Map ES-1. Lower Duwamish Waterway
Total PCB concentration (µg/kg dw)

- 95th percentile = 810
- 75th percentile = 210
- > 810
- ≤ 210 and ≤ 810
- ≤ 210

Dioxin and furan TEQ (ng/kg dw)

95th percentile = 524
75th percentile = 25

TEQs were calculated on an area basis as the Thiessen polygon 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.

Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has IDW-interpolated values less than or equal to that concentration. Thiessen polygons were created that had concentrations above these percentile values. Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects for all individual Aroclors, a value equal to the highest RL of an individual Aroclor was used.

For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005.

Map ES-2a. 95th and 75th Percentiles of risk driver chemicals, RM 0.0 to RM 1.8

Scale is the same for each inset map.
**Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has IDW-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 concentrations ≤ 810 µg/kg dw). Thiessen polygons were created that had concentrations above these percentile values. Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects for all individual PAH compounds, the highest RL of an individual Aroclor was used.**

**Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has IDW-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 concentrations ≤ 810 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects for all individual PAH compounds, the highest RL of an individual Aroclor was used.**

**Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has IDW-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 concentrations ≤ 810 µg/kg dw). Thiessen polygon 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.**

**Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has IDW-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 concentrations ≤ 810 µg/kg dw). Thiessen polygon 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.**

**Percentiles were calculated on a numerical basis using all values from the baseline dataset.** Percentiles were not calculated on an area basis as for the other chemicals because there were too few dioxin and furan samples to establish a spatial distribution. TEQs were calculated using mammalian PEFs for seven individual PAH compounds. For locations with non-detects, a value of one-half the RL at that location was used.

**Percentiles were calculated on a numerical basis using all values from the baseline dataset.** Percentiles were not calculated on an area basis as for the other chemicals because there were too few dioxin and furan samples to establish a spatial distribution. TEQs were calculated using mammalian PEFs for seven individual PAH compounds. For locations with non-detects, a value of one-half the RL at that location was used.**

**Percentiles were calculated on a numerical basis using all values from the baseline dataset.** Percentiles were not calculated on an area basis as for the other chemicals because there were too few dioxin and furan samples to establish a spatial distribution. TEQs were calculated using mammalian PEFs for seven individual PAH compounds. For locations with non-detects, a value of one-half the RL at that location was used.
Percentiles were calculated on an area basis as the concentration at which a particular percentage of locations in the study area had concentrations less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations less than or equal to that concentration). Thiessen polygon values were calculated including locations with non-detected values. For locations with non-detects for all individual Aroclor, a value equal to the highest RL of an individual Aroclor was used.

i Percentiles were calculated on an area basis as the concentration at which a particular percentage of locations in the study area had concentrations less than or equal to that concentration (e.g., the 96th percentile is the concentration at which 96% of the LDW area has concentrations less than or equal to that concentration). Thiessen polygon 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.

Percentiles of risk driver chemicals, RM 3.7 to RM 6.0

For the Norfolk Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 and 2004.
For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005.
SQS/CSL categories for all chemicals

- > CSL, detect
- > SQS and ≤ CSL, detect
- > SQS or ≤ CSL, non-detect
- ≤ SQS, detect or non-detect

SMS designation based on toxicity tests

- > CSL
- ≤ SQS and ≤ CSL
- ≤ SQS

SQS/CSL categories for total PCBs

- > CSL, detect
- > SQS and ≤ CSL, detect
- ≤ SQS, detect or non-detect

SQS/CSL categories for BEHP and BBP

- > CSL, detect
- BEHP
- BEHP and BBP
- > SQS and ≤ CSL, detect
- BBP
- BEHP and BBP
- ≤ SQS, detect or non-detect
- BEHP
- BBP

Map ES-3b. Exceedances of SMS criteria in LDW surface sediment, RM 1.8 to RM 3.7

Metals and PAHs

- Metals
- PAHs
- Metals and PAHs
- > SQS or > CSL, non-detect
- ≤ SQS, detect or non-detect
- Metals and/or PAHs

*Metals include all individual metals with SMS values; PAHs include all individual PAHs with SMS values, as well as LPAHs and HPAHs.

Produced by CEH, 06/28/2010, MAP #3375; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Intro - Env Setting
Map ES-4. Exceedances of SGS and CSL (chemical criteria and toxicity combined) using Thiessen polygons for the baseline surface sediment dataset

± Exceedances of the SGS and CSL chemical criteria are based on detected concentrations. For chemicals whose SGS and CSL are on an organic carbon normalized basis, if the TOC was < 0.5% or > 4.0%, the dry weight concentration of that chemical was compared to the LAET and 2LAET, and exceedances of the LAET and 2LAET were equated with exceedances of the SGS and CSL, respectively.

> CSL toxicity or > CSL chemistry if no toxicity data
> SGS and ≤ CSL toxicity or > SGS and ≤ CSL chemistry if no toxicity data
≤ SGS toxicity or ≤ SGS chemistry if no toxicity data

Outside LDW study area
Road
River mile
Navigation channel

Scale is the same for each inset map
Map 2-1. LDW and historical meanders
Map 2-2. Water Resource Inventory Area 9

- Duwamish Estuary Subwatershed
- Middle Green River Subwatershed
- Lower Green River Subwatershed
- Upper Green River Subwatershed
- Nearshore Subwatershed
Map 2-4. Locations of LDW dredging events, 1986 to present

Note: Navigation channel dredging event dates and locations are provided in Table 2-1.

USACE labels mark the northern extent of the dredge event; the southern extent for all USACE dredge events is RM 4.65, except for the 1996 event which ends at RM 4.48 as marked.
Plate 2. Surficial Geology Map with Cross-Section Locations

Duwamish Hydrogeologic Passways Project
City of Seattle Office of Economic Development
King County Office of Budget and Strategic Planning

March 1998

Legend

Plate 2-5. Surficial geology in the Greater Duwamish Valley and associated cross section locations
Map 2-6. Grain size distribution in surface sediment using Thiessen polygons

Silt-clay (% fines dw)
- > 80%
- > 60% and ≤ 80%
- > 40% and ≤ 60%
- > 25% and ≤ 40%
- ≤ 20%

Outfall classification*
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

* Outfalls shown were identified during a City of Seattle in-place survey in 2000 (Tanner, 2000). Some outfalls were initially identified using the National Pollution Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later verified in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWWG members; some additional outfall locations were identified during these subsequent verifications. More recent locations were added based on that survey, as well as other field work completed prior to the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.
Percent total organic carbon

- > 6%
- > 4% and ≤ 6%
- > 2% and ≤ 4%
- > 0.5% and ≤ 2%
- ≤ 0.5%

Outfall classification:
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Bowering, 2003). Some outfalls were initially identified using the Lower Duwamish Waterway System (LDWS) database. LDWS personnel provided additional outfall-specific information, which allowed these locations to be included in the baseline data. Some locations were field-verified by LDWS personnel; some additional outfall locations were identified during these subsequent verifications. It is important to remember that this baseline data is only valid for the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.

Map 2-7. Percent total organic carbon in surface sediment using Thiessen polygons

Scale is the same for each inset map
Data are based on the Ecology SPI survey (2006). Statistics are based on mean aRPD depth (from three replicate images) at each station.

- Minimum: 0.3 cm
- Maximum: 5.4 cm
- Mean: 2.6 cm
- Std Dev: 1.1 cm
- N: 80
- 95% UCL: 2.9 cm

Map 2-9. SPI station mean aRPD depth with percent fines using Thiessen polygons
Slip 1

Harbor I.

6.7
13.3
4.9
10.8
7.6
13.9
9.7
12.6
4.6
10.4
4.7
10
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

Slip 2

Slip 3

Slip 4

Slip 6

Upper Turning Basin

Station minimum and maximum depth below the mudline of observed feeding voids (cm below mud-line)

Silt+clay (% fines dw)

> 80%
> 60% and ≤ 80%
> 40% and ≤ 60%
> 20% and ≤ 40%
≤ 20%

River mile

Navigation channel

Data are based on the Ecology SPI survey (2006). Statistics based on deepest void depth observed in each replicate image at each station.

Minimum: 0 cm
Maximum: 19.5 cm
Mean: 10.3 cm
Std Dev: 3.9 cm
N: 119
95% UCL: 11.0 cm

Map 2-10. SPI station minimum and maximum void depth with percent fines using Thiessen polygons
Successional Stage
- Early Colonizing Communities
- Transitional Communities
- Mature Communities
- Indeterminate

Silt+clay (% fines dw)
- > 80%
- > 60% and ≤ 80%
- > 40% and ≤ 60%
- > 20% and ≤ 40%
- ≤ 20%

River mile
Navigation channel

Data are based on the Ecology SPI survey (2006).
Map 2-12. Upland, intertidal, and subtidal land ownership.

Port of Seattle

Lower Duwamish Waterway shoreline

Navigation channel

River mile

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.

Lighter shades indicate areas where property ownership extends into water.
Notes:
1. Bathymetry data provided by Windward Environmental LLC based on waterway-wide October 2003 survey.
2. Estimated net sedimentation rates calculated from radiocarbon core data provided by OEA LLC.
   2006 core chemistry data and historical core data provided by Windward Environmental LLC; and
   historical dredge event data provided by USACE.
3. Numerous time markers used to calculate estimated net sedimentation rates are from radiocarbon,
   physical, and chemical geochronology profiles.
4. Areas generally delineated within Reaches 1, 2, and 3, the east and west bench areas; and the
   navigation channel. Water depth, grain size, and distance to other cores also considered.
5. Ranges shown are calculated from recovered depths.
6. Potentially disturbed areas include documented dredge events after 1980, notes from USACE bathymetry surveys,
   or in-water debris/disturbances evident in the core logs.
7. Red font represents rate from dredge event marker outside range of other rates.
Spatial distribution of predicted net erosion during 2-year high-flow event.

Note: Net erosion is bed elevation change due to scour and deposition process.

- **Non-cohesive bed maximum net erosion depth= 9 cm**
- **Cohesive bed maximum net erosion depth= 14 cm**

Legend:
- Net erosion depth (cm)
  - Orange: > 10
  - Green: 6 - 10
  - Blue: 2 - 6
  - Purple: 0 - 2
- Net deposition
- Navigation channel
- Shore line
- River miles
- Roads
- Neighborhoods
- Outside model domain
- Hard bottom area

LOWER DUWAMISH WATERWAY STUDY AREA
SEATTLE, WA

Map 3-4.
LOWER DUWAMISH WATERWAY STUDY AREA
SEATTLE, WA

LEGEND

Net erosion depth (cm)

- > 10
- 6 - 10
- 2 - 6
- 0 - 2
- Net deposition
- Navigation channel
- Shore line
- River miles
- Roads
- Neighborhoods
- Outside model domain
- Hard bottom area

Spatial distribution of predicted net erosion during 10-year high-flow event.

Note: Net erosion is bed elevation change due to scour and deposition process.

Cohesive bed maximum net erosion depth = 19 cm

Non-cohesive bed maximum net erosion depth = 16 cm

June 2008
Spatial distribution of predicted net erosion during 100-year high-flow event.

Note: Net erosion is bed elevation change due to scour and deposition process.

Non-cohesive bed maximum net erosion depth = 20 cm

Cohesive bed maximum net erosion depth = 21 cm

LEGEND

Net erosion depth (cm)

> 10
6 - 10
2 - 6
0 - 2
Net deposition

Navigation channel
Shore line
River miles
Roads
Neighborhoods
Outside model domain
Hard bottom area

LOWER DUWAMISH WATERWAY STUDY AREA
SEATTLE, WA

Map 3-6

June 2008
Spatial distribution of predicted maximum bed scour depth during 100-year high-flow event.

Map 3-7.

Cohesive bed maximum scour depth = 22 cm

Non-cohesive bed maximum scour depth = 21 cm

LOWER DUWAMISH WATERWAY STUDY AREA
SEATTLE, WA

June 2008
There are approximately 200 outfalls in the LDW study area. Model inputs for storm drains at 8 locations represent the combined flow from outfalls within a specific region of the LDW. The extent of each representative region for the composite outfall flows is denoted by a red bracket. Storm drain inputs representing combined outfalls are denoted as (COMP).
LEGEND

- Navigation Channel
- Shore Line
- River Miles
- Roads
- Hard Bottom
- Neighborhoods
- Outside model domain

Model Predicted NSR (cm/yr)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- > 3.0
- Net Erosion

LOWER DUWAMISH WATERWAY STUDY AREA
SEATTLE, WA

Map 3-9.
Spatial distribution of predicted net sedimentation rate (NSR) for 30-year period.

June 2008
LEGEND

Bed source content (%)
- 0 - 25
- 25 - 50
- 50 - 75
- 75 - 100

- Navigation channel
- Shore line
- River miles
- Roads
- Neighborhoods
- Outside model domain
- Hard bottom

LOWER DUWAMISH WATERWAY STUDY AREA
SEATTLE, WA

Map 3-10. Spatial distribution of predicted bed-source content in surface layer (0-10 cm) of the bed at the end of 30-year period.

April 2008
Map 3-11. Spatial distribution of predicted upstream-source content in surface layer (0-10 cm) of the bed at the end of 30-year period.

April 2008