Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites

USACE/USEPA/SMWG Joint Sediment Conference
October 26-28, 2004

Panel 13:
Estimating & Evaluating Post-Dredging Residuals: Approaches, Tools, and Methods

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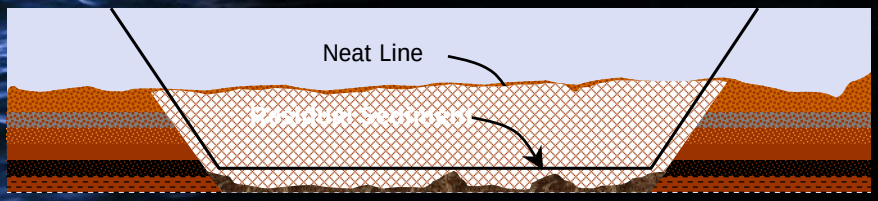
Discussion Outline

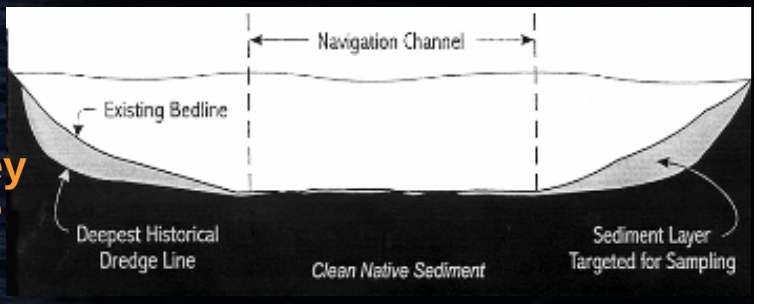
- *Defining post-dredge residuals*
- *Sediment residuals – where do they come from?*
  - *Resuspension*
  - *Fluidized mud flows*
  - *Local deposition*
- *Representative case study examples*
  - *Measuring residuals*
  - *Scales: how deep, how far, how long?*
- *Predictive capabilities (or not)*
- *Management solutions*

Post-Dredge Residual Sediments Defined

Contaminated sediments that either: 1) remain after dredging below the clean interface; or 2) have been spread to previously clean areas as a result of dredging



Sediment Residuals – Where Do They Come From?



Three primary sources of sediment residuals/releases:

1. *Disturbed sediments loosened by dredge head or bucket, but not effectively captured and removed*
2. *Failure of steep cut slopes*
3. *Resettling of escaped sediment from dredging and haul barges*

Factors Affecting Sediment Residuals

- *Sediment Physical Characteristics*
  - *Liquid limit of sediment*
  - *Fines content vs. sand content*
- *Site Characteristics*
  - *Current or propeller wash velocities*
  - *Confined vs. open sites*
  - *Bathymetry*
  - *Hydrography*
  - *Debris/subsurface condition*
- *Accuracy of Required Dredging*
- *Equipment Selection and Precision*
- *Operational Considerations / BMPs*

Sediment Residual Sources – Production Dredging Approach

Sediment Residuals – Effective BMP Controls Commonly Applied in Environmental Dredging

- *Minimize overfill of dredge bucket*
- *Slower rate of bucket descent and retrieval*
- *No "sweeping" of the bottom to contour*
- *No bottom stockpiling*
- *Slow release of excess water at surface*
- *No over-fill of barges*
- *Separate sediment from barge return water*

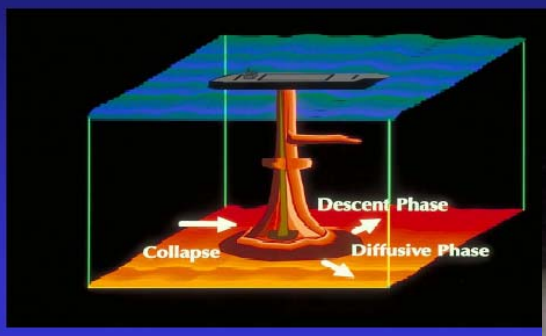
Cable Arm Environmental Bucket

Sediment Residuals – Three Primary Sediment Transport Pathways: Environmental Dredging

1. *Local deposition (near field)*
2. *Fluidized mud flows (intermediate field)*
   - *Can be primary source of residuals*
   - *Environmental buckets can **increase** mud flows*
   - *Complicated by propeller wash and currents*
- *Water column resuspension and settling (far field)*
  - *Typically a small contribution*
  - *Primary focus of water quality monitoring*

Sediment Residuals – Fluidized Mud Flows

A Brief Review of the Physics of Dredged Material Disposal



Residual Sediment Characteristics

- *Typical physical properties*
  - *Soft*
  - *Unconsolidated*
  - *High moisture content*
  - *May exist as a "fluid mud" layer*
- *Typical chemical properties*
  - *Constituent concentrations typically equal the average dredge prism concentration*

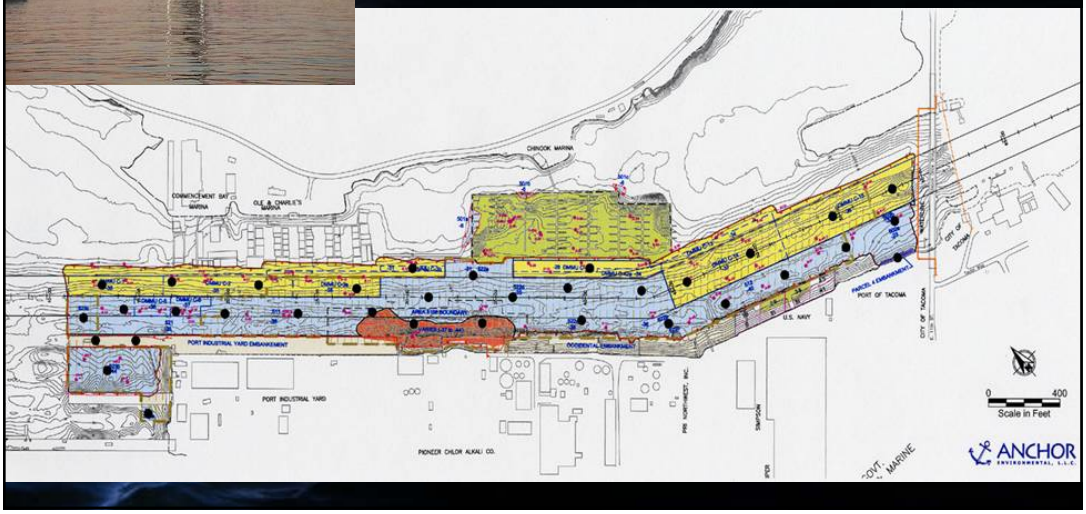
Three Representative Case Study Examples

1. *Mouth of Hylebos Waterway (Tacoma, WA)*
   - *Digging clamshell bucket with BMPs*
   - *Loose, sandy silt overlying dense sand*
   - *Dredge prism conc. - 5 to 50 times cleanup level*

2. *East Waterway (Seattle, WA)*
   - *Combination of digging and closed buckets with BMPs*
   - *Loose soft silt/clay overlying dense sand*
   - *Dredge prism conc. - 10 to 100 times cleanup level*

3. *Reynolds Aluminum (Massena, NY)*
   - *Cable arm bucket with BMPs*
   - *Loose, soft silt overlying gravel/cobble*
   - *Dredge prism conc. - 50 to 500 times cleanup level*

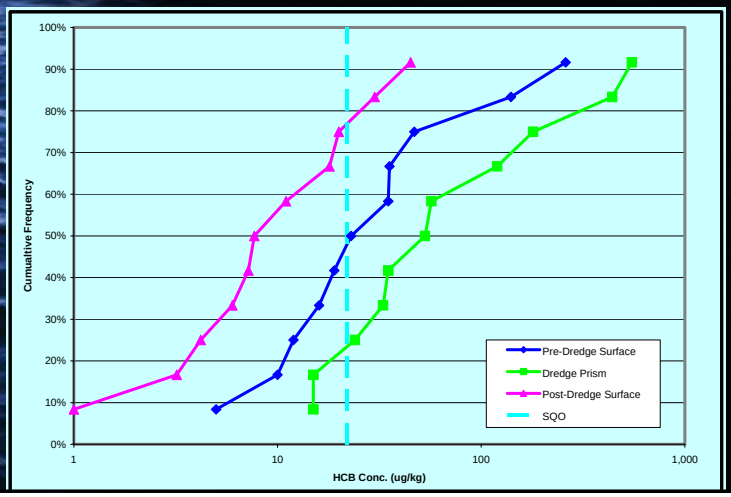
Hylebos Waterway Mouth: Dredge Verification Sample Plan (500,000 cy dredged)



Example Dredge Residual Data: Hylebos Mouth Hexachlorobenzene

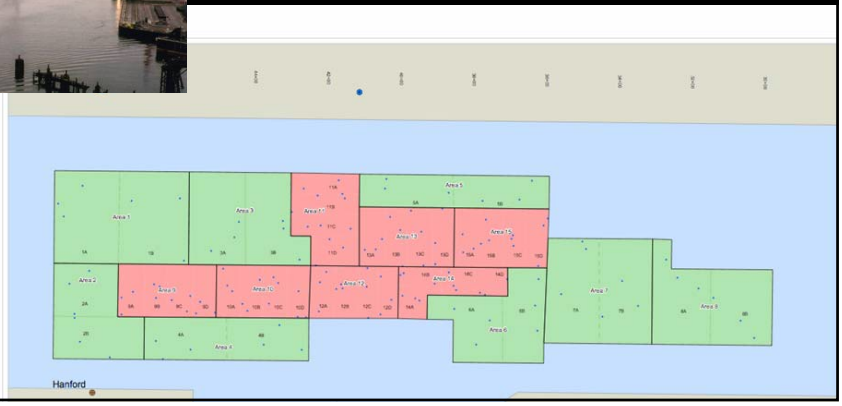
10 to 15 percent of cleanup areas required second pass dredging

Natural recovery and confirmatory biological testing - 6 months after dredging



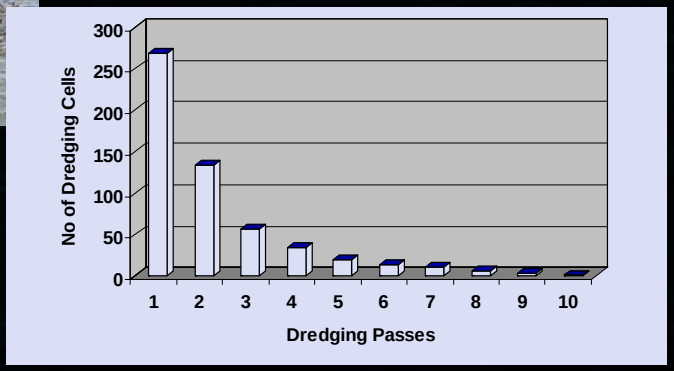
East Waterway Dredge Residuals (500,000 cy dredged)

- *Adaptive decision matrix/plan to determine need for contingency actions*
- *Dredge additional 1 foot (second pass) then place 6 inch clean cap*



Reynolds Metals – St. Lawrence River (70,000 cy dredged)

50% re-dredging of cells before cleanup level achieved



Estimating Residual Concentrations

In the absence of technical reasons to believe the residual volume comes disproportionately from a sediment depth…

- *The depth-averaged constituent concentration of the sediment dredged during a single pass is a reasonable estimate of residual sediment concentration resulting from that dredge pass*
- *Residual sediment concentrations for subsequent dredge passes will be influenced by residual sediment volume and concentration from prior dredge passes.*

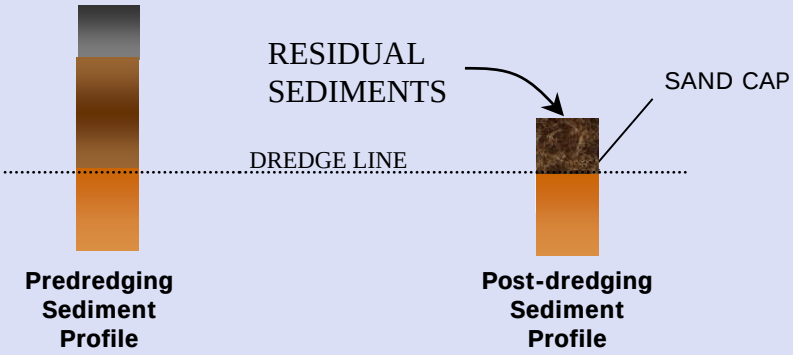
Estimating Residual Sediment Volume

- *Limited data available for estimating volume*
- *Range could be as high 10 to 20% of the sediment dredged*
- *Very weak basis for any approximation*
  - *Additional research needed*

Management Solutions

- *Apply practicable BMPs to reduce residuals*
  - *Dredge operations and sediment management*
- *Need for up-front contingency planning*
  - *Post-dredge data interpretation (e.g., 95% UCL)*
  - *Facilitate rapid management decisions*
- *Re-Dredge*
  - *Limited effectiveness in many cases*
  - *Focus second pass dredging efforts*
- *Cap residual sediment*
  - *More certain solution*
- *Enhanced natural recovery*
  - *Risk management framework*

Capping Residual Sediments can be an effective BMP



Example Post-Dredge Residual Management Decision Tree