Prediction of Suspended Sediment Due to Dredging at the Willamette River

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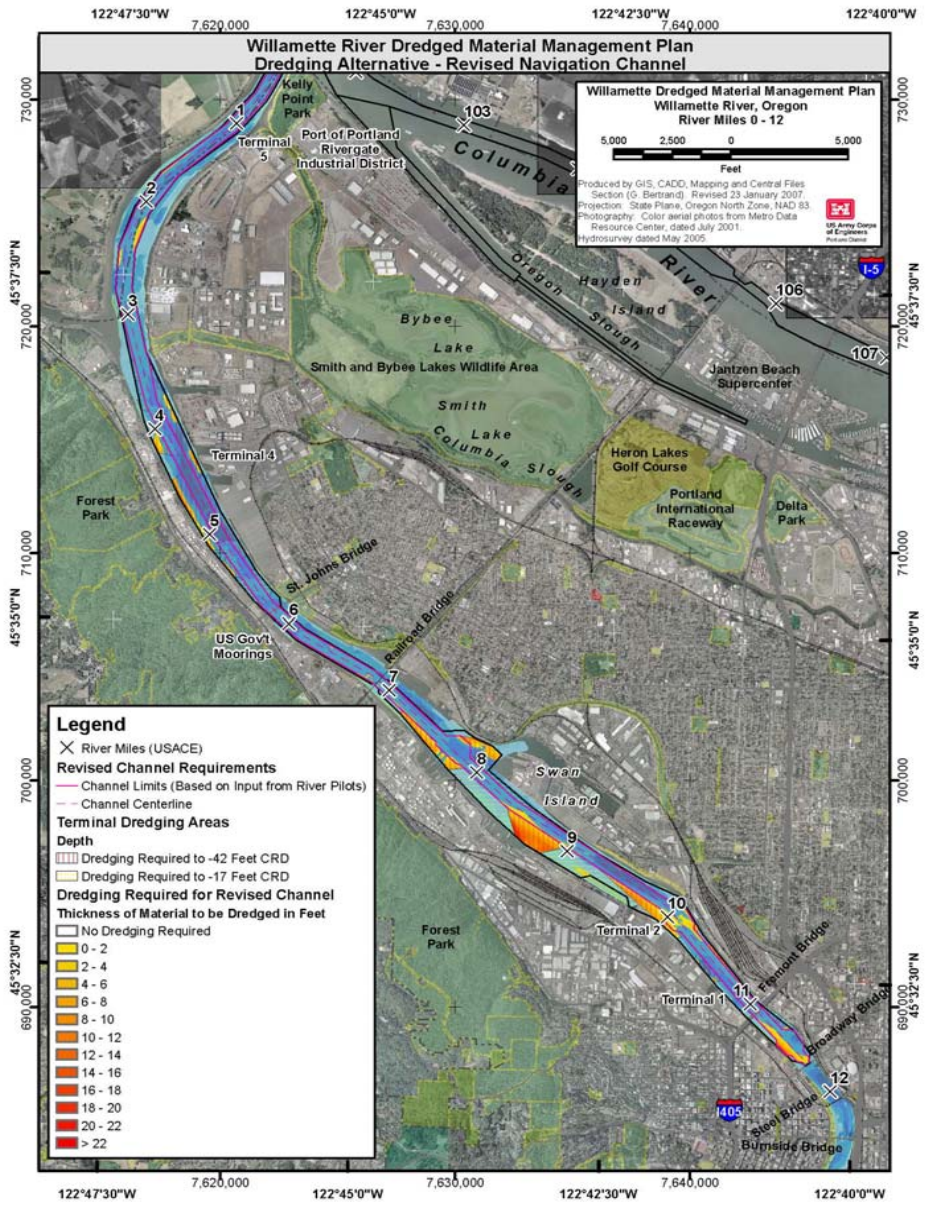
History of Lower Willamette River

- 1850 - Willamette River system in the Portland area is an extremely integrated and ecologically active region.
- Early 1900s -Industrialization and modifications to improve navigation, reduce the amount and quality of open slack water areas, off-water channels, and wetland habitats. With the aid of these events, pollution and urban waste water discharge result in the river declared almost biologically dead by the 1930's.
- 1960s - Interagency groups through focused efforts, increase the health of the river.
- 2000 – Parts of river declared Superfund sites.

Proposed Dredging Plan

- The focus region is Lower Willamette River near the confluence of the Willamette and Columbia Rivers.
- Lower Willamette was last dredged in 1997 to an authorized depth of -40ft MLLW.
- Utilizing both clamshell and hopper dredges, maintenance dredging will be performed.



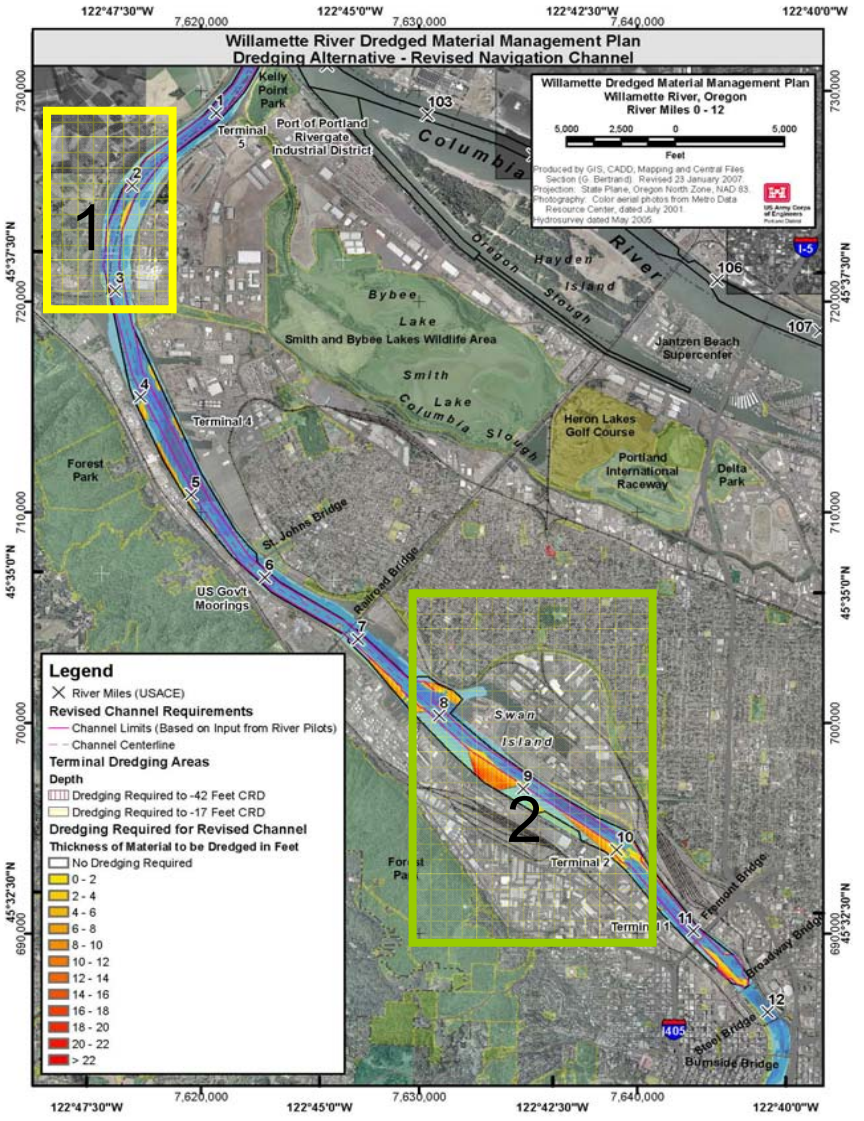
Problem

- The Lower Willamette serves as a navigation access to a host of industrial facilities
- Portions of the river bed have been identified as containing contaminated sediment and several of these areas are listed as national priorities through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - Superfund
- Although the specific area in question for this project is not likely CERCLA, the sediment to be dredged from the channel does include some of the Contaminants of Concern.
- Efforts must be made to predict and quantify exposure for assessment of effects, and risks of the proposed dredging operations.

Objective

- Characterize exposure from dredging operations in region 1
  - Simulate dredging operations using the Particle Tracking Model. Consider deposition and mixing of sediment suspended due to dredging.
    - Start date July 15
    - Dredge Types
      - Clamshell
      - Hopper
    - Placement (Columbia River)

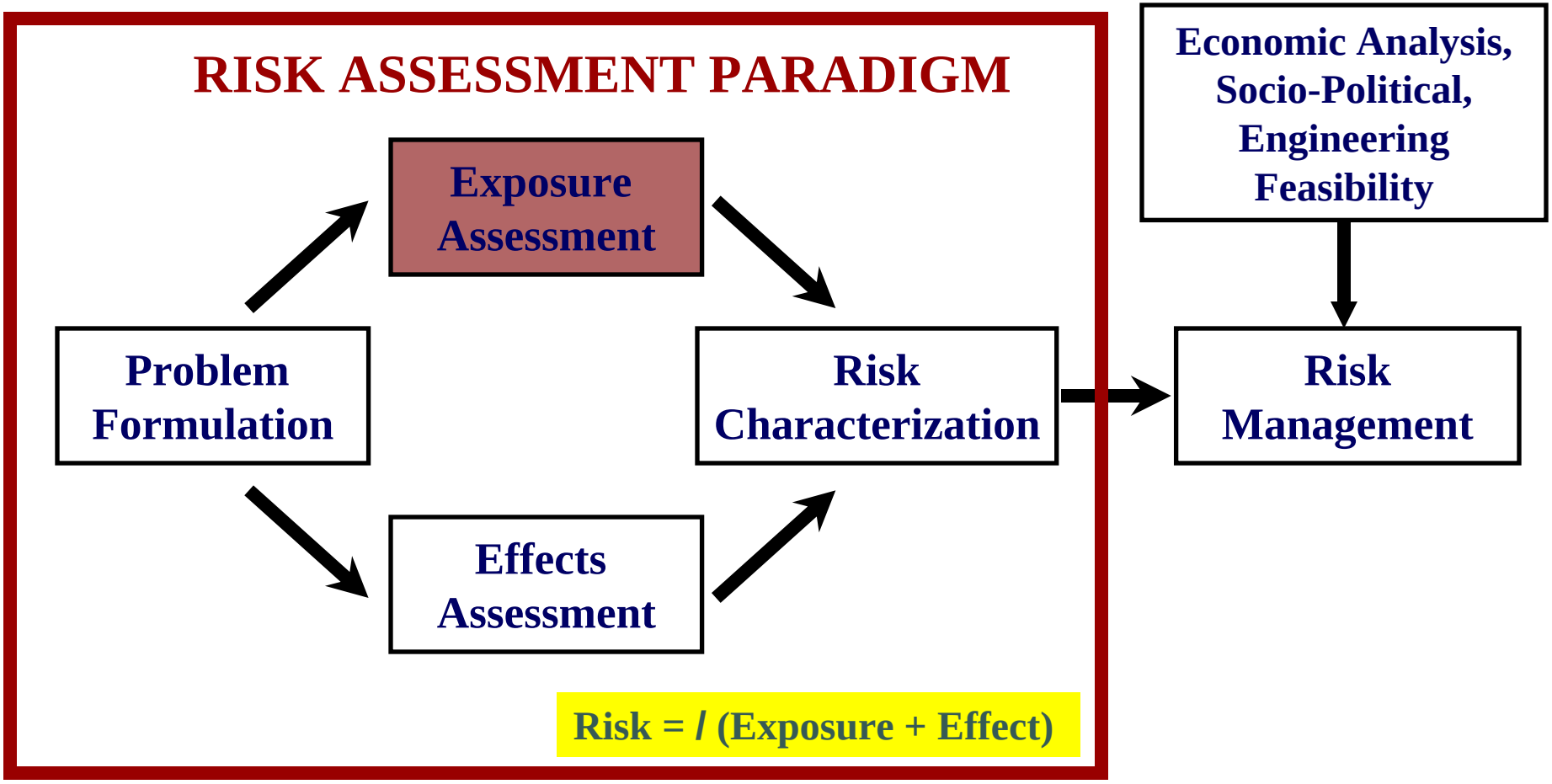
- Ultimately (if needed) provide input information to TrophicTrace Model to determine the effect of contaminant transport (EFFECTS on species and associated RISK)



- ERDC Simulation

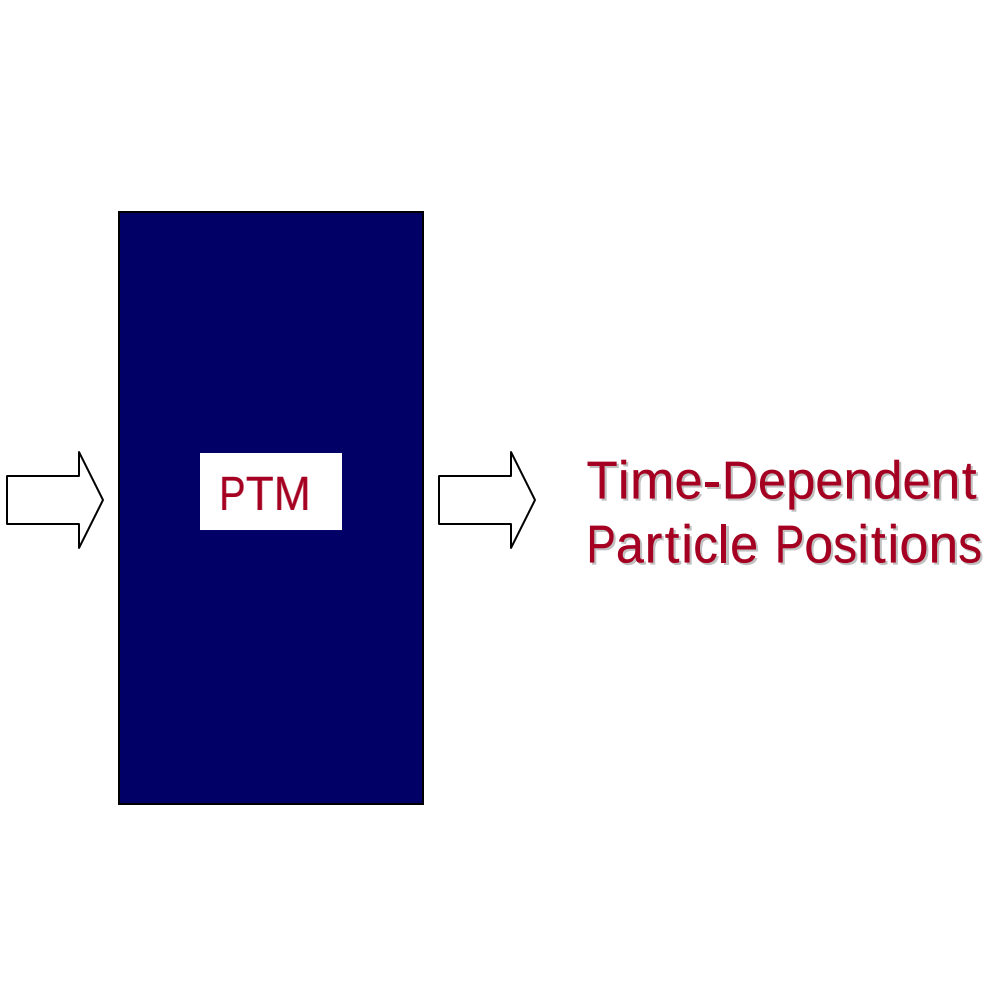
- NWP Simulation

RISK FRAMEWORK



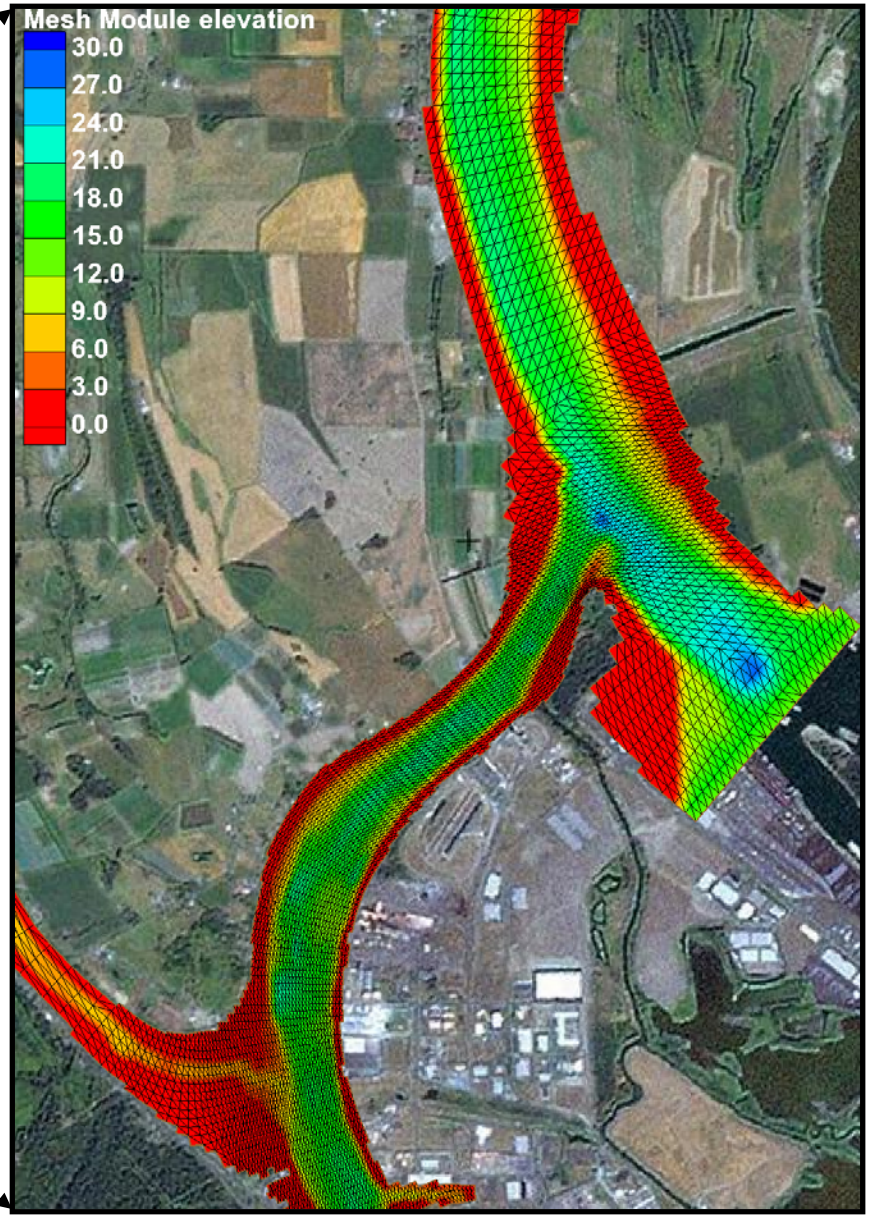
Particle Tracking Model Input and Output

- ❑ MESH/Bathymetry Data
- ❑ Hydrodynamic and Wave Data
  - ❑ ADCIRC/ADCIRC3D
  - ❑ ADH
  - ❑ CMS/M3D
  - ❑ CH3D
  - ☑ EFDC
  - ❑ STWave
  - ❑ WABED
- ❑ Native Sediment Data
- ❑ User Defined Source Data – Mass Release
  - ☑ Dredging Sources



Bathymetry

Simulation Mesh Area



EFDC MESH and bathymetry data provided by WEST Consultants – PTM converted

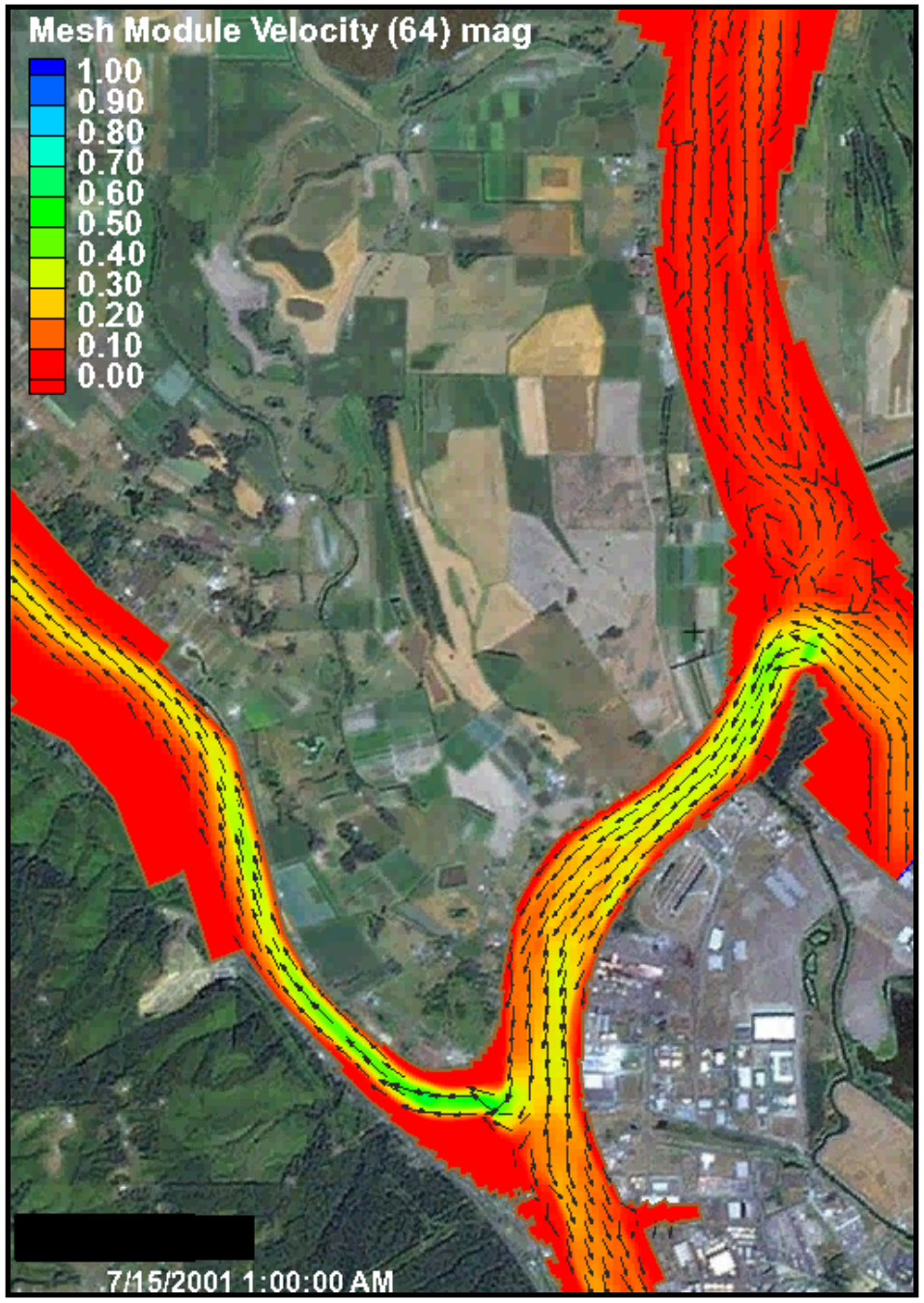
Hydrodynamics

- 25% low-flow water year for the Lower Willamette River
- 16 June 2001 – 14 Oct 2001
- Boundary conditions applied at Columbia and Multnomah channel

Animation:

Velocity Magnitude (m/s)

July 15-July 21

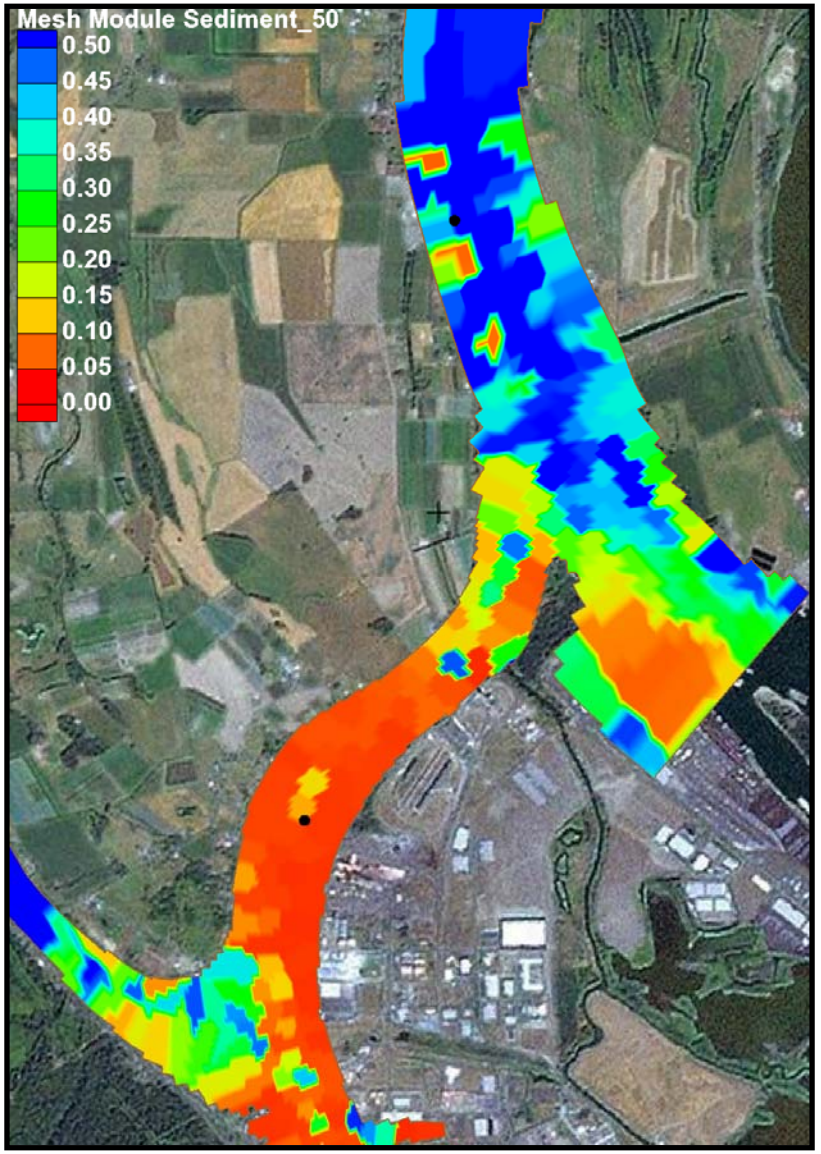


Sediment Characteristics

Sediment data provided by NWP

Dredged Sediment Distribution

	Fines	Sand
%	73.9	26.1
D50 (mm)	0.025	0.127
SD	0.50	0.35



Bed Sediment Map - D50 (mm)

Dredge Operation Sources

- Clamshell
  - Ascent & Descent
  - Impact
  - Slewing
- Placement

- Hopper
  - Overflow
  - Draghead
- Placement

DOER Dredging Source Terms Contact: Thomas.Borrowman@erdc.usace.army.mil

Hopper Simulation

Schedule

- Dredge 60 minutes
  - 45min overflow
- 30 minutes round trip for placement

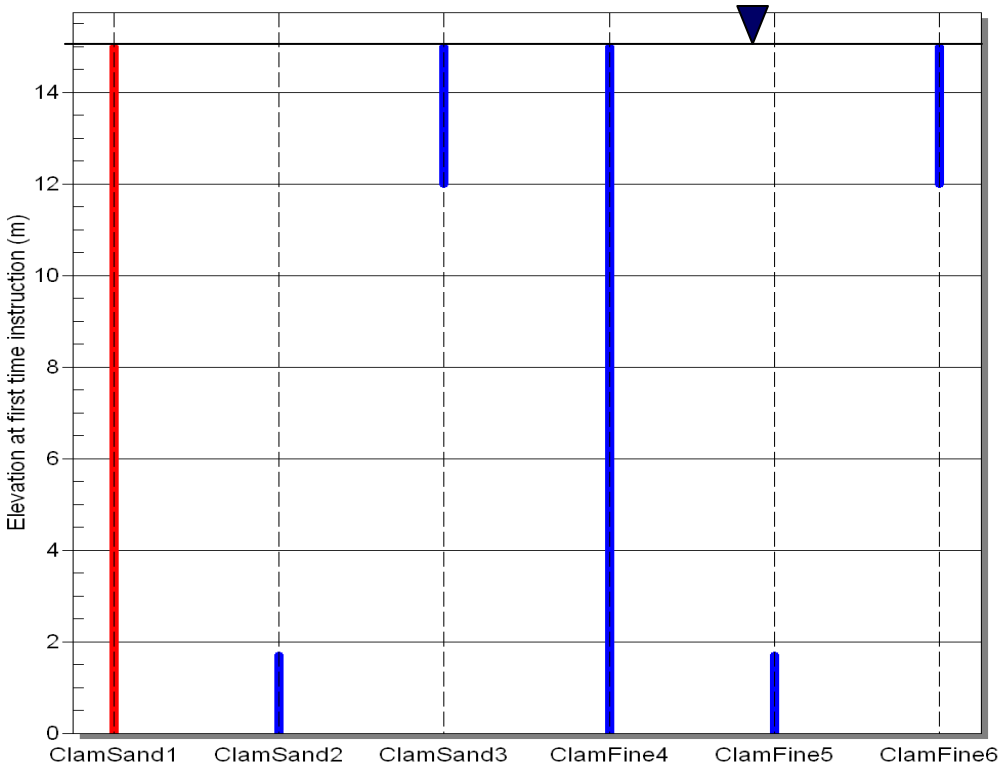
Sources

Overflow	0.48kg/m/s	Distributed over water column
Draghead	0.18kg/m/s	Distributed over width of the draghead

Clamshell Simulation

Schedule

- Dredge 7 hours and 1 hour break
- Scow change every 2hr 20min

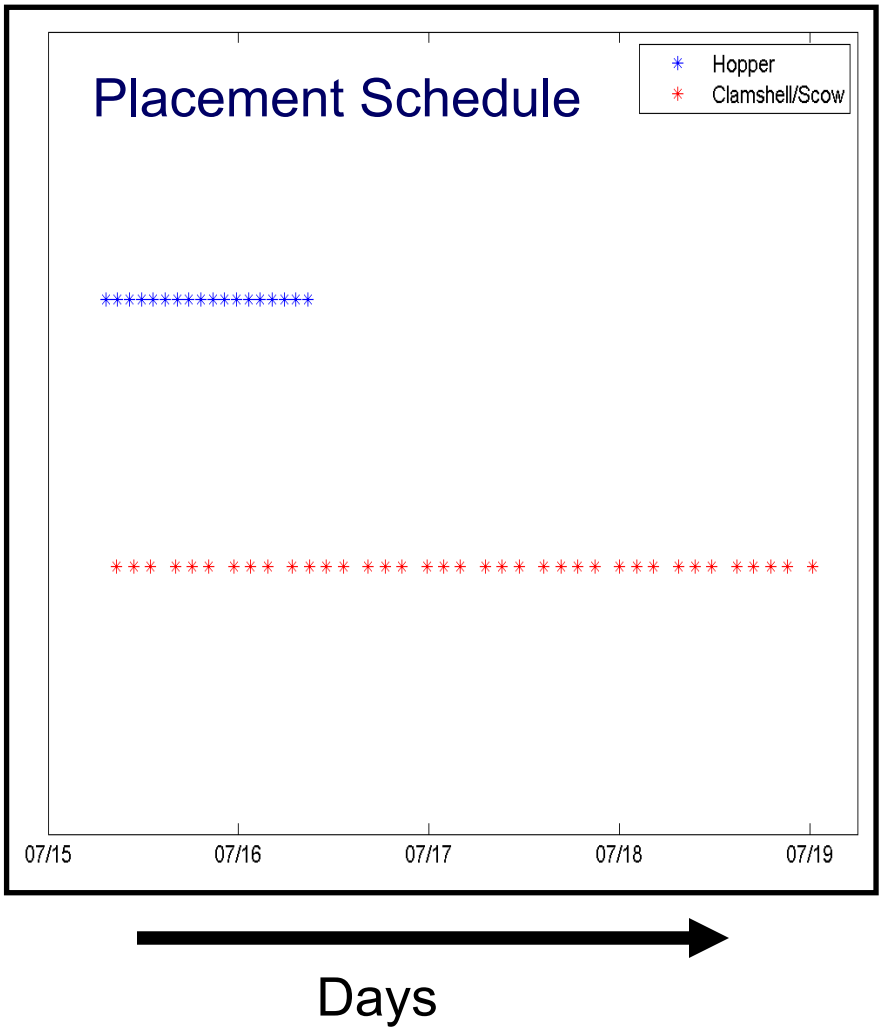


PTM Graph of Clamshell Source

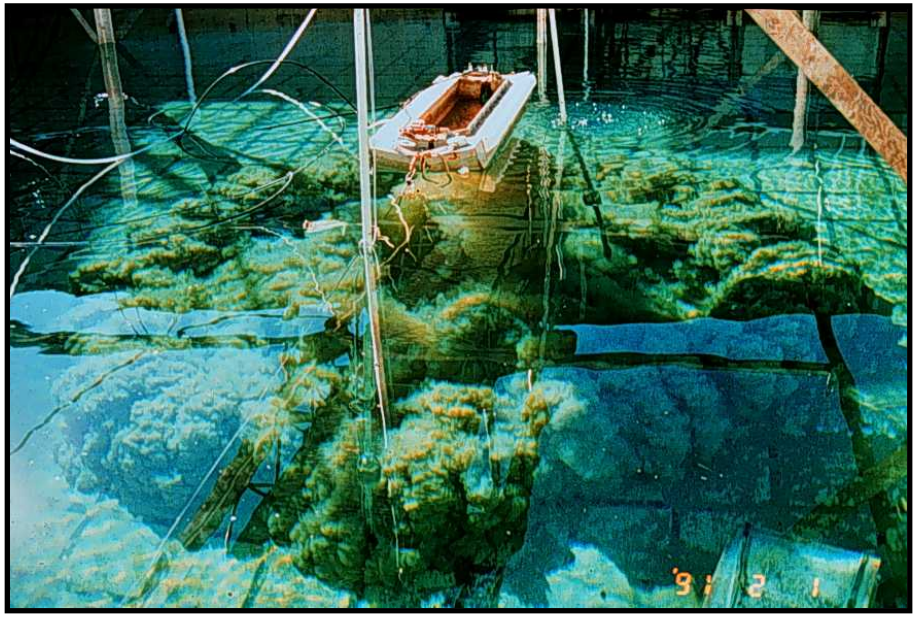
- Sources (kg/m/s)

Ascent & Descent	0.015 (over water column)
Impact	0.034 (1/2 bucket diameter from bottom)
Slewing	0.042 (upper 3m)

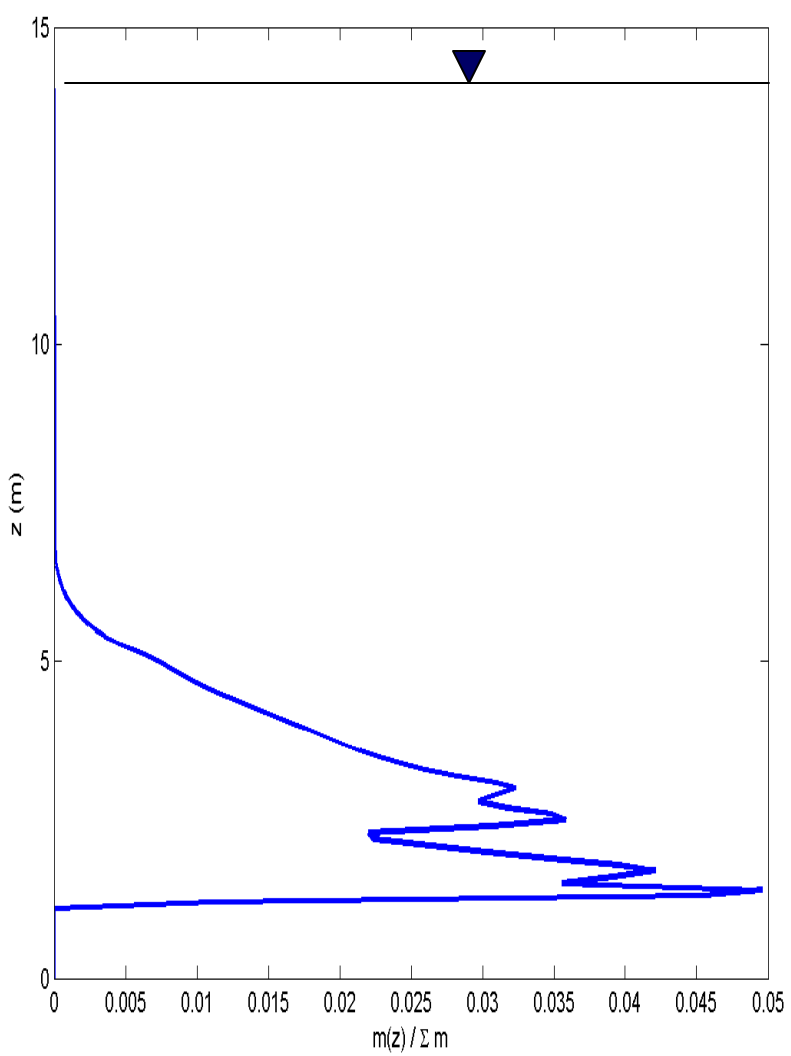
Placement



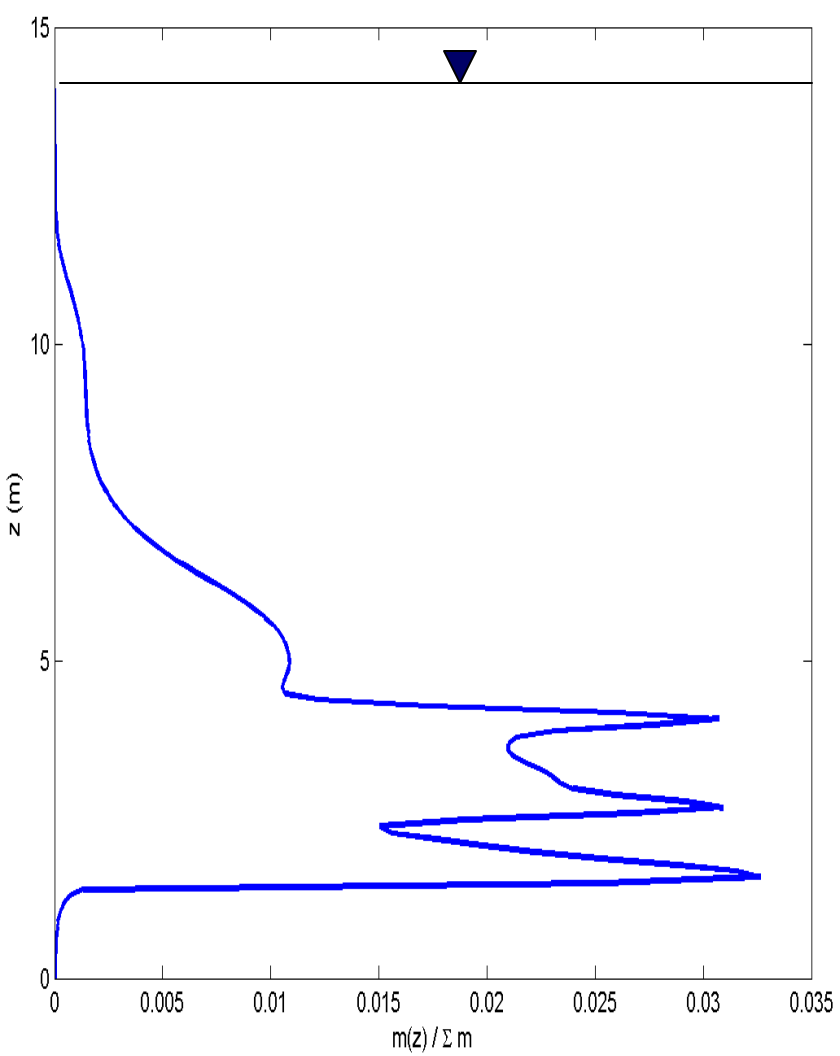
Placement occurs at an open water disposal site on the Columbia River. Placement sources were modeled as a series of instantaneous releases using STFATE.



Placement Distribution Along Water Column



Distance from bed (m)



Hopper Placement

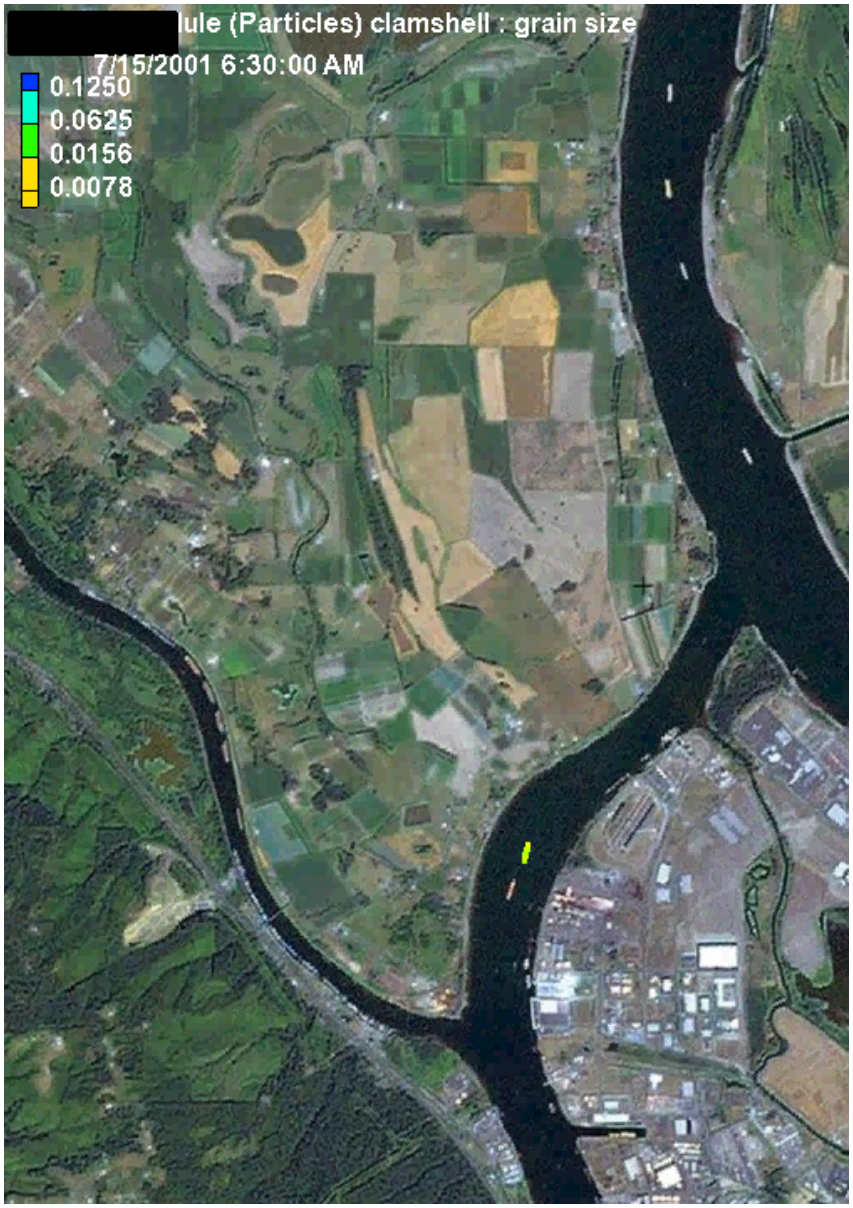
Scow Placement

Simulation - Deposition

Clamshell Dredge

Hopper Dredge

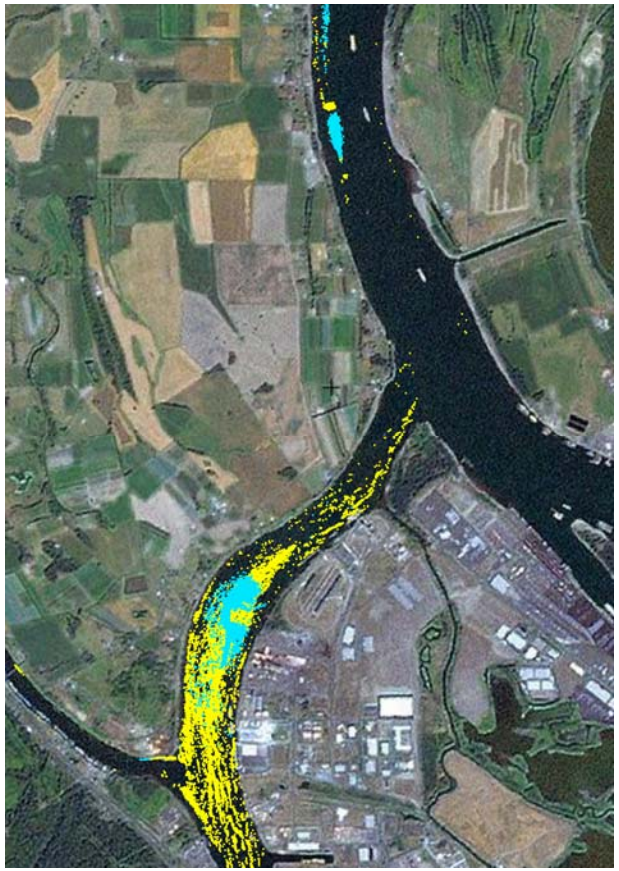
Simulation- Grainsize



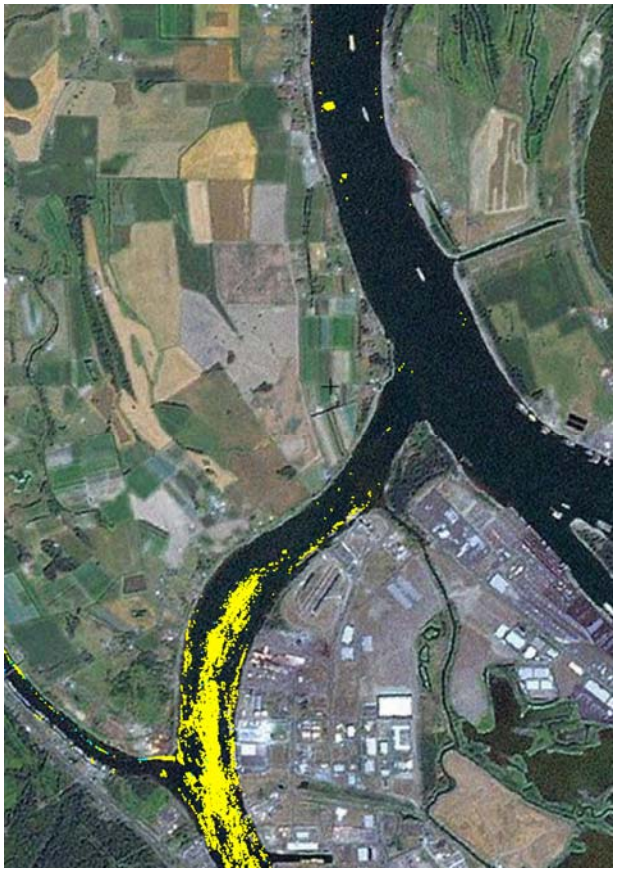
Clamshell Dredge

Hopper Dredge

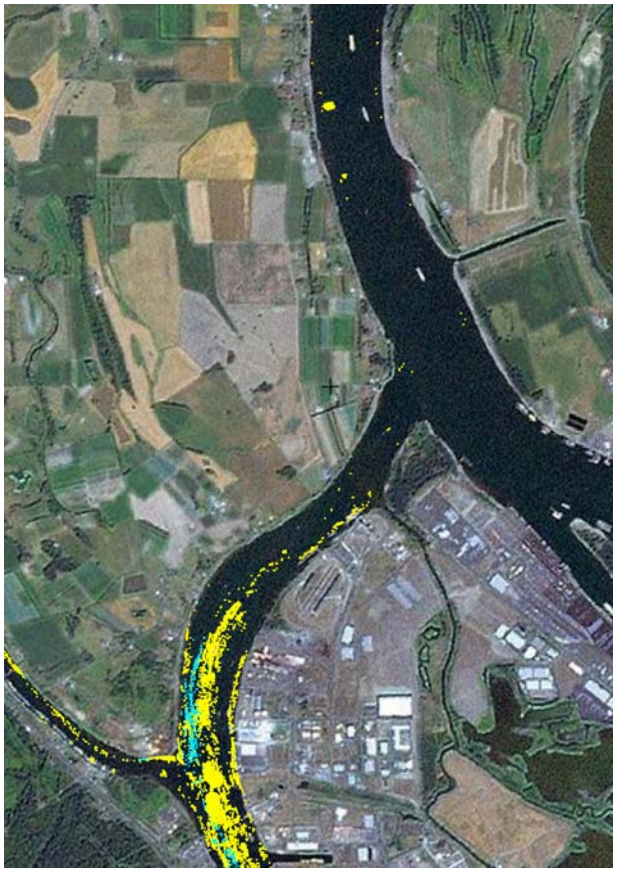
Hopper Dredge Results



7/16/01 – 9am

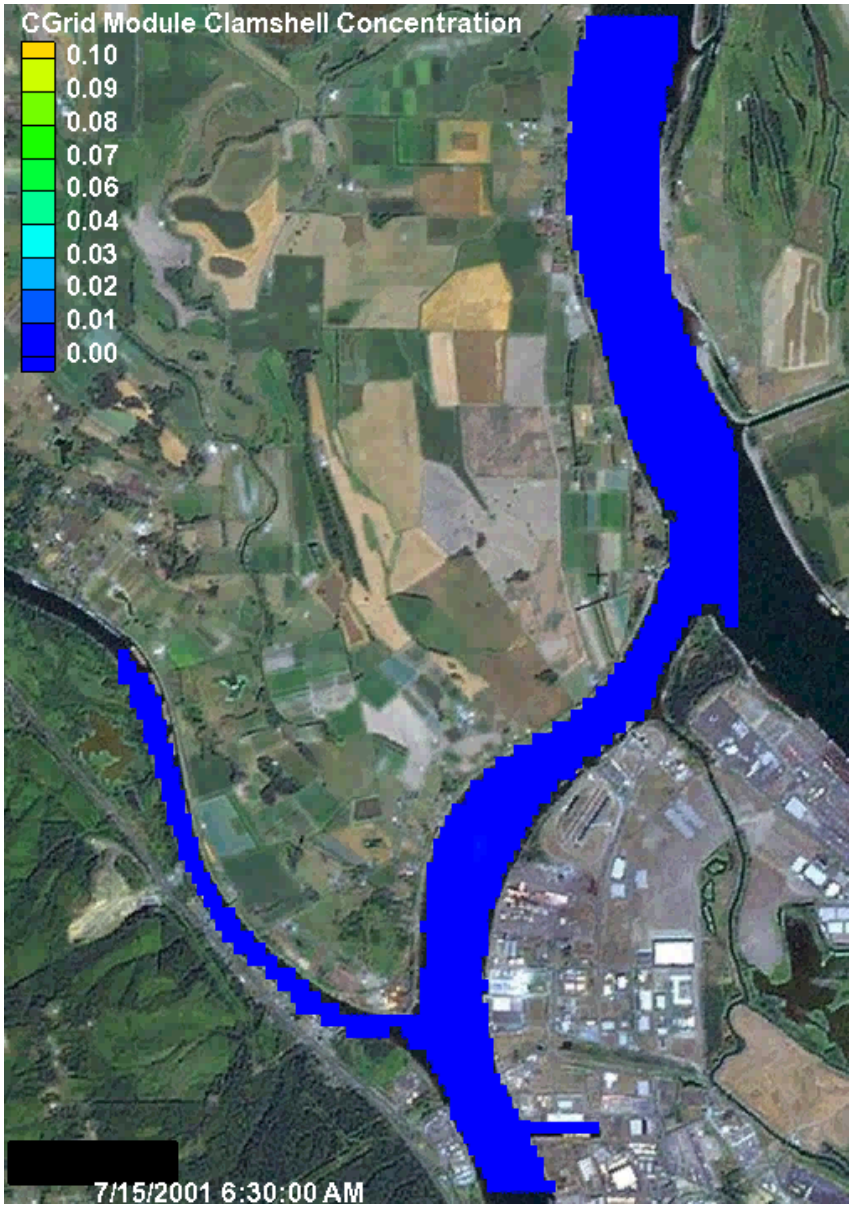


7/18/01 – 8pm

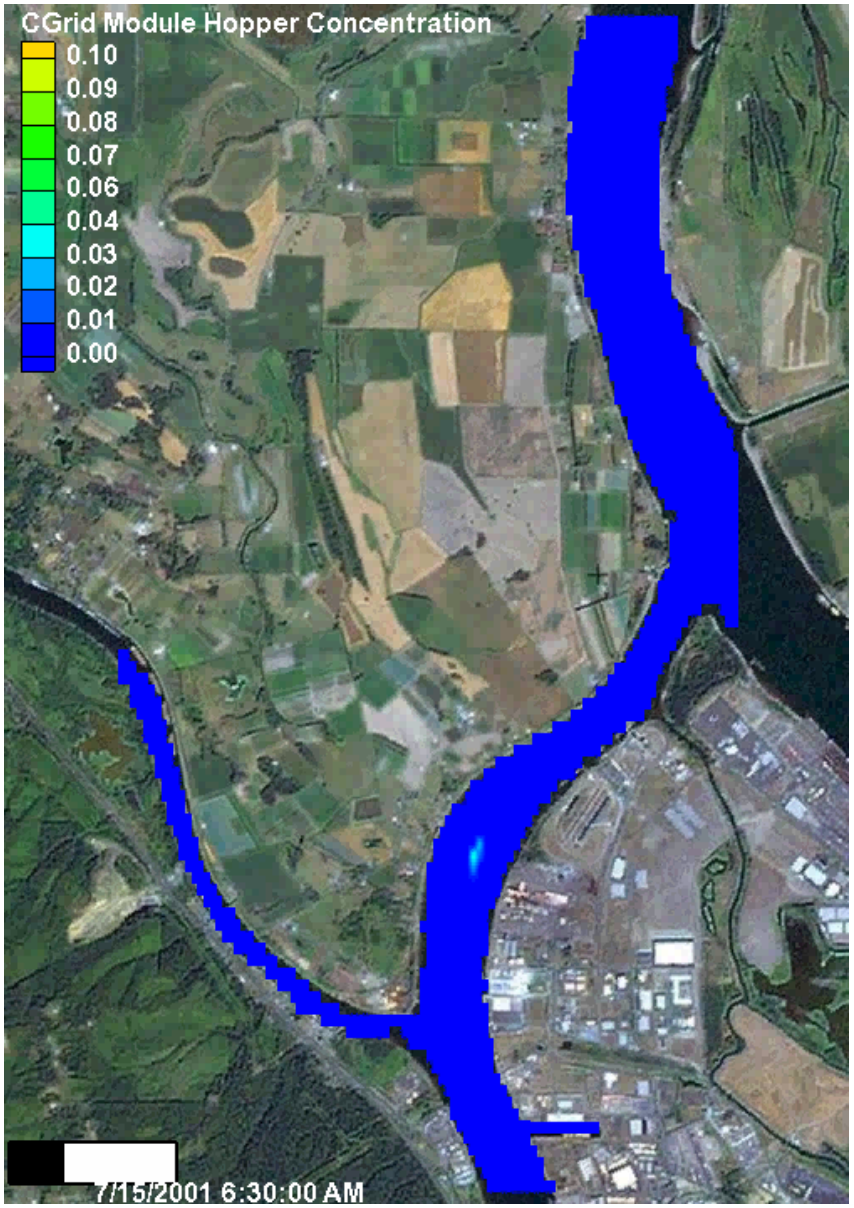


7/22/01 – 6am

Suspension – Concentration (kg/m^3)

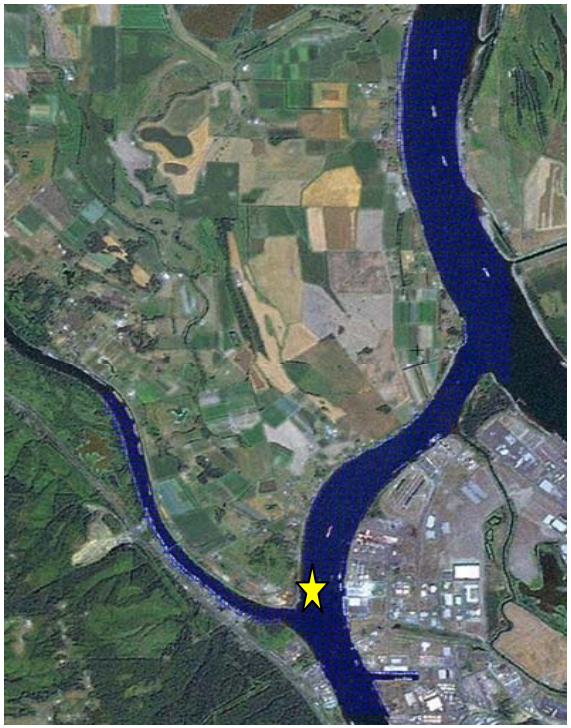


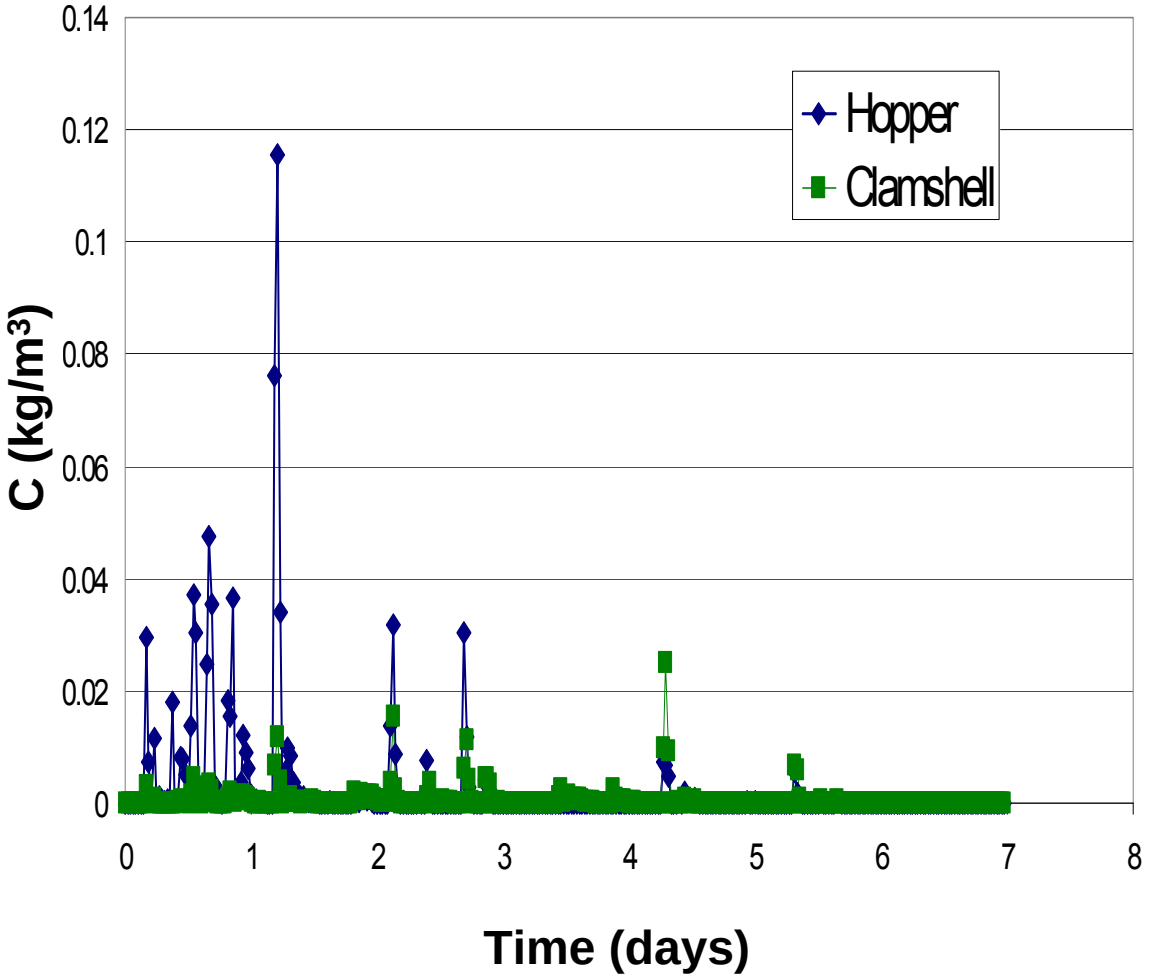
Clamshell Dredge



Hopper Dredge

Time Series of Concentration at a Point





Quantitative Comparisons Dredging Sources

Total Sediment Dredged =50,000 cy

	Clamshell	Hopper
Dredging Time	4 days	1.125 days
Total Mass (kg)	15.2 million	15.2 million
Total Resuspended (kg)	40 thousand	120 thousand
% Resuspended	0.79 %	2.6 %

Conclusions

- Simulations of two dredging operations (clamshell and hopper) to dredge 50,000 cy at the Willamette River were performed.
- Findings
  - In order to dredge the same amount of material, the length of the clamshell operation is significantly longer.
  - The hopper dredge with the current rate of overflow provides a larger total mass of resuspended sediment.
  - The largest suspended sediment concentration values occur in the placement region.

Questions Derived from Analysis

- Are concentration and deposition within acceptable levels?
- What are the cost issues that result from longer dredging periods?
- Is additional modeling needed to predict effects (TrophicTrace Model)?

Future work

- Disassociated contaminants?
- Sediment transport modeling in region 2.