

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Remedial Investigation

APPENDIX A. PHASE 1 SCOPING-PHASE ECOLOGICAL RISK ASSESSMENT FINAL

ATTACHMENT A-1. GIS MAPS

For submittal to:

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

July 3, 2003

Prepared by:  WindWard
environmental LLC

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List of GIS maps cited in Appendix A, ERA

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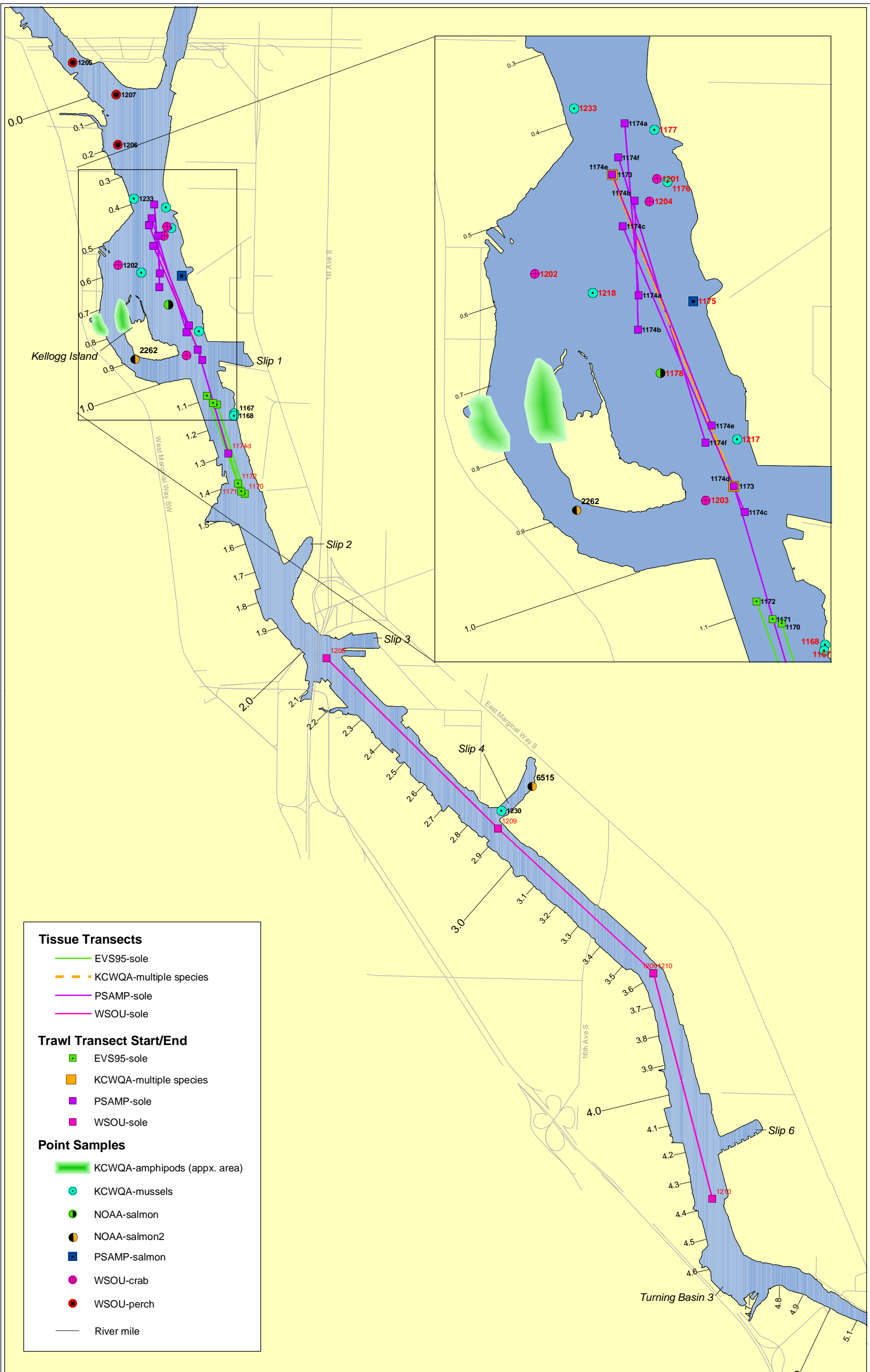
Notes regarding maps in this folio:

1. Many of the sediment chemistry maps present data both as points and Thiessen polygons. Where a single chemical is shown on a map, the size of areas represented by the Thiessen polygons is a function of the sample density for that chemical. As sample density increases, the area of a Thiessen polygon associated with a sampling station decreases. As sample density decreases, the area of a Thiessen associated with a sampling station polygon increases.

Not all stations were analyzed for the same chemicals. Where multiple chemicals are shown on the same map, Thiessen polygons are defined by the sample density for the chemical(s) that were sampled most frequently (with smaller polygons). This technique underrepresents the area associated for a chemical that was measured less frequently (with larger polygons). See Phase 1 RI Appendix C for additional discussion on Thiessen polygons. Other spatial data analysis techniques will be considered for the Phase 2 RI.

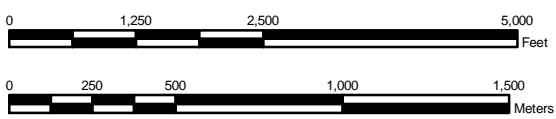
2. Some of the sediment chemistry maps portray the ratio of actual chemical concentrations to chemical-specific sediment quality standards or guidelines. This ratio has been called an exceedance factor (EF) in this document. EFs have no regulatory relevance, and are not necessarily related to the degree of risk. They are presented here only to indicate the relative magnitude of chemical concentrations or detection limits.

3. The primary focus of the maps is sediment chemistry. Since 1990, sediment toxicity testing has also been conducted at 10 locations shown on the sediment chemistry maps, as shown on RI Map 2-11 and described in Section A.3.2.2 of the ERA (Appendix A of the Phase 1 RI report). The results of these toxicity tests, particularly as they relate to interpretation of compliance with the Washington State Sediment Management standards (SMS), are not shown on any of the sediment chemistry maps. At most of the locations at which toxicity tests were conducted, the toxicity test "passed" the biological effects criteria of the Sediment Quality Standards (SQS). In other words, the SQS exceedances based on chemistry alone for such locations were not confirmed by the toxicity test results.



Map A-2-1 LDW tissue sampling locations

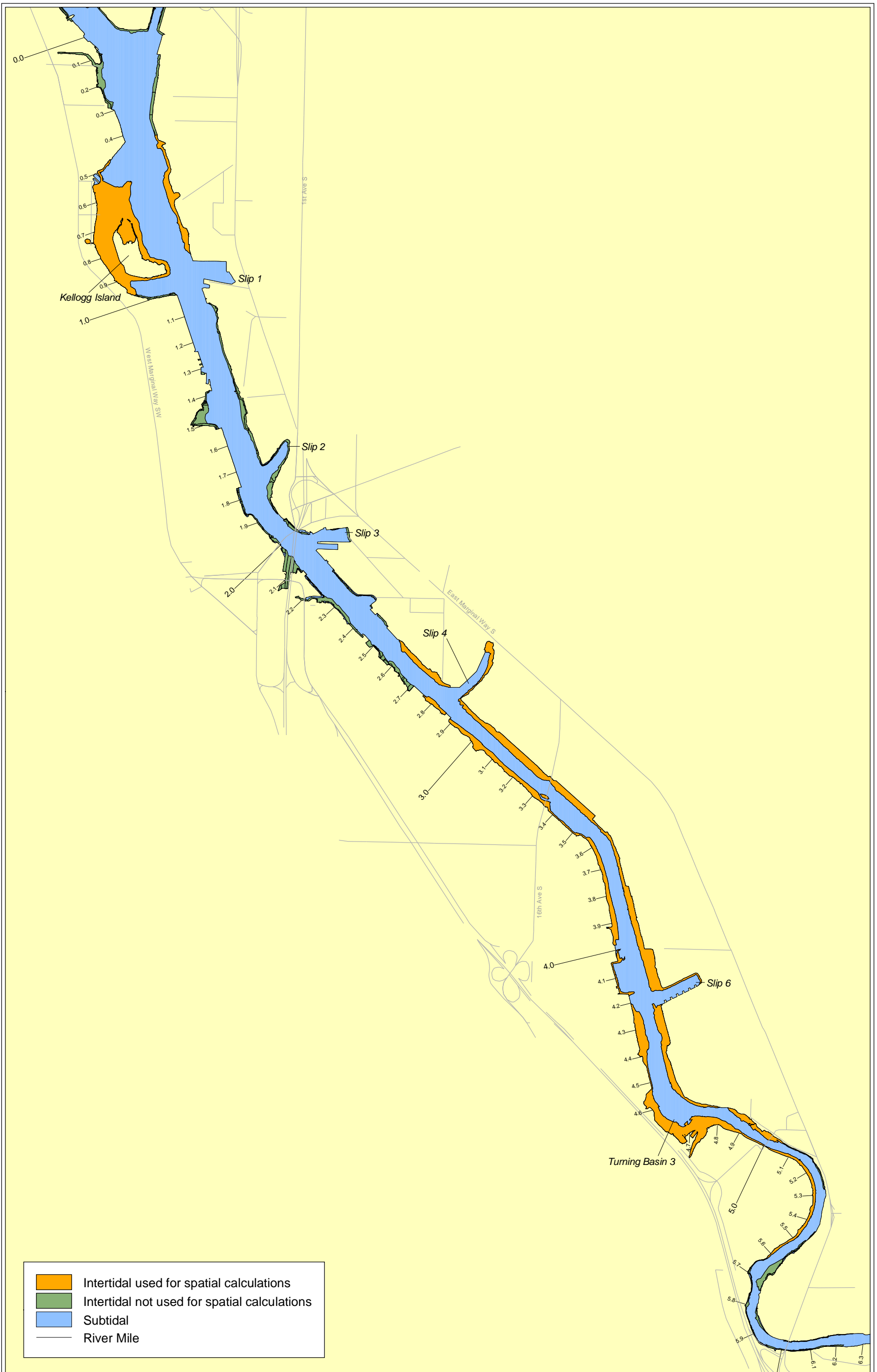
Samples associated with location numbers shown on this map are listed in Map Table 3.



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Map A-2-2. Intertidal and subtidal areas in the LDW

Elevation distinguishing intertidal from subtidal is -2 ft MLLW
 Some intertidal areas excluded from spatial calculations because of insufficient sampling density

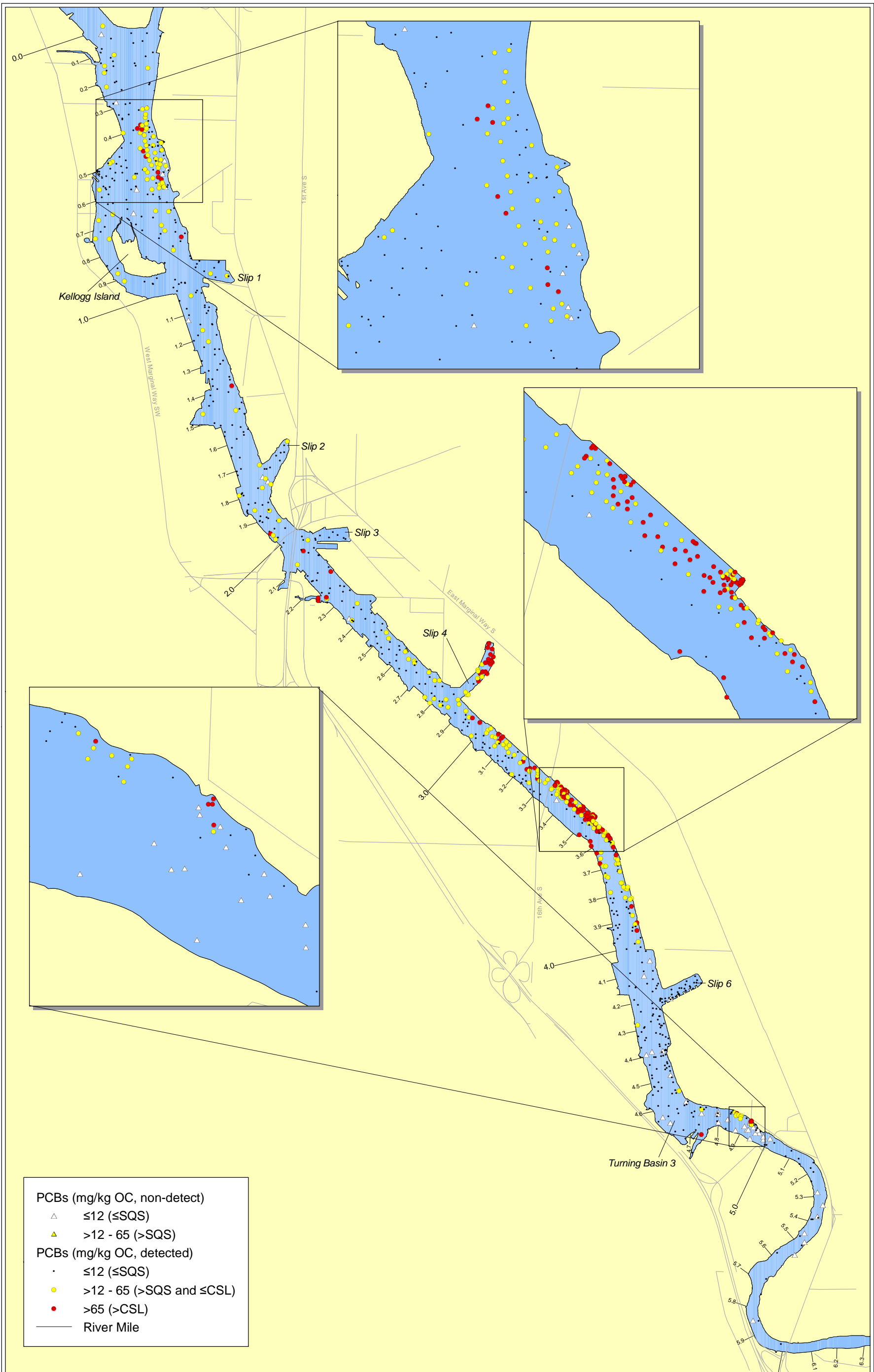
0 625 1,250 2,500
 Feet

0 250 500 1,000
 Meters



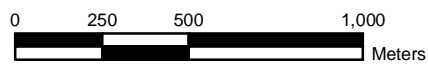
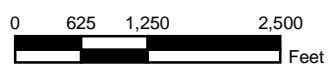
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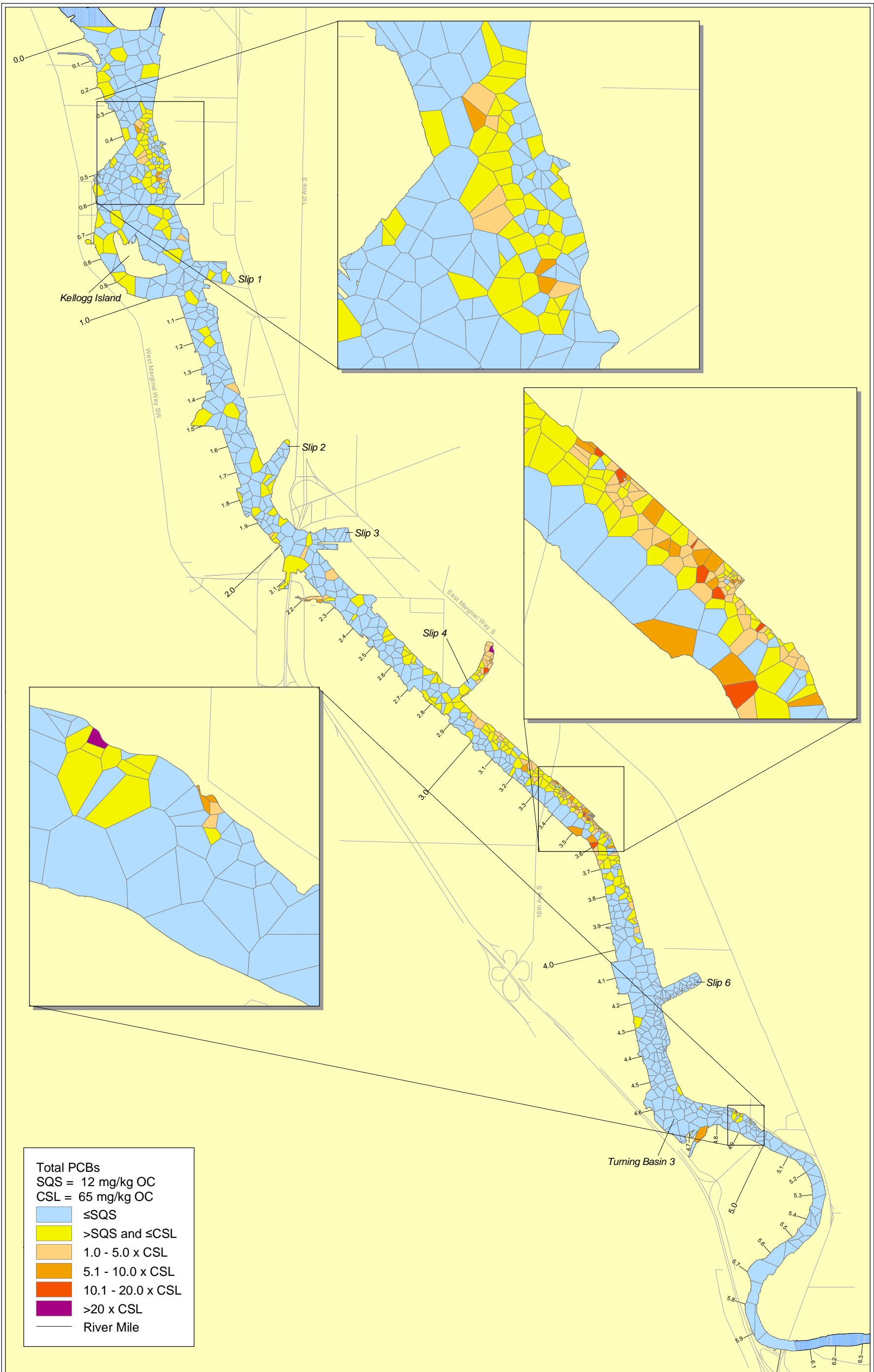


Map A-3-1a. Exceedances of SQS/CSL by point location for total PCBs in LDW surface sediments

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.



Prepared by RAC 12/12/02 Map 361



Map A-3-1b. Exceedances of SQS/CSL by Thiessen polygon for total PCBs in LDW surface sediment (full DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

Detection limits for concentrations reported as undetected were assigned a value equal to the detection limit for the purpose of data aggregation.

0 625 1,250 2,500
 Feet

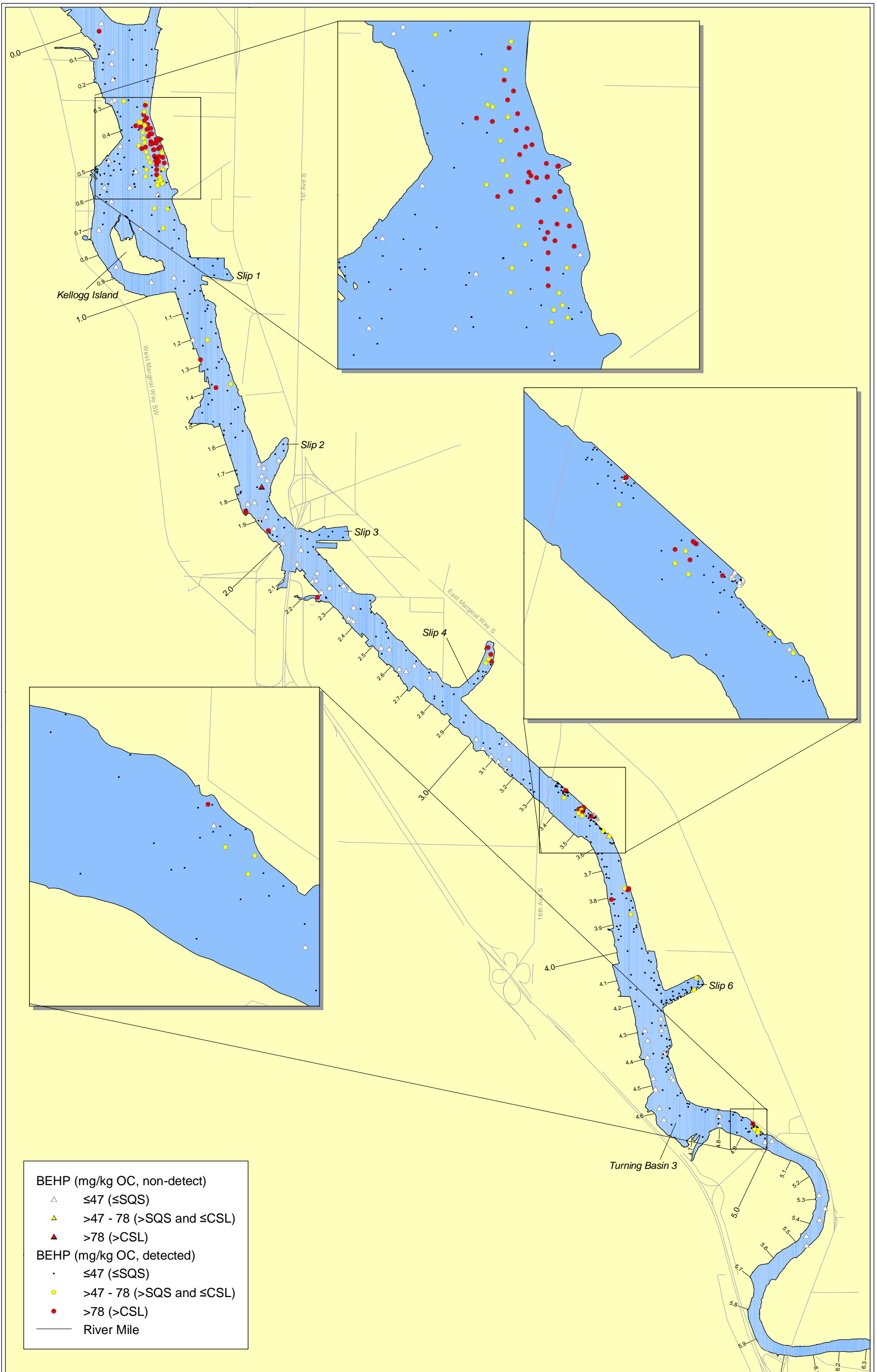
0 250 500 1,000
 Meters



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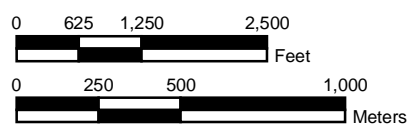
Prepared by RAC 12/12/02 Map 362

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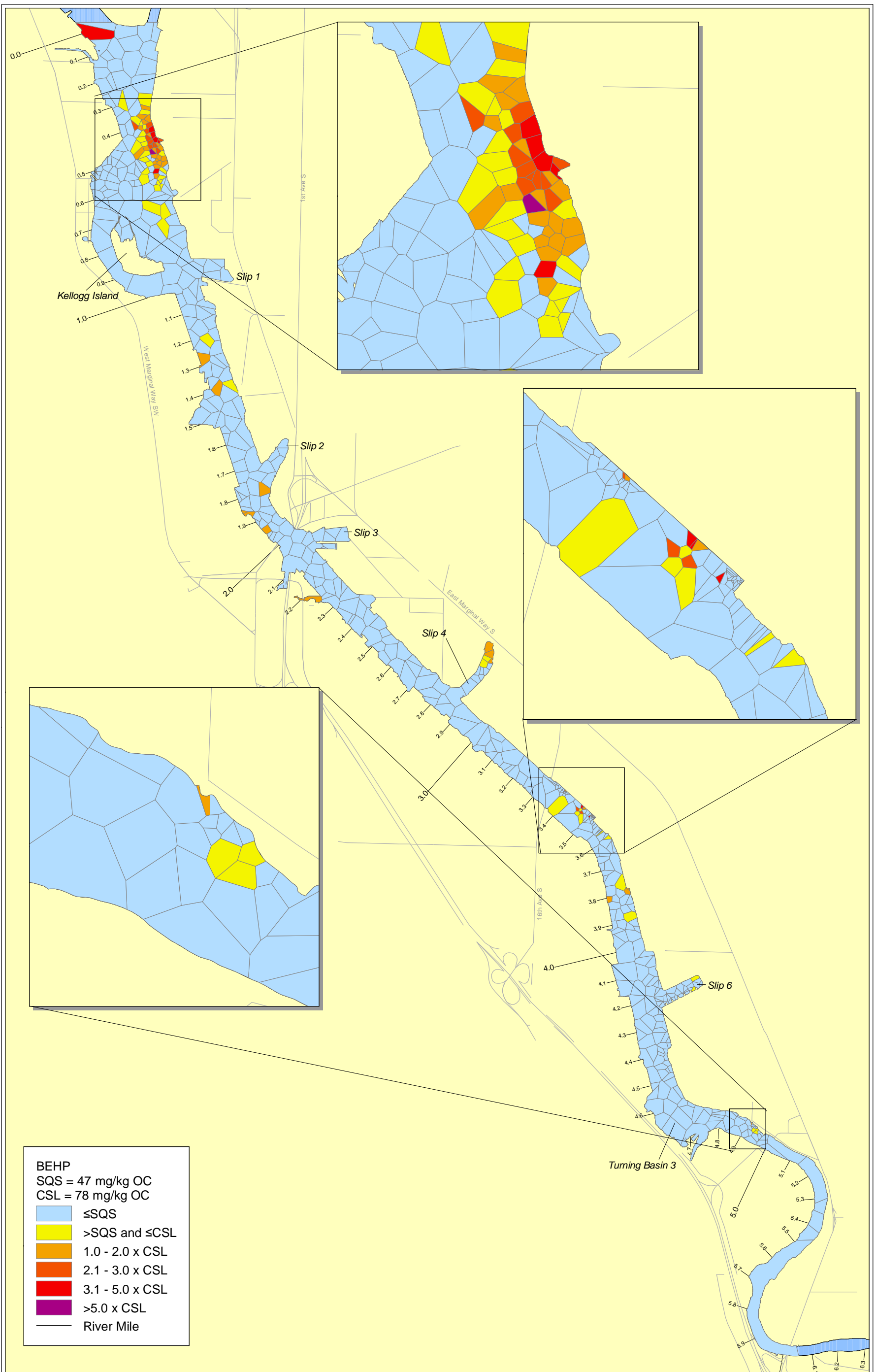


Map A-3-2a. Exceedances of SQS/CSL by point location for BEHP in LDW surface sediment

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with 0.2% TOC or lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.



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Map A-3-2b. Exceedances of SQS/CSL by Thiessen polygon for BEHP in LDW surface sediment (full DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with 0.2% TOC or lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

0 625 1,250 2,500
 Feet

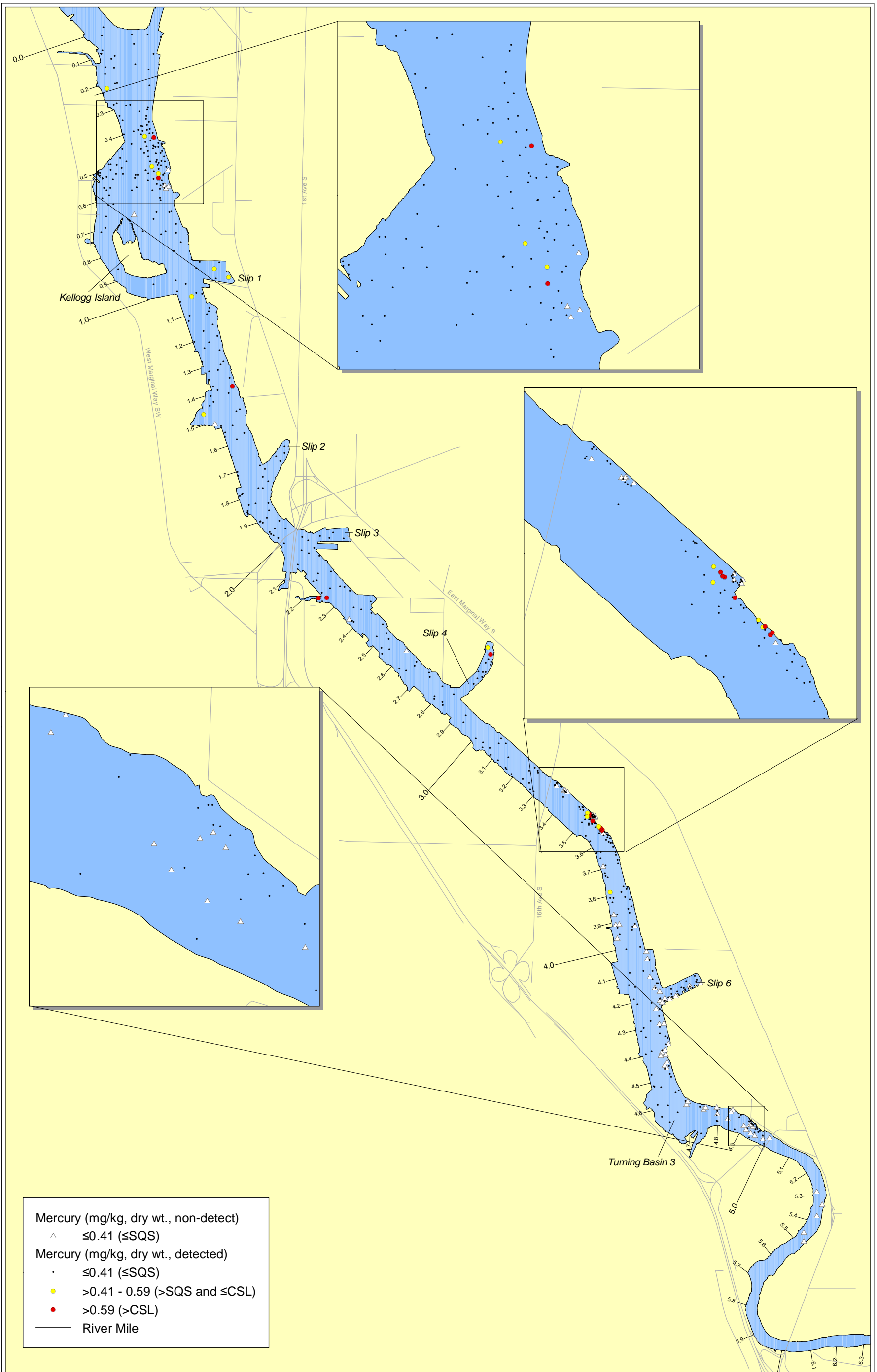
0 250 500 1,000
 Meters

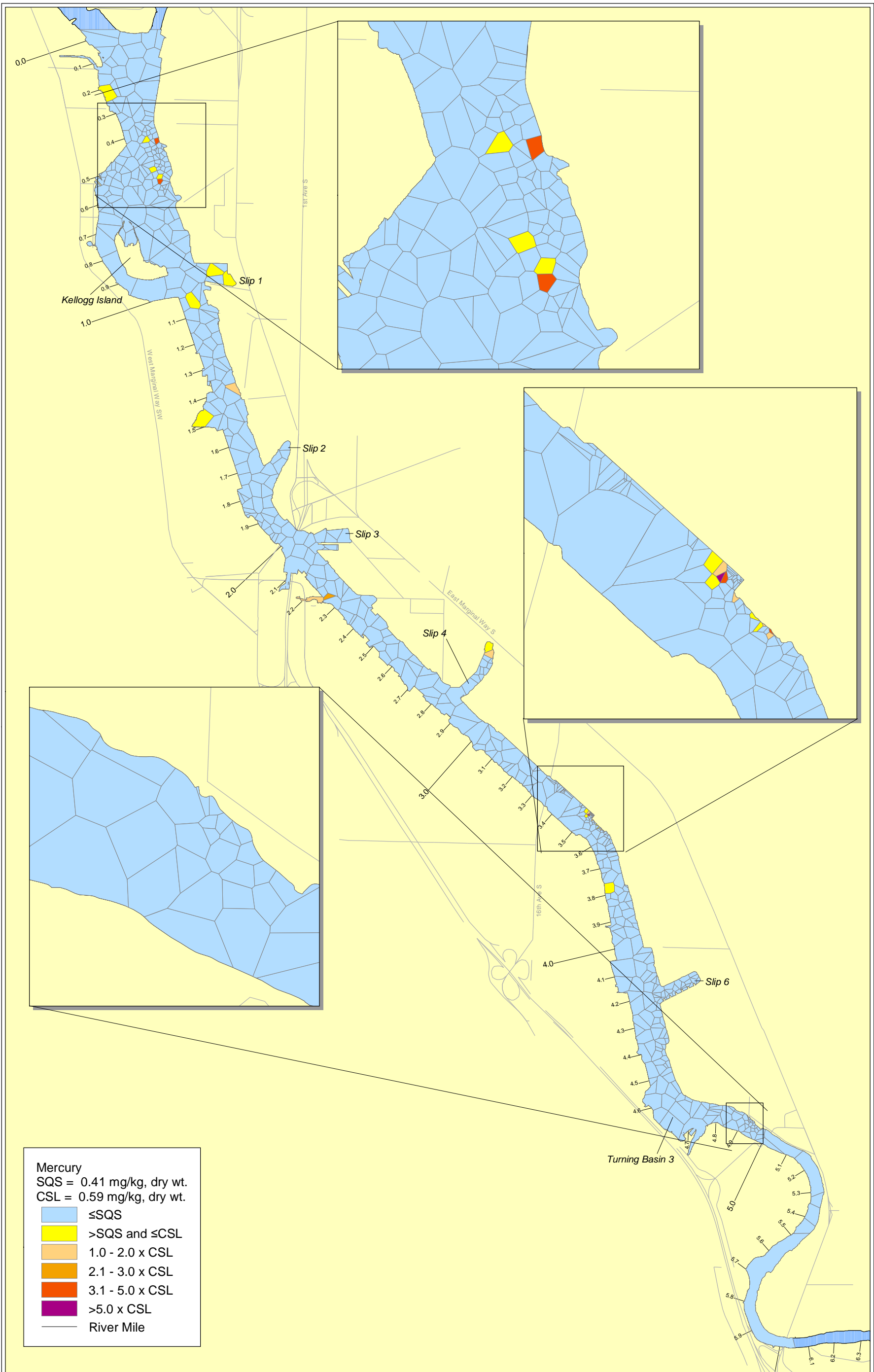


Prepared by RAC 12/10/02 Map 364

Detection limits for concentrations reported as undetected were assigned a value equal to the detection limit for the purpose of data aggregation.

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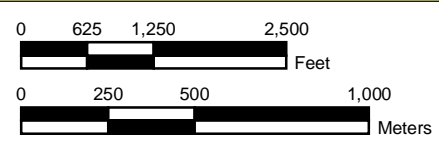


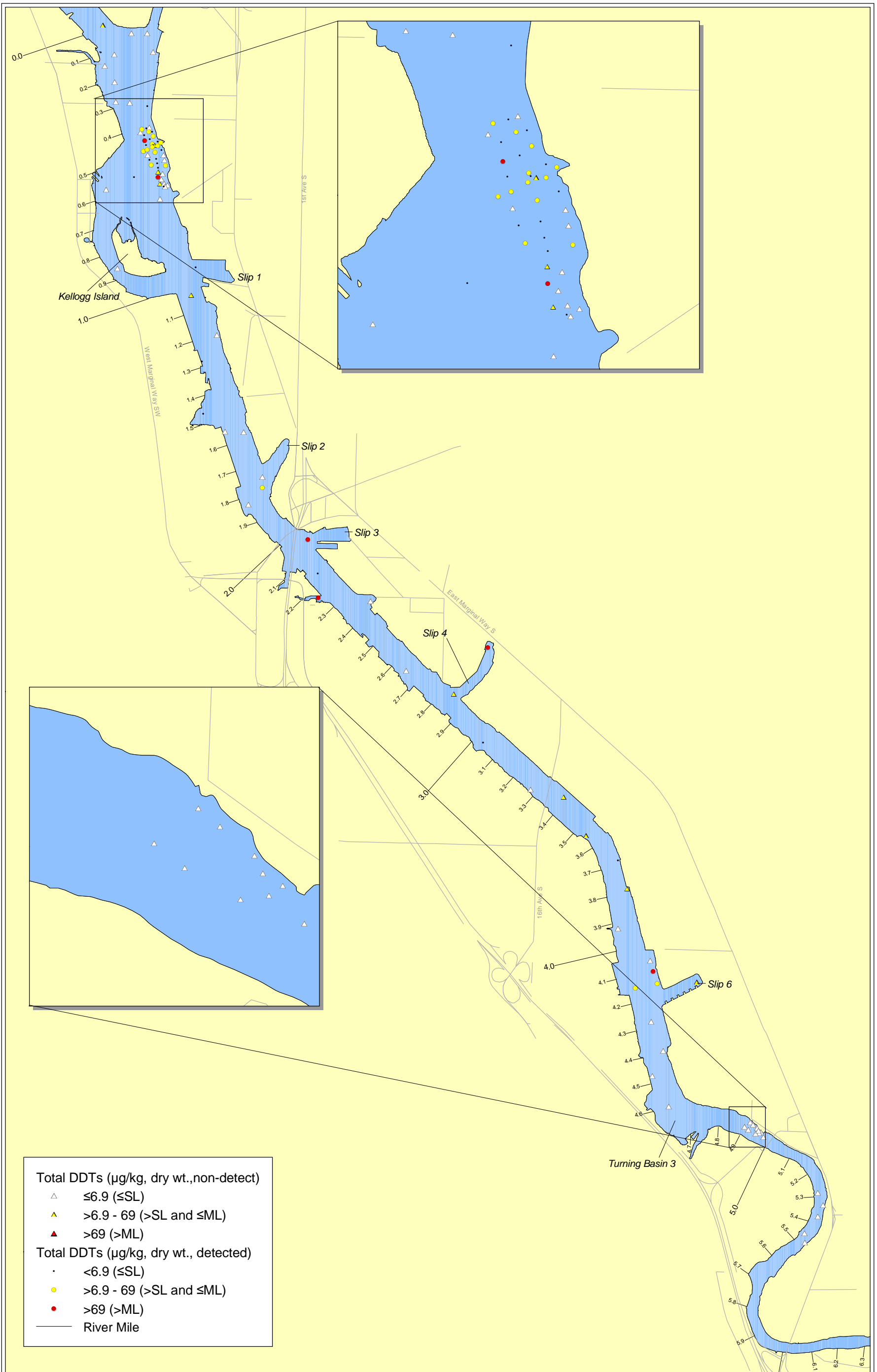


Mercury
 SQS = 0.41 mg/kg, dry wt.
 CSL = 0.59 mg/kg, dry wt.

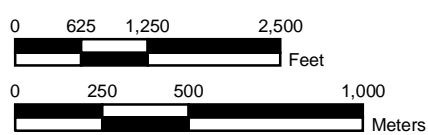
Light Blue	≤SQS
Yellow	>SQS and ≤CSL
Light Orange	1.0 - 2.0 x CSL
Dark Orange	2.1 - 3.0 x CSL
Red	3.1 - 5.0 x CSL
Purple	>5.0 x CSL
Line	River Mile

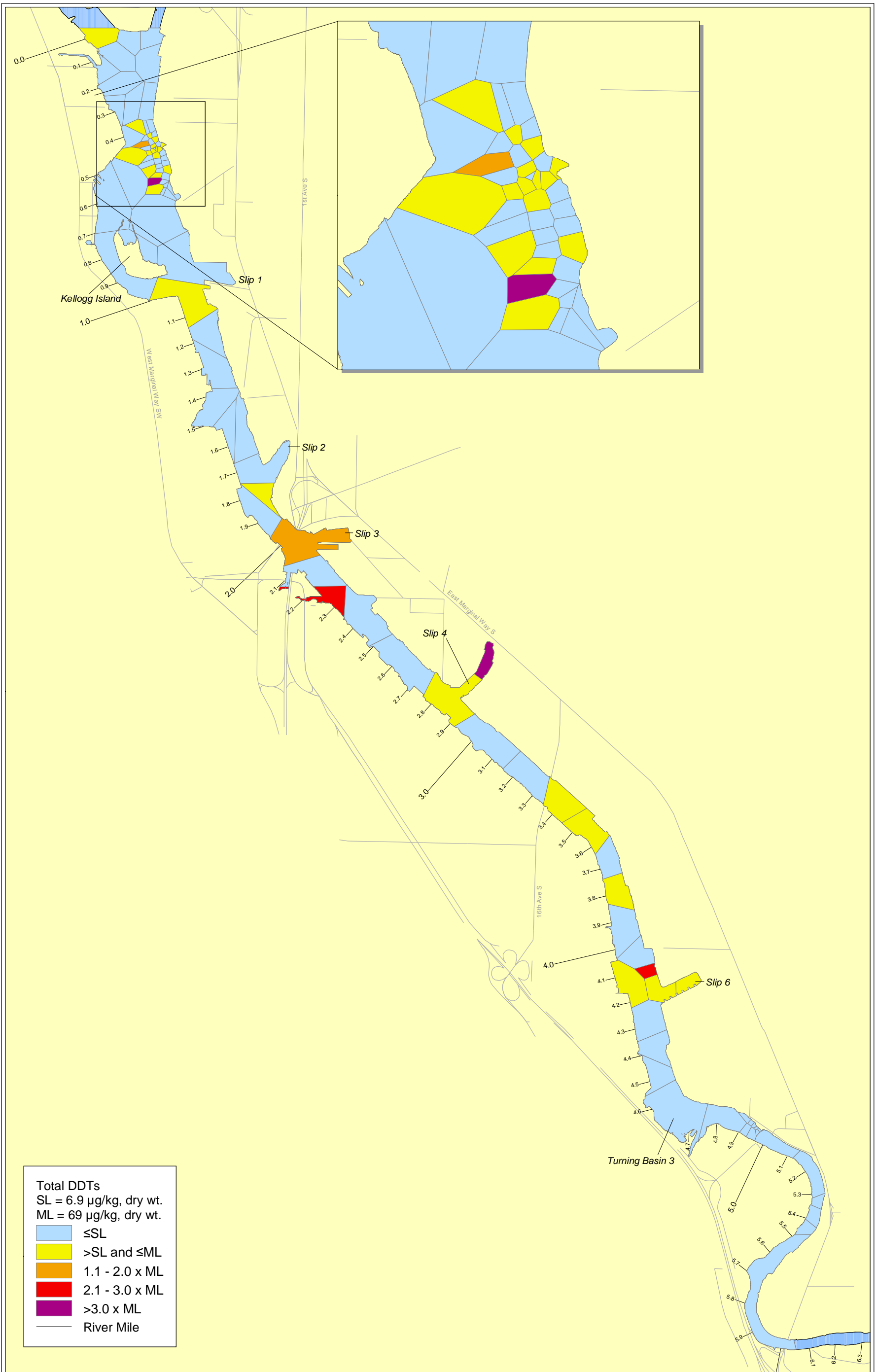
Map A-3-3b. Exceedances of SQS/CSL by Thiessen polygon for mercury in LDW surface sediment (full DL)
Detection limits for concentrations reported as undetected were assigned a value equal to the detection limit for the purpose of data aggregation.





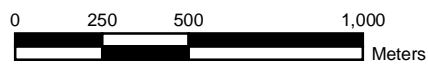
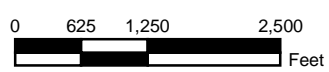
Map A-3-4a. Exceedances of SL/ML by point location for total DDTs in LDW surface sediment



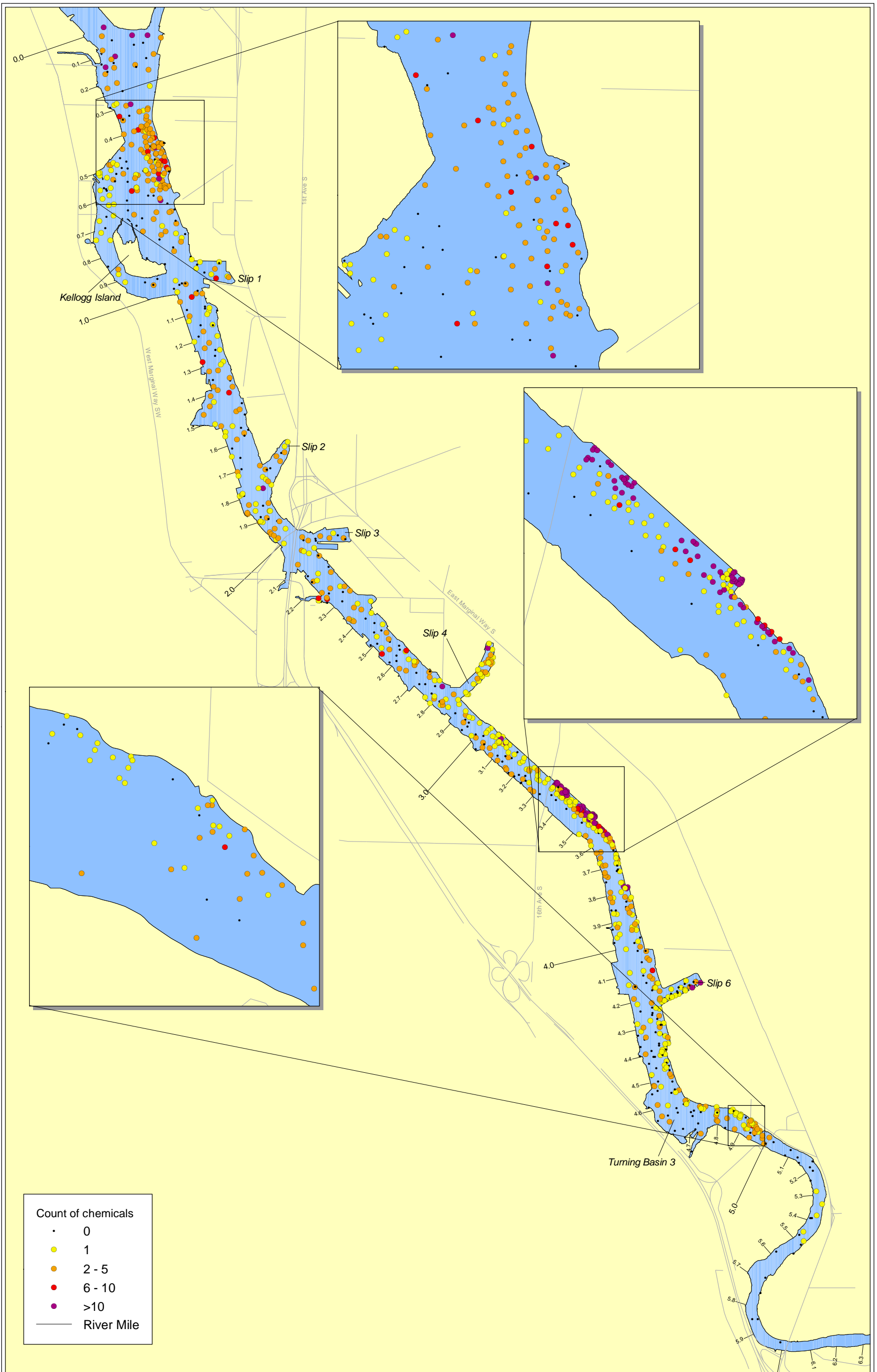


Map A-3-4b. Exceedances of SL/ML by Thiessen polygon for total DDTs in LDW surface sediment (full DL)

Detection limits for concentrations reported as undetected were assigned a value equal to the detection limit for the purpose of data aggregation.



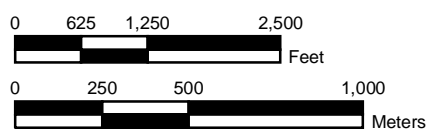
Prepared by RAC 12/11/02 Map 368



Map A-3-5. Number of chemicals exceeding SQS/SL by location in LDW surface sediments (full DL)

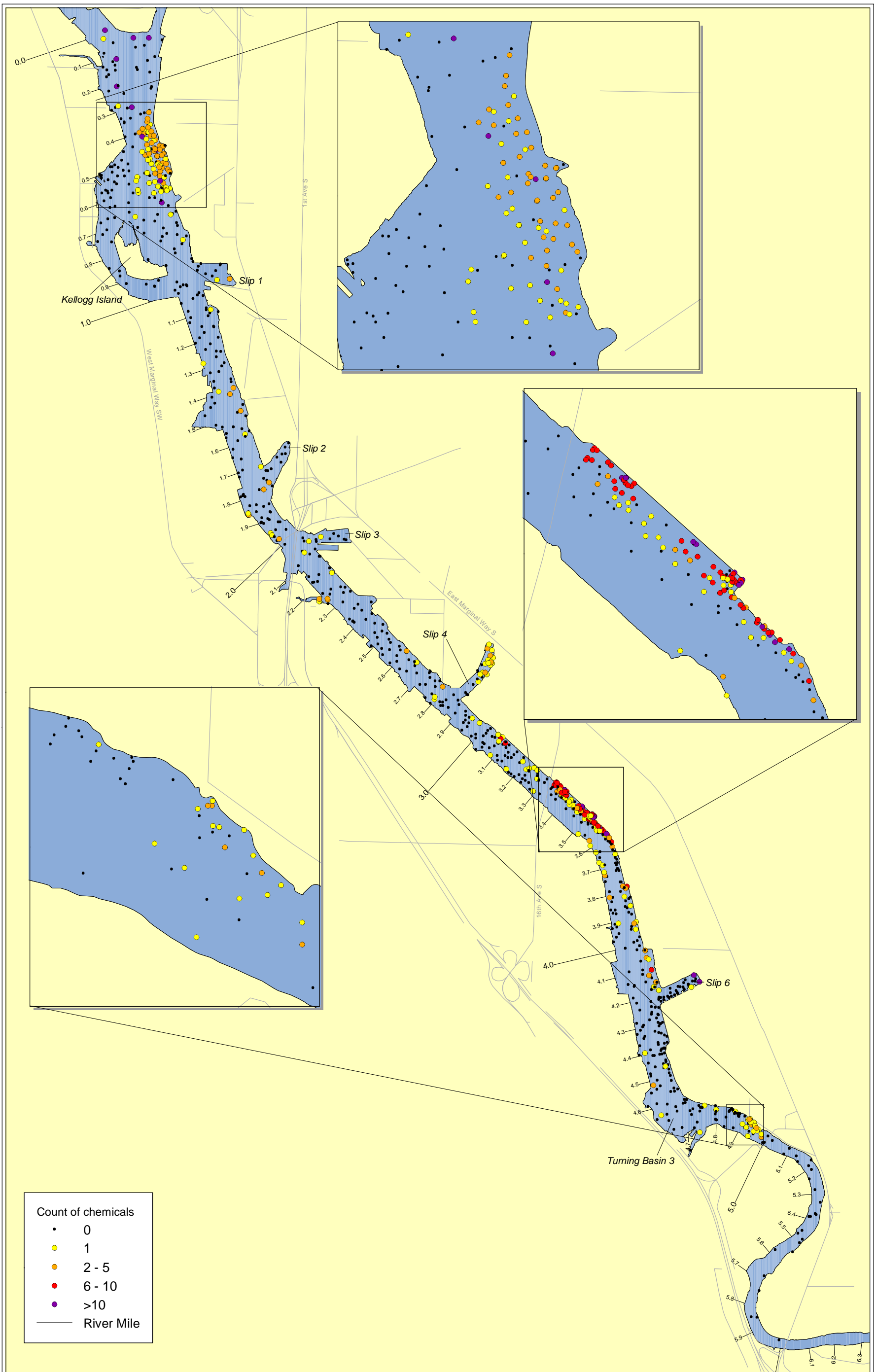
TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentrations of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

Detection limits for concentrations reported as undetected were assigned a value equal to the detection limit for the purpose of data aggregation.



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Detection limits for concentrations reported as undetected were assigned a value equal to the detection limit for the purpose of data aggregation.

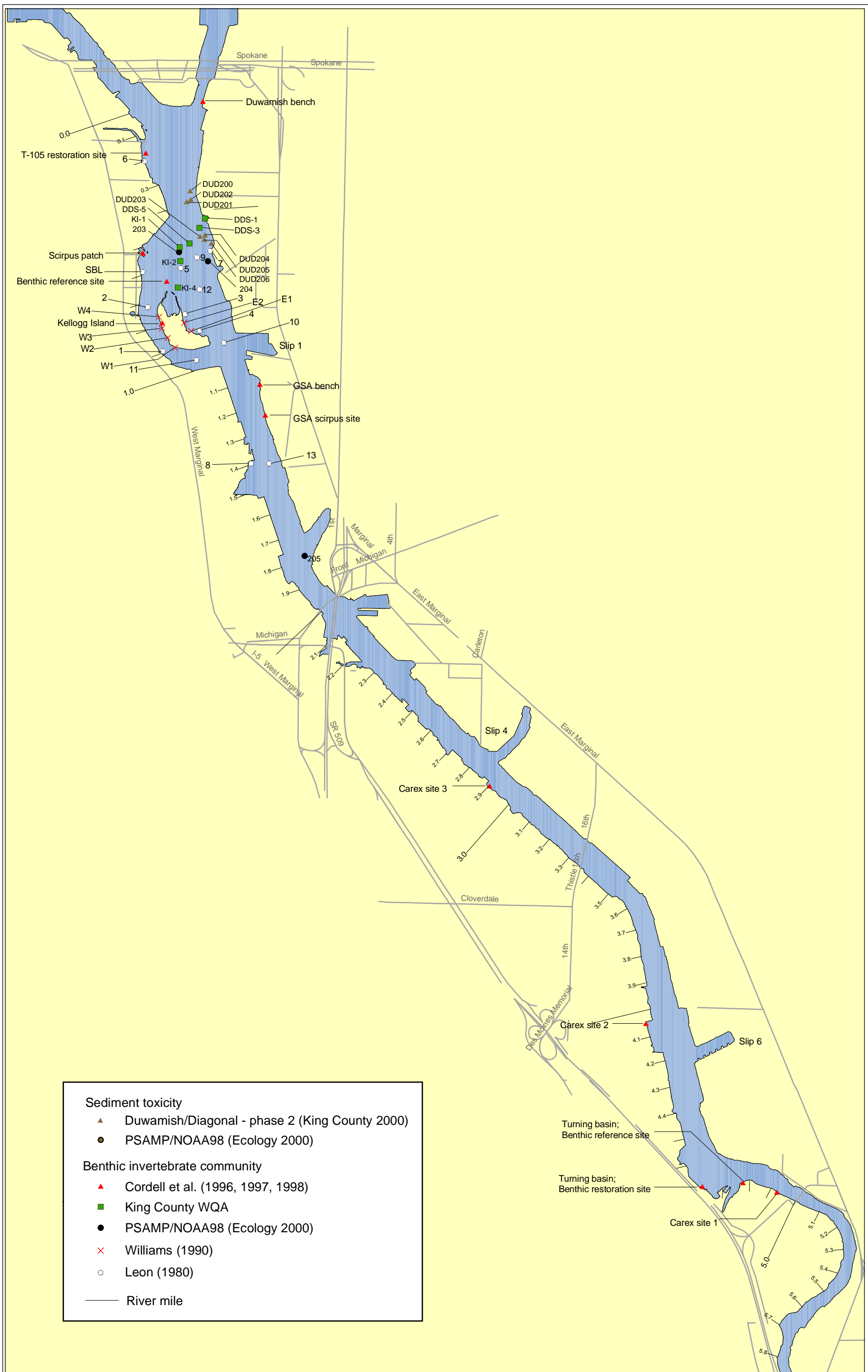
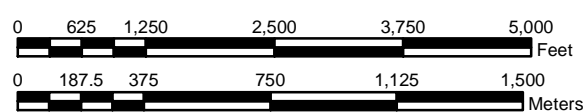


Figure A-3-7. Benthic invertebrate community and sediment bioassay sampling locations in the Lower Duwamish Waterway



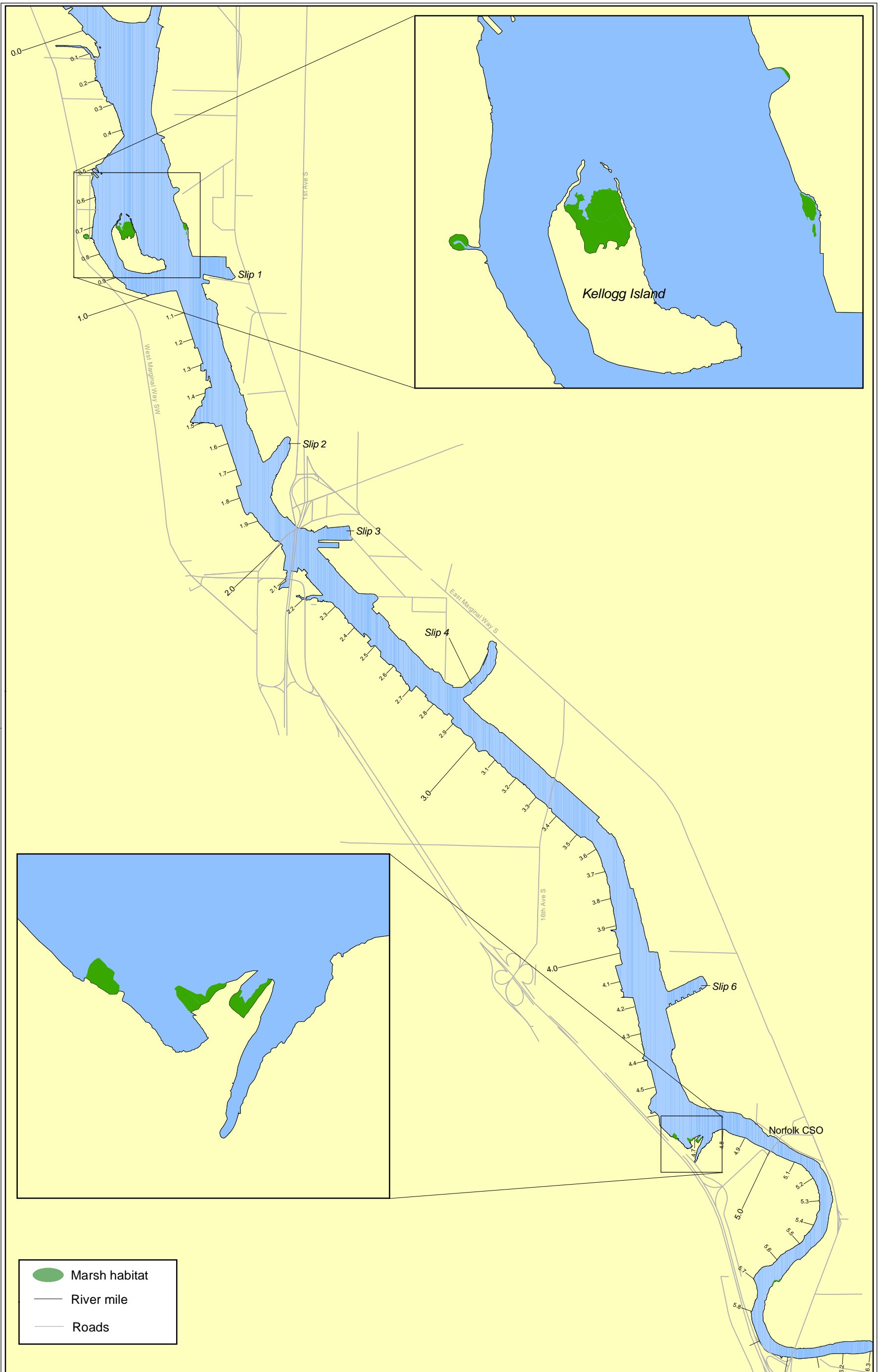
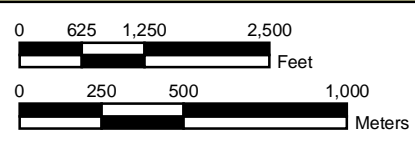
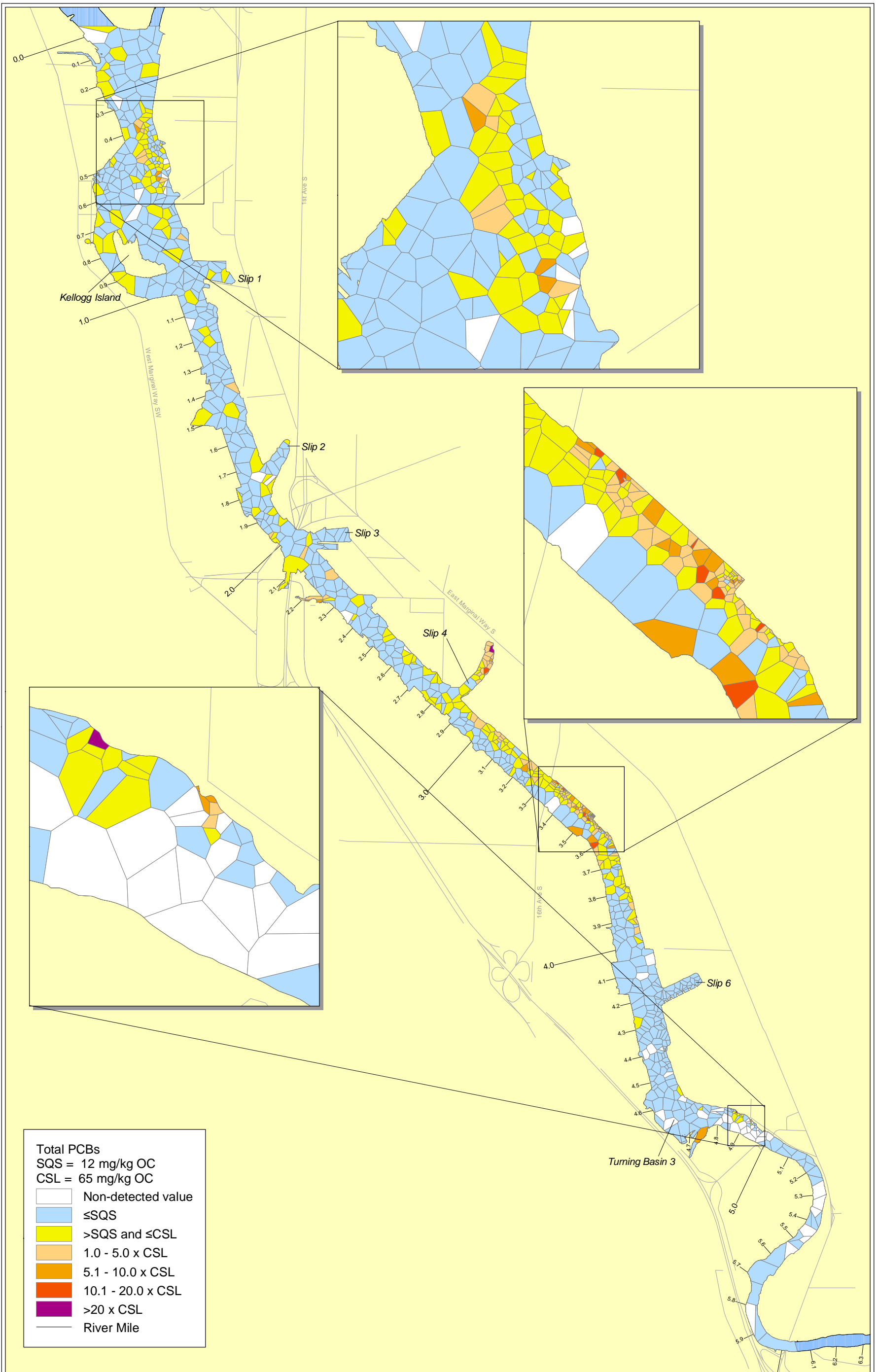


Figure A-6-1. Marsh habitat in the LDW





Total PCBs
 SQS = 12 mg/kg OC
 CSL = 65 mg/kg OC

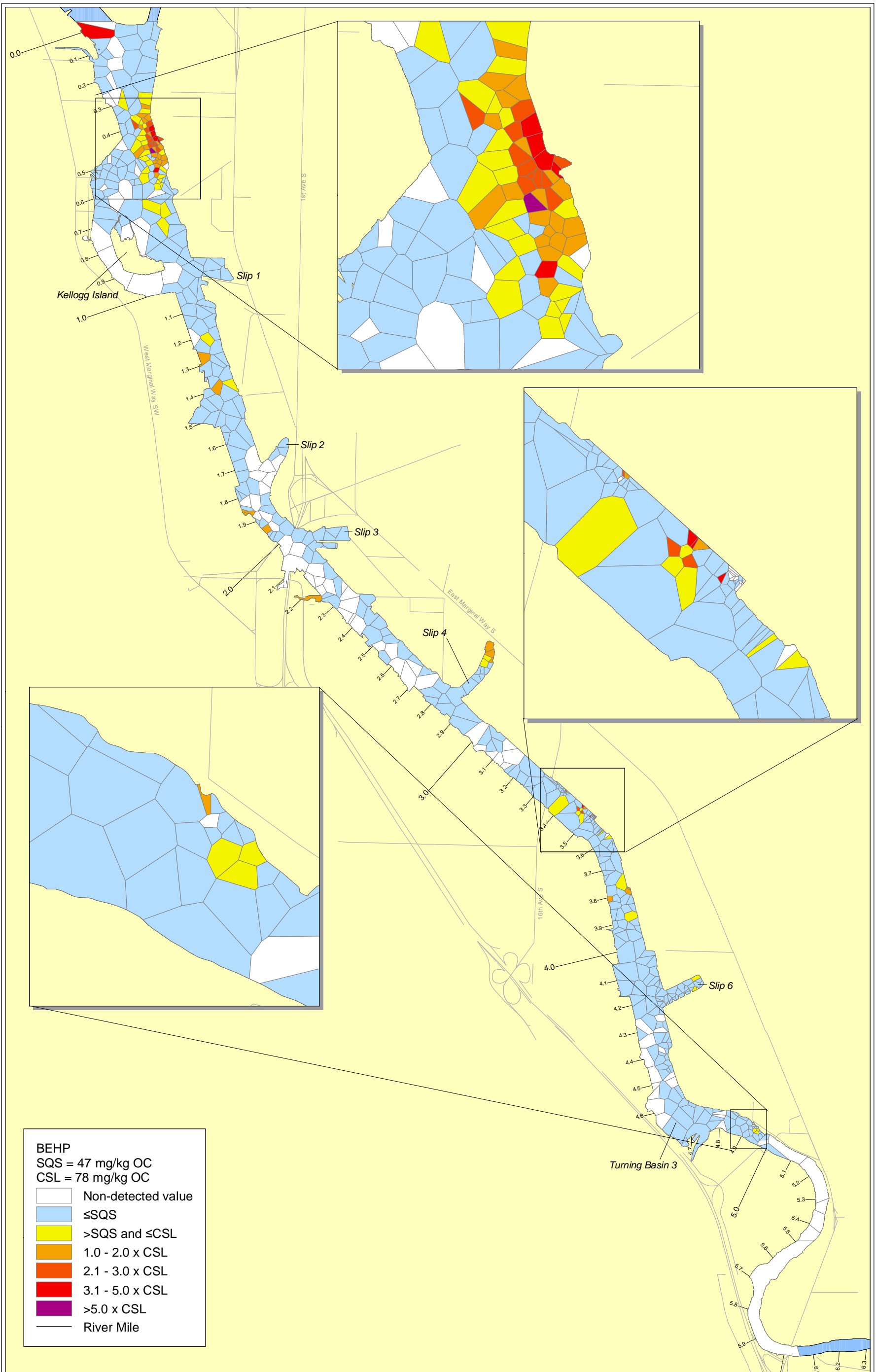
- Non-detected value
- ≤SQS
- >SQS and ≤CSL
- 1.0 - 5.0 x CSL
- 5.1 - 10.0 x CSL
- 10.1 - 20.0 x CSL
- >20 x CSL
- River Mile

Map A-7-1. Exceedances of SQS/CSL by Thiessen polygon for total PCBs in LDW surface sediment (zero DL)
 TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with 0.2% TOC or lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

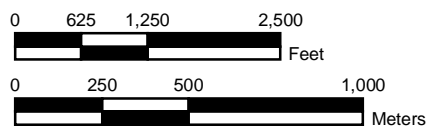


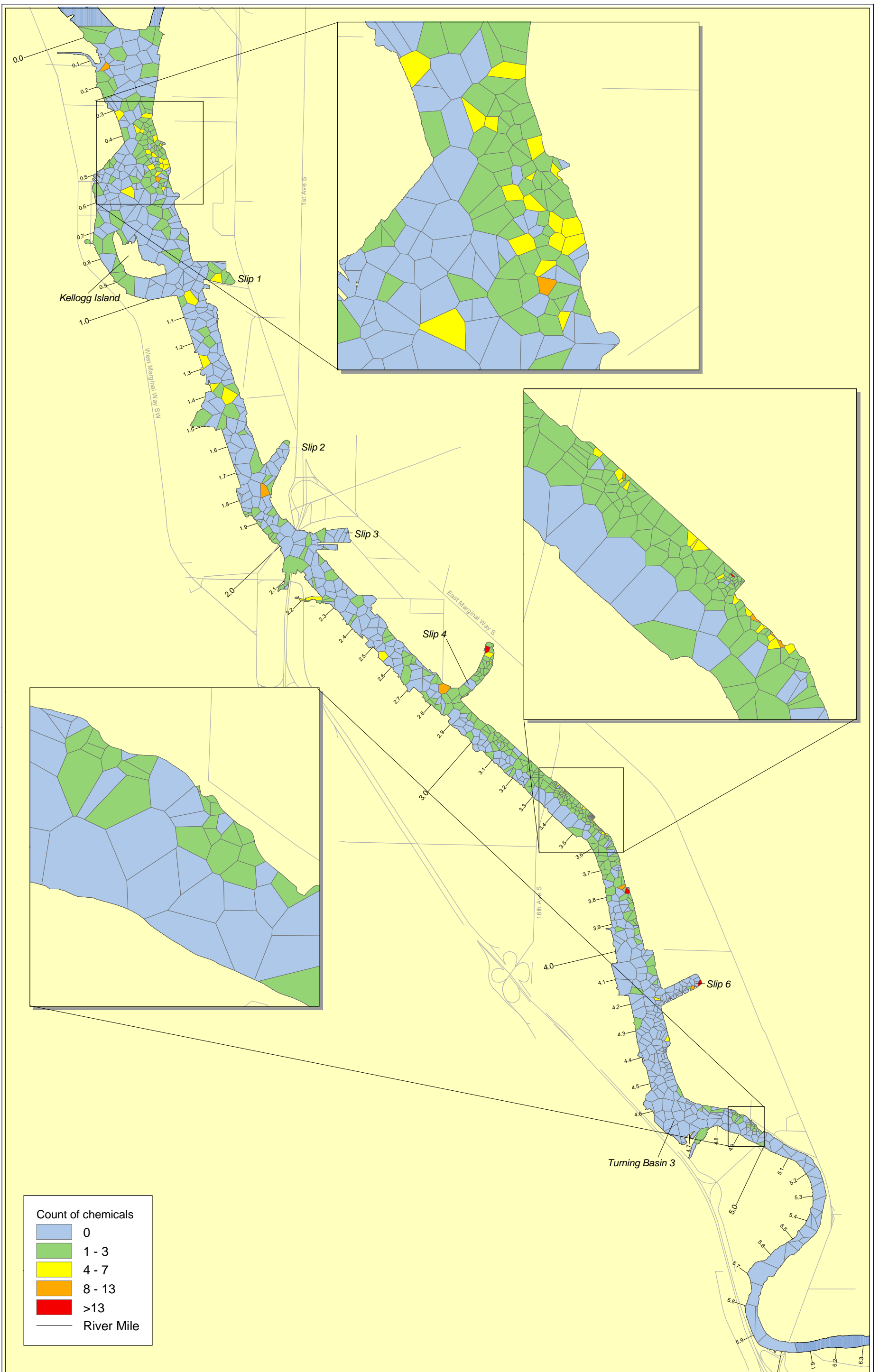
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Detection limits for concentrations reported as undetected were assigned a value of zero for the purpose of data aggregation.



Map A-7-2. Exceedances of SQS/CSL by Thiessen polygon for BEHP in LDW surface sediment (zero DL)
 TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with 0.2% TOC or lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.





Map A-7-3. Number of chemicals exceeding SQS/SL by Thiessen polygon in LDW surface sediments (zero DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentration of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

Detection limits for concentrations reported as undetected were assigned a value of zero for the purpose of data aggregation.

0 625 1,250 2,500
Feet

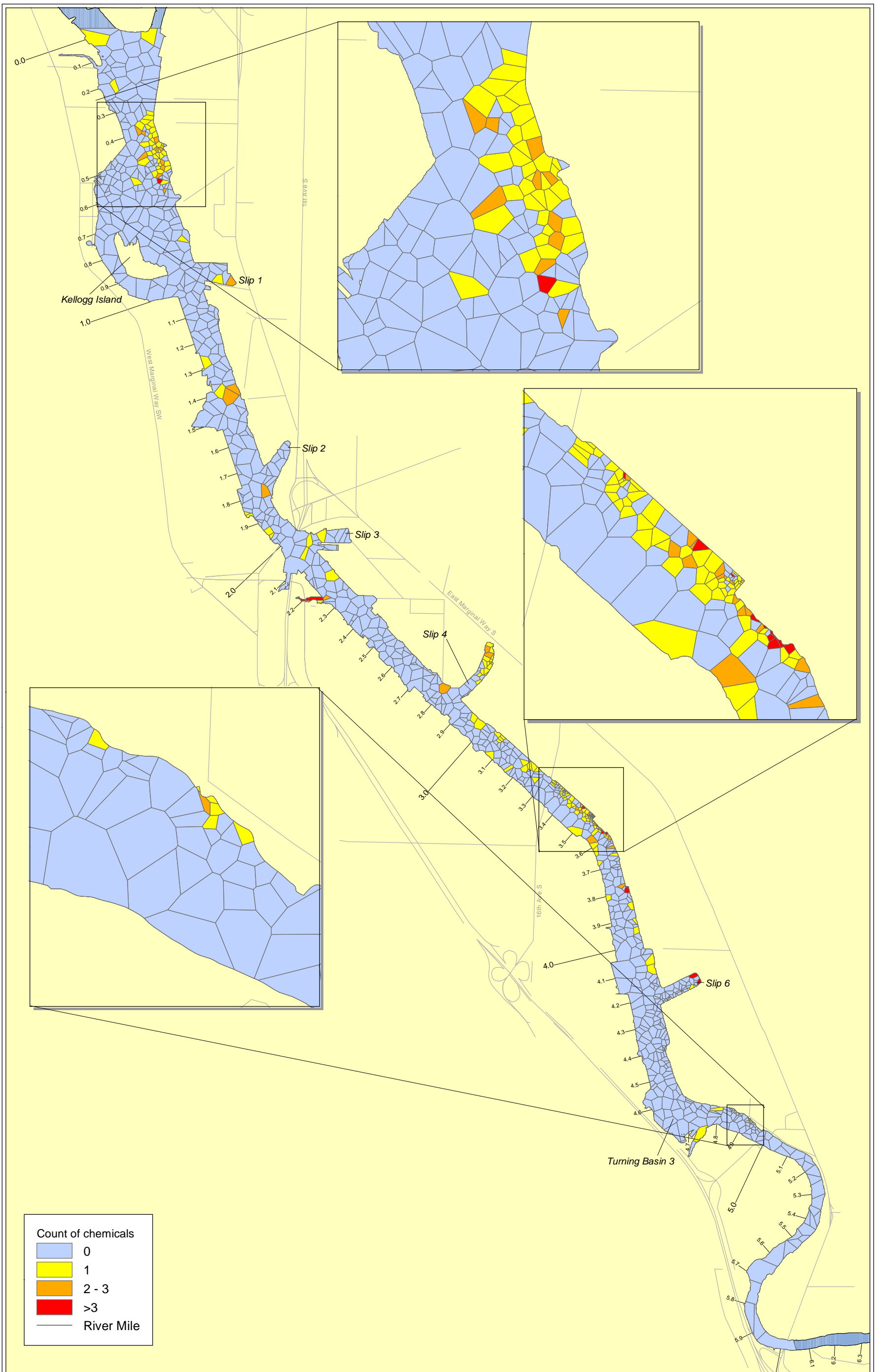
0 250 500 1,000
Meters



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Map A-7-4. Number of chemicals exceeding CSL/ML by Thiessen polygon in LDW surface sediments (zero DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentrations of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

Detection limits for concentrations reported as undetected were assigned a value of zero for the purpose of data aggregation.

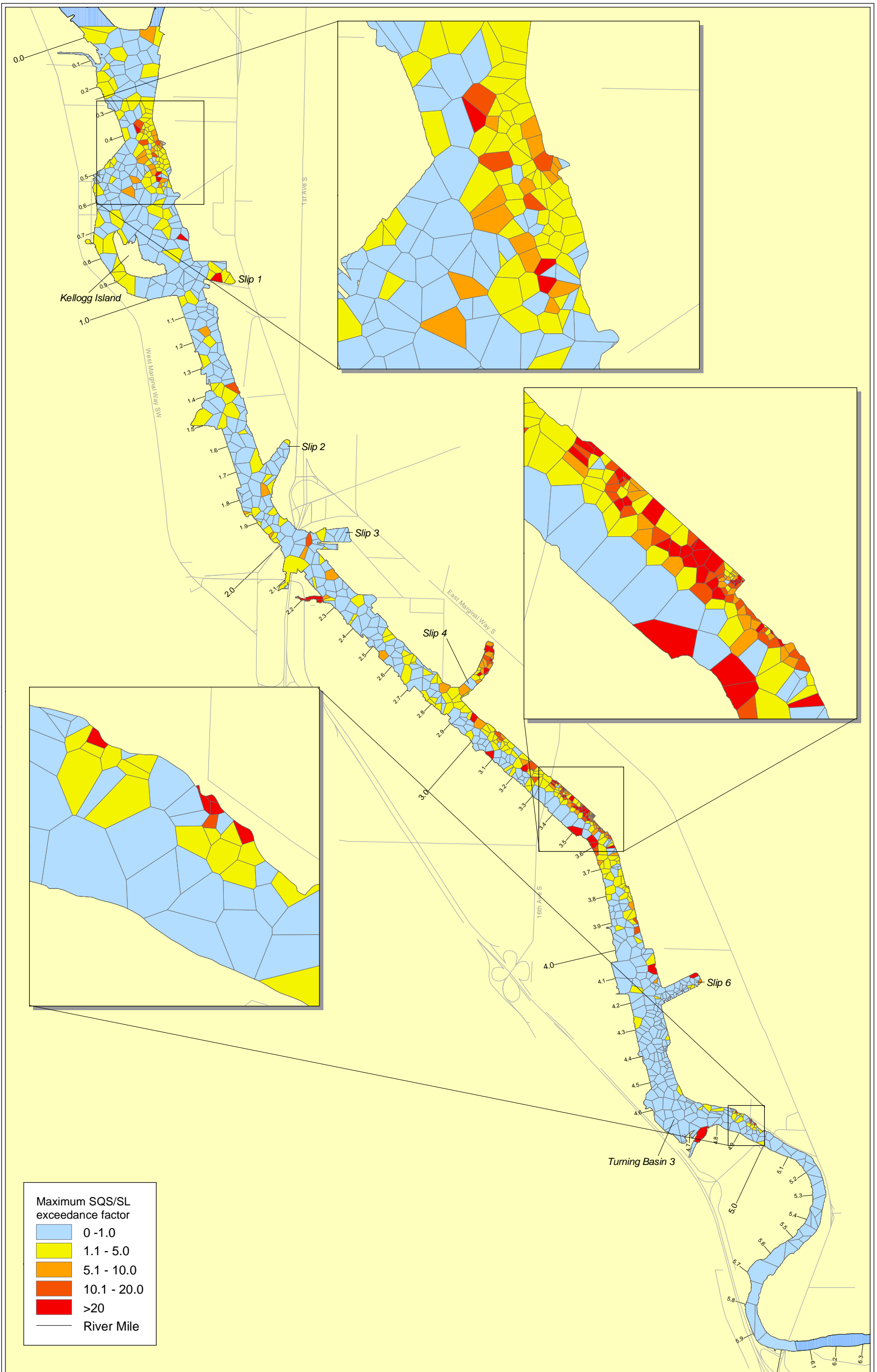
0 625 1,250 2,500
Feet

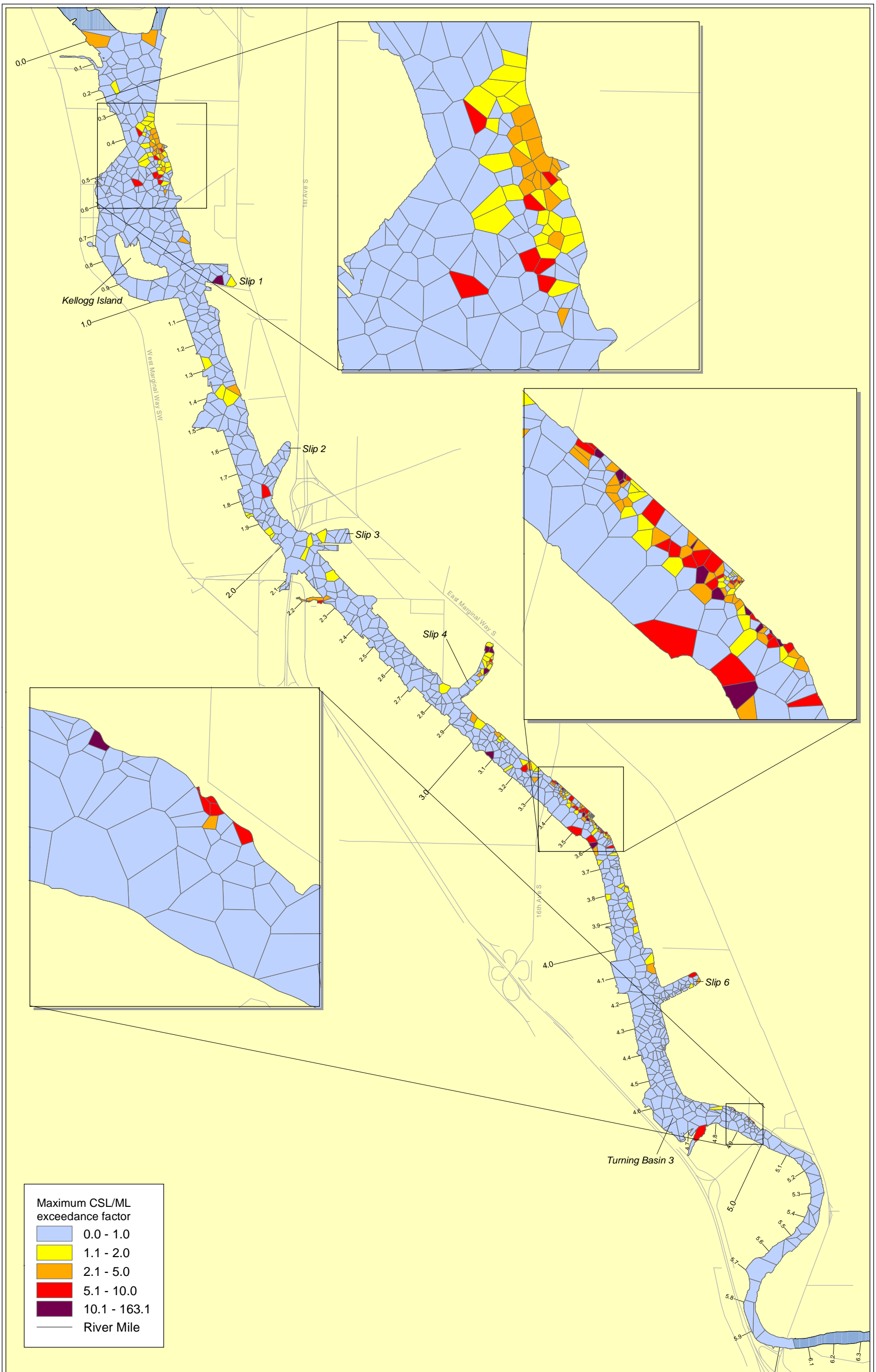
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Meters



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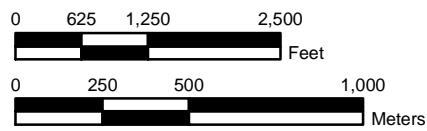




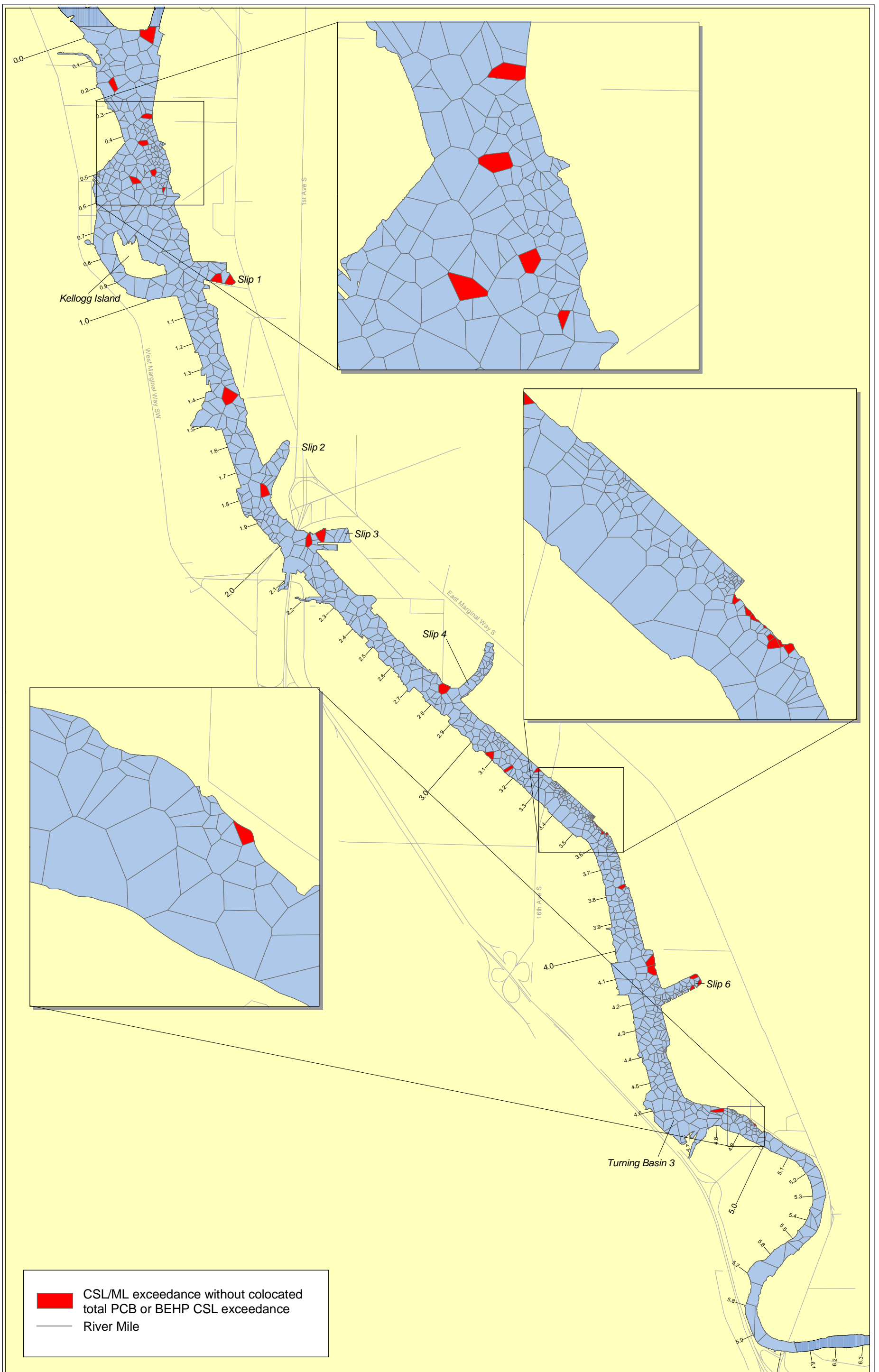
Map A-7-6. Maximum CSL/ML exceedance factor by Thiessen polygon in LDW surface sediments (zero DL)

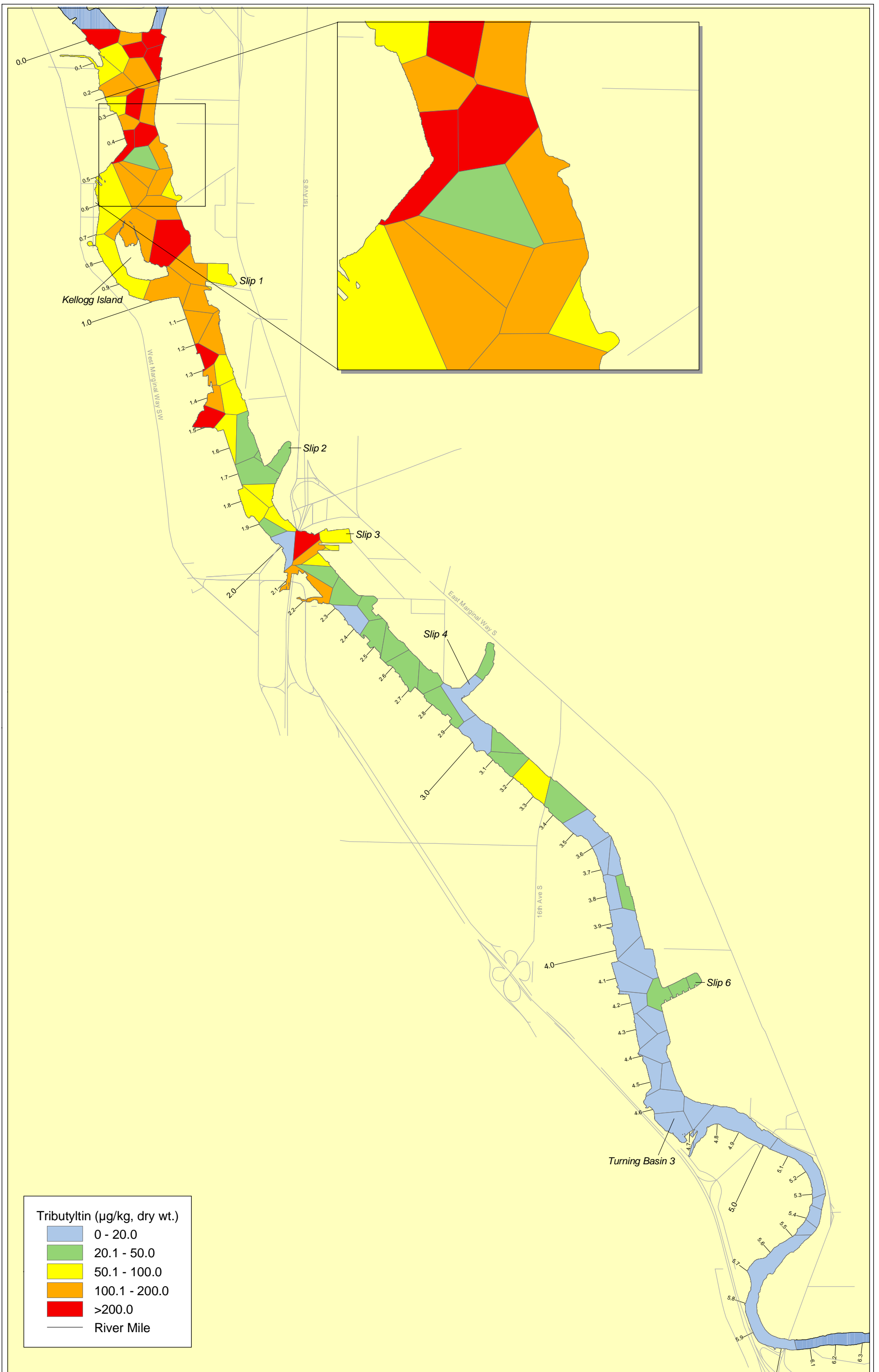
TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentrations of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

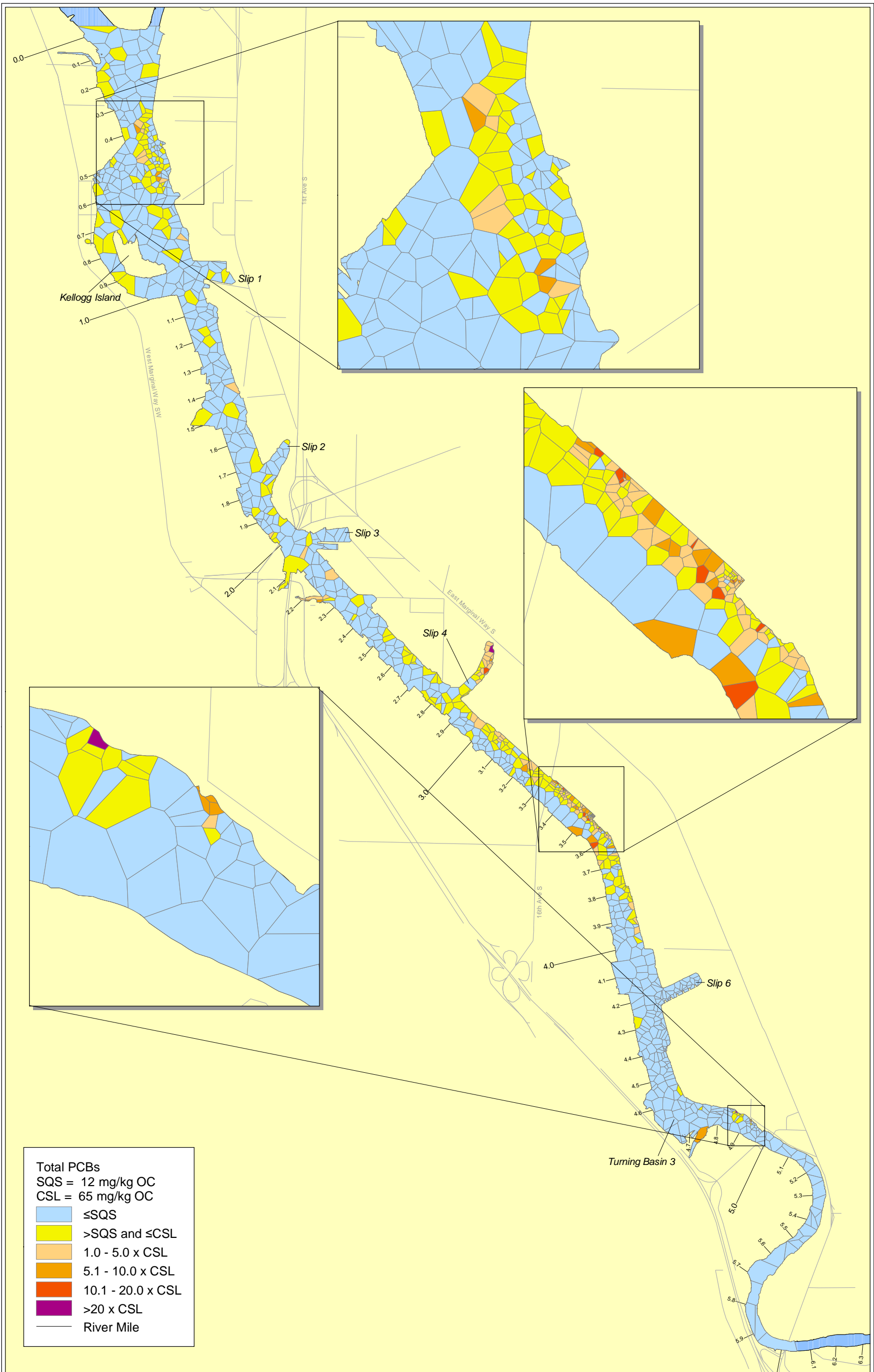
Detection limits for concentrations reported as undetected were assigned a value of zero for the purpose of data aggregation.



Prepared by SMS 12/13/02 Map 341







Total PCBs
 SQS = 12 mg/kg OC
 CSL = 65 mg/kg OC

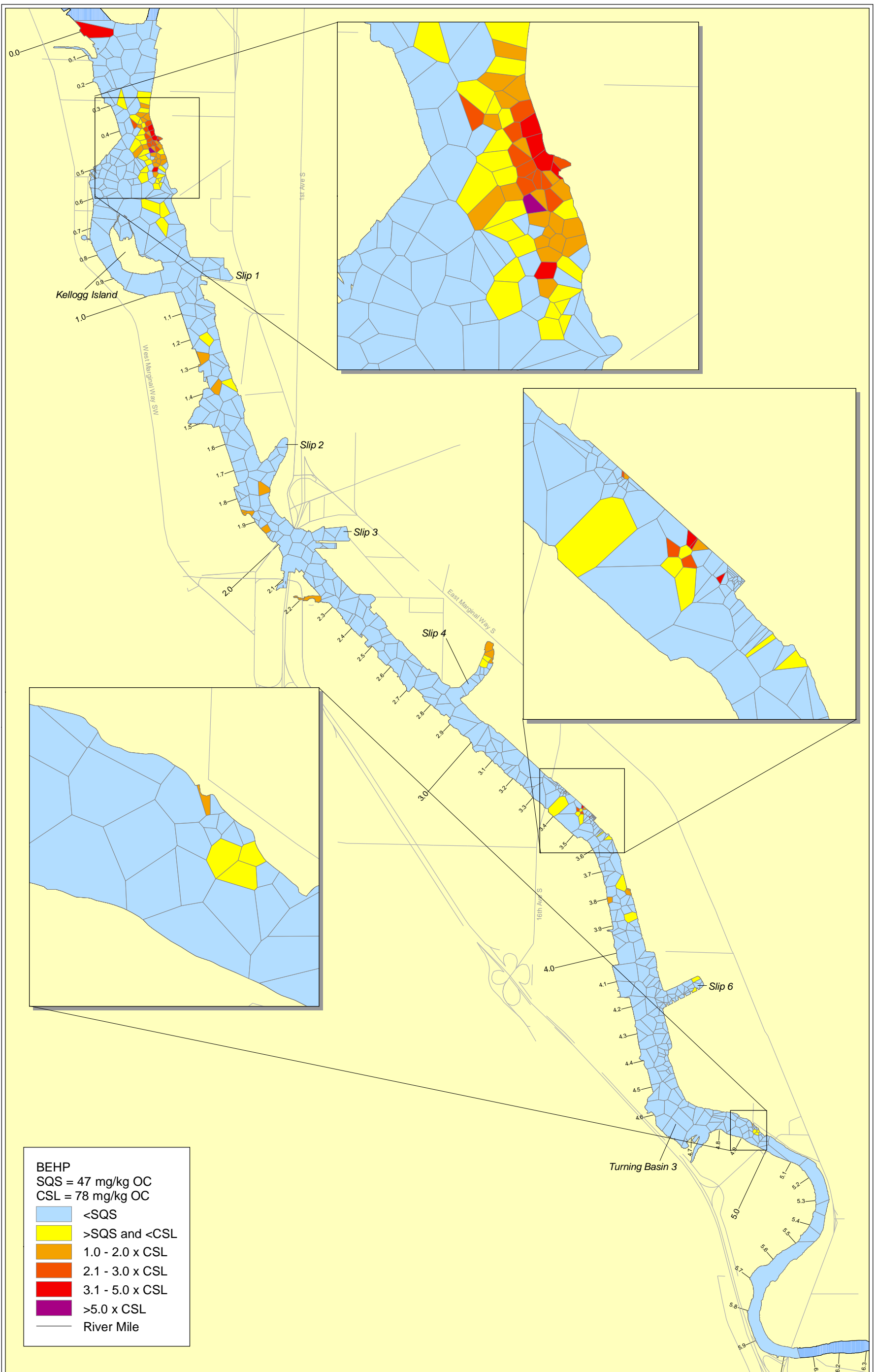
Light Blue	≤SQS
Yellow	>SQS and ≤CSL
Light Orange	1.0 - 5.0 x CSL
Dark Orange	5.1 - 10.0 x CSL
Red	10.1 - 20.0 x CSL
Purple	>20 x CSL
Line	River Mile

Map A-7-9. Exceedances of SQS/CSL by Thiessen polygon for total PCBs in LDW surface sediment (half DL)
 TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with 0.2% TOC or lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

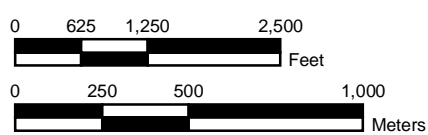


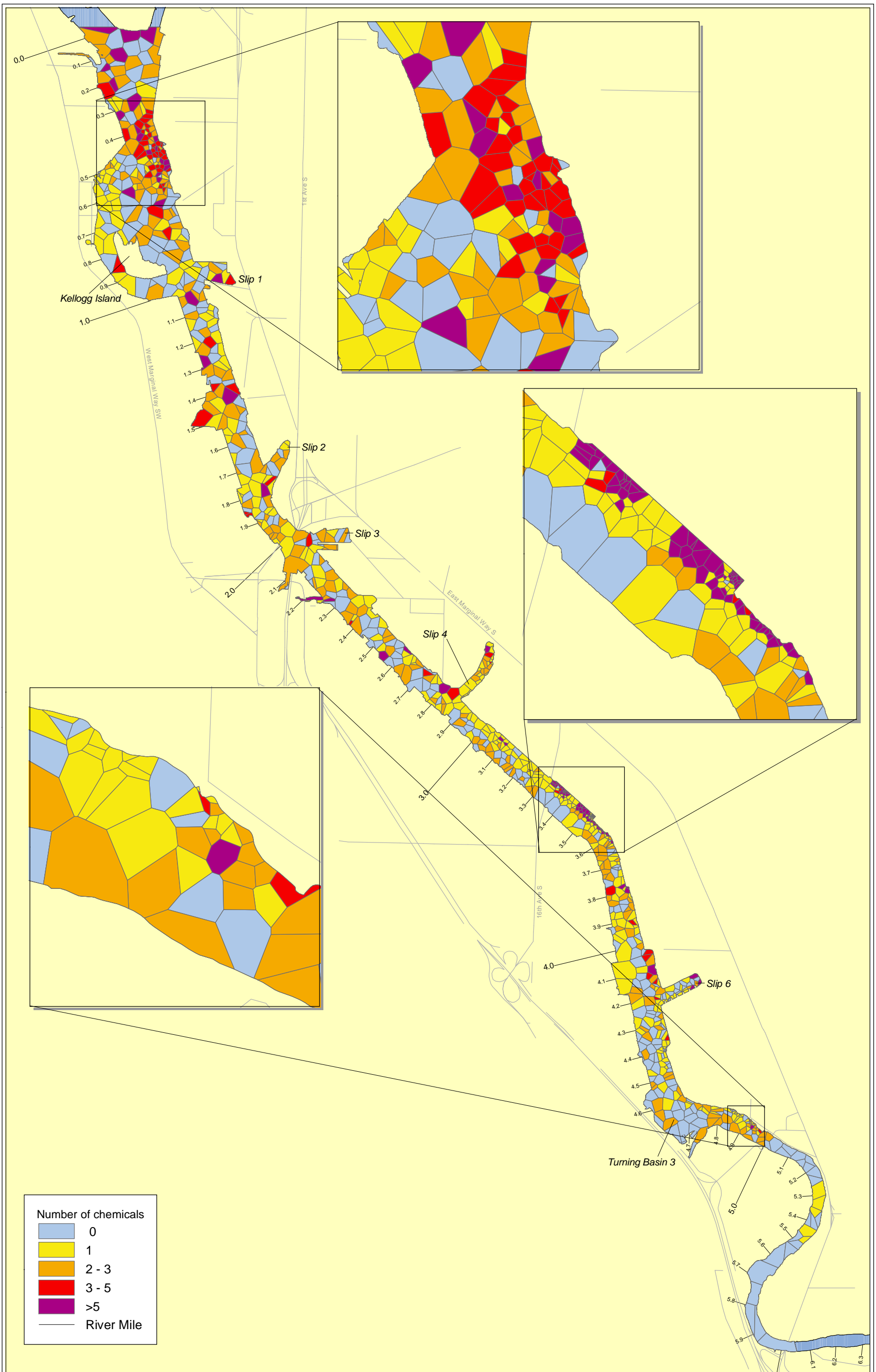
Prepared by RAC 12/17/02 Map 379

Detection limits for concentrations reported as undetected were assigned a value of one-half detection limit for the purpose of data aggregation.



Map A-7-10. Exceedances of SQS/CSL by Thiessen polygon for BEHP in LDW surface sediment (half DL)
 TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with 0.2% TOC or lower or missing TOC concentrations, chemical concentrations were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.



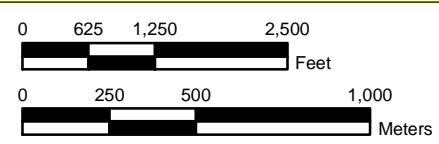


Number of chemicals	
Light Blue	0
Yellow	1
Orange	2 - 3
Red	3 - 5
Purple	>5
Grey line	River Mile

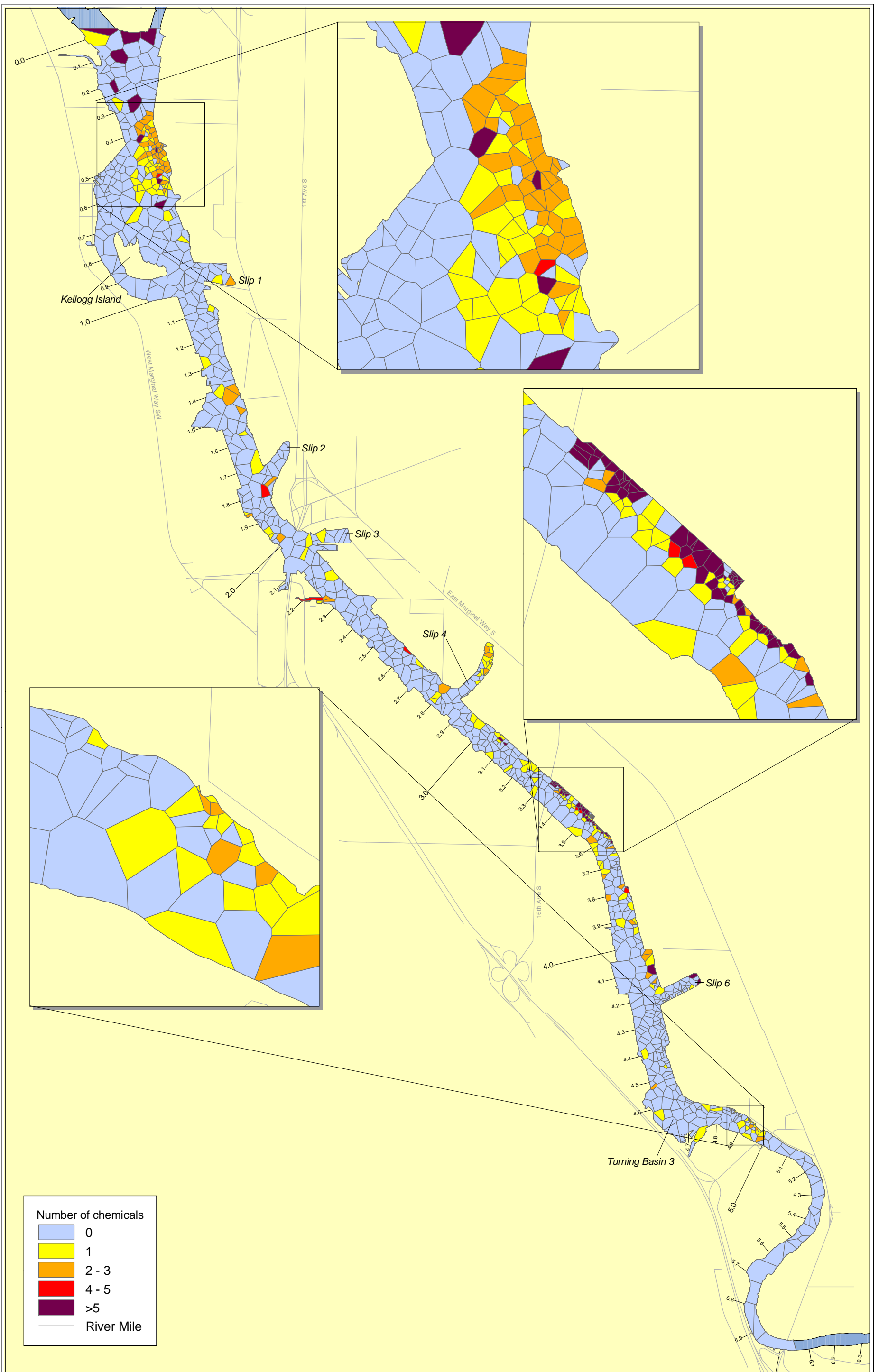
Map A-7-11. Number of chemicals exceeding SQS/SL by Thiessen polygon in LDW surface sediment (half DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentrations of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

Detection limits for concentrations reported as undetected were assigned a value of one-half detection limit for the purpose of data aggregation.



Prepared by SMS 12/13/02 Map 350



Map A-7-12. Number of chemicals exceeding CSL/ML by Thiessen polygon in LDW surface sediment (half DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentrations of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

Detection limits for concentrations reported as undetected were assigned a value of one-half detection limit for the purpose of data aggregation.

0 625 1,250 2,500
Feet

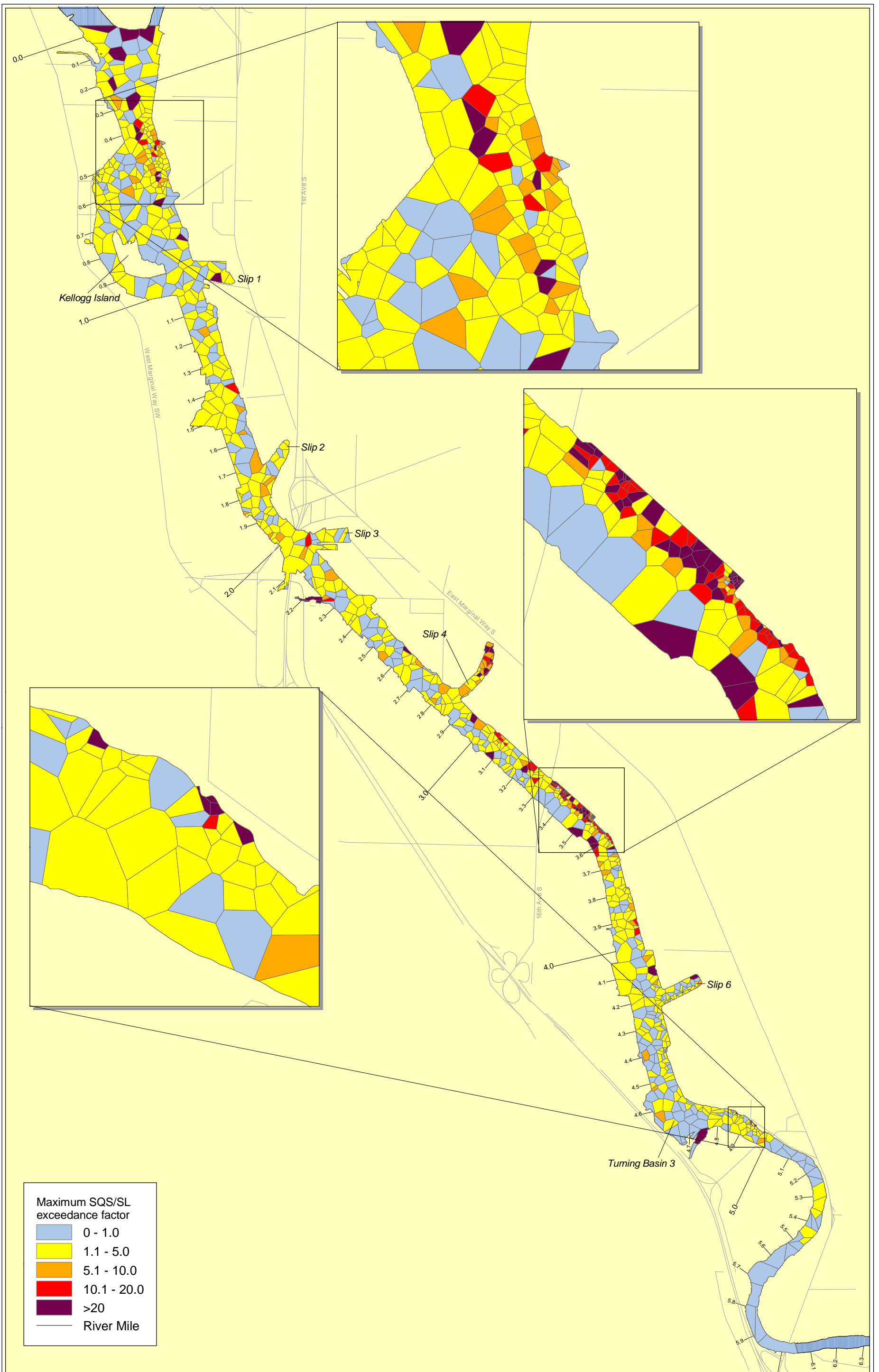
0 250 500 1,000
Meters



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Prepared by SMS 012/17/02 Map 350

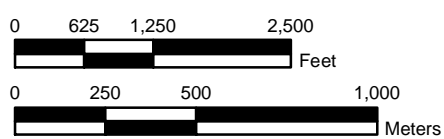
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Map A-7-13. Maximum SQS/SL exceedance factor by Thiessen polygon in LDW surface sediments (half DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentrations of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SQS) and second lowest AET (equivalent to CSL) in dry weight units.

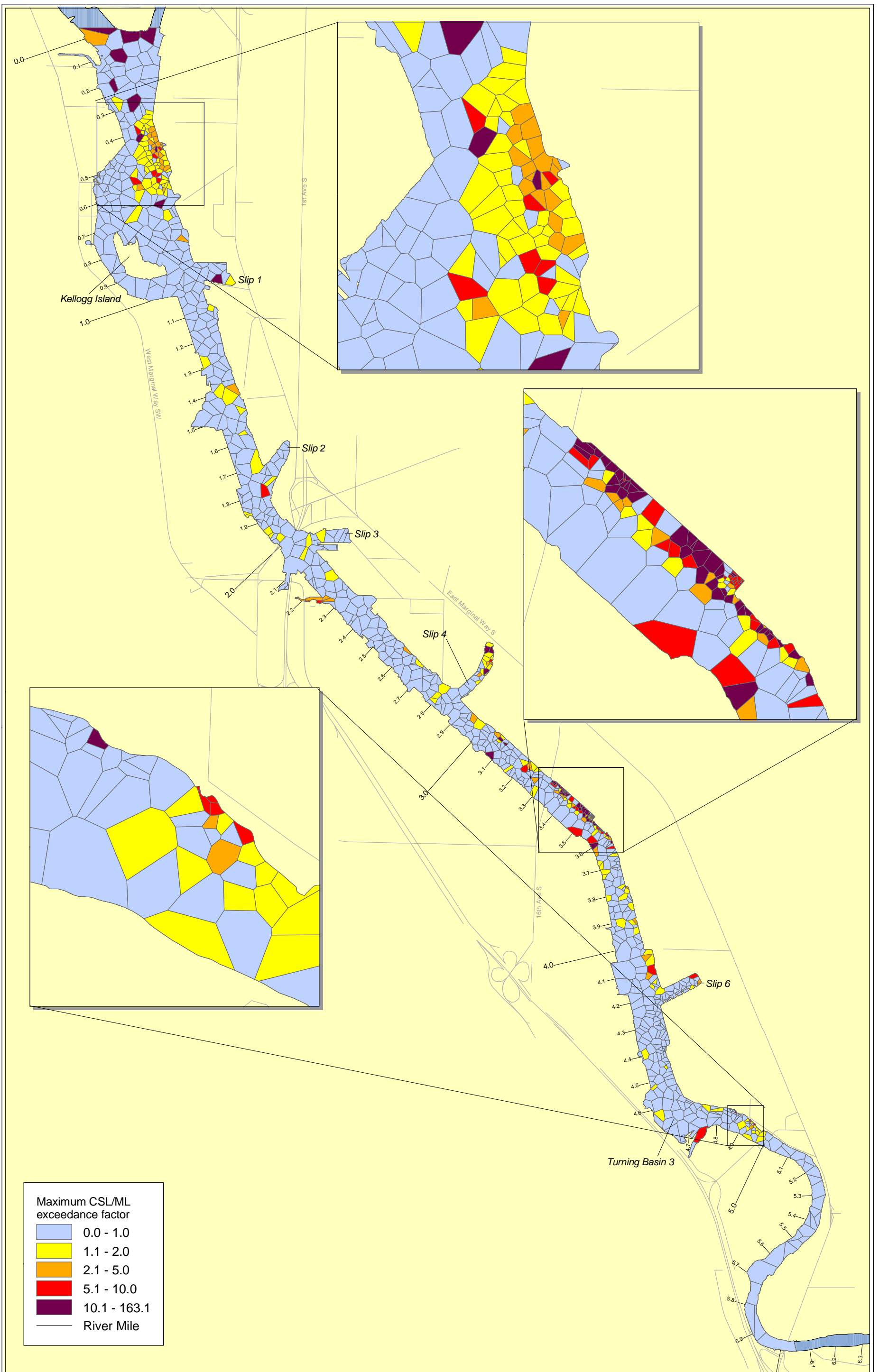
Detection limits for concentrations reported as undetected were assigned a value of one-half detection limit for the purpose of data aggregation.



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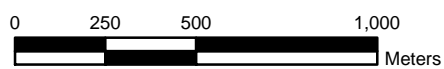
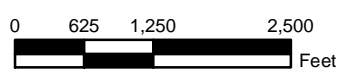
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Map A-7-14. Maximum CSL/ML exceedance factor by Thiessen polygon in LDW surface sediments (half DL)

TOC normalization conducted for all samples with TOC concentrations greater than 0.2%. For samples with lower or missing TOC concentrations, concentrations of chemicals requiring TOC normalization were compared to lowest AET (equivalent to SOS) and second lowest AET (equivalent to CSL) in dry weight units.

Detection limits for concentrations reported as undetected were assigned a value of one-half detection limit for the purpose of data aggregation.



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