Green-Duwamish Watershed Pollutant Loading Assessment

Technical Advisory Committee
Meeting #13
August 21st, 2019

DEPARTMENT OF ECOLOGY
State of Washington

PLA Updates

PLA Updates

- Groundwater Database Report (under review)
- HSPF update

Assessment of existing data for groundwater quality in the Green-Duwamish watershed

Craig Senter (csenter@usgs.gov) and Kathy Conn (kconn@usgs.gov)

U.S. Geological Survey

Washington Water Science Center

Watershed:

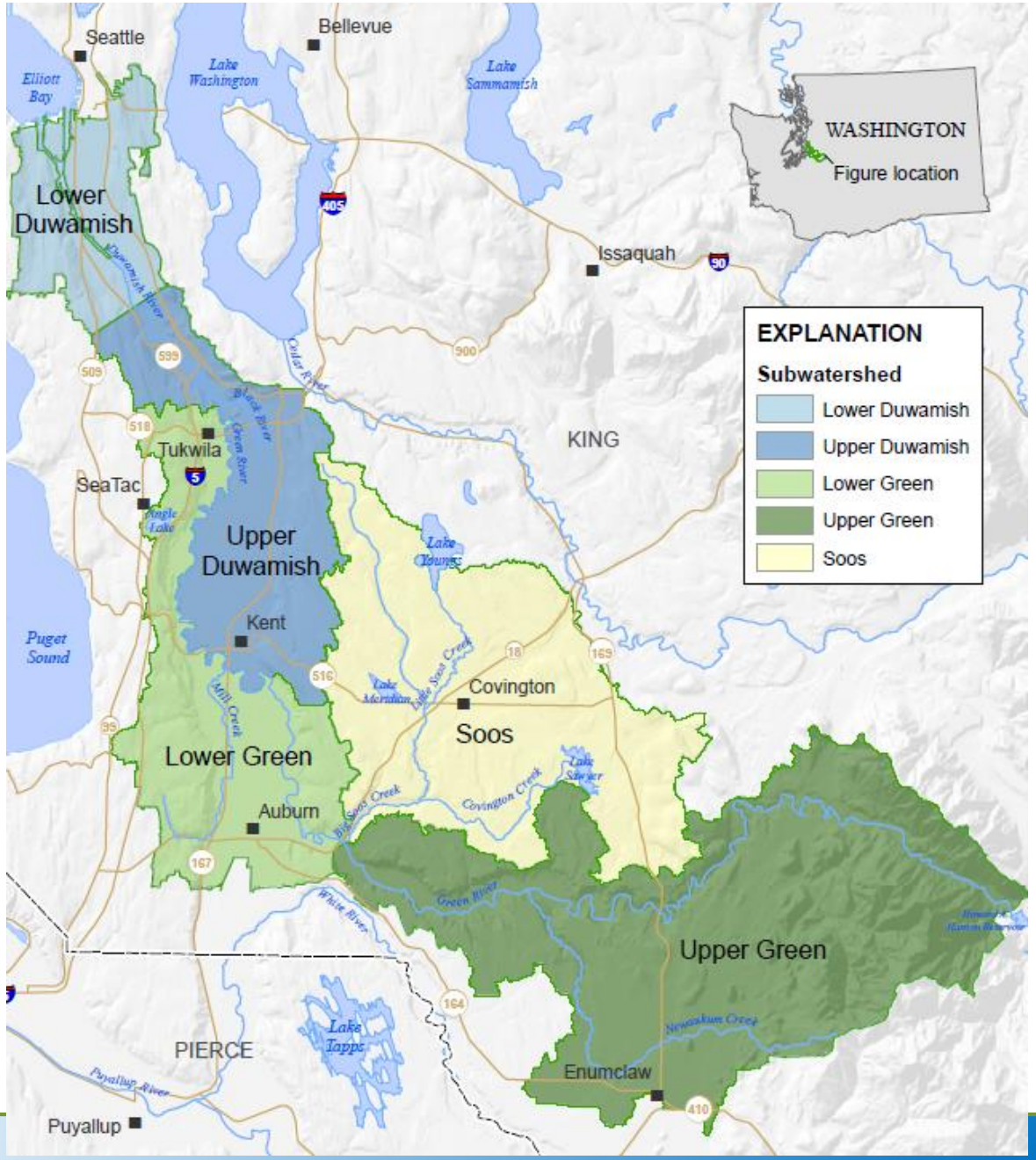
- **Duwamish**
  - **Lower Duwamish**
  - **Upper Duwamish**
- **Lower Green**
- **Soos**
- **Upper Green**

Concentrations of:

- PCBs
- cPAHs
- Arsenic
- Phthalates
- Copper
- Zinc

Sources:

- **Leidos database**
- **Ecology EIM database**
- **USGS NWIS database**



Results (Draft Report in Review Process)

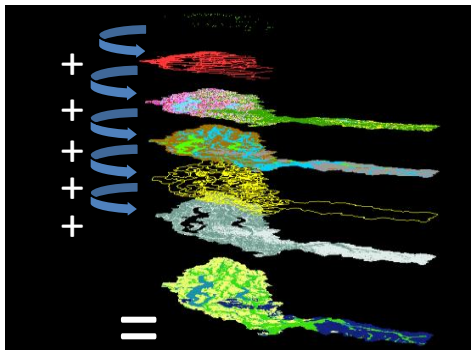
	# Results	% Lower Duwamish	% non-detects	Mean (*estimator method)	Median (*estimator method)
PCBs (Aroclors)	1572	98%	75%	0.4 µg/L*	0.001 µg/L*
PCBs (Congeners)	54	100%	28%	0.03 µg/L*	0.0002 µg/L*
PCBs (TEQ)	54	100%	35%	1e-7 µg/L*	2e-8 µg/L*
Arsenic (unfiltered)	5271	76%	12%	565 µg/L*	3.7 µg/L*
Arsenic (dissolved)	1897	91%	15%	823 µg/L*	3.7 µg/L*
Arsenic (inorganic)	15	100%	0%	624 µg/L	112 µg/L
Arsenic (III)	32	100%	0%	550 µg/L	147 µg/L
Copper (unfiltered)	1658	98%	29%	10.8 µg/L*	1.3 µg/L*
Copper (dissolved)	1331	96%	49%	5.59 µg/L*	0.62 µg/L*
Zinc (unfiltered)	3162	99%	43%	23.6 µg/L*	3.5 µg/L*
Zinc (dissolved)	1314	96%	57%	11 µg/L*	2.5 µg/L*
cPAHs (unfiltered)	3710	79%	85%	n/a	0.015 µg/L
cPAHs (dissolved)	12	100%	100%	< Reporting Level	< Reporting Level
Phthalates	2456	75%	85%	n/a	0.7 µg/L

Results, non-detects, and mean are of entire watershed

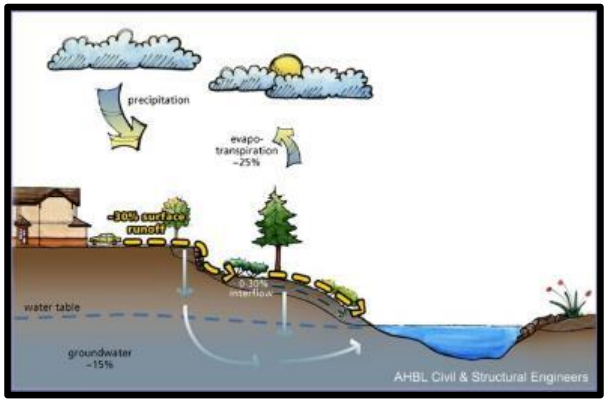
HSPF update

Recap: Watershed Modeling

Data to build model

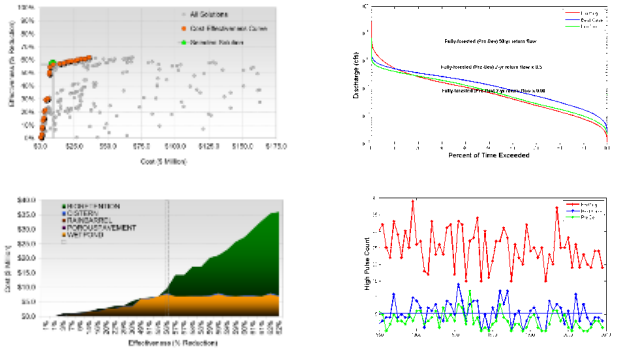


Simulate Existing and Future Conditions



Model Outputs

Analyze Model Outputs



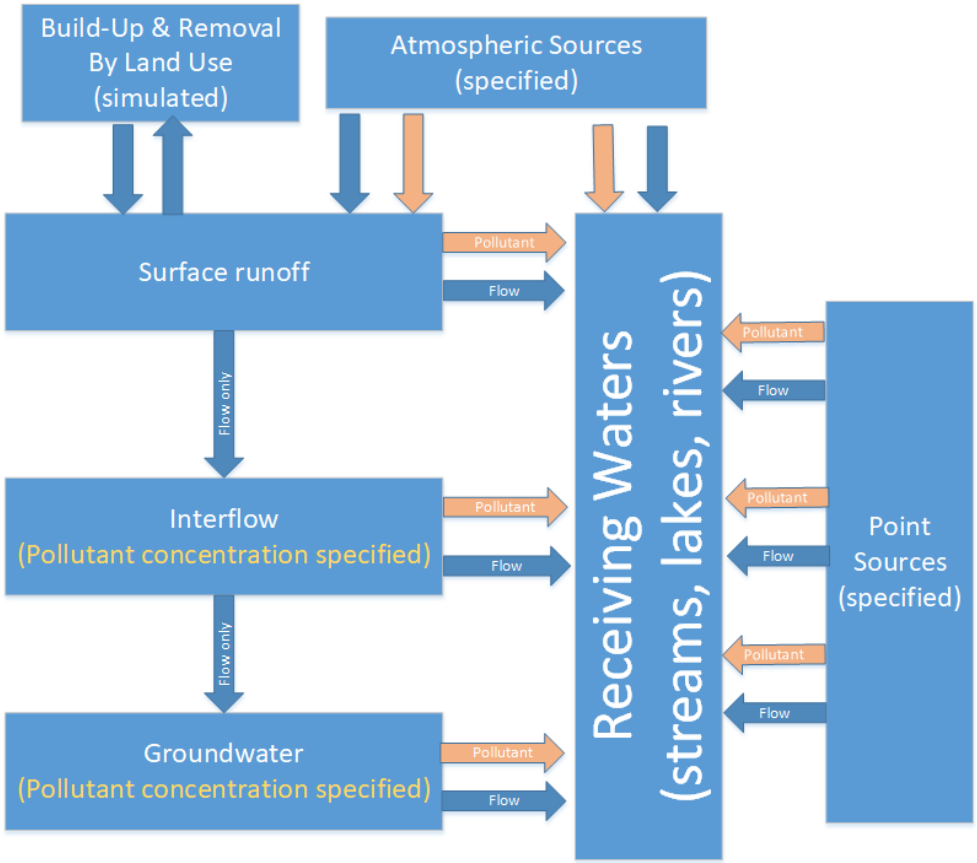
Calibration approach

(1) Use *simple/empirical*

- Boundaries
- Atmospheric
- Point Sources
- Groundwater

(2) Use Build-up/Wash-off

- Land Use specific
- Age of structure
- Discriminate known hotspots



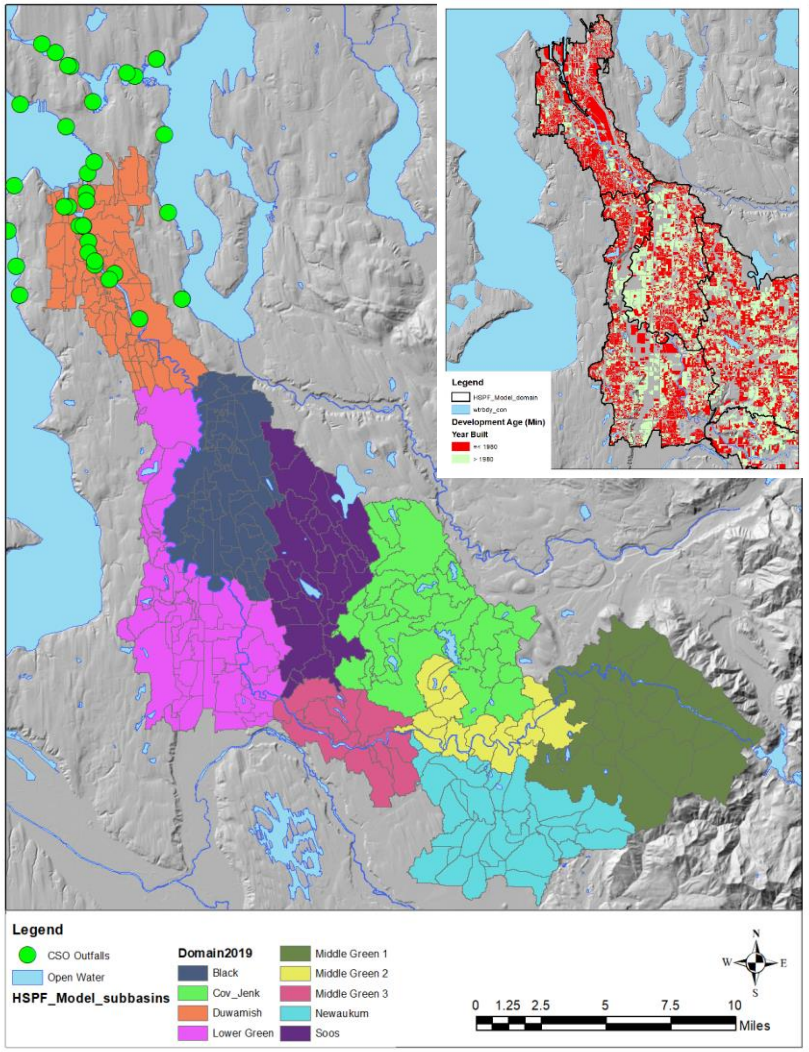
- Boundaries
  - Regression models
  - Constant concentration
- Atmospheric
  - Constant concentration
  - Three zones
- Point Sources
  - WTD CSO discharge modeling
  - SPU/PLM modeling (possible elements)
  - Leachate rates from previous studies
- Groundwater
  - USGS concentrations
  - NOT(?) land use specific

Model Configuration

- Modeling domains (was 4, now 9)
- 329 catchments
  - collaborating with SPU to refine combined sewer areas
- 206 HRUs (x4) (was 991)

  Combinations of:

  Land Use & Cover
  Geology
  Slope
  Rainfall
  Age of Development (1980)
  Combined/Partial/Separated
- Atmospheric Loadings by Model Domain
- External Sources
  - Point (e.g., CSOs)
  - Distributed (e.g., creosote pilings)



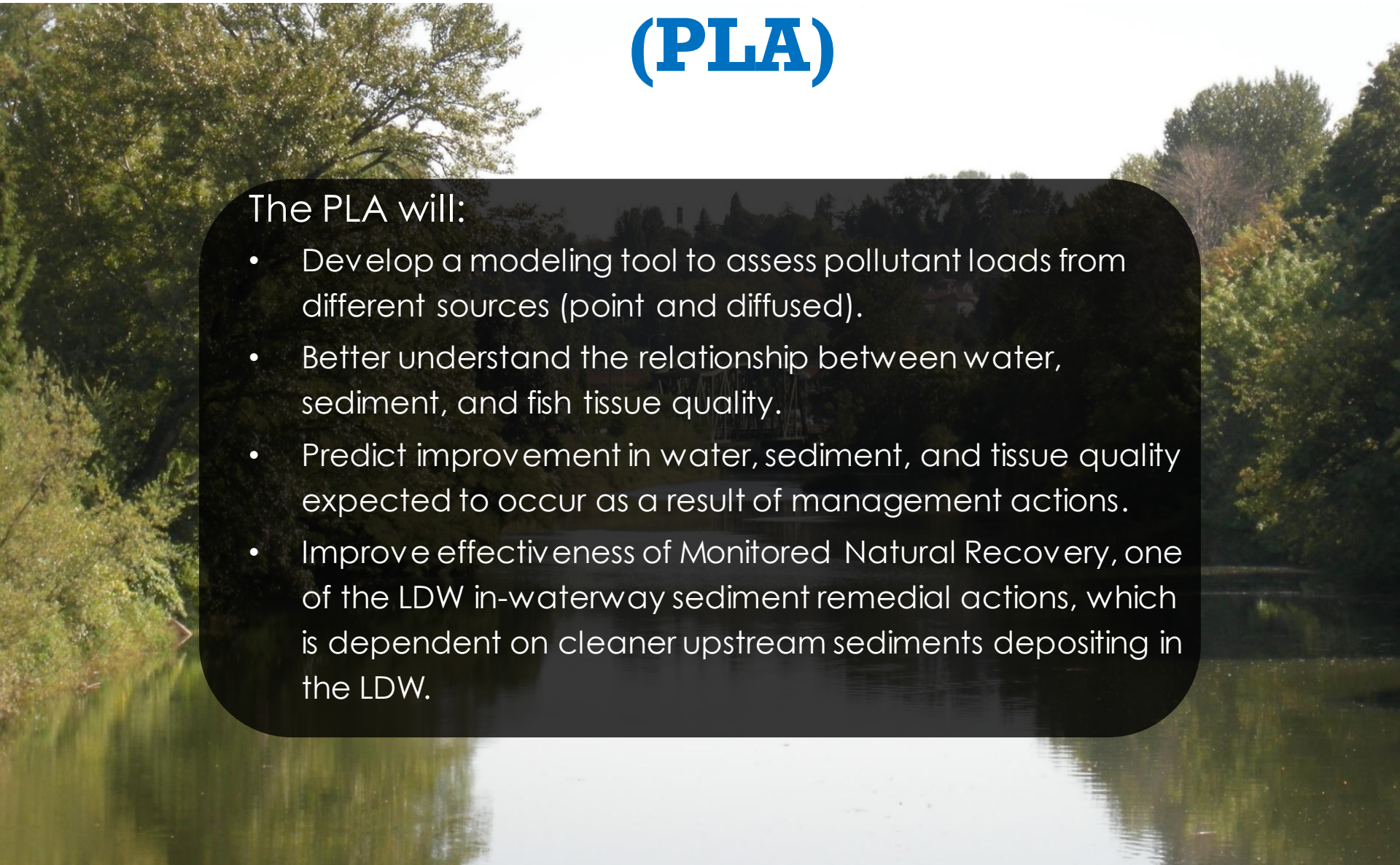
Model Status

Watershed Model Status (August 2019)												
Model Domain	Flow	Grnd Wtr	TSS	Total PCBs	cPAHs TEQ	Arsenic	Copper	Zinc	DEHP	TOC	DOC	Temperature
Duwamish	C	C	I	I	I	I	I	I	I	N	N	N
Lower Green	C	C	I	I	I	I	I	I	I	N	N	N
Black	C	C	I	I	I	I	I	I	I	N	N	N
Soos	C	C	I	I	I	I	I	I	I	N	N	N
Covington/Jenkins	C	C	I	I	I	I	I	I	I	N	N	N
Middle Green 3	C	C	C	I	I	I	I	I	I	N	N	N
Middle Green 2	C	C	C	I	I	I	I	I	I	N	N	N
Newaukum	C	C	C	I	I	I	I	I	I	N	N	N
Middle Green 1	C	C	C	I	I	I	I	I	I	N	N	N
C = Complete												
I = In progress												
N = Not started												
Quality of Calibration												
Good												
Fair												
Poor												
Not calibrated												

Note: Models are in progress getting rebuilt.

PLA Objectives

Green-Duwamish Watershed Pollutant Loading Assessment (PLA)



The PLA will:

- Develop a modeling tool to assess pollutant loads from different sources (point and diffused).
- Better understand the relationship between water, sediment, and fish tissue quality.
- Predict improvement in water, sediment, and tissue quality expected to occur as a result of management actions.
- Improve effectiveness of Monitored Natural Recovery, one of the LDW in-waterway sediment remedial actions, which is dependent on cleaner upstream sediments depositing in the LDW.

How will PLA be used?

Use PLA to:
- Evaluate the sources
- Prioritize source control actions
- Predict the outcomes of the management actions

Can we meet water quality standards after cleanup and source control?

Yes → Implement Actions

No →
- TMDL
- Water Quality Variance
- Use Attainability Analysis

Temporal and Spatial scale considerations for model development

(Water/Sediment/Fish Tissue quality criteria)

Water Quality Standards for the LDW

Freshwater

Marine

Criteria by Medium

Water column

Sediment

Fish tissue*

Parameters

PCBs

cPAHs

Phtha-lates

Arsenic

Copper

Zinc

PCBs

Water column (µg/L)						Sediment	
Aquatic Life Criteria Freshwater		Aquatic Life Criteria Marine Water		Human Health Criteria (EPA)			
Acute	Chronic	Acute	Chronic	Freshwater	Marine	Freshwater (µg/kg dw)	Marine (µg/kg OC)
2.0[1]	0.014[1]	10.0[1]	0.030[1]	0.000007[1,2]	0.000007[1,2]	110[3,4]	12,000

[1] A 24-hour average not to be exceeded

[2] Applies to Total PCBs

[3] Represents the sum of the following Aroclors: 1016, 1221, 1242, 1248, 1254, 1260, 1268

[4] Not EPA approved

Carcinogenic PAHs (cPAHs)*

Water column (µg/L)						Sediment	
Aquatic Life Criteria Freshwater		Aquatic Life Criteria Marine Water		Human Health Criteria (EPA)			
Acute	Chronic	Acute	Chronic	Freshwater	Marine	Freshwater (µg/kg dw)	Marine (µg/kg OC)
–	–	–	–	0.000016 – 0.016	0.000016 – 0.016	17,000[1,2]	595,000

* Benzo(a) anthacene, Bezo(a) pyrene, Bezo(b) fluoranthene, Benzo(k) fluoranthene, Chrysene, Dibenzo(a,h) anthracene, Indeno(1,2,3-c,d) pyrene. For water column, total equivalent for cPAHs is based on Benzo(a) Pyrene.

[1] Based on a total of 17 PAHs

[2] Not EPA approved

Phthalates*

Water column (µg/L)						Sediment	
Aquatic Life Criteria Freshwater		Aquatic Life Criteria Marine Water		Human Health Criteria (EPA)			
Acute	Chronic	Acute	Chronic	Freshwater	Marine	Freshwater (µg/kg dw)	Marine (µg/kg OC)
–	–	–	–	0.045	0.046	500[1]	47,000

* Total equivalent for phthalates is based on Bis (2-Ethylhexyl) Phthalate (DEHP)

[1] Not EPA approved

Metals

Metal	Water column (µg/L)						Sediment (µg/kg dw)	
	Aquatic Life Criteria Freshwater		Aquatic Life Criteria Marine Water		Human Health Criteria (EPA)			
	Acute	Chronic	Acute	Chronic	Freshwater	Marine	Freshwater [1]	Marine
Arsenic	360.0 (a)	190.0 (b)	69.0 (a)	36.0 (b)	0.018 (c)	0.14 (c)	14,000	57,000
Copper	(a, d)	(b, d)	4.8 (a)	3.1 (b)	1,300 (WA)	–	400,000	390,000
Zinc	(a, d)	(b, d)	90.0 (a)	81.0 (b)	1,000	1,000	3,200,000	410,000

(a) One-hour average concentration not to be exceeded more than once every 3 years on the average.

(b) A 4-day concentration not to be exceeded more than once every 3 years on the average.

(c) Inorganic arsenic only.

(d) Based on formula using hardness as input parameter.

[1] Not EPA approved

Water Quality Standards for the LDW

Freshwater

Marine

Criteria by Medium

Water column ✓

Sediment ✓

Fish tissue*

Parameters

PCBs	cPAHs	Phtha-lates
Arsenic	Copper	Zinc

Assessment of designated uses for harvesting and drinking water

Three approaches to assess toxics for human health protection:

1. Direct assessment of human health criteria using a statistically valid study
   - Attainment of HHC in water column ≠ designated beneficial use is supported
2. Tissue exposure concentrations (TEC)
   - Do not represent WQ criteria because they have not been adopted, except for methylmercury
   - Based on tissue analysis of resident fish
3. Drinking water exposure concentrations (DWEC)
   - Only applies to freshwater

Assessment of designated uses for harvesting and drinking water

Other lines of evidence:

1. Washington Department of Health fish advisories
2. Safe Drinking Water Act Maximum Contaminant Levels (MCL)

Segmentation

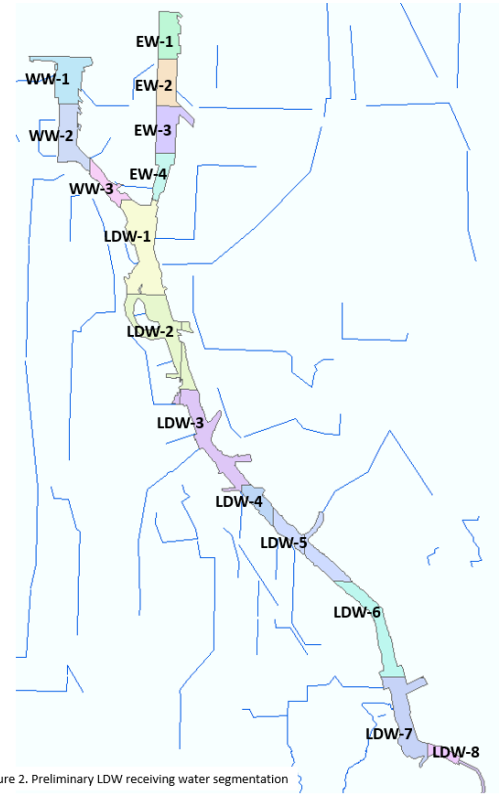
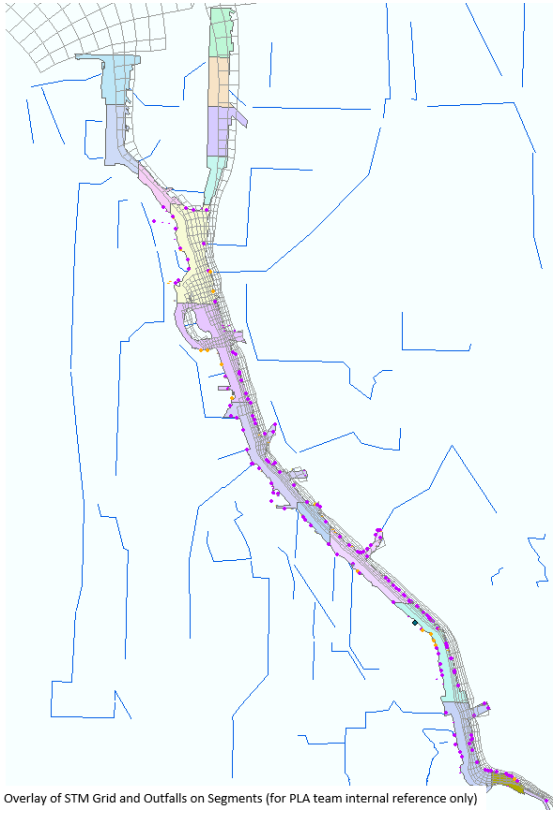


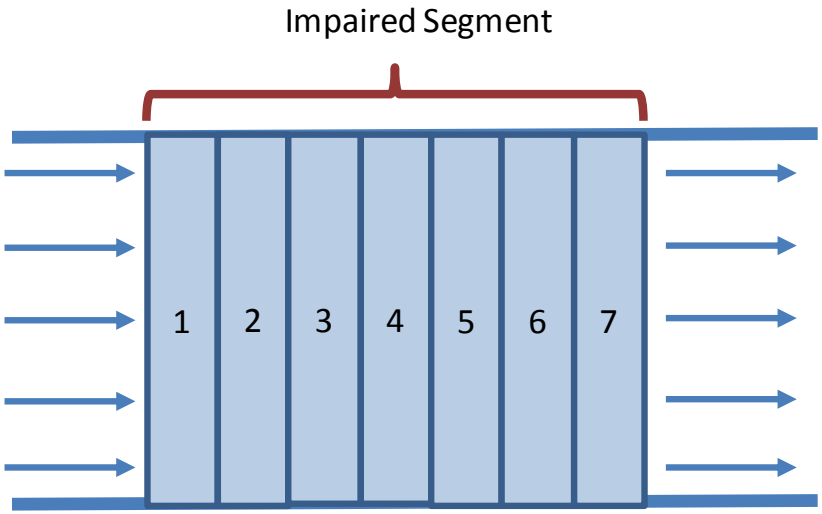
Figure 2. Preliminary LDW receiving water segmentation



Overlay of STM Grid and Outfalls on Segments (for PLA team internal reference only)

Options for verification points

Verification Point Type	Cross Section ID(s)
Single representative cross section	6
Single cross section forming terminal end transect	7
Single aggregate representative cross section cluster	4-7
Multiple aggregate cross section cluster for entire impaired segment	1-2,3-5,6-7
Single aggregate for entire impaired segment	1-7
Individual cross section for entire impaired segment	1,2,3,4,5, 6,7
Single representative cross section at prior sampling locations for water quality assessment	3(sampling location)



Management Questions

Introduction

- Review management questions
- Open discussion:
  - What are we missing for management questions that can help your agency's source control actions?

Management questions: Watershed Model

- Rank the biggest to the smallest source contributor to the river by type.
- What is the contribution from groundwater?
- What is the contribution from air deposition and can it alone cause recontamination above the RAL?

Management questions: Receiving Water Model

- For the loading to water column, how much is contributed by each source? (Stormwater, CSO, groundwater, air deposition and etc..)
- For the loading to water column, how much will be reduced by sediment clean-up?
- What effect will cleaning up the upper 2 miles (RM 3-5) have on RM 2-3? Inversely, will the contaminated sediment potentially re-contaminate the upstream portion of the river due to tidal reversal?
- After clean-up, for the cleaned up area, what are the load contributions from the adjoining sediment and lateral loads?
- If the upstream sediment loading is half of what is originally assumed, what will be the effect on the natural recovery area?

Management questions: Receiving Water Model

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Management questions: Linked Model

- Baseline Scenario (Source Assessment)
- Management Scenario
  - Planned actions
  - Sensitivity analysis

Source Assessment (example)

	Air deposition	Point sources (MS4, CSO, Industrial stormwater)	Non point sources	Groundwater	Suspended sediment sources upstream of LDW	Upstream surface water
Water Column Conc.						
Bed Sediment Conc.						
Fish Tissue Conc.						

Management scenarios – planned action

- Based on existing permits and cleanup actions, without any further management actions, can we achieve water/ sediment/fish tissues quality standards?
  - If the answer is yes, we can be confident that the existing permitting and clean-up strategies are sufficient to meet the standards.
  - If the answer is no, then we will run additional sensitivity analyses in order to prioritize the next source control actions.

Sensitivity Analysis

Example sensitivity analysis results for source X.

	-10%	-30%	-50%
Water Conc.			
Sediment Conc.			
Fish Tissue Conc.			

Questions?

Question for discussion

- What are we missing for management questions that can help your agency's source control actions?

Receiving water modeling approach

Summary of SSM and EFDC Comparisons

- SSM (Salish Sea Model)
  - Advantage
    - ✓ flexible triangular mesh to fit the shoreline
    - ✓ Hybrid vertical coordinate [Sigma and S (or GVC) vertical coordinates can be used for LDW waterway and Elliot Bay, respectively]
  - Disadvantage
    - ✓ toxic module is not ready
    - ✓ high cost
- EFDC (Dynamic Solution version)
  - Advantage
    - ✓ fully coupled hydrodynamic-sediment transport-toxic model
    - ✓ sediment transport uncertainty can be reduced
  - Disadvantage
    - ✓ the steep area (LDW → Elliot Bay) is difficult for Sigma vertical coordinate

Discussion

- Met with PNNL and EPA.
  - Ongoing work for SSM
  - Possibility of transition from EFDC to SSM in the future

Recommendation

- Continue the receiving water model setup using Dynamic Solution EFDC
  - The first year will focus on the data input which will be the same for all the models.
  - Will monitor the progress for SSM.
  - When special needs arise, be prepared to transition to SSM when necessary.

Technical Comparison

- Based on current management questions, both EFDC and SSM are capable to address those scenarios.
- SSM will be favored if following scenarios are requested:
  - Individual discharger
  - Habitat restoration
  - Floodplain
  - Sources from Puget Sound Watershed

Remaining work

- SSM is in the process of development of toxic fate and transport module. Will require calibration before it is ready.
- The current version of Dynamic Solution EFDC is already coupled with the module and is ready to use.

Resources Required

- If choose SSM, all the PLA funding will be used to support model development conducted by PNNL over at least six years.
- If choose Dynamic Solution EFDC, the remaining PLA funding can be used to support various projects:
  - Data analysis
  - Sampling
  - Model review

Receiving Water Modeling Schedule

- QAPP update
- HSPF toxic
- EFDC data input compilation
- Data analysis
- Bathymetry and post-remediation data prep
- Grid extension
- Linkage between HSPF and EFDC
- Calibration
- Long-term simulation
- Management scenarios

Next Steps

- Will send out the final groundwater database analysis report
- Will update QAPP and send for review
- Next TAC meeting will be early next year
  - Update on watershed model toxic calibration
  - Update on receiving water model setup
  - Update on QAPP