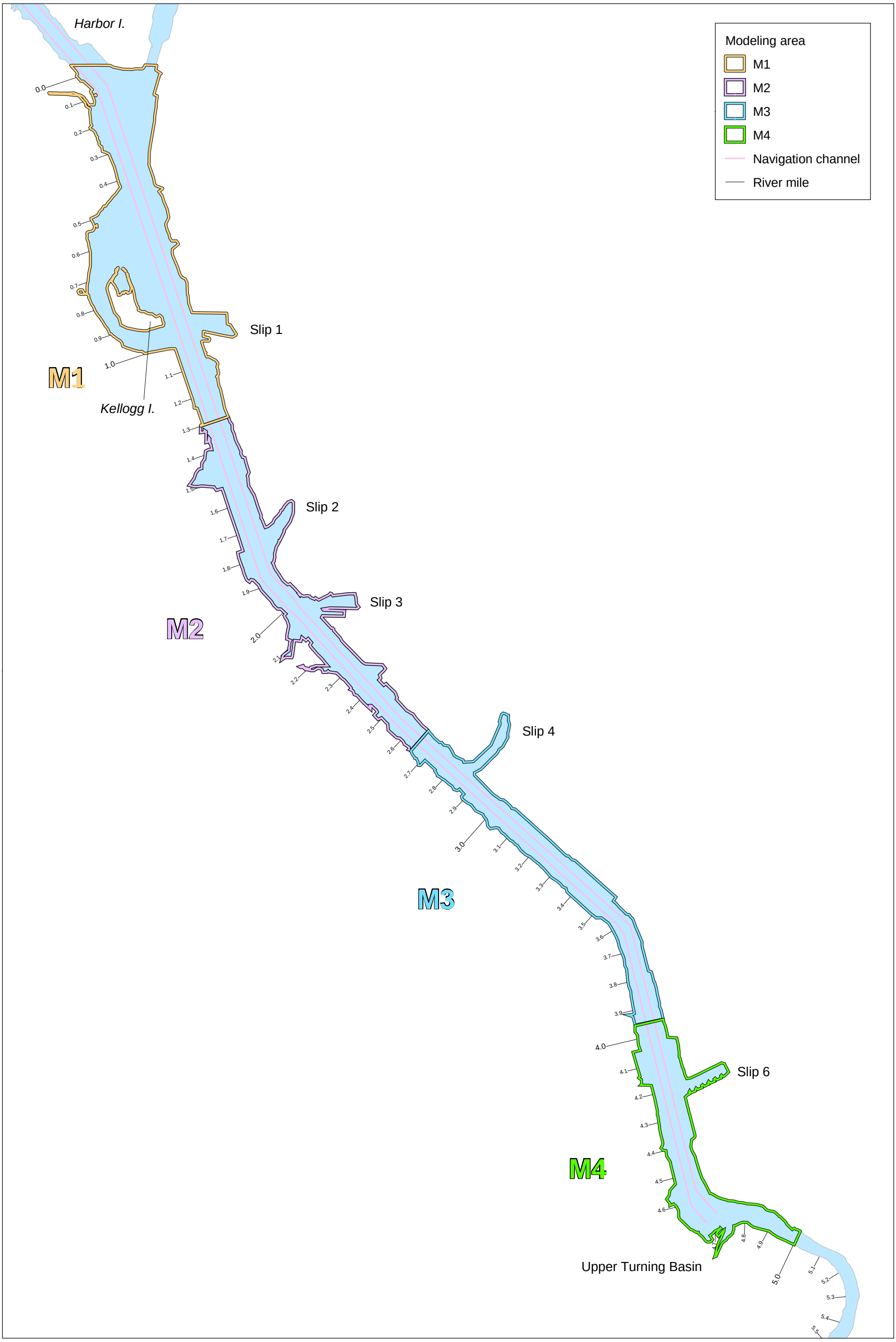

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N

0 0.25 0.5 Miles

0 0.25 0.5 Kilometers

Map 5-1. Modeling areas in the LDW used in the fish exposure assessment and the food web model

Harbor I.

Exposure Area 1

Kellogg I.

Slip 1

Slip 2

Slip 3

Exposure Area 2

Slip 4

Slip 6

Exposure Area 3

Upper Turning Basin

0:0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 5.0 5.1

Sandpiper foraging habitat quality

Habitat defined for intertidal zone only

- High
- Poor
- No habitat present
- Intertidal area not surveyed for sandpiper foraging habitat

Exposure area

- Area 1 (RM 0.0 - RM 1.8)
- Area 2 (RM 1.1 - RM 3.1)
- Area 3 (RM 3.3 - RM 5.0)
- Navigation channel
- River mile

N

0 1,000 2,000 Feet

0 210 420 Meters

Scale is the same for each inset map

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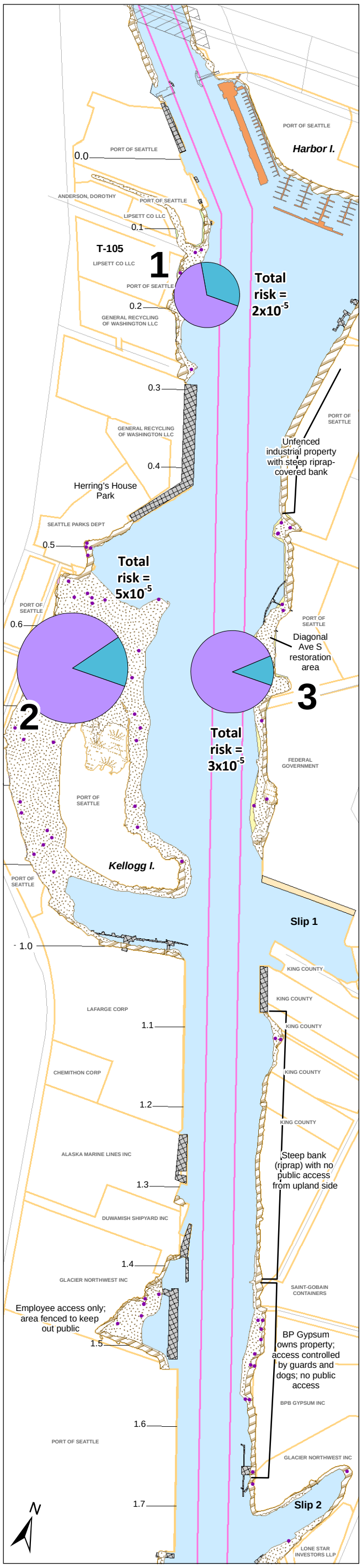
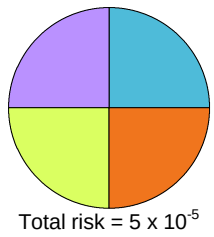
Map 5-2. Spotted sandpiper exposure areas in the LDW

Prepared by CEH, 07/15/2010; Map 2 283; W:\Projects\00-08-06_Duwamish_R\data\gis\Phase2 R\ERA Summary



Excess cancer risk for individual beaches



Total risk = 5 x 10^{-5}

- Arsenic
- cPAH[b]
- Total PCBs
- D/F TEQ

Beach play exposure area

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Intertidal conditions (> -2 ft MLLW)

- Marsh
- Mud
- Riprap

Subtidal (< -2 ft MLLW)

- Road
- Bridge
- Building
- Dock/pier
- Marina
- Tax parcel[a]
- Navigation channel
- River mile

Intertidal baseline surface sediment sampling location

Risk = excess cancer risk estimate
cPAH = carcinogenic PAHs
COPC = chemical of potential concern
D/F TEQ = dioxin and furan toxic equivalent (data available only at beaches 4, 5 and 7)

Excess cancer risk charts for individual beaches compare risks by chemical as a fraction of total risk from all COPCs. Chemicals other than PCBs, arsenic, cPAHs, and dioxins and furans are not shown on charts because they contribute 1% or less to the total risk. The size of each chart is proportional to the total risk, as defined by the scale in the legend.

[a] Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.

[b] cPAH concentrations are based on benzo(a)pyrene equivalents. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Because of the potential for increased susceptibility of children to carcinogens with mutagenic activity, as described in EPA guidance (EPA 2005), the risk estimate for beach play RME for cPAHs is based on dose adjustments across the 0-to-6-year age range of children. See Section B.5.1 for more information.

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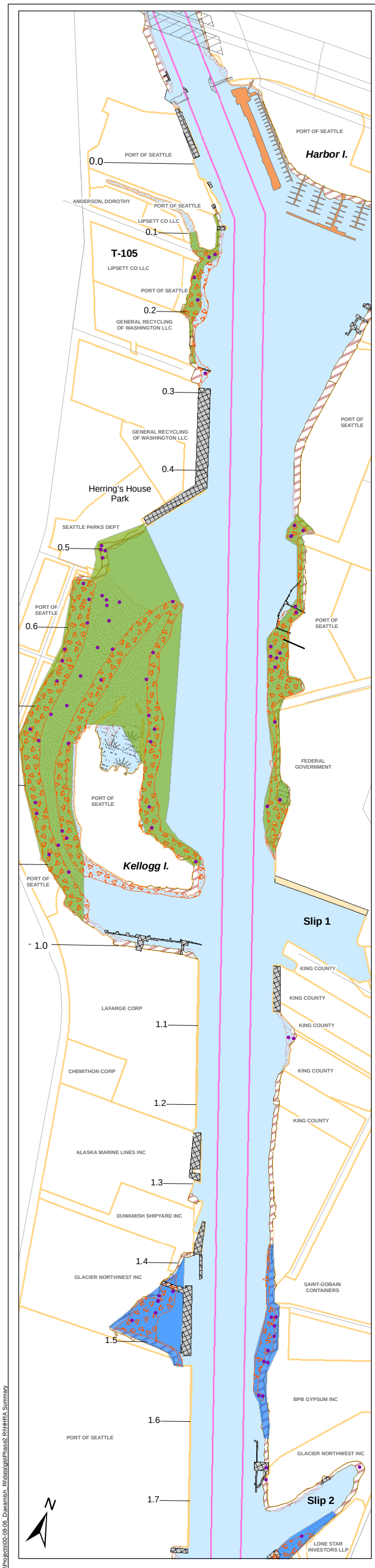
0 0.1 0.2 Miles

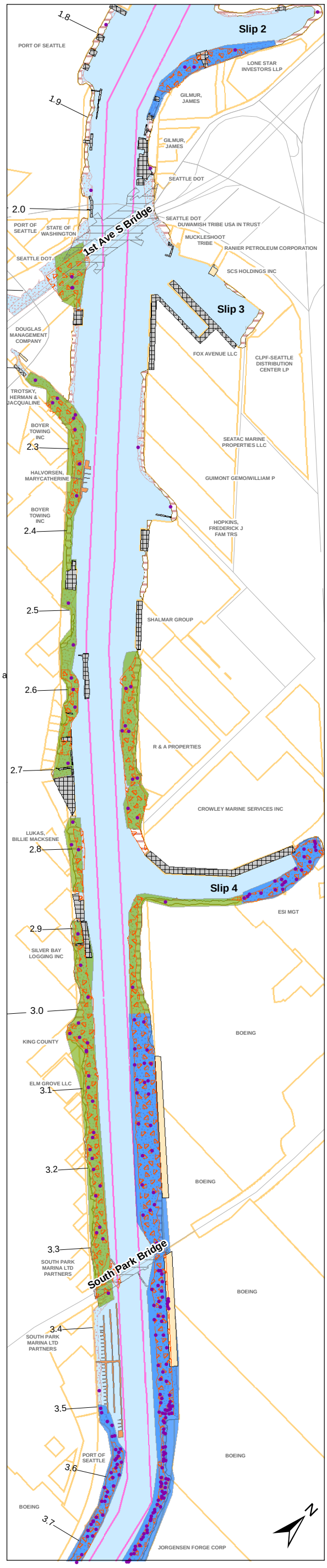
0 0.1 0.2 Kilometers

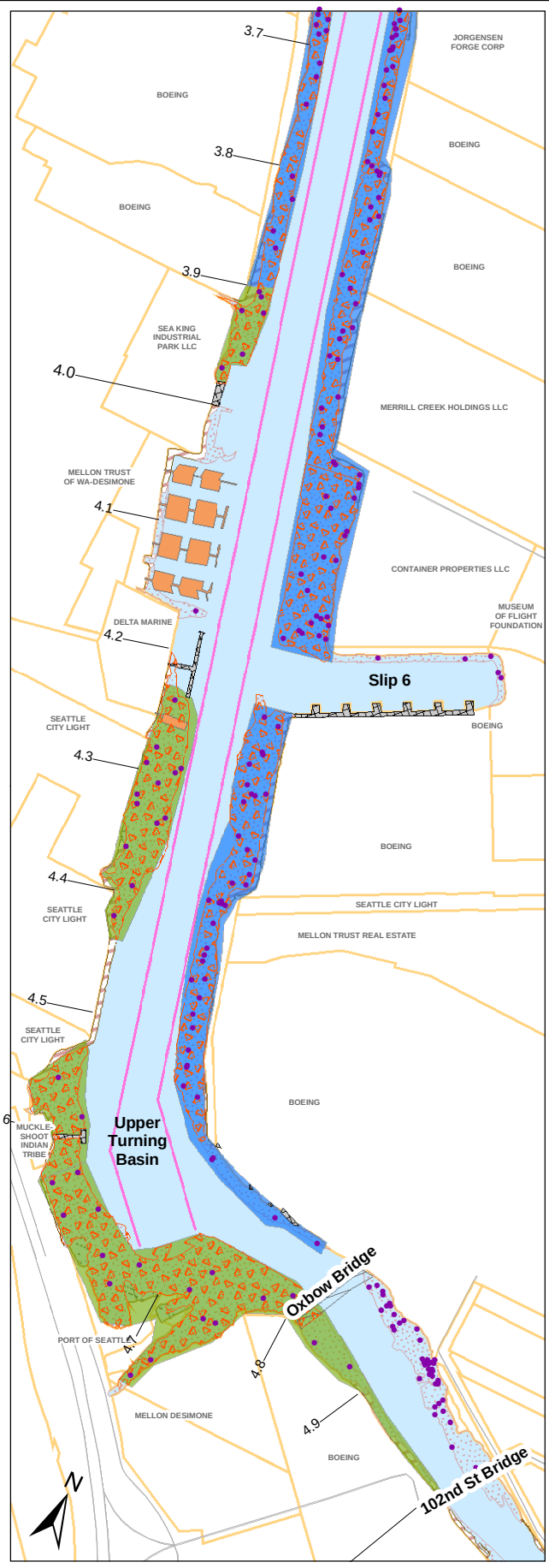
Scale is the same for each inset map

Map 6-1. LDW intertidal areas included in the beach play direct sediment contact exposure scenarios and excess cancer risk estimates

Prepared by CEH, 07/15/2010. Map 2602: W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\HHRA Summary







Intertidal baseline surface sediment sampling location

Clamming access
- Shoreline
- Boat only

Intertidal conditions (> -2 ft MLLW)
- Marsh
- Mud
- Riprap

Subtidal (< -2 ft MLLW)

- Bridge
- Building
- Dock/Pier
- Marina
- Tax parcel[a]
- Road
- Navigation channel
- River mile

[a]Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.

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0 0.1 0.2 Miles
0 0.1 0.2 Kilometers

Scale is the same for each inset map

Map 6-2. LDW intertidal areas included in the clam harvesting direct sediment contact exposure scenarios

Prepared by CEH, 07/15/2010; Map 2245; W:\Projects\00-08-06 Duwamish Rl\data\gis\Phase2 RI\HHRA Summary

Prepared by CEH, 07/15/2010, Map 3240; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Background

Map 7-1. Locations of surface sediment PCB and dioxin and furan data available for natural background from reference areas prior to 2008

Vancouver Island, BC

San Juan Co.

Whatcom Co.

Samish Bay

Skagit Co.

West Beach

Island Co.

Straight of Juan de Fuca

Whidbey Island

Camano Island

Freshwater Bay

Dungeness Bay

Port Townsend

Snohomish Co.

Port Angeles

Saratoga Passage

Sequim Bay

Discovery Bay

Clallam Co.

Jefferson Co.

Dabob Bay

Kitsap Co.

Bainbridge Island

Seattle

Bremerton

Rich Passage

King Co.

Vashon Island

Mason Co.

Grays Harbor Co.

Carr Inlet

Case Inlet

Wollocher Bay

Tacoma

Pierce Co.

Thurston Co.

- Arsenic sediment sample location
- Background sampling area
- Waterbody or river

Note: Puget Sound 2008 survey locations are shown on Map 7-4.

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N

0 5 10 Miles

0 5 10 Kilometers

Map 7-2. Locations of surface sediment arsenic data available for natural background from reference areas prior to 2008

Prepared by CEH, 07/15/2010; Map 3242; W:\Projects\00-08-06_Duwamish_Rl\data\gis\Phase2 RI\Background

Vancouver Island, BC

San Juan Co.

Whatcom Co.

Samish Bay

Skagit Co.

West Beach

Island Co.

Straight of Juan de Fuca

Whidbey Island

Camano Island

Snohomish Co.

Freshwater Bay

Dungeness Bay

Port Townsend

Port Angeles

Saratoga Passage

Sequim Bay

Discovery Bay

Clallam Co.

Jefferson Co.

Dabob Bay

Kitsap Co.

Bainbridge Island

Seattle

Bremerton

Rich Passage

King Co.

Vashon Island

Mason Co.

Grays Harbor Co.

Carr Inlet

Case Inlet

Wollocher Bay

Tacoma

Pierce Co.

Thurston Co.

cPAH sediment sample location

Background sampling area

Waterbody or river

Note: Puget Sound 2008 survey locations are shown on Map 7-4.

N

0 5 10 Miles

0 5 10 Kilometers

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Map 7-3. Locations of surface sediment cPAH data available for natural background from reference areas prior to 2008

Prepared by CEH, 07/15/2010; Map 3241; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Background

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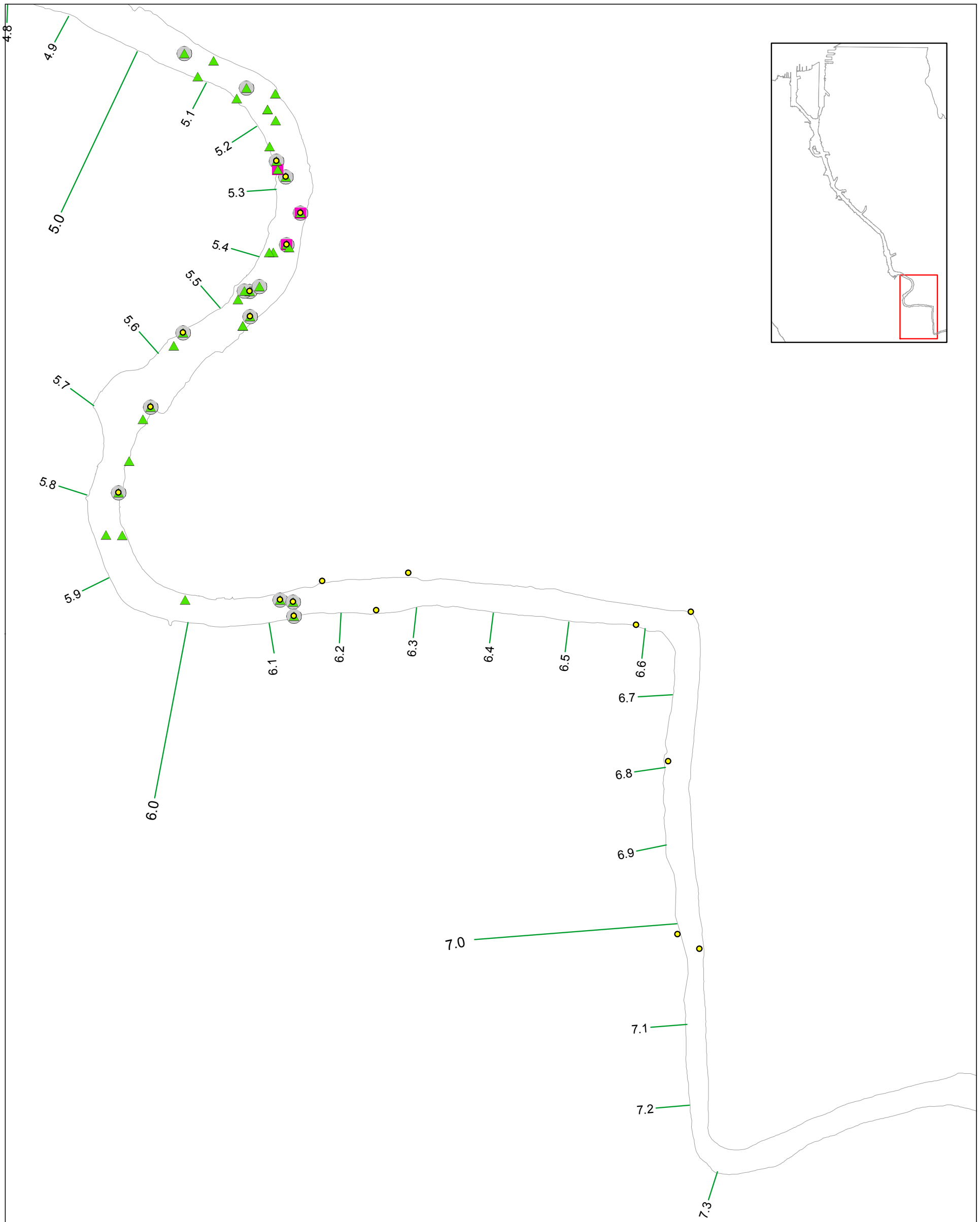
Map 7-4. Locations of surface sediment data available for arsenic, PCBs, cPAHs, and dioxins and furans from the Puget Sound 2008 survey for natural background consideration

Prepared by CEH, 07/15/2010, Map 3786, W:\Projects\00-08-06 Duwamish Rl\data\gis\Phase2 RIBackground



Legend

- Arsenic sample location
- PCB sample location
- cPAH sample location
- Dioxin and furan sample location
- Navigation channel
- River Mile marker

0 250 500 1,000 Feet

0 50 100 200 Meters

AECOM

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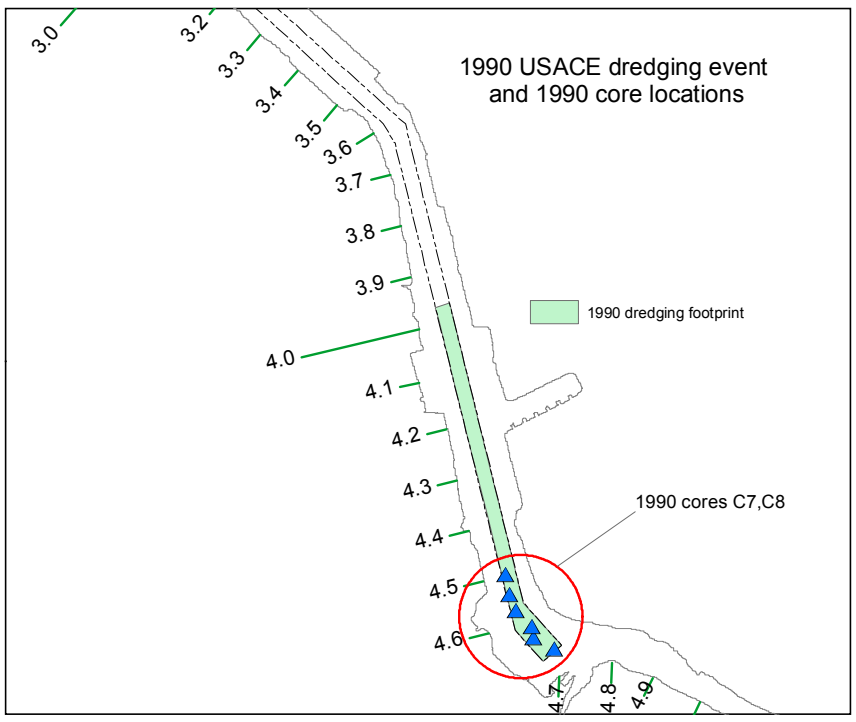
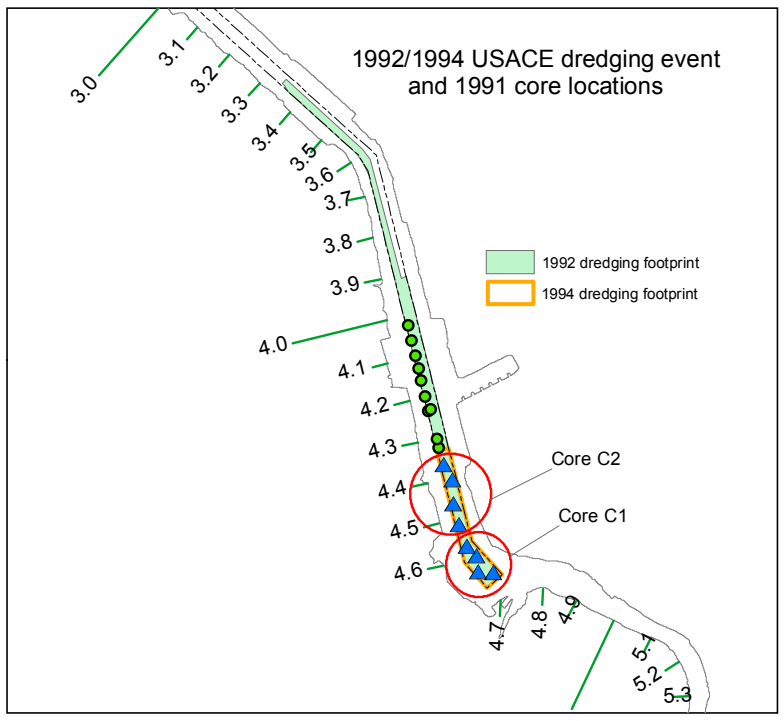
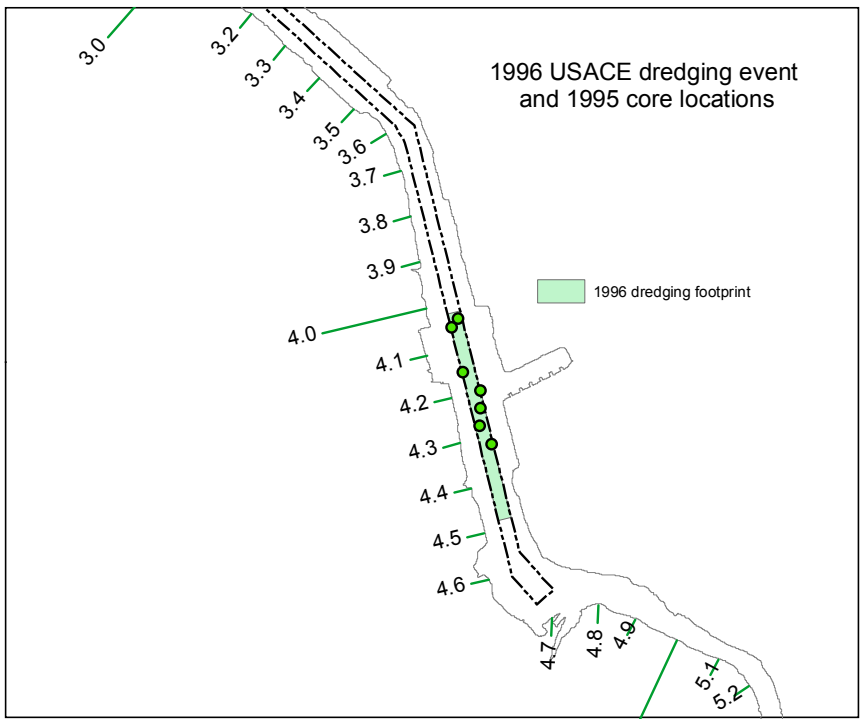
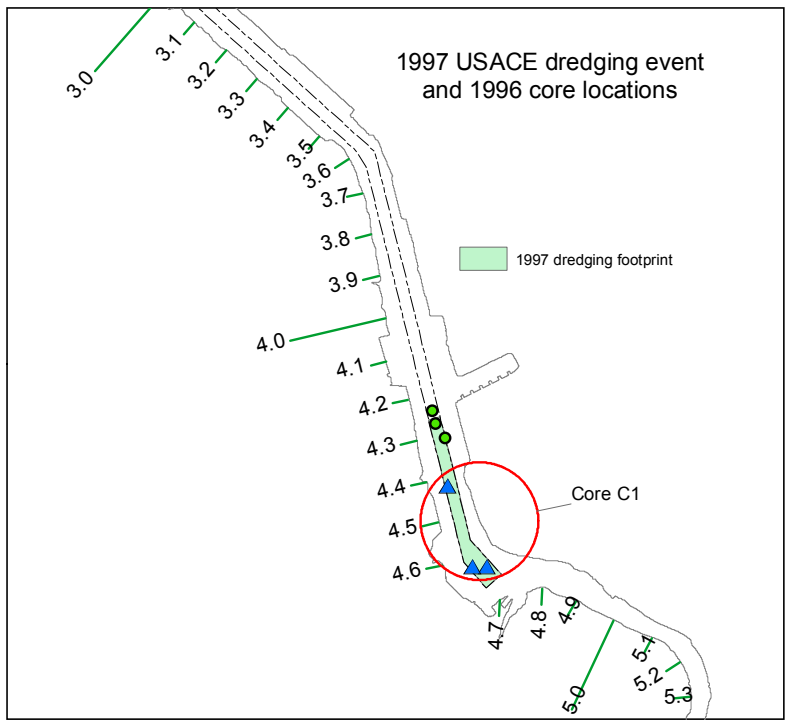
Notes:
1. An additional sample collected from Springbrook Creek (which enters the Duwamish River at RM 10.2) was included in the dioxin and furan dataset for samples from RM 5.0 - 7.0, but is not shown on this map.

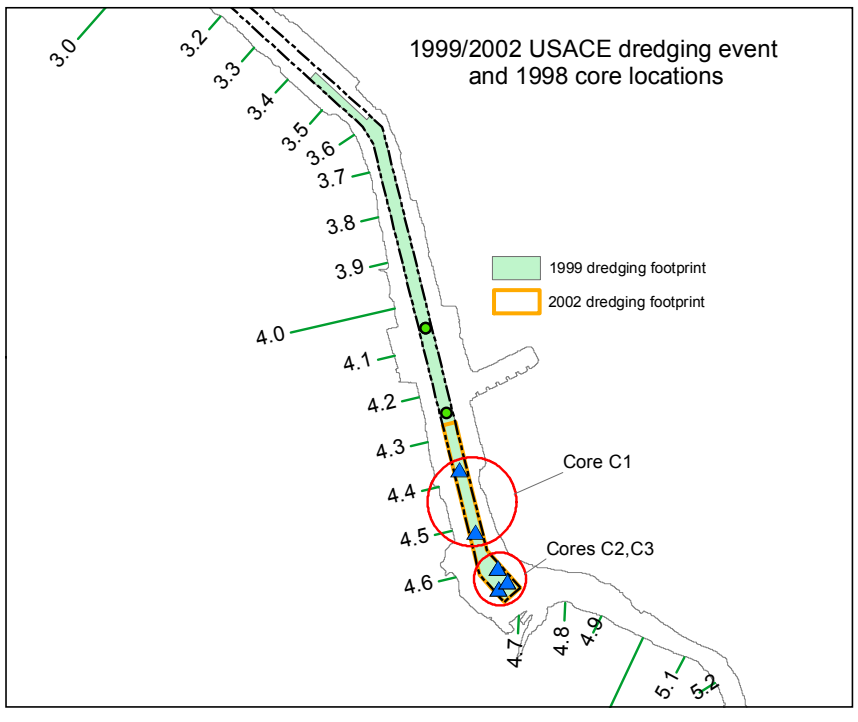
Map 7-5. Surface sediment sampling locations for arsenic, PCBs, cPAHs, or dioxins and furans - RM 5.0 to RM 7.0

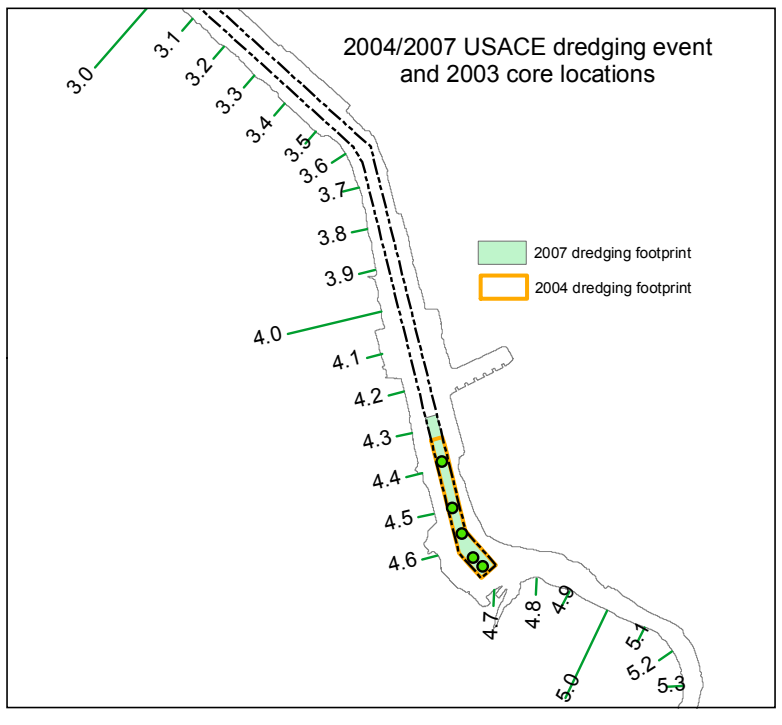












Notes:
1. Sampling data provided by USACE (2007).
2. Dredge footprints from USACE dredge summary and analysis reports.
3. Single sample locations represent stations where a single core was collected (generally from 0 to 4 ft below the mudline), composited over the length of the core, and analyzed. Composite sample locations represent stations where single cores from each of those stations (again, generally from 0 to 4 ft below the mudline) were first composited over the length of the core and then composited with the samples from the cores at other stations prior to analysis.
4. Stations downstream of RM 4.0 not shown.

Legend

- Single core location
- Composite core location
- Navigation channel
- River mile

AECOM

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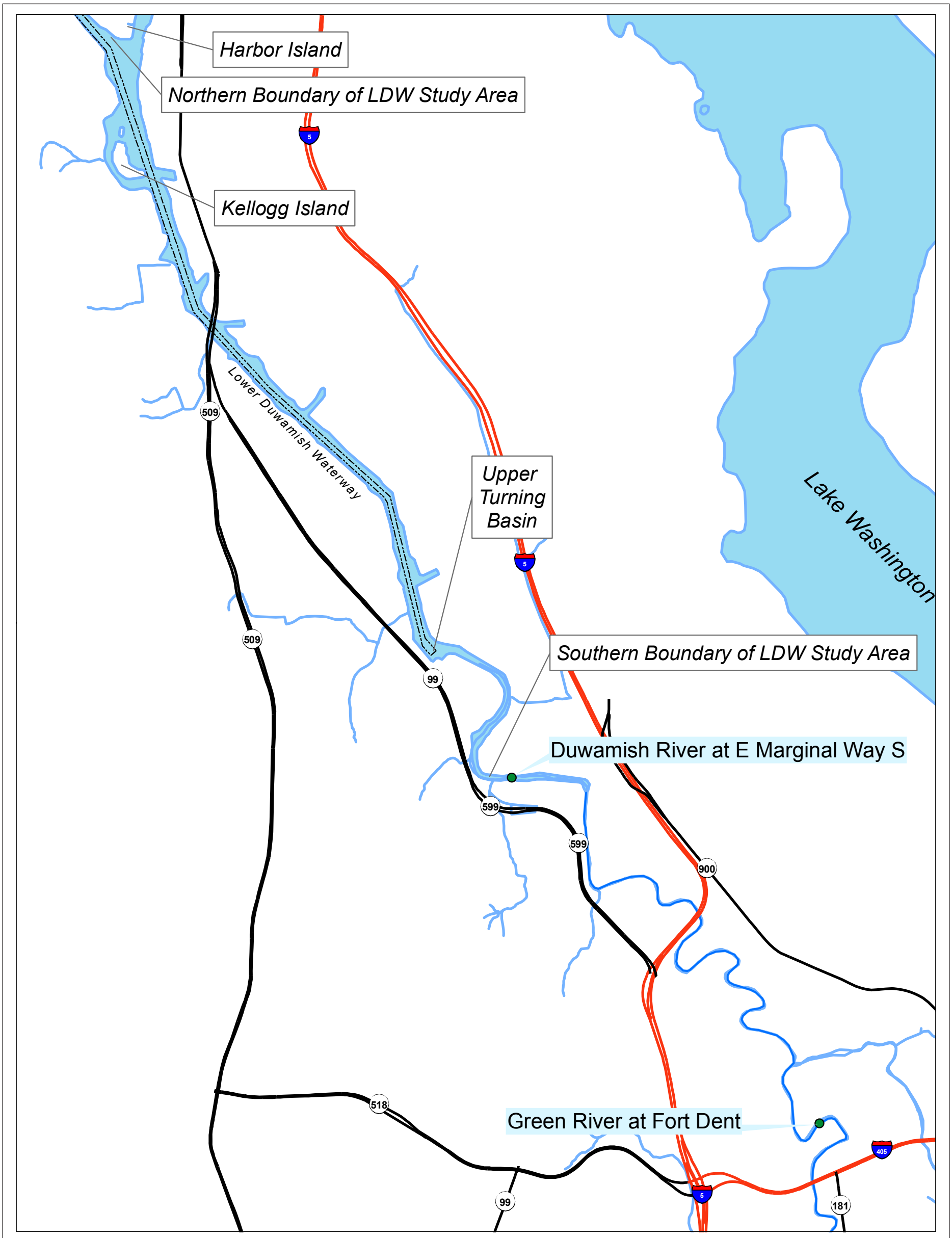
0 250 500 1,000 Meters

N

Map 7-6. Locations of subsurface sediment samples collected as part of the 1990 to 2003 USACE dredged material characterization events



Legend

- King County surface water sampling location
- Navigation channel
- Interstate highway
- State highway

AECOM

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N

0 0.25 0.5 1 Miles

0 0.25 0.5 1 Kilometers

Map 7-7. Upstream surface water sampling locations

Centroid location number
Dioxin and furan TEQ (ng/kg dw)
J: estimated

3 13.2 J

Dioxin and furan TEQs were calculated from individual dioxin and furan concentrations with mammalian TEFs, using ½ the reporting limit for undetected dioxin and furan congeners. The TEQ at location 3 is the average of the original sample value and the field duplicate sample value.

Puget Sound

3 13.2 J

Sammamish R.

1 1a 187 J
1b 63.1 J

9 9a 5.46 J
9b 26.1 J

8 53.4 J

Lake Union

2 2a 13.7 J
2b 18.9 J

Elliott Bay

Seattle

Lake Washington

Mercer Island

4 14.7 J

Lower Duwamish Waterway

7 2.59 J

5 5a 14.1 J
5b 14.5 J

Cedar R.

6 2.23 J

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N

0 1.5 3 Miles

0 2.5 5 Kilometers

Map 7-8. Dioxin and furan TEQs in surface sediment samples from the greater Seattle area

Prepared by CEH, 07/15/2010. MAP #2307. W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Background

British Columbia

Whatcom County

Vancouver Island

Skagit County

Whidbey Island

Camano Island

Snohomish County

Port Townsend

Port Angeles

Clallam County

Island County

Jefferson County

Kitsap County

Bremerton

Seattle

King County

Mason County

Vashon Island

Tacoma

Pierce County

Olympia

Fish tissue sample locations

- Near-urban English sole (West et al. 2001)
- Non-urban English sole (West et al. 2001)
- Non-urban English and flathead sole (Gahler et al. 1982; as cited in Cubbage 1992)
- Non-urban English sole (Era-Miller 2006)
- Near urban rock sole (Era-Miller 2006)
- Non-urban rock sole (Era-Miller 2006)

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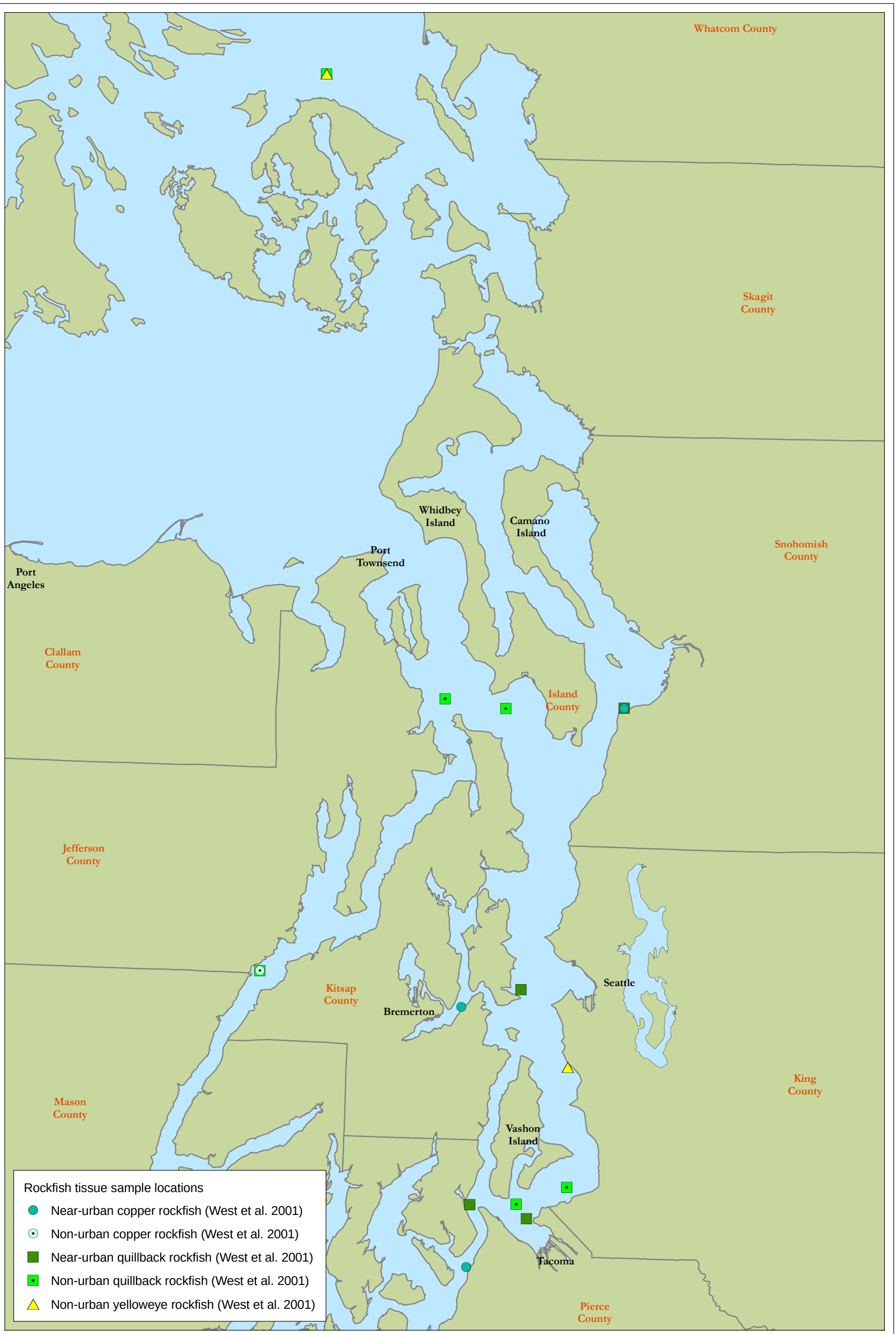
N

0 10 20 Miles

0 10 20 Kilometers

Map 7-9. Greater Puget Sound sampling locations for English, rock, and flathead sole analyzed for PCBs



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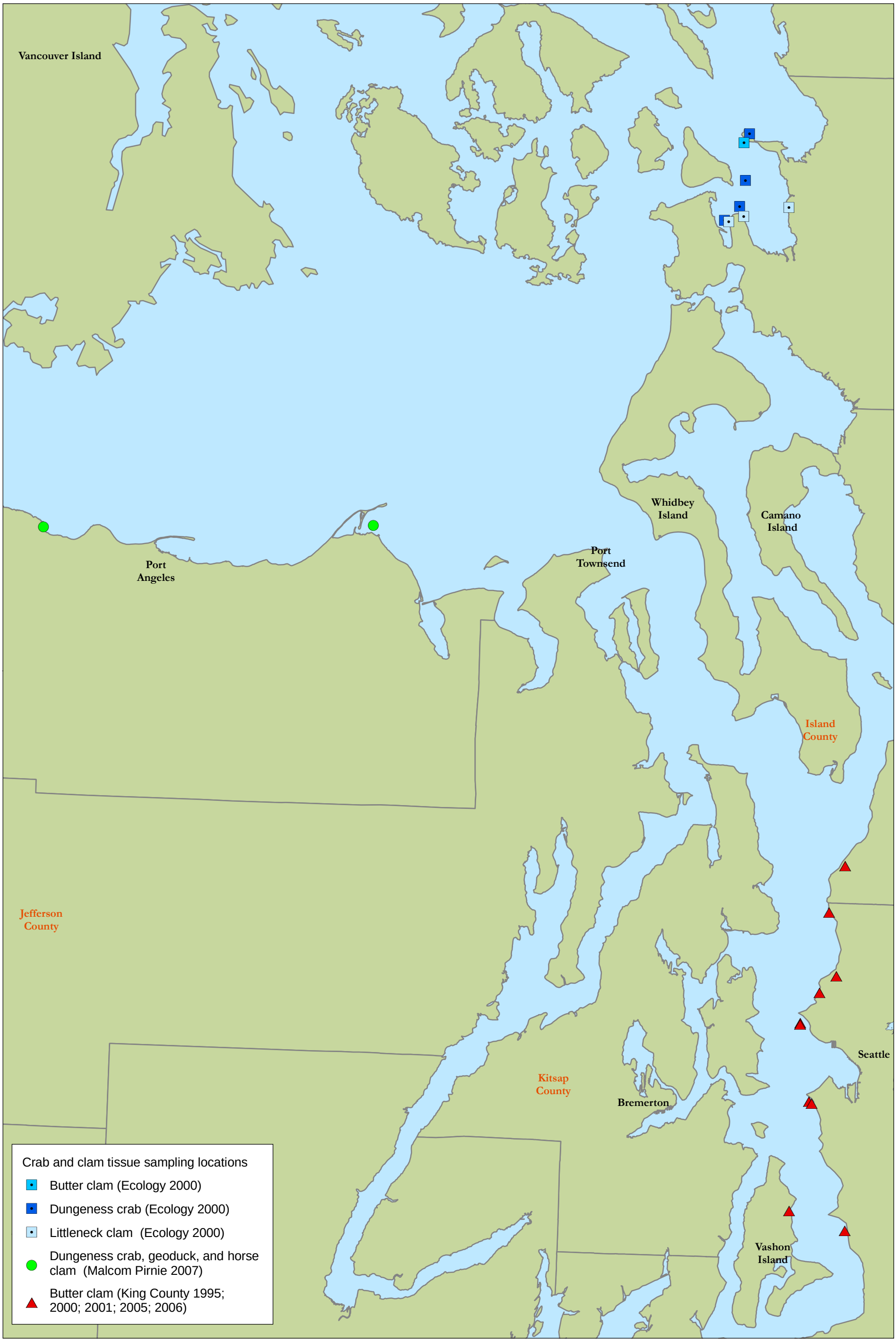
Map 7-10. Greater Puget Sound sampling locations for rockfish species analyzed for PCBs



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Map 7-11. Greater Puget Sound sampling locations for crab and clam species analyzed for PCBs

DU
Port Angeles
Port Townsend
Whidbey Island
Everett
Olympic Penninsula
Olympic National Park
Puget Sound
BI
Bainbridge Island
Seattle
Bellevue
Bremerton
BL
EP
SP
VI
Vashon Island
Federal Way
Asarco Smelter
Tacoma
Olympia
101
16
5
405
2

Background clam sampling areas
BI Fay Bainbridge State Park (2004)
SP Seahurst Park, Burien (2004)
DU Dungeness NWR (2005)
VI Vashon Island (2005)

Background English sole, shiner surfperch, and slender crab sampling areas
BL Blake Island (2004)
EP East Passage (2004)

Area potentially affected by Asarco smelter emissions[a]

Duwamish River basin

[a] Area-Wide Soil Contamination Task Force 2003; based on soil data

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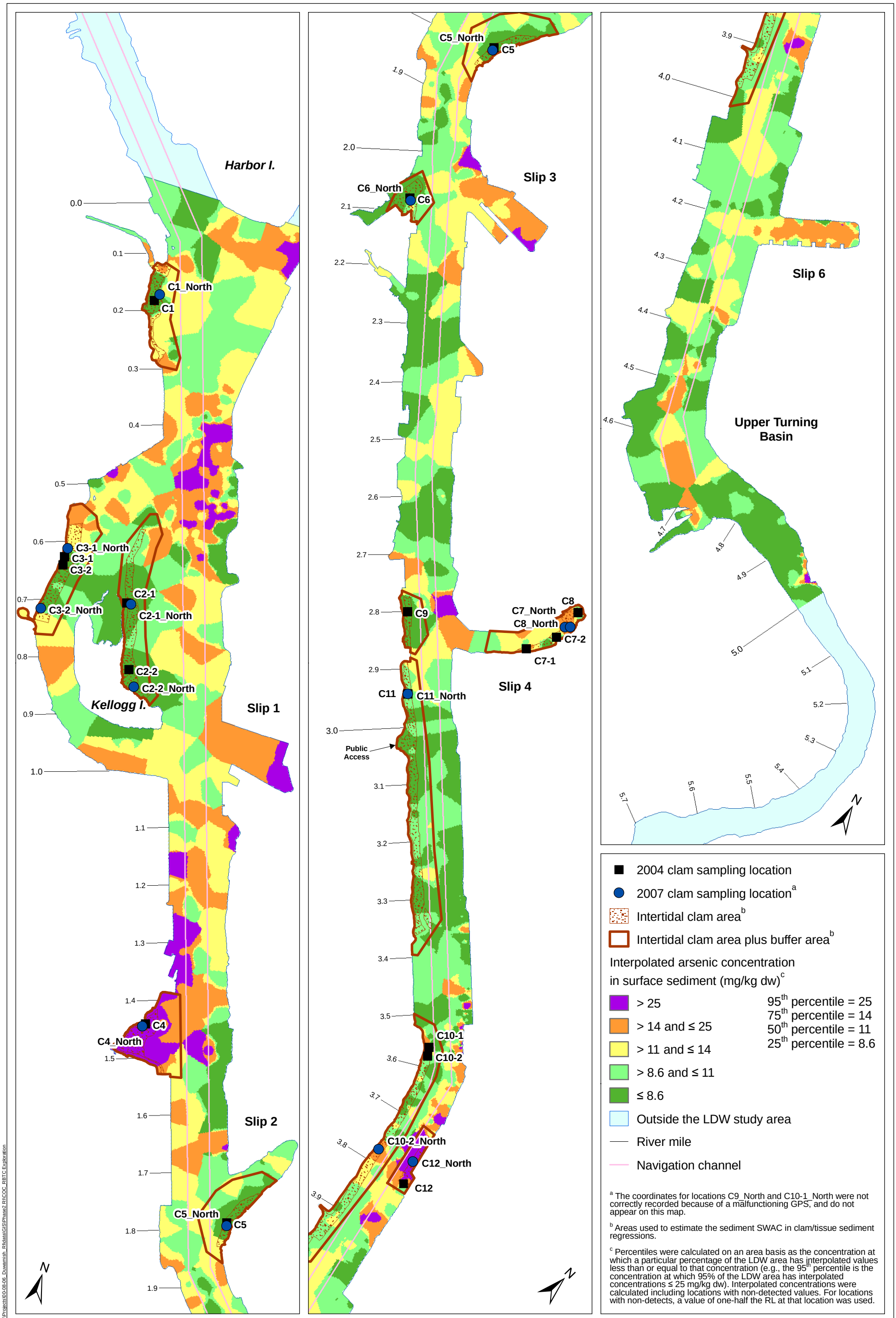
N

0 6 12 Miles

0 6 12 Kilometers

Map 7-12. Background areas where tissue sampling for arsenic was conducted as part of the RI

Prepared by CEH, 07/15/2010, MAP #2282, W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Background



[a] The coordinates for locations C9_North and C10-1_North were not correctly recorded because of a malfunctioning GPS, and do not appear on this map.

[b] Areas used to estimate the sediment SWAC in clam/tissue sediment regressions.

[c] Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 25 mg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used.

Map 8-1. Clam sampling locations and habitat relative to IDW interpolation of arsenic concentrations in surface sediment

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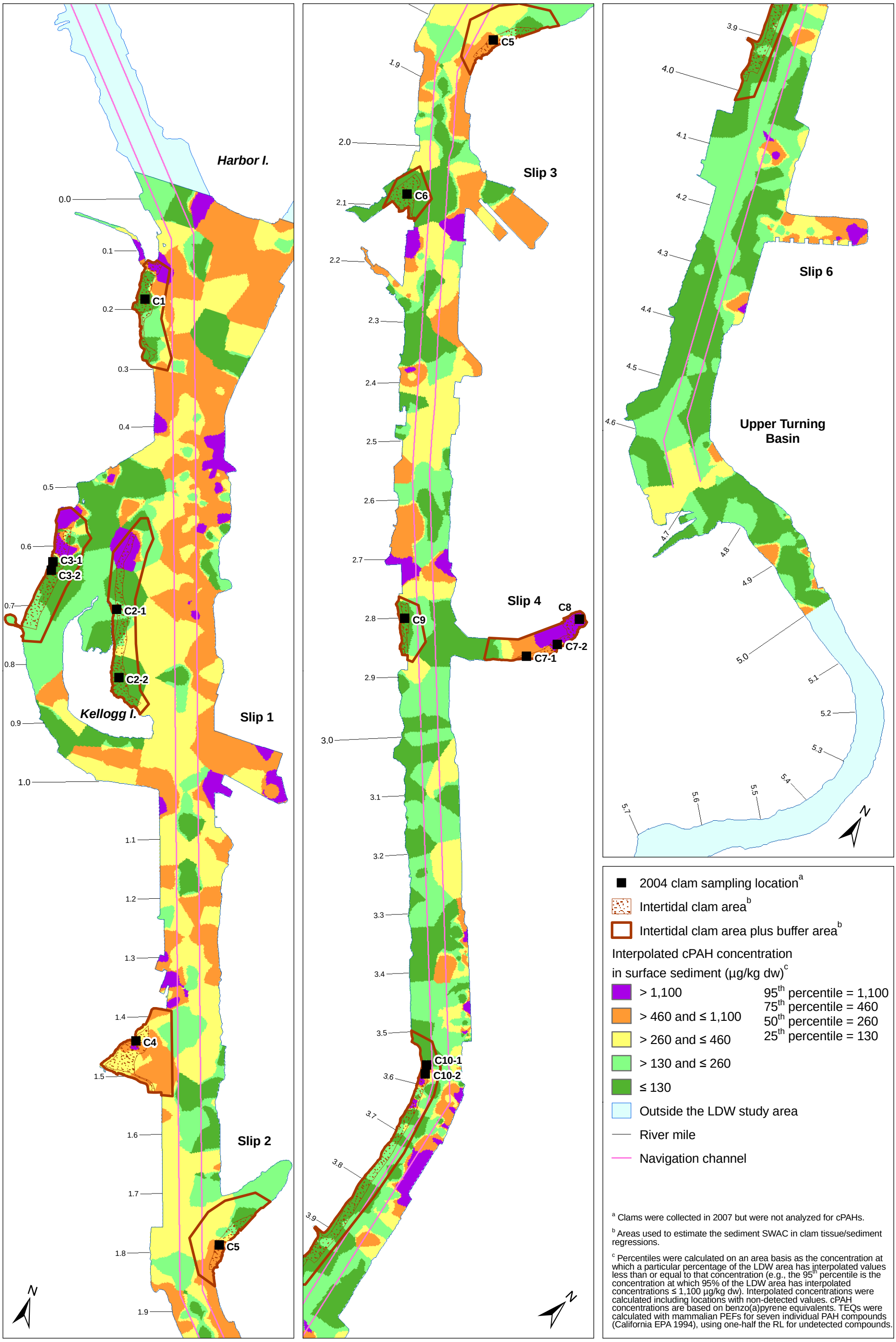
Prepared by CEH, 07/15/2010, MAP #2573, W:\Projects\00-08-06_Duwamish_R\data\GIS\Phase2 RI\COC_RBTC Exploration



[a] Clams were collected in 2007 but were not analyzed for cPAHs.

[b] Areas used to estimate the sediment SWAC in clam tissue/sediment regressions.

[c] Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. cPAH concentrations are based on benzo(a)pyrene equivalents. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds.

Map 8-2. Clam sampling locations and habitat relative to IDW interpolation of cPAH concentrations in surface sediment

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Prepared by CEH, 07/15/2010; MAP #3379; W:\Projects\00-08-08_Duwamish_RI\data\GIS\Phase2 RI\COC_RBTC Exploration