KING COUNTY SEDIMENT MANAGEMENT PLAN 2018 UPDATE

APPENDIX E: SEDIMENT CLEANUP EVALUATION

Prepared for

King County Department of Natural Resources and Parks Sediment Management Program

Sediment Management Plan Update Project

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1 INTRODUCTION

As described in Section 2, the lines of evidence used to identify the necessary sediment management strategy for each King County CSO suggest that a hazard assessment is needed and identification of a cleanup site is likely at one CSO: University RS Overflow. This is in addition to the original seven SMP sites, and CSOs located in existing Superfund sites. To understand the potential cost implications of any cleanup required at this site for long-range planning, University RS Overflow has been identified for evaluation of cleanup alternatives. This appendix describes the site and develops and compares cleanup alternatives. The purpose of this evaluation is to provide a planning-level analysis and costs for decision making on how King County will likely be required to move forward to address sediments at this location. The evaluation presented in this appendix generally meets the requirements for a remedial investigation/feasibility study for a simple site, as described in Section 2.4 of the Sediment Cleanup Users Manual (Ecology 2015). It is anticipated that this evaluation will be used to support the future development of a cleanup action plan (CAP) consistent with WAC 173-204-575.

2 SITE DESCRIPTION

University RS Overflow (NPDES Discharge Serial Number 015) was originally a City of Seattle CSO on the North Trunk; Metro (now King County) assumed operation of the North Trunk in 1962. The regulator was built by Metro in 1976.

The overflow is in surface water to Portage Bay through the seawall on the south side of the University of Washington (UW) campus in Seattle (Figure E-1). Bathymetric elevations in the proposed site unit range from +12 feet North American Vertical Datum 88 (NAVD88) or greater near the seawall to -16 feet NAVD88 in the navigation channel. The water depth at this site ranges from 4 to 35 feet throughout the site unit based on the elevation of the lake (controlled by USACE from 16.6 to 18.6 feet NAVD88 or 20 to 22 feet USACE datum). The following sections describe the CSO, site uses, and receiving sediment conditions.

2.1 CSO Control Status

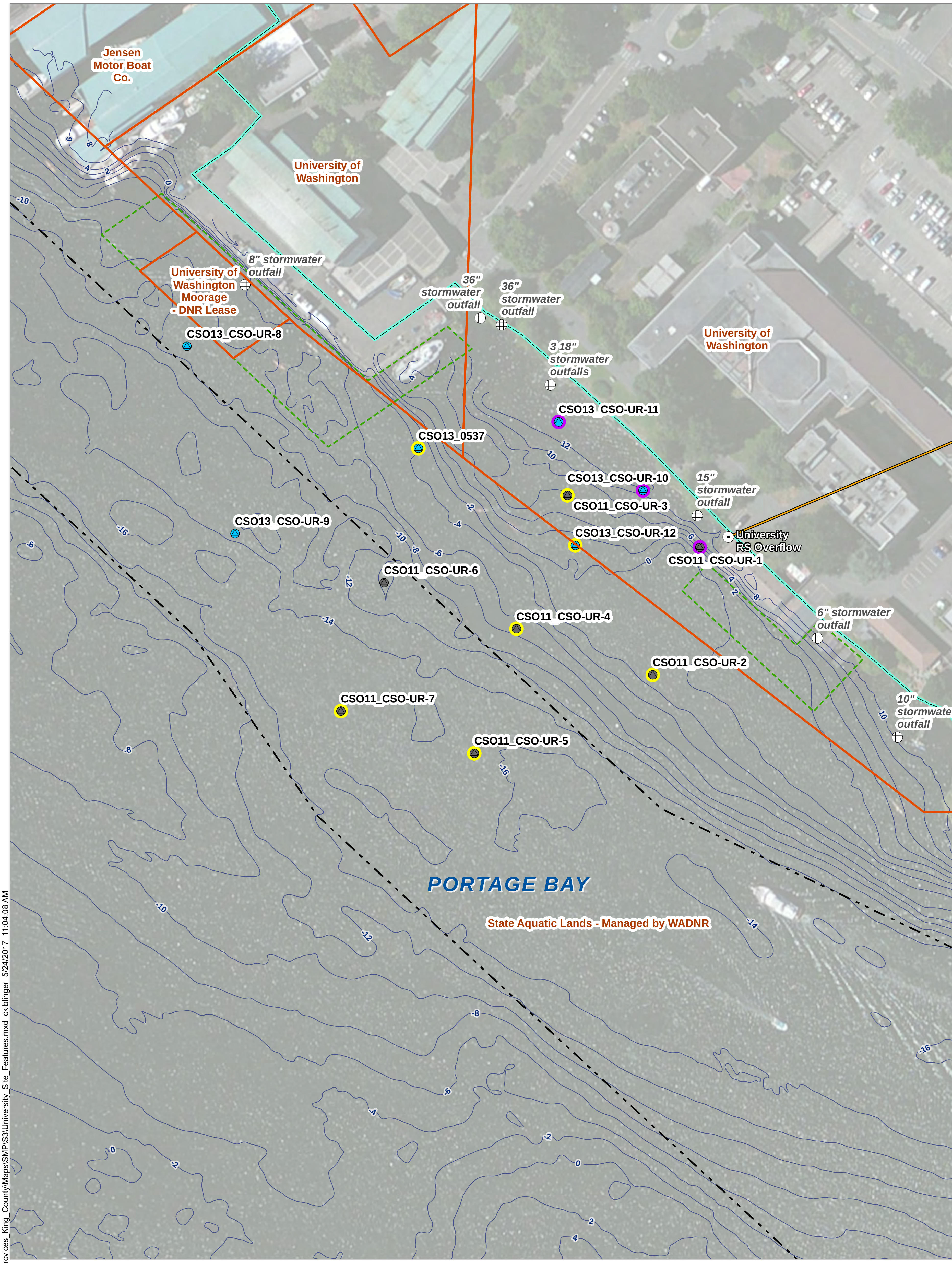
In 1983, the University RS Overflow baseline was 13 events and 126 million gallons (MG) per year. A Phase I partial separation project was completed in 1994, creating a new stormwater overflow under the I-5/University Bridge, called the Densmore Drain. The project volume reduction was approximately 36 MG per year. Between 1996 and 2015, the University RS Overflow has overflowed between 2 and 14 times per year, with an average of 7.2 events per year (King County 2016). The CSO is still considered uncontrolled because of its overflow frequency in excess of one event per year. The current average discharge volume over the same time period is 88 MG per year.

The 2012 CSO Control Plan proposes to construct a 5.2-MG storage tank and green stormwater infrastructure (GSI) to control the University RS Overflow. Flows to the CSO are currently being reduced through the GSI initiative in the catchment area, and design for a storage tank will commence in 2022 (King County 2016).

2.2 Site Uses and Other Potential Sources

The University RS Overflow is located in the heavily developed area at the south end of the UW campus (Figure E-1). Activities along the shoreline include oceanographic and fisheries research vessel operations, recreational boating, and marina activities. Along the shoreline to the northwest of the University RS Overflow, the UW Marine Sciences building provides docking for oceanographic research vessels, the largest of which is the 274-foot *R/V Thomas G. Thompson.* Along the shoreline to the southwest of the University RS Overflow, a smaller oceanographic and fisheries building provides docking for smaller vessels. The building is situated over the water; sediments below the building are within the immediate vicinity of the CSO. The cleanup of sediments in and around these structures and berthing areas would need to be done in a manner to preserve current and potential future uses of these sites.

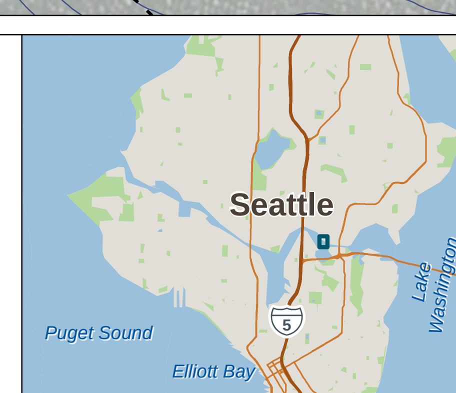
Nine UW stormwater discharge locations are located along the 1,800-foot-long shoreline adjacent to the University RS Overflow, draining the southern portion of the UW campus, including the marine sciences buildings, portions of the medical center, and other areas of campus. One of these stormdrains empties into the conveyance pipe from the



Sediment Sample
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- King County Tax Parcels
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline
- Bathymetry (NAVD88, feet)

NOTE:
Berthing areas and outfall locations are approximate.



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Feet
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Figure E-1
Site Features
University RS Overflow
King County Sediment Management Plan

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University RS Overflow to the discharge and shares the discharge location. Source control investigations to support sediment cleanup will require the investigation of the UW stormwater catchments, as well as the University RS Overflow.

Farther from the shoreline, the Lake Washington Ship Canal Navigation channel is federally authorized at 30 feet of water depth. Because the minimum controlled water elevation is 16.6 feet NAVD88, the authorized elevation is approximately -13.4 feet NAVD88.

The nearshore area approximately 100 feet from the overflow is owned by the UW; beyond that is state-owned aquatic land managed by the Washington State Department of Natural Resources.

2.3 Nature and Extent of Sediment Contamination

The lateral extent of contaminated sediments was evaluated in 12 surface sediment samples collected in 2011 and 2013, and one sediment core collected in 2013 (Figure E-1 and Table E-1). Nine out of 12 sample locations exceeded the SCO, with exceedances at one or more locations for mercury, silver, BEHP, total PCBs, nickel, lead, and phenol (phenol in the core only). Three out of 12 surface sediment locations exceeded the CSL with exceedances for mercury, silver, and total PCBs. Total PCBs were identified as a key risk-driver for the site; 6 of 12 samples exceed the SCO of 110 micrograms per kilogram (μg/kg), two locations exceed three times the SCO (330 μg/kg), and one location exceeds the CSL of 2,500 μg/kg (Figure E-2).

The depth of contaminated sediment was evaluated with one sediment core location collected in triplicate in 2013. The three gravity cores penetrated to depths of 33 cm, 18 cm, and 32 cm. On average, the upper interval was black/brown mud and the deeper interval (when sampled) consisted of hard, gray sand typical of native glacial till. The composited brown upper interval sample exceeded the SCO for phenol only, and the composited gray deeper interval did not exceed for any chemical. Based on this information, the recent deposition representing the layer of contaminated sediment is relatively thin throughout the site, with a depth of less than 25 cm over most of the site and possibly thicker depths closer to the overflow.

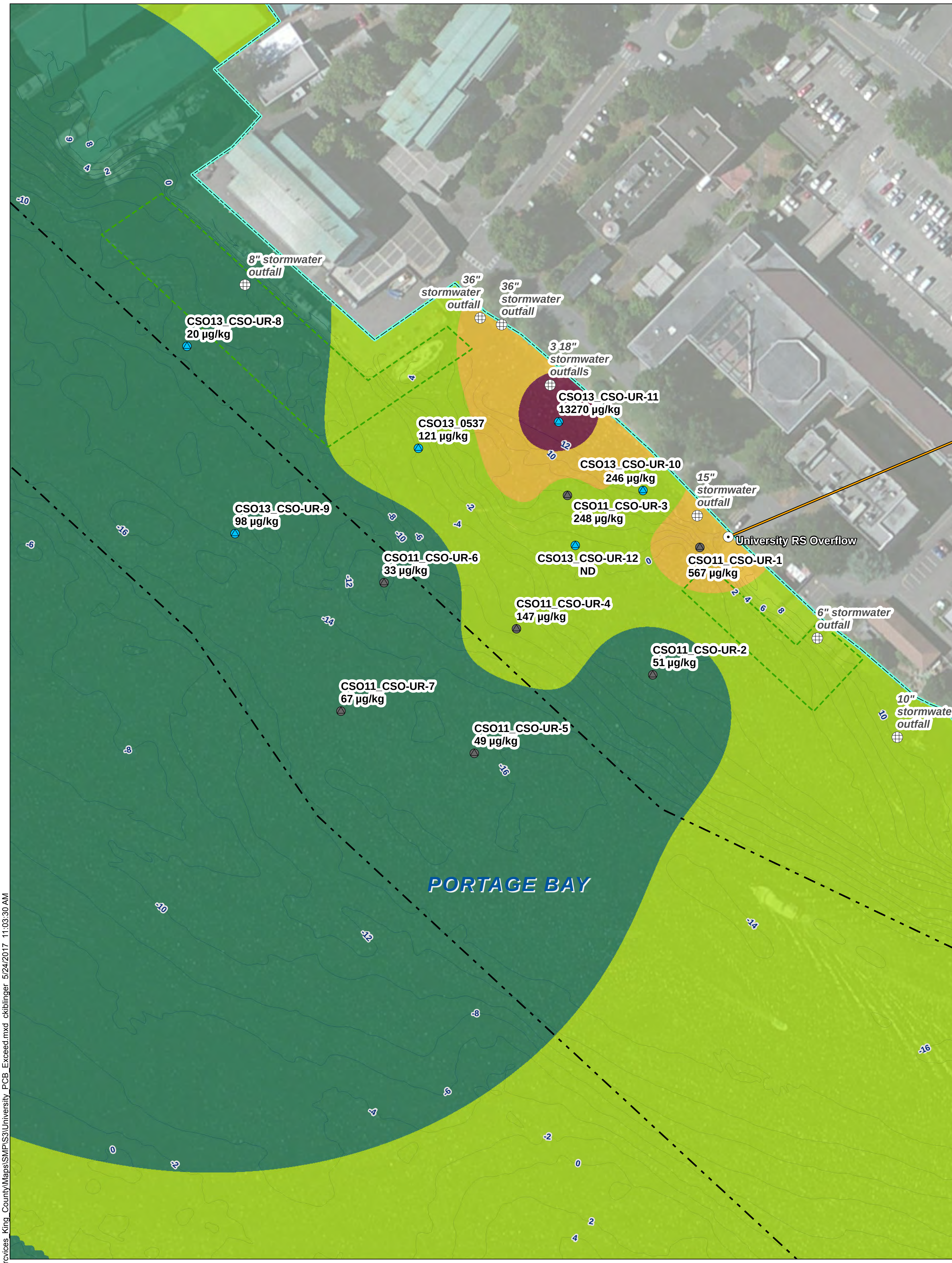
2.4 Hydrodynamic Forces

The primary hydrodynamic forces on sediment in the area are wind and wave forces, primarily at shallow water depths; vessel propeller wash forces from transiting and maneuvering vessels in the shipping canal and berthing areas; and current velocities as water flows from Lake Washington through the Ship Canal to the Ballard Locks. The hydrodynamic forces will be an important consideration for evaluating the stability of native and depositing sediment within the area, evaluating the potential mixing of surface sediments, and evaluating the stability of potential placement materials for remediation.

The surface sediment grain sizes are predominantly sands and silts (Table E-1) and soft sediment extends to approximately 25 cm of depth. A complete hydrodynamic analysis will be completed in remedial design, if necessary, including an evaluation of potential periodic propeller wash events during vessel maneuvering at UW berths.

2.5 CSO Particulate Modeling and Recontamination Potential

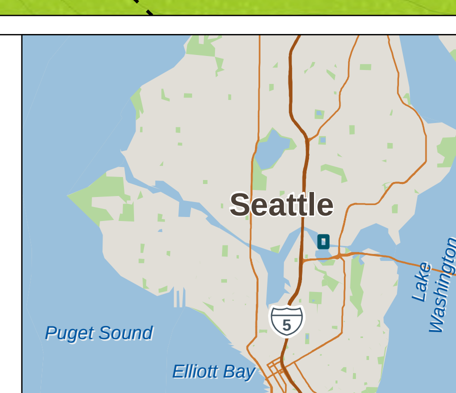
Figure E-3 shows the model-predicted (EFDC) depositional pattern for the University RS Overflow CSO. The highest deposition rate is immediately adjacent to the discharge location, with the plume extending to the southeast, consistent with the prevailing currents in the area. Based on the model results, CSO-related deposition is predicted to exceed 0.1 cm/year within 350 feet of the discharge location with a maximum deposition rate of 1.2 cm/year within 100 feet of the discharge location. The net deposition rate of ambient deposition (i.e., non-CSO-related deposition), is estimated to average 0.3 cm/year across this area. Model information was used to identify possible exceedances within the area, based on the maximum CSO deposition rates (see Appendix B). The model did not indicate any probable CSL exceedances, but identified possible CSL exceedances for silver, di-n-octyl phthalate, and mercury. The model indicated probable SCO exceedance for nickel, BEHP, silver, and PCBs, and possible SCO exceedances for di-n-octyl phthalate, cadmium, and mercury. The list of potential contaminant exceedances identified through modeling generally matches those measured in sediments discussed in Section 3.1.3.



Sediment Sample
- 2013, King County
- 2011, King County

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline
- Bathymetry (NAVD88, feet)

TPCB Aroclors (µg/kg)
- 21 - 110
- 111 - 330
- 331 - 2,500
- 2,501 - 13,213



NOTE:
Berthing areas and outfall locations are approximate.

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Feet
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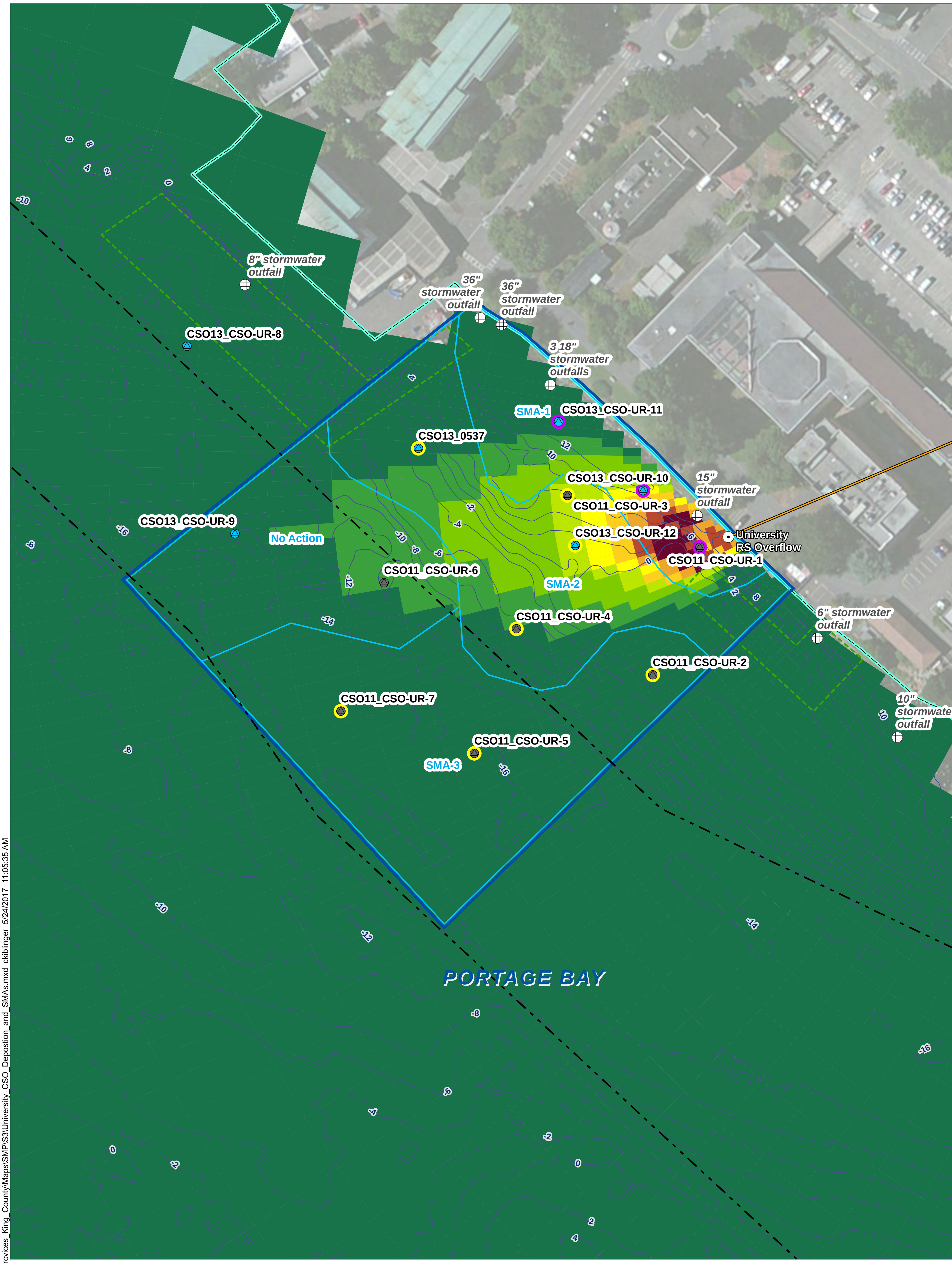
Figure E-2
Total PCBs Concentrations
University RS Overflow
King County Sediment Management Plan

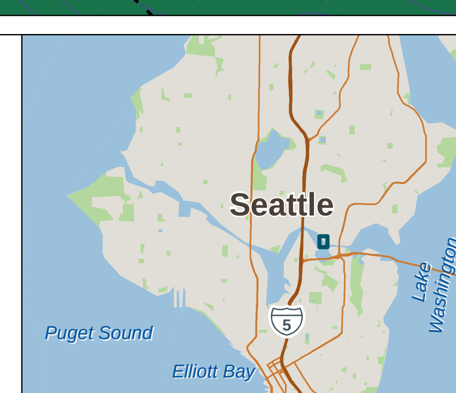


Sediment Sample
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- SMAs
- University Regulator CSO Sediment Site Unit Boundary
- Approximate Shoreline
- Bathymetry (NAVD88, feet)

Deposition (cm/yr)[2]
- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.6
- 0.61 - 0.7
- 0.71 - 0.84

NOTES:
1. Berthing areas and outfall locations are approximate.
2. Model from King County Wastewater Treatment Division.



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Feet
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Figure E-3
Sediment Management Areas and CSO Solids Deposition Rate
University RS Overflow
King County Sediment Management Plan

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Table E-1
University RS Overflow Sediment Data

Distance to CSO (ft)			31	99	156	156	160
Location ID			CSO11_CSO-UR-1[1]	CSO13_CSO-UR-10	CSO13_CSO-UR-12	CSO13_CSO-UR-12	CSO11_CSO-UR-2
Area			LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB
CSO			University	University	University	University	University
Task			KC_CSO_2011	KC_CSO_2013	KC_CSO_2013	KC_CSO_2013	KC_CSO_2011
Sample ID			L54227-8	L57797-1	L58172-2	L58172-1	L54227-9
Sample Date			10/10/2011	4/23/2013	6/20/2013	6/20/2013	10/10/2011
Depth			0 - 10 cm	0 - 10 cm	0 - 25 cm	26 - 33 cm	0 - 10 cm
Sample Type			N	N	N	N	N
Sample Collection Method			Grab	Grab	Core	Core	Grab
	SCO	CSL					
Conventional Parameters (pct)							
Total organic carbon			**10.9**	**7.31**	**6.86**	**0.072 J**	**4.16**
Total solids			**14.1**	**26.4**	**27.1**	**88.7**	**32.2**
Grain Size (pct)							
Pebble			0.9 U	--	--	--	**4.8**
Gravel			--	**1.4 J**	--	--	--
Granule (very fine gravel)			0.9 U	--	--	--	0.4 U
Sand			--	**62.7**	--	--	--
Sand, very coarse			**1.4 J**	--	--	--	**1.6 J**
Sand, coarse			**1.2 J**	--	--	--	**2.3 J**
Sand, medium			**1.6 J**	--	--	--	**3.6**
Sand, fine			**2.5 J**	--	--	--	**7.9**
Sand, very fine			**5.8 J**	--	--	--	**17**
Silt			--	**23.6**	**41.65**	**27**	--
Silt, coarse			**13.4**	--	--	--	**15.4**
Silt, medium			**34.7**	--	--	--	**21.3**
Silt, fine			**5 J**	--	--	--	**3.5**
Silt, very fine			**5 J**	--	--	--	**3.5**
Clay			--	**9.5**	**1.83**	**5.1**	--
Clay, coarse			**5 J**	--	--	--	1.8 U
Clay, medium			**5 J**	--	--	--	**3.5**
Clay, fine			**14.9**	--	--	--	**3.5**
Metals (mg/kg)							
Antimony			**0.993 J**	--	**0.36 J**	0.289 U	**0.22 J**
Arsenic	14	120	**10.6**	**6.67**	**6.01**	**1.01**	**8.01**
Cadmium	2.1	5.4	**1.01**	**0.67**	**0.424 J**	**0.026 J**	**0.317**
Chromium	72	88	**24.1**	**28.1 J**	**19.4**	**12.5**	**17.9**
Copper	400	1200	**113**	**96.2**	**20.7 J**	**5.22**	**21.6**
Lead	360	1300	**109**	**189 J**	**53.9**	**1.42**	**57.1**
Mercury	0.66	0.8	**2.23**	**0.473**	**0.22 J**	**0.038 J**	**0.197**

Table E-1
University RS Overflow Sediment Data

		Distance to CSO (ft)	31	99	156	156	160
		Location ID	CSO11_CSO-UR-1[1]	CSO13_CSO-UR-10	CSO13_CSO-UR-12	CSO13_CSO-UR-12	CSO11_CSO-UR-2
		Area	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB
		CSO	University	University	University	University	University
		Task	KC_CSO_2011	KC_CSO_2013	KC_CSO_2013	KC_CSO_2013	KC_CSO_2011
		Sample ID	L54227-8	L57797-1	L58172-2	L58172-1	L54227-9
		Sample Date	10/10/2011	4/23/2013	6/20/2013	6/20/2013	10/10/2011
		Depth	0 - 10 cm	0 - 10 cm	0 - 25 cm	26 - 33 cm	0 - 10 cm
		Sample Type	N	N	N	N	N
		Sample Collection Method	Grab	Grab	Core	Core	Grab
	SCO	CSL					
Nickel	26	110	**22.4**	**31.6**	**25.8**	**18.6**	**27**
Silver	0.57	1.7	**0.794**	**1.99 J**	**0.165**	0.0551 U	**0.137**
Zinc	3200	4200	**386**	**286**	**81.2**	**12.3**	**70.5**
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene			1.4 U	48.5 U	2.57 U	1.21 U	1.4 U
1,2-Dichlorobenzene			13.7 U	60.6 U	12.8 U	6.01 U	14.2 U
1,4-Dichlorobenzene			20.5 U	90.9 U	19.3 U	9.02 U	21.3 U
2,4-Dimethylphenol			14 U	485 U	25.7 U	12.1 U	14 U
2-Methylnaphthalene			14 U	485 U	25.7 U	12.1 U	14 U
2-Methylphenol (o-Cresol)			14 U	121 U	25.7 U	12.1 U	14 U
4-Methylphenol (p-Cresol)	260	2000	68 U	606 U	128 U	60.1 U	71 U
Acenaphthene			**29.7**	121 U	25.7 U	12.1 U	14 U
Acenaphthylene			**15 J**	121 U	25.7 U	12.1 U	14 U
Anthracene			**119**	**87 J**	**19 J**	12.1 U	**37.9**
Benzo(a)anthracene			**650**	**394**	**95.6**	12.1 U	**123**
Benzo(a)pyrene			**551**	**458**	**118**	12.1 U	**183**
Benzo(b,j,k)fluoranthenes			--	**1130**	**214**	12.1 U	--
Benzo(g,h,i)perylene			**404**	**127**	**78.6**	12.1 U	**121**
Benzoic acid	2900	3800	**538**	4850 U	257 UJ	121 UJ	**425**
Benzyl alcohol			34.2 U	152 U	32.1 U	15 U	35.4 U
bis(2-Ethylhexyl)phthalate	500	22000	**12300**	**2640 J**	**35 J**	**15 J**	**602**
Butylbenzyl phthalate			**2330**	**107**	19.3 U	9.02 U	21.3 U
Carbazole	900	1100	--	121 U	25.7 U	12.1 U	--
Chrysene			**1030**	**530**	**144**	12.1 U	**192**
Dibenzo(a,h)anthracene			**71.8**	121 U	**17 J**	12.1 U	**38.5**
Dibenzofuran	200	680	**28.9**	121 U	25.7 U	12.1 U	14 U
Diethyl phthalate			**41 J**	242 U	51.3 U	24 U	**413**
Dimethyl phthalate			27.4 U	121 U	25.7 U	12.1 U	**70.2**
Di-n-butyl phthalate	380	1000	130 UJ	242 U	51.3 U	24 U	53 UJ
Di-n-octyl phthalate	39	1100	27.4 U	121 U	25.7 U	12.1 U	28.4 U

Table E-1
University RS Overflow Sediment Data

		Distance to CSO (ft)	**31**	**99**	**156**	**156**	**160**
		Location ID	**CSO11_CSO-UR-1[1]**	**CSO13_CSO-UR-10**	**CSO13_CSO-UR-12**	**CSO13_CSO-UR-12**	**CSO11_CSO-UR-2**
		Area	**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**
		CSO	**University**	**University**	**University**	**University**	**University**
		Task	**KC_CSO_2011**	**KC_CSO_2013**	**KC_CSO_2013**	**KC_CSO_2013**	**KC_CSO_2011**
		Sample ID	**L54227-8**	**L57797-1**	**L58172-2**	**L58172-1**	**L54227-9**
		Sample Date	**10/10/2011**	**4/23/2013**	**6/20/2013**	**6/20/2013**	**10/10/2011**
		Depth	**0 - 10 cm**	**0 - 10 cm**	**0 - 25 cm**	**26 - 33 cm**	**0 - 10 cm**
		Sample Type	**N**	**N**	**N**	**N**	**N**
		Sample Collection Method	**Grab**	**Grab**	**Core**	**Core**	**Grab**
	SCO	**CSL**					
Fluoranthene			**1690**	**932**	**307**	12.1 UJ	**297**
Fluorene			**63.2**	121 U	25.7 U	12.1 U	14 U
Hexachlorobenzene			1.4 U	12.1 U	2.57 U	1.21 U	1.4 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)			6.8 U	242 U	12.8 U	6.01 U	7.1 U
Indeno(1,2,3-c,d)pyrene			**305**	**147**	**88.2**	12.1 U	**95.7**
Naphthalene			**17 J**	485 U	**14 J**	12.1 U	14 U
n-Nitrosodiphenylamine			34.2 U	152 U	32.1 U	15 U	35.4 U
Pentachlorophenol	1200	1200	205 U	909 U	193 U	90.2 U	213 U
Phenanthrene			**487**	**338**	**119**	12.1 UJ	**131**
Phenol	120	210	68 U	909 U	**150 J**	90.2 U	71 U
Pyrene			**1420**	**981**	**362**	12.1 UJ	**299**
Total Benzofluoranthenes (lab reported total)			**1520**	--	--	--	**297**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 0)			**815.98**	**630.4**	**160.92 J**	12.1 U	**240.34**
Total PAH (SMS Freshwater 2013) (U = 0)	17000	30000	**8372.7 J**	**5124 J**	**1576.4 J**	12.1 UJ	**1815.1**
Pesticides (µg/kg)							
4,4'-DDD (p,p'-DDD)			--	--	--	--	--
4,4'-DDE (p,p'-DDE)			--	--	--	--	--
4,4'-DDT (p,p'-DDT)			--	--	--	--	--
Sum DDD (U = 0)	310	860	--	--	--	--	--
Sum DDE (U = 0)	21	33	--	--	--	--	--
Sum DDT (U = 0)	100	8100	--	--	--	--	--
PCB Aroclors (µg/kg)							
Aroclor 1016			23 U	30.3 U	29.5 U	9.02 U	4 U
Aroclor 1221			48 U	30.3 U	29.5 U	9.02 U	8.4 U
Aroclor 1232			48 U	30.3 U	29.5 U	9.02 U	8.4 U
Aroclor 1242			**45 J**	**16 J**	29.5 U	9.02 U	4 U
Aroclor 1248			23 U	30.3 U	29.5 U	9.02 U	4 U
Aroclor 1254			**282**	**151**	29.5 U	9.02 U	**25.2**
Aroclor 1260			**240**	**78.8**	29.5 U	9.02 U	**25.5**
Total PCB Aroclors (SMS Freshwater 2013) (U = 0)	110	2500	**567 J**	**245.8 J**	29.5 U	9.02 U	**50.7**

Table E-1
University RS Overflow Sediment Data

	SCO	CSL					
Distance to CSO (ft)			169	209	235	332	340
Location ID			CSO11_CSO-UR-3	CSO13_CSO-UR-11	CSO11_CSO-UR-4	CSO13_0537	CSO11_CSO-UR-5
Area			LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB
CSO			University	University	University	University	University
Task			KC_CSO_2011	KC_CSO_2013	KC_CSO_2011	KC_CSO_2013	KC_CSO_2011
Sample ID			L54227-10	L57797-2	L54227-11	L57645-3	L54227-12
Sample Date			10/10/2011	4/23/2013	10/10/2011	3/27/2013	10/10/2011
Depth			0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
Sample Type			N	N	N	N	N
Sample Collection Method			Grab	Grab	Grab	Grab	Grab
Conventional Parameters (pct)							
Total organic carbon			**7.34**	**6.87**	**2.86**	**1.48**	**3.27**
Total solids			**22.2**	**32.3**	**53.2**	**42.6**	**39.8**
Grain Size (pct)							
Pebble			0.6 U	--	**6.1**	--	**6**
Gravel			--	**2.3 J**	--	**5.3**	--
Granule (very fine gravel)			0.6 U	--	0.2 U	--	**1 J**
Sand			--	**69.9**	--	**82.2**	--
Sand, very coarse			0.6 U	--	**0.6 J**	--	**2.4 J**
Sand, coarse			**1.8 J**	--	**1.2 J**	--	**2 J**
Sand, medium			**5.5 J**	--	**3.6**	--	**3.1**
Sand, fine			**19.9**	--	**14.4**	--	**10.2**
Sand, very fine			**18.4**	--	**43.3**	--	**22.8**
Silt			--	**15.8**	--	**8.5**	--
Silt, coarse			**11.1**	--	**16.8**	--	**12.6**
Silt, medium			**23.8**	--	**4**	--	**15.2**
Silt, fine			**5.9**	--	1 U	--	**5.5**
Silt, very fine			**3 J**	--	1 U	--	**6.9**
Clay			--	**7.9**	--	**7.1**	--
Clay, coarse			**3 J**	--	1 U	--	1.4 U
Clay, medium			**5.9**	--	**2**	--	**2.8**
Clay, fine			**5.9**	--	**2**	--	**5.5**
Metals (mg/kg)							
Antimony			**0.842 J**	--	**0.21 J**	**1.31**	0.098 UJ
Arsenic	14	120	**8.78**	**7.03**	**3.55**	**4.25**	**6.53**
Cadmium	2.1	5.4	**0.914**	**1.09**	**0.265**	**0.254**	**0.14**
Chromium	72	88	**27.7**	**26.1**	**22.7**	**16.9**	**20.2**
Copper	400	1200	**89.6**	**73.1**	**20.7**	**34.7**	**16.4**
Lead	360	1300	**112**	**746**	**48.7**	**37.3**	**10.9**
Mercury	0.66	0.8	**0.464**	**1.2 J**	**0.136**	**0.172 J**	**0.07 J**

Table E-1
University RS Overflow Sediment Data

		Distance to CSO (ft)	169	209	235	332	340
		Location ID	CSO11_CSO-UR-3	CSO13_CSO-UR-11	CSO11_CSO-UR-4	CSO13_0537	CSO11_CSO-UR-5
		Area	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB
		CSO	University	University	University	University	University
		Task	KC_CSO_2011	KC_CSO_2013	KC_CSO_2011	KC_CSO_2013	KC_CSO_2011
		Sample ID	L54227-10	L57797-2	L54227-11	L57645-3	L54227-12
		Sample Date	10/10/2011	4/23/2013	10/10/2011	3/27/2013	10/10/2011
		Depth	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
		Sample Type	N	N	N	N	N
		Sample Collection Method	Grab	Grab	Grab	Grab	Grab
	SCO	CSL					
Nickel	26	110	**35.6**	**30.8**	**26.5**	**18.8**	**30.7**
Silver	0.57	1.7	**0.802**	**0.283**	**0.0985**	**0.12 J**	**0.0653 J**
Zinc	3200	4200	**293**	**523**	**77.8**	**99.3**	**34.7**
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene			5 U	12.4 U	1 U	1.2 U	1.3 U
1,2-Dichlorobenzene			51.4 U	61.9 U	10 U	12.5 U	13.4 U
1,4-Dichlorobenzene			77 U	92.9 U	15 U	**41.1**	20.1 U
2,4-Dimethylphenol			50 U	124 U	10 U	12 U	13 U
2-Methylnaphthalene			50 U	124 U	10 U	12 U	13 U
2-Methylphenol (o-Cresol)			50 U	124 U	10 U	12 U	13 U
4-Methylphenol (p-Cresol)	260	2000	260 U	619 U	51 U	63 U	68 U
Acenaphthene			50 U	124 U	**12 J**	12 U	13 U
Acenaphthylene			50 U	124 U	10 U	12 U	13 U
Anthracene			**155**	**140**	**39.8**	**29.6**	**34.2**
Benzo(a)anthracene			**430**	**740**	**226**	**123**	**115**
Benzo(a)pyrene			**536**	**920**	**258**	**120 J**	**127**
Benzo(b,j,k)fluoranthenes			--	**1550**	--	**244**	--
Benzo(g,h,i)perylene			**353**	**400 J**	**163**	63 U	**72.4**
Benzoic acid	2900	3800	1030 U	1240 UJ	**214**	251 U	269 U
Benzyl alcohol			129 U	155 U	25 U	31.2 U	33.4 U
bis(2-Ethylhexyl)phthalate	500	22000	**2840**	**2140**	325 UJ	**732**	79.6 UJ
Butylbenzyl phthalate			676 UJ	92.9 U	15 U	18.8 U	20.1 U
Carbazole	900	1100	--	124 U	--	--	--
Chrysene			**653**	**988**	**258**	**149**	**137**
Dibenzo(a,h)anthracene			**144**	495 U	**52.1**	63 U	**25 J**
Dibenzofuran	200	680	50 U	124 U	10 U	12 U	13 U
Diethyl phthalate			100 U	248 U	**23 J**	26 U	28 U
Dimethyl phthalate			103 U	124 U	**54.9**	25.1 U	26.9 U
Di-n-butyl phthalate	380	1000	180 UJ	248 U	112 UJ	**142**	38 UJ
Di-n-octyl phthalate	39	1100	103 U	495 U	20.1 U	125 U	26.9 U

Table E-1
University RS Overflow Sediment Data

Distance to CSO (ft)			**169**	**209**	**235**	**332**	**340**
Location ID			**CSO11_CSO-UR-3**	**CSO13_CSO-UR-11**	**CSO11_CSO-UR-4**	**CSO13_0537**	**CSO11_CSO-UR-5**
Area			**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**	**LWShipCnlLakeUPortB**
CSO			**University**	**University**	**University**	**University**	**University**
Task			**KC_CSO_2011**	**KC_CSO_2013**	**KC_CSO_2011**	**KC_CSO_2013**	**KC_CSO_2011**
Sample ID			**L54227-10**	**L57797-2**	**L54227-11**	**L57645-3**	**L54227-12**
Sample Date			**10/10/2011**	**4/23/2013**	**10/10/2011**	**3/27/2013**	**10/10/2011**
Depth			**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**
Sample Type			**N**	**N**	**N**	**N**	**N**
Sample Collection Method			**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
	SCO	**CSL**					
Fluoranthene			**1030**	**1250**	**427**	**270**	**394**
Fluorene			50 U	124 U	**16 J**	**26.3**	13 U
Hexachlorobenzene			5 U	12.4 U	1 U	1.2 U	1.3 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)			26 U	61.9 U	5.1 U	6.3 U	6.8 U
Indeno(1,2,3-c,d)pyrene			**273**	**430 J**	**141**	63 U	**57.8**
Naphthalene			50 U	124 U	10 U	12 U	13 U
n-Nitrosodiphenylamine			129 U	155 U	25 U	31.2 U	33.4 U
Pentachlorophenol	1200	1200	770 U	929 U	150 U	188 U	201 U
Phenanthrene			**357**	**446**	**171**	**195**	**153**
Phenol	120	210	260 U	929 U	51 U	63 U	68 U
Pyrene			**811**	**1560 J**	**365**	**700**	**344**
Total Benzofluoranthenes (lab reported total)			**1100**	--	**430**	--	**215**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 0)			**737.23**	**1201.88 J**	**345.49**	**158.19 J**	**169.65 J**
Total PAH (SMS Freshwater 2013) (U = 0)	17000	30000	**5842**	**8424 J**	**2558.9 J**	**1856.9 J**	**1674.4 J**
Pesticides (µg/kg)							
4,4'-DDD (p,p'-DDD)			--	--	--	**12.4 J**	--
4,4'-DDE (p,p'-DDE)			--	--	--	**5.68 J**	--
4,4'-DDT (p,p'-DDT)			--	--	--	**4.41 J**	--
Sum DDD (U = 0)	310	860	--	--	--	**12.4 J**	--
Sum DDE (U = 0)	21	33	--	--	--	**5.68 J**	--
Sum DDT (U = 0)	100	8100	--	--	--	**4.41 J**	--
PCB Aroclors (µg/kg)							
Aroclor 1016			3 U	495 U	2.4 U	4.7 U	3.3 U
Aroclor 1221			5.9 U	495 U	5.1 U	14 U	6.8 U
Aroclor 1232			5.9 U	495 U	5.1 U	14 U	6.8 U
Aroclor 1242			**12.6**	495 U	**6.45**	**11 J**	3.3 U
Aroclor 1248			3 U	495 U	2.4 U	4.7 U	3.3 U
Aroclor 1254			**136**	**11300**	**43.6**	**60.3**	**36.2**
Aroclor 1260			**99.1**	**1970 J**	**97**	**49.5**	**12.7**
Total PCB Aroclors (SMS Freshwater 2013) (U = 0)	110	2500	**247.7**	**13270 J**	**147.05**	**120.8 J**	**48.9**

Table E-1
University RS Overflow Sediment Data

		Distance to CSO (ft)	354	433	589	493
		Location ID	CSO11_CSO-UR-6	CSO11_CSO-UR-7	CSO13_CSO-UR-8	CSO13_CSO-UR-9
		Area	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB
		CSO	University	University	University	University
		Task	KC_CSO_2011	KC_CSO_2011	KC_CSO_2013	KC_CSO_2013
		Sample ID	L54227-13	L54227-14	L57645-1	L57645-2
		Sample Date	10/10/2011	10/10/2011	3/27/2013	3/27/2013
		Depth	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
		Sample Type	N	N	N	N
		Sample Collection Method	Grab	Grab	Grab	Grab
	SCO	CSL				
Conventional Parameters (pct)						
Total organic carbon			**1.97**	**5.09**	**0.747**	**1.12**
Total solids			**58.9**	**33.4**	**74**	**64.7**
Grain Size (pct)						
Pebble			**2.3**	**0.4 J**	--	--
Gravel			--	--	**31.2**	**6.9**
Granule (very fine gravel)			**0.4 J**	0.3 U	--	--
Sand			--	--	**68**	**85.3**
Sand, very coarse			**1.9**	**0.4 J**	--	--
Sand, coarse			**3.1**	**0.4 J**	--	--
Sand, medium			**8.8**	**1.3 J**	--	--
Sand, fine			**28.6**	**9.3**	--	--
Sand, very fine			**29.6**	**45.6**	--	--
Silt			--	--	**2.3**	**4.1**
Silt, coarse			**12**	**19.2**	--	--
Silt, medium			**6**	**12.7**	--	--
Silt, fine			**0.9 J**	**3.2**	--	--
Silt, very fine			0.9 U	**1.6 J**	--	--
Clay			--	--	**3.1**	**3.3**
Clay, coarse			**0.9 J**	**1.6 J**	--	--
Clay, medium			0.9 U	1.6 U	--	--
Clay, fine			**2.6**	**6.4**	--	--
Metals (mg/kg)						
Antimony			**0.15 J**	0.22 UJ	**0.27 J**	**0.28 J**
Arsenic	14	120	**2.6**	**5.15**	**2.39**	**3.14**
Cadmium	2.1	5.4	**0.161**	**0.245**	**0.108**	**0.173**
Chromium	72	88	**15.8**	**19**	**11.7 J**	**14.6**
Copper	400	1200	**25.6**	**23.2**	**13.4**	**11.6**
Lead	360	1300	**22.6**	**48.2**	**15.1**	**46.5**
Mercury	0.66	0.8	**0.061 J**	**0.099 J**	**0.036 J**	**0.066 J**

Table E-1
University RS Overflow Sediment Data

		Distance to CSO (ft)	354	433	589	493
		Location ID	CSO11_CSO-UR-6	CSO11_CSO-UR-7	CSO13_CSO-UR-8	CSO13_CSO-UR-9
		Area	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB
		CSO	University	University	University	University
		Task	KC_CSO_2011	KC_CSO_2011	KC_CSO_2013	KC_CSO_2013
		Sample ID	L54227-13	L54227-14	L57645-1	L57645-2
		Sample Date	10/10/2011	10/10/2011	3/27/2013	3/27/2013
		Depth	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
		Sample Type	N	N	N	N
		Sample Collection Method	Grab	Grab	Grab	Grab
	SCO	CSL				
Nickel	26	110	**25.3**	**31.4**	**21.9 J**	**19.2**
Silver	0.57	1.7	**0.0825**	**0.12 J**	**0.035 J**	**0.0862**
Zinc	3200	4200	**48**	**67.7**	**37.2 J**	**40.8**
Semivolatile Organics (µg/kg)						
1,2,4-Trichlorobenzene			0.9 U	1.1 U	1.45 U	1.65 U
1,2-Dichlorobenzene			9.05 U	10.9 U	7.2 U	8.24 U
1,4-Dichlorobenzene			13.6 U	16.3 U	10.8 U	12.4 U
2,4-Dimethylphenol			9 U	11 U	14.5 U	16.5 U
2-Methylnaphthalene			9 U	11 U	14.5 U	16.5 U
2-Methylphenol (o-Cresol)			9 U	11 U	14.5 U	16.5 U
4-Methylphenol (p-Cresol)	260	2000	46 U	54 U	72 U	82.4 U
Acenaphthene			**27.3**	11 U	**46.8**	**19**
Acenaphthylene			9 U	11 U	14.5 U	16.5 U
Anthracene			**85.7**	**78.7**	**18.5**	**10 J**
Benzo(a)anthracene			**156**	**250**	**31.5**	**30.1**
Benzo(a)pyrene			**150**	**338**	**32.6**	**26.1**
Benzo(b,j,k)fluoranthenes			--	--	**68.6**	**64.9**
Benzo(g,h,i)perylene			**77.6**	**181**	**23.5**	**14 J**
Benzoic acid	2900	3800	**212**	**284**	145 U	165 U
Benzyl alcohol			22.6 U	27.2 U	18 U	20.6 U
bis(2-Ethylhexyl)phthalate	500	22000	260 UJ	311 UJ	**38.9**	**115**
Butylbenzyl phthalate			13.6 U	152 UJ	10.8 U	12.4 U
Carbazole	900	1100	--	--	--	--
Chrysene			**173**	**326**	**42.7**	**53.6**
Dibenzo(a,h)anthracene			**36.5**	**71.3**	14.5 U	16.5 U
Dibenzofuran	200	680	**12 J**	11 U	**19.3**	16.5 U
Diethyl phthalate			19 U	22 U	28.8 U	32.9 U
Dimethyl phthalate			18.2 U	21.8 U	14.5 U	16.5 U
Di-n-butyl phthalate	380	1000	31 UJ	184 UJ	28.8 U	32.9 U
Di-n-octyl phthalate	39	1100	18.2 U	21.8 U	14.5 U	16.5 U

Table E-1
University RS Overflow Sediment Data

		Distance to CSO (ft)	354	433	589	493
		Location ID	CSO11_CSO-UR-6	CSO11_CSO-UR-7	CSO13_CSO-UR-8	CSO13_CSO-UR-9
		Area	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB	LWShipCnlLakeUPortB
		CSO	University	University	University	University
		Task	KC_CSO_2011	KC_CSO_2011	KC_CSO_2013	KC_CSO_2013
		Sample ID	L54227-13	L54227-14	L57645-1	L57645-2
		Sample Date	10/10/2011	10/10/2011	3/27/2013	3/27/2013
		Depth	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
		Sample Type	N	N	N	N
		Sample Collection Method	Grab	Grab	Grab	Grab
	SCO	CSL				
Fluoranthene			**416**	**329**	**82.6**	**85.8**
Fluorene			**45.5**	11 U	**46.9**	**14 J**
Hexachlorobenzene			0.9 U	1.1 U	1.45 U	1.65 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)			4.6 U	5.4 U	7.2 U	8.24 U
Indeno(1,2,3-c,d)pyrene			**68.3**	**167**	**20.8**	**10 J**
Naphthalene			9 U	11 U	14.5 U	16.5 U
n-Nitrosodiphenylamine			22.6 U	27.2 U	18 U	20.6 U
Pentachlorophenol	1200	1200	136 U	163 U	108 U	124 U
Phenanthrene			**278**	**108**	**164**	**61.5**
Phenol	120	210	46 U	54 U	108 U	124 U
Pyrene			**341**	**299**	**79.5**	**85**
Total Benzofluoranthenes (lab reported total)			**250**	**563**	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 0)			**202.81**	**446.39**	**45.117**	**37.136 J**
Total PAH (SMS Freshwater 2013) (U = 0)	17000	30000	**2104.9**	**2711**	**658**	**474 J**
Pesticides (µg/kg)						
4,4'-DDD (p,p'-DDD)			--	--	**3 J**	**23.3 J**
4,4'-DDE (p,p'-DDE)			--	--	**1.13 J**	**6.04 J**
4,4'-DDT (p,p'-DDT)			--	--	1.08 UJ	**2.1 J**
Sum DDD (U = 0)	310	860	--	--	**3 J**	**23.3 J**
Sum DDE (U = 0)	21	33	--	--	**1.13 J**	**6.04 J**
Sum DDT (U = 0)	100	8100	--	--	1.08 UJ	**2.1 J**
PCB Aroclors (µg/kg)						
Aroclor 1016			2.2 U	3.9 U	10.8 U	12.4 U
Aroclor 1221			4.6 U	8.1 U	10.8 U	12.4 U
Aroclor 1232			4.6 U	8.1 U	10.8 U	12.4 U
Aroclor 1242			**4.4 J**	**12**	10.8 U	**12.5**
Aroclor 1248			2.2 U	3.9 U	10.8 U	12.4 U
Aroclor 1254			**15.7**	**32.9**	**13.5**	**46.4**
Aroclor 1260			**12.6**	**22.5**	**7 J**	**39.3**
Total PCB Aroclors (SMS Freshwater 2013) (U = 0)	110	2500	**32.7 J**	**67.4**	**20.5 J**	**98.2**

Table E-1
University RS Overflow Sediment Data

Notes:
1. The analytical values presented in this table for location CSO11_CSO-UR-1 are combined from two discrete samples sampled and analyzed on the same day. Sample ID L54227-8 was analyzed for metals and PCBs, and L55155-1 was analyzed for SVOCs . The TOC and TS were analyzed for both samples. The values shown in the table correspond to L54227-8, and values of TOC=13.7% and TS=23.4% correspond to L55155-1 .

Detected concentration is greater than SMS_Fresh_SCO_2013 screening level (yellow)
Detected concentration is greater than SMS_Fresh_CSL_2013 screening level (cyan)

Bold = Detected result

J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
R = Rejected

The pattern of elevated surface sediment concentrations are generally consistent with the CSO modeling, with the highest concentration samples near the overflow and east of the overflow. Sample location UR-11 had the highest concentrations of total PCBs of the 2011 and 2013 samples, and is located 209 feet from the overflow. This location is within the predicted depositional pattern of the CSO but closer to a stormwater outfall than the CSO, and other stations closer to the CSO have lower concentrations. The data at UR-11 may suggest the effect of other potential sources, such as shoreline stormwater outfalls toward the UW oceanography dock. There was also an old structure (the UW Showboat) previously on top of this station location.

After the CSO is controlled, it is predicted to recontaminate to above cleanup standards in smaller areas near to the overflow. After control, the area predicted to exceed the SCO will shrink as less solids enter receiving waters; however, the concentration of those solids is likely to be similar to existing CSO solids concentrations (because, while CSO control reduces the total sediment load to receiving waters, most control mechanisms do not affect the chemical concentration of sediment to the overflow). University RS Overflow currently discharges an average 88 MG per year, with post-CSO control volumes reduced to an average of 24 MG per year. The maximum CSO deposition rate is predicted to be approximately 0.34 cm/year after CSO control (based on the current simple model estimate reduced proportionally to the reduction in expected overflow volume). At this maximum deposition rate, silver is identified as a potential CSL exceedance; nickel, BEHP, and silver are considered probable SCO exceedances; and di-n-octyl phthalate, PCBs, cadmium, and mercury are considered possible SCO exceedances, depending on the concentration in CSO solids and ambient deposition solids. These estimates take into account the influence of local ambient concentrations (see Appendix B).

Considering the model-predicted recontamination potential, both CSO and storm drain source characterization, and source tracing and control, where appropriate, is needed to determine when cleanup can proceed.

3 CLEANUP STANDARDS

The MTCA and SMS regulations provide that a cleanup action must comply with cleanup standards. Site-specific cleanup standards are summarized in the following sections. Applicable or relevant and appropriate requirements (ARARs) based on federal and state laws (WAC 173-340-710) that the selected cleanup remedy must meet are also summarized in Appendix D. Under the SMS, cleanup standards consist of: 1) cleanup levels that are protective of human health and the environment; and 2) the point of compliance at which the cleanup levels must be met. Site-specific cleanup standards are developed below for the protection of the benthic community, human health, and other endpoints, discussed as follows.

3.1 University RS Overflow Sediment Cleanup Unit

The current MTCA and SMS regulations recognize that, in urban areas such as Portage Bay, sediment contamination from a variety of different sites and sources can become co-mingled, potentially creating a very large "site." In such areas, a sediment cleanup unit associated with an individual facility or project may be established (see WAC 173-204-500). Sediment cleanup units within a larger site can be proposed by property owners or potentially liable parties interested in cleaning up a focused area within a larger site, and can be delineated in a number of ways, including the sediment source characteristics (WAC 173-204-505(20)), which is the situation with the University RS Overflow. The University RS Overflow sediment cleanup unit was delineated considering model-generated deposition patterns, sediment sample data, site features, and constructability considerations (e.g., constructible squared off areas). The sediment cleanup unit generally encompasses those sediments within a distance from the overflow that can be reasonably attributed to the CSO. The extent of sediment concentrations elevated above the SCO was bounded to the northwest of the CSO, but not bounded to the south or to the southeast of the CSO overflow. In these directions, the EFDC nearfield model was used to predict the extent of the CSO deposition that could affect the concentrations in the receiving sediment to set the boundary. Outside this area, sediment is more likely affected by other sources that contribute to area-wide concentrations, and therefore are not included in the sediment cleanup unit. The final sediment cleanup unit is an area approximately 500 feet by 500 feet centered over the area with the largest predicted CSO impacts (Figure E-3).

3.2 Protection of the Benthic Community

Benthic cleanup levels under the SMS have been developed for 35 chemicals and include protective no effects concentrations representing the lower bound for developing the site-specific cleanup levels (the SCO), as well as upper bound minor adverse effects levels for developing the site-specific cleanup levels (the CSL). For the University RS Overflow sediment cleanup unit, the lower bound (benthic SCO chemical criteria) was initially evaluated as the cleanup level for all benthic contaminants of concern (CoCs) that exceed in one or more samples (mercury, silver, BEHP, total PCBs, nickel, lead, and phenol).

BEHP and nickel have very low SCO values related to ambient conditions and are commonly elevated in urban areas due to urban run-off. Therefore, SCO values may not be achievable in the cleanup unit due to diffuse sources. In particular, nickel concentrations are remarkably consistent throughout the site, ranging from 19 mg/kg to 36 mg/kg and averaging 26 mg/kg (compared to the SCO of 26 mg/kg), indicative of regionally elevated values. In addition, average ambient Lake Washington concentrations presented in Appendix B were found to be higher than the SCO criterion of 26 mg/kg (see Appendix B, Tables B-4a and B-4b). Further evaluation may be necessary in future decision documents (e.g., CAP) to decide if the cleanup levels should be elevated above the SCO for these chemicals.

3.3 Protection of Human Health and Higher Trophic-level Species

The SMS also provide a process for developing site-specific cleanup levels for protection of human health and higher trophic-level species, considering risk-based threshold concentrations and background concentrations. Potential human health risks would be from consumption of seafood or direct contact with sediment. It is expected that cleanup of the sediment cleanup unit to meet cleanup standards for benthic toxicity would also meet human health and higher trophic-level species cleanup standards (which would be set based on site exposures), because it is anticipated that most of the sediment cleanup unit requires remediation. An initial assessment of potential risk is nonetheless provided below. This assessment is subject to change, based on various factors, also discussed below. Ultimately, human health and higher trophic-level species risks will be evaluated further if and when any area-wide cleanup is conducted for Portage Bay.

Although site-specific cleanup levels are not developed for protection of human health or higher trophic-level species in this document, sediment cleanup unit-site average concentrations for common human health and higher trophic-level species risk drivers (total PCBs and cPAHs) are provided in the alternatives analysis (see Section 3.6) for reference as a preliminary screening. This screening-level assessment was conducted to look at conditions of the sediment site unit in context to future area-wide cleanup levels that could be set.

Regional background values are not developed in this evaluation; however, cleanup standards for protection of human health and higher trophic-level species tend to default to regional background in many urban sites. Therefore, future evaluation of human health and higher trophic-level species will require regional background evaluations. Regional background values will be developed, if necessary, for the University RS Overflow sediment cleanup unit during CAP development.

A recent draft document from Ecology estimated regional background concentrations from existing data within Lake Washington and Lake Union/Portage Bay (Ecology 2016). The report estimates regional background concentrations to be 180 μg/kg for cPAHs. Arsenic and mercury concentrations were estimated to be equal to natural background levels (11 mg/kg for arsenic and 0.21 mg/kg for mercury). These regional background values may or may not be applicable to Portage Bay conditions, as little data came from Lake Union/Portage Bay, and no assessment was made to determine if a separate background number was needed. In addition, these regional background values will not become cleanup levels for the University RS Overflow sediment cleanup unit if risk-based threshold concentrations exceed regional background values.

For reference, 8 of 12 sample locations exceed the cPAH concentration of 180 μg/kg, and the average of all sample locations is 420 μg/kg. For mercury, 4 of 12 locations exceeded 0.21 mg/kg, with an average of 0.44 mg/kg at all sample locations. For arsenic, no locations exceeded 11 mg/kg, and the average of all locations was 5.7 mg/kg. Finally, total PCBs has an average concentration of 1,200 μg/kg (mostly driven by a single high-concentration location).

PCBs, cPAHs, arsenic, and mercury could be re-evaluated as a potential human health or higher trophic-level CoC during the development of a CAP. This screening is also factored into the sediment cleanup unit alternatives comparison, to assess whether the sediment cleanup unit is likely to meet area-wide cleanup standards.

3.4 Point of Compliance

Under MTCA, the point of compliance is the point or location within a sediment cleanup unit where the cleanup levels must be attained. For sediments, the point of compliance for protection of the environment is surface sediments within the biologically active zone. The biologically active zone is the depth in surface sediments within which benthic organisms are found. Consistent with the Sediment Cleanup Users Manual (Ecology 2015), a 10-cm biologically active zone was applied to address potential benthic and human health exposure pathways.

4 SEDIMENT MANAGEMENT AREAS

Based on the nature and extent of contamination (see Section 3.1.3), three sediment management areas (SMAs) were established (Figure E-4). SMA-1 is the area with the highest concentrations, identified by concentrations exceeding the CSL for any chemical or three times the SCO for PCBs. Three times the SCO was selected as a reasonable threshold concentration for distinguishing between the areas with higher concentrations, which are less likely to use some form of natural recovery as part of cleanup, and the areas with moderate concentrations, which are more likely to use some form of natural recovery as part of cleanup. SMA-1 contains small areas used for berthing by UW research vessels and part of the over-water UW fisheries building, which will require special considerations for remediation, as described in Section 3.4.2. SMA-1 includes sample locations UR-1, UR-10, and UR-11 and encompasses approximately 0.7 acre.

SMA-2 is identified as the remaining area exceeding the SCO for total PCBs. This area is considered moderately elevated in concentration. Like SMA-1, SMA-2 contains small areas used for berthing by UW research vessels and part of the over-water UW fisheries building, which will require special considerations for remediation. SMA-2 includes sample locations UR-3, UR-4, and 537 and encompasses approximately 1.4 acres. SMA-3 is identified as the area exceeding the SCO for chemicals other than PCBs. SMA-3 has SCO exceedances for nickel and BEHP only, and has concentrations similar to that of surrounding areas. SMA-3 extends into the Lake Washington Ship Canal federal navigation channel and would require that elevations be maintained for most of the area. SMA-3 includes sample locations UR-2, UR-5, and UR-7 and encompasses 1.8 acres.

The No Action Area is identified as the area with no SCO exceedances but still within the influence of CSO particulates, based on modeling. The No Action Area is mostly in the Lake Washington Ship Canal federal navigation channel. No Action Areas include UR-6, UR-8, and UR-9 and includes 1.0 acre of area within the sediment unit.

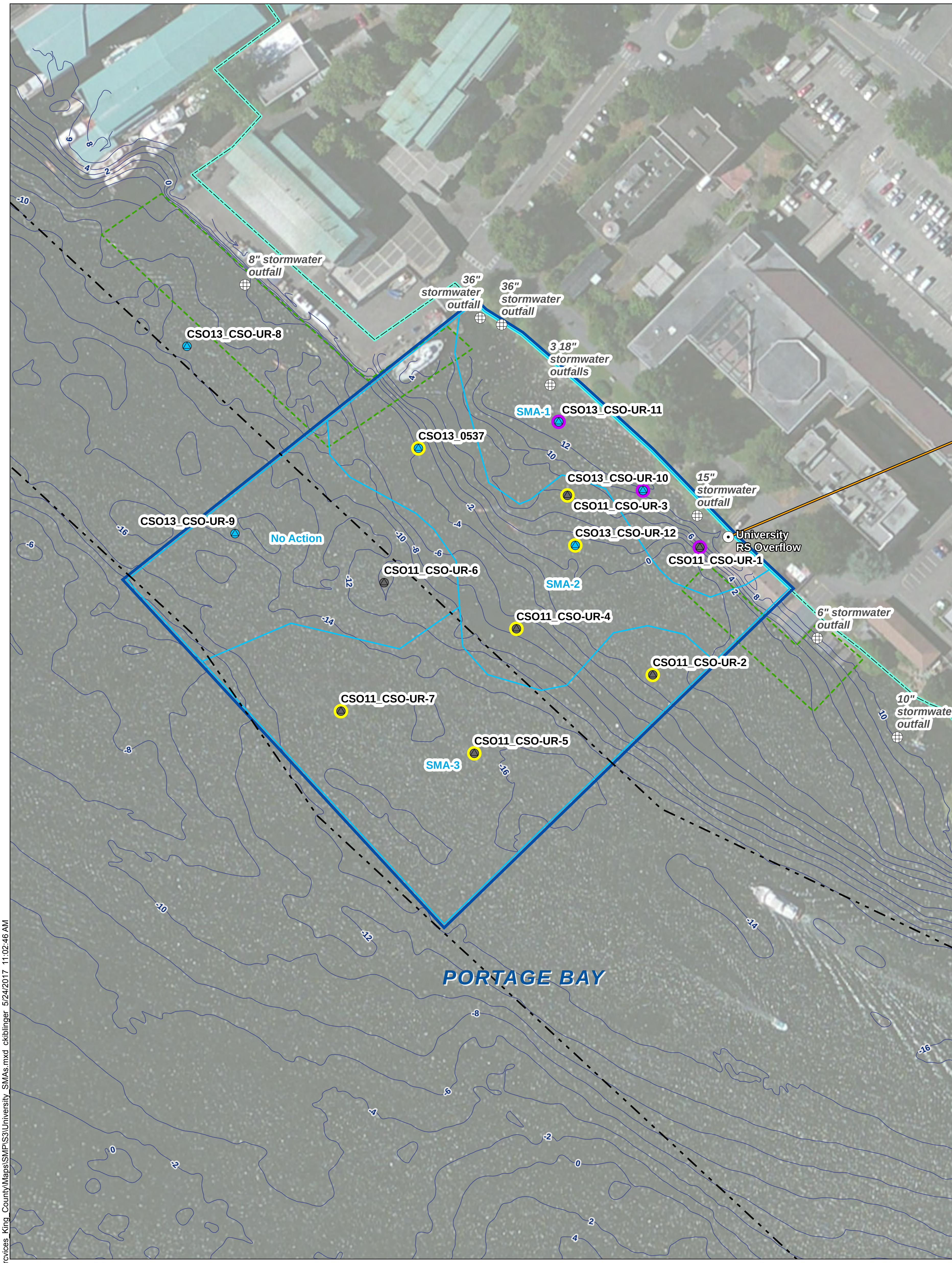
5 APPLICABLE REMEDIAL TECHNOLOGIES

Remedial technologies and sediment remediation practices are relatively well established for sediment cleanup sites in the Puget Sound region, and common remedial technologies are listed in the SMS rule (WAC 173-204-570(4)(b) and described in Section 12.4.3 of the Sediment Cleanup Users Manual II (SCUM II; Ecology 2015).

5.1 Remedial Technology Screening

Table E-2 presents the cleanup unit technology screening for the University RS Overflow sediment cleanup unit based on the technologies listed in the SMS rule. The list of remedial technologies retained for further evaluation in this CAP include the following:

- Monitored natural recovery (MNR)
- Enhanced natural recovery (ENR)
- In situ treatment
- Capping
- Removal and residual management

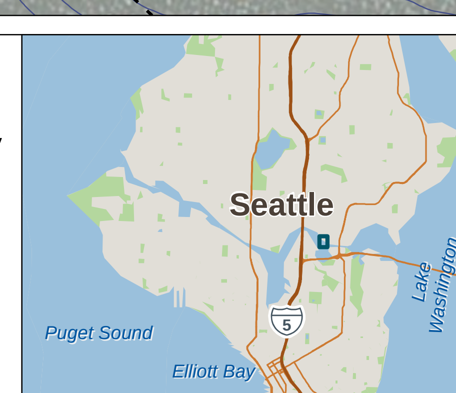


Sediment Sample

- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline
- Bathymetry (NAVD88, feet)

- SMAs
- University Regulator CSO Sediment Site Unit Boundary



NOTE:
Berthing areas and outfall locations are approximate.

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Figure E-4
Sediment Management Areas
University RS Overflow
King County Sediment Management Plan

Table E-2
Technology Screening

Remedial Technology (173-204-570(4)(b))	**Screening Determination**
(i) Source controls in combination with other cleanup technologies	**Retained**. The implementation of source control actions is a fundamental feature of King County's University RS Overflow Control Project. Ongoing sources continue to be monitored and assessed for further progressive improvements under King County's NPDES permit. In addition, stormwater sources managed by the University of Washington will require evaluation to assess whether stormwater sources are sufficiently controlled to move forward with cleanup.
(ii) Beneficial reuse of site sediments	**Eliminated**. There is a lack of currently viable beneficial uses for contaminated sediments.
(iii) Treatment to immobilize, destroy, or detoxify contaminants	**Retained**. Promising in-situ treatment technologies are available for total PCBs. Note that these technologies have not been demonstrated to be effective for the full suite of CoCs (e.g., mercury, silver, nickel, BEHP). In situ treatment is assumed to be an average 4-inch-thick layer of activated carbon mixed with a placement substrate (e.g., sand or gravel).
(iv) Dredging and disposal in an upland engineered facility that minimizes subsequent releases and exposures to contaminants	**Retained**. Dredging is a common and proven technology for sediment remediation. Based on sediment core data, less than 1 foot of contaminated sediment is present within most of the site.
(v) Dredging and disposal in a nearshore, in-water, confined aquatic disposal facility	**Eliminated**. This technology would conflict with permitting requirements, including the need to maintain or mitigate for the loss of aquatic area and no current facility exists.
(vi) Containment of contaminated sediments in-place with an engineered cap	**Retained**. Capping is a common and proven technology for sediment remediation. Capping would require raising the grade by 1 to 3 feet, depending on the final hydrodynamic evaluation to isolate contaminated sediment.
(vii) Dredging and disposal at an open water disposal site approved by applicable state and federal agencies	**Eliminated**. The DMMP has made past determinations that sediments with concentrations similar to those in the University RS Overflow sediment cleanup unit are not suitable for open water disposal.
(viii) Enhanced natural recovery	**Retained**. ENR is a common and proven technology for sediment remediation. ENR would consist of the placement of a thin layer (e.g., average 9 inches) of sand or gravel to reduce surface sediment concentrations and mix with underlying contaminated sediments.

Remedial Technology (173-204-570(4)(b))	Screening Determination
(ix) Monitored natural recovery	**Retained**. Natural recovery has not been measured within the cleanup unit; however, MNR is a viable remedial technology as sources come under control in areas with lower surface sediment concentrations.
(x) Institutional controls and monitoring	**Retained**. Institutional controls and monitoring are important aspects of all alternatives. However, consistent with MTCA/SMS rules, institutional controls and monitoring are not employed as stand-alone technologies, but are used in conjunction with other cleanup technologies.

Notes:
CoC = contaminant of concern
BEHP = bis(2-ethylhexyl) phthalate
DMMP = Dredged Material Management Program
ENR = enhanced natural recovery
CSO = combined sewer overflow
MNR = monitored natural recovery
MTCA = Model Toxics Control Act
NPDES = National Pollutant Discharge Elimination System
PCB = polychlorinated biphenyl
SMA = sediment management area
SMS = Sediment Management Standards

All remedial actions are assumed to occur after CSO control is complete and potential other sources have been evaluated. Institutional controls, and monitoring are combined with each remedial technology and are part of all alternatives.

5.2 SMA – Specific Considerations for Remedial Technologies

The retained remedial technologies have varying applicability depending on SMA. This section reviews the applicability of the retained technologies for each SMA, and retains the most applicable technologies for the development of cleanup alternatives in Section 3.5.

SMA-1 is located closest to the CSO along the shoreline in the area with the highest concentrations. All of the retained remedial technologies are incorporated into one or more remedial alternatives for this SMA. MNR is applicable in SMA-1, but is unlikely to meet cleanup standards in this area in less than 50 years, even after source control. ENR is applicable in SMA-1; however, a coarse-grained material, such as gravel, may be necessary to maintain stability due to wind/wave and propeller forces. ENR is expected to meet cleanup standards after construction; however, if ENR material mixes completely with underlying sediments, then an additional period of natural recovery would be required to meet cleanup standards. ENR could have limited applicability in the berthing areas if the current berthing depths must be maintained. In situ treatment is applicable in SMA-1 for reducing the bioavailability of PCBs, the key risk-driver at the site; however, in situ treatment has uncertain effectiveness for other CoCs. Capping is a traditional remedial technology that is likely to be successful in this area. However, capping would have limited applicability in existing berth areas if the current berthing depths must be maintained. Removal is also a traditional remedial technology that is likely to be successful in SMA-1; however, removal would be challenging to implement in the underpier area, where placement remedies would be more effective.

SMA-2 is located farther from the CSO and from the shoreline and has moderate concentrations. MNR, ENR, and removal are retained for the development of remedial technologies. In this area, MNR is predicted to meet cleanup standards in approximately 30 years, provided sources are controlled. ENR is expected to meet and maintain cleanup standards following construction, even with mixing of ENR material and underlying sediment. ENR could have limited applicability in the berthing areas if the current berthing depths must be maintained. In situ treatment is not incorporated into the remedial alternatives for this area because of relatively low concentrations of PCBs and the presence of other CoCs that may not be addressed by in situ treatment. Capping is not proposed in this area because capping would shallow up potential navigation areas, and ENR is expected to be effective as a placement technology. Removal is a traditional remedial technology that is expected to be successful in this area.

SMA-3 is located farther from the CSO and shoreline, and has SCO exceedances for nickel and BEHP only; these two chemicals are commonly elevated in urban areas due to urban run-off. Because concentrations in SMA-3 are close to area-wide elevated concentrations, removal, capping, and in situ treatment are not required in this area for effective cleanup. MNR and ENR are retained for alternatives evaluation. MNR is expected to meet cleanup standards (when considering regional background concentrations) 10 years following source control. ENR could have limited applicability in the navigation channel where the current depths are above the authorized depth.

6 DESCRIPTION OF CLEANUP ALTERNATIVES

The general and SMA-specific screening of remedial technologies in Section 3.4 was used to develop six remedial alternatives that have been developed to capture the range of potential cleanup options. All remedial alternatives are designed to achieve significant risk reduction following construction (with the exception of MNR) and achieve cleanup standards in the long term. The alternatives are summarized in Table E-3, and are shown in Figures E-5 through E-10. The alternative areas and volumes are presented in Table E-4, and Table E-5 estimates the costs for the alternatives. Table E-6 summarizes the predicted post-construction outcomes for the alternatives. The following sections describe the alternatives. All cleanup is expected to be performed after the CSO is controlled (approximately 2029).

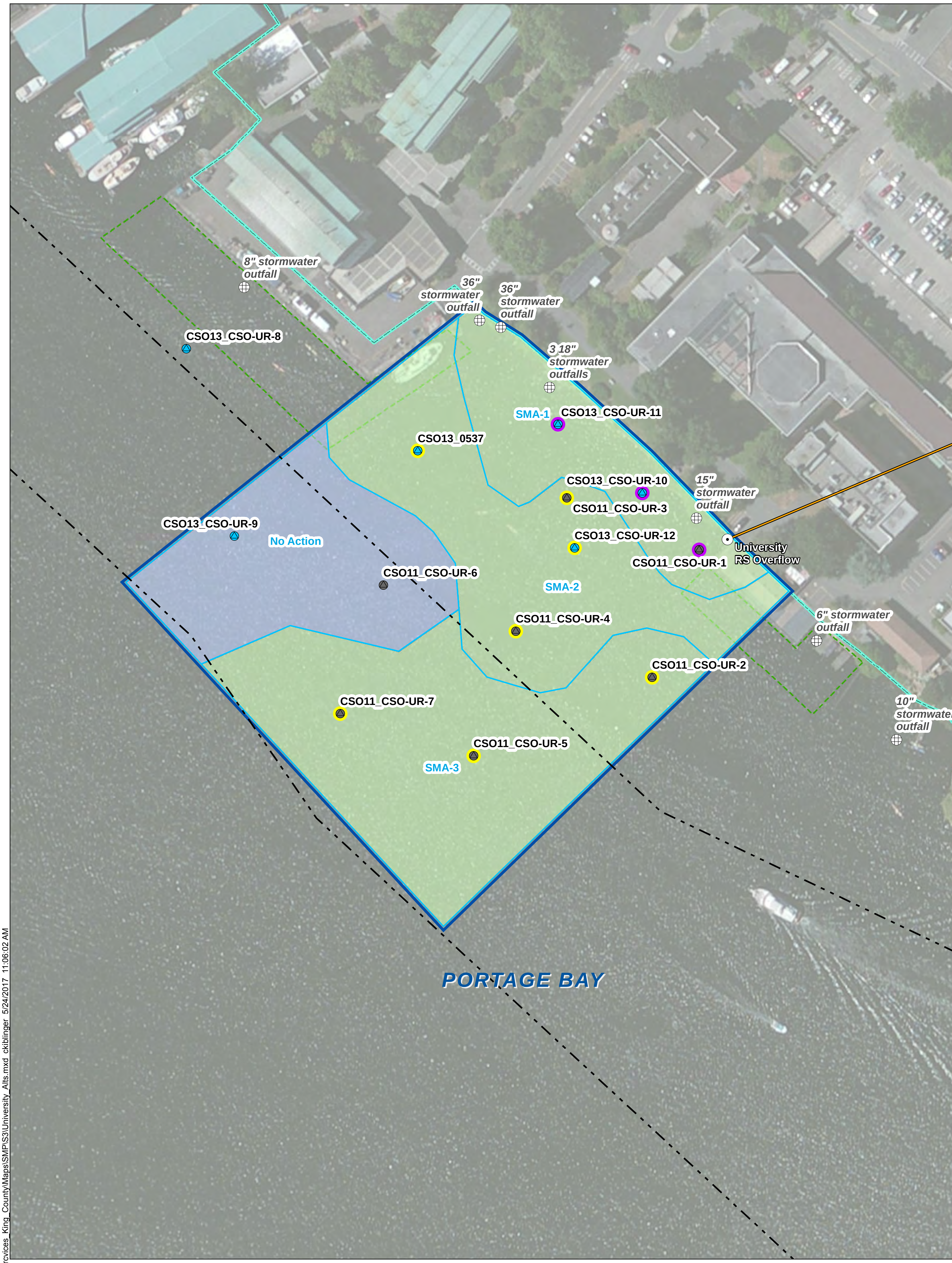
6.1 Alternative 1 – MNR

Alternative 1 consists of source control followed by monitoring to assess recovery toward achieving cleanup standards (Figure E-5). Modeling results indicate that surface sediment concentrations will reduce over time; however, sediments are not likely to recover within 30 years within SMAs 1 and 2, even following CSO control. Therefore, a sediment recovery zone would be required as part of the remedy.

Alternative 1 includes monitoring every 5 years for 30 years (seven events, including a year 0 event), and is estimated to cost a total of $460,000. Potential contingency actions should MNR not meet cleanup standards have not been included in the costs.

6.2 Alternative 2 – ENR/MNR

Alternative 2 consists of source control followed by ENR within SMAs 1 and 2 and MNR within SMA-3 (Figure E-6). Alternative 2 reduces surface sediment concentrations in the area with the highest and moderate surface sediment concentrations and reduces surface sediment concentrations over time in MNR areas. MNR areas are predicted to achieve cleanup standards within about 10 years following construction. Alternative 2 would include the placement of 2,500 cy of ENR material (sand/gravel), 15 years of monitoring (four events), and cost approximately $690,000.

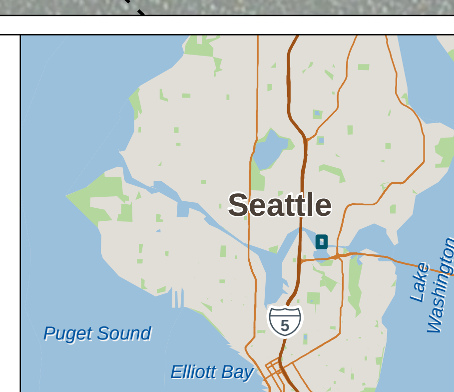


Sediment Sample
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline

- SMAs
- University Regulator CSO Sediment Site Unit Boundary

Alternatives
- MNR
- No Action



NOTE:
Berthing areas and outfall locations are approximate.

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Figure E-5
Alternative 1
University RS Overflow
King County Sediment Management Plan

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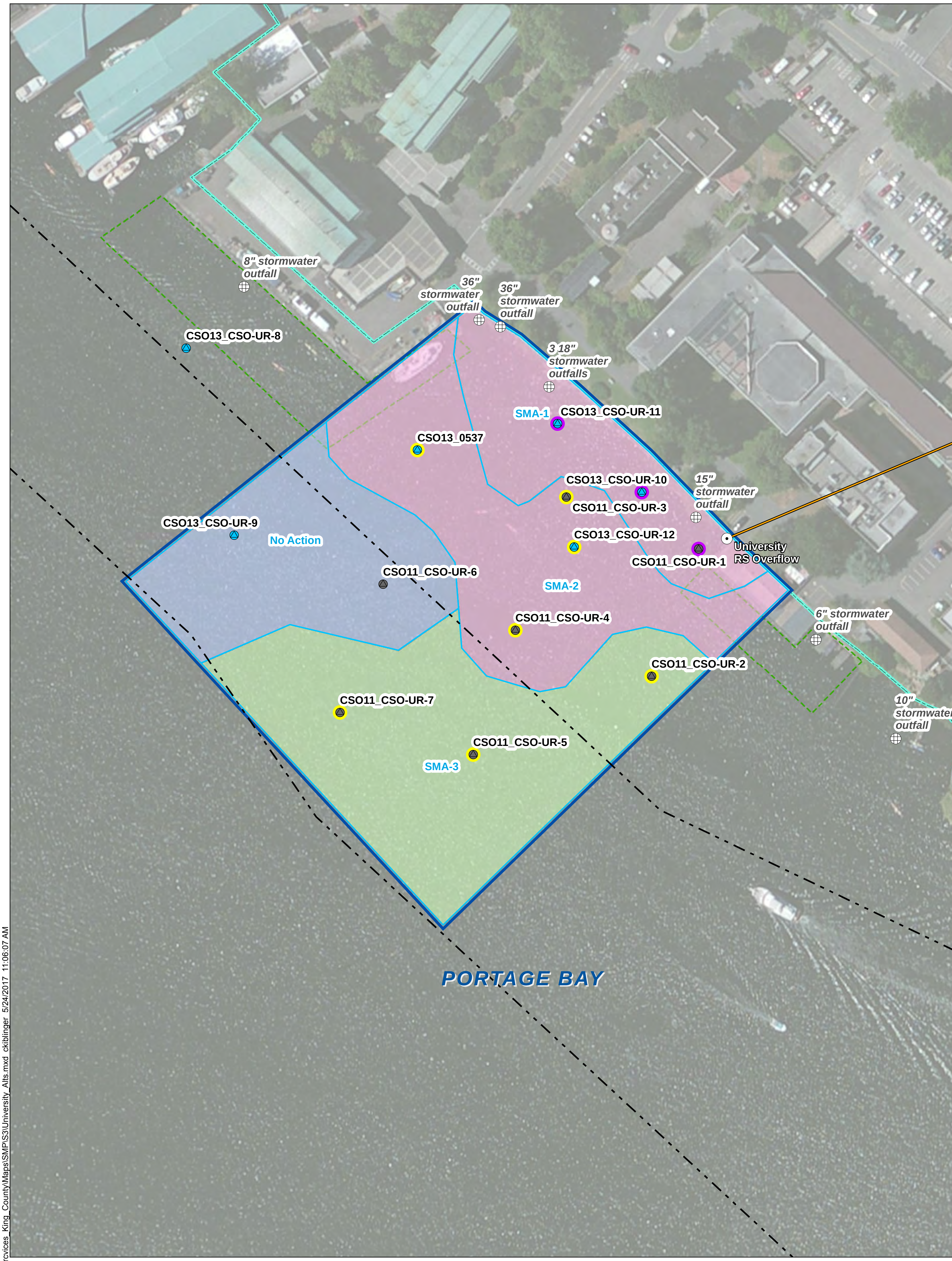
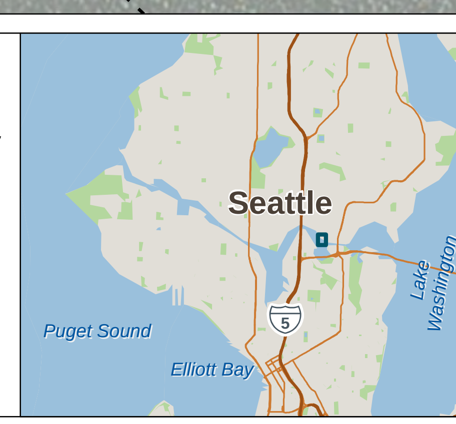


Sediment Sample
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline

- SMAs
- University Regulator CSO Sediment Site Unit Boundary

Alternatives
- ENR
- MNR
- No Action



NOTE:
Berthing areas and outfall locations are approximate.

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Figure E-6
Alternative 2
University RS Overflow
King County Sediment Management Plan

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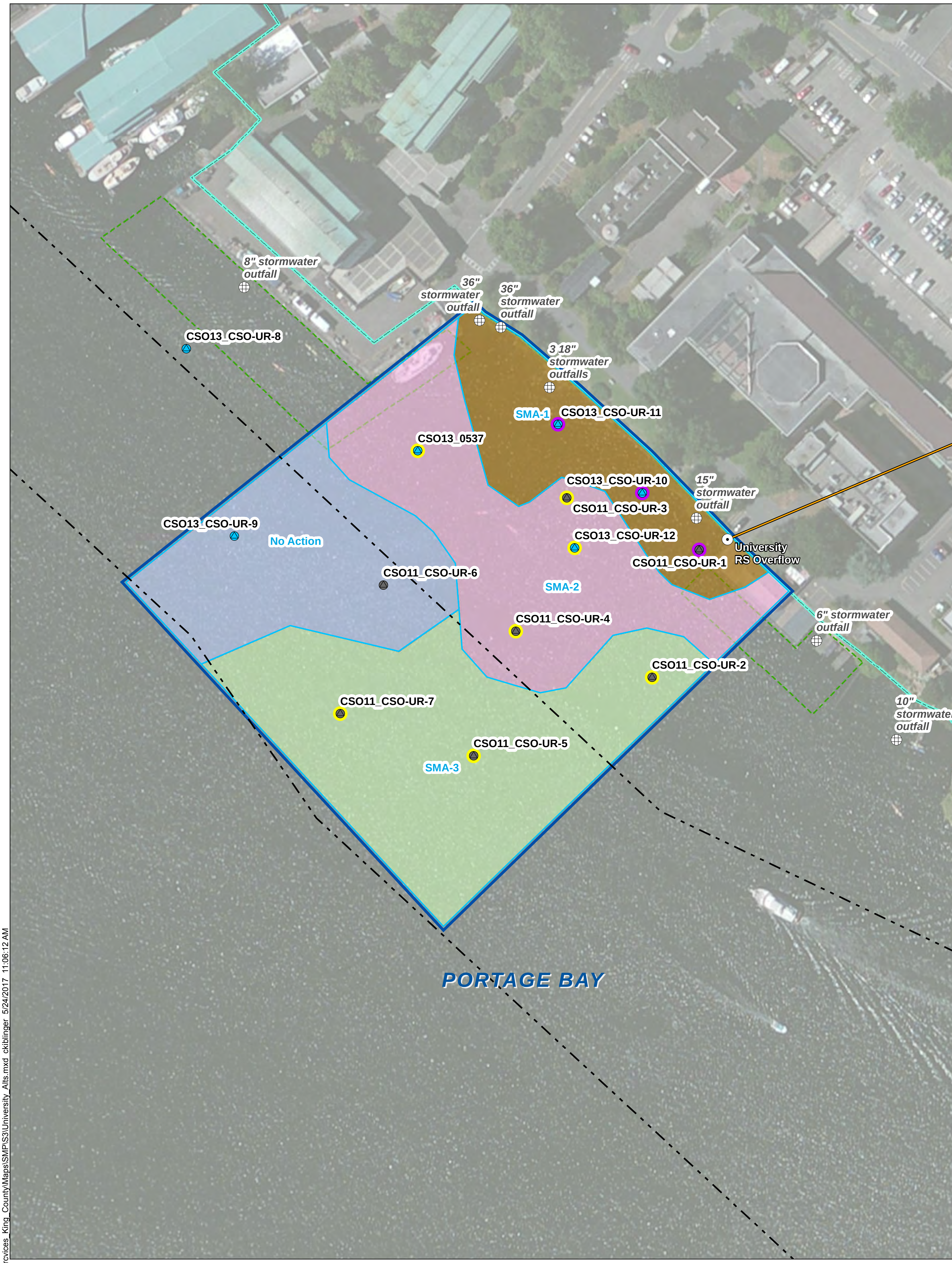
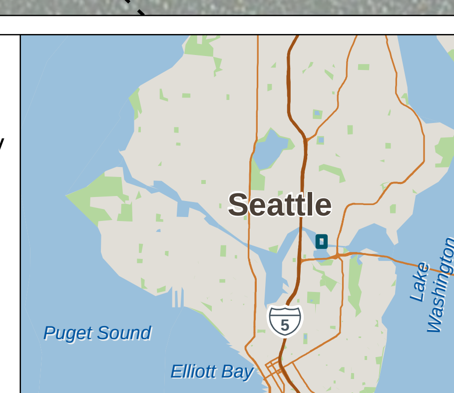


Sediment Sample
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline

- SMAs
- University Regulator CSO Sediment Site Unit Boundary

Alternatives
- In situ Treatment
- ENR
- MNR
- No Action



NOTE:
Berthing areas and outfall locations are approximate.

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Figure E-7
Alternative 3
University RS Overflow
King County Sediment Management Plan

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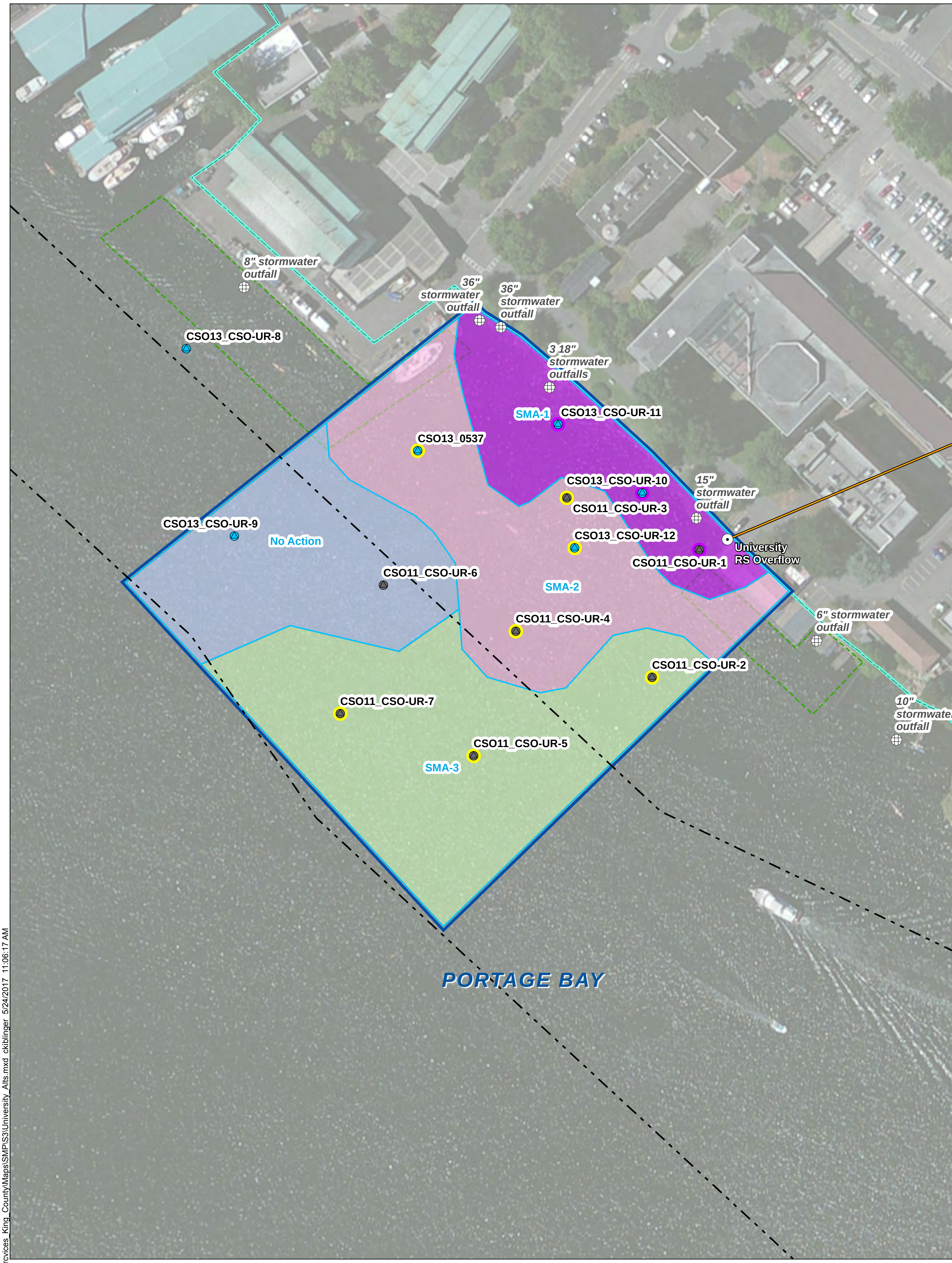

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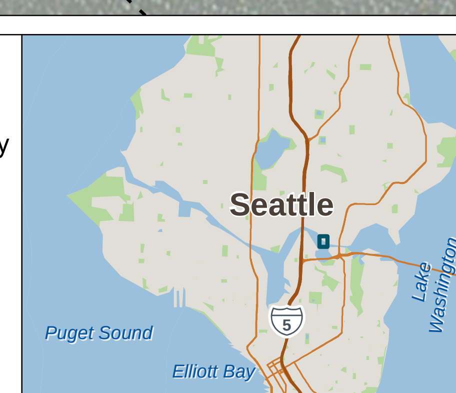
Sediment Sample
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline

- SMAs
- University Regulator CSO Sediment Site Unit Boundary

Alternatives
- Capping
- ENR
- MNR
- No Action



NOTE:
Berthing areas and outfall locations are approximate.

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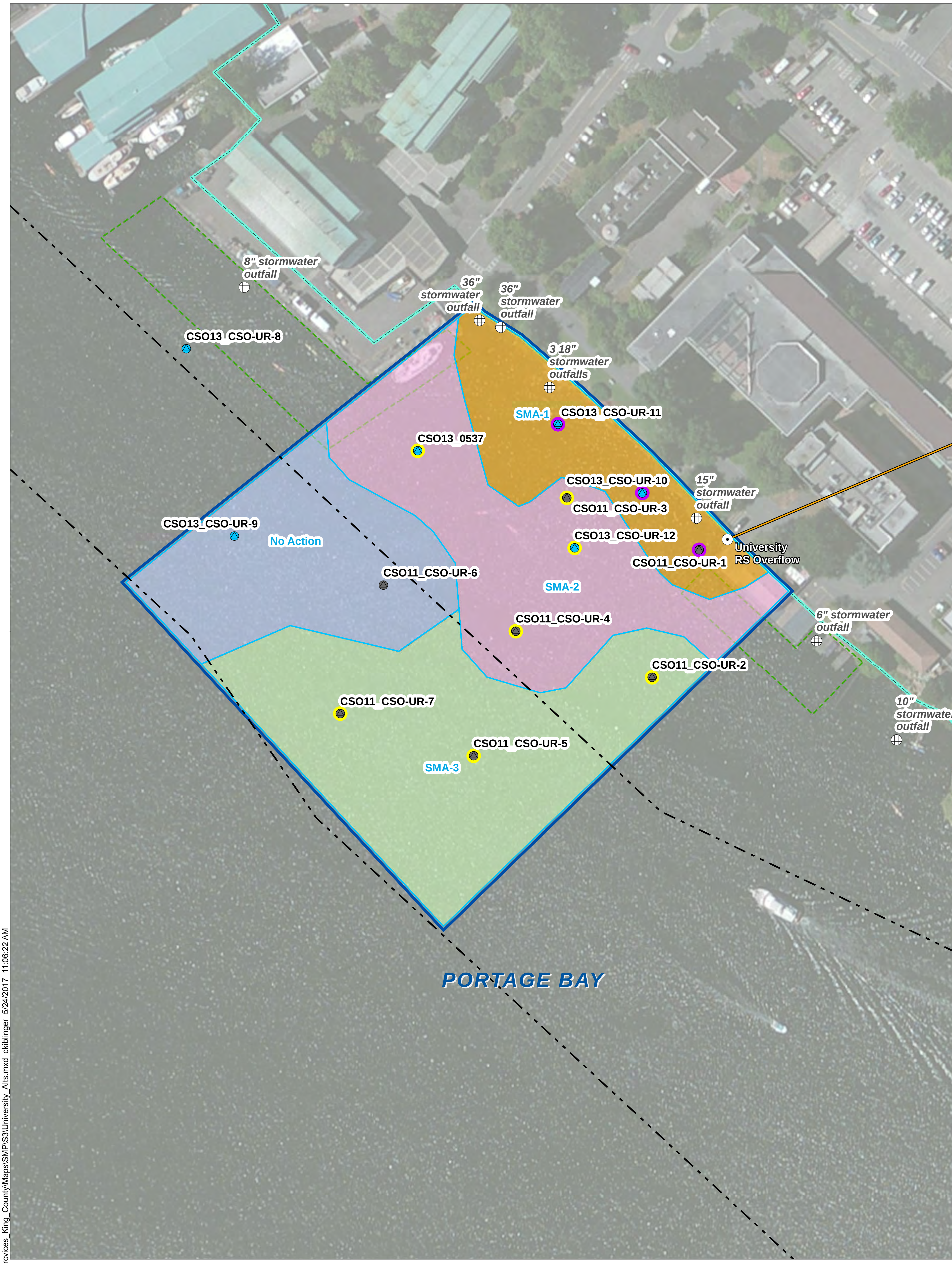
Figure E-8
Alternative 4
University RS Overflow
King County Sediment Management Plan



Sediment Sample

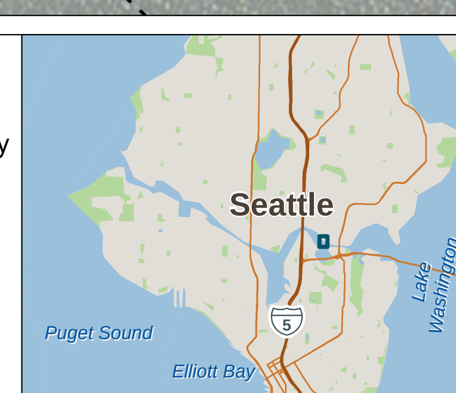
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline

- SMAs
- University Regulator CSO Sediment Site Unit Boundary

Alternatives

- Removal
- ENR
- MNR
- No Action



NOTE:
Berthing areas and outfall locations are approximate.

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Figure E-9
Alternative 5
University RS Overflow
King County Sediment Management Plan

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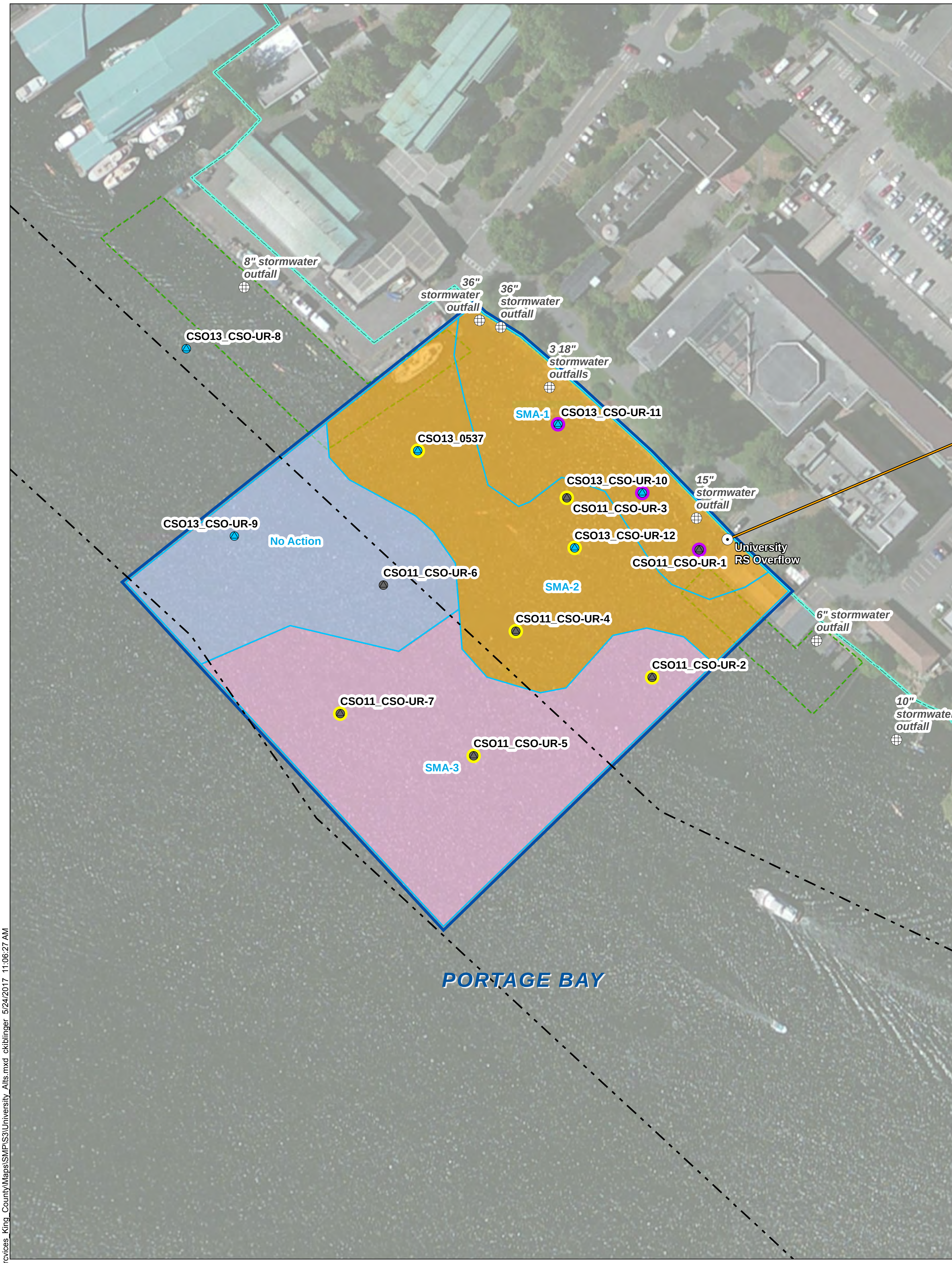


Sediment Sample

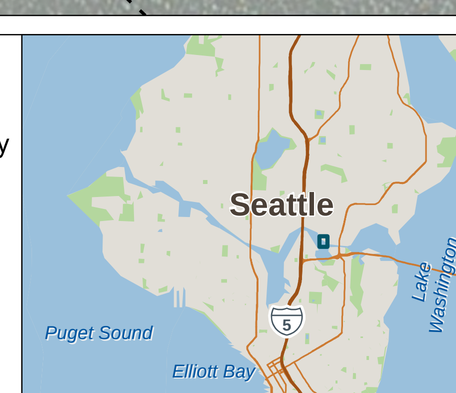
- 2013, King County
- 2011, King County
- Detected concentration is greater than SCO
- Detected concentration is greater than CSL

- CSO
- Stormwater Outfall
- Navigation Channel
- UW Research Vessel Berthing Areas
- Approximate Shoreline

- SMAs
- University Regulator CSO Sediment Site Unit Boundary

Alternatives

- Removal
- ENR
- No Action



NOTE:
Berthing areas and outfall locations are approximate.

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Figure E-10
Alternative 6
University RS Overflow
King County Sediment Management Plan

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6.3 Alternative 3 – In Situ Treatment/ENR/MNR

Alternative 3 consists of source control followed by in situ treatment within SMA-1, ENR within SMA-2, and MNR within SMA-3 (Figure E-7). Alternative 3 reduces surface sediment concentrations and bioavailability of hydrophobic organic contaminants in the area with the highest surface sediment concentrations, and reduces surface sediment concentrations over time in MNR areas. In situ treatment material will reduce surface sediment concentrations of other contaminants (e.g., metals) through dilution of surface sediment by thin-layer placement. MNR areas are predicted to achieve cleanup standards within about 10 years following construction. Alternative 3 would include the placement of 360 cy of in situ treatment material, 1,700 cy of ENR material (sand/gravel), monitoring for 15 years following construction (four events), and cost approximately $760,000.

6.4 Alternative 4 – Capping/ENR/MNR

Alternative 4 consists of source control followed by capping within SMA-1, ENR within SMA-2, and MNR within SMA-3 (Figure E-8). Alternative 4 isolates surface sediments in the area with the highest surface sediment concentrations, reduces surface sediment concentrations in the area with moderate surface sediment concentrations, and reduces surface sediment concentrations over time in MNR areas. MNR areas are predicted to achieve cleanup standards within about 10 years following construction. Alternative 4 would include the placement of 4,400 cy of capping and ENR material (sand/gravel), monitoring for 15 years following construction (four events), and cost approximately $1,010,000.

6.5 Alternative 5 – Removal/ENR/MNR

Alternative 5 consists of source control followed by removal of contaminated sediment within SMA-1, ENR within SMA-2, and MNR within SMA-3 (Figure E-9). Alternative 5 removes surface sediments in the area with the highest surface sediment concentrations, reduces surface sediment concentrations in the area with moderate surface sediment concentrations, and reduces surface sediment concentrations over time in MNR areas.

Table E-3
University RS Overflow Cleanup Alternatives

SMA	Acres	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
SMA-1	0.7	MNR	ENR	In situ treatment	Capping	Removal	Removal
SMA-2	1.4	MNR	ENR	ENR	ENR	ENR	Removal
SMA-3	1.8	MNR	MNR	MNR	MNR	MNR	ENR
No action	1.0	No action	No action	No action	No action	No action	No action

Note:
Source control is part of all remedial alternatives.

Table E-4
University RS Overflow Alternatives: Areas and Volumes

Item	Unit	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
		MNR	ENR/MNR	In situ Treatment/ ENR/MNR	Capping/ ENR/MNR	Removal/ ENR/MNR	Removal/ENR
Total Sediment Cleanup Unit Area	sf	4.9	4.9	4.9	4.9	4.9	4.9
Remediation Area	sf	3.9	3.9	3.9	3.9	3.9	3.9
MNR							
MNR Area	ac	3.9	1.8	1.8	1.8	1.8	0.0
ENR							
ENR Area	ac	0.0	2.1	1.4	1.4	1.4	1.8
ENR Average Placement Thickness	ft	0.75	0.75	0.75	0.75	0.75	0.75
ENR Placement Volume	cy	0	2,505	1,678	1,678	1,678	2,163
In situ Treatment							
In situ Treatment Area	ac	0.0	0.0	0.7	0.0	0.0	0.0

Item	Unit	Alternative 1 MNR	Alternative 2 ENR/MNR	Alternative 3 In situ Treatment/ ENR/MNR	Alternative 4 Capping/ ENR/MNR	Alternative 5 Removal/ ENR/MNR	Alternative 6 Removal/ENR
In situ Treatment Average Placement Thickness	ft	0.33	0.33	0.33	0.33	0.33	0.33
In situ Treatment Placement Volume	cy	0	0	364	0	0	0
Capping							
Cap Area	ac	0.0	0.0	0.0	0.7	0.0	0.0
Cap Depth	ft	2.5	2.5	2.5	2.5	2.5	2.5
Cap Volume	cy	0	0	0	2,756	0	0
Removal							
Dredging Area	ac	0.0	0.0	0.0	0.0	0.7	2.1
Dredging Depth: SMA-1	ft	1.5	1.5	1.5	1.5	1.5	1.5
Dredging Depth: SMA-2	ft	1.5	1.5	1.5	1.5	1.5	1.5
Dredging Volume	cy	0	0	0	0	1,654	5,010
Remedial Management Cover Thickness	ft	0.75	0.75	0.75	0.75	0.75	0.75
Remedial Management Cover Volume	cy	0	0	0	0	827	2,505

Notes:
ac = acres
cy = cubic yards
ft = feet
sf = square feet

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Table E-5
University RS Overflow Alternatives: Costs

Item Description	Unit Cost	Unit	Unit Cost Notes	Quantity					
				Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
				MNR	ENR/MNR	In situ Treatment/ ENR/MNR	Capping/ ENR/MNR	Removal/ ENR/MNR	Removal/ENR
Mobilization and Demobilization; Project Coordination and Submittals	25%	LS	Minimum of 25% of all construction related items (not including oversight), or $200,000.	0	1	1	1	1	1
ENR Purchase and Placement	$ 58	CY	Assumes $18/cy for purchase and delivery of sand/ gravel, and $40/cy for placement (500 CY/day at $20,000/day).	0	2,505	1,678	1,678	1,678	2,163
In situ Treatment Purchase and Placement	$ 260	CY	Assumes $220/cy for purchase and delivery and mixture of GAC/substrate, and $40/cy for placement (500 CY/day at $20,000/day).	0	0	364	0	0	0
Cap Purchase and Placement	$ 58	CY	Assumes $18/cy for purchase and delivery of sand/ gravel, and $40/cy for placement (500 CY/day at $20,000/day).	0	0	0	2,756	0	0
Remedial Management Cover Purchase and Placement	$ 58	CY	Assumes $18/cy for purchase and delivery of sand/ gravel, and $40/cy for placement (500 CY/day at $20,000/day).	0	0	0	0	827	2,505
Open-water Dredging	$ 25	CY	Cost consistent with similar open-water sites in the Puget Sound region.	0	0	0	0	1,654	5,010
Transportation and Disposal	$ 125	CY	Cost consistsnt with similar open-water sites in the Puget Sound region; includes material transit through the ship canal, transfer from barge onto offloading area, water management at transloading facility, transfer and tipping are a Subtitle D landfill.	0	0	0	0	1,654	5,010
Survey and Control	$ 5,000	LS	Assuming pre-dredge and post-dredge surveys at $5,000 each.	0	2	2	2	2	2
Subtotal of Construction Costs									
Tax	9.5%	--	Percent of subtotal of construction costs.	1	1	1	1	1	1
Design and Permitting	$ 200,000	--	Design and permitting for the remediation project.	0	1	1	1	1	1
Water Quality Montoring	$ 3,000	DY	Includes cost for staff, equipment, and boat/boat captian.	0	5	4	9	8	19
Construction Management Support	$ 3,000	DY	Assume $3,000/day for staff support.	0	5	4	9	8	19
Post-construction and Long-term Monitoring	$ 50,000	event	Assume monitoring in Year 0 Post-Construction and every 5 years.	7	4	4	4	4	3
Contingency	30%	--	Assumes 30% of total other costs for contingency	1	1	1	1	1	1
		Total Cost							
	Total Cost (rounded)								

Construction Timeframe									
Placement Time	500	CY/day	Typical of small dredging and placement projects in the Puget Sound region.	0	5	4	9	5	9
Dredging Time	500	CY/day		0	0	0	0	3	10
Total		days		0	5	4	9	8	19

Table E-5
University RS Overflow Alternatives: Costs

Item Description	Unit Cost	Unit	Unit Cost Notes	Cost: Alternative 1 MNR	Alternative 2 ENR/MNR	Alternative 3 In situ Treatment/ ENR/MNR	Alternative 4 Capping/ ENR/MNR	Alternative 5 Removal/ ENR/MNR	Alternative 6 Removal/ENR
Mobilization and Demobilization; Project Coordination and Submittals	25%	LS	Minimum of 25% of all construction related items (not including oversight), or $200,000.	$ -	$ 38,821	$ 50,479	$ 66,794	$ 100,830	$ 200,000
ENR Purchase and Placement	$ 58	CY	Assumes $18/cy for purchase and delivery of sand/ gravel, and $40/cy for placement (500 CY/day at $20,000/day).	$ -	$ 145,286	$ 97,332	$ 97,332	$ 97,332	$ 125,434
In situ Treatment Purchase and Placement	$ 260	CY	Assumes $220/cy for purchase and delivery and mixture of GAC/substrate, and $40/cy for placement (500 CY/day at $20,000/day).	$ -	$ -	$ 94,584	$ -	$ -	$ -
Cap Purchase and Placement	$ 58	CY	Assumes $18/cy for purchase and delivery of sand/ gravel, and $40/cy for placement (500 CY/day at $20,000/day).	$ -	$ -	$ -	$ 159,845	$ -	$ -
Remedial Management Cover Purchase and Placement	$ 58	CY	Assumes $18/cy for purchase and delivery of sand/ gravel, and $40/cy for placement (500 CY/day at $20,000/day).	$ -	$ -	$ -	$ -	$ 47,954	$ 145,286
Open-water Dredging	$ 25	CY	Cost consistent with similar open-water sites in the Puget Sound region.	$ -	$ -	$ -	$ -	$ 41,339	$ 125,247
Transportation and Disposal	$ 125	CY	Cost consistsnt with similar open-water sites in the Puget Sound region; includes material transit through the ship canal, transfer from barge onto offloading area, water management at transloading facility, transfer and tipping are a Subtitle D landfill.	$ -	$ -	$ -	$ -	$ 206,696	$ 626,233
Survey and Control	$ 5,000	LS	Assuming pre-dredge and post-dredge surveys at $5,000 each.	$ -	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
Subtotal of Construction Costs				**$ -**	**$ 194,107**	**$ 252,396**	**$ 333,972**	**$ 504,152**	**$ 1,232,199**
Tax	9.5%	--	Percent of subtotal of construction costs.	$ -	$ 18,440	$ 23,978	$ 31,727	$ 47,894	$ 117,059
Design and Permitting	$ 200,000	--	Design and permitting for the remediation project.	$ -	$ 200,000	$ 200,000	$ 200,000	$ 200,000	$ 200,000
Water Quality Montoring	$ 3,000	DY	Includes cost for staff, equipment, and boat/boat captian.	$ -	$ 15,030	$ 12,252	$ 26,605	$ 24,951	$ 58,065
Construction Management Support	$ 3,000	DY	Assume $3,000/day for staff support.	$ -	$ 15,030	$ 12,252	$ 26,605	$ 24,951	$ 58,065
Post-construction and Long-term Monitoring	$ 50,000	event	Assume monitoring in Year 0 Post-Construction and every 5 years.	$ 350,000	$ 200,000	$ 200,000	$ 200,000	$ 200,000	$ 150,000
Contingency	30%	--	Assumes 30% of total other costs for contingency	$ 105,000	$ 192,782	$ 210,263	$ 245,673	$ 300,585	$ 544,616
		Total Cost		**$ 455,000**	**$ 835,389**	**$ 911,140**	**$ 1,064,581**	**$ 1,302,533**	**$ 2,360,003**
	Total Cost (rounded)			**$ 460,000**	**$ 840,000**	**$ 910,000**	**$ 1,100,000**	**$ 1,300,000**	**$ 2,400,000**

Construction Timeframe

Placement Time	500	CY/day	Typical of small dredging and placement projects in the Puget Sound region.
Dredging Time	500	CY/day	
Total		days	

Table E-6

University RS Overflow Alternatives: Performance at Year 0 Post-Construction

CoC		Alternative 1 MNR	Alternative 2 ENR/MNR	Alternative 3 In situ Treatment/ ENR/MNR	Alternative 4 Capping/ ENR/MNR	Alternative 5 Removal/ ENR/MNR	Alternative 6 Removal/ENR
Benthic Risk Driver SCO Point Exceedances[a]	PCBs	6	0	0	0	0	0
	Mercury	2	0	0	0	0	0
	Lead	1	0	0	0	0	0
	Silver	3	0	0	0	0	0
	BEHP	6	1	1	1	1	0
	Nickel	7	3	3	3	3	0
PCBs SWAC[b]	µg/kg dw	295	46	46	46	46	20[c]
cPAHs SWAC[d]	µg/kg dw	370	139	139	139	139	42[c]

Notes:

Green Shading = 0 exceedances

a. Benthic exceedances are assumed to be remediated by ENR, in situ treatment, capping, or dredging. All exceedances for PCBs, mercury, lead, and silver are confined to SMAs 1 and 2, and therefore are completely cleaned up for Alternatives 2 through 6.
b. PCBs SWAC was calculated assuming a post-construction concentration equal 3.5 ug/kg based on Puget Sound natural background because of the low concentration in sand/gravel placement materials. Remediation areas are expected to equilibrate with diffuse urban inputs. PCBs SWAC based on interpolated surface within the sediment site unit.
c. PCBs and cPAHs SWACs for Alternative 6 are less than ambient deposition concentrations (see Appendix B and Section 3.2.3.1) and therefore are likely to increase following construction.
d. cPAHs are not identified as a CoC in this analysis and is presented for informational purposes only. cPAHs SWAC was calculated assuming a post-construction concentration equal 21 ug/kg (Puget Sound natural background). Remediation areas are expected to equilibrate with diffuse urban inputs. cPAHs SWAC calculated based on the average of point concentrations within the sediment site unit.

MNR areas are predicted to achieve cleanup standards within about 10 years following construction. Alternative 5 would include the removal of 1,700 cy of sediment, placement of 2,500 cy of ENR and residuals management cover material (sand/gravel), monitoring for 15 years following construction (four events), and cost approximately $1,200,000.

6.6 Alternative 6 – Removal/ENR

Alternative 6 consists of source control followed by removal of contaminated sediment within SMAs 1 and 2 and ENR within SMA-3 (Figure E-10). Alternative 6 removes surface sediments in the areas with the highest and moderate surface sediment concentrations and reduces surface sediment concentrations in the area with the lowest surface sediment concentrations. Alternative 6 would include the removal of 5,000 cy of sediment, placement of 4,700 cy of ENR and residuals management cover material (sand/gravel), monitoring for 10 years following construction (three events), and cost approximately $2,400,000.

7 DETAILED EVALUATION OF CLEANUP ALTERNATIVES

Remedy selection criteria under the SMS are similar to those required under MTCA. The SMS evaluation criteria are specified in WAC 173-204-570, which evaluates the cleanup action alternatives under the SMS and provides the basis for selecting a preferred alternative.

7.1 Minimum Requirements

Cleanup actions performed under the SMS must comply with 11 minimum requirements under WAC 173-204-570(3). Alternatives that do not comply with those criteria would typically not be considered suitable cleanup actions under the SMS. This section summarizes the evaluation of SMS minimum requirements.

7.1.1 Compliance with Cleanup Standards

Under the SMS, compliance with cleanup standards represents the measure of whether and when an alternative has reduced risk sufficiently to protect human health and the environment. Compliance with cleanup standards is used to evaluate three minimum requirements:

1. "Protection of human health and the environment" (WAC 173-204-570(3)(a))

2. "Compliance with cleanup standards" (WAC 173-204-570(3)(c))
3. "Provide for a reasonable restoration time frame" (WAC 173-204-570(3)(d))

All of the alternatives require source control measures to meet cleanup standards in the long term. Cleanup standard requirements achieved by each cleanup alternative are summarized as follows:

- **Alternative 1 – MNR:** Cleanup standards not likely to be met in a reasonable restoration time frame in some SMAs. Cleanup standards are predicted to be met within 30 years in SMA-2, 10 years in SMA-3, and longer than 30 years in SMA-1.
- **Alternative 2 – ENR/MNR:** Cleanup standards are likely to be met following construction (SMAs 1 and 2) and within approximately 10 years following construction (SMA-3).
- **Alternative 3 – In situ treatment/ENR/MNR:** Cleanup standards are likely to be met following construction (SMAs 1 and 2) and within approximately 10 years following construction (SMA-3).
- **Alternative 4 – Capping/ENR/MNR:** Cleanup standards are likely to be met following construction (SMAs 1 and 2) and within approximately 10 years following construction (SMA-3).
- **Alternative 5 – Removal/ENR/MNR:** Cleanup standards are likely to be met following construction (SMAs 1 and 2) and within approximately 10 years following construction (SMA-3).
- **Alternative 6 – Maximum Removal/ENR:** Cleanup standards are likely to be met following construction (SMAs 1–3).

Consistent with WAC 173-204-570(5)(a), Alternatives 2 through 6 would achieve a reasonable restoration time frame and meet the three minimum requirements listed previously. Alternative 1 may require a sediment recovery zone in SMA-1 to accommodate restoration time frames of longer than 10 years unless sources can be controlled, but still meets the three minimum requirements.

7.1.2 Other Minimum Requirements

Cleanup of the University RS Overflow sediment cleanup unit must also meet other SMS minimum requirements. The alternatives meet, or do not meet, those requirements as described in the following list.

- All alternatives would comply with all applicable laws (WAC 173-204-570(3)(b)), as summarized in Appendix D.
- All alternatives include source control elements to achieve cleanup standards, which includes CSO control and evaluation for and control of any other sources prior to cleanup construction (WAC 173-204-570(3)(f)).
- A sediment recovery zone would be necessary in SMA-1 for Alternative 1 – MNR because all cleanup standards would not be achieved within 10 years (WAC 173-204-570(3)(g)). The requirements of a sediment recovery zone (WAC 173-204-590) may be met for Alternative 1, but further evaluation of source control efforts would be needed to justify that the alternative would meet all the requirements of the sediment recovery zone and therefore could be selected in the CAP.
- Because of the strong source control component, no alternative exclusively relies on MNR or institutional controls (WAC 173-204-570(3)(h)). Alternative 4 would require additional institutional controls (e.g., deed restrictions) to ensure that the cap is not damaged by future development (e.g., maintenance dredging).
- Once a CAP is developed for the site, it will be reviewed by stakeholders and the public (WAC 173-204-570(3)(i)).
- All alternatives include monitoring to verify the effectiveness of the cleanup action (WAC 173-204-570(3)(j)).
- Following implementation of the cleanup action, periodic review will be performed to assess long-term effectiveness and protectiveness (WAC 173-204-570(3)(k)).

The disproportionate cost analysis (DCA) is discussed in the next section and addresses the minimum requirement of "using permanent solutions to the maximum extent practicable" (WAC 173-204-570(3)(d)).

7.2 Disproportionate Cost Analysis

The SMS specify that preference shall be given to actions that are permanent solutions to the maximum extent practicable. Identifying an alternative that is permanent to the maximum extent practicable requires weighing costs and benefits. SMS uses the MTCA (WAC 173-340-360(3)(e))) as the tool for comparing each remedial alternative's incremental environmental benefits with its incremental costs. The DCA is the primary method by which the alternatives are systematically compared to each other in this document. According to WAC 173-340-360(3)(e)(i), costs are considered disproportionate to benefits when the incremental costs of those alternatives that meet minimum threshold protective criteria exceed the incremental benefits achieved by the alternative compared other, lower-cost, protective alternatives.

Seven MTCA criteria, which are listed in WAC 173-340-360(3)(f), are used to evaluate and compare remedial alternatives when conducting the DCA. Under the SMS, each criterion is not equal in the DCA evaluation and, therefore, is assigned a relative weight for the DCA. Consistent with recent DCA and equivalent evaluations performed by Ecology at other sediment cleanup sites, the first six evaluation criteria are weighted and assigned a score for total benefits; those total benefits are then summed and compared with costs of the alternatives, using the following weighting:

- Protectiveness (30% of total benefit score)
- Permanence (20% of total benefit score)
- Effectiveness over the long term (20% of total benefit score)
- Management of short-term risks (10% of total benefit score)
- Technical and administrative implementability (10% of total benefit score)
- Consideration of public concerns (10% of total benefit score)
- Cost (compared to total benefits)

The following sections describe the methodology and rationale for evaluating alternatives under each criterion. Total benefit scores and costs are shown in Table E-7 and plotted in Figures E-11 and E-12.

7.2.1 Protectiveness

WAC 173-340-360(3)(f)(i) define protectiveness as:

> *Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.*

Consistent with DCAs used by Ecology at other sediment cleanup sites, the protectiveness of each remedial alternative was scored based on two considerations:

- Overall protection of the environment, considering the reduction in risk to the benthic community.
- Overall protection of human health, considering anticipated human health risk reductions for the key human health risk driver, total PCBs, and cPAHs.

As shown in Table E-7, Alternative 1 is predicted to meet protective levels only after a long term (more than 30 years) and, therefore, scores significantly lower than the other alternatives for overall protection (1 out of 5). Alternatives 2 through 5 are all predicted to achieve significant risk reduction and most cleanup standards following construction. The alternatives achieve cleanup standards for nickel and BEHP 10 years following construction and therefore score 4.5 out of 5. Alternative 6 achieves all cleanup standards following construction and therefore scores 5 out of 5. For PCBs and cPAHs, Alternatives 2 through 5 achieve concentrations within the range of ambient concentrations/regional background concentrations (see Appendix B and Section 3.3 of this appendix). Alternative 6 is not considered more effective than Alternatives 2 through 5 because concentrations are likely to increase to levels similar to Alternatives 2 through 5 following construction. In summary, the alternatives score as follows for protectiveness:

- Alternative 1 1.0
- Alternative 2 4.5
- Alternative 3 4.5
- Alternative 4 4.5
- Alternative 5 4.5
- Alternative 6 5.0

Table E-7
University RS Overflow Alternatives: Disproportionate Cost Analysis

Criterion	Weighting	Washington Administrative Code (WAC) Language	Considerations for Site-Specific Evaluation		Alternative 1 MNR	Alternative 2 ENR/MNR	Alternative 3 In situ Treatment/ ENR/MNR	Alternative 4 Capping/ENR/MNR	Alternative 5 Removal/ENR/MNR	Alternative 6 Removal/ENR
Protectiveness	30%	*Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and offsite risks resulting from implementing the alternative, and improvement of the overall environmental quality.*	Protection of the Benthic Community (Post-Construction Exceedances)	PCBs, Mercury, Silver, and Lead	CSL and SCO	None	None	None	None	None
				BEHP and Nickel	SCO	SCO (achieves in year 10)	SCO (achieves in year 10)	SCO (achieves in year 10)	SCO (achieves in year 10)	None
				Score	1	4	4	4	4	5
			Protection of Human Health (Post-Construction SWAC)	PCBs (ug/kg)	295	46	46	46	46	20
				Score	1	5	5	5	5	5
			Total	**Score**	**1.0**	**4.5**	**4.5**	**4.5**	**4.5**	**5.0**
Permanence	20%	*The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*	Permanence of the sediment remedial technologies		MNR is least permanent	ENR scores low for permanence placement is more permanent	In situ treatment is expected to permanently reduce bioavailability of hydrophobic organic compounds	Capping is expected to permanently isolate contaminated sediment	Removal permanently removes contaminated sediment from SMA 1.	Removal permanently removes contaminated sediment from SMAs 1 and 2.
			Total	**Score**	**1**	**2**	**3**	**3**	**4**	**5**
Effectiveness over the Long Term	20%	*When assessing the relative degree of long-term effectiveness of cleanup action components, the following types of components may be used as a guide, in descending order: (i) Source controls in combination with other cleanup technologies; (ii) Beneficial reuse of the sediments; (iii) Treatment to immobilize, destroy, or detoxify contaminants; (iv) Dredging and disposal in an upland engineered facility that minimizes subsequent releases and exposures to contaminants; (v) Dredging and disposal in a nearshore, in-water, confined aquatic disposal facility; (vi) Containment of contaminated sediments in-place with an engineered cap; (vii) Dredging and disposal at an open water disposal site approved by applicable state and federal agencies; (viii) Enhanced natural recovery; (ix) Monitored natural recovery; and (x) Institutional controls and monitoring.*	Remedial Technologies	Characteristics	Remedial Technology by Area					
			SMA-1	Highest Concentration Area	MNR	ENR	In situ treatment	Capping	Dredging	Dredging
			SMA-2	Medium Concentration Area	MNR	ENR				Dredging
			SMA-3	Lowest Concentration Area	MNR					ENR
			Subtotal	**Score**	**1**	**2**	**3**	**3**	**4**	**5**
			Source Control	Performance	CSO control is integral to all alternatives. Alternatives score 3 because solids loading is not fully eliminated form CSO systems.					
				Score	**3**	**3**	**3**	**3**	**3**	**3**
			Total	**Score**	**2.0**	**2.5**	**3.0**	**3.0**	**3.5**	**4.0**

Table E-7
University RS Overflow Alternatives: Disproportionate Cost Analysis

Criterion	Weighting	Washington Administrative Code (WAC) Language	Considerations for Site-Specific Evaluation		Alternative 1 MNR	Alternative 2 ENR/MNR	Alternative 3 In situ Treatment/ ENR/MNR	Alternative 4 Capping/ENR/MNR	Alternative 5 Removal/ENR/MNR	Alternative 6 Removal/ENR
Management of Short-term Risk	10%	*The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.*	Risk to Human Health and Safety and Risks to Environment During Construction (Inversely Proportional to Construction Time)	Construction Time (days)	0	5	4	9	10	24
				Score	**5.0**	**4.2**	**4.3**	**3.5**	**3.4**	**1.0**
			Risks until cleanup standards are achieves	Restoration Timeframe (years following construction)	50	10	10	10	10	0
				Score	**1.0**	**4.2**	**4.2**	**4.2**	**4.2**	**5.0**
			Total	**Score**	**3.0**	**4.2**	**4.3**	**3.9**	**3.8**	**3.0**
Technical and Administrative Implementability	10%	*Technical and administrative implementability. Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary offsite facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.*	Technical feasibility to implement	Performance	No construction, but protracted monitoring program	ENR is relatively simple to implement	In situ treatment may require additional bench studies and bioavailability monitoring	Capping is relatively simple to implement, but could result in site use restrictions	Dredging is relatively simple to implement but requires coordination for disposal of dredged material.	
			Total	**Score**	**4.0**	**4.0**	**2.0**	**3.0**	**3.0**	**3.0**
Consideration of Public Concerns	10%	*Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.*	Consistency with land use, protection of users, habitat restoration, and permanently improve the environment	Performance	Unlikely to satisfy public desire for rapidly reducing site risk	Public may question leaving contaminated sediment on site. Public more likely to support isolation capping			Public is more likely to support the permanent removal of contaminated sediment.	
			Total	**Score**	**1.0**	**3.0**	**2.5**	**4.0**	**4.5**	**5.0**
Total Weighted Benefits					**1.7**	**3.4**	**3.4**	**3.6**	**4.0**	**4.4**
Cost					**$460,000**	**$840,000**	**$910,000**	**$1,100,000**	**$1,300,000**	**$2,400,000**

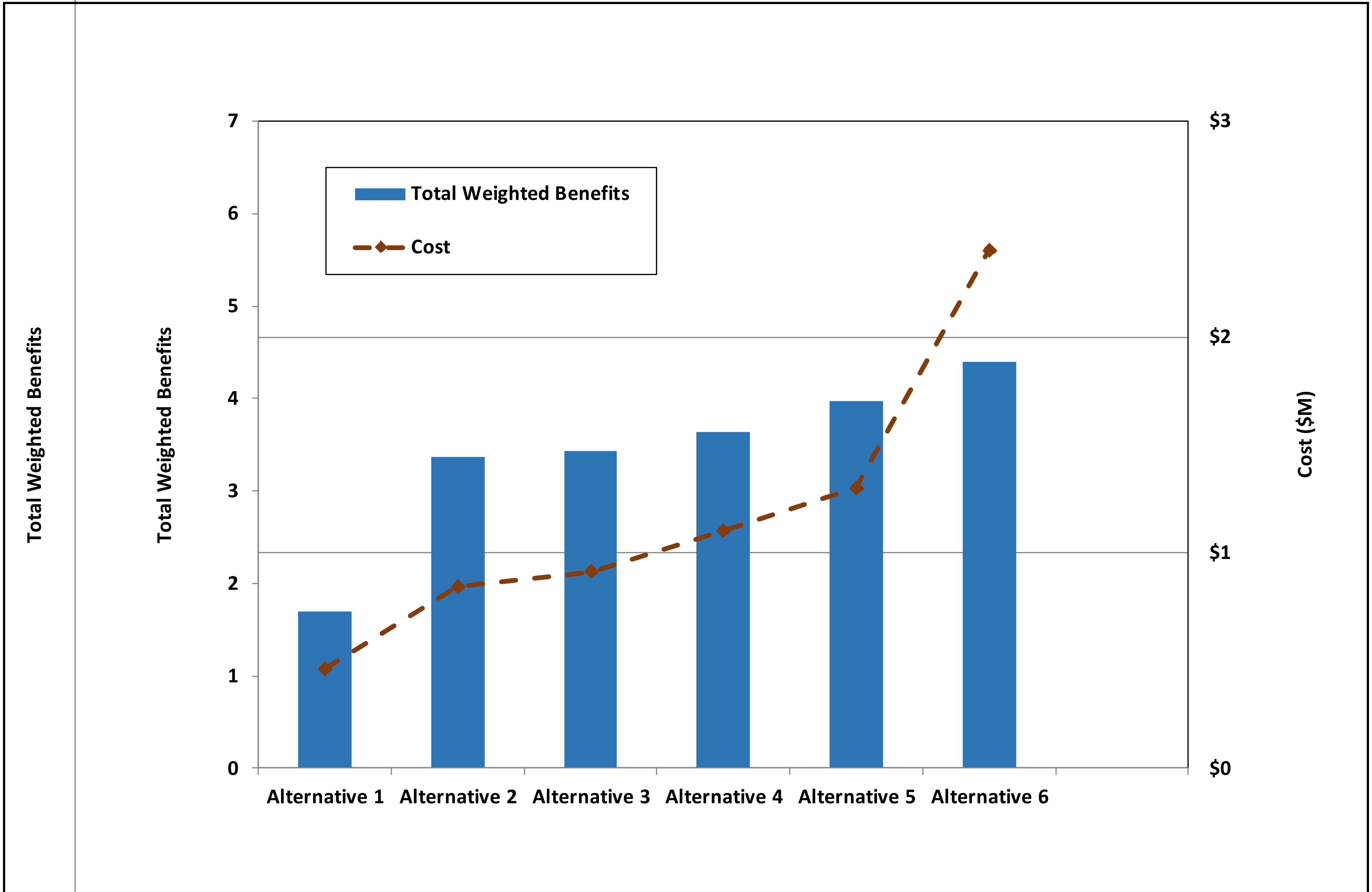

Figure E-11
Disproportionate Cost Analysis – Bar Chart
University RS Overflow
King County Sediment Management Plan

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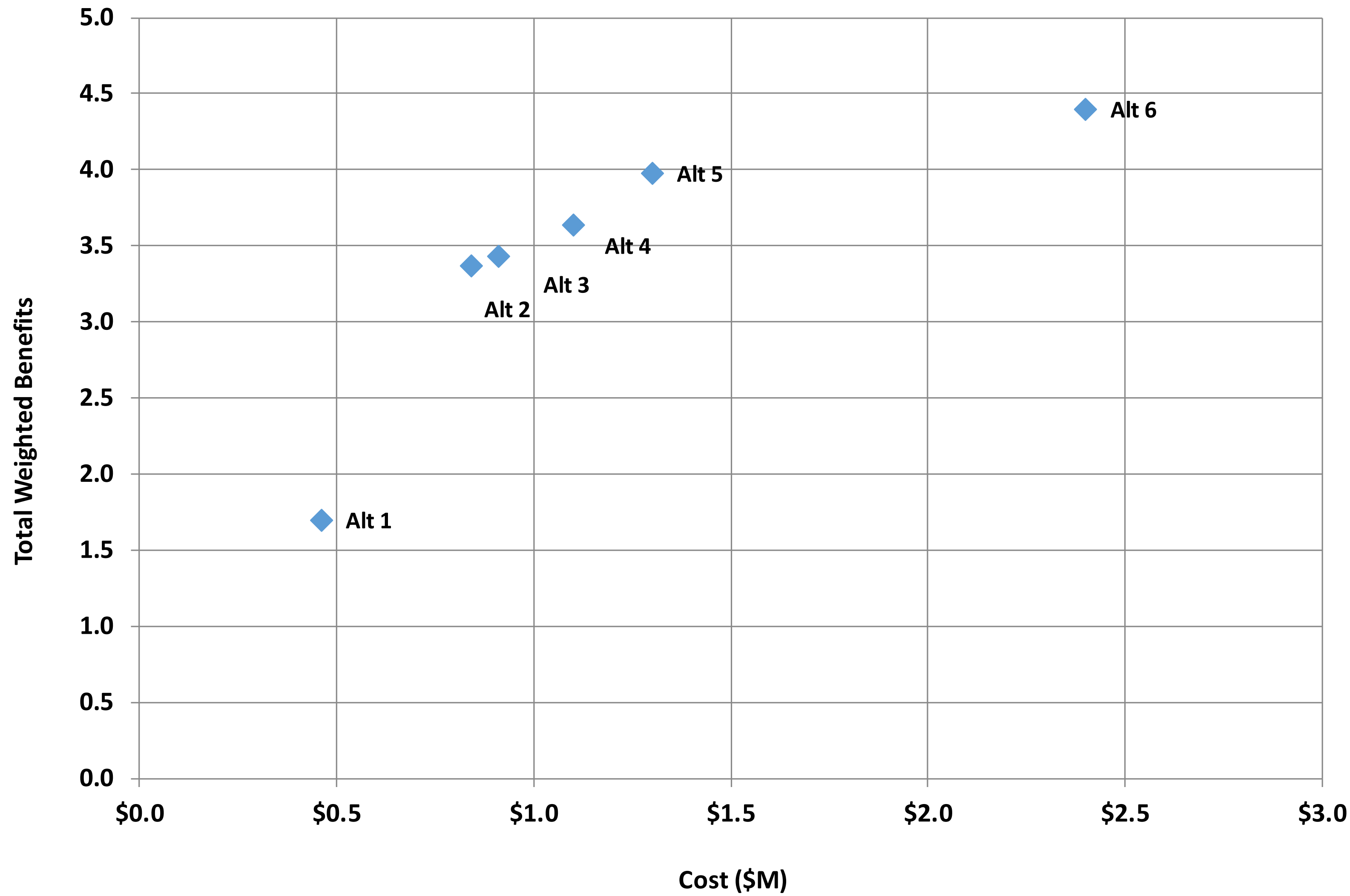

Figure E-12
Disproportionate Cost Analysis – Scatter Plot
University RS Overflow
King County Sediment Management Plan

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7.2.2 Permanence

WAC 173-340-360(3)(f)(ii) defines permanence as:

> *The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*

For the University RS Overflow sediment cleanup unit, permanence is scored based on the relative degree of permanence for the remedial technologies proposed.

Alternative 1 scores the lowest (1) because MNR leaves contaminated sediment on site and has no engineering controls to isolate contaminants. Alternative 2 scores the next lowest (2) because ENR leaves contaminated sediment on site and uses thin sand placement to bury contaminated sediment. Alternatives 3 and 4 score moderately (3) because in situ treatment is expected to permanently reduce bioavailability of hydrophobic organic compounds, and capping is expected to permanently isolate contaminants, although both leave contaminants in place and rely on ENR or MNR in parts of the site. Alternative 5 scores higher (4) because it permanently removes contaminated sediment from the waterway (but also includes ENR and MNR in part of the site). Alternative 6 scores highest (5) because it permanently removes the most contaminated sediment from the waterway (but includes ENR in part of the site). In summary, the alternatives score as follows for permanence:

- Alternative 1 1.0
- Alternative 2 2.0
- Alternative 3 3.0
- Alternative 4 3.0
- Alternative 5 4.0
- Alternative 6 5.0

7.2.3 Effectiveness over the Long Term

As part of the long-term effectiveness evaluation, SMS provides a preferential hierarchy of remedial technologies, which replaces a similar upland-oriented list in MTCA, as follows:

When assessing the relative degree of long-term effectiveness of cleanup action components, the following types of components may be used as a guide, in descending order, in place of the components listed in WAC 173-340-360 (3)(f)(iv):

(i) Source controls in combination with other cleanup technologies;
(ii) Beneficial reuse of the sediments;
(iii) Treatment to immobilize, destroy, or detoxify contaminants;
(iv) Dredging and disposal in an upland engineered facility that minimizes subsequent releases and exposures to contaminants;
(v) Dredging and disposal in a nearshore, in-water, confined aquatic disposal facility;
(vi) Containment of contaminated sediments in-place with an engineered cap;
(vii) Dredging and disposal at an open water disposal site approved by applicable state and federal agencies;
(viii) Enhanced natural recovery;
(ix) Monitored natural recovery; and
(x) Institutional controls and monitoring (WAC 173-204-570(4)(b)).

As discussed previously, all alternatives rely on source control and investigation of other potential sources to achieve cleanup standards (because, and therefore score similarly for source control. In addition, the active remedy elements were scored consistent with the WAC. In summary, the alternatives score as follows for effectiveness over the long term:

- Alternative 1 2.0
- Alternative 2 2.5
- Alternative 3 3.0
- Alternative 4 3.0
- Alternative 5 3.5
- Alternative 6 4.0

7.2.4 Management of Short-term Risk

Management of short-term risk considers impacts during construction and the risks remaining on site during the restoration timeframe. WAC 173-340-360(3)(f)(v) defines management of short-term risk as:

The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.

During construction, material placement and sediment removal would disrupt the existing benthic community, and removal would result in releases of contaminants into the water column and sediment residuals through resuspension of contaminated sediment. Table E-7 presents the construction timeframe for the remedial alternatives as a metric for assessing the magnitude of impacts on human health and the environment during construction. The estimated construction timeframe for the alternatives range from 0 to 24 construction days and are scored on a scale from 1 to 5, inversely proportional to the construction duration.

In addition, short-term risk considers the risks until the time when cleanup standards are achieved. The time to achieve the cleanup standards (i.e., the restoration timeframe) for the alternatives is approximately 50 years for Alternative 1, 10 years for Alternatives 2 through 5, and 0 years for Alternative 6. The alternatives are scored on a scale from 1 to 5, inversely proportional to the construction duration.

The total scores average these two considerations, and the alternatives score as follows for management of short-term risk:

- Alternative 1 3.0
- Alternative 2 4.2
- Alternative 3 4.3
- Alternative 4 3.9
- Alternative 5 3.8
- Alternative 6 3.0

7.2.5 Technical and Administrative Implementability

WAC 173-340-360(3)(f)(vi) defines technical and administrative implementability as:

Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and *monitoring, and integration with existing facility operations and other current or potential remedial actions.*

All of the alternatives are highly implementable and use common remediation technologies. Alternatives 3, 5, and 6 score lower (2, 3, and 3, respectively) because of increased technical challenges associated with implementing and monitoring in situ treatment (Alternative 3) and equipment and coordination needed for removal (Alternatives 5 and 6). Alternatives 2 and 4 score higher (4) because they rely on sand and gravel placement only. Finally, Alternative 1 also scores 4 because there is no construction for MNR, but a long period of monitoring and highest risk of contingency actions. In summary, the alternatives score as follows for technical and administrative implementability:

- Alternative 1 4.0
- Alternative 2 4.0
- Alternative 3 2.0
- Alternative 4 3.0
- Alternative 5 3.0
- Alternative 6 3.0

7.2.6 Consideration of Public Concerns

WAC 173-340-360(3)(f)(vii) defines consideration of public concerns as:

Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.

Public outreach has not been performed for the project, and will occur through a formal process during final design and permitting. The alternatives are rated for public concerns considering that the public tends to value more permanent remedies. Alternative 1 scores lowest (1) because risks are not reduced within a reasonable timeframe and contaminated sediment remains on site. Alternatives 2 and 3 score moderately (3 and 2.5, respectively) because they reduce site risks within a reasonable timeframe but leave contaminated sediment on site. Alternative 4 scores higher (4) because isolation capping of the highest concentrations is more likely to garner public support. Finally, Alternatives 5 and 6 score highest (4.5 and 5, respectively) because they permanently remove contaminated sediment from the site. In summary, the alternatives score as follows for consideration of public concerns:

- Alternative 1 1.0
- Alternative 2 3.0
- Alternative 3 2.5
- Alternative 4 4.0
- Alternative 5 4.5
- Alternative 6 5.0

7.2.7 Total Benefits and Costs

Total benefit scores and costs are shown in Table E-7 and plotted in Figures E-11 and E-12.

The total weighted benefits range from 2.2 for Alternative 1 to 4.3 for Alternative 6, and costs range from $390,000 to $2.7 million. The alternatives increase in both costs and benefits moving from Alternative 1 through Alternative 6. MTCA states that "costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative" (WAC 173-340-360(3)(e)(i)). As shown in Table E-7 and Figures E-5 and E-6, Alternative 6 is disproportionately costly compared to its benefits, relative to Alternative 5.

8 CONCLUSIONS

This section presents planning-level conclusions from the alternatives analysis. A preferred remedy will be developed in a CAP for the site.

8.1 Alternatives Analysis

Alternatives 1 and 6 would not be selected under SMS. At one end of the alternative array, Alternative 1 has a restoration timeframe that is longer than 10 years and is unlikely to meet the requirements of a sediment recovery zone (e.g., because other alternatives with shorter restoration timeframes are practicable; WAC 173-204-590(2)). At the other end of the alternative array, Alternative 6 is disproportionately costly compared to Alternative 5, without achieving proportional increased benefit.

Of the remaining alternatives, Alternative 2 and Alternative 5 are the most compatible with site-specific conditions and have better DCA results. Alternative 3 features in situ treatment, which reduces bioavailability in hydrophobic organic compounds (e.g., PCBs), but may not address other contaminants at the site. Alternative 4 features capping, which fully isolates contaminated sediment, but has the drawback of shallowing up the aquatic area and therefore may not be compatible with berthing activities at the site. In addition, the thin deposit of contaminated sediment at the site (<1 foot) does not warrant the long-term maintenance and monitoring costs associated with capping. Capping could be reconsidered if thicker deposits of contaminated sediments are discovered in nearshore areas.

Both Alternatives 2 and 5 are expected to be effective at meeting cleanup standards. Alternative 2 has fewer impacts during construction but leaves more contaminated sediment on site. Alternative 2 is applicable if natural recovery is observed to be occurring at the site. Alternative 5 has more impacts during construction and leaves less contaminated sediment on site. Alternative 5 relies less on natural recovery and therefore is more applicable if natural recovery is not being observed at the site.

8.2 Additional Evaluations

Additional evaluations would be useful to develop the CAP and provide important information to select the preferred alternative. These evaluations could address the following areas:

- **Source Control:** Measure solids concentrations and estimate loading from University RS Overflow and UW stormwater outfalls.
- **Natural Recovery:** Measure trends in surface sediment concentrations by reoccupying sampling stations or by additional core sampling.
- **Depth of Contaminated Sediment:** Perform more coring to further characterize the volume of contaminated sediment at the site.
- **Sediment Stability:** Evaluate potential propeller wash, wind/wave, and currents at the site to identify stable grain sizes and slope angles for remediation.
- **Site Uses:** Verify the UW navigation depth needs and the condition of the over-water structure located in the sediment cleanup unit.

8.3 Timeline

GSI is currently being designed to reduce flows to the University RS Overflow. The design for the storage tank to complete control will commence in 2022, and be constructed by approximately 2029. Prior to construction of the storage tank, sources will be characterized and traced and recontamination potential will be reassessed. This information will be used to inform the development of a CAP and a preferred cleanup alternative. Based on modeling, cleanup activities should not commence until after the storage tank is constructed, to minimize recontamination potential. This assumption can be revisited flowing GSI completion.

9 REFERENCES

Ecology (Washington State Department of Ecology), 2015. *Sediment Cleanup Users Manual II – Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards*, Chapter 173-204 WAC. Publication No. 12-09-057. March 2015.

Ecology 2016. *Lake Washington Area Regional Background Draft Data Evaluation and Summary Report*. Publication No. 16-09-064. September 2016.

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