Overview of Water Injection Dredging (WID) and Potential Application to Reservoirs

Adapted from a presentation by

Timothy L. Welp
Joe Gailani
Paul Schroeder

USACE Engineer Research and Development Center
Vicksburg MS

Timothy.L.Welp@usace.army.mil 601-634-2083
Joe.Z.Gailani@usace.army.mil 601-634-4851
Paul.R.Schroeder@usace.army.mil 601-634-3709
Reservoir Sediment Management Strategies

- Sediment yield reduction
- Sediment traps
- Sediment bypass
- Sediment pass-through (routing, sluicing)
- Drawdown flushing
- Hydrosuction
- Inlet extension
- Density current venting
- Water-injection Dredging
- Dredging with land disposal
- Dredging with downstream recharge
- Pressure flushing
- Sediment focusing
- Reallocation
- New reservoirs/dam raises
Outline

- Water Injection Dredge (WID) Overview
- Corps R&D
- WID Potential Application to Tuttle Creek Lake
Water Injection Dredge (WID)
Density Current

WID Principal process

1 = Injection
2 = Transition zone
3 = Transport

Water chamber
Nozzle array

Source: PIANC
https://www.youtube.com/watch?v=JfVK5rLYXiM
Worldwide WID
Worldwide WID
Worldwide WID
The Marine Group “150 m³/hr in soft material”
Water Injection Dredge (WID)
Weeks Marine BT 773
WEEKS MARINE
Barge BT 773
Length: 120’
Breadth: 32’
Draft: 8’
Injection Pipe: 30” dia. w/ 23 – 2.4” nozzles
Pump Size: 24” x 30” (Goulds Pump 3420)
Engine: CAT 398 (825 HP)
Pump Capacity: 23,000 GPM
Max. Dredging Depth: 70’
Min. Dredging Depth: 5’
Towing Vessel: 1,200 HP minimum
WID Applicability

- Could be a very cost effective way of removing sediment from unwanted locations.
- Has the ecological advantage that it does not disturb the sediment balance of the watercourse.
- However, the technique requires very specific site conditions.
Parameters That Influence WID Production

- Soil characteristics
- Site bathymetry and geometry (have to have somewhere where sediment can deposit)
- Hydrodynamic conditions
- Geographic location (accessibility, proximity to structures, etc.)
- Type and level of contamination
### US WID Dredging Projects

#### Traditional Operations

**Private Dock Work**
- **Mississippi River**
  - Grain Dock – Convent, LA
  - Refinery – Baton Rouge, LA
  - Refinery – Sunshine, LA
  - Grain Dock – Destrehan, LA
  - Chemical – Plaquemines, LA
  - Refinery – St. James, LA
  - Barge Dock – Jefferson, LA
  - Refinery – St. James, LA
  - Refinery – Jefferson, LA
  - Refining Facility – Baton Rouge, LA
  - Agricultural – Jefferson, LA

**Atchafalaya River**
- Refinery – Krotz Springs, LA

#### Federal Navigation

**New Orleans District**
- New Orleans Harbor
- Michoud Canal
- Miss. River Gulf Outlet
- E & W Calumet Floodgates
- Tiger Pass Channel

**Galveston District**
- Houston Ship Channel
- Bayport Ship Channel

**Mobile District**
- Horn Island

Source: WEEKS MARINE
<table>
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<tr>
<th>Project Name</th>
<th>Project Site</th>
<th>Cost ($)</th>
<th>Volume (yd³)</th>
<th>Duration (days)</th>
<th>Production Rate (yd³/hr)</th>
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WID Monitoring
Michoud Canal

- WID worked 6-10 August 2002
- ERDC monitored 7 August 2002
- Focused on near and intermediate field density current characteristics
Density Current/Water Samples

Total Suspended Solids (TSS) – mg/l

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Acoustic Backscatter
Michoud Canal Monitoring
Conclusions

- Elevated TSS levels stayed in the lower 5 to 6 ft of the water column. Above about 33 ft, essentially no difference in TSS levels between the area in the vicinity of the dredge and background could be measured.
- Some distance away from the dredge head, all the resuspended sediments appeared to stay within about 3 ft of the bottom.
- Where it could be detected, the density current flows under the influence of gravity and underwater slopes toward the deeper laying parts.

Similar results when monitoring the Mississippi River Gulf Outlet project.
WID Advantages

For appropriate locations where favorable bottom material and bathymetry exist, WID can offer several advantages:

- In optimum conditions WID is capable of very high production rates.
- WID can rapidly move from one project location to another on short notice and can immediately go to work once at the site.
- Because WID does not require pipelines, etc., the reduction directly translates into a reduction of required manpower and attendant operating costs.
WID Limitations

- WID can effectively operate only where favorable conditions exist.
- WID cannot be used where unacceptable environmental impacts occur (contaminant resuspension, unacceptable suspended solids impacts, etc.).
- Destination of dredged material more difficult to predict.
Dredging Operations and Environmental Research (DOER) Program

Innovative Sediment Management Technologies for Channels and Reservoirs
Timothy Welp, Joseph Gailani, Paul Schroeder

- **Problem**
  - Navigation dredging budgets not keeping pace with dredging costs
  - Reservoir capacities (flood, water supply, navigation, rec, etc.) are being reduced by sedimentation
  - Conventional dredging and dredged material placement alternatives are getting too expensive to be sustainable management practices

- **Objective**
  - Identify and promote adoption of innovative sediment management technologies applicable to BOTH navigation channels and reservoirs
WID in Reservoirs

- To date, WID has not been applied in reservoirs.

- However, the technology holds promise for reservoirs with the right conditions:
  - Fine sediments
  - Uncontaminated
  - Low-level outlets
WID and Tuttle Creek Lake

- Preliminary review of Tuttle Creek Lake indicates that it has potential to be a candidate for a WID demonstration.

  - Low Level Outlet: Tuttle Creek structure possesses one that is used frequently for discharges.

  - Tuttle Creek Lake studies show that sediment near the dam is fine-grained - very low critical shear stresses in the upper several feet of sediment (< 0.5 Pa), and that the fines are still very erodible at deeper depths (10 ft deep, close to the dam has Tc of 0.66 Pa).

  - Studies also show that these sediments are uncontaminated.
DOER Work Unit
WID-Related Aspects

1) Develop laboratory procedure for evaluation potential for site-specific sediments to be fluidized using the WID process;
2) Develop a suite of field tools that can be applied to evaluate sediment bulk properties at a site;
3) Utilizing bulk property data and laboratory testing, develop a screening matrix of sediment properties and site characteristics favorable for fluidization;
4) Develop a screening-level numerical model that identifies the potential for WID fluidized sediments to be transported as a density current under site-specific sediment, bed slope and hydrodynamic conditions;
5) Develop technical guidance describing field, laboratory, and numerical model application to evaluate potential use of WID at a site; and
6) Foster private industry/government collaboration to build WID infrastructure applicable to reservoir sediment management.
QUESTIONS?