Contained Aquatic Disposal (CAD)/Capping

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Purpose

Manage risks from contaminated material by:

- Physical isolation of contaminants
- Reduction of contaminant flux
- Physical stabilization
  - Limiting losses during placement
  - Reducing mobilization and erosion
CAD Approaches

• Existing Pits/Fills or Excavated Pits – (most stable)
• Lateral Confinement

Confined Aquatic Disposal

• Mounds

Level Bottom Capping (LBC)
Where has CAD been done?

- New York
- Boston
- Los Angeles
- Netherlands
- Belgium
- Hong Kong
- Brazil
- New Bedford, MA
- Portland, OR
- Puget Sound, WA
- Duwamish, WA Demo
- Puerto Rico
Considerations

- Site Conditions and Sediment Characteristics
- Design and Disposal Objectives
- Design and Construction
- Placement Methods
- Placement Losses
- Dredged Material Strength and Consolidation
- Cap Stability and Design
- Cap Placement
- Habitat Restoration
- Monitoring and Maintenance
Site Characterization for Selection

- Physical environment
- Environmental setting
- Hydrodynamic conditions
- Access
- Geotechnical/Geological conditions
- Hydrogeological conditions
- Sediment characterization and stability
- Waterway uses
CAD Design Objectives

• Accommodate projected volume of dredged material
• Control releases of dredged material or associated contaminants to the water column within acceptable limits
• Control bioavailability of contaminants in surficial sediment biozone
• Maintain stability in response to physical, chemical and biological processes
• Consider habitat restoration/creation
  - Recolonization: Biodensity and Biodiversity
  - Substrate: Grain Size and Nutrients
  - Vegetation: Elevation and Turbidity Control
CAD Sizing for Storage Capacity

- Compression settling test analysis using SETTLE model for hydraulic placement or consolidation test analysis using PSDDF model for mechanical placement
- Examine range of dredging rate and conditions
- Analyze range of parameters
CAD Design and Construction

- Site selection: existing pits or excavation
- Access and exposure
- Ocean disposal of excavated materials or use for capping material
- Excavation depth
- Side slopes

- Fill limitations
- Surface Area
- Shape/ L:W ratio
- Number of cells
- Orientation
- Volume changes

Dredged Material Assessment and Management Seminar
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Placement Methods

Hopper, NY Mud Dump

Submerged Diffuser

Denny Way CSO

One Tree Island Marina

In-Pit Retention of Material

Illustration of STFATE grid for pit retention efficiency simulations
FATE Models

- STFATE
- MDFATE
- LTFATE
- CDFATE
- SSFATE
- DREDGE
Cap Designs

Minimal Isolation Capping

Isolation Capping

Bioturbation

Biodiffusion

Contaminated Sediment

Chemical Isolation

Contaminated Sediment
Migration Pathways for Contained Aquatic Disposal (CAD)

- Erosion via waves/ currents
- Bioturbation
- Contaminated Sediment
- Cap
- Ground Water
- Soluble Diffusion
- Convection

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Models are needed for long term effectiveness evaluations
Cap Design

- Mixed Layer
- Biodiffusion
- Advection/ Diffusion

Designed to accommodate:
- Advection/ Diffusion
- Bioturbation
- Erosion
- Consolidation
- Operational factors
CAP Design Specifications

- Cap thickness designed to prevent breach from:
  - Props
  - Anchors
  - Fishing trawlers/nets
  - Storm waves
  - Flood currents

- Materials
  - Erosion control – armor, cohesive
  - Contaminant control
  - Habitat

Example Cap Design

12" GRADED ARMOR STONE
20" SAND MATERIAL
GEOTEXTILE FABRIC
SEDIMENT
BEDROCK
Capping Materials

• Granular Materials
  ➢ Sediments
  ➢ Soils
  ➢ Quarry run materials

• Amendments
  ➢ Adsorbents
  ➢ Reactants

• Fabrics, Membranes and Specialty Materials

• Armor Stone

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Physical Cap Processes

- Erosion and Armoring/Winnowing/Bed Load
  - Cap Elevation or Cap Thickness Distribution
  - Grain Size Distribution Profile throughout Cap Depth
Physical Cap Processes

- **Deposition**
  - Cap Elevation or Cap Thickness
  - Contaminant Concentration, Organic Content, and Grain Size Distribution Profiles

- **Consolidation and Differential Settlement**
  - Cap Elevation or Cap Thickness or Settlement
  - Dry Bulk Density Profile throughout Cap Depth
  - Shear Strength/ Cap Support
Physical Cap Processes

- Mixing and Disruption
  - Visual Inspection
  - Geophysical Surveys
Cap Placement Methods

Baffle Plate on MS River

Sprayed slurry system placing sand at Soda Lake, WY

Simpson-Kraft Sand Box

Sand Spreader Barge

Eagle Harbor
Chemical Cap Processes

- Diffusion
- Advection/Convection
- Biotic Degradation
- Abiotic Degradation
- Adsorption/Retardation
- Volatilization/Stripping by Gas Transport
Biological Cap Processes

- **Recolonization**
  - Benthic Population and Diversity

- **Bioturbation**
  - Total Concentration Profile
  - Porosity, TOC and Grain Size Profile

- **Biouptake/Bioaccumulation**
  - Benthic
  - Water Column

- **Toxicity**
Monitoring

• Define Objectives
• Tiered Approach
• Equipment and Methods
• Construction Monitoring
• Cap Performance Monitoring
• Monitoring Plan
Maintenance and Rehabilitation

• Assess findings to establish needs by comparing with performance predictions, considering natural processes
  ➢ If in agreement or better, adapt monitoring plan to findings
  ➢ If contradicts predictions, determine processes of interest
  ➢ Perform process-based confirmation monitoring
  ➢ Determine maintenance and rehabilitation needs

• Maintenance: Restores performance in response to extreme events

• Rehabilitation: Upgrades performance to achieve long-term performance goals
QUESTIONS?

• USACE guidance for DM capping

• EPA (ARCS) guidance for ISC
  ➢ http://www.epa.gov/glnpo/sediment/iscmain/index.html