Risk Management

Engineering and Operational Controls

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RISK FRAMEWORK

RISK ASSESSMENT PARADIGM

Problem Formulation

Exposure Assessment

Risk Characterization

Effects Assessment

Risk Management

Risk = (Exposure + Effect)

Economic Analysis, Socio-Political, Engineering Feasibility
Risk Management –

Reduce sediment resuspension risks (where unacceptable) to acceptable levels by use of engineering controls, and/or use of operational controls.
Concept

- Risk is managed by managing the exposure.
- Exposure can be managed by controls that:
  - reduce the source concentration,
  - alter the source location,
  - reduce total mass of sediment resuspended in the water column,
  - alter transport of resuspended sediment,
  - increase settling.
Definition: Requires a physical construction technology or modification of the physical dredge plant to cause the desired change in conditions.

Source: Geotechnical Supply Inc
Operational Control

**Definition:** Action that can be undertaken by dredge operator to reduce unacceptable risks of the dredging operations.
If it is determined that unacceptable risk(s) exist

Engineering and/or operational controls must be evaluated for effectiveness for the site and sediment conditions.
Changes in dredging equipment and/or operations can modify:

- the resuspended sediment concentration at source,
- total mass of sediment resuspended in the water column,
- the release points, and
- transport of resuspended material.
Control Applications

But changes in dredging equipment and/or operations involves tradeoffs:

- dredge production rates,
- project duration,
- costs,
- etc.
Tradeoffs

• Are involved with the use of engineering and operational controls as risk reduction solutions.

  ➢ Big hopper dredges can cost approximately $85K/day.
  
  ➢ Big cutterheads can cost approximately $45K-$55K/day.
Factors Influencing Sediment Resuspension

Mechanical versus hydraulic issues.

- Magnitude of resuspension,
- Location of resuspension in water column,
- Strength of resuspension,
- Continuous or intermittent.

Relative performance is a function of site-specific conditions.
Engineering Controls
Type of Dredge

- **Empirical Solids Releases**

  - **Mechanical dredges**
    - Open or watertight: 0.2 to 9%, typically 0.5 to 2%
    - Environmental: 0.1 to 5%, typically 0.3 to 1%
  
  - **Hydraulic dredges**: 0.01 to 4%, typically 0.2 to 0.8%

  Resuspension of fine-grained mass of dredged sediment to water column
As size increases:

- Production rate increases,
- Resuspension rate and therefore strength (concentration) of resuspended sediment increases,

But, exposure time is decreased because the dredge is operated for a shorter amount of time and total mass of sediment resuspended is decreased.
Silt curtains are devices designed to control suspended solids and turbidity in the water column generated by dredging and disposal of dredged material.
Components of a Silt Curtain

Source: Julie Kistle
Effectiveness of Silt Curtains

Depends on:

- Nature of operation
- Quantity and type of material in suspension
- Characteristics, construction, and conditions
- Method of deployment
- Hydrodynamics

Source: Layfield
Silt Curtains “Lessons Learned”

• Used at various sites with various degrees of success.
• Should not be considered a “one-solution-fits-all” type of BMP.
• Are highly specialized, temporary-use devices that should be selected only after careful evaluation.
• Requires knowledge and practical experience for successful applications.
Silt Curtain “Lessons Learned”

- Deploying in currents > 1 to 1 ½ knots problematic.
- Low current/high current conundrum.
- In general, should be used in slow to moderate currents, stable water levels, and relatively shallow water depths.
- Selection/use is extremely site-specific (not a silver bullet).

Operational Controls
Operational Controls
Slow Down

• Slowing operation can decrease strength but may increase total mass of resuspension.

• Slowing operation would change exposures - turbidity, - net deposition, - deposition rate - and potential dose.
Operational Controls
Mechanical Dredges

- Varying the bucket descent speed
- Varying the bucket ascent speed
- Varying the slewing speed
- Barge overflow/no overflow
## Operational Controls

### Mechanical Dredges

## Varying Bucket Speeds

<table>
<thead>
<tr>
<th>Mechanical Dredge Bucket Size</th>
<th>Bucket Cycle Time</th>
<th>Bucket Ascent &amp; (Descent) Velocity</th>
<th>Instantaneous Production Rate</th>
<th>Mass Resuspension Rate</th>
<th>Percent Resuspension</th>
<th>Project Duration Days*</th>
</tr>
</thead>
<tbody>
<tr>
<td>yd³ (m³)</td>
<td>sec</td>
<td>m/s (m/s)</td>
<td>m³/hr</td>
<td>g/s</td>
<td></td>
<td></td>
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<tr>
<td>4.0 (3.0)</td>
<td>50</td>
<td>1.06 (0.8)</td>
<td>184</td>
<td>217</td>
<td>0.72</td>
<td>27</td>
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<tr>
<td>4.0 (3.0)</td>
<td>75</td>
<td>0.5 (0.37)</td>
<td>122</td>
<td>142</td>
<td>0.71</td>
<td>39</td>
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<tr>
<td>4.0 (3.0)</td>
<td>100</td>
<td>0.32 (0.24)</td>
<td>92</td>
<td>123</td>
<td>0.81</td>
<td>50</td>
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<tr>
<td>30.0 (23.0)</td>
<td>50</td>
<td>1.06 (0.8)</td>
<td>1408</td>
<td>1432</td>
<td>0.61</td>
<td>4</td>
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<tr>
<td>30.0 (23.0)</td>
<td>75</td>
<td>0.5 (0.37)</td>
<td>938</td>
<td>977</td>
<td>0.63</td>
<td>5</td>
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<tr>
<td>30.0 (23.0)</td>
<td>100</td>
<td>0.32 (0.24)</td>
<td>704</td>
<td>843</td>
<td>0.73</td>
<td>6</td>
</tr>
</tbody>
</table>

*Based on 100,000 m³ project
Operational Controls
Cutterhead Dredges

- Using different cutterhead rotation speeds
- Using different swing speeds
- Varying the suction velocity
- Varying the cut height and step length
- Varying the direction of cut
Operational Controls
Hopper Dredges

- Changing the suction pipe velocity
- Varying the trailing speed
- Loading with one suction pipe instead of two
- Allowing overflow, not allowing overflow
- Vary draghead operation
Hypothetical Example: Operational Controls

With Overflow

Without Overflow
Time Series of 0, 15, and 30 Minute Overflow Deposition

Deposition (cm) vs Time (Days)

31-May  2-Jun  4-Jun  6-Jun  8-Jun  10-Jun  12-Jun  14-Jun  16-Jun

0 0.01 0.02 0.03 0.04 0.05 0.06 0.07
## Hypothetical Example

### Dredging Scenarios

<table>
<thead>
<tr>
<th>Dredging Scenario</th>
<th>Production Per Day</th>
<th>Dredging Duration (Days)</th>
<th>Approximate Project Dredging Cost*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Overflow</td>
<td>32,000 m³</td>
<td>219</td>
<td>$13,140,000</td>
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<tr>
<td>With 15 Minutes Overflow</td>
<td>48,000 m³</td>
<td>146</td>
<td>$8,760,000</td>
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<tr>
<td>With 30 Minutes Overflow</td>
<td>57,600 m³</td>
<td>122</td>
<td>$7,320,000</td>
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</tbody>
</table>

*Assume $2,500/hr dredge rental cost*
Questions?