Managing Debris for Environmental Dredging Projects

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Prepared by:

EA Engineering, Science, and Technology, Inc., PBC

Co-authors:

Don Hayes, PhD
Mike Palermo, PhD
Jamie Beaver, Matt Bowman, Mike Ciarlo

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Presentation Outline

- **Debris Challenges for Environmental Dredging**
- **Debris Impacts to Four R's**
- **Managing Debris Issues Through:**
  - Investigations
  - Effective Project Planning Phase
  - Operational Approaches and Logistics
- **Closing Thoughts**

Debris Definition

- **What is debris?**

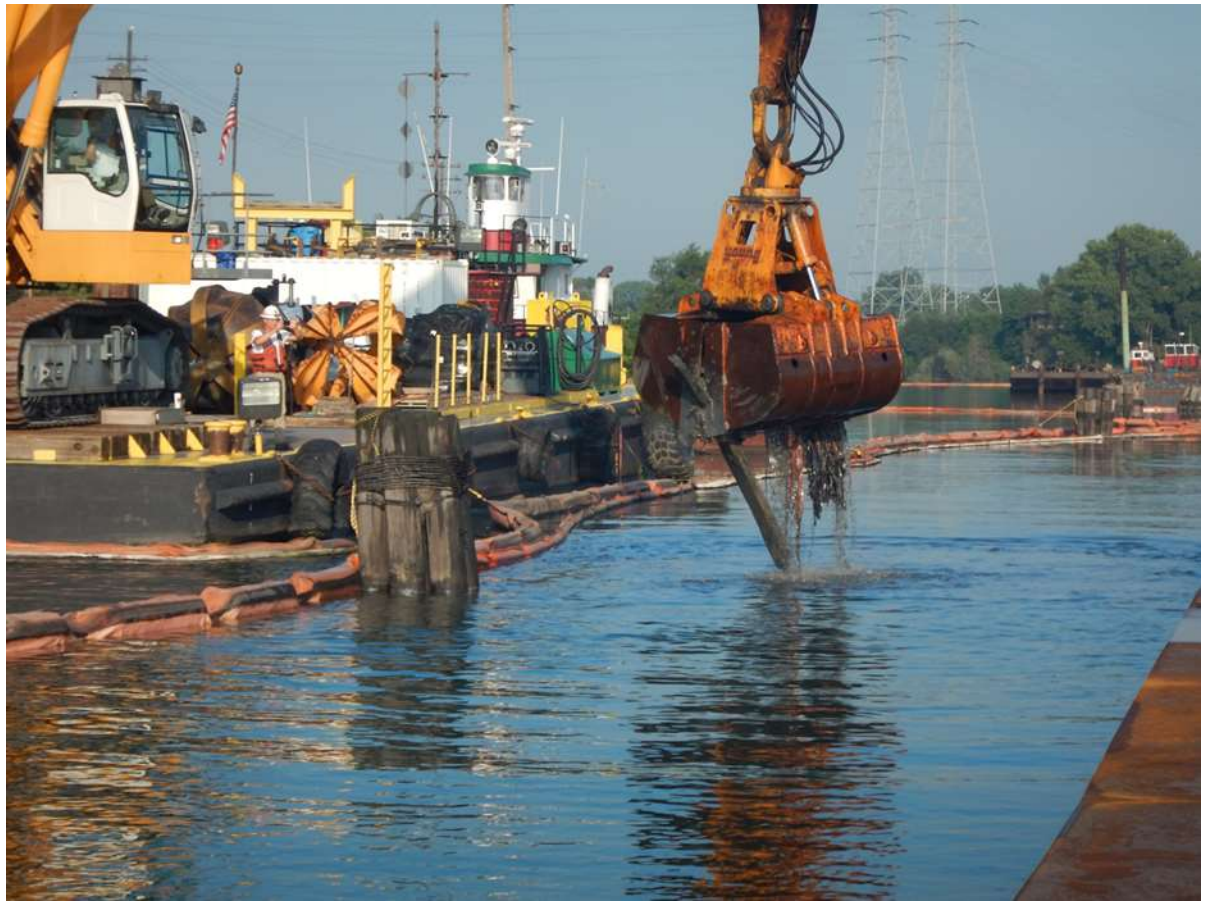
Conference paper offers the following definition:

*"**Non-sediment material(s) of limited intrinsic value** scattered or clustered within the sediment matrix, either buried or on its surface, having characteristics such as being **sufficiently large and strong as to potentially impact dredging operations** intended to remove sediment and/or impact the managing activities of the dredged materials. Debris **can range in size from very small objects to large obstructions** that require special equipment to remove. Items may **range in composition from organic to inorganic materials**. Debris typically excludes non-sediment granular materials such as saw dust and spilled raw materials."*

- **Debris matrix table: http://thedredgingprofessor.com/debris-matrix-table**

Key Debris Characteristics for Project Planning

- **Types**
  - Wood versus metal versus concrete weight may influence equipment and logistics
- **Sizes**
  - Small debris may be contained in a bucket or pass through a hydraulic intake, but large debris may require special equipment
- **Distribution**
  - Isolate, in pockets or zones, and/or equally distributed in dredging volume
  - Is there a percentage of dredge volume that debris that can be assigned?
- **Quantity**
- **Environmental Factors**



Expected versus Unexpected Debris – a goal for project planning is to place as much of the debris issues in the "expected" category before construction

Four R's of Environmental Dredging

Resuspension | Release | Residuals | Risk

Debris impacts resuspension and residuals, which contributes to release and risk

A recent study showed residuals are primarily a function of insitu dry density (Patmont et al.); however, debris likely plays a role

Influence on Four R's may vary between mechanical and hydraulic operations

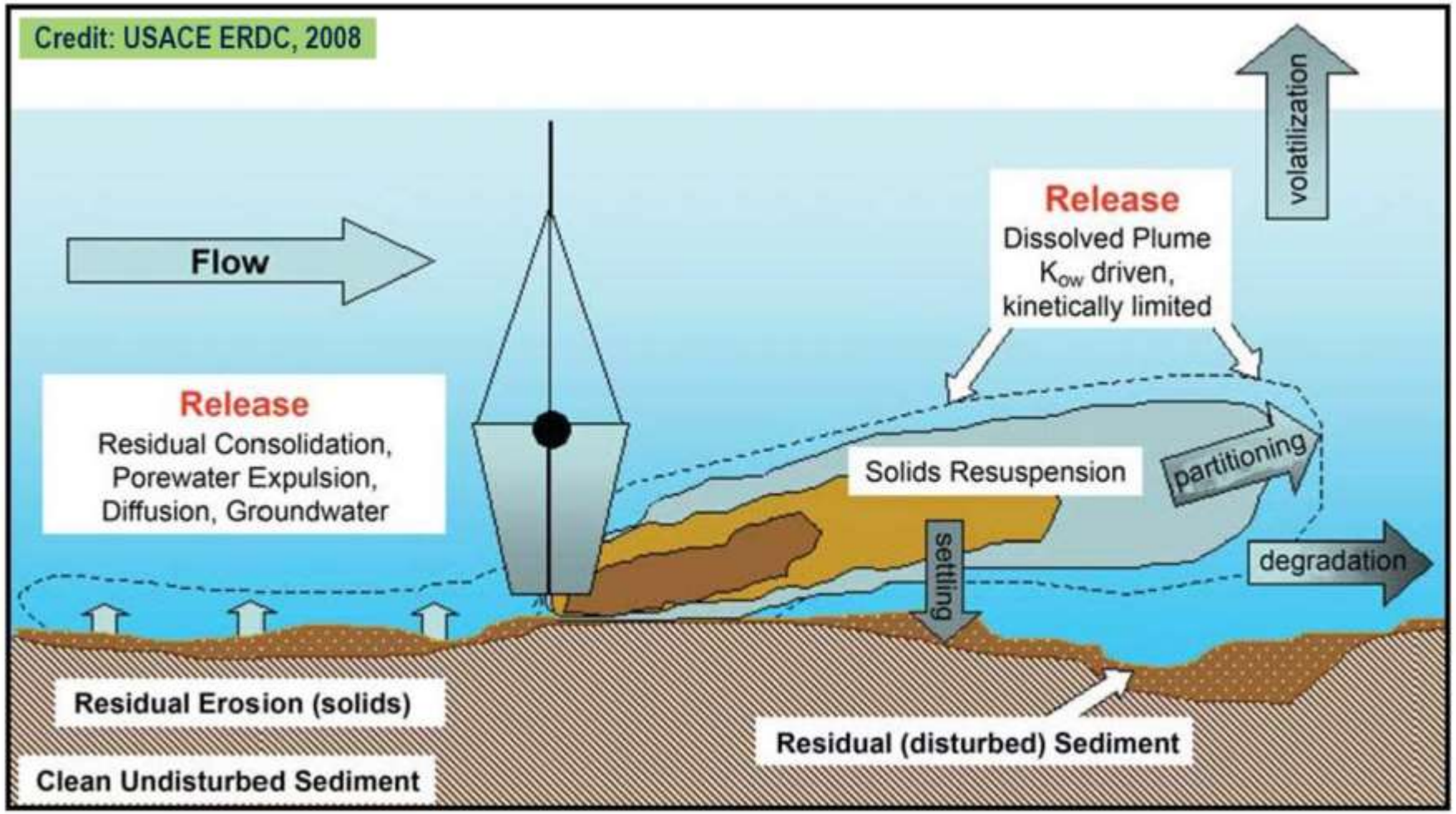
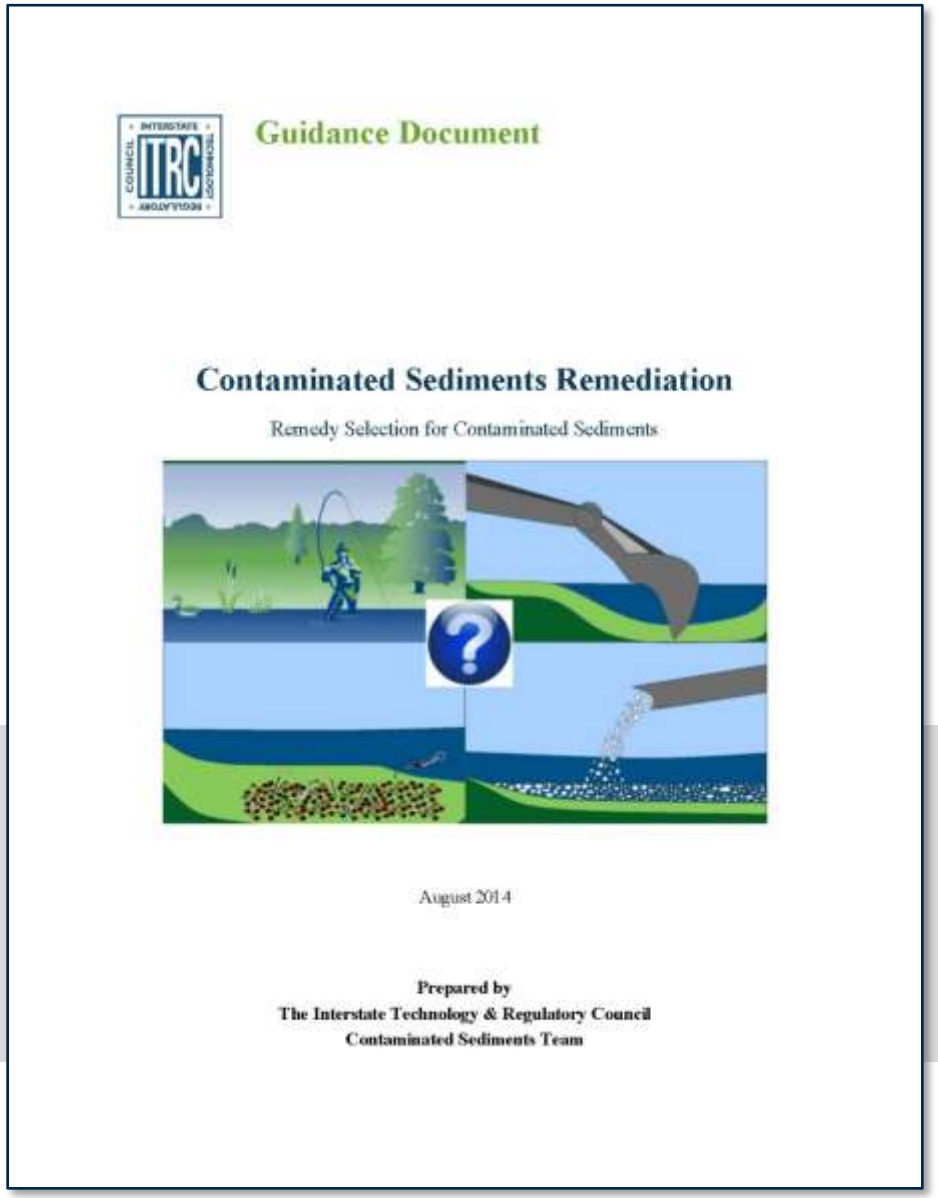


Figure 1. Schematic of contaminant release sources and mechanisms.

ITRC Sediment Remediation Guidance

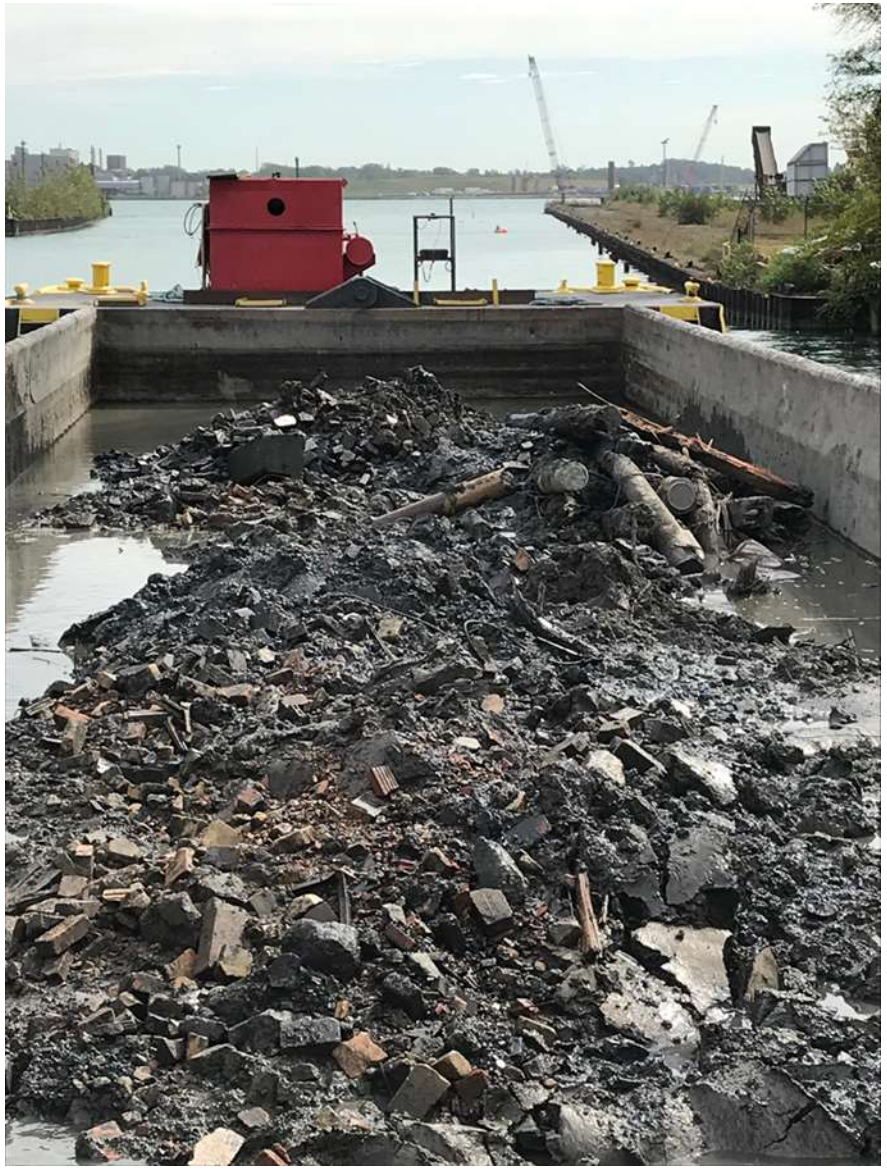
- **Recognizes the importance of debris in remedy selection**
- **Acknowledges debris as a factor in project planning and as a consideration for construction**
- **Acknowledges some impact to environmental dredging:**

> "In general, the presence of debris tends to result in increased resuspension and generation of residuals and, consequently, reduced production."



Project Planning Challenges/Considerations

- **Limited guidance in literature**
- **Inconsistent project-by-project approaches to debris**
  - Greater uncertainty in debris conditions adds constraints to quantification, “Four R’s” evaluations, and cost estimates
  - How will compensation for both expected and unexpected debris be managed?
- **Will debris be a factor in remedy effectiveness and/or environmental protectiveness objectives?**
  - Decision framework for addressing contaminated sediment will ideally also address debris implications, e.g., residual sand covers – was this effective for the debris issues?
  - Best management practices for water quality for contaminated sediment will ideally address the suite of operations needed for debris removal – was this effective for the debris issues?
  - Limited peer-reviewed data is available to support development of analysis tools to predict debris contribution to resuspension and residuals



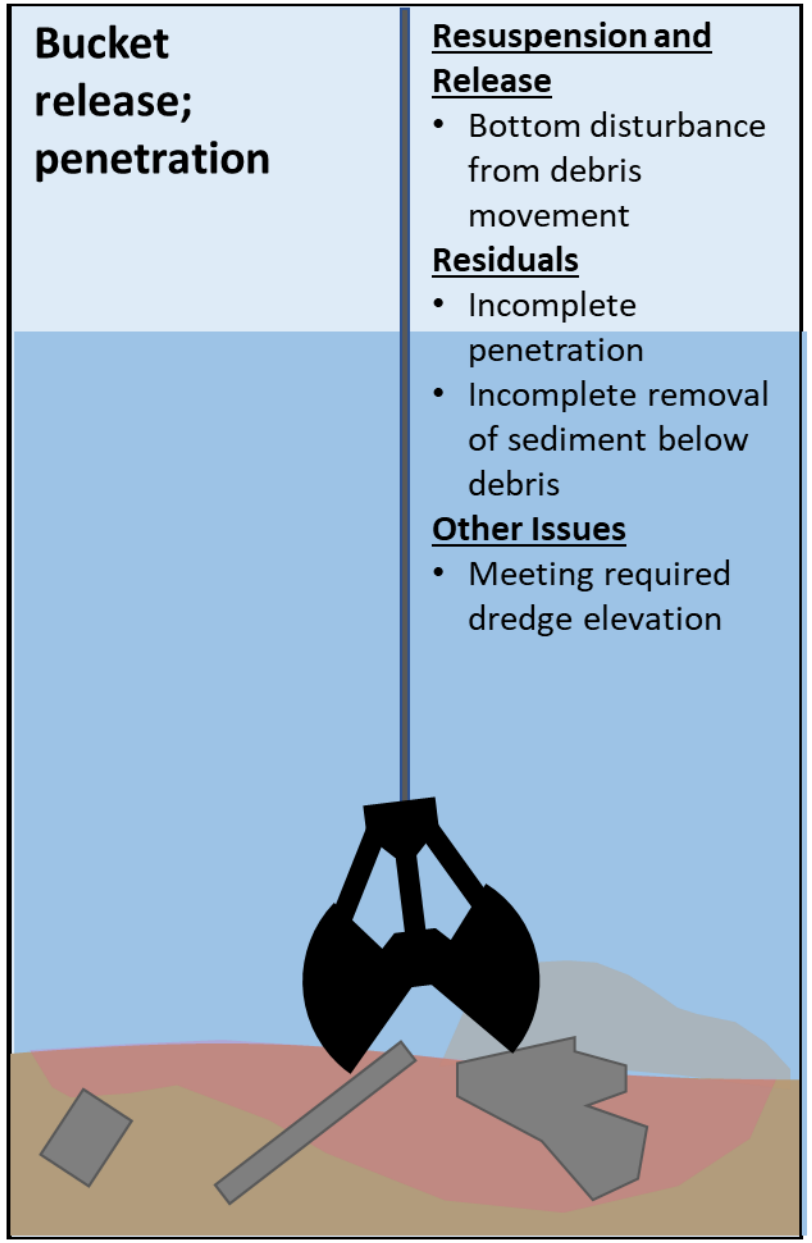
Mechanical Dredging Operations

Bucket release; penetration

Resuspension and Release
- Bottom disturbance from debris movement

Residuals
- Incomplete penetration
- Incomplete removal of sediment below debris

Other Issues
- Meeting required dredge elevation

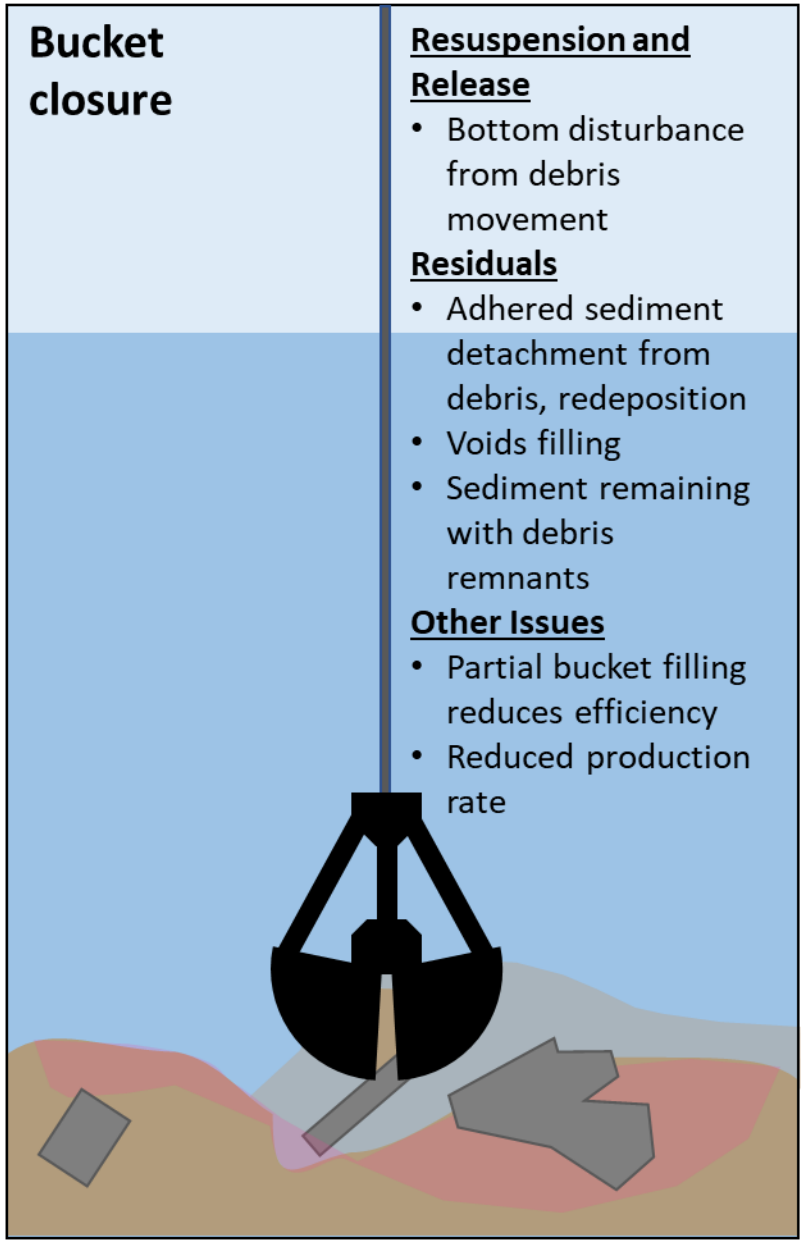


Bucket closure

Resuspension and Release
- Bottom disturbance from debris movement

Residuals
- Adhered sediment detachment from debris, redeposition
- Voids filling
- Sediment remaining with debris remnants

Other Issues
- Partial bucket filling reduces efficiency
- Reduced production rate

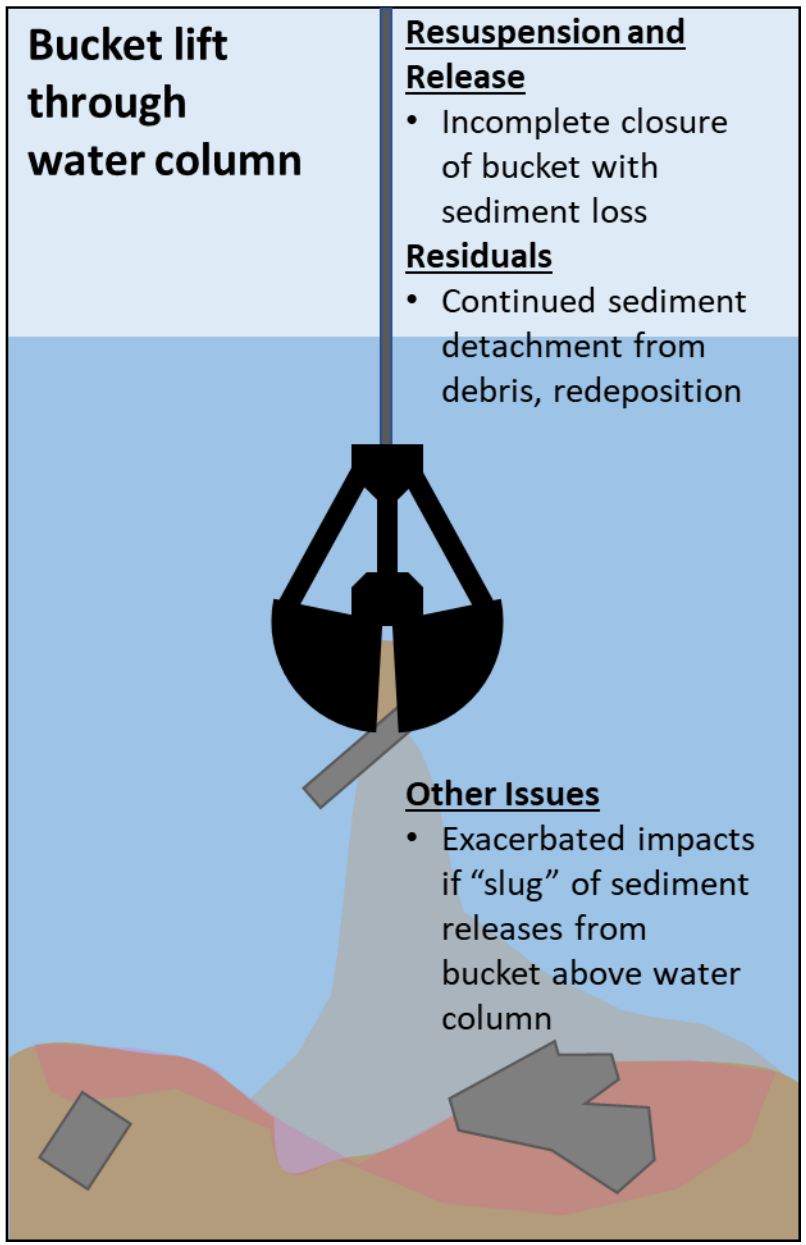


Bucket lift through water column

Resuspension and Release
- Incomplete closure of bucket with sediment loss

Residuals
- Continued sediment detachment from debris, redeposition

Other Issues
- Exacerbated impacts if “slug” of sediment releases from bucket above water column



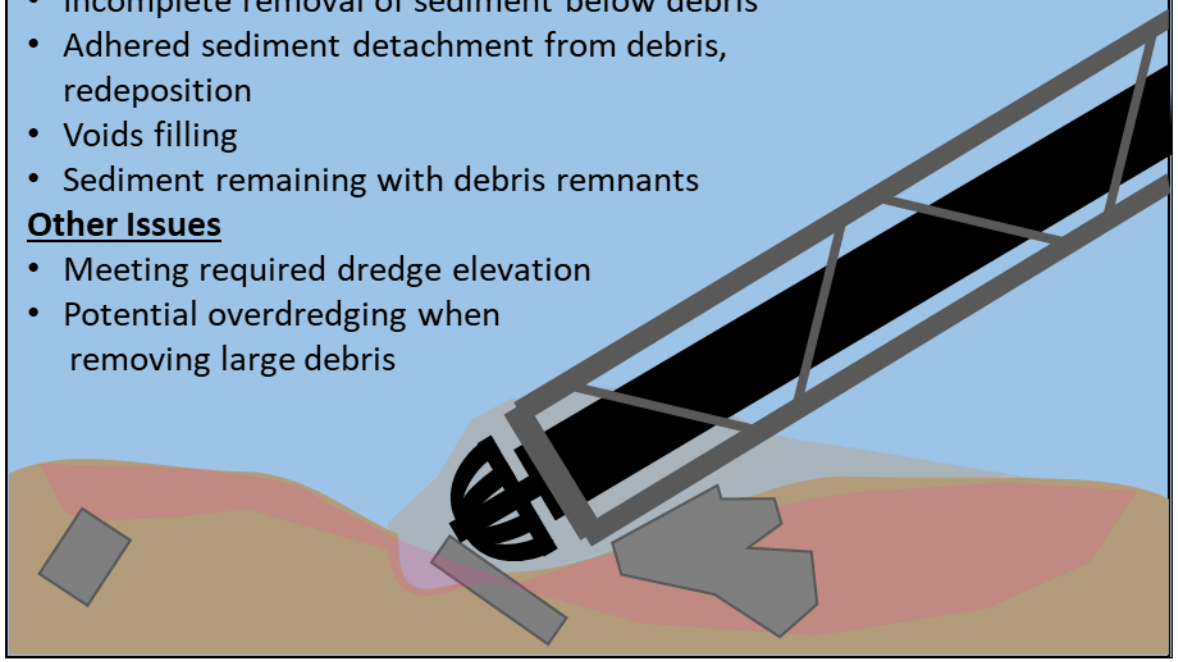
Hydraulic Dredging Operations

Cutterhead "swing"

Resuspension and Release
- Bottom disturbance from debris movement
- Variable suction increases resuspension

Residuals
- Incomplete penetration
- Incomplete removal of sediment below debris
- Adhered sediment detachment from debris, redeposition
- Voids filling
- Sediment remaining with debris remnants

Other Issues
- Meeting required dredge elevation
- Potential overdredging when removing large debris

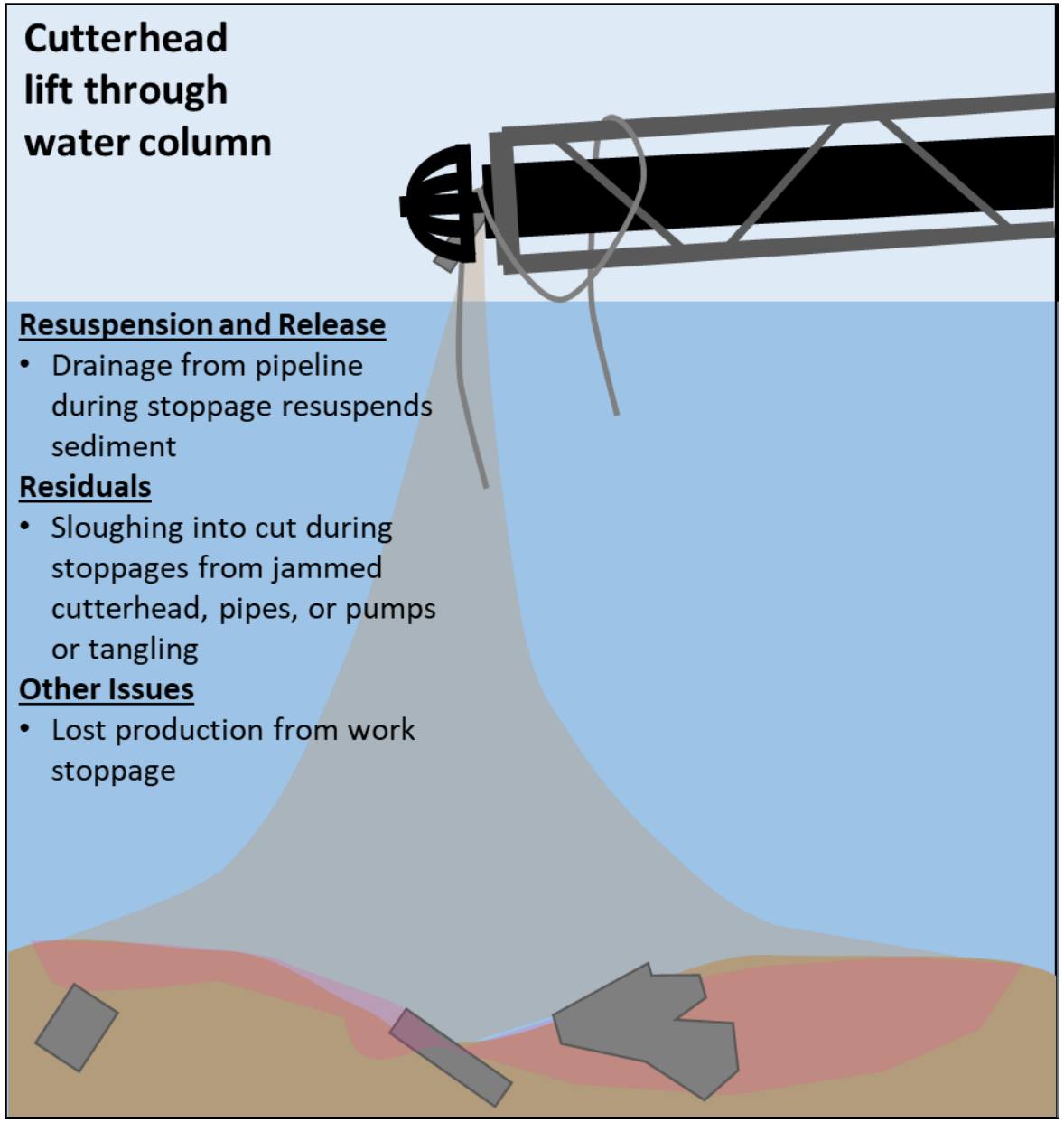


Cutterhead lift through water column

Resuspension and Release
- Drainage from pipeline during stoppage resuspends sediment

Residuals
- Sloughing into cut during stoppages from jammed cutterhead, pipes, or pumps or tangling

Other Issues
- Lost production from work stoppage



Debris Impacts Summary

Dredge Type	Debris Impact	Sediment Resuspension	Contaminant Release	Post-Dredging Residuals
Mechanical	Incomplete bucket closure	●	●	●
	Incomplete bucket penetration			●
	Unable to remove debris in same pass as dredging		●	
	Disturbance of surrounding sediment when debris is removed	●	●	●
	Disrupts clean cut between target and underlying sediments (loosens/softens for reduced sediment density)	●		●
Hydraulic	Failure to intake sediments			●
	Incomplete penetration			●
	Unable to remove debris in same pass as dredging		●	
	Disturbance of surrounding sediment when debris is removed	●	●	●
	Disrupts clean cut between target and underlying sediments (loosens/softens for reduced sediment density)	●		●

Construction Impacts Considerations

- **Production rate**
- **Increased downtime for equipment maintenance and/or debris clearing**
- **Extended project schedule for mobilized operations related to dredging**
  - Material management
  - Water treatment
- **Disposal quantities**
- **Turbidity barrier configurations and maintenance/repairs**
- **Interference with sampling equipment for post-dredge decision framework**
- **Project costs and contracting concerns**

Managing Debris-related Project Planning Challenges

Addressing these questions aid in effective project planning:

- *How much debris is present and what are the characteristics?*
- *Where is debris located?*
- *What is needed to remove debris effectively while limiting environmental impacts?*
- *What are the requirements to address the suite of removal, management, and disposal activities that are necessary for the debris conditions?*
- *Are the actual costs of debris reliably understood before construction, and has the approach to contractor compensation accounted for the expected (and unexpected) debris conditions?*

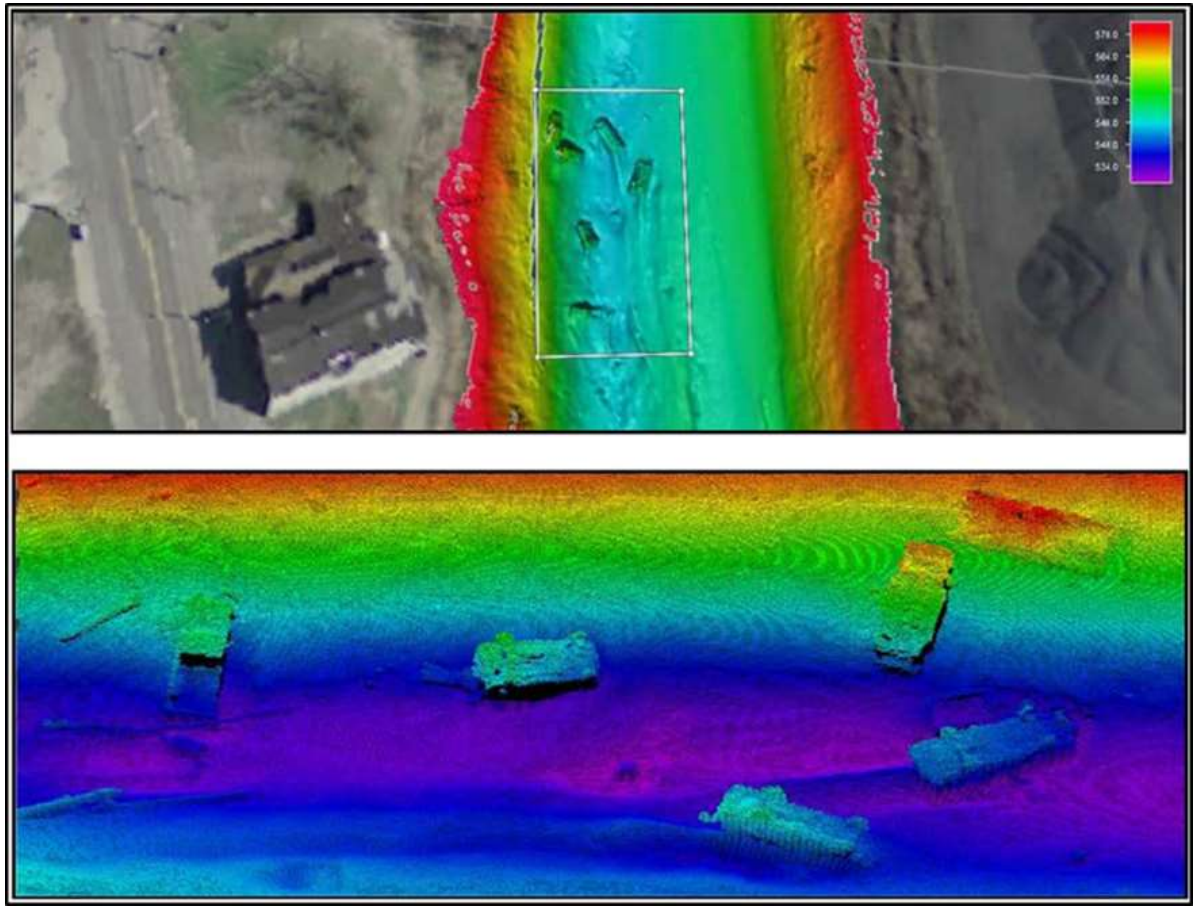
Debris questionnaire sent to environmental dredging contractors provided helpful information for construction challenges and available approaches to debris operations


Photo Courtesy of Sevenson Environmental Construction

Photo Courtesy of JF Brennan Company

Debris Investigations

- **Investigations**
  - Multibeam bathymetry and side-scan sonar *(surface debris)*
  - ROV *(surface debris)*
  - Diving *(surface debris)*
  - Magnetometer and electromagnetic *(surface and subsurface debris)*
  - Subbottom profiling *(large subsurface debris)*
- **Timing?**
  - ***Feasibility study*** - provides more representative implementation assumptions and cost estimates
  - ***Pre-design/design*** - necessary to include appropriate requirements to manage debris impacts
  - ***Construction*** - Supplementary investigation by the contractor may be performed to refine operations

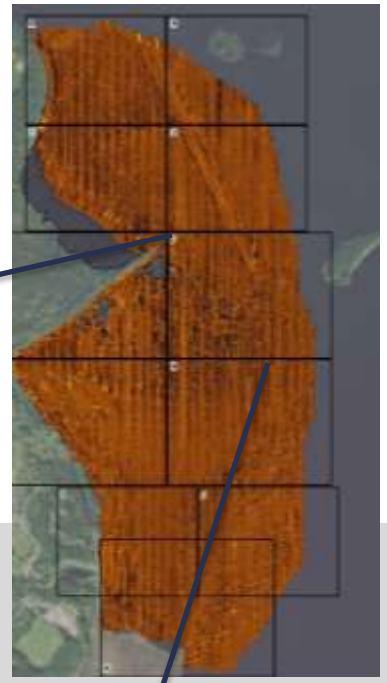


Images from high resolution multi-beam sonar

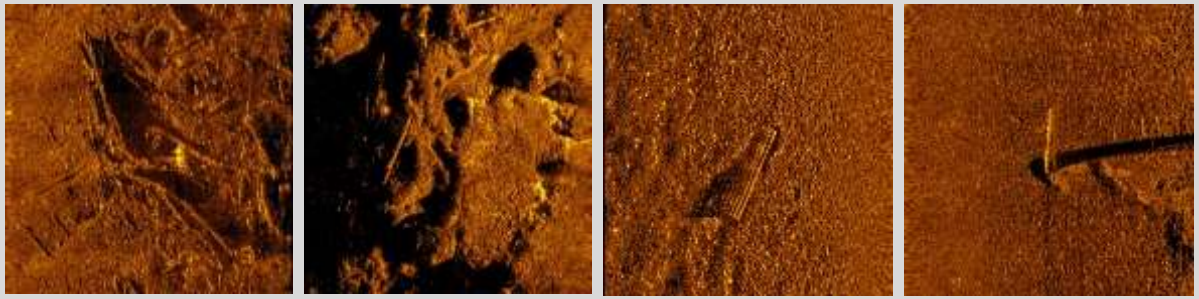
Side-Scan Sonar Example

Methods for investigating surface debris provide information aiding in:

- **Debris identification**
- **Quantification of buried debris**



Zooming in from mosaic at right:



Note: buried debris is virtually impossible to quantify accurately

ROV Investigation (surface debris and structures)

Excerpt of an ROV swim of showing sediment surface adjacent to a structure

Video courtesy of USACE Detroit District

Managing Debris Impacts

Contractors may integrate a range of approaches during construction to address debris issues, *as needed*

- **Mechanical**
  - Pre-removal for surface and embedded debris

    may have challenges in locating all large debris (could lose some efficiency if similar debris is discovered during dredging)

- **Hydraulic**
  - Removal of medium and large debris before production dredging and/or during
  - Screen for intake
  - Sediment processing operations incorporating debris removal

Managing Debris Impacts

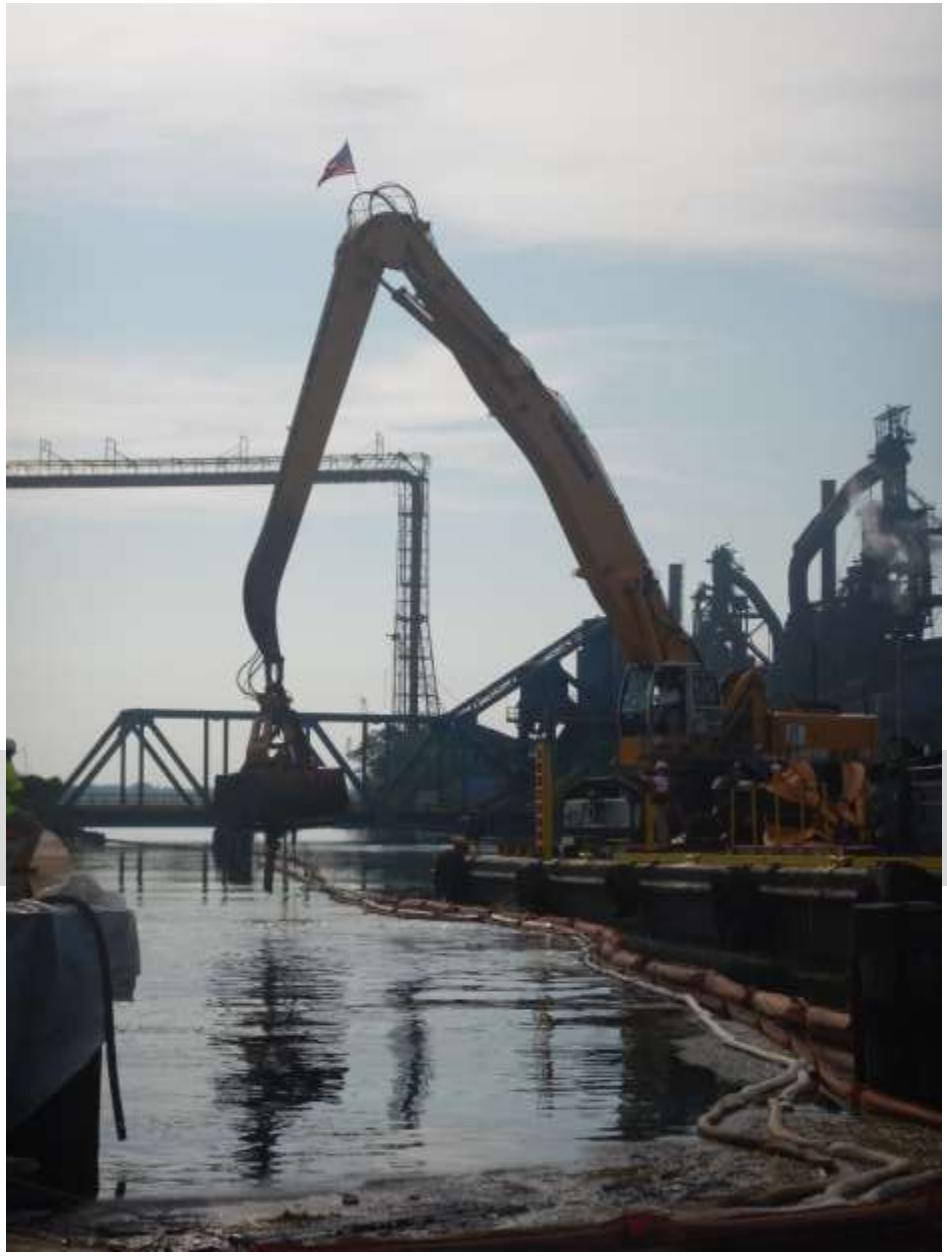
Best management practices for water quality concerns

- Separate debris removal operations may not be specifically addressed in FS, design, and permits
  - Turbidity barriers surrounding debris removal nearshore
  - Sorbent booms
  - Scow or temporary storage on deck barges – contained or allowed to drain into work area
  - Other BMPs, e.g., air curtain for vessel entrances and exits from the containment area

BMPs require active maintenance and may impact costs and schedule

Cost escalation and schedule control

- Risk sharing between owner and contractor, e.g., unit prices not lump sum
- Contingency planning prior to construction



Generalized Overview of Debris Approaches

REMOVAL

- **Mechanical**
  - Debris removal during production dredging versus pre-dredging debris removal
  - *May require conventional clamshell *(environmental buckets less effective for medium and large debris)*
- **Hydraulic**
  - Medium and large debris, dense debris, and vegetation complicate operations and reduces production rate
  - Small debris through intake may affect downstream processing
- **Combined**
  - Pre-removal with grapple or mechanical excavator followed by hydraulic dredging

Generalized Overview of Debris Approaches

MANAGEMENT

- **Mechanical**
  - Direct barge loading comingled with sediment in scow; compartments for medium or large debris
  - Potential need or benefit for segregation from sediment
  - Stockpiling for offsite disposal
  - Stockpiling for decontamination and recycling
- **Hydraulic**
  - Separation from slurry by sizes, large through small debris is removed by screens, and “very small sizes” may not require removal from slurry
  - Debris size permitted into geotextile tubes (manifold) may differ from a filter press or open basin
- **Combined**
  - *Mixed handling/transport – mechanical dredge removal into barges, hydraulic offload of sediment, mechanical removal of debris from barge for landfill disposal
    (example for USACE Pointe Mouille CDF)

Photo Courtesy of JF Brennan Company


Photo Courtesy of JF Brennan Company

Generalized Overview of Debris Approaches

DISPOSAL OR RECYCLING

- Offsite landfill
- Metal recycling facility
- Special waste disposal facility
- Onsite confined disposal facility or landfill

Closing Thoughts

- ✓ Debris continues to be a challenge for environmental dredging projects
- ✓ Debris investigations starting early in projects are recommended
- ✓ Buried debris investigation is an area of innovation opportunity
- ✓ Data that includes direct measurements of residuals (and resuspension) due to debris is not available, but may be warranted
- ✓ Tools that more reliably predict the relative importance of debris impacts to resuspension and residuals for site conditions needed
- ✓ Operations can be more cost-effective with owner-contractor risk sharing

Acknowledgements

- **Respondents supplying information on debris questionnaire and/or supplying photos**
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- **Coauthors: Matt Bowman, Mike Ciarlo, Mike Palermo, Don Hayes**

Thank You!

Jamie Beaver, PE
EA Engineering, Science & Technology, Inc., PBC
jbeaver@eaest.com

Scavenger Hunt Keyword = “Debris”