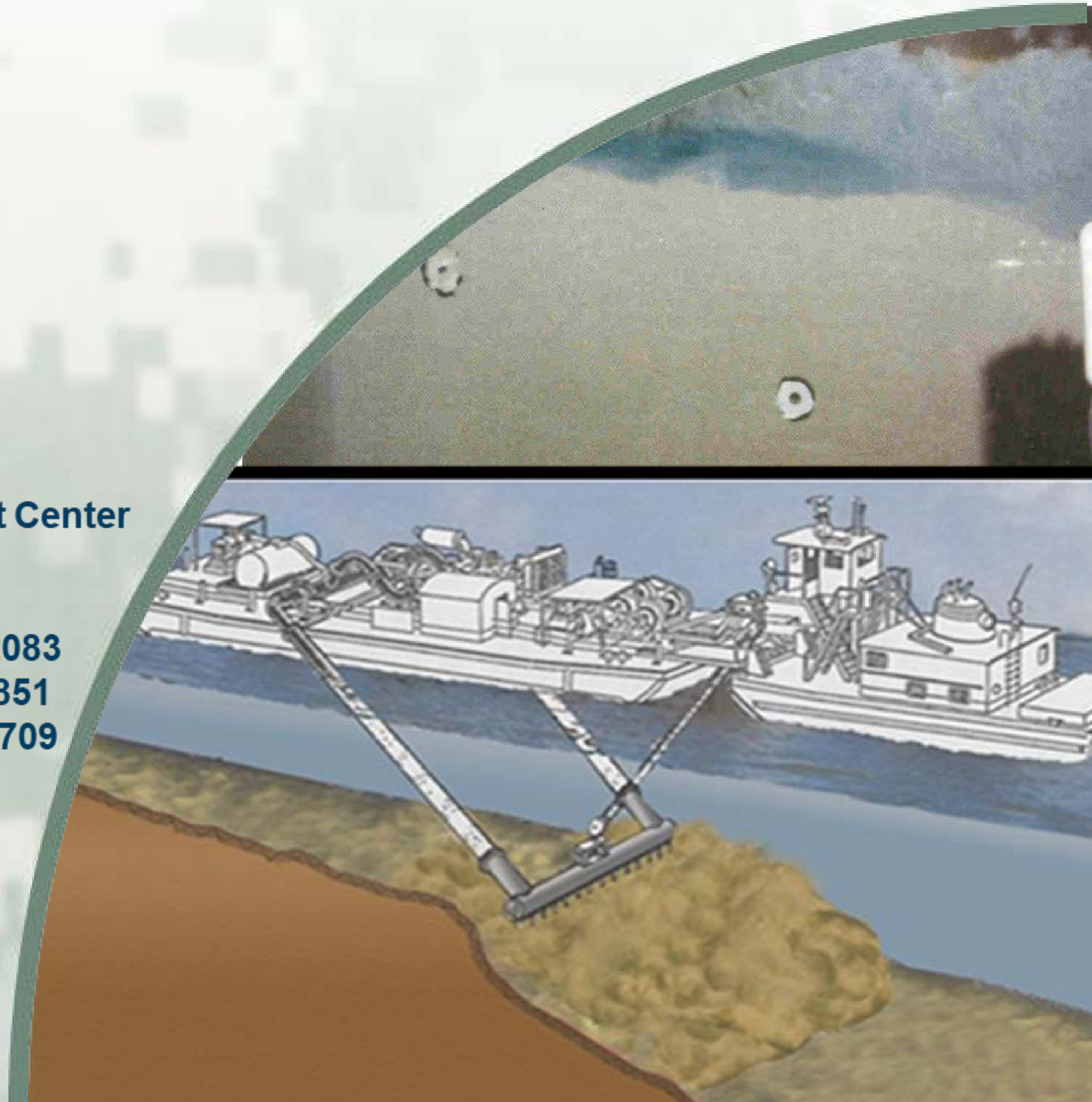
Overview of Water Injection Dredging (WID) and Potential Application to Reservoirs



Adapted from a presentation by

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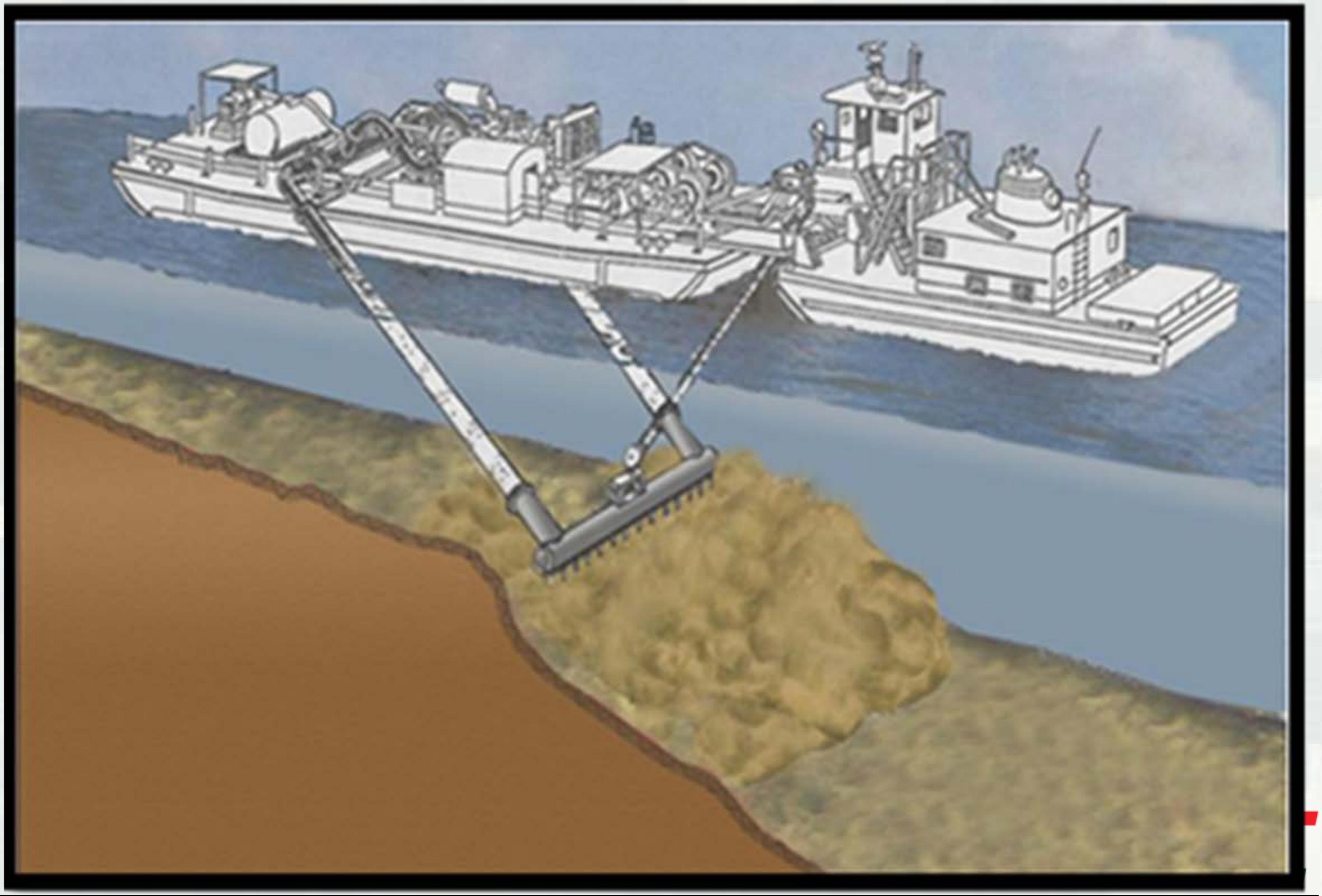
Reservoir Sediment Management Strategies

- 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

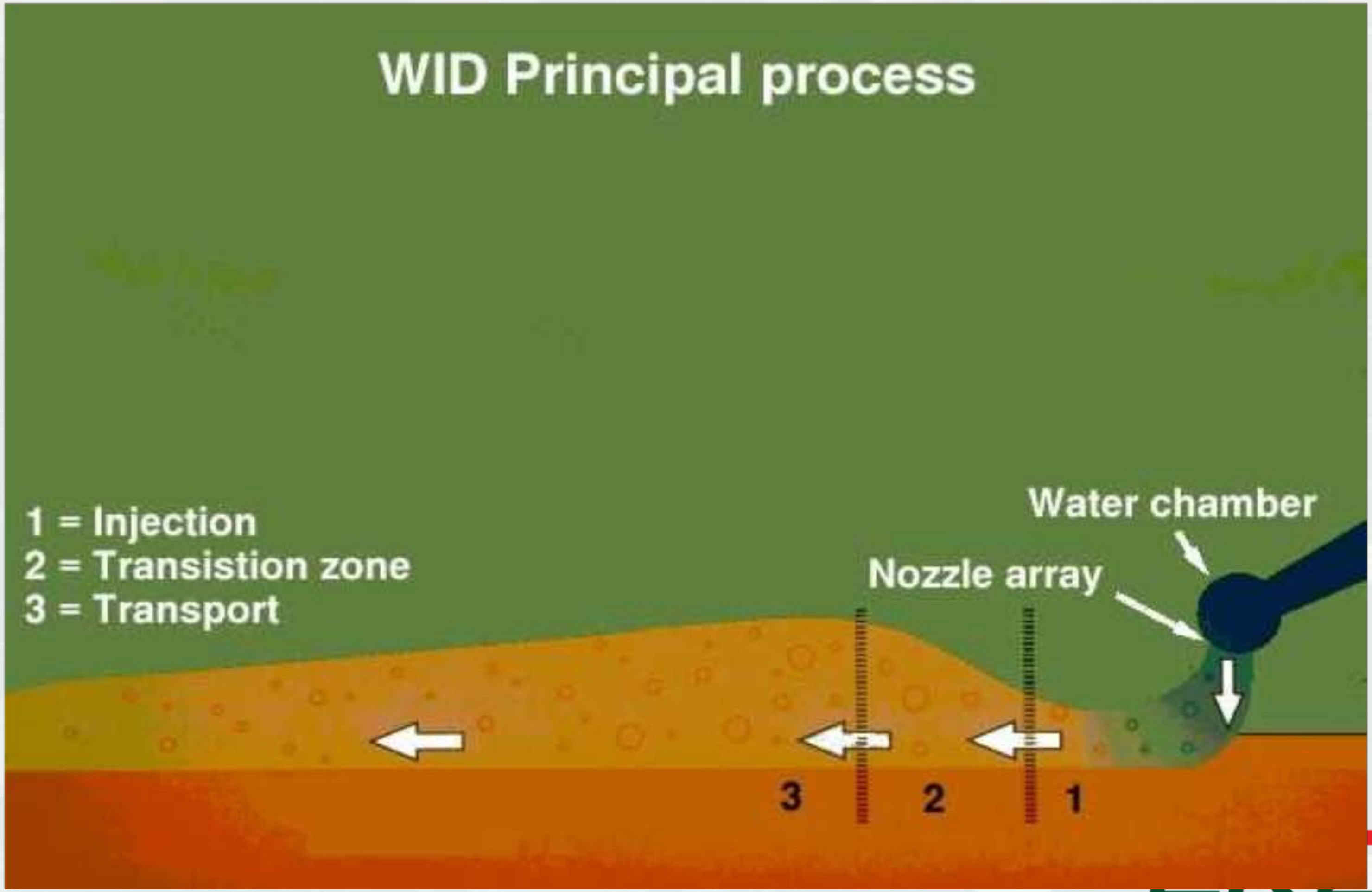
- ➢Water Injection Dredge (WID) Overview
- ➢Corps R&D
- ➢WID Potential Application to Tuttle Creek Lake

Water Injection Dredge (WID)



Density Current

Source: PIANC



https://www.youtube.com/watch?v=JfVK5rLYXiM

Worldwide WID

Worldwide WID

Worldwide WID

Worldwide WID

The Marine Group “150 m^3/hr in soft material”

TMS

http://www.tms-supplies.nl/documents/dredging-and-soil-improvement-equipment/small-dredgers.xm

Water Injection Dredge (WID)

Weeks Marine BT 773

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

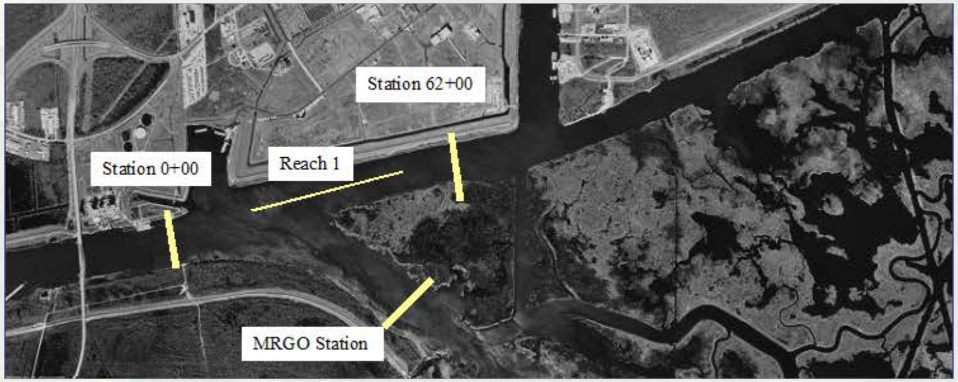
Project Name	Project Site	Cost ($)	Volume (yd^3)	Duration (days)	Production Rate (yd^3/hr)
Upper Mississippi River 1992	Minn. & Ill.	NA	8,000	4	182
Calumet 1994	LA	41,438	15,644	1	652
New Orleans Harbor 1998	LA	731,975	650,482	57	476
New Orleans Harbor 2001	LA	794,260	334,530	46	394
Houston Ship Channel Emergency 2001	TX	335,810	113,200	4	1,179
Houston Ship Channel Bayport Flare 2001	TX	NA	116,671	2	2,431
Houston Ship Channel Carpenters to Green Bayou 2001	TX	NA	26,259	4	274
Houston Ship Channel Bayport Flare 2001	TX	NA	97,900	3	1,360
New Orleans Harbor 2002	LA	1,619,968	888,406	40	925
Michoud Canal 2002	LA	79,264	232,235	4	2,419
MRGO* 2003	LA	98,900	350,000	4	3,645
Houston Ship Channel Mid Bay 2004	TX	1,183,014	566,507	89	265
New Orleans Harbor 2005	TX	2,339,686	531,046	28	790
Calumet 2010	LA	260,436	22,406	1	934

Source: Wilson 2007

WID Monitoring
Michoud Canal

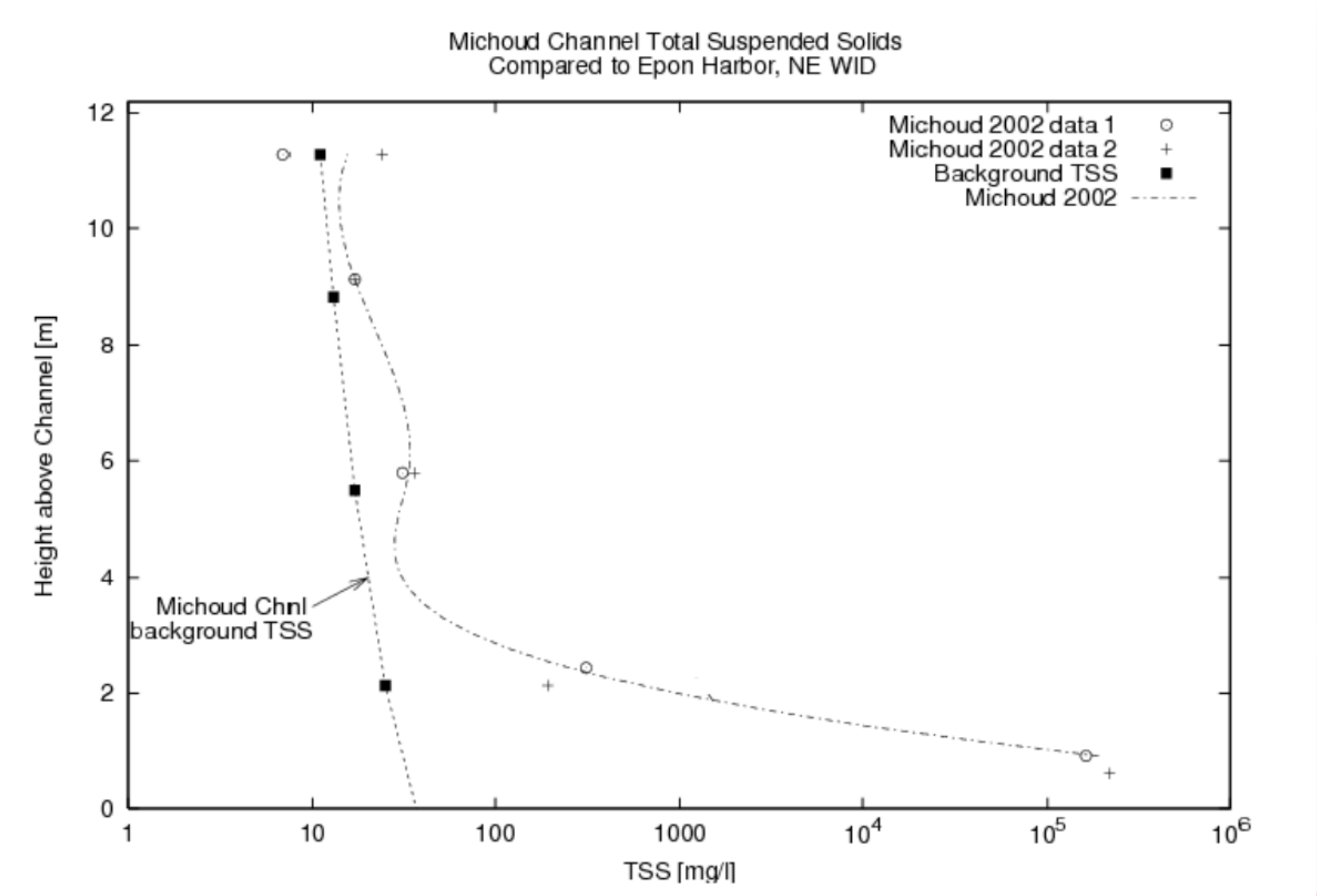
- WID worked 6-10 August 2002
- ERDC monitored 7 August 2002
- Focused on near and intermediate field density current characteristics

Density Current/Water Samples

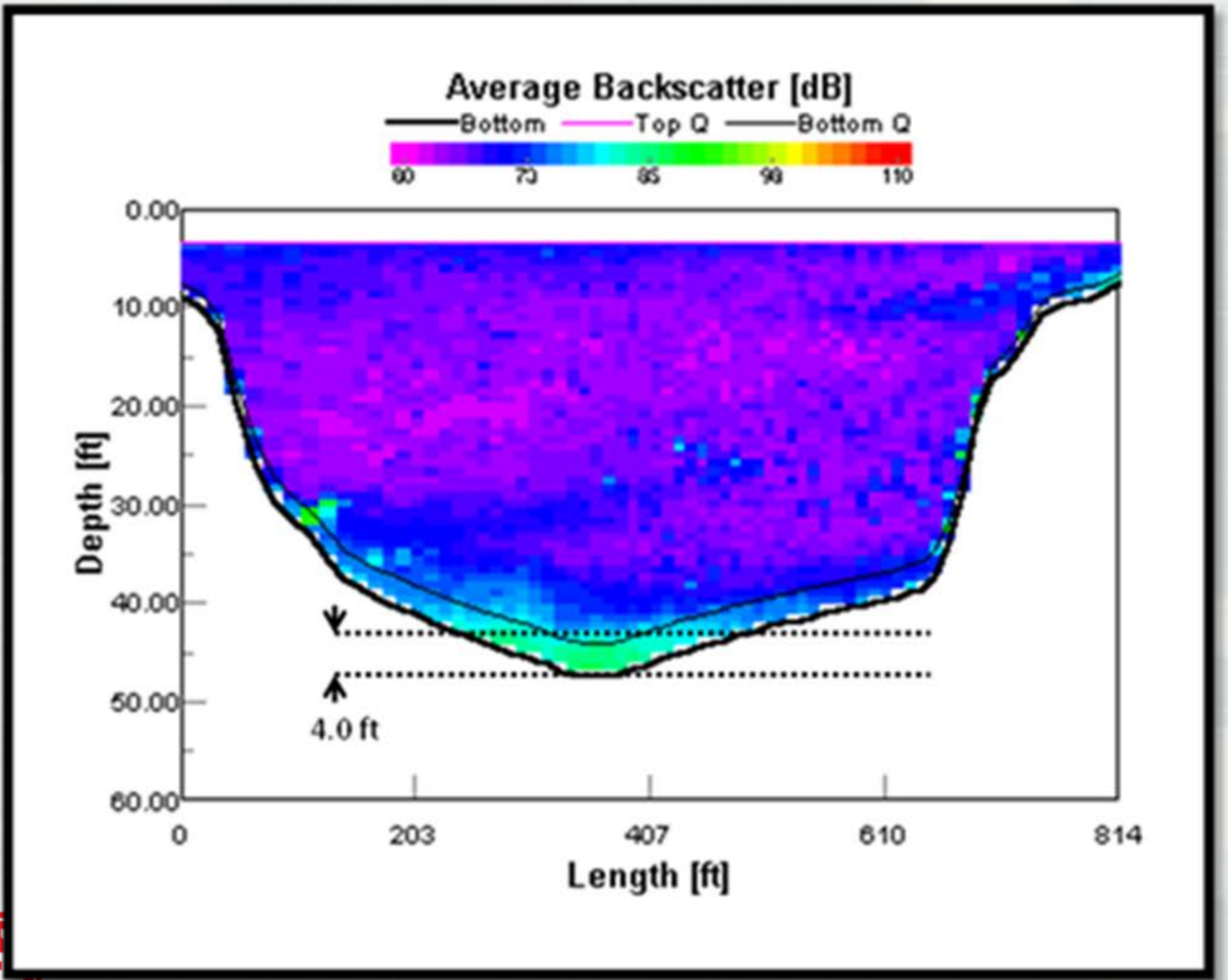


Total Suspended Solids (TSS) – mg/l

3 ft - 7	3 ft - 24
10 ft - 17	10 ft - 17
21 ft - 31	21 ft - 36
32 ft - 313	33 ft - 193
37 ft - 162641	38 ft - 219134


Michoud Channel Total Suspended Solids
Compared to Epon Harbor, NE WID
Michoud 2002 data 1
Michoud 2002 data 2
Background TSS
Michoud 2002
Height above Channel [m]
TSS [mg/l]
Michoud Chnl
background TSS
0
2
4
6
8
10
12
1
10
100
1000
10^4
10^5
10^6

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

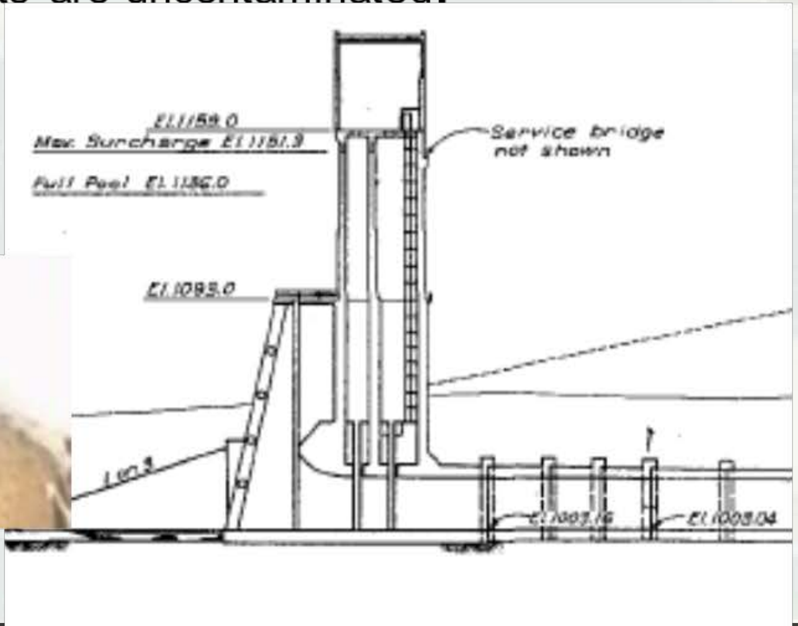
WID and Tuttle Creek Lake

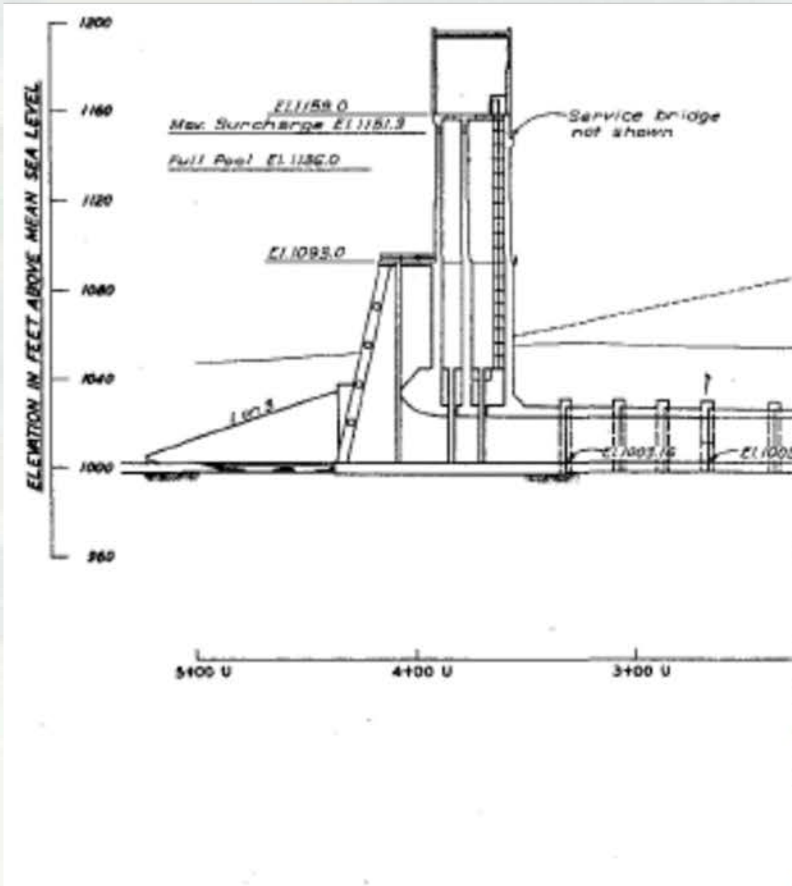
- Preliminary review of Tuttle Creek Lake indicates that it has potential to be a candidate for a WID demonstration.

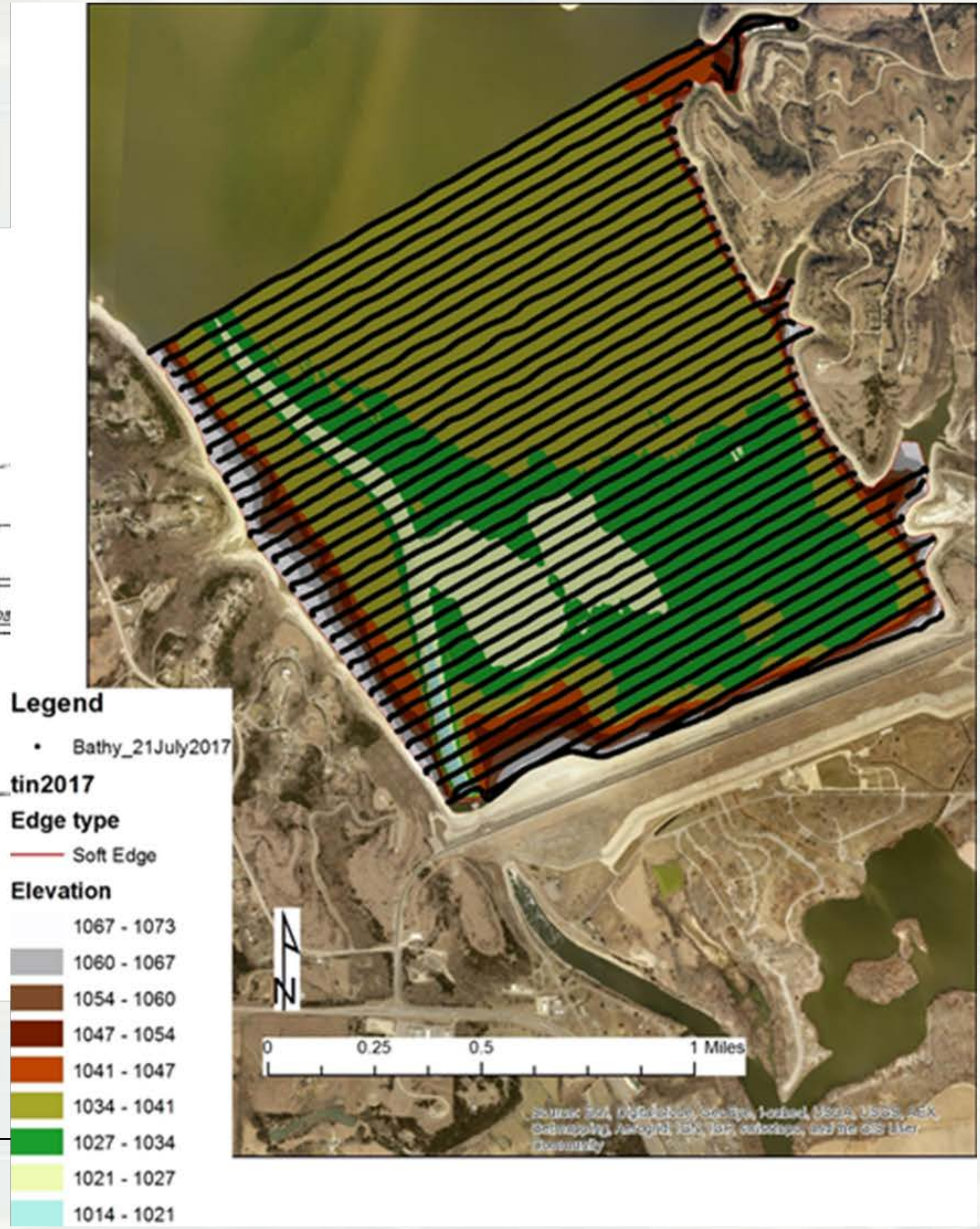
- ❑ Low Level Outlet: Tuttle Creek structure possesses one that is used frequently for discharges.

- ❑ 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.

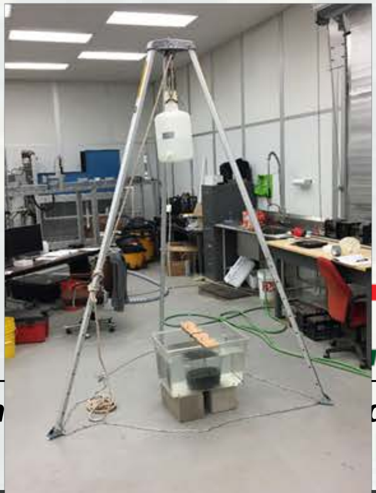



ELEVATION IN FEET ABOVE MEAN SEA LEVEL
1200
1160
1120
1080
1040
1000
960
El.1159.0
Max. Surcharge El.1151.3
Full Pool El.1150.0
Service bridge not shown
El.1095.0
1 on 3
5+00 U
4+00 U
3+00 U


Legend
Bathy_21July2017
tin2017
Edge type
Soft Edge
Elevation
1067 - 1073
1060 - 1067
1054 - 1060
1047 - 1054
1041 - 1047
1034 - 1041
1027 - 1034
1021 - 1027
1014 - 1021
N
0
0.25
0.5
1 Miles

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?