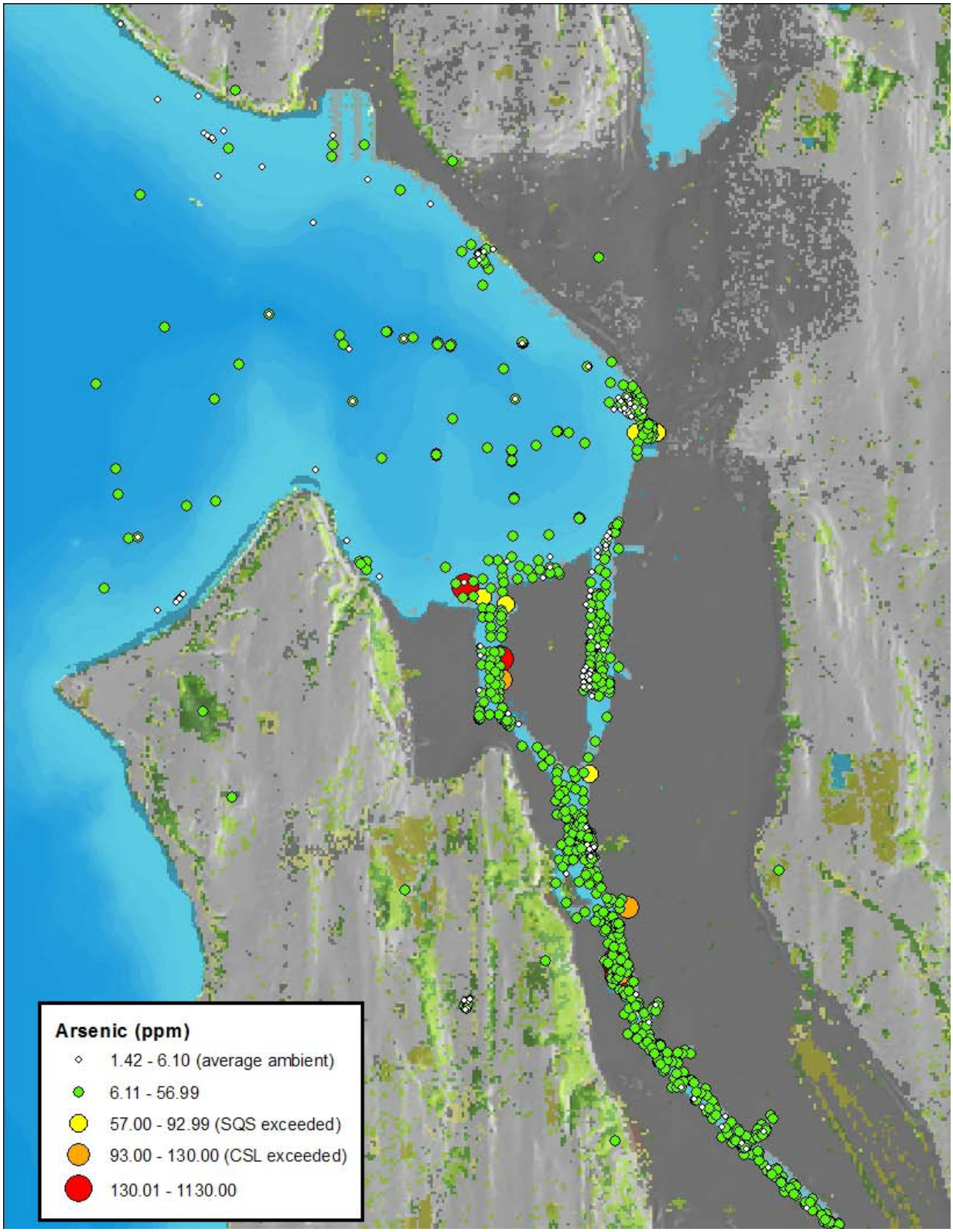

Figure A-1. Spatial distribution map of measured concentrations of arsenic in Elliott Bay and the lower Duwamish Waterway.

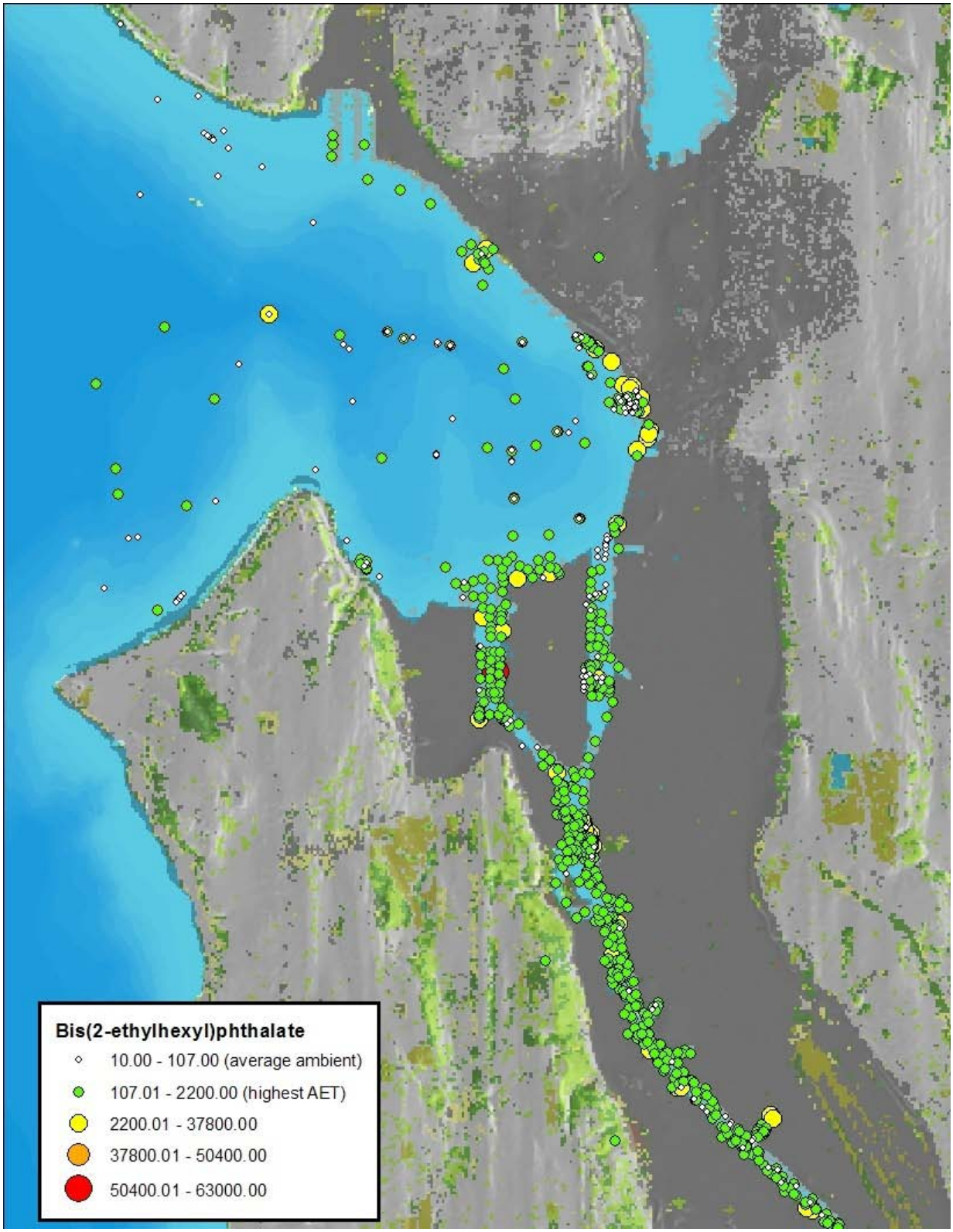

Figure A-2. Spatial distribution map of measured concentrations of bis(2-ethylhexyl) phthalate in Elliott Bay and the lower Duwamish Waterway.

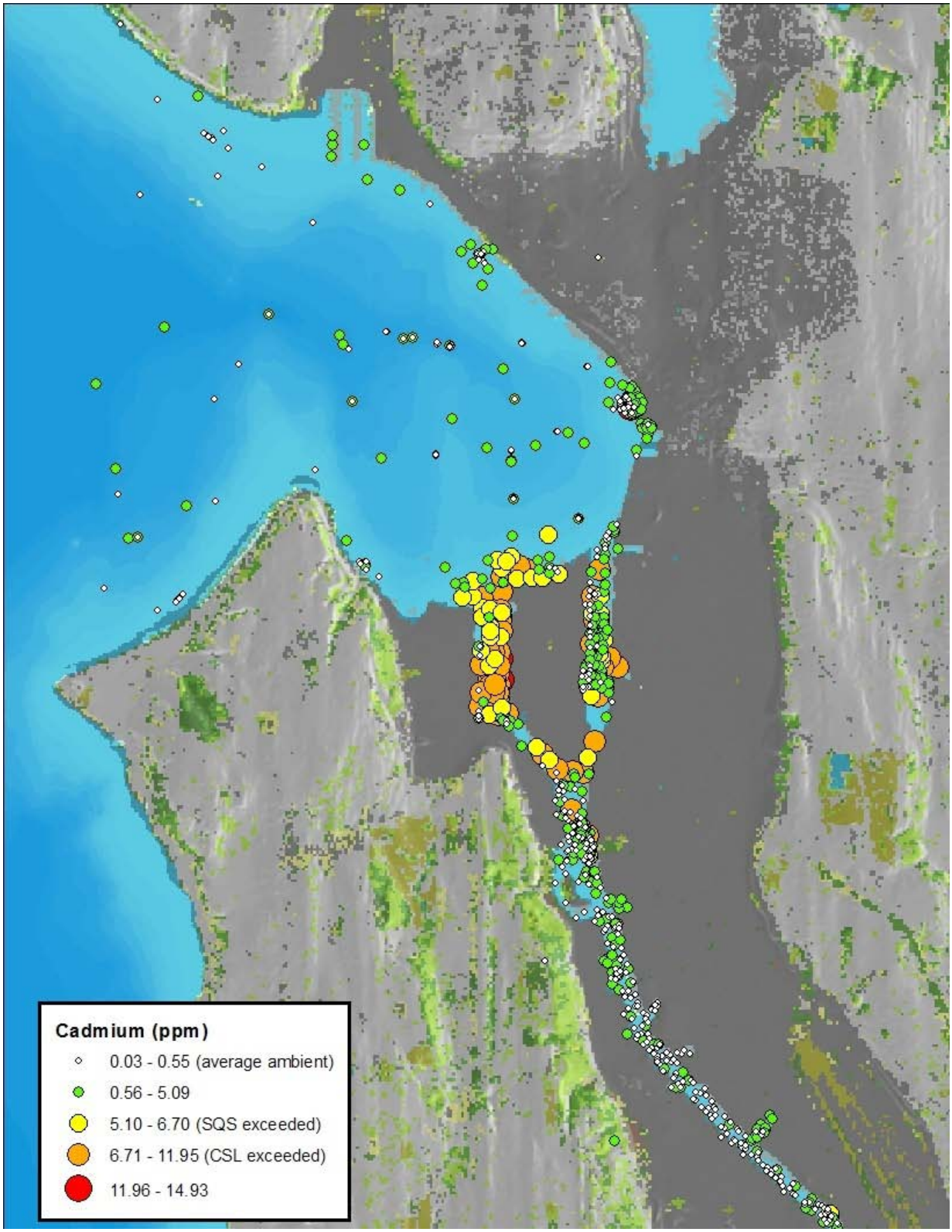

Figure A-3. Spatial distribution map of measured concentrations of cadmium in Elliott Bay and the lower Duwamish Waterway.

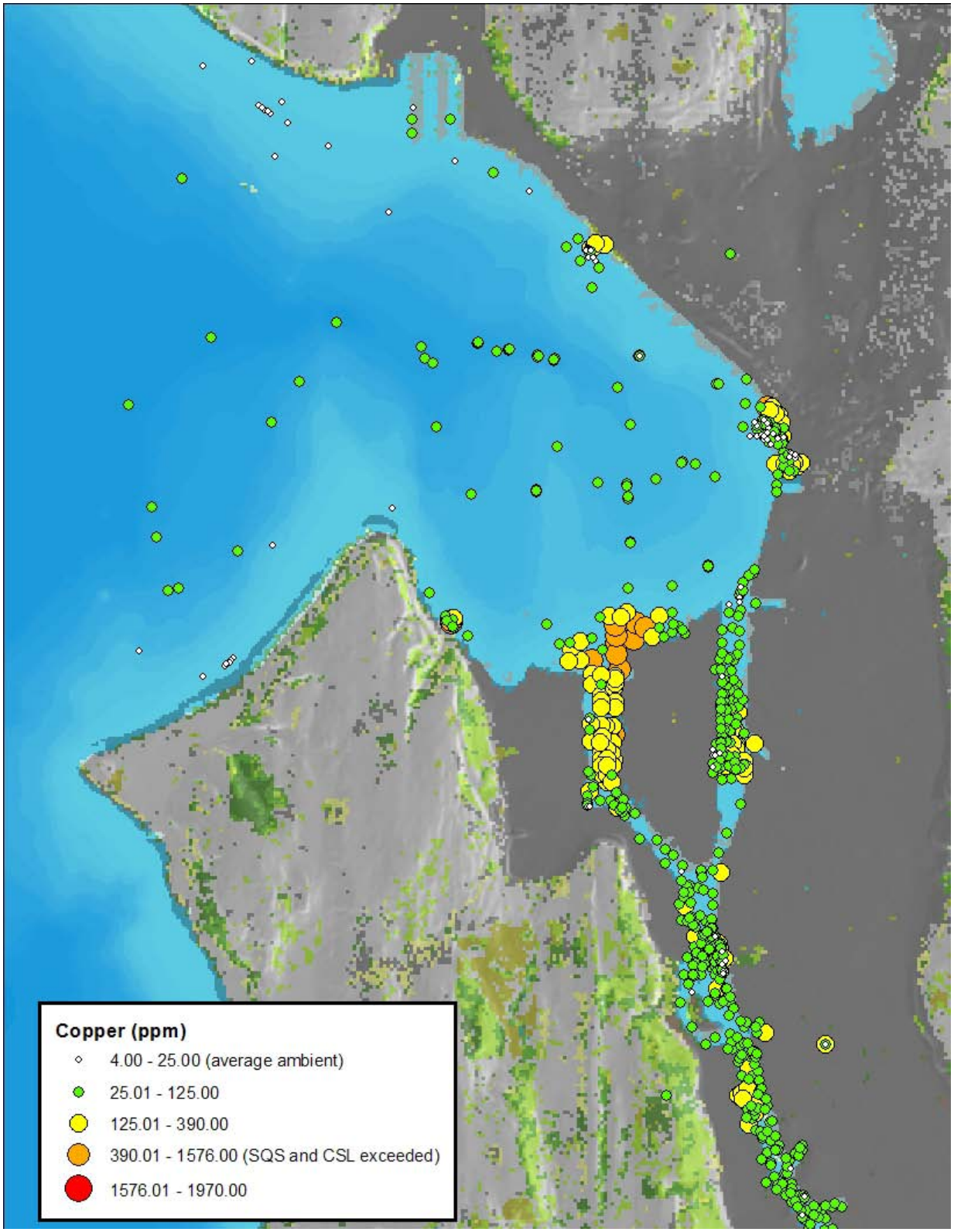

Figure A-4. Spatial distribution map of measured concentrations of copper in Elliott Bay/ Lower Duwamish.

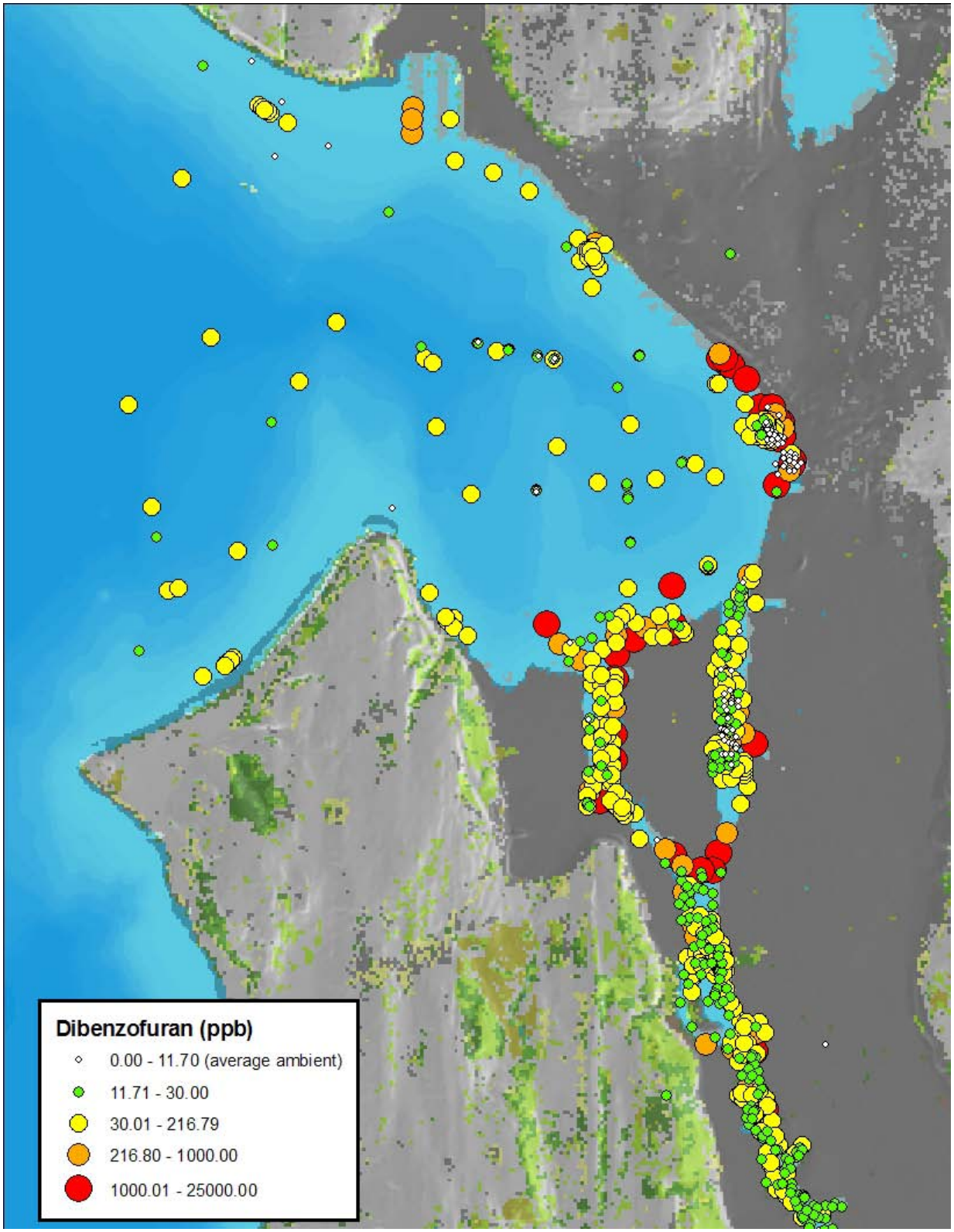

Figure A-5. Spatial distribution map of measured concentrations of dibenzofuran in Elliott Bay and the lower Duwamish Waterway.

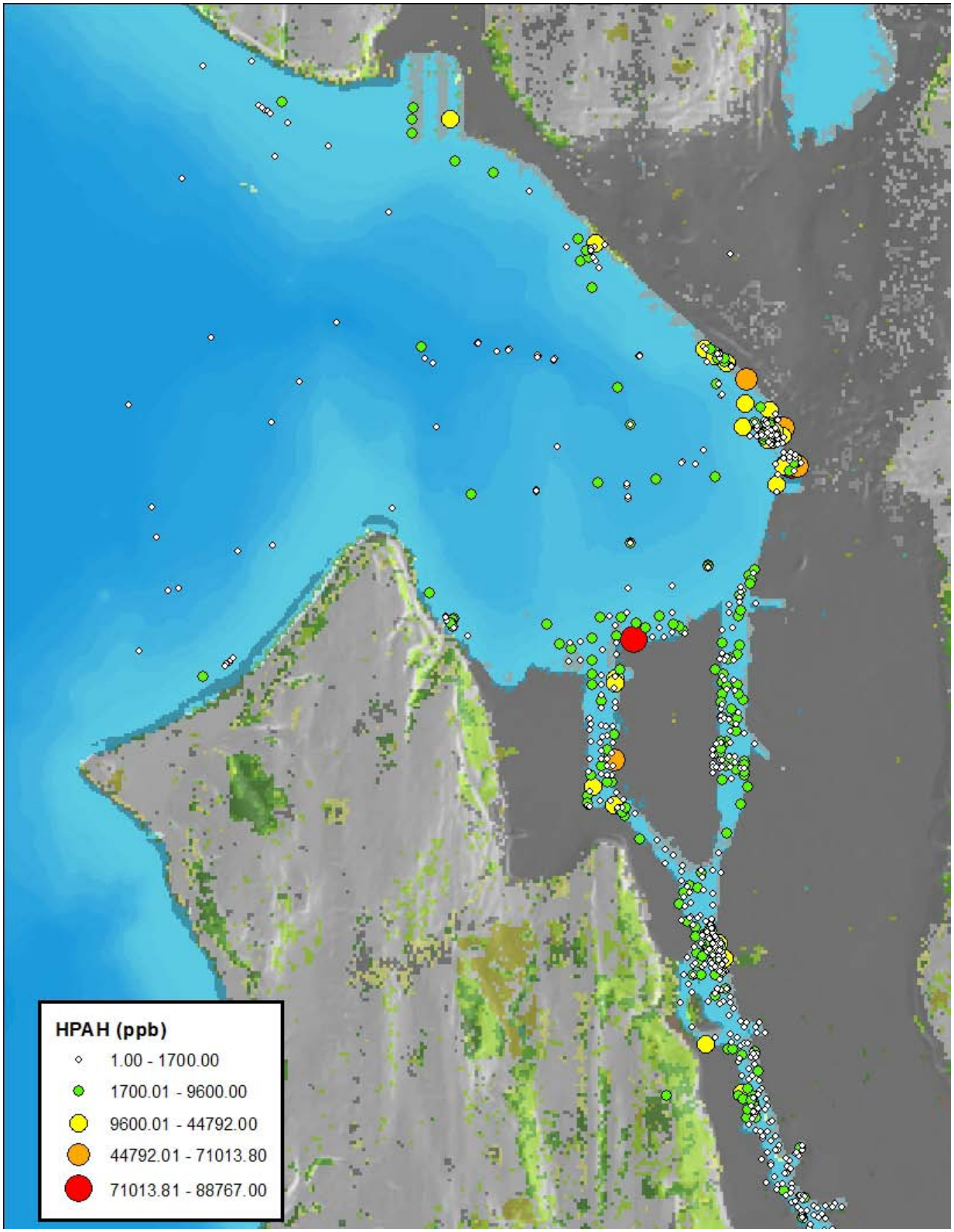

Figure A-6. Spatial distribution map of measured concentrations of HPAHs in Elliott Bay and the lower Duwamish Waterway. Sum of chemicals varies for studies and samples.

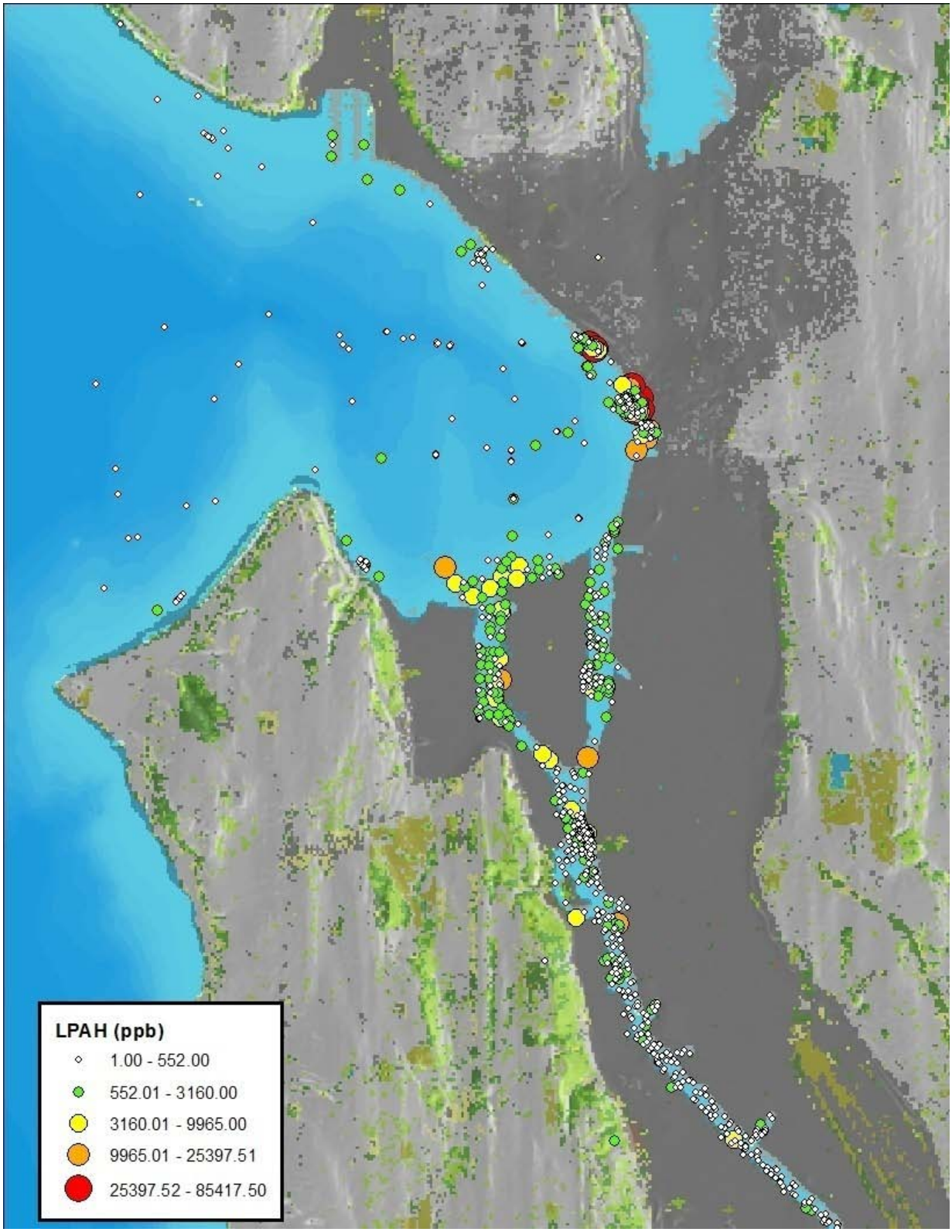

Figure A-7. Spatial distribution map of measured concentrations of LPAHs in Elliott Bay and the lower Duwamish Waterway. Sum of chemicals varies for studies and samples.

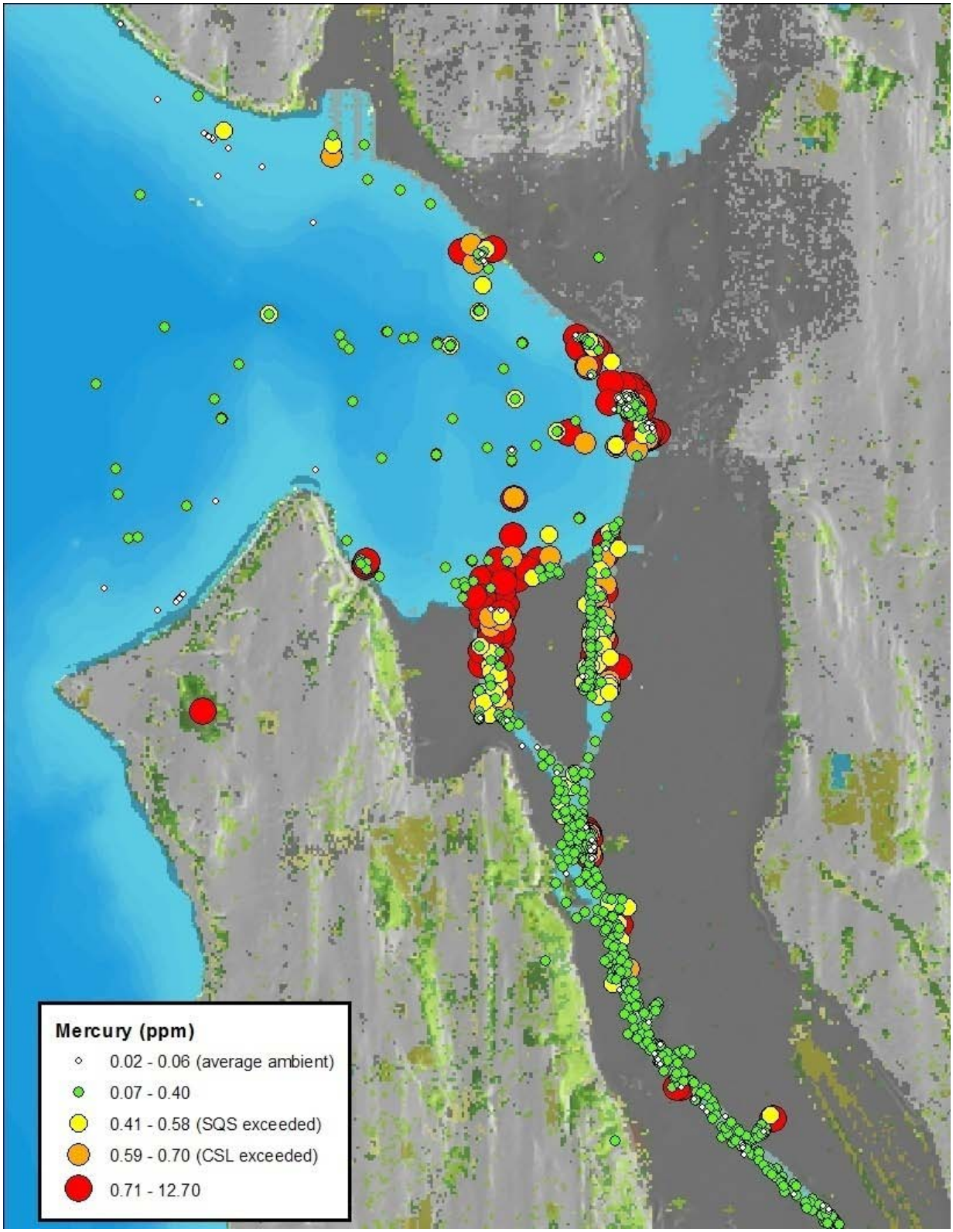

Figure A-8. Spatial distribution map of measured concentrations of mercury in Elliott Bay and the lower Duwamish Waterway.

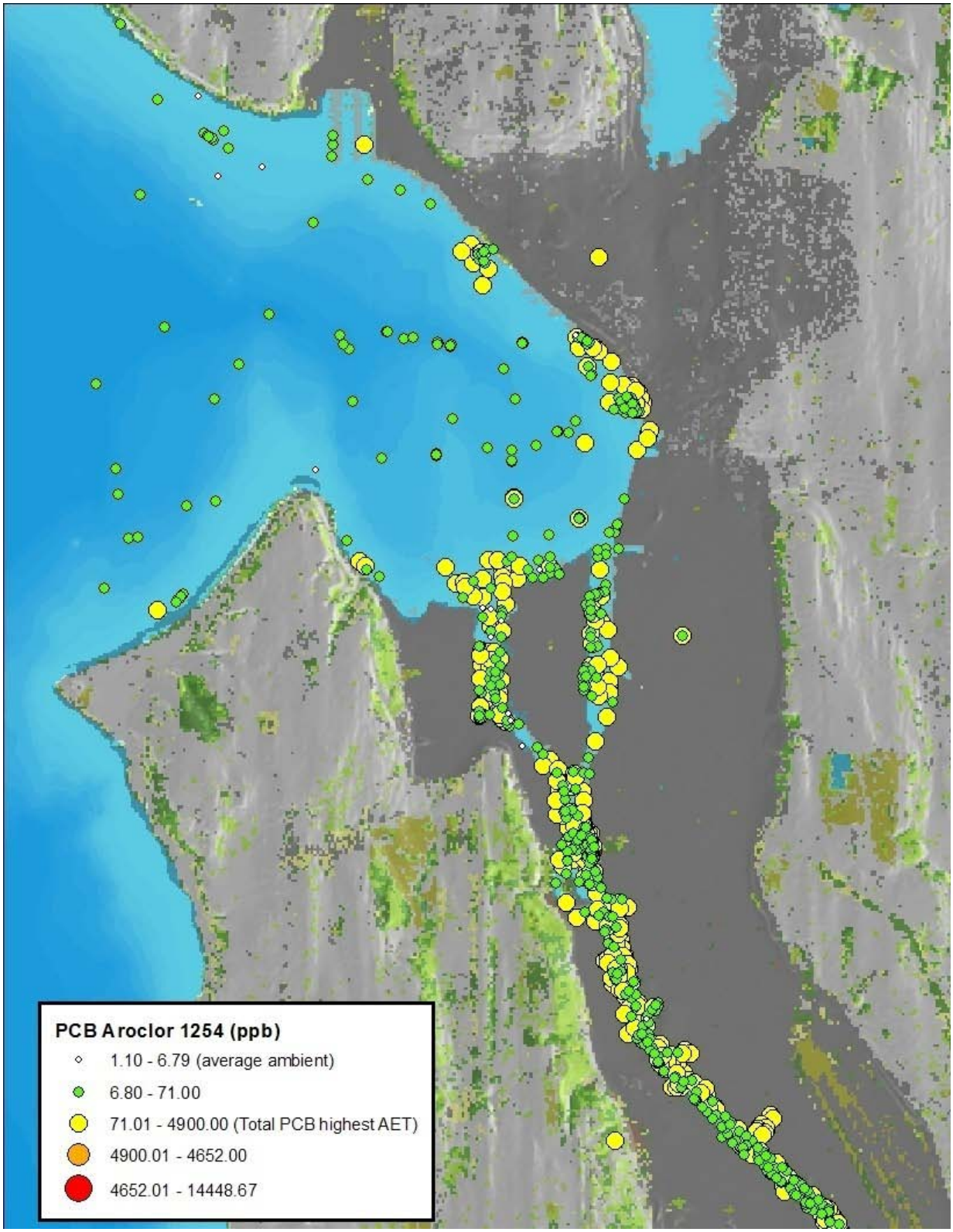

Figure A-9. Spatial distribution map of measured concentrations of PCB Aroclor 1254 in Elliott Bay and the lower Duwamish Waterway.

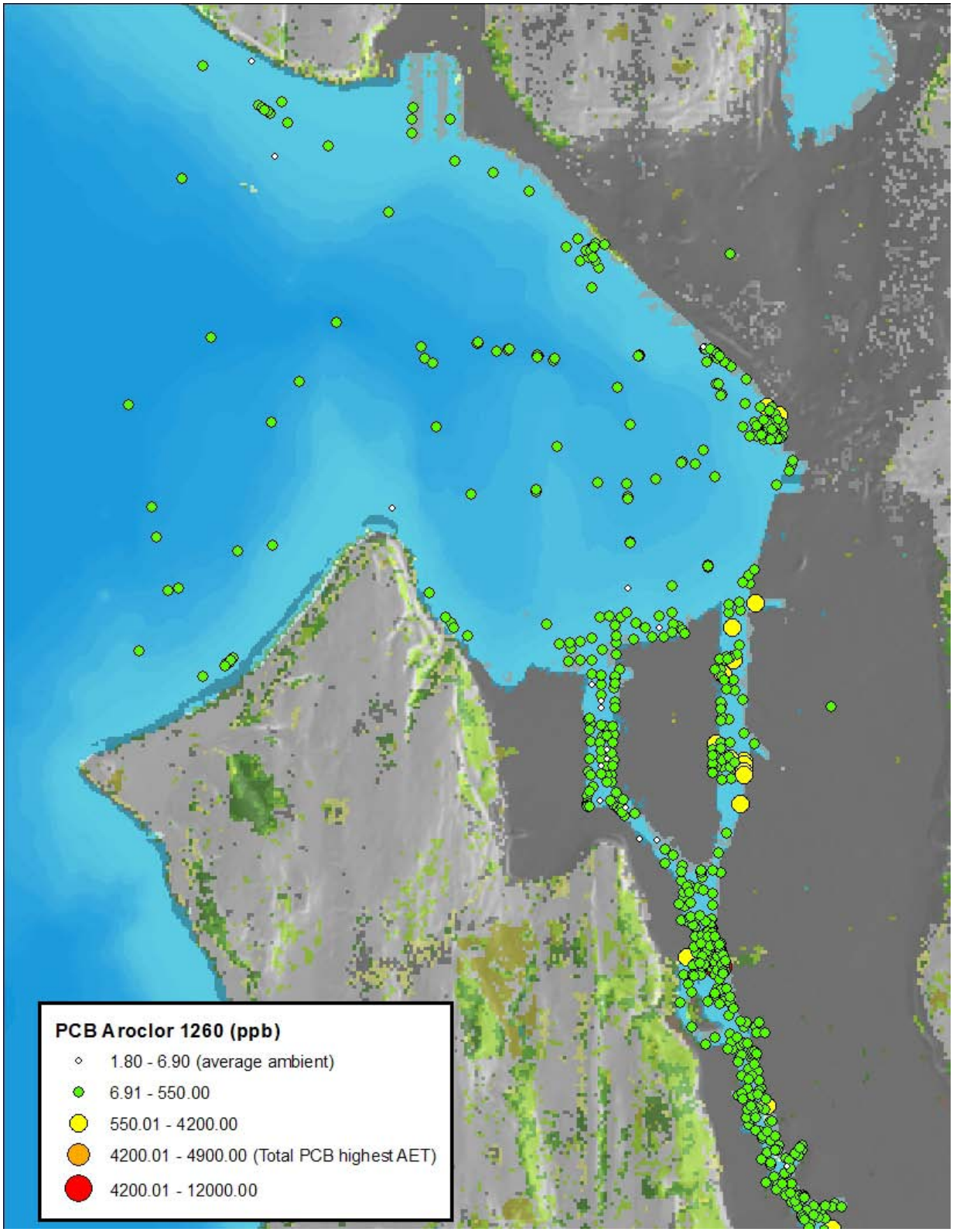

Figure A-10. Spatial distribution map of measured concentrations of PCB Aroclor 1260 in Elliott Bay and the lower Duwamish Waterway.

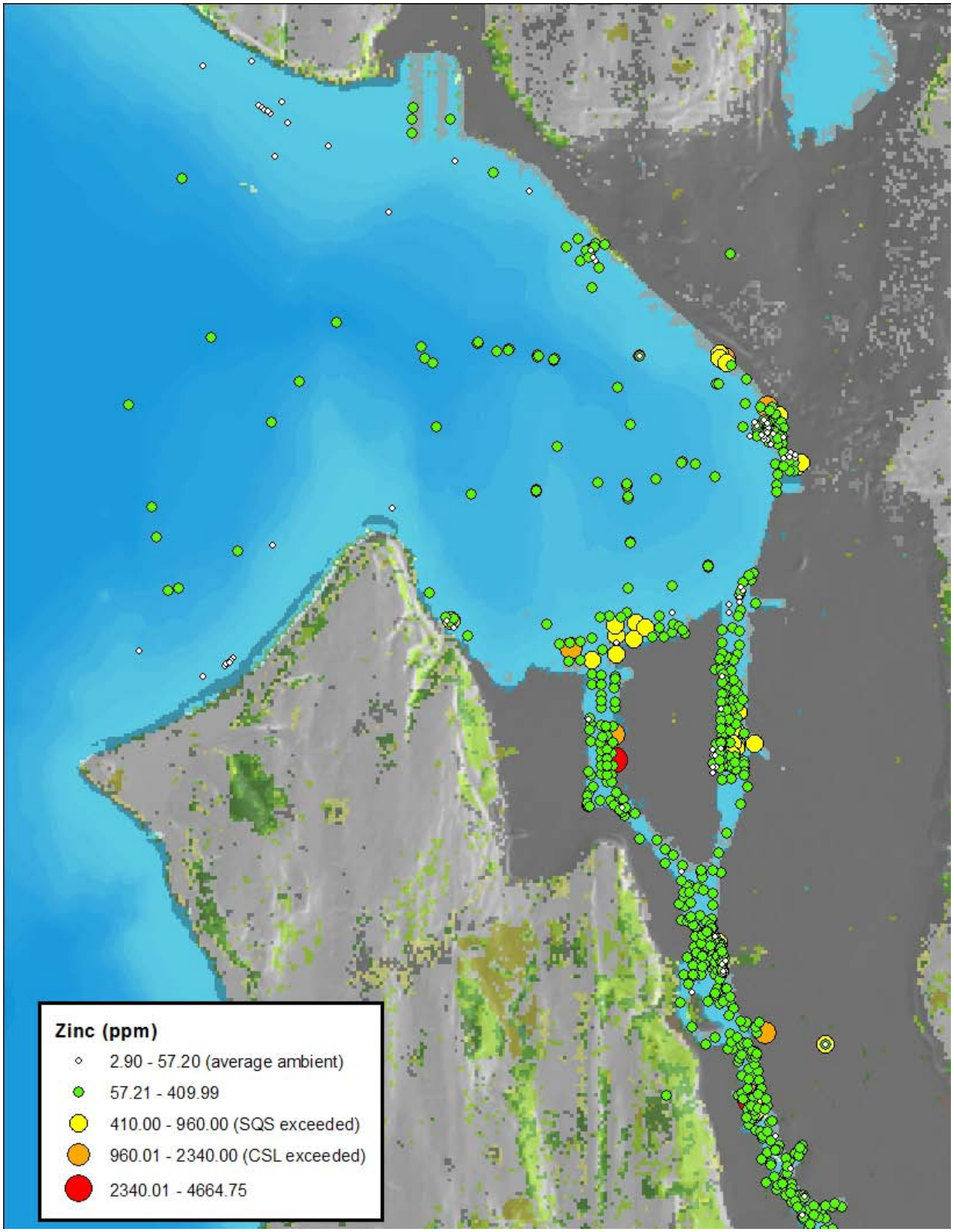

Figure A-11. Spatial distribution map of measured concentrations of zinc in Elliott Bay and the lower Duwamish Waterway.

2. Previous NOAA Studies in Elliott Bay/Lower Duwamish

by Edward Long

Sediment Chemistry

During 1979-1981, NOAA sampled numerous (up to 77) locations throughout Puget Sound as part of the marine pollution studies of the Marine EcoSystems Analysis (MESA) Puget Sound project (Malins et al., 1980, 1982; Long, 1982). Surficial sediments, marine demersal fish, and marine invertebrates were collected at locations selected to likely represent worst conditions, intermediate conditions, and reference conditions throughout the Sound. The entire study area extended from Bellingham Bay to Budd Inlet. However, most of the work was done in the vicinity of Seattle, Tacoma, and Bremerton.

Chemical analyses were performed on the sediments and animal tissues. Several species of both demersal fishes and benthic invertebrates were examined for histopathological disorders among the internal organs. All sediment samples were analyzed for potentially toxic metals and organic compounds (PAHs and COHs).

In the first year of the study (1979), samples were taken at 41 locations in central and southern Puget Sound. In the Elliott Bay portion of the study, there were 16 stations, three of them sampled twice for a total of 19 samples that were collected in the summer of 1979. They were scattered throughout the central bay, along the Seattle waterfront, up both waterways of the Duwamish River to the turning basin, and seaward to Denny Way, piers 90/91, Alki Point, and West Point (Malins et al., 1980). Therefore, the scope of the study area in Elliott Bay and the distribution of the sampling stations were similar to that of the Elliott Bay UWI survey of 2007.

Spatial patterns

The chemical composition of the sediments differed among the urban bays that were sampled. Some bays had a distinctive chemical "signature" as a result of the nature of the local inputs. However, within each bay many of the chemicals co-varied in concentrations with each other.

In Elliott Bay, there was a relatively distinct and re-occurring spatial pattern in contamination (Malins et al., 1982). The concentrations of PAHs, PCBs, and most trace metals often (but not always) were highest in various reaches of the Duwamish River. The concentrations of some chemicals decreased slightly to moderately in central Elliott Bay off Harbor Island. Some of these concentrations decreased along the Seattle waterfront, while some others remained relatively high in that area. Chemical concentrations often were highly variable from one station to the next, possibly reflecting the heterogeneity of and proximity to local sources. Usually, the concentrations continued to decrease into the center of the bay and seaward toward and beyond both Alki Point and West Point into the central basin.

Metals

The concentrations of mercury ranged from 30 ppb dry wt to 1200 ppb among the 19 samples (Table A-6). The average was 460 ppb, which ranked Elliott Bay as third highest among 14 bays. Both the Washington state SQS and CSL values are 0.59 ppm dry wt or 590 ppb. The

NOAA ERL and ERM values are 0.15 ppm (150 ppb) and 0.71 ppm (710 ppb). There were 6 samples from Elliott Bay in which the mercury concentrations were greater than 590 ppb. All of them were collected in the lower Duwamish River or off the Seattle waterfront. There were 13 samples with mercury concentrations exceeding the ERL value, and 4 in which the ERM value was exceeded. All of the latter were collected in either the lower Duwamish River or along the docks of the Seattle waterfront.

The concentrations of lead ranged from 13 ppm off Alki Point to 630 ppm in the Duwamish west waterway (Table A-6). The average concentration for the bay was 130 ppm, which ranked Elliott Bay tied for first (highest) with Commencement Bay. The Washington State SQS and CSL values are 450 ppm and 530 ppm dry wt, respectively, while the NOAA ERL and ERM are 47 ppm and 218 ppm, respectively. There was only one sample collected in the Duwamish west waterway in which the lead concentration exceeded both the SQS and CSL values. Among the 19 samples, there were 14 and 4 samples with lead concentrations greater than the ERL and ERM values, respectively.

As with many of the other chemicals, the concentrations of lead were highest in the lower Duwamish River and along the docks of the Seattle waterfront. They gradually decreased into the central bay and seaward toward both West Point and Alki Point.

Arsenic was not detected at measurable concentrations in 13 of the 19 samples (Table A-6). However, arsenic was found in the lower Duwamish River stations around Harbor Island. Three concentrations there exceeded the SQS and one exceeded the CSL. Also, 6 exceeded the ERL (8 ppm) and 3 exceeded the ERM (70 ppm).

Sixteen samples were analyzed for silver. Silver concentrations ranged from about 1 to 4 ppm with a bay-wide average of 2.5 ppm (Table A-6), which ranked the bay fourth. None exceeded the SQS and CSL value of 6 ppm. All samples exceeded the ERL value of 1 ppm, but only 1 exceeded the ERM value of 3.7 ppm.

Cadmium concentrations ranged from 2 to 18 ppm with a bay-wide average among 19 samples of 7.1 ppm (Table A-6), which ranked the bay second among 14 bays that were sampled. Concentrations exceeded the SQS value of 5.1 ppm in 12 samples and exceeded the CSL value of 6.7 ppm in 9 samples. All concentrations exceeded the ERL of 1.2 ppm and 3 exceeded the ERM value of 9.6 ppm. The concentrations were highest in the lower Duwamish waterways, decreased slightly along the Seattle waterfront, and then decreased again seaward toward the central basin.

PAHs

Among the 19 samples, the concentrations of total PAHs (sums of 27 compounds) ranged from 220 ppb dry wt to 63,000 ppb (Table A-6). Among 14 Puget Sound bays included in the MESA survey, the average concentration of total PAH in Elliott Bay sediments ranked first (highest), at 13,000 ppb dry wt.

There are no Washington state standards for total PAHs, and the standards for individual compounds are listed in units of organic carbon. The MESA data are listed in units of dry wt

with no conversion to organic carbon concentrations. The NOAA ERL and ERM values for total PAHs (generally sums of 20-23 compounds) are about 4000 ppb dry wt and 45,000 ppb, respectively (Long et al., 1995). Among the 19 samples analyzed in the MESA survey, 12 had total PAH concentrations greater than the ERL. Only two concentrations exceeded the ERM value, one from a station off the docks of the Seattle waterfront and another from a station off West Point.

The concentrations of PAHs were highest in the lower Duwamish River and along the docks of the Seattle waterfront. They gradually decreased into the central bay and seaward toward both Alki Point and West Point. However, the station off West Point, interestingly, had a spike in concentrations.

PCBs

The concentrations of PCBs were calculated as sums of chlorination levels and expressed as units of dry wt. The concentrations ranged from 8 to 2100 ppb (Table A-6). The average concentration for the 19 Elliott Bay samples was 380 ppb, which ranked the bay as first (highest) among 14 Puget Sound bays. The Washington State standards are listed in units of organic carbon, whereas the MESA data are shown in units of dry wt with no data for conversion to organic carbon concentrations. The NOAA ERL and ERM values for total PCBs are 23 ppb and 180 ppb, respectively. There were 17 of the 19 samples that had PCB concentrations greater than the ERL, and 9 concentrations exceeded the ERM.

PCB concentrations were highest in the lower Duwamish River and along the Seattle waterfront. They decreased out into the central bay and seaward along the north shoreline of the bay to West Point and beyond. They also decreased along the south shoreline to and beyond Alki Point.

Sediment Toxicity

In addition to the analyses of sediment chemistry, the MESA project funded some of the initial surveys of sediment toxicity in Puget Sound. Up until this era, sediment toxicity tests mainly had been conducted nationwide to determine uptake of toxicants from contaminated sediments in large hardy clams, shrimp, and polychaetes in sediment samples from sites that were intended to be dredged.

This work in Puget Sound was among the first in which measures of toxicity in relatively sensitive species were employed as survey tools, not solely enforcement tools (Long and Chapman, 1983). These early studies followed the methods proposed for use in Puget Sound by Swartz et al. (1979).

The MESA sediment toxicity studies were performed in four stages.

1. First, in Phase 1 there was a broad-scale study of toxicity in numerous urban bays of Puget Sound in which 97 samples were collected and tested (Chapman et al., 1982). In that first phase there were 37 stations sampled in the Elliott Bay region, including many in the lower Duwamish River.

2. In Phase 2, another 22 selected stations were sampled, 9 in Elliott Bay, and tested for reproductive effects (Chapman et al., 1983).

3. Phase 3 involved surveys farther north in Everett harbor, Samish Bay, and Bellingham Bay (Chapman et al., 1984a).

4. The last phase, Phase 4, involved analyses of the relationships between sediment chemistry, toxicity, and benthic effects with a small database (12 stations) compiled from several contemporary studies (Chapman et al., 1984b). Four of these stations were in Elliott Bay.

EVS Environment in Vancouver, BC conducted all four phases of this work in conjunction with scientists at the University of Washington.

The following narrative summary will focus mainly on the data from Phase 1 because it was geographically the most comprehensive. The incidence and spatial patterns in toxicity observed in Phase 1 will be augmented with the data from the subsequent phases.

Phase 1

In Phase 1, 97 sediment samples were collected throughout Puget Sound and tested for toxicity (Chapman et al., 1982). There were 37 of these samples collected in Elliott Bay and adjoining Duwamish River. The station locations were selected to represent the spatial gradients in sediment chemistry observed in the previous chemical surveys. Tests were run in the laboratory to determine acute mortality in an oligochaete worm and an amphipod. Other tests were performed to determine loss in respiration rate in the worms and genotoxicity (chromosomal damage) in a fish cell line.

Very little acute mortality was observed among all 97 samples in Phase 1. Elevated acute mortality was recorded in only one sample collected from a station off the Denny Way CSO in Elliott Bay, in the amphipod survival test. Tests with the oligochaetes and fish cells showed no significant mortality.

However, respiration rates in the worms decreased relative to the controls in some samples and increased in other samples. There were 9 samples in which the respiration rates decreased significantly among the 37 Elliott Bay samples. The control response was 0.24 uLO_2/mg dry wt/h. The range in response among the 37 Elliott Bay samples was 0.15 to 0.38 uLO_2/mg dry wt/h. Samples classified as having a significantly lower response were primarily from along the Seattle waterfront (mainly off the Denny Way CSO) and in the lower west Duwamish waterway.

In Elliott Bay, 24 of the 37 samples induced significant genotoxic effects in the fish cells relative to controls. This was the most sensitive test. The percentages of cells with cytological abnormalities ranged from 3% to 35%, whereas the mean in the controls was 11.5%. The samples with the most significantly elevated incidence of cellular abnormalities were from stations along the Seattle waterfront and in the west Duwamish waterway.

Phase 2

In Phase 2, sediment samples were collected at 22 selected stations throughout the Sound, 9 of which were scattered throughout the Elliott Bay region (Chapman et al., 1983). This was a field experiment to test methods for measuring reproductive effects in many kinds of tests. One test involved exposing oyster larvae to settled sediments following preparation and mixing (shaking) sediment-water slurries. Another involved analyses of hatching success and presence of abnormally shaped cells in the embryos of surf smelt. Various measures of effects of the sediments on the life cycle of a polychaete were measured. Cultured trout cells and bluegill fry cells were exposed to sediment extracts, and various cytotoxicity endpoints were noted.

In the sediment controls, a mean of 487 embryos survived the 48-hour exposures and only 2% were morphologically abnormal. The range in response in the 22 survey samples was from 0 to 351 embryos. In Elliott Bay the range in response among the 9 samples was 9 to 351 live embryos, and 2% to 86% were abnormal. The most toxic samples were those collected in the Duwamish River with 9 to 47 live embryos and 50% to 86% abnormal.

The surf smelt assay included 4 endpoints, the most sensitive of which appeared to be percent larvae survival after a 10-day exposure. In the sediment controls, 58% of the larvae survived the exposures, whereas the range in response in the 22 samples was 0% in 10 samples to 65%. In the 9 Elliott Bay samples, the range in percent survival was 0% in 6 samples to 25%. The most toxic samples (i.e., 0% survival) were scattered around the bay (off Magnolia Bluff, off the Seattle waterfront, off Alki Point, and in the Duwamish River waterways).

In the 26-day elutriate tests with the polychaete worms, 70-80% survival was recorded in the sediment controls, whereas the range in response among the 22 field-collected samples was 40% to 90%. In the 9 Elliott Bay samples, the range in response was 40% to 80%. The most toxic samples (<75% survival in 26 days) were collected off the Denny Way CSO, off the Alki peninsula, along the Seattle waterfront, and in the Duwamish River.

In the fish cell proliferation assays, the cells of the bluegill were not very responsive, whereas the trout gonad cells were highly responsive. Among the 9 samples from Elliott Bay, 4 were ranked as having a highly significant response. One of these 4 samples was collected off Alki Point, and the other three came from the Duwamish River.

Phase 4

In Phase 4 of these studies, matching sediment chemistry, toxicity, and benthic data were compiled from several surveys to evaluate how this triad of measurements related to each other (Chapman et al., 1984b). Data from Elliott Bay, Sinclair Inlet, Commencement Bay, Case Inlet, and Samish Bay were assembled. Four of the 12 stations were in the Elliott Bay/Duwamish

River area. All four of those stations were contaminated with trace metals. They had a variety of mixtures of organic toxicants that were toxic in at least one test (usually several). In addition, the benthic assemblages were dominated by relatively resistant polychaetes and molluscs, and were devoid of relatively sensitive amphipods.

Summary

NOAA, through its MESA Puget Sound Project, generated considerable information on sediment quality in the Elliott Bay region in the early 1980s. Many of the methods used in the MESA studies were sufficiently similar to those still used by Ecology in the PSAMP monitoring to warrant qualitative comparisons.

In this region, sediments were most degraded in the lower Duwamish River and along the Seattle waterfront. Substantial numbers and percentages of samples were contaminated. There were mixtures of toxic chemicals in the sediments that could have caused toxicity in various animals and adverse effects to the resident benthos. Conditions tended to improve seaward toward and beyond the mouth of the bay.

Subsequent tests of sediments indicated that many of the places that were contaminated also were toxic in a variety of acute and sublethal tests. Measures of toxicity ranged from acute mortality to genotoxicity and other kinds of cytological damage. Toxicity and benthic effects were most apparent in the lower Duwamish River waterways and off the Seattle waterfront docks and Denny Way CSO. The stations that were most toxic supported only relatively resistant molluscs and polychaetes, and were devoid of relatively sensitive amphipods and other crustaceans.

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Tables

Table A-6. Comparison of summary results from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

Study	Year	Analyte	Components of Sums	Units	Min*	Max	Mean*	N	# ND	ERL	# > ERL*	ERM	# > ERM*	SQS	# > SQS*	CSL	# > CSL*
MESA	1979	Arsenic		ppm	8.5	280	90	19	13	8.2	6	70	3	57	3	93	2
		Cadmium		ppm	2.2	18	7.1	19	1	1.2	18	9.6	3	5.1	12	6.7	8
		Lead		ppm	8.2	630	130	19	0	46.7	13	218	4	450	1	530	1
		Mercury		ppm	0.03	1.2	0.46	19	0	0.15	13	0.71	4	0.41	17	0.59	6
		Silver		ppm	1.3	3.9	2.5	16	0	1	16	3.7	2	6.1	0	6.1	0
		sum of PAH	27 compounds	ppb	150	63000	13000	19	0	4022	12	44792	2	--	--	--	--
		sum of PCB	chlorination levels	ppb	35	2100	380	19	2	23	17	180	13	--	--	--	--
PSAMP/ NOAA	1998	Arsenic		ppm	1.8	102	11.35	30	0	8.2	18	70	1	57	1	93	1
		Cadmium		ppm	0.11	0.82	0.321	30	3	1.2	0	9.6	0	5.1	0	6.7	0
		Lead		ppm	7.22	128	46.39	30	0	46.7	11	218	0	450	0	530	0
		Mercury		ppm	0.029	1.5	0.339	30	0	0.15	22	0.71	4	0.41	6	0.59	5
		Silver		ppm	0.11	1.49	0.604	30	1	1	5	3.7	0	6.1	0	6.1	0
		sum of HPAH	12 compounds	ppb	137.3	75951	8159.9	30	0	1700	24	9600	7	--	--	--	--
		sum of HPAH	6 compounds	ppb	83.3	62831	5441	30	0	1700	20	9600	3	--	--	--	--
		sum of LPAH	14 compounds	ppb	14	6878	1865.8	30	0	552	25	3160	5	--	--	--	--
		sum of LPAH	7 compounds	ppb	11.5	6048	1443.5	30	0	552	21	3160	4	--	--	--	--
		sum of PAH	26 compounds	ppb	189.5	82829	10025.7	30	0	4022	15	44792	1	--	--	--	--
		sum of PAH	13 compounds	ppb	104	68879	6884.4	30	0	4022	14	44792	1	--	--	--	--
		sum of PCB	7 aroclors	ppb	21.4	2000	277.4	30	2	22.7	28	180	14	--	--	--	--
		sum of PCB	19 congeners	ppb	0.45	933.3	119.18	30	1	22.7	25	180	6	--	--	--	--

Study	Year	Analyte	Components of Sums	Units	Min*	Max	Mean*	N	# ND	ERL	# > ERL*	ERM	# > ERM*	SQS	# > SQS*	CSL	# > CSL*
Urban Waters	2007	Arsenic		ppm	1.74	186	14.69	30	0	8.2	17	70	1	57	1	93	1
		Cadmium		ppm	0.11	0.91	0.316	30	5	1.2	0	9.6	0	5.1	0	6.7	0
		Lead		ppm	6.75	188	39.2	30	0	46.7	7	218	0	450	0	530	0
		Mercury		ppm	0.044	0.853	0.251	30	0	0.15	20	0.71	1	0.41	5	0.59	4
		Silver		ppm	0.12	1.31	0.490	30	4	1	4	3.7	0	6.1	0	6.1	0
		sum of HPAH	12 compounds	ppb	69.1	82674	6419.7	30	0	1700	22	9600	3	--	--	--	--
		sum of HPAH	6 compounds	ppb	34.1	75508	4657	30	0	1700	13	9600	1	--	--	--	--
		sum of LPAH	14 compounds	ppb	35.09	11416	1748	30	0	552	24	3160	4	--	--	--	--
		sum of LPAH	7 compounds	ppb	18.6	8878	1304.6	30	0	552	18	3160	3	--	--	--	--
		sum of PAH	26 compounds	ppb	104.19	94090	8167.7	30	0	4022	8	44792	1	--	--	--	--
		sum of PAH	13 compounds	ppb	52.7	84386	5961.6	30	0	4022	8	44792	1	--	--	--	--
		sum of PCB	7 aroclors	ppb	14	778	162.2	30	3	22.7	27	180	11	--	--	--	--
		sum of PCB	19 congeners	ppb	2.47	236.9	55.6	30	2	22.7	21	180	3	--	--	--	--

ND = nondetect.
ERL = NOAA Effects Range – Low sediment-quality guideline.
ERM = NOAA Effects Range – Median sediment-quality guideline.
SQS = Washington State Sediment Quality Standard.
CSL = Washington State Cleanup Screening Level.
* = Detected values only.

Figures

The figures listed below are given on the following pages. They display means, ranges, and numbers of measured (detected) sediment concentrations of the listed contaminants in Elliott Bay and the lower Duwamish Waterway from the 1979 MESA, 1998 PSAMP/NOAA, and 2007 Urban Waters Initiative surveys.

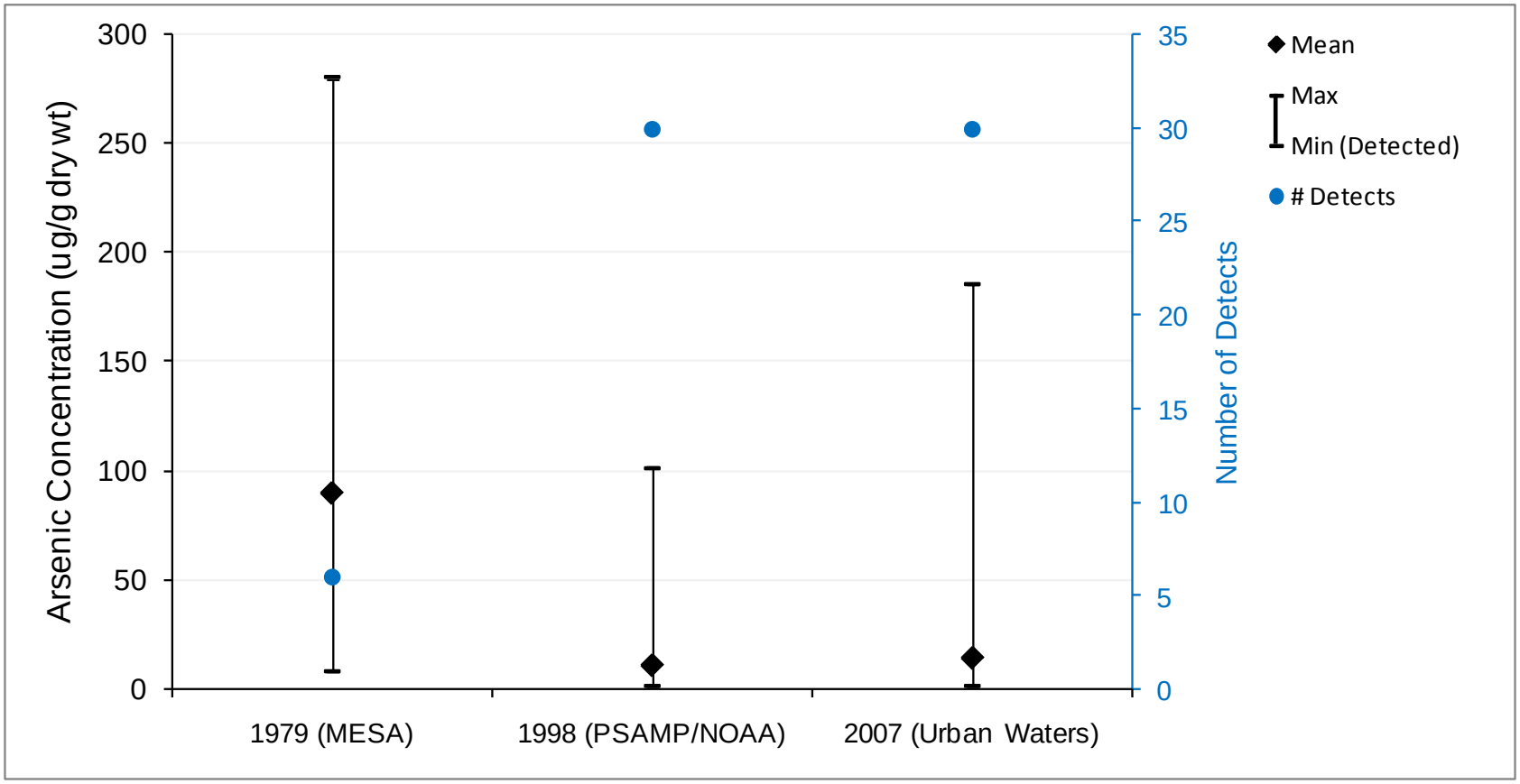

Figure A-12. Comparison of arsenic concentrations from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

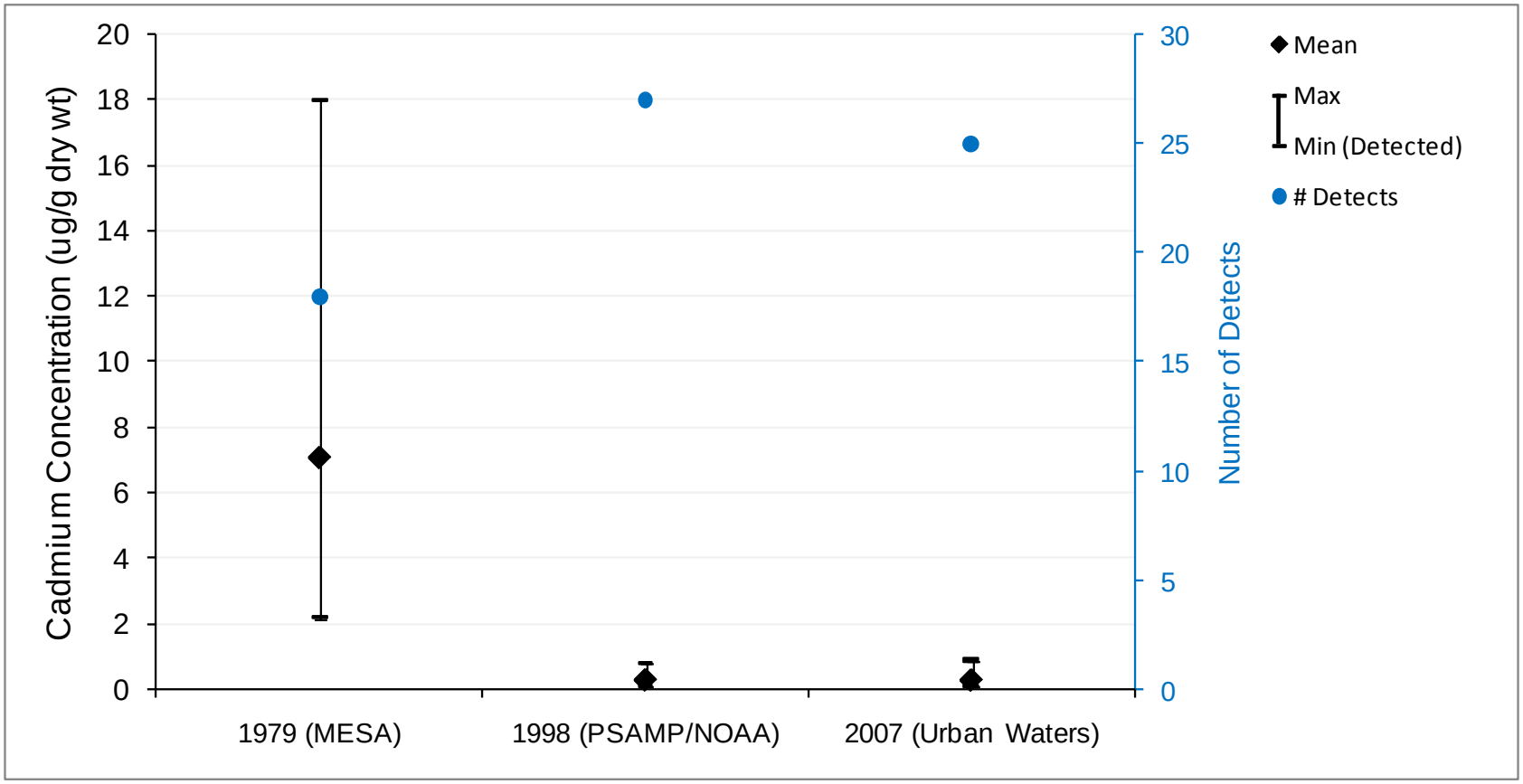

Figure A-13. Comparison of cadmium concentrations from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

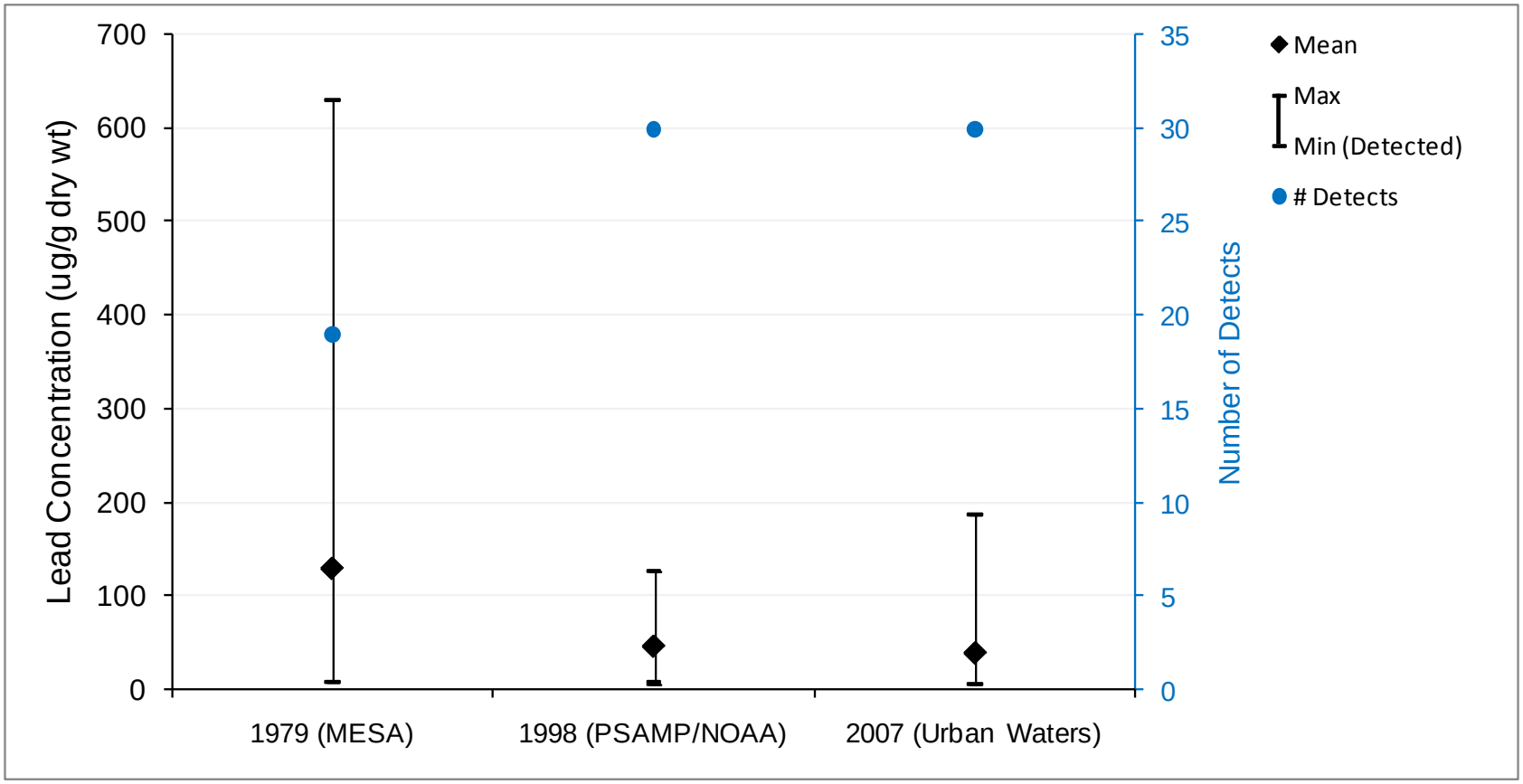

Figure A-14. Comparison of lead concentrations from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

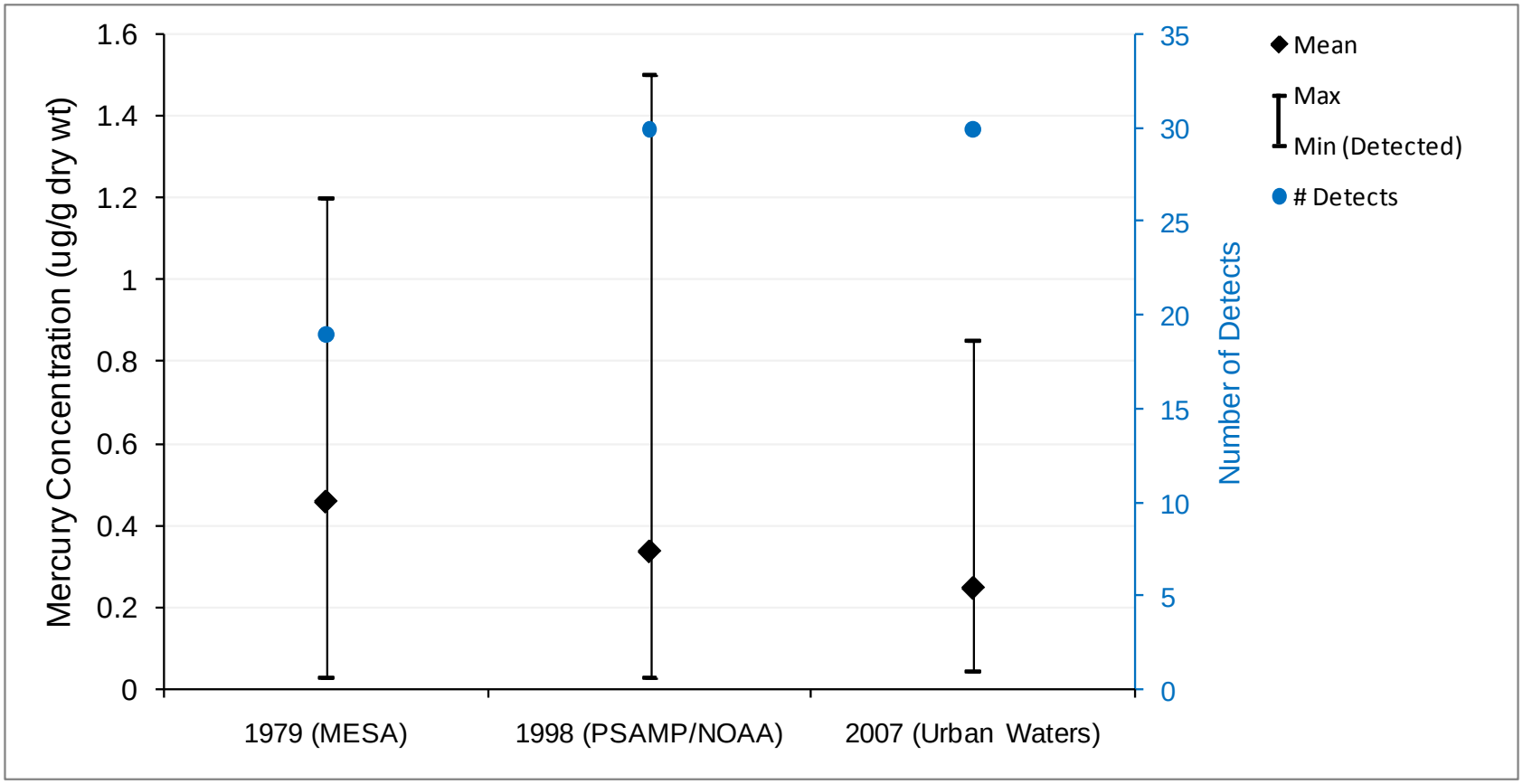

Figure A-15. Comparison of mercury concentrations from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

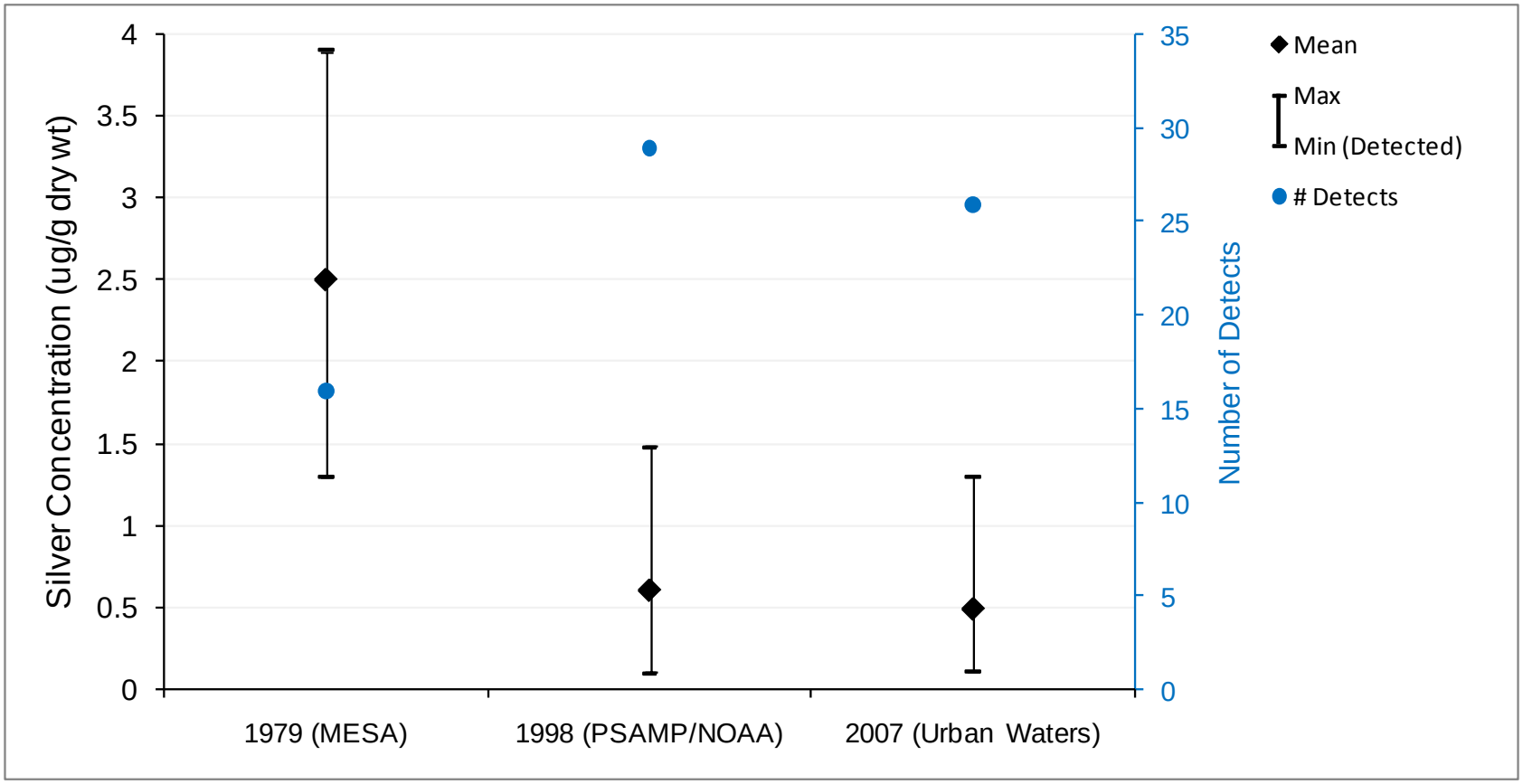

Figure A-16. Comparison of silver concentrations from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

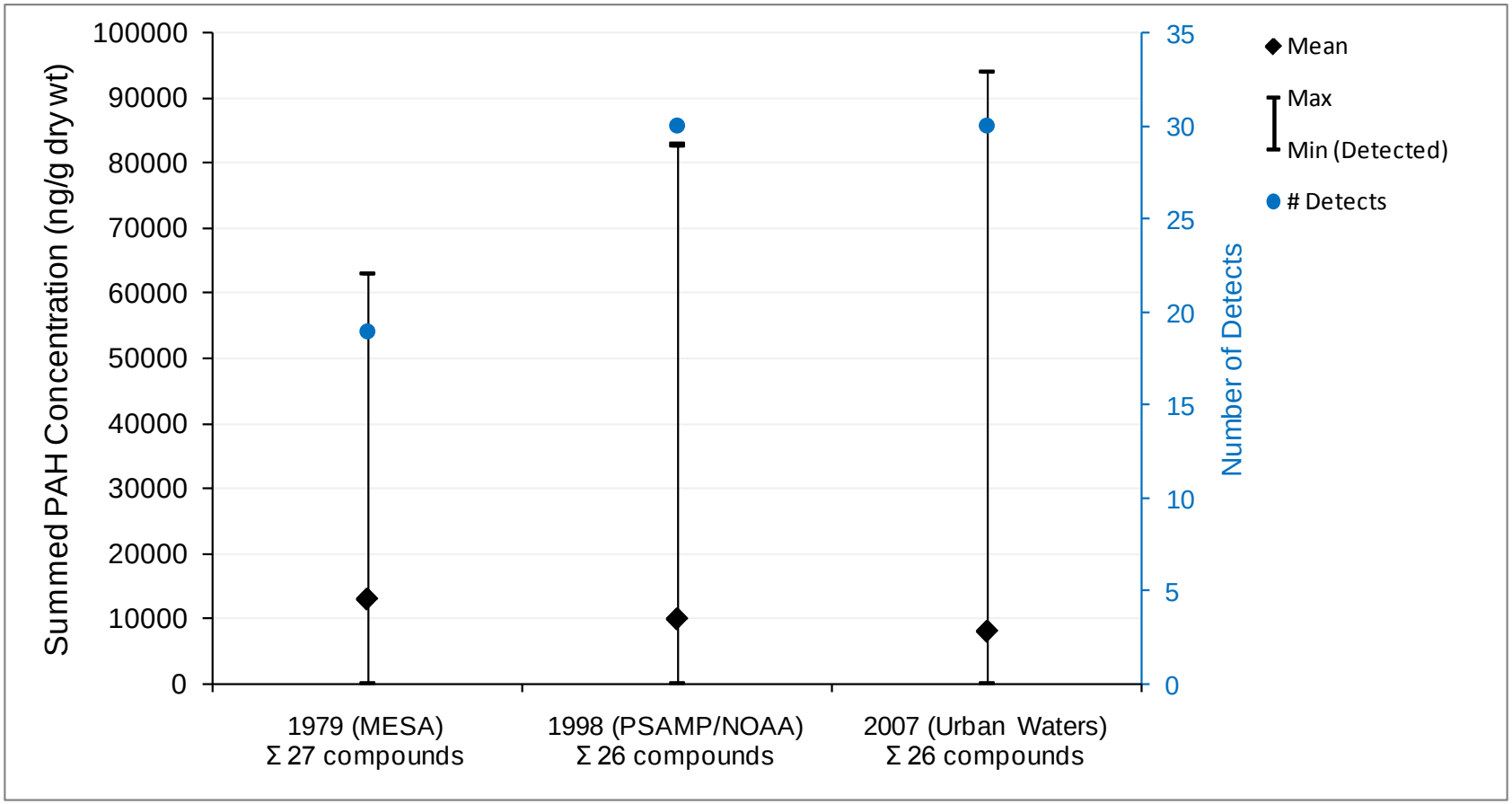

Figure A-17. Comparison of summed PAH concentrations from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

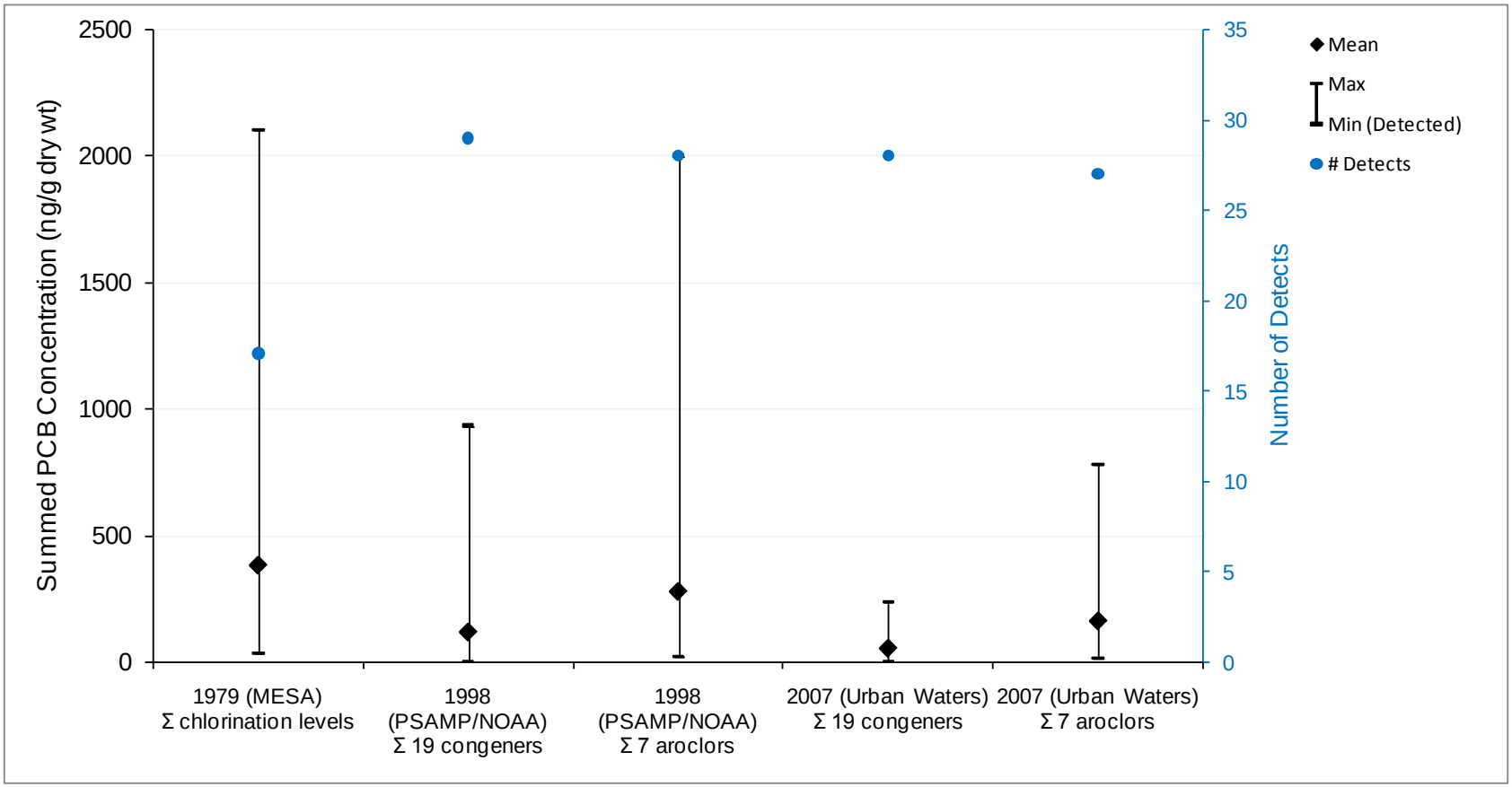

Figure A-18. Comparison of summed PCB concentrations from Urban Waters Initiative, PSAMP/NOAA, and MESA surveys in Elliott Bay and lower Duwamish River.

Appendix B. Navigation report for the 2007 Elliott Bay/Lower Duwamish Waterway Urban Waters Initiative.

Station ID Location	Sta. Rep.	Date	Station Target NAD 1983 Decimal Minutes Latitude	Station Target NAD 1983 Decimal Minutes Longitude	Sample Location Trimble NT300D (2-m accuracy) NAD 1983, Decimal Minutes Latitude	Sample Location Trimble NT300D (2-m accuracy) NAD 1983, Decimal Minutes Longitude	GPS Time	Distance to Target (meters)	Meter Wheel Depth (meters)	Predicted Tide (m): Nearest Station	Predicted Mudline Depth, m (MLLW)	GPS Status HDOP <2 good	Comments
Station 197	1	13-Jun-07	47 35.1826	122 21.8243	47 35.1825	122 21.8245	1003	0.3	8.2	-0.9	-9.1	1.0	weighted grab
Elliott Bay, south	2		47 35.1826	122 21.8243	47 35.1826	122 21.8248	1014	0.6	8.1	-0.9	-9.0	1.0	
	3		47 35.1826	122 21.8243	47 35.1829	122 21.8244	1021	0.6	8.7	-0.9	-9.6	1.0	
	4		47 35.1826	122 21.8243	47 35.1824	122 21.8238	1029	0.7	8.2	-0.9	-9.1	0.9	
	5		47 35.1826	122 21.8243	47 35.1826	122 21.8232	1038	1.4	8.8	-0.9	-9.7	0.9	
	6		47 35.1826	122 21.8243	47 35.1822	122 21.8235	1046	1.2	8.8	-0.8	-9.6	0.9	
	7		47 35.1826	122 21.8243	47 35.1828	122 21.8243	1053	0.4	8.7	-0.8	-9.5	1.1	
	8		47 35.1826	122 21.8243	47 35.1826	122 21.8239	1102	0.5	8.7	-0.7	-9.4	0.9	
Station 199	1	13-Jun-07	47 35.1999	122 21.9018	47 35.1998	122 21.9014	1132	0.5	13.2	-0.5	-13.7	1.2	weighted grab
Elliott Bay, south	2		47 35.1999	122 21.9018	47 35.2003	122 21.9013	1152	1.0	13.3	-0.3	-13.6	1.2	
	3		47 35.1999	122 21.9018	47 35.2000	122 21.9010	1204	1.0	13.5	-0.1	-13.6	1.2	
Station 189	1	13-Jun-07	47 35.4308	122 22.8303	47 35.4308	122 22.8302	1320	0.1	15.7	1.0	-14.8	1.0	weighted grab
Elliott Bay,	2		47 35.4308	122 22.8303	47 35.4318	122 22.8293	1330	2.2	16.0	1.1	-14.9	1.2	
east of Duwamish Head	3		47 35.4308	122 22.8303	47 35.4305	122 22.8307	1340	0.7	15.9	1.3	-14.6	1.3	
Station 190	1	13-Jun-07	47 35.8300	122 23.1048	47 35.8298	122 23.1049	1411	0.4	7.8	1.7	-6.1	1.1	weighted grab
Elliott Bay,	2		47 35.8300	122 23.1048	47 35.8299	122 23.1050	1424	0.3	7.8	1.9	-5.9	1.0	
Duwamish Head	3		47 35.8300	122 23.1048	47 35.8294	122 23.1056	1440	1.5	7.8	2.2	-5.6	1.0	
Station 172	1	14-Jun-07	47 35.6640	122 24.7597	47 35.6642	122 24.7603	0912	0.8	151.0	-0.5	-151.5	1.2	weighted grab
West of	2		47 35.6640	122 24.7597	47 35.6636	122 24.7589	0934	1.2	151.0	-0.7	-151.7	1.1	
Duwamish Head	3		47 35.6640	122 24.7597	47 35.6642	122 24.7595	0950	0.4	151.2	-0.8	-152.0	1.7	
Station 173	1	14-Jun-07	47 36.2243	122 23.9619	47 36.2247	122 23.9618	1031	0.8	134.2	-1.1	-135.3	0.9	weighted grab
Northwest of	2		47 36.2243	122 23.9619	47 36.2234	122 23.9611	1112	1.9	135.4	-1.1	-136.5	1.3	
Duwamish Head	3		47 36.2243	122 23.9619	47 36.2234	122 23.9615	1130	1.7	134.8	-1.0	-135.8	1.5	
Station 185	1	14-Jun-07	47 36.5990	122 22.9213	47 36.5981	122 22.9208	1305	1.8	158.0	-0.1	-158.1	1.1	weighted grab
North of	2		47 36.5990	122 22.9213	47 36.5990	122 22.9214	1325	0.1	158.5	0.2	-158.3	1.1	
Duwamish Head	3		47 36.5990	122 22.9213	47 36.5992	122 22.9219	1350	0.8	158.8	0.6	-158.2	1.1	

Station ID Location	Sta. Rep.	Date	Station Target NAD 1983 Decimal Minutes Latitude	Longitude	Sample Location Trimble NT300D (2-m accuracy) NAD 1983, Decimal Minutes Latitude	Longitude	GPS Time	Distance to Target (meters)	Meter Wheel Depth (meters)	Predicted Tide (m): Nearest Station	Predicted Mudline Depth, m (MLLW)	GPS Status HDOP <2 good	Comments
Station 192	1	14-Jun-07	47 36.1366	122 21.9574	47 36.1370	122 21.9575	1431	0.8	70.6	1.3	-69.3	1.0	weighted grab
Elliott Bay, central	2		47 36.1366	122 21.9574	47 36.1363	122 21.9570	1454	0.7	71.1	1.7	-69.4	1.1	
	3		47 36.1366	122 21.9574	47 36.1366	122 21.9573	1513	0.1	71.5	2.0	-69.5	1.0	
	4		47 36.1366	122 21.9574	47 36.1371	122 21.9579	1543	1.1	71.3	2.4	-68.9	1.2	
Station 195	1	15-Jun-07	47 35.9747	122 21.6620	47 35.9745	122 21.6609	0906	1.4	78.3	0.2	-78.1	1.2	weighted grab
Elliott Bay,	2		47 35.9747	122 21.6620	47 35.9748	122 21.6623	0926	0.4	78.0	0.1	-77.9	1.1	
west of Pier 48	3		47 35.9747	122 21.6620	47 35.9746	122 21.6618	0942	0.3	78.2	0.3	-77.9	1.6	
Station 194	1	15-Jun-07	47 36.0152	122 20.8385	47 36.0156	122 20.8378	1015	1.1	67.0	-0.7	-67.7	1.0	weighted grab
Elliott Bay,	2		47 36.0152	122 20.8385	47 36.0152	122 20.8387	1028	0.3	67.0	-0.8	-67.8	1.3	
west of Pier 48	3		47 36.0152	122 20.8385	47 36.0156	122 20.8379	1048	1.1	66.8	-1.0	-67.8	1.2	
Station 182	1	15-Jun-07	47 36.2515	122 20.6497	47 36.2514	122 20.6496	1218	0.2	35.2	-1.1	-36.3	1.5	weighted grab
Elliott Bay,	2		47 36.2515	122 20.6497	47 36.2513	122 20.6489	1233	1.1	35.1	-1.0	-36.1	1.7	
west of Pier 54	3		47 36.2515	122 20.6497	47 36.2508	122 20.6496	1246	1.3	35.5	-0.9	-36.4	1.9	
Station 183	1	15-Jun-07	47 36.2399	122 20.4234	47 36.2398	122 20.4228	1325	0.8	11.8	-0.4	-12.2	1.3	weighted grab
Elliott Bay, Pier 54	2		47 36.2399	122 20.4234	47 36.2397	122 20.4233	1342	0.4	11.8	-0.3	-12.1	1.2	
	3		47 36.2399	122 20.4234	47 36.2402	122 20.4229	1351	0.8	12.0	-0.1	-12.1	1.2	
	4		47 36.2399	122 20.4234	47 36.2399	122 20.4225	1404	1.1	12.0	0.1	-11.9	1.3	
Station 177	1	18-Jun-07	47 37.9413	122 24.1651	47 37.9412	122 24.1654	0917	0.4	6.0	2.1	-3.9	1.1	weighted grab
Magnolia Bluff	2		47 37.9413	122 24.1651	47 37.9409	122 24.1651	0928	0.7	5.9	2.0	-3.9	1.6	
	3		47 37.9413	122 24.1651	47 37.9413	122 24.1653	0941	0.3	5.8	1.8	-4.0	1.0	
	4		47 37.9413	122 24.1651	47 37.9412	122 24.1652	0954	0.2	5.4	1.7	-3.7	1.0	
	5		47 37.9413	122 24.1651	47 37.9412	122 24.1648	1001	0.4	5.2	1.6	-3.6	1.0	
Station 176	1	18-Jun-07	47 37.7506	122 23.9474	47 37.7509	122 23.9473	1032	0.6	11.9	1.2	-10.7	1.1	weighted grab
Elliott Bay,	2		47 37.7506	122 23.9474	47 37.7508	122 23.9469	1041	0.7	11.4	1.1	-10.3	1.3	
west of EB Marina	3		47 37.7506	122 23.9474	47 37.7505	122 23.9467	1051	0.9	11.7	1.0	-10.7	1.3	
	4		47 37.7506	122 23.9474	47 37.7506	122 23.9468	1101	0.8	11.3	0.8	-10.5	1.3	
	5		47 37.7506	122 23.9474	47 37.7506	122 23.9474	1111	0.0	11.2	0.7	-10.5	1.2	
	6		47 37.7506	122 23.9474	47 37.7506	122 23.9468	1139	0.8	11.1	0.3	-10.8	1.2	
Station 178	1	18-Jun-07	47 37.5479	122 23.6138	47 37.5475	122 23.6133	1258	1.0	20.8	-0.4	-21.2	1.6	weighted grab
Elliott Bay,	2		47 37.5479	122 23.6138	47 37.5477	122 23.6138	1308	0.4	21.0	-0.5	-21.5	1.5	
south of EB Marina	3		47 37.5479	122 23.6138	47 37.5476	122 23.6135	1319	0.7	20.4	-0.5	-20.9	1.3	

Station ID Location	Sta. Rep.	Date	Station Target NAD 1983 Decimal Minutes Latitude	Station Target NAD 1983 Decimal Minutes Longitude	Sample Location Trimble NT300D (2-m accuracy) NAD 1983, Decimal Minutes Latitude	Sample Location Trimble NT300D (2-m accuracy) NAD 1983, Decimal Minutes Longitude	GPS Time	Distance to Target (meters)	Meter Wheel Depth (meters)	Predicted Tide (m): Nearest Station	Predicted Mudline Depth, m (MLLW)	GPS Status HDOP <2 good	Comments
Station 178 (cont.)	4		47 37.5479	122 23.6138	47 37.5474	122 23.6140	1331	1.0	20.5	-0.6	-21.1	1.3	
	5		47 37.5479	122 23.6138	47 37.5479	122 23.6137	1342	0.1	20.7	-0.6	-21.3	1.2	
	6		47 37.5479	122 23.6138	47 37.5477	122 23.6138	1350	0.4	21.0	-0.6	-21.6	1.1	
Station 180	1	18-Jun-07	47 37.4889	122 22.7208	47 37.4886	122 22.7211	1412	0.7	21.8	-0.6	-22.4	1.0	weighted grab
Elliott Bay, Piers 89-90	2		47 37.4889	122 22.7208	47 37.4891	122 22.7205	1425	0.5	21.7	-0.5	-22.2	1.0	
	3		47 37.4889	122 22.7208	47 37.4885	122 22.7204	1436	0.9	22.0	-0.5	-22.5	1.1	
	4		47 37.4889	122 22.7208	47 37.4891	122 22.7206	1449	0.4	21.5	-0.4	-21.9	1.1	
Station 186	1	18-Jun-07	47 37.0907	122 21.9217	47 37.0906	122 21.9223	1519	0.8	38.2	-0.2	-38.4	1.2	weighted grab
Elliott Bay,	2		47 37.0907	122 21.9217	47 37.0914	122 21.9211	1533	1.5	37.9	-0.1	-38.0	1.2	split sample
west of Denny Way	3		47 37.0907	122 21.9217	47 37.0912	122 21.9221	1547	1.1	38.0	0.1	-37.9	1.4	
	4		47 37.0907	122 21.9217	47 37.0910	122 21.9215	1601	0.6	38.1	0.3	-37.8	1.2	
Station 181	1	19-Jun-07	47 36.9020	122 21.7381	47 36.9026	122 21.7380	0903	1.1	38.6	2.5	-36.1	1.1	weighted grab
Elliott Bay,	2		47 36.9020	122 21.7381	47 36.9020	122 21.7385	0916	0.5	39.0	2.4	-36.6	1.5	split sample
west of Piers 70-71	3		47 36.9020	122 21.7381	47 36.9020	122 21.7381	0936	0.0	39.2	2.3	-36.9	1.0	
	4		47 36.9020	122 21.7381	47 36.9019	122 21.7384	0955	0.4	39.1	2.1	-37.0	1.0	
	5		47 36.9020	122 21.7381	47 36.9020	122 21.7376	1011	0.6	38.7	2.0	-36.8	1.0	
	6		47 36.9020	122 21.7381	47 36.9031	122 21.7368	1021	2.6	38.2	1.9	-36.3	0.9	
	7		47 36.9020	122 21.7381	47 36.9020	122 21.7382	1031	0.1	38.0	1.8	-36.2	1.2	
Station 187	1	19-Jun-07	47 36.4312	122 21.5416	47 36.4316	122 21.5418	1104	0.8	104.8	1.5	-103.3	1.2	unwt. grab
Elliott Bay,	2		47 36.4312	122 21.5416	47 36.4311	122 21.5415	1130	0.2	103.8	1.2	-102.6	1.6	
west of Pier 59	3		47 36.4312	122 21.5416	47 36.4312	122 21.5412	1145	0.5	104.0	1.0	-103.0	1.2	
Station 188	1	19-Jun-07	47 36.3618	122 20.6336	47 36.3614	122 20.6330	1243	1.1	34.6	0.4	-34.2	1.7	unwt. grab
Elliott Bay,	2		47 36.3618	122 20.6336	47 36.3616	122 20.6330	1300	0.8	34.7	0.2	-34.5	1.0	
west of Pier 57	3		47 36.3618	122 20.6336	47 36.3618	122 20.6338	1314	0.3	34.2	0.1	-34.1	1.3	
Station 184	1	19-Jun-07	47 36.2806	122 20.4588	47 36.2810	122 20.4582	1340	1.1	10.8	-0.1	-10.9	1.1	weighted grab
Elliott Bay, Pier 55	2		47 36.2806	122 20.4588	47 36.2807	122 20.4592	1357	0.5	10.8	-0.1	-10.9	1.0	
	3		47 36.2806	122 20.4588	47 36.2811	122 20.4591	1408	1.0	11.0	-0.2	-11.2	1.2	
	4		47 36.2806	122 20.4588	47 36.2807	122 20.4594	1436	0.8	10.8	-0.2	-11.0	1.4	
	5		47 36.2806	122 20.4588	47 36.2808	122 20.4594	1447	0.8	10.8	-0.2	-11.0	1.1	
	6		47 36.2806	122 20.4588	47 36.2809	122 20.4593	1457	0.8	10.9	-0.2	-11.1	1.0	

Station ID Location	Sta. Rep.	Date	Station Target NAD 1983 Decimal Minutes Latitude	Longitude	Sample Location Trimble NT300D (2-m accuracy) NAD 1983, Decimal Minutes Latitude	Longitude	GPS Time	Distance to Target (meters)	Meter Wheel Depth (meters)	Predicted Tide (m): Nearest Station	Predicted Mudline Depth, m (MLLW)	GPS Status HDOP <2 good	Comments
Station 196	1	19-Jun-07	47 36.0731	122 20.9792	47 36.0731	122 20.9789	1532	0.4	72.5	-0.1	-72.6	1.4	weighted grab
Elliott Bay,	2		47 36.0731	122 20.9792	47 36.0728	122 20.9791	1549	0.6	72.3	0.0	-72.3	1.4	
west of Yesler Way	3		47 36.0731	122 20.9792	47 36.0734	122 20.9781	1602	1.5	72.5	0.1	-72.4	1.2	
Station 115	1	20-Jun-07	47 37.6865	122 22.7632	47 37.6862	122 22.7628	0903	0.7	14.4	2.5	-12.0	1.1	weighted grab
Elliott Bay,	2		47 37.6865	122 22.7632	47 37.6867	122 22.7629	0911	0.5	14.2	2.4	-11.8	1.2	
east side of Pier 90	3		47 37.6865	122 22.7632	47 37.6863	122 22.7623	0923	1.2	14.2	2.4	-11.8	1.6	
	4		47 37.6865	122 22.7632	47 37.6868	122 22.7621	0941	1.5	14.6	2.4	-12.2	1.1	
	5		47 37.6865	122 22.7632	47 37.6857	122 22.7618	0952	2.3	14.4	2.3	-12.1	1.0	
	6		47 37.6865	122 22.7632	47 37.6865	122 22.7616	1005	2.0	14.5	2.3	-12.2	1.0	
	7		47 37.6865	122 22.7632	47 37.6868	122 22.7641	1018	1.3	14.1	2.2	-11.9	1.2	
Station 200	1	20-Jun-07	47 35.0786	122 20.7475	47 35.0788	122 20.7478	1106	0.5	18.9	1.9	-17.0	1.5	weighted grab
East Waterway,	2		47 35.0786	122 20.7475	47 35.0784	122 20.7475	1122	0.4	18.9	1.8	-17.1	1.2	
Terminal 18	3		47 35.0786	122 20.7475	47 35.0782	122 20.7473	1145	0.8	18.8	1.6	-17.2	1.2	
Station 201	1	20-Jun-07	47 34.9571	122 20.6067	47 34.9573	122 20.6067	1318	0.4	15.0	0.8	-14.2	1.3	unwt. grab
East Waterway,	2		47 34.9571	122 20.6067	47 34.9572	122 20.6071	1330	0.5	15.0	0.7	-14.3	1.1	
Pier 32	3		47 34.9571	122 20.6067	47 34.9571	122 20.6066	1345	0.1	15.0	0.6	-14.4	0.9	
	4		47 34.9571	122 20.6067	47 34.9566	122 20.6066	1359	0.9	14.9	0.5	-14.4	1.0	
Station 202	1	20-Jun-07	47 34.4596	122 20.5997	47 34.4593	122 20.6003	1435	0.9	15.0	0.3	-14.7	1.1	unwt. grab
East Waterway,	2		47 34.4596	122 20.5997	47 34.4592	122 20.5992	1451	1.0	14.9	0.2	-14.7	1.0	split sample
south end	3		47 34.4596	122 20.5997	47 34.4596	122 20.5998	1509	0.1	15.1	0.2	-14.9	1.1	
	4		47 34.4596	122 20.5997	47 34.4598	122 20.6001	1522	0.6	14.9	0.2	-14.7	1.2	
Station 114	1	21-Jun-07	47 34.5267	122 21.6423	47 34.5268	122 21.6424	0916	0.2	21.9	2.2	-19.7	1.6	weighted grab
West Waterway,	2		47 34.5267	122 21.6423	47 34.5266	122 21.6415	0930	1.0	21.8	2.2	-19.6	1.7	
Terminal 5	3		47 34.5267	122 21.6423	47 34.5267	122 21.6424	0940	0.1	21.9	2.3	-19.7	1.8	
	4		47 34.5267	122 21.6423	47 34.5266	122 21.6427	0951	0.5	21.7	2.3	-19.5	1.1	
Station 203	1	21-Jun-07	47 33.6844	122 20.8461	47 33.6840	122 20.8460	1021	0.8	6.4	2.2	-4.2	1.2	weighted grab
Duwamish River,	2		47 33.6844	122 20.8461	47 33.6847	122 20.8462	1036	0.6	6.3	2.2	-4.1	1.3	
north	3		47 33.6844	122 20.8461	47 33.6841	122 20.8453	1048	1.1	6.0	2.2	-3.8	1.3	
Station 204	1	21-Jun-07	47 33.6554	122 20.7053	47 33.6555	122 20.7069	1236	2.0	6.8	1.7	-5.1	1.6	weighted grab
Duwamish River,	2		47 33.6554	122 20.7053	47 33.6557	122 20.7070	1247	2.2	6.8	1.7	-5.1	1.6	moved 2 m west
north	3		47 33.6554	122 20.7053	47 33.6552	122 20.7064	1257	1.4	6.7	1.6	-5.1	1.0	

Station ID Location	Sta. Rep.	Date	Station Target NAD 1983 Decimal Minutes Latitude	Longitude	Sample Location Trimble NT300D (2-m accuracy) NAD 1983, Decimal Minutes Latitude	Longitude	GPS Time	Distance to Target (meters)	Meter Wheel Depth (meters)	Predicted Tide (m): Nearest Station	Predicted Mudline Depth, m (MLLW)	GPS Status HDOP <2 good	Comments
Station 205	1	21-Jun-07	47 32.7066	122 20.2126	47 32.7068	122 20.2131	1322	0.7	8.5	1.5	-7.1	1.3	weighted grab
Duwamish River,	2		47 32.7066	122 20.2126	47 32.7066	122 20.2123	1337	0.4	8.5	1.4	-7.2	1.2	
SW of Slip 2	3		47 32.7066	122 20.2126	47 32.7066	122 20.2119	1348	0.9	8.4	1.3	-7.1	1.0	

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Appendix C. Field notes for the 2007 Elliott Bay and Lower Duwamish Waterway Urban Waters Initiative.

Station number	Location	Strata type	Meter Wheel Depth (m)	Pene-tration (cm)	Overlying Sediment Color	Underlying Sediment Color	Composition	Odor	Odor intensity	Shell Hash	Wood Frag	Salinity (ppt)	Sediment Temp-erature (°C)	Sheen
114	West Waterway, Terminal 5	Harbor	22	13	Gray Black	Black	Silt/clay	None	None	No	Yes	30	10.5	Yes
115	Elliott Bay east side of Pier 90	Harbor	14	14	Black	Black	Sand with fines	Petro -leum	Moderate	Yes	Yes	30	11.7	Yes
172	West of Duwamish Head	Basin	151	17	Olive	Olive	Silt/clay	None	None	No	No	30	17	None
173	Northwest of Duwamish Head	Basin	134	17	Olive	Olive	Silt/clay	None	None	No	No	25	10.5	None
176	Elliott Bay, west of EB Marina	Urban	12	11.9	Brown	Brown	Sand	None	None	No	No	30	10.6	None
177	Magnolia Bluff	Urban	6	10	Brown	Brown	Sand	None	None	Yes	No	30	10.8	None
178	Elliott Bay, south of EB Marina	Urban	21	9.5	Brown	Brown	Sand	None	None	No	No	30	10.9	None
180	Elliott Bay, Piers 89-90	Harbor	22	12	Brown	Brown	Sand with fines	None	None	No	No	30	10.5	None
181	Elliott Bay, west of Piers 70-71	Harbor	39	9	Olive Gray	Gray Brown	Mixed	None	None	No	No	30	10	None
182	Elliott Bay, west of Pier 54	Harbor	35	17	Olive	Gray	Mixed	None	None	No	No	29	9.9	None
183	Elliott Bay, Pier 54	Harbor	12	11	Gray Brown	Gray	Sand	None	None	No	No	29	10.4	None
184	Elliott Bay, Pier 55	Harbor	11	12	Olive	Gray Brown	Mixed	None	None	No	No	30	10.4	Yes
185	North of Duwamish Head	Urban	158	17	Olive	Olive	Silt/clay	None	None	No	No	25	9	None
186	Elliott bay, west of Denny Way	Urban	38	16	Brown	Gray	Sand with fines	None	None	No	No	30	10.2	None
187	Elliott Bay, west of Pier 59	Urban	105	17	Olive	Gray	Silt/clay	None	None	No	No	30	9.6	None
188	Elliott Bay, west of Pier 57	Urban	35	17	Olive	Gray	Sand with fines	None	None	No	No	30	10	None

Station number	Location	Strata type	Meter Wheel Depth (m)	Pene-tration (cm)	Overlying Sediment Color	Underlying Sediment Color	Composition	Odor	Odor intensity	Shell Hash	Wood Frag	Salinity (ppt)	Sediment Temp-erature (°C)	Sheen
189	Elliott Bay, east of Duwamish Head	Urban	16	8.5	Olive	Brown	Sand with fines	None	None	No	No	30	10.6	None
190	Elliott Bay, Duwamish Head	Urban	8	7	Gray	Gray	Sand	None	None	No	No	30	11.4	None
192	Elliott Bay, central	Urban	71	17	Olive	Olive	Sand and cobble	None	None	No	No	27	9.5	None
194	Elliott Bay, west of Pier 48	Urban	67	17	Olive	Gray	Silt/clay	None	None	None	None	28	9.3	None
195	Elliott Bay, west of Pier 48	Urban	78	17	Olive	Gray	Sand with fines	None	None	No	Yes	27	9.7	None
196	Elliott Bay, west of Yesler Way	Urban	72	17	Olive	Gray	Sand with fines	None	None	No	No	27	9.7	None
197	Elliott Bay, south	Harbor	8	10.5	Brown	Brown	Gravel and sand	None	None	Yes	No	30	10.5	None
199	Elliott Bay, south	Harbor	13	13	Gray	Gray	Sand with fines	None	None	No	No	30	10.4	None
200	East Waterway, Terminal 18	Harbor	19	17	Olive	Gray	Sand with fines	None	None	Yes	Yes	30	12.2	None
201	East Waterway, Pier 32	Harbor	15	13	Brown	Gray	Gravel with fines	H2S	Strong	No	No	28	10.7	None
202	East Waterway, South end	Harbor	15	15	Olive	Gray	Silt/clay	None	None	No	No	27	10.5	None
203	Duwamish River, North	Harbor	6	14	Gray	Black	Sand with fines	None	None	No	No	25	10.8	None
204	Duwamish River, North	Harbor	7	10	Brown	Gray	Gravel and sand	None	None	No	No	26	10.7	None
205	Duwamish River, SW of Slip 2	Harbor	8	17	Gray	Black	Sand with fines	H2S	Slight	No	Yes	20	10.7	None

Appendix D (Electronic in part). Data and graphical summaries for physical parameters.

Tables

The tables listed below contain the raw data for physical parameters for the 2007 Urban Waters Initiative study in Elliott Bay and the lower Duwamish Waterway. The table contents are given in their entirety in the electronic appendix.

Table D-1 (Appendix Page 46). Grain size.

Table D-2 (Appendix Page 47). Total organic carbon (TOC).

Table D-3 (Electronic). Sediment chemistry.

Table D-1. Results of grain size analyses of sediments collected for the 2007 Urban Waters Initiative study.

Station	Location	% Gravel	Coarse Sand	Fine Sand	Medium Sand	Very Coarse Sand	Very Fine Sand	Total Sand	Total Silt	Total Clay
114	West Waterway, Terminal 5	0.1	1.4	19.8	9.4	0.4	17.4	48.3	35.9	15.7
115	Elliott Bay, east side of Pier 90	4.3	1.8	26.1	8.0	1.4	22.1	59.5	25.5	10.7
172	West of Duwamish Head	0.0	4.3	2.4	4.2	0.3	4.1	15.3	44.5	40.2
173	Northwest of Duwamish Head	6.2	5.6	10.4	11.6	2.4	9.9	39.9	30.3	23.6
176	Elliott Bay, west of EB Marina	0.3	5.3	34.5	45.9	0.7	4.0	90.4	6.0	3.3
177	Magnolia Bluff	0.1	1.3	52.6	36.7	0.2	5.4	96.3	2.9	0.7
178	Elliott Bay, south of EB Marina	0.2	2.2	39.4	41.4	0.1	8.7	91.8	5.7	2.3
180	Elliott Bay, Piers 89-90	0.3	2.0	32.3	12.9	0.5	26.9	74.5	21.5	3.7
181	Elliott Bay, west of Piers 70-71	15.2	8.2	8.2	11.1	9.3	5.9	42.5	28.2	14.2
182	Elliott Bay, west of Pier 54	4.4	4.0	10.3	11.3	3.3	7.3	36.3	44.0	15.3
183	Elliott Bay, Pier 54	1.1	14.0	16.6	45.0	3.0	3.3	81.8	11.9	5.2
184	Elliott Bay, Pier 55	25.8	6.6	15.6	22.0	5.4	5.0	54.6	13.7	5.9
185	North of Duwamish Head	0.0	3.2	3.2	4.0	2.3	3.9	16.7	50.7	32.6
186	Elliott bay, west of Denny Way	2.7	3.8	31.1	17.5	2.6	10.9	65.8	24.0	7.6
187	Elliott Bay, west of Pier 59	0.2	3.7	3.6	5.1	0.3	5.0	17.6	51.1	31.1
188	Elliott Bay, west of Pier 57	0.8	3.3	8.1	9.6	1.3	7.3	29.7	52.6	16.9
189	Elliott Bay, east of Duwamish Head	0.6	1.3	36.3	9.4	0.3	26.9	74.2	21.2	4.0
190	Elliott Bay, Duwamish Head	0.3	1.0	56.4	29.4	0.2	9.5	96.5	3.2	0.0
192	Elliott Bay, central	20.8	8.8	15.4	17.8	7.8	7.3	57.1	15.5	6.6
194	Elliott Bay, west of Pier 48	0.0	3.9	3.1	4.4	3.0	4.4	18.7	57.3	24.0
195	Elliott Bay, west of Pier 48	0.1	1.7	15.2	6.3	0.7	18.0	41.9	42.5	15.5
196	Elliott Bay, west of Yesler Way	0.0	3.7	2.8	4.0	4.2	3.9	18.7	56.5	24.8
197	Elliott Bay, south	1.5	8.3	29.9	30.7	1.6	14.6	85.1	10.3	3.1
199	Elliott Bay, south	2.6	5.4	20.8	13.9	2.3	22.2	64.7	28.3	4.4
200	East Waterway, Terminal 18	0.6	1.7	27.8	14.2	0.5	15.0	59.3	28.0	12.1
201	East Waterway, Pier 32	0.8	1.9	13.4	6.4	0.9	13.8	36.4	41.9	20.9
202	East Waterway, south end	0.2	4.5	4.1	7.5	1.9	6.4	24.2	56.2	19.5
203	Duwamish River, North	0.4	4.1	18.8	33.8	0.7	4.4	61.7	26.7	11.2
204	Duwamish River, North	12.7	7.0	15.1	19.3	2.3	5.9	49.6	25.4	12.3
205	Duwamish River, SW of Slip 2	1.0	16.7	7.8	19.4	4.0	4.9	52.7	36.5	9.8

Table D-2. Results of total organic carbon (TOC) analyses of sediments collected for the 2007 Urban Waters Initiative study.

Station	Location	Percent Total Organic Carbon			
		Sample	Field duplicate	Lab duplicate	Lab triplicate
114	West Waterway, Terminal 5	1.08			
115	Elliott Bay, east side of Pier 90	1.83			
172	West of Duwamish Head	2.25			
173	Northwest of Duwamish Head	1.92			
176	Elliott Bay, west of EB Marina	0.40			
177	Magnolia Bluff	0.17			
178	Elliott Bay, south of EB Marina	0.19			
180	Elliott Bay, Piers 89-90	0.69			
181	Elliott Bay, west of Piers 70-71	1.30	1.29		
182	Elliott Bay, west of Pier 54	4.04			
183	Elliott Bay, Pier 54	1.86			
184	Elliott Bay, Pier 55	3.32			
185	North of Duwamish Head	2.27			
186	Elliott Bay, west of Denny Way	0.92	0.91		
187	Elliott Bay, west of Pier 59	1.96			
188	Elliott Bay, west of Pier 57	2.44			
189	Elliott Bay, east of Duwamish Head	0.65			
190	Elliott Bay, Duwamish Head	0.16			
192	Elliott Bay, central	0.85			
194	Elliott Bay, west of Pier 48	2.13			
195	Elliott Bay, west of Pier 48	2.07			
196	Elliott Bay, west of Yesler Way	2.00			
197	Elliott Bay, south	0.54		0.37	0.44
199	Elliott Bay, south	5.76			
200	East Waterway, Terminal 18	1.16			
201	East Waterway, Pier 32	1.71			
202	East Waterway, south end	2.67		2.81	2.58
202	East Waterway, south end		2.55	2.63	2.63
203	Duwamish River, North	1.62			
204	Duwamish River, North	1.61			
205	Duwamish River, SW of Slip 2	1.62			

Table D-3 (Electronic). Results of chemistry analyses of sediments collected for the 2007 Urban Waters Initiative study.
Electronic dataset name: Table D-3 raw chemistry results.xls

The table headings below contain only the lists of variables. The table contents are given in their entirety in the electronic appendix.

Chemical	Station 114		. . .		Station 205	
	Concentration	Qualifier	Concentration	Qualifier	Concentration	Qualifier

Figures

Figures D-1 – D-132 (Electronic). Graphical summaries and spatial patterns of grain size, TOC, and analytical chemical concentrations in sediments collected from the 2007 Urban Waters Initiative study. Comparisons to 1998 results from the PSAMP/NOAA survey are included. *Electronic filename:* Appendix D graphical summaries - all grain size TOC chem.ppt

Figure	ParameterCode
Grain Size	
D-1	Percent Fines
Total Organic Carbon	
D-2	Total Organic Carbon
Priority Pollutant Metals	
D-3	Arsenic
D-4	Cadmium
D-5	Chromium
D-6	Copper
D-7	Lead
D-8	Mercury
D-9	Nickel
D-10	Selenium
D-11	Silver
D-12	Zinc
Trace Elements	
D-13	Tin
Organic Compounds	
Chlorinated Alkanes	
D-14	Hexachlorobutadiene
Chlorinated and Nitro-Substituted Phenols	
D-15	Pentachlorophenol
Chlorinated Aromatic Compounds	
D-16	1,2,4-Trichlorobenzene
D-17	1,2-Dichlorobenzene
D-18	1,3-Dichlorobenzene
D-19	1,4-Dichlorobenzene
D-20	2-Chloronaphthalene
D-21	Hexachlorobenzene (Method 8270)
Chlorinated Pesticides	
D-22	2,4'-DDD
D-23	2,4'-DDE
D-24	2,4'-DDT
D-25	4,4'-DDD
D-26	4,4'-DDE
D-27	4,4'-DDT
D-28	Aldrin
D-29	Cis-chlordane (Alpha-chlordane)
D-30	Dieldrin
D-31	Endosulfan I
D-32	Endosulfan II
D-33	Endosulfan Sulfate
D-34	Endrin
D-35	Endrin Aldehyde
D-36	Endrin Ketone
D-37	Gamma-BHC (Lindane)
D-38	Heptachlor
D-39	Heptachlor Epoxide
D-40	Hexachlorobenzene
D-41	Mirex
D-42	Oxychlordane
D-43	Toxaphene
D-44	Trans-Chlordane (Gamma)

Figure	ParameterCode
Polynuclear Aromatic Hydrocarbons	
LPAHs	
D-45	1,6,7-Trimethylnaphthalene
D-46	1-Methylnaphthalene
D-47	2,6-Dimethylnaphthalene
D-48	2-Methylnaphthalene
D-49	2-Methylphenanthrene
D-50	Acenaphthene
D-51	Acenaphthylene
D-52	Anthracene
D-53	Biphenyl
D-54	Dibenzothiophene
D-55	Fluorene
D-56	Naphthalene
D-57	Phenanthrene
D-58	Retene
HPAHs	
D-59	Benzo(a)anthracene
D-60	Benzo(a)pyrene
D-61	Benzo(b)fluoranthene
D-62	Benzo[e]pyrene
D-63	Benzo(g,h,i)perylene
D-64	Benzo(k)fluoranthene
D-65	Chrysene
D-66	Dibenzo(a,h)anthracene
D-67	Fluoranthene
D-68	Indeno(1,2,3-c,d)pyrene
D-69	Perylene
D-70	Pyrene
Miscellaneous Extractable Compounds	
D-71	Benzoic Acid
D-72	Benzyl Alcohol
D-73	Beta-coprostanol
D-74	Carbazole
D-75	Cholesterol
D-76	Dibenzofuran
D-77	Isophorone
Organonitrogen Compounds	
D-78	Caffeine
D-79	N-Nitrosodiphenylamine
Phenols	
D-80	2,4-Dimethylphenol
D-81	2-Methylphenol
D-82	4-Methylphenol
D-83	Phenol
D-84	P-nonylphenol
Phthalate Esters	
D-85	Bis(2-Ethylhexyl) Phthalate
D-86	Butylbenzylphthalate
D-87	Diethylphthalate
D-88	Dimethylphthalate
D-89	Di-N-Butylphthalate
D-90	Di-N-Octyl Phthalate

Figure	ParameterCode
Polychlorinated Biphenyls (PCBs)	
PCB Congeners	
D-91	PCB Congener 8
D-92	PCB Congener 18
D-93	PCB Congener 28
D-94	PCB Congener 44
D-95	PCB Congener 52
D-96	PCB Congener 66
D-97	PCB Congener 77
D-98	PCB Congener 101
D-99	PCB Congener 105
D-100	PCB Congener 118
D-101	PCB Congener 126
D-102	PCB Congener 128
D-103	PCB Congener 138
D-104	PCB Congener 153
D-105	PCB Congener 169
D-106	PCB Congener 170
D-107	PCB Congener 180
D-108	PCB Congener 187
D-109	PCB Congener 195
D-110	PCB Congener 206
PCB Aroclors	
D-111	PCB Aroclor 1016
D-112	PCB Aroclor 1221
D-113	PCB Aroclor 1232
D-114	PCB Aroclor 1242
D-115	PCB Aroclor 1248
D-116	PCB Aroclor 1254
D-117	PCB Aroclor 1260
D-118	PCB Aroclor 1262
D-119	PCB Aroclor 1268
Polybrominated Diphenylethers (PBDEs)	
D-120	PBDE- 47
D-121	PBDE- 49
D-122	PBDE- 66
D-123	PBDE- 71
D-124	PBDE- 99
D-125	PBDE-100
D-126	PBDE-138
D-127	PBDE-153
D-128	PBDE-154
D-129	PBDE-183
D-130	PBDE-184
D-131	PBDE-191
D-132	PBDE-209

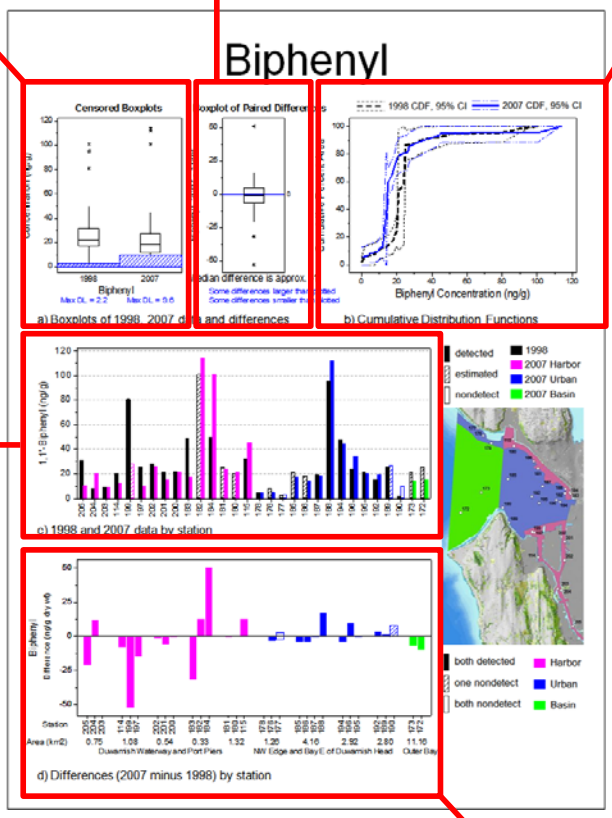
Elements of Graphical Summaries

The graphical summaries in this appendix display the following information for each parameter.

Censored boxplots
Boxplots of data censored at highest detection limit (DL) each year for that analyte.
See Helsel (2005).

Boxplots of differences
2007 minus 1998 by station:
positive = increase,
negative = decrease.
Median estimated due to uncertainties in nondetects.

CDF comparisons
Cumulative Distribution Function (CDF) = % of area summed cumulatively for increasing values of parameter.
Also shown are confidence intervals (CI) for estimated % area.



Raw data by station and year, ordered by increasing area represented
Values for the 1st replicate, indicating estimates and nondetects (raw chemistry data in electronic Appendix D Table D-3).
For nondetects, the height of the bar is the detection limit.

Differences (2007 minus 1998) by station, ordered by increasing area represented
Paired differences: negative = decrease, positive = increase.
Uncertainty in nondetects is displayed as range of values.

Appendix E (Electronic only). Grain-size analysis report (Analytical Resources, Inc.).

Electronic filename: 2007 Urban Waters Grain Size case narrative.pdf

Appendix F (Electronic only). Chemistry Case Narratives

Electronic filenames:

2007 Urban Waters TOC Case Narrative.pdf

2007 Urban Waters Metals Case Narrative.pdf

2007 Urban Waters PAH Case Narrative.pdf

2007 Urban Waters BNA Case Narrative.pdf

2007 Urban Waters Pesticides and PCB Case Narrative.pdf

2007 Urban Waters PBDE Case Narrative.pdf

2007 Urban Waters PBDE Case Narrative 2.pdf

Appendix G (Electronic only). Toxicity of marine sediments from the 2007 Urban Waters Initiative in Elliott Bay and the lower Duwamish Waterway to *Strongylocentrotus purpuratus.* Final reports and appendices from U.S. Geological Survey.

Electronic filenames:

PSAMP Spatial and Urban Waters 2007 Final Report.pdf

Table 4 Water quality URBANWATERS2007.xls

Table 5 Urbanwaters_FERT.xls

Figure 2 2007 Urban Waters Elliott Bay-Lower Duwamish.ai

Appendix 1. Relevant sample dates PSAMP 2007.xls

Attachment 1. SOP P. 649 PWExtraction.doc

Attachment 2. SOP P. 651 Water Quality Adjustments.doc

Attachment 3. SOP P. 646 Measuring Ammonia.doc

Attachment 4. SOP P. 657 Measuring Sulfide.doc

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Appendix H (Electronic only). Data and graphical summaries for benthos.

Figures H-1 – H-10 (Electronic). Graphical summaries and spatial patterns of measures of benthic invertebrate assemblages in sediments collected from the 2007 Urban Waters Initiative survey in Elliott Bay and the lower Duwamish Waterway stations. Comparisons to 1998 results from the PSAMP/NOAA survey are included.

Figure	Benthic Measure
H-1	Total Abundance
H-2	Taxa Richness
H-3	Pielou's Evenness J'
H-4	Swartz' Dominance Index (SDI)
H-5	Swartz' Dominance Index standardized by Taxa Richness
H-6	Annelid Abundance
H-7	Arthropod Abundance
H-8	Echinoderm Abundance
H-9	Mollusc Abundance
H-10	Abundance of Miscellaneous Taxa

Electronic filename: Appendix H graphical summaries - all benthic measures and major taxa.ppt

Tables

The table listed below contains the raw data for benthic invertebrates for the 2007 Urban Waters Initiative study in Elliott Bay and the lower Duwamish Waterway. The table contents are given in their entirety in the electronic appendix.

Table H-1 (Electronic). Benthic invertebrate data by assemblage group
Electronic filename: Appendix H benthos raw data by assemblage group.xls.

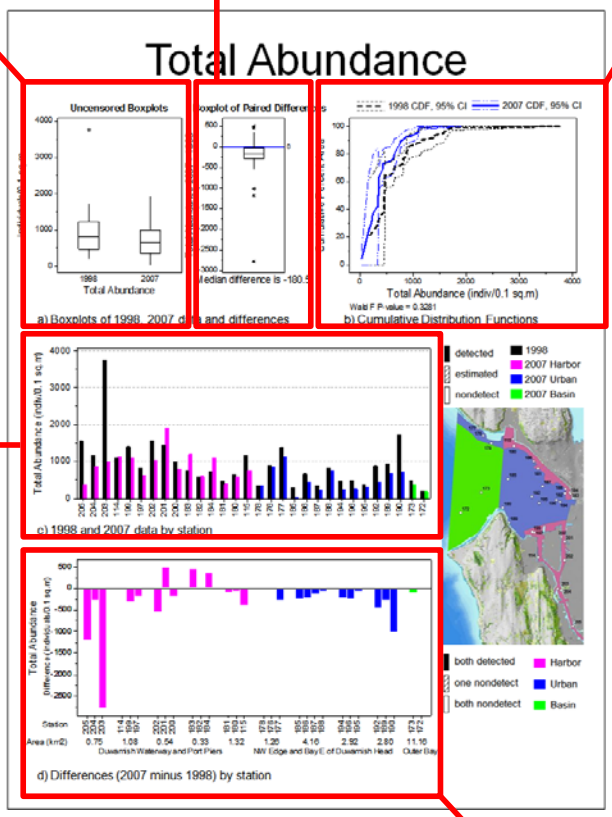
Elements of Graphical Summaries

The graphical summaries in this appendix display the following information for each parameter.

Boxplots
Boxplots of data each year for that benthic measure.

Boxplots of differences
2007 minus 1998 by station:
positive = increase,
negative = decrease.

CDF comparisons
Cumulative Distribution Function (CDF) = % of area summed cumulatively for increasing values of parameter.
Also shown are confidence intervals (CI) for estimated % area.



Data by station and year, ordered by increasing area represented
Values for the 1st replicate.

Differences (2007 minus 1998) by station, ordered by increasing area represented
Paired differences: negative = decrease, positive = increase.

Appendix I (Electronic only). Benthic infaunal species.

Tables

The tables listed below contain the benthic infaunal species for the 2007 Urban Waters Initiative survey in Elliott Bay and the lower Duwamish Waterway. The table contents are given in their entirety in the electronic appendix.

Table I-1 (Electronic). Benthic infaunal species identified for the 2007 Urban Waters Initiative study.
Electronic filename: Benthic infaunal species identified for the 2007 Urban Waters Initiative.doc

Table I-2 (Electronic). Top ten species abundances.
Electronic filename: Appendix I Table I-2 top ten abundances.xls

Appendix J. Benthos QA report.

Tables

The tables listed below contain the raw data for physical parameters for the 2007 Urban Waters Initiative study in Elliott Bay and the lower Duwamish Waterway. The table contents are given in their entirety in the electronic appendix.

Table J-1. Sort quality assurance / quality control (QA/QC).

Station	Location	Date	Sorted by	QA/QC Sorter	QA/QC Percent sorted	QA/QC Pass/Fail
114	West Waterway, Terminal 5	6/21/2007	SW	SA	25%	Pass
115	Elliott Bay, east side of Pier 90	6/20/2007	SW	SA	25%	Pass
172	West of Duwamish Head	6/14/2007	SW	SA	25%	Pass
173	Northwest of Duwamish Head	6/14/2007	SW	SA	100%	Fail/Resort
176	Elliott Bay, west of EB Marina	6/18/2007	SW	SA	25%	Pass
177	Magnolia Bluff	6/18/2007	SW	SA	100%	Fail/Resort
178	Elliott Bay, south of EB Marina	6/18/2007	SW	SA	25%	Pass
180	Elliott Bay, Piers 89-90	6/18/2007	SW	SA	25%	Pass
181	Elliott Bay, west of Piers 70-71	6/19/2007	SW	SA	25%	Pass
182	Elliott Bay, west of Pier 54	6/15/2007	SW	SA	25%	Pass
183	Elliott Bay, Pier 54	6/15/2007	SW	SA	100%	Fail/Resort
184	Elliott Bay, Pier 55	6/19/2007	SW	SA	25%	Pass
185	North of Duwamish Head	6/14/2007	SW	SA	25%	Pass
186	Elliott Bay, west of Denny Way	6/18/2007	SW	SA	100%	Fail/Resort
187	Elliott Bay, west of Pier 59	6/19/2007	SW	SA	25%	Pass
188	Elliott Bay, West of Pier 57	6/19/2007	SW	SA	25%	Pass
189	Elliott Bay, east of Duwamish Head	6/13/2007	SW	SA	100%	Fail/Resort
190	Elliott Bay, Duwamish Head	6/13/2007	SW	SA	25%	Pass
192	Elliott Bay, central	6/14/2007	SW	SA	25%	Pass
194	Elliott Bay, west of Pier 48	6/15/2007	SW	SA	25%	Pass
195	Elliott Bay, west of Pier 48	6/15/2007	SW	SA	100%	Fail/Resort
196	Elliott Bay, west of Yesler Way	6/19/2007	SW	SA	25%	Pass
197	Elliott Bay, south	6/13/2007	SW	SA	25%	Pass
199	Elliott Bay, south	6/13/2007	SW	SA	100%	Fail/Resort
200	East Waterway, Terminal 18	6/20/2007	SW	SA	25%	Pass
201	East Waterway, Pier 32	6/20/2007	SW	SA	25%	Pass
202	East Waterway, south end	6/20/2007	SW	SA	25%	Pass
203	Duwamish River, north	6/21/2007	SW	SA	25%	Pass
204	Duwamish River, north	6/21/2007	SW	SA	25%	Pass
205	Duwamish River, SW of Slip 2	6/21/2007	SW	SA	25%	Pass

Table J-2. Taxonomy quality assurance (QA).

Stage	Annelida	Crustacea	Echinodermata	Mollusca	Misc. Taxa
Primary Taxonomist	Eugene Ruff	Jeffery Cordell	Steven Hulsman	Susan Weeks	Steven Hulsman
QA Taxonomist	Kathy Welch	--	Scott McKuen	Allan Fukuyama	Scott McKuen
Number of Bulk Samples QA'ed	2	0	1	2	1
Identifications confirmed	100%	NA	100%	100%	100%
Identifications changed (includes species-level changes)	0	NA	0	0	0
Species-level changes	0	NA	0	0	0
Vouchers generated	0	0	0	0	0

Appendix K (Electronic only). Selected results for chemistry, toxicity, and infaunal analyses.

Electronic filename: Appendix K - weight of evidence table.xls