ALTERED HYDROLOGY – EFFECTS ON UPPER MISSISSIPPI RIVER DREDGING AND HABITAT RESTORATION

Presented at the Upper Mississippi River Conference, Moline, Illinois, October 24, 2019

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AGENDA

Navigation
Upper Mississippi River Restoration (UMRR) Program
Hydrologic Trends
Water Exchange Rates
Dredging Trends
Future Challenges
EMPHASIS IS ON REACH FROM LOCK & DAM 2-10

Upper Pool 9
Lower Pool 8
Lock 8 Embankment

BUILDING STRONG®
and Taking Care of People!
Dredging and Dredge Material Management ...

Average dredging season length = 178 days, range = 106 to 237 days
UPPER MISSISSIPPI RIVER RESTORATION PROGRAM

Authorized by Congress in 1986

Two Elements
1. Habitat Rehabilitation and Enhancement Projects
2. Long-Term Resource Monitoring

Three Districts
**POOL 8, PHASE III, STAGE 3A AND 3B ISLANDS**

<table>
<thead>
<tr>
<th>STAGE</th>
<th>Granular (sand) Used and Source</th>
<th>Benefits to Channel Maintenance?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 3A</td>
<td>340,000 yd³ of granular fill from placement sites</td>
<td>Provided 5 years of additional capacity at placements sites</td>
</tr>
<tr>
<td>Stage 3B</td>
<td>165,000 yd³ of granular fill from navigation channel cuts</td>
<td>No Benefit – Sand was obtained from a reach of channel that isn't normally dredged.</td>
</tr>
</tbody>
</table>

Note – Average Annual Dredging for Pool 8 is 72,000 yd³/year for the years 1981-2018
FLOOD EFFECTS ON PROJECTS

Islands were stable during the 1993 flood. Note green rows of grass beneath water.
Average Annual Discharge at Winona
1943 to 1980 = 29,000 cfs
1981 to 2018 = 36,700 cfs (26.5 % increase)

2016, 2017, and 2018 = 45,000, 48,000 and 51,000 cfs
HYDROLOGY

Decade Overbank Flooding Events
1930-1939 0
1940-1949 1
1950-1959 3
1960-1969 5
1970-1979 2
1980-1989 5
1990-1999 9
2000-2009 6
2010-2019 17
LATE SEASON HIGH WATER

Number of events that exceeded 40,000 cfs during fall and winter months for the 1942 to 1980 and 1981 to 2019 time periods. Pool 3 at Prescott, WI

<table>
<thead>
<tr>
<th>Time Period</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946 to 1980</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1981 to 2015</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

A discharge of 40,000 cfs was exceeded in October for each year from 2016 to 2019
WATER EXCHANGE (2 CONSIDERATIONS)


2. Distribution of Water within the River Valley
WATER EXCHANGE

In this example, the water exchange ratio between the channel and the backwater is

\[ \frac{Q_3}{Q_{\text{dam}}} \] where \( Q = \) river flow

Expressed as a ratio or percentage
WATER EXCHANGE - A SURROGATE FOR GEOMORPHIC CHANGE

Change in Water Exchange Ratio
Lower Pool 7

<table>
<thead>
<tr>
<th>Water Exchange Ratio</th>
<th>1994-95</th>
<th>2015-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation Channel</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Old Nav Channel</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Lake Onalaska</td>
<td>0.3</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Change in Water Exchange Ratio:
- Shifted dredging downstream
- Increased outdraft at LD 7
ANNUAL DREDGING, ST. PAUL DISTRICT

Total Dredging: Minnesota, St. Croix and Mississippi Rivers
By Year (1981 - 2018)

2019?
MOSQUITO ISLAND BENEFICIAL USE PROJECT

March 22, 2018

May 24, 2018

USGS 05378500 MISSISSIPPI RIVER AT WINONA, MN

5-Year Flood
2-Year Flood

--- Provisional Data Subject to Revision ---

Daily mean discharge

Value is affected by ice at the measurement site.
HARPERS SLOUGH HREP: 2018 AND 2019 FLOOD EFFECTS

Sept 13, 2017

June 27, 2019

Fine Sediments
FUTURE – IF CURRENT TRENDS CONTINUE:

Will existing projects be damaged? Yes and No.
Will recently constructed projects be damaged? Yes

Will dredging volumes continue to increase? Yes
1. Sand loads from tributaries will continue to be higher
2. Sediment Sinks (backwaters, other off-channel areas) will decrease

Project Teams need to consider this during Planning, Design, and Construction.
### FUTURE PROJECTS

<table>
<thead>
<tr>
<th>Project</th>
<th>Beneficial Use</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Pool 10</td>
<td>Y</td>
<td>2021</td>
</tr>
<tr>
<td>McGregor Lake</td>
<td>Y</td>
<td>2020</td>
</tr>
<tr>
<td>Conway Lake</td>
<td>Y</td>
<td>2020</td>
</tr>
<tr>
<td>Reno Bottoms</td>
<td>Y</td>
<td>2022</td>
</tr>
<tr>
<td>Upper Pool 4</td>
<td>Y</td>
<td>2021</td>
</tr>
<tr>
<td>Lock and Dam 2 Island</td>
<td>Y</td>
<td>2020</td>
</tr>
<tr>
<td>Pigs Eye Lake</td>
<td>Y</td>
<td>2021</td>
</tr>
<tr>
<td>Bass Ponds</td>
<td></td>
<td>2020</td>
</tr>
</tbody>
</table>

- **Bass Ponds**
- **McGregor Lake**
- **Conway Lake**
- **Reno Bottoms**
- **Upper Pool 4**
- **Lock and Dam 2 Island**
- **Pigs Eye Lake**
- **Lower Pool 10**

*Map showing locations of future projects.*
CONCLUSIONS

Changes in Climate and Land-use

Altered Hydrology
Increased Flow and Number of Overbank Flooding Events

Sediment Transport, Deposition, and Erosion
Increased Sediment Loads | New Construction Vulnerable | Existing Projects Affected

Driver
Stressor
Mgmt
Action
Effect & New Endpoint

Future

Project Teams Consider New Hydrologic Risk
- Use Lessons Learned from last four decades
Adjust Planning and Design
- Stabilization, Operation and Maintenance

Islands
Backwater Dredging
Dredge Material Management
Floodplain Forests