HYDRAULIC CONCERNS 2019 AND 2020

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US Army Corps of Engineers®

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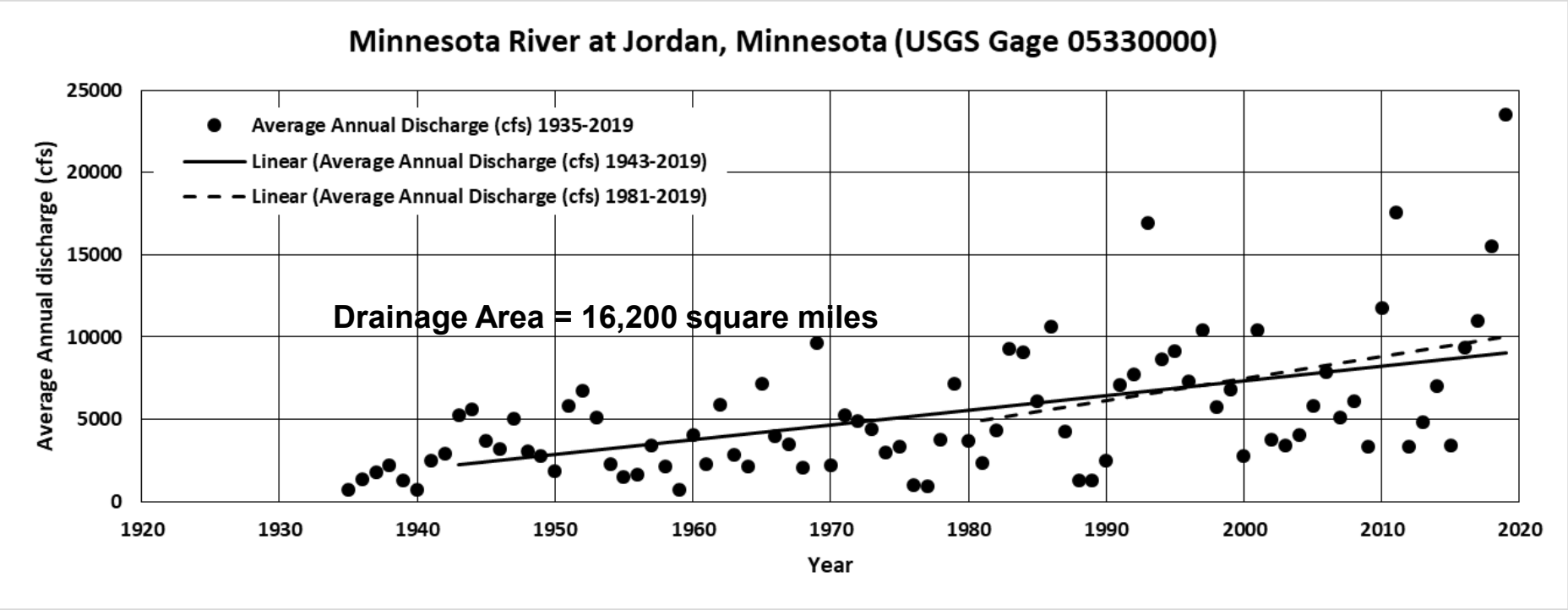
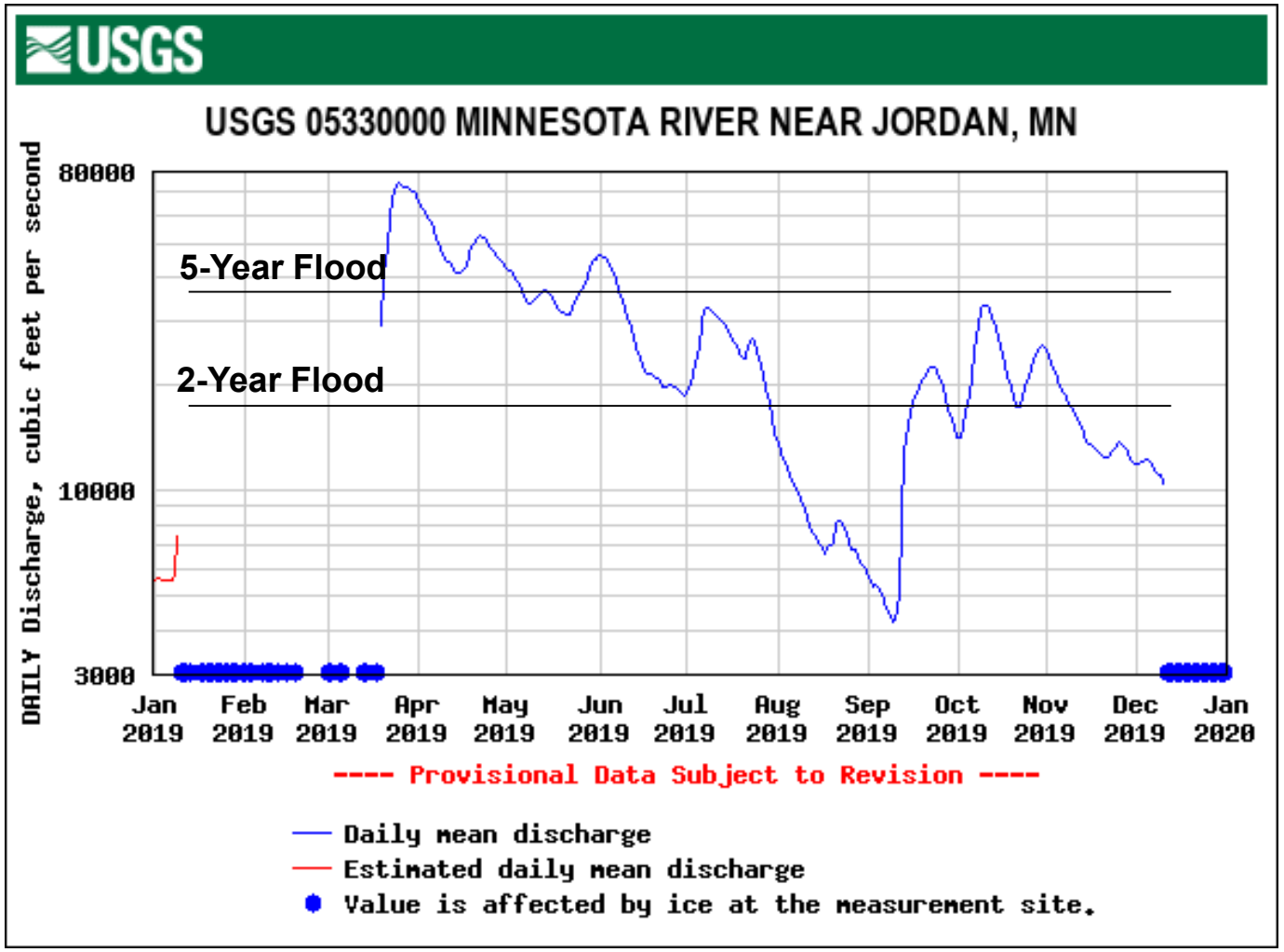
MINNESOTA RIVER



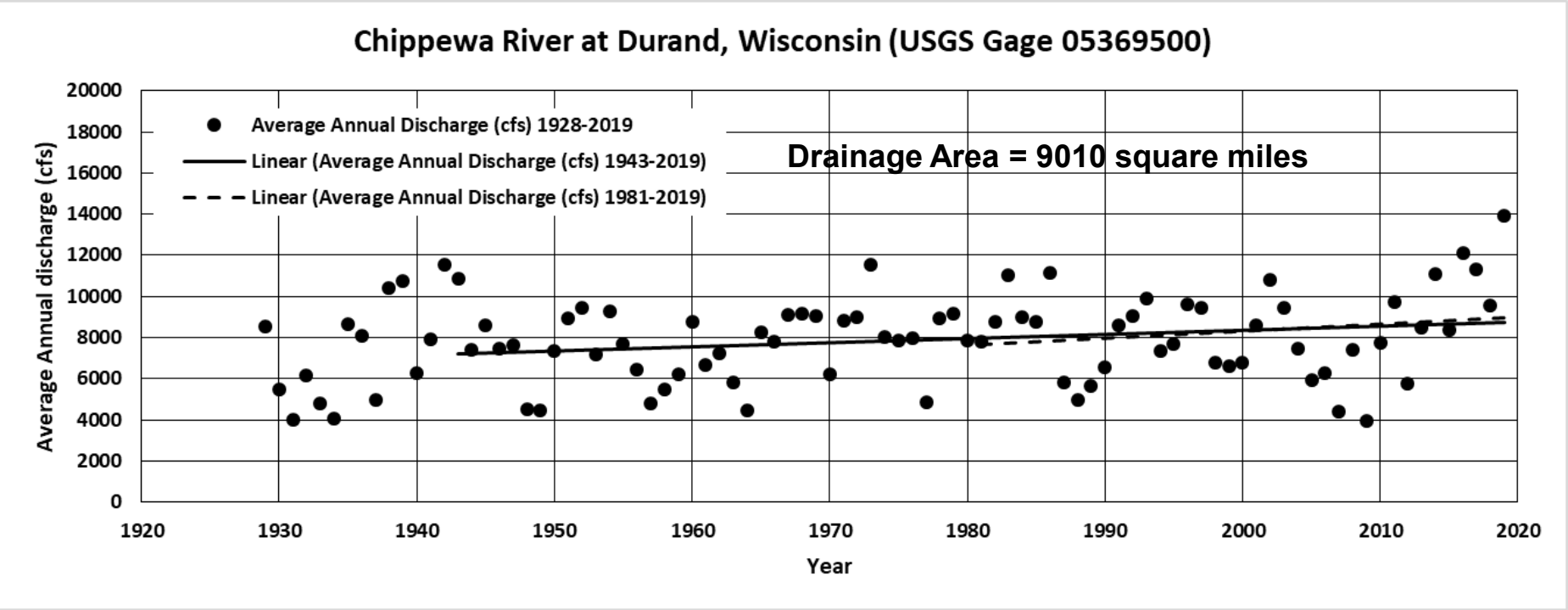
Decade	Bankful Flooding Events
1930-1939	0
1940-1949	1
1950-1959	3
1960-1969	5
1970-1979	2
1980-1989	5
1990-1999	9
2000-2009	6
2010-2019	18

- There is a statistically significant trend of increasing discharge from 1943 to 2019
- Average Discharge at Jordan
  - 1943 to 1980 = 3770 cfs
  - 1981 to 2019 = 7460 cfs (double the 1943 to 1980 ave.)
- Discharge in 2016, 2017, 2018, 2019 = 9360, 11,000,15520, 23550 cfs
- The number of bankfull flooding events (Q > 26,000 cfs) has increased in the 2010s (see table)
- 2010 to 2019 is wettest decade on record

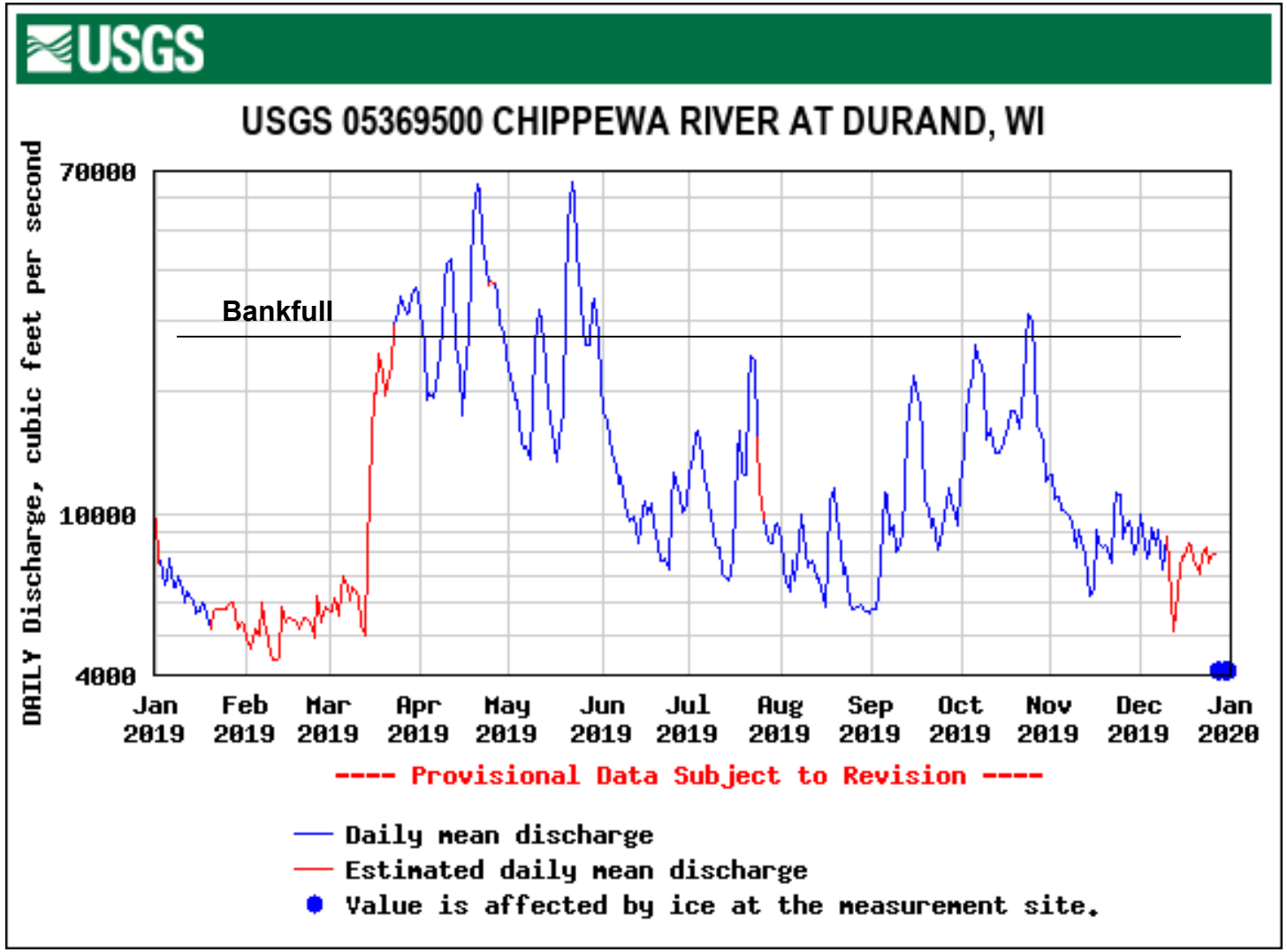
MINNESOTA RIVER, 2019



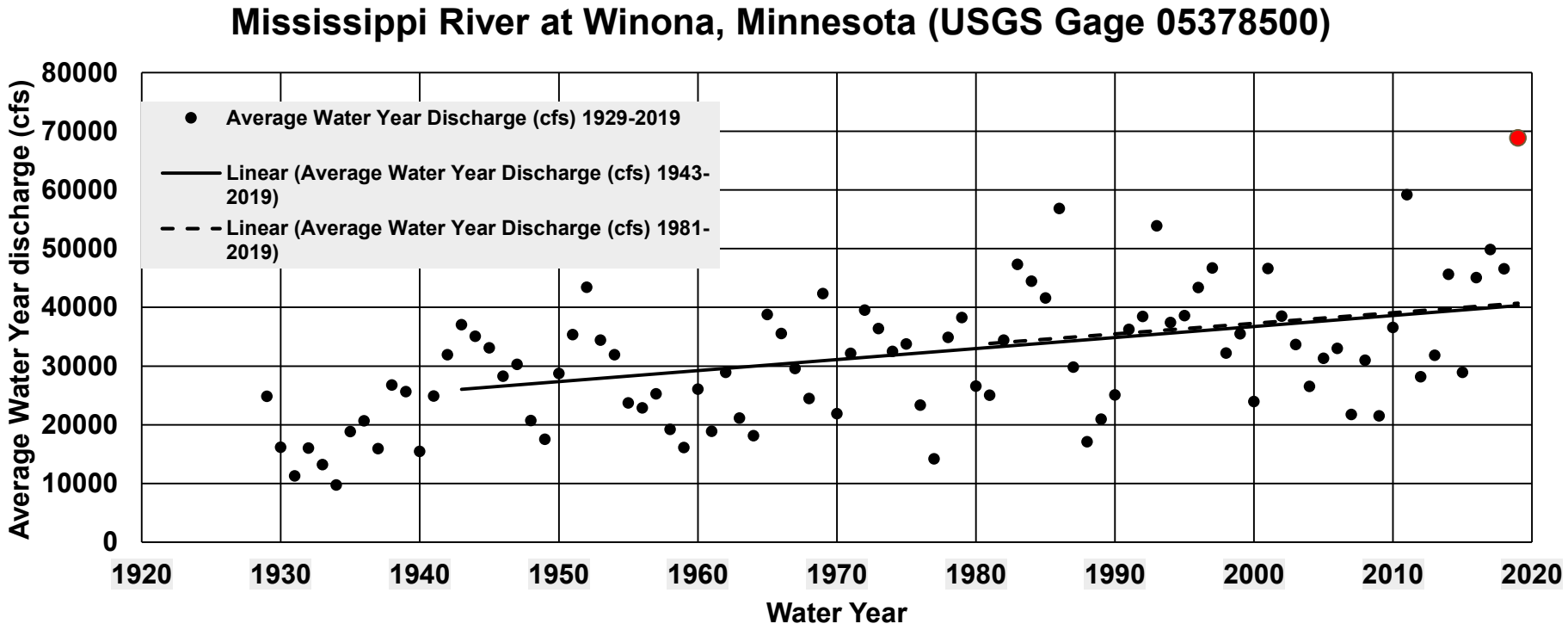
CHIPPEWA RIVER



CHIPPEWA RIVER, 2019

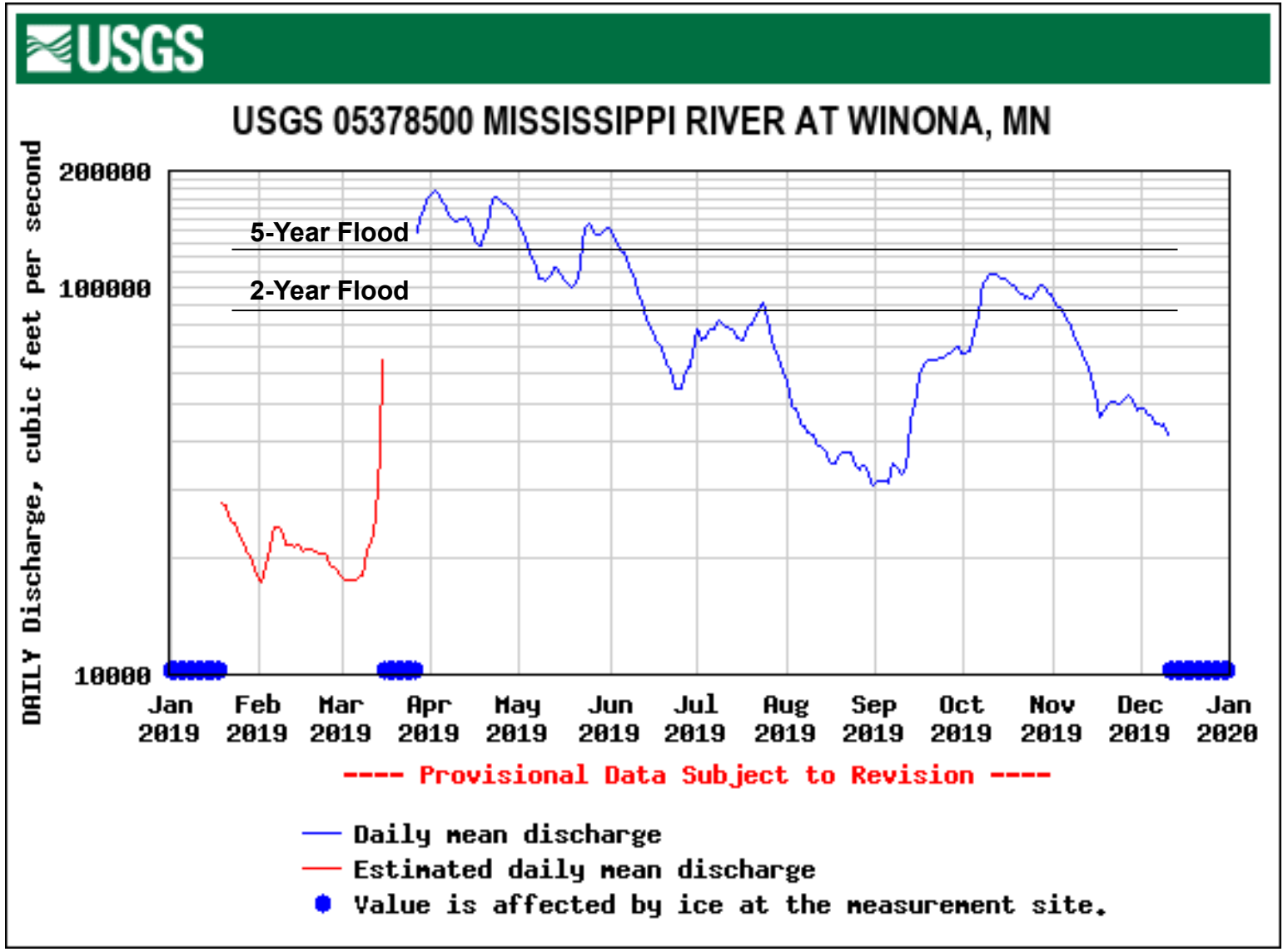


MISSISSIPPI RIVER



Average Water Year Discharge at Winona
1943 to 1980 = 29,000 cfs
1981 to 2019 = 37,300 cfs (28.6 % increase)

2016, 2017, 2018, 2019 = 45,000, 48,000, 51,000 and 69,000 cfs
2010 to 2019 is wettest decade on record

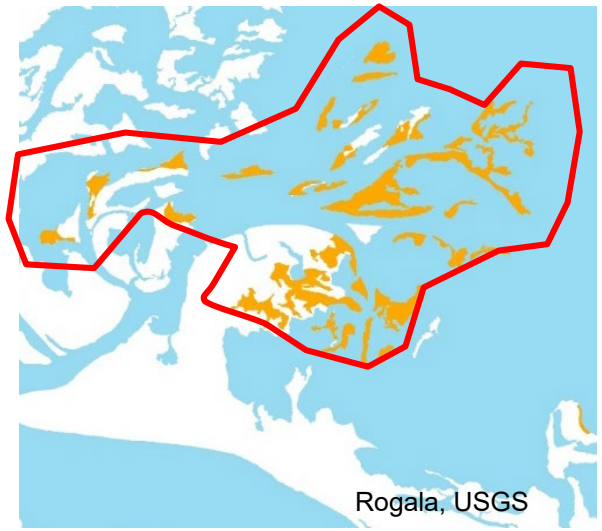

USGS
USGS 05378500 MISSISSIPPI RIVER AT WINONA, MN
DAILY Discharge, cubic feet per second
200000
100000
10000
5-Year Flood
2-Year Flood
Jan 2019
Feb 2019
Mar 2019
Apr 2019
May 2019
Jun 2019
Jul 2019
Aug 2019
Sep 2019
Oct 2019
Nov 2019
Dec 2019
Jan 2020
---- Provisional Data Subject to Revision ----
Daily mean discharge
Estimated daily mean discharge
Value is affected by ice at the measurement site.

HYDROLOGY, GEOMORPHIC CHANGE, AND DREDGING

- Higher flow rates are accelerating geomorphic change:
  - Tributary sand loads are increasing??
  - Increased bank erosion
  - Sediment Sinks are decreasing
  - Side Channel – Delta Change

- Altered Navigation Channel Shoaling, Dredging, and Flow Patterns

- Pool 7 is Probably Most Significant Example to Date
  - Outdraft
  - Shift in Dredging
  - Greater sand loads to Pool 8??



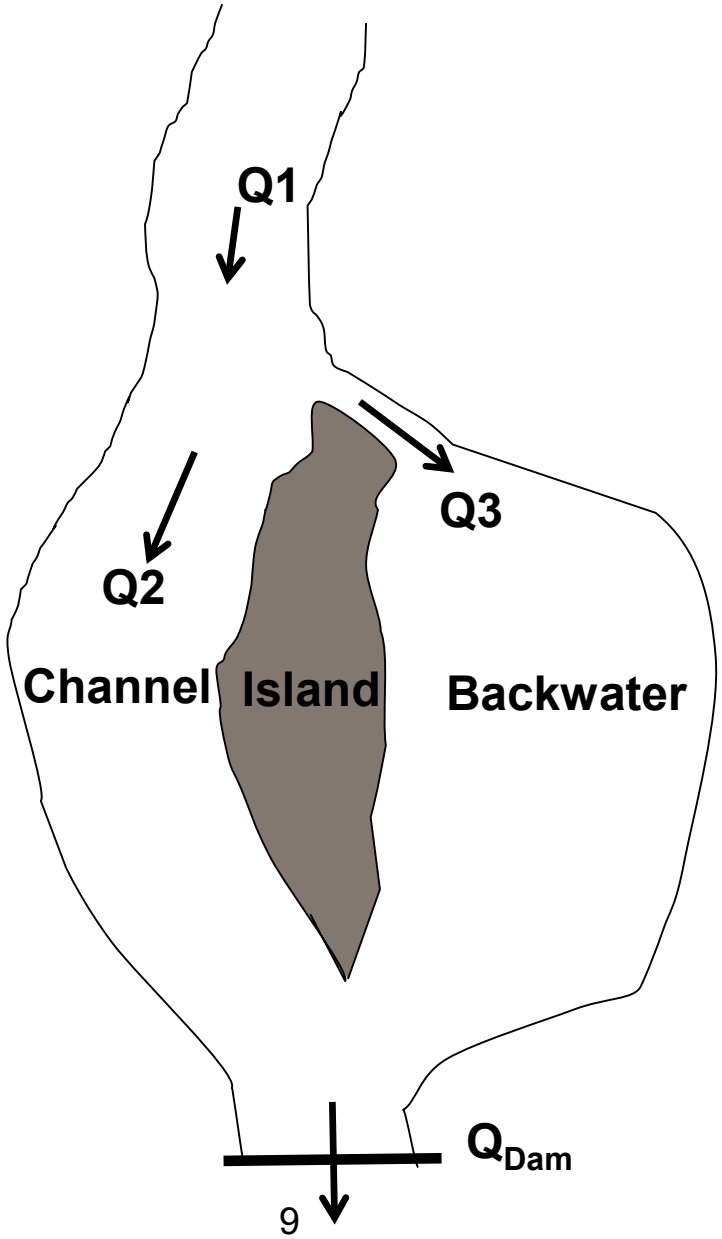
Hydrogeomorphic units

WATER EXCHANGE

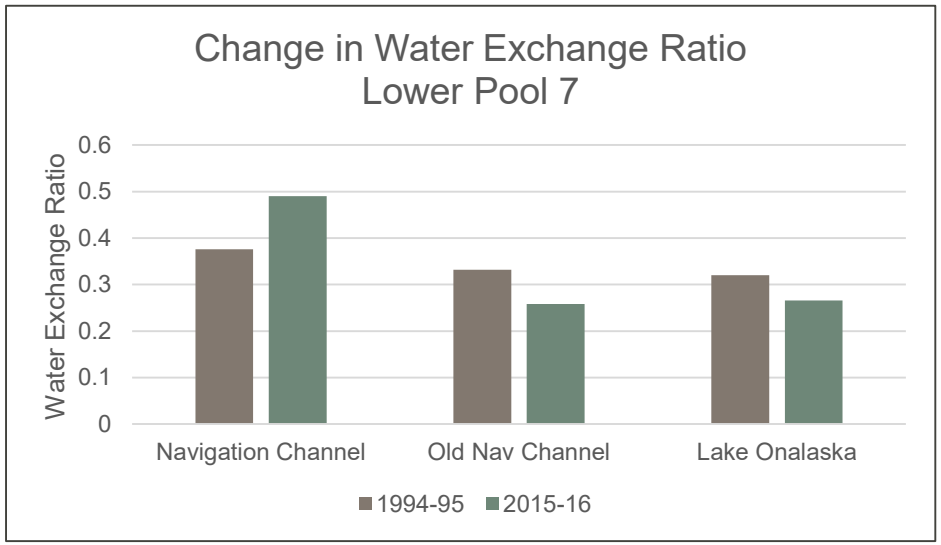
In this example, the water exchange ratio between the channel and the backwater is

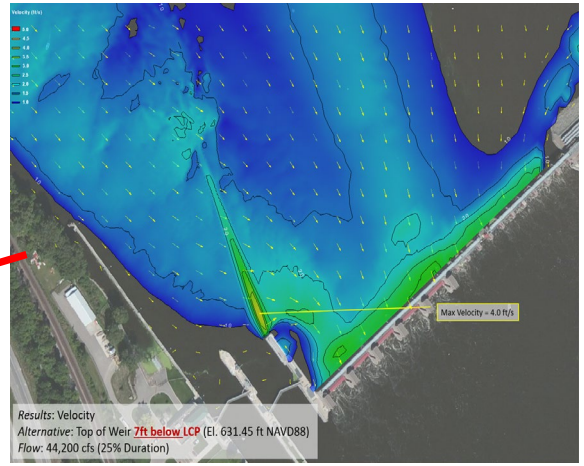
Q_3/Q_{dam} where Q = river flow

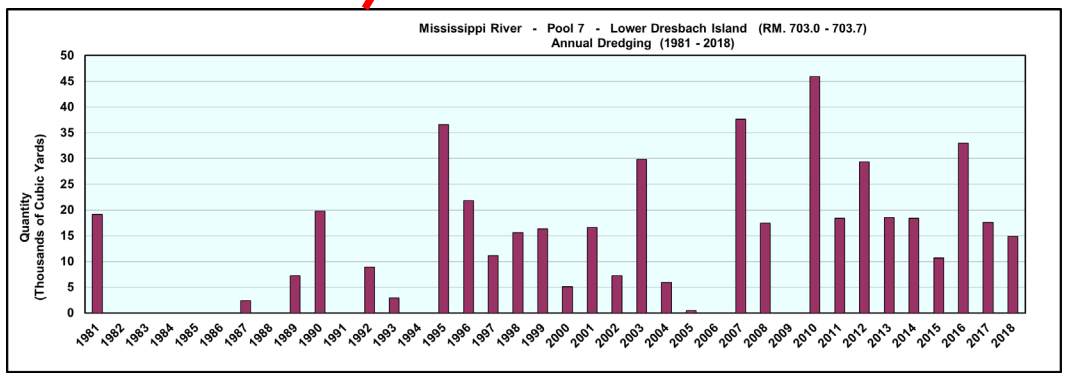
Expressed as a ratio or percentage



WATER EXCHANGE – A SURROGATE FOR GEOMORPHIC CHANGE

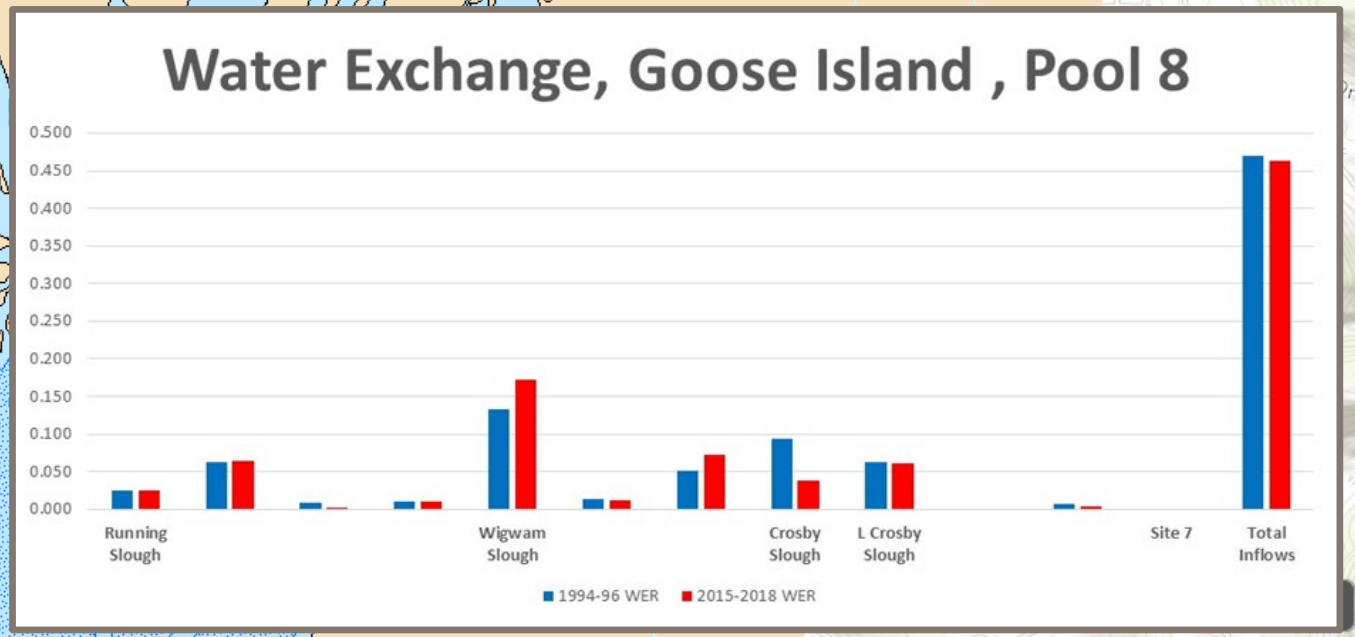




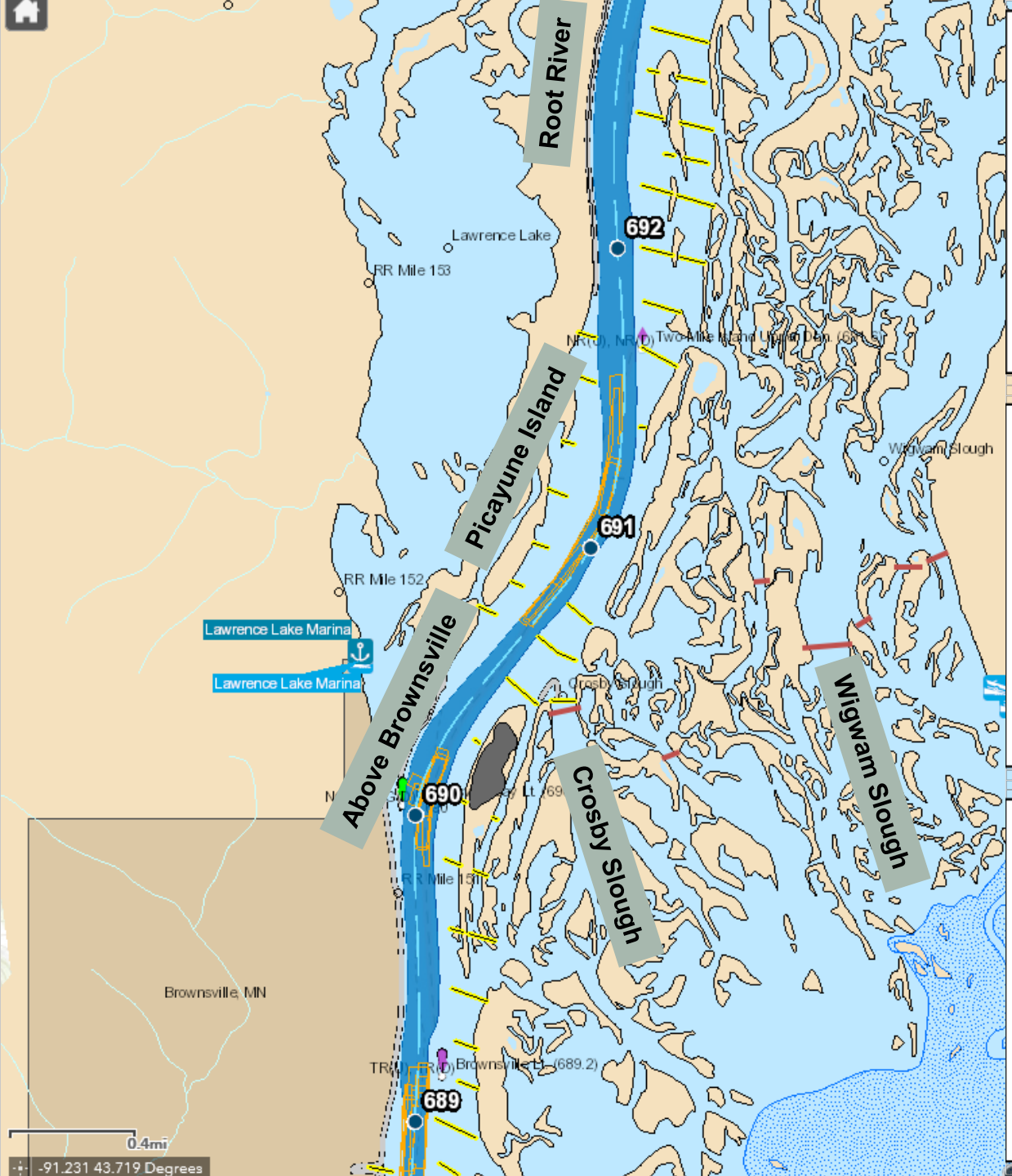


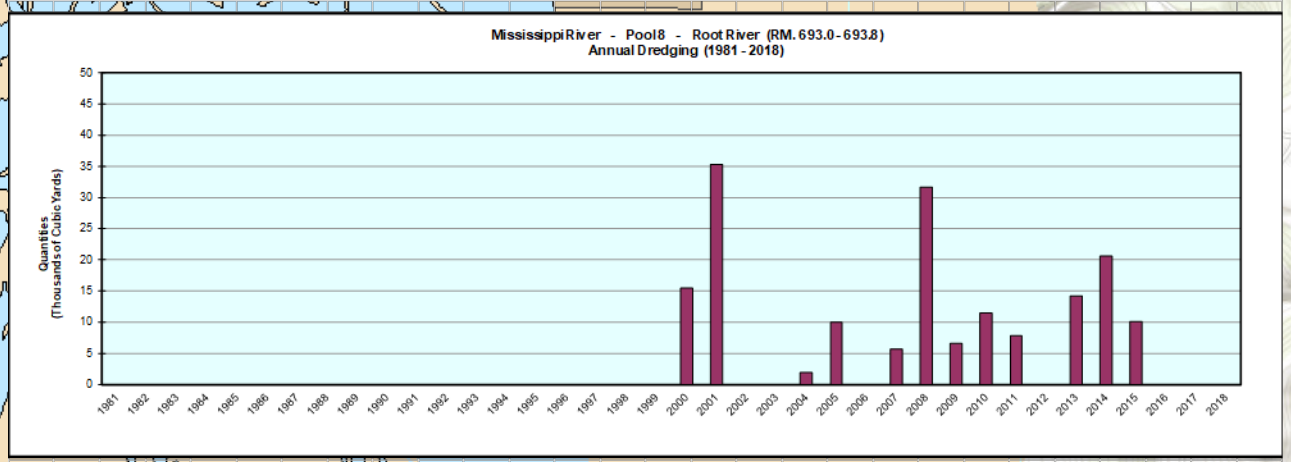
Change in Water Exchange Ratio:

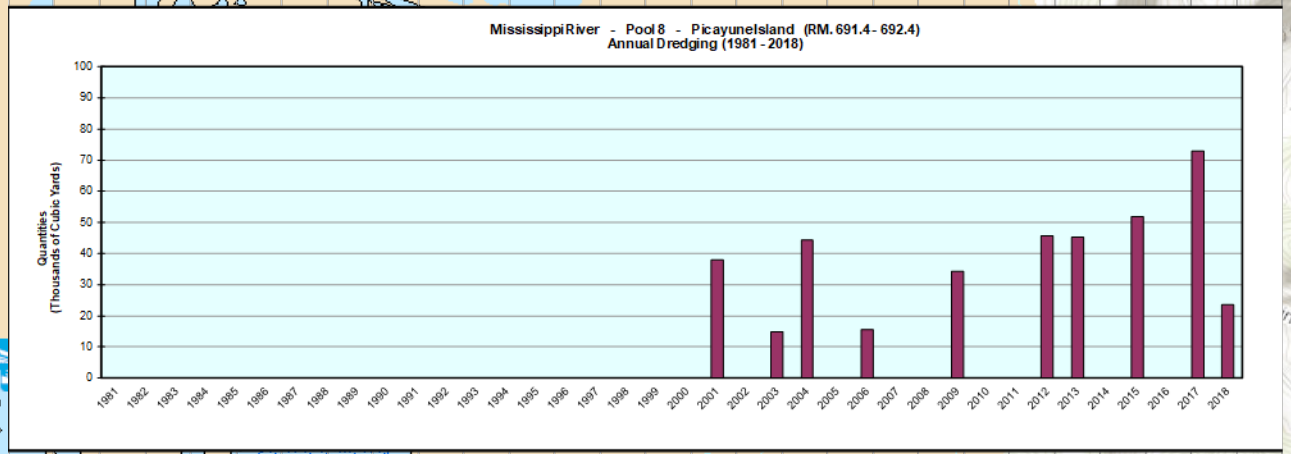
- Shifted dredging downstream
- Increased outdraft at LD 7

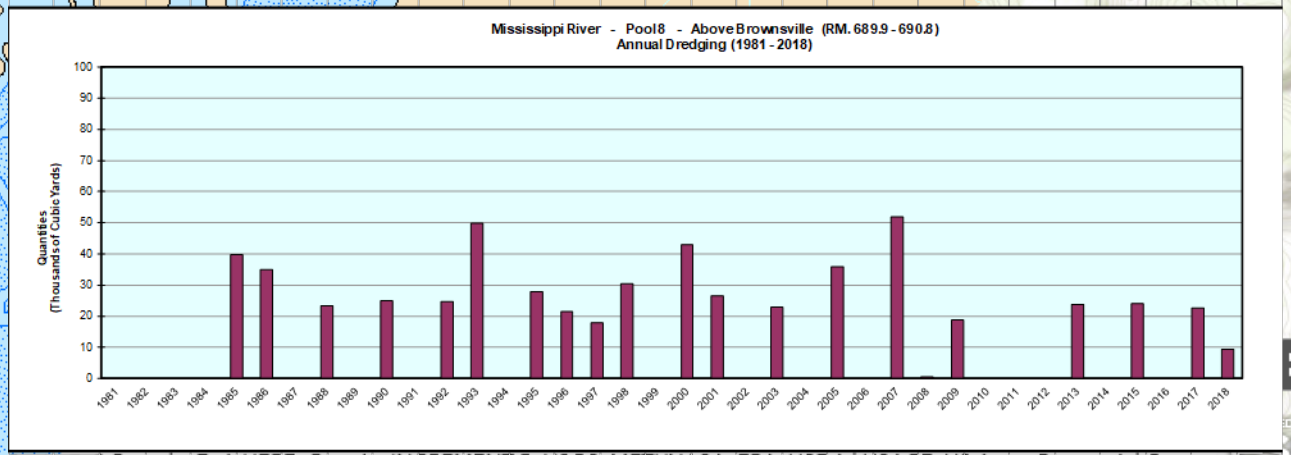


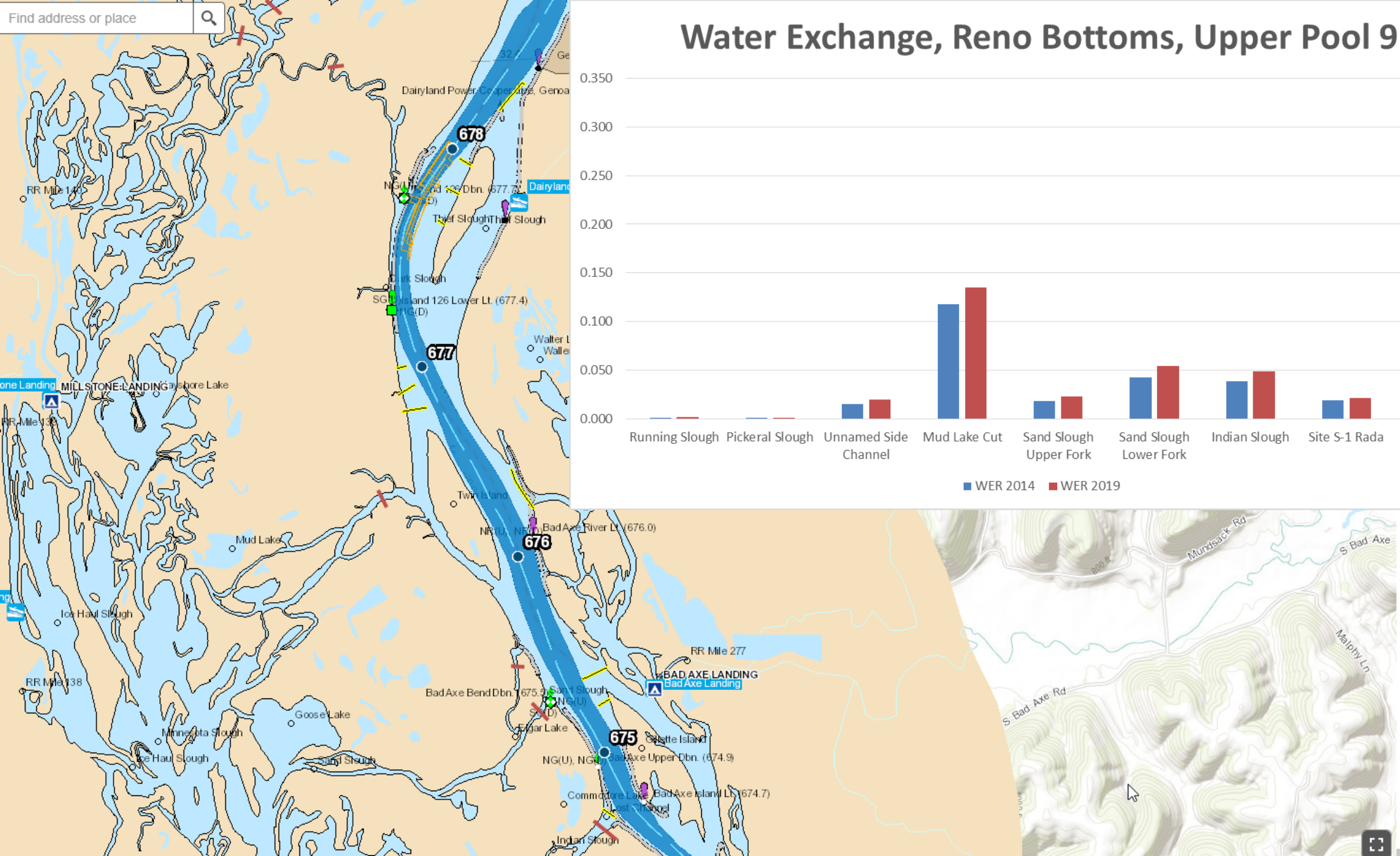
Goose Island
Goose Island Landing
Lawrence Lake
RR Mile 153
692
691
RR Mile 152
Lawrence Lake Marina
Lawrence Lake Marina
Wigwam Slough
Crosby Slough
690
Brownsville, MN
689
0.4mi
-91.231 43.719 Degrees
Esri Canada, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA | USACE, US Army Geospatial Cen...









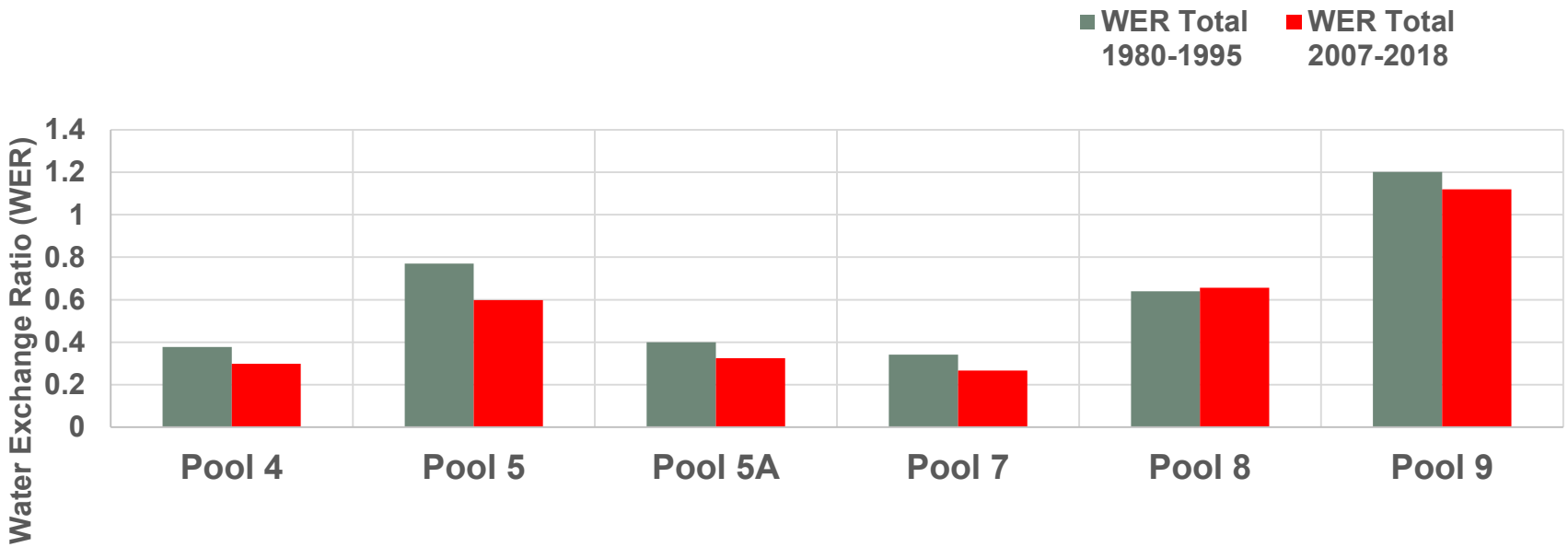


Water Exchange, Reno Bottoms, Upper Pool 9

WATER EXCHANGE RATIO, GEOMORPHIC REACH 3

Total Water Exchange Ratio (WER) for Navigation Pools in Geomorphic Reach 3
for the Discharge Exceeded 25% of the Time Annually

$$WER = (\sum Q_{backwater}/Q_{total})$$



SEDIMENT MEASUREMENTS CHIPPEWA RIVER AT DURAND AND PEPIN

District/Other USACE PDT Members

St. Paul – Jon Hendrickson, Zach Kimmel, Alex Nelson

ERDC – David Abraham, William Butler

Leveraging/Collaborative Opportunities

1. St. Paul was developing a support agreement with the USGS
2. MVD suggested including ERDC ISSDOTv.2 surveys and methods
3. RSM funds created the St. Paul, ERDC, USGS team

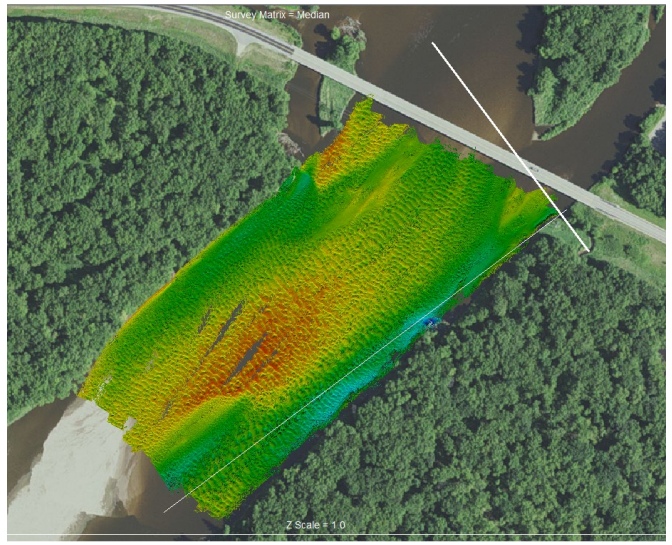
Stakeholders/Partners

Jeff Ziegeweid, Will Lund, Joel Groten, USGS Minn.

Dave Dean, USGS Grand Canyon Research Center

Dan Buscombe, Northern Arizona State University

Faith Fitzpatrick, Joe Shuler, USGS Wisc.



CHIPPEWA RIVER SCHEDULE

2017

- **Field Reconnaissance of Durand to Pepin Reach - St. Paul District, USGS, USACE-ERDC personnel.**
- **Purchased Equipment and set up monitoring stations this year**

2018

- **USGS begins collecting data. Combined effort between Minnesota, Wisconsin, Arizona, & California Water Science Centers**
- **USACE-ERDC and St. Paul personnel measure bed load using Dune-Tracking Technology using Regional Sediment Management (RSM) funds.**

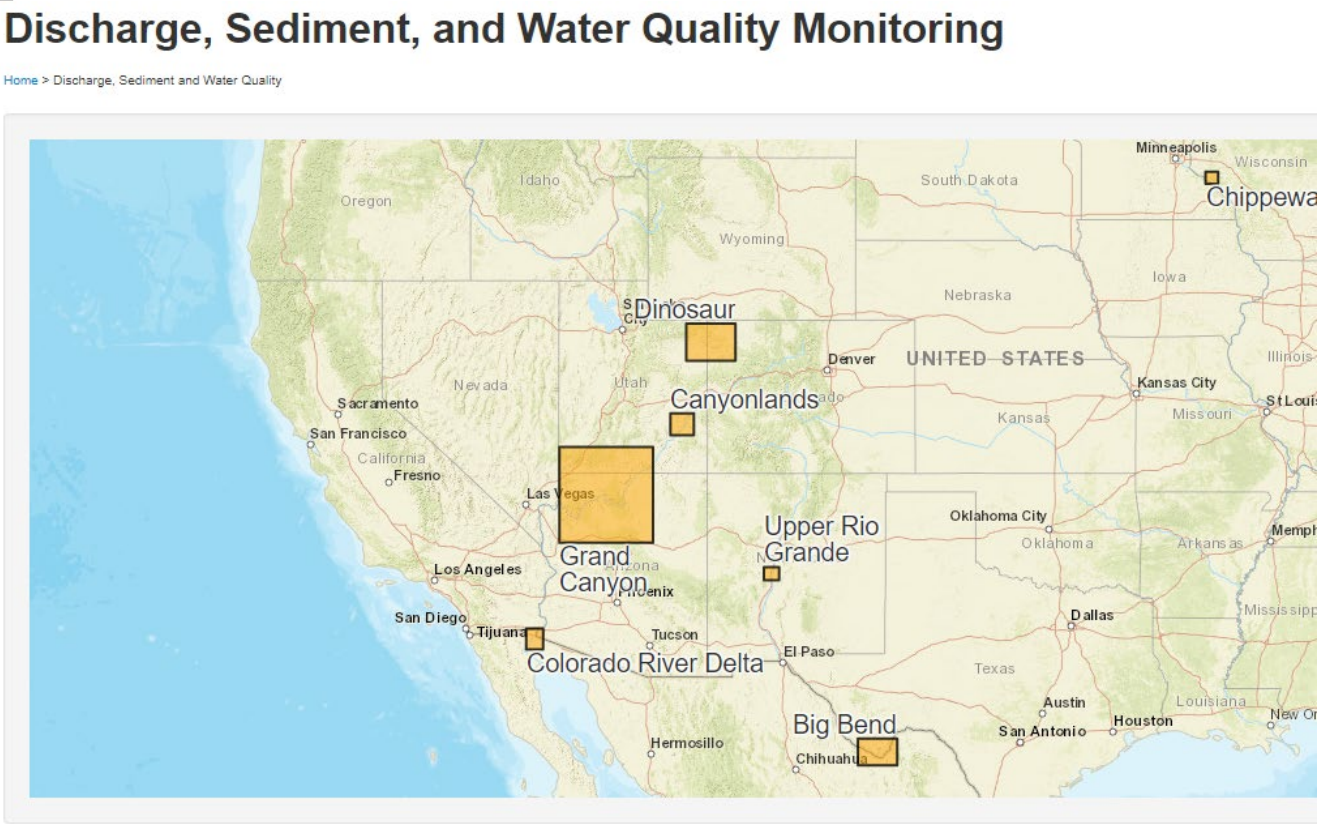
2019

- **USGS continue data collection**
- **St. Paul district develop HEC-RAS sediment model using RSM funds**

2020

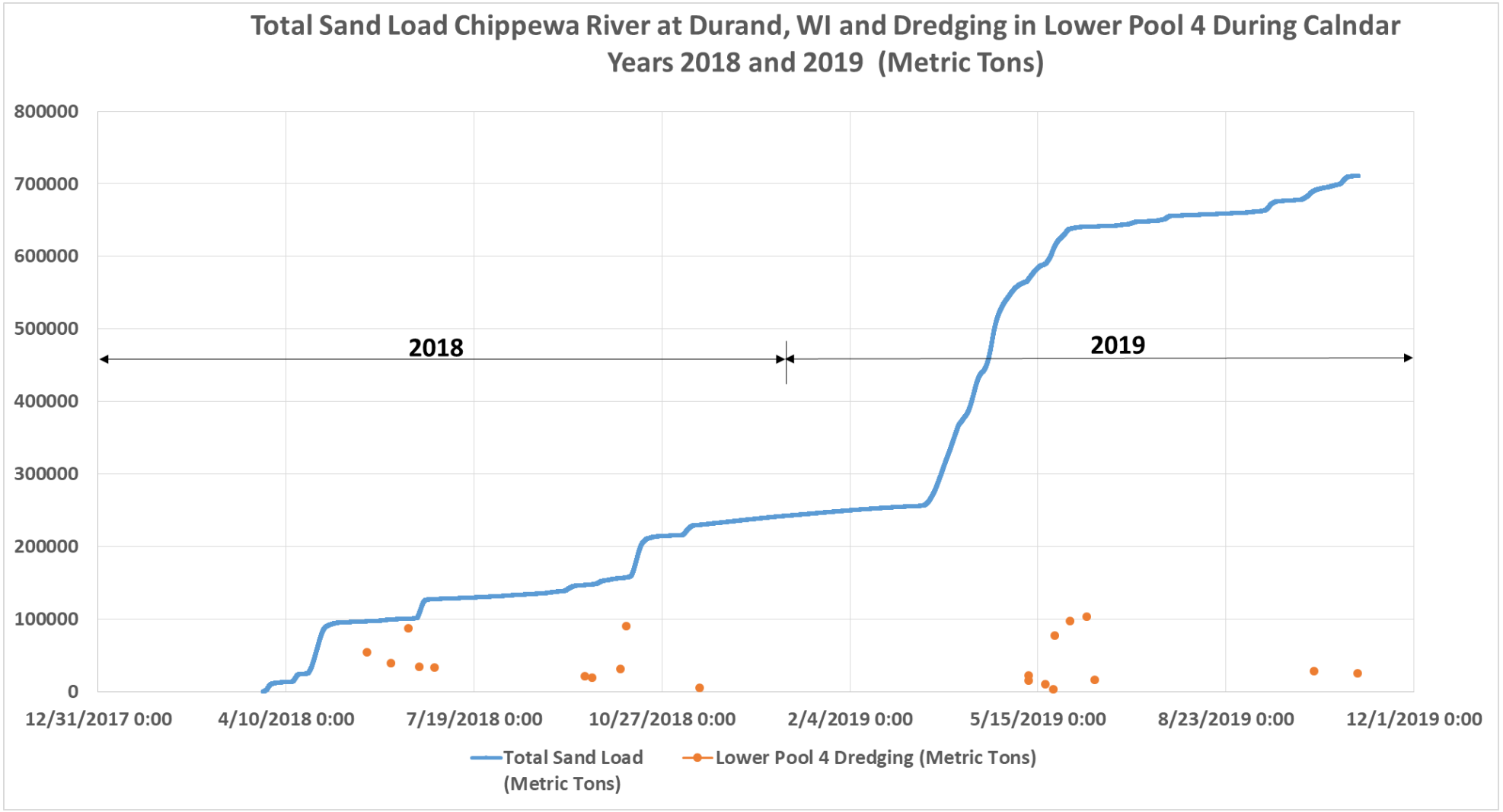
- **USGS data collection & analysis**
- **USGS summarizes results in Scientific Investigations Report**
- **USACE- HEC and St. Paul personnel test HEC-RAS 1D/2D sediment model**

HTTPS://WWW.GCMRC.GOV/DISCHARGE_QW_SEDIMENT/?

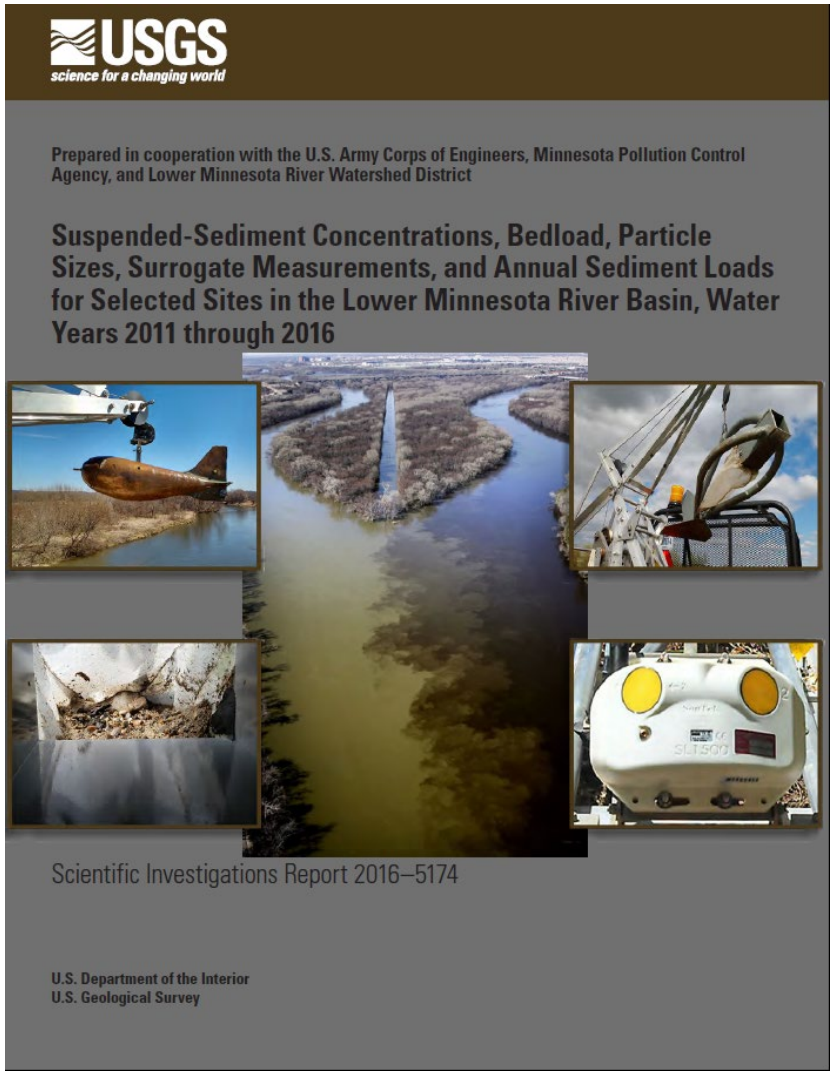


- Gage height
- Q
- Water Temp
- Total suspended sediment concentration
- Susp silt and clay concentration
- Susp sand concentration
- Susp sand median grain size
- Instantaneous suspended silt and clay load
- Cumulative suspended silt and clay load
- Instantaneous suspended sand load
- Cumulative suspended sand load
- Calculated Instantaneous sand bedload
- Calculated cumulative Sand bedload

CHIPPEWA RIVER SAND LOAD



Minnesota River Surrogate Metric: Acoustic Backscatter



Groten, J.T., Ellison, C.A., and Hendrickson, J.S., Suspended-Sediment Concentrations, Bedload, Annual Sediment Loads, Particle-Sizes, and Surrogate Measurements for Selected Sites in the Lower Minnesota River, 2011 through 2014: U.S. Geological Survey Scientific Investigations Report 2016–5174, 29 p.

Data indicates:

- Minnesota River Sand Load is 250,000 yd3/yr.
- Minn. River dredging is 21,000 yd3/yr or 8.4% of total sand load.

DISCUSSION?

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Questions?