



# NORTH DAKOTA

## 2011 FLOOD EVENT



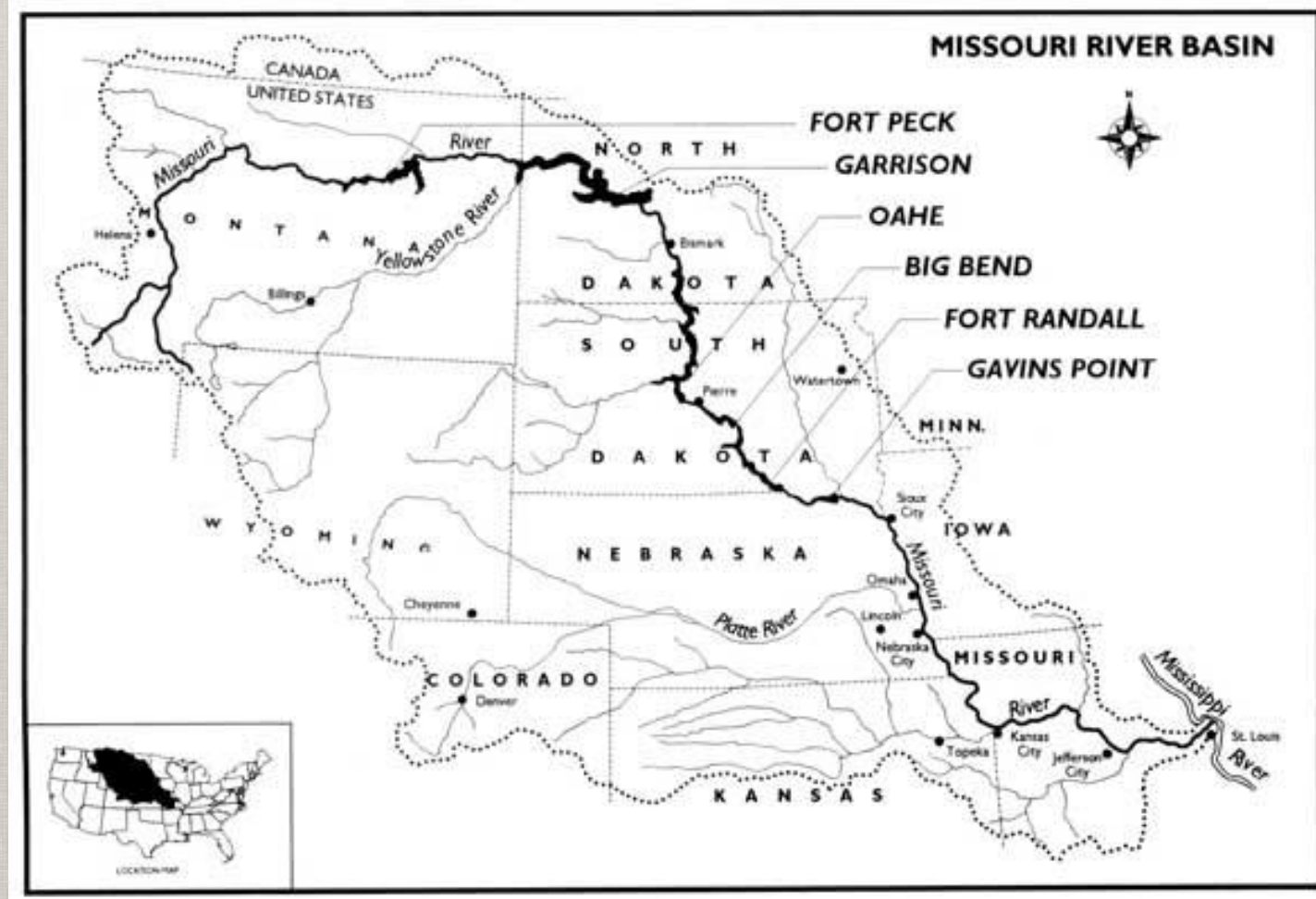


# OUTLINE

- Missouri River Basin Geography
- Generic Reservoir Operations
- Weather and Climate 2011
- Basin-wide Hydrology
- Missouri River Timeline
- Missouri River Damages
- Mouse River Basin Geography
- Generic Reservoir Operations
- Basin-wide Hydrology
- Missouri River Timeline
- Missouri River Damages
- States involvement



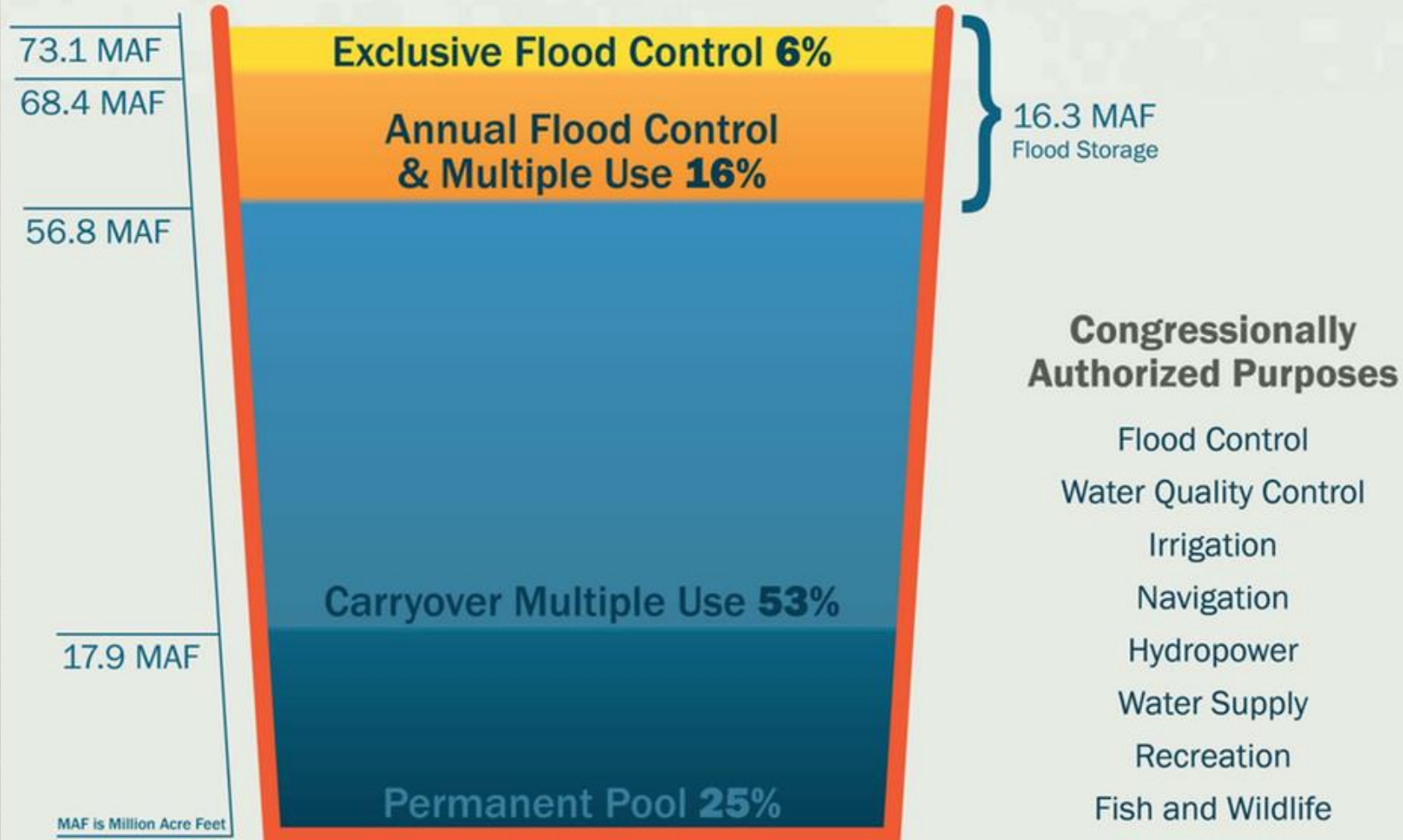
# MISSOURI MAINSTEM RESERVOIR SYSTEM



Courtesy of Missouri Department of Natural Resources

# MISSOURI MAINSTEM RESERVOIR SYSTEM

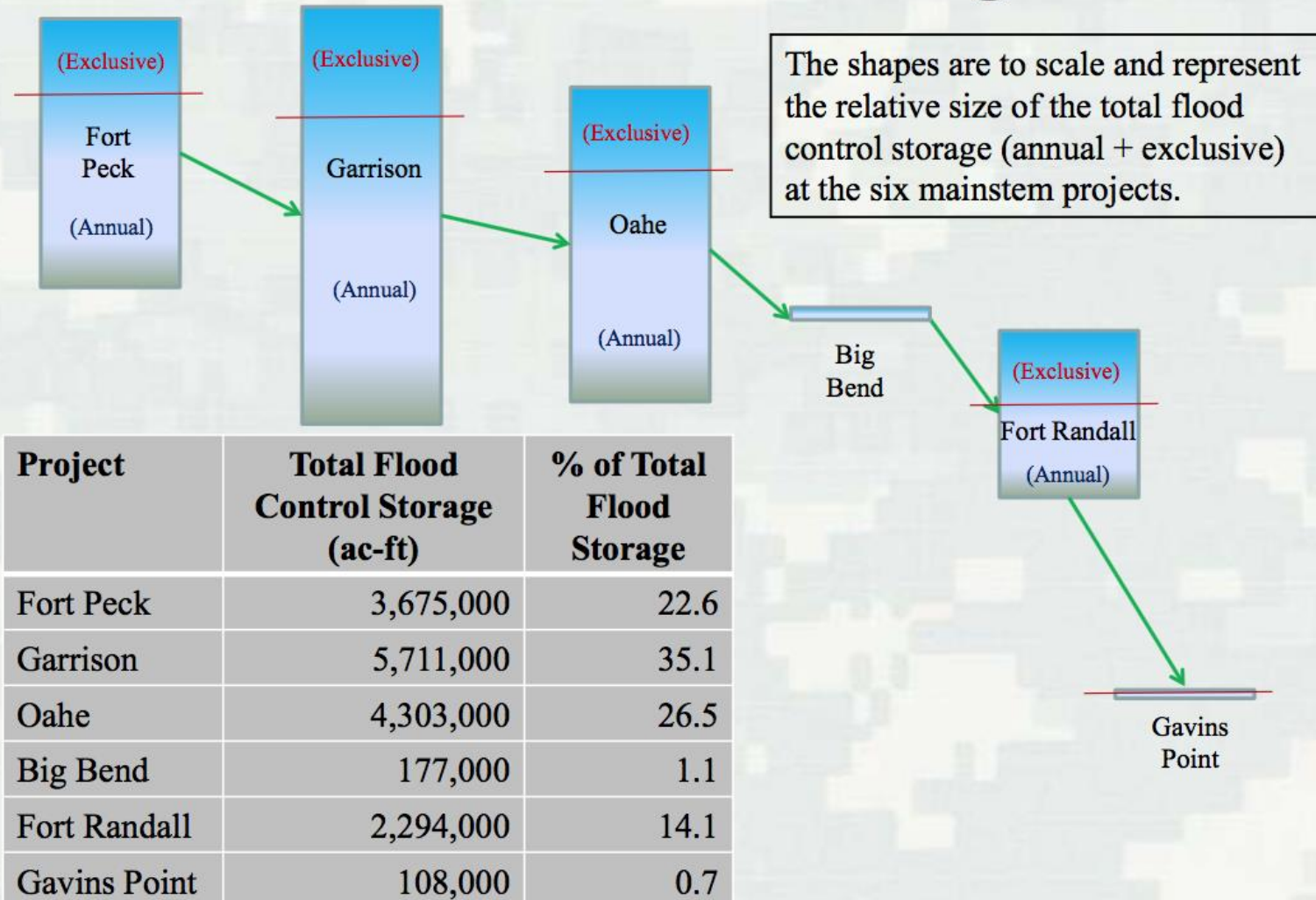
## Zones & Allocations of the Total Storage Capacity





# MISSOURI MAINSTEM RESERVOIR SYSTEM

## Flood Control Storage

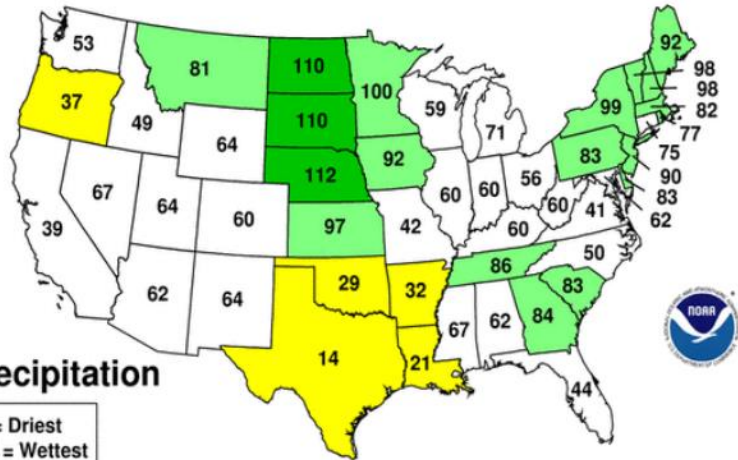




# FALL SEASON PRECIPITATION

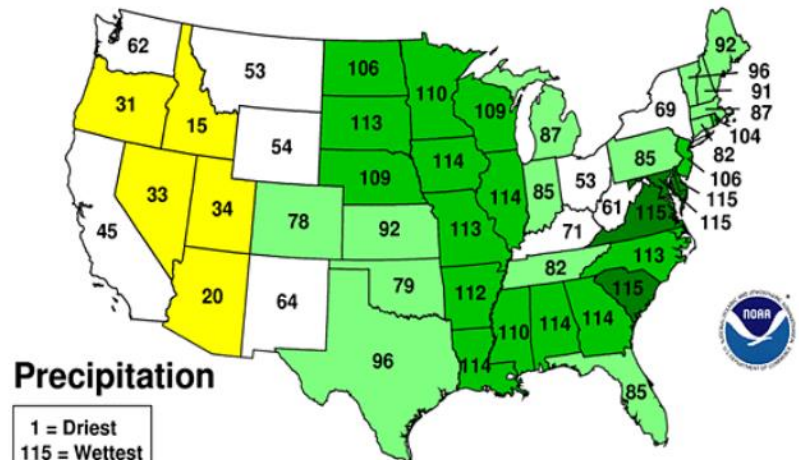
## October-December 2008 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



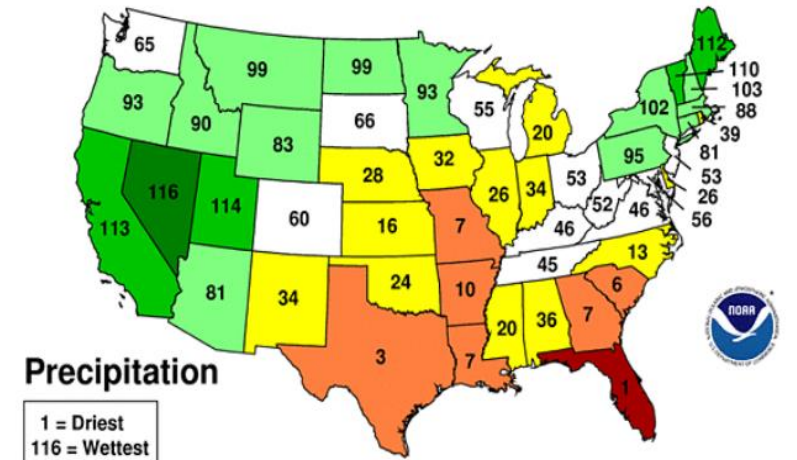
## October-December 2009 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



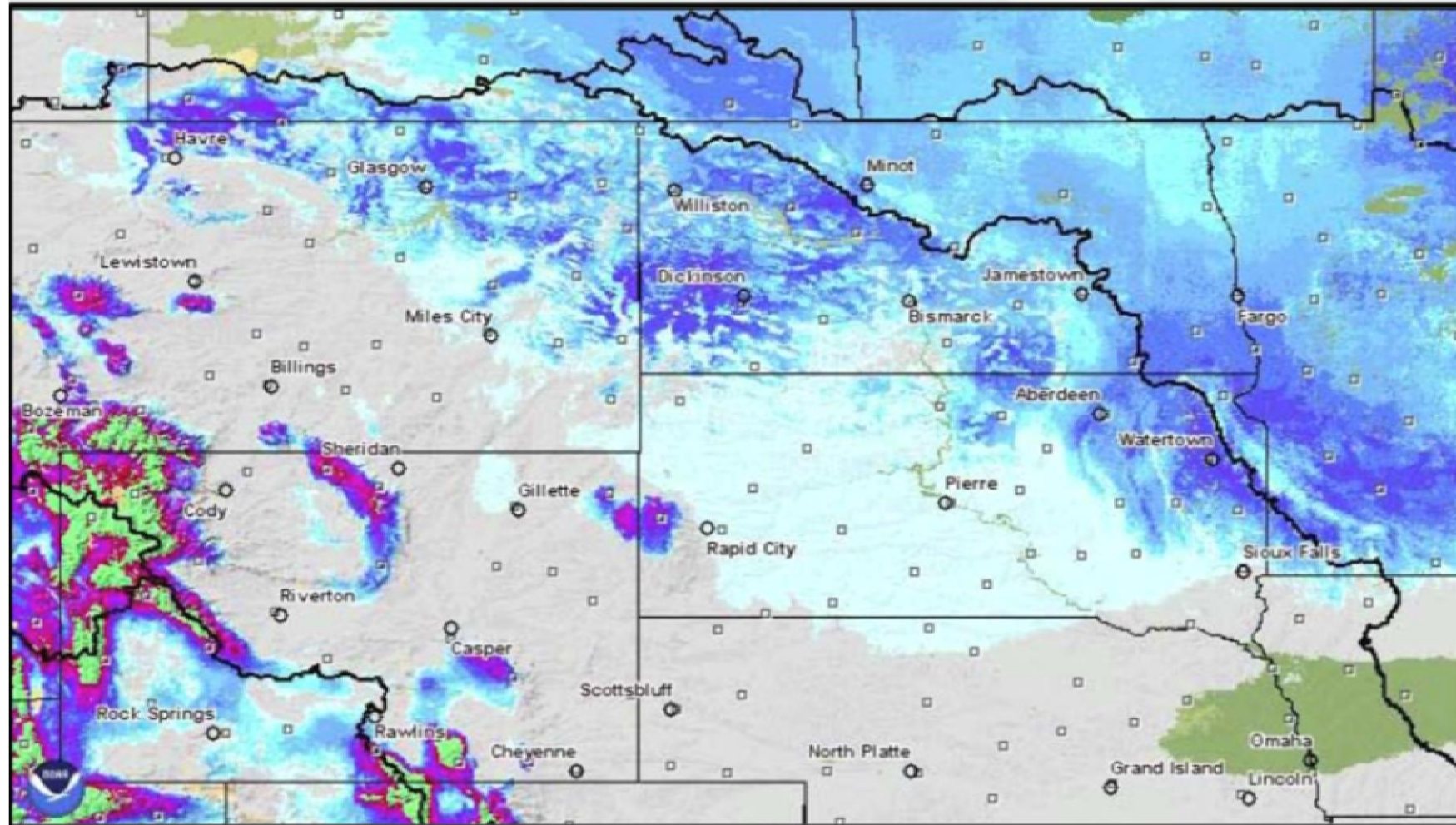
## October-December 2010 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA

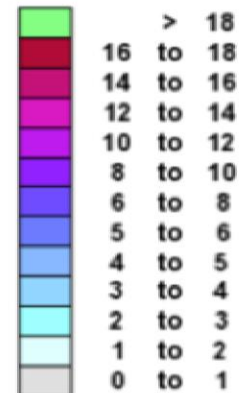




# NORTHERN PLAINS SNOWPACK (FEBRUARY 2011)

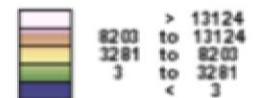


Inches of water equivalent



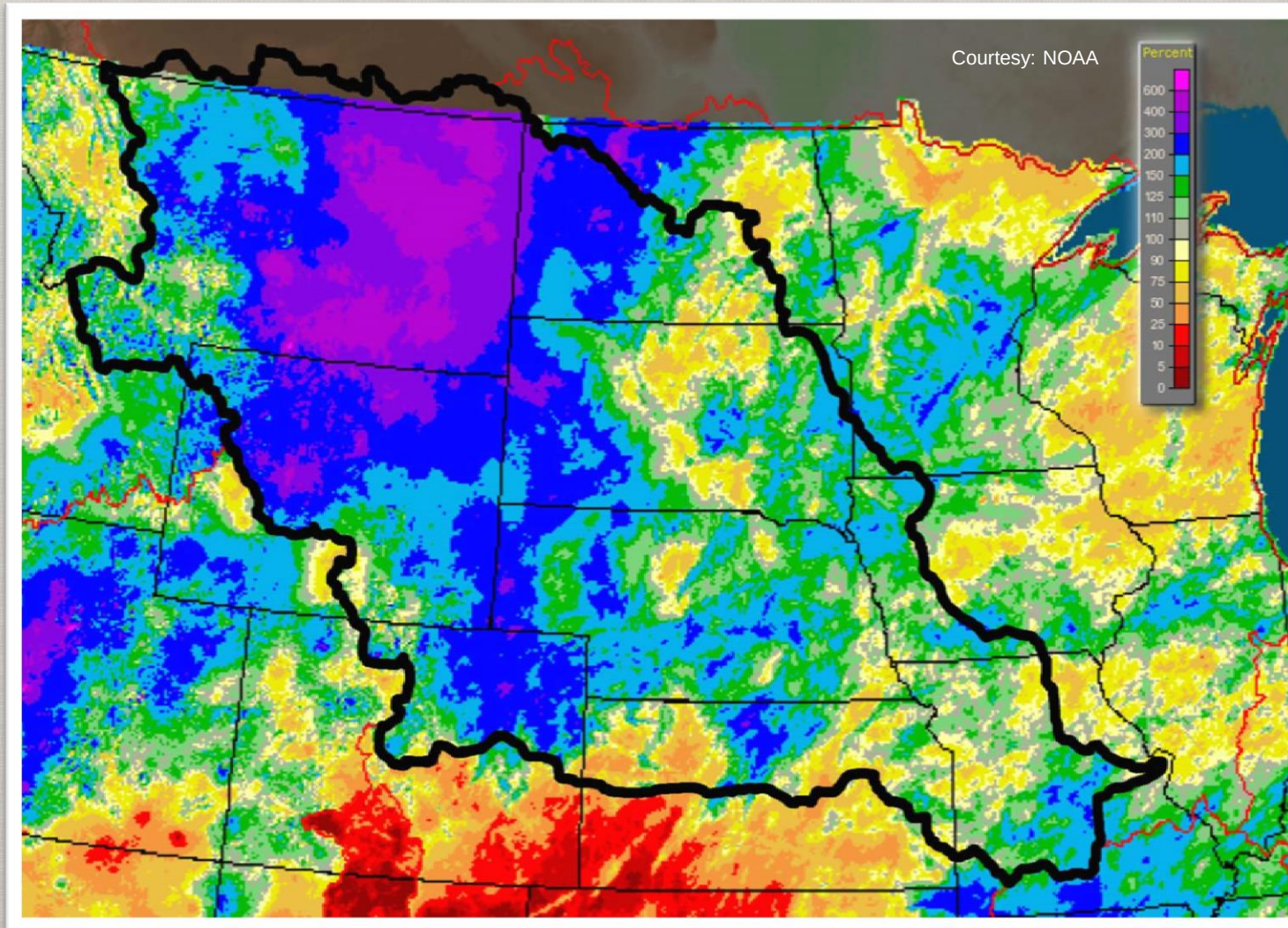
Not Estimated

Elevation in feet  
(Not estimated)



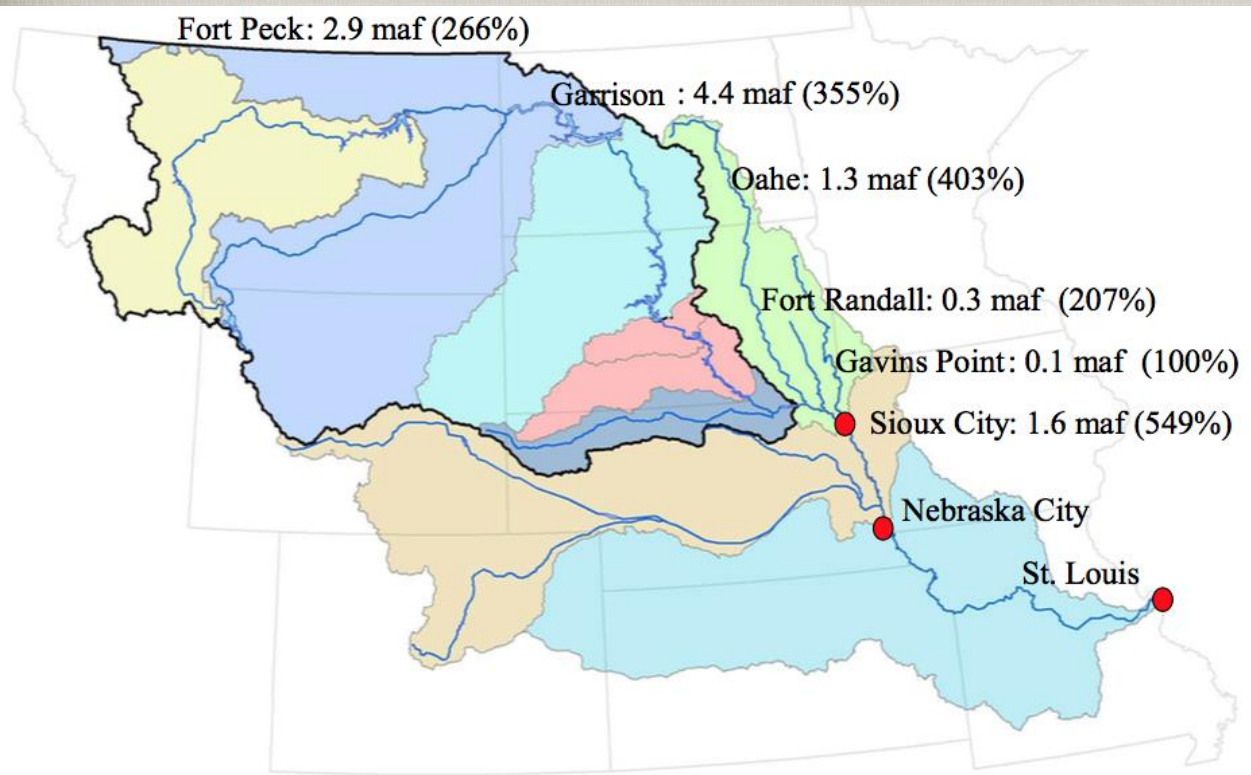


# MRB MAY PRECIP. % OF NORMAL

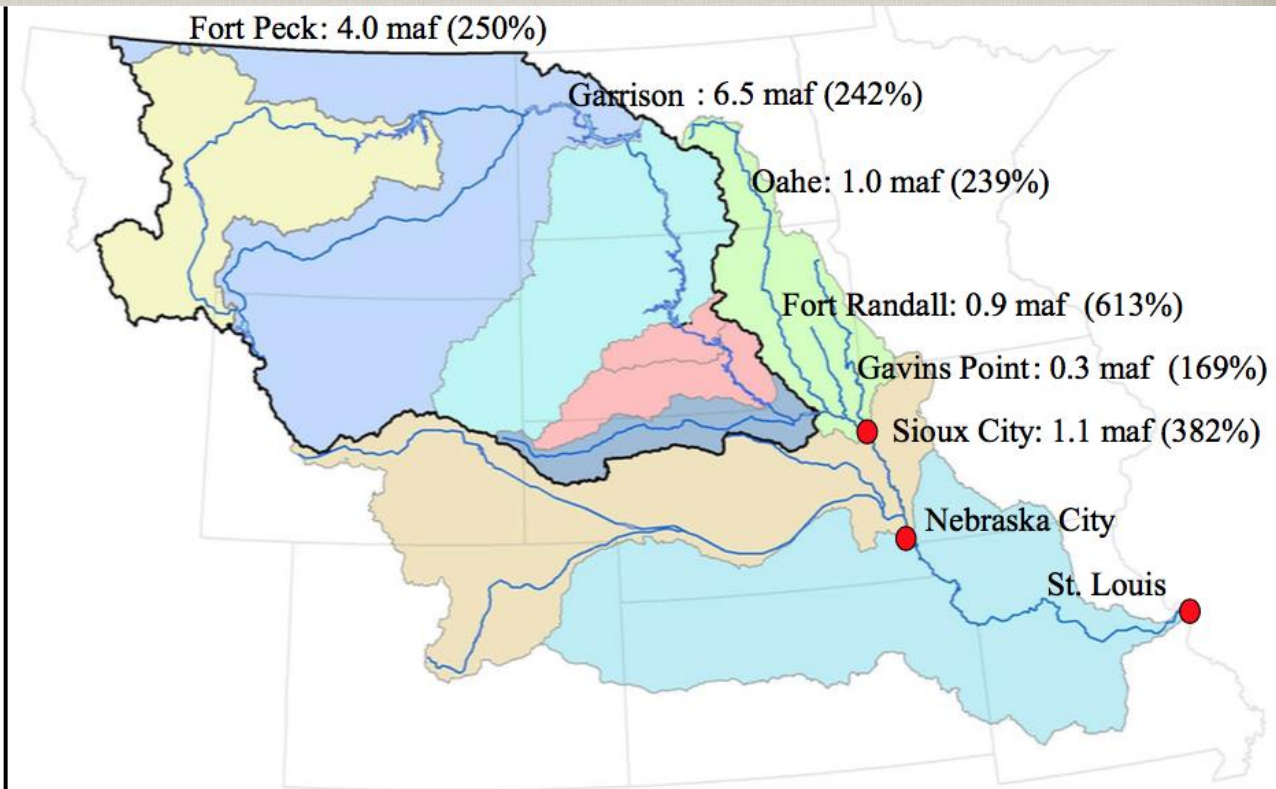




# MISSOURI RIVER RUNOFF (MAY/JUNE 2011 RUNOFF)



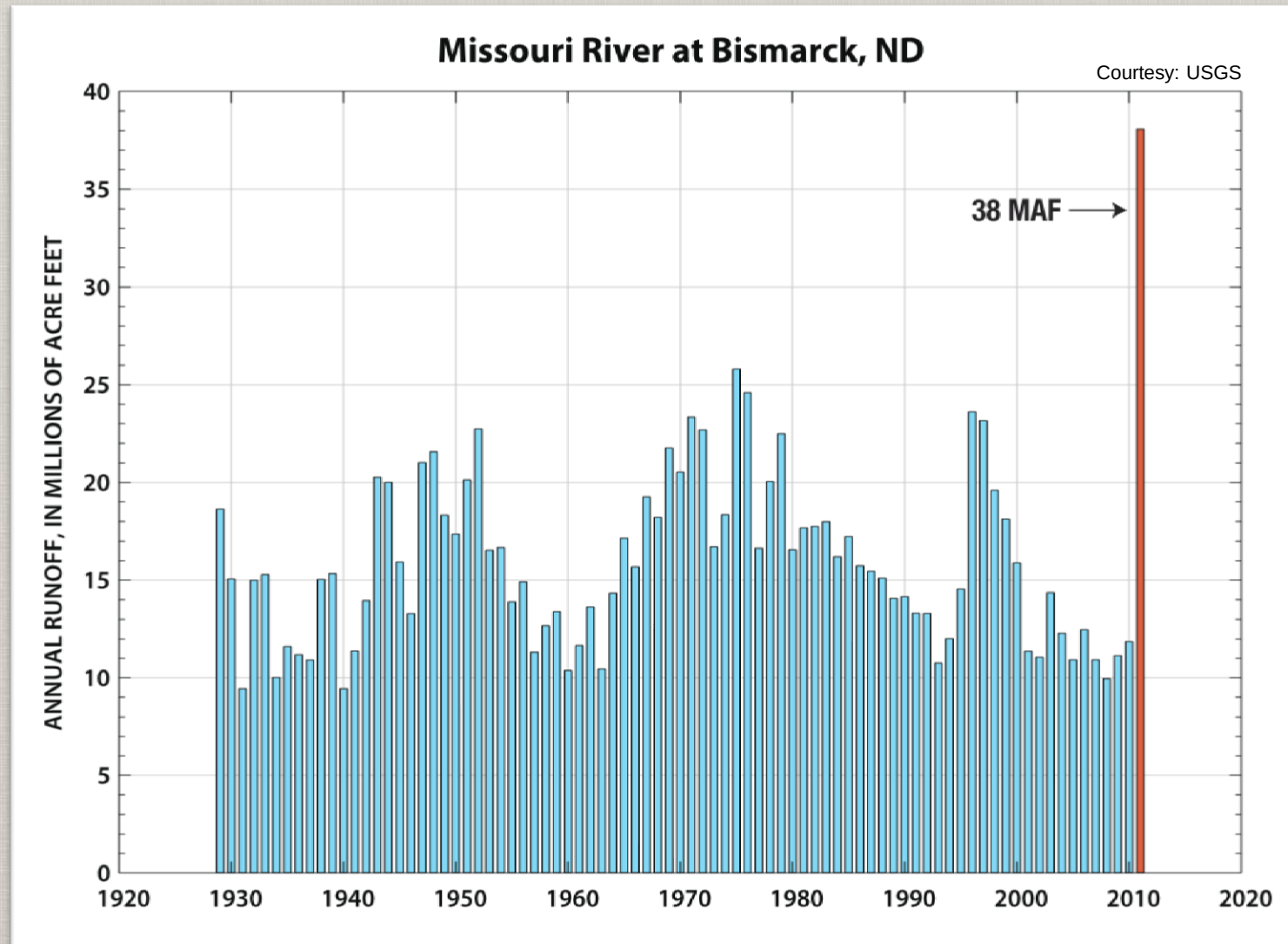
MAY 2011



JUNE 2011



# MISSOURI RIVER 2011 FLOOD





# MISSOURI RIVER 2011 FLOOD TIMELINE

- April 1 – Mountain Snowpack ~116% Of Normal
- April 13 – NDSWC Voices Concern Of Water Volumes
- April 20 – NDSWC Sends Letter To USACE Urging Higher Releases
- May 1 – Mountain Snowpack
  - 136% Above Fort Peck, 141% Above Garrison
- May 5 – Officials Discuss Garrison Release Of 55,000 cfs
- May 6 – USACE Garrison Releases at 49,000 cfs
- May 10/11 – 2.5 To 3.5 Inches Of Rain Fell In Eastern MT
- May 20 – USACE Releases at 60,000 cfs
- May 20/22 – 5 To 8 Inches Of Rain Fell In MT/SD/WY



# MISSOURI RIVER 2011 FLOOD TIMELINE

- May 23 – USACE Releases at 85,000 cfs
- May 25 – 1.5 To 2 Inches Of Rain Fell Over Eastern MT
- May 26 – USACE Releases at 120,000 cfs @ Garrison
- May 30/31 – 2 To 4 Inches Of Rain Fell In MT
- June 1 – USACE Opens Emergency Spillway @ Garrison
- June 25 – Max Of 154,000 cfs
- Max lake level 1854.6 ft
  - Top of Emergency Spillway 1825, top of closed gates 1854 (top of exclusive zone)
  - Max flow 827,000 cfs @ 1854.8
- July 1 – Max MR Stage @ Bismarck 19.23 Ft
- September 29 – Return To Normal Discharge @ Bismarck 27,700 Cfs/6.60 Ft



# MISSOURI RIVER 2011 FLOOD





# MISSOURI RIVER 2011 FLOOD



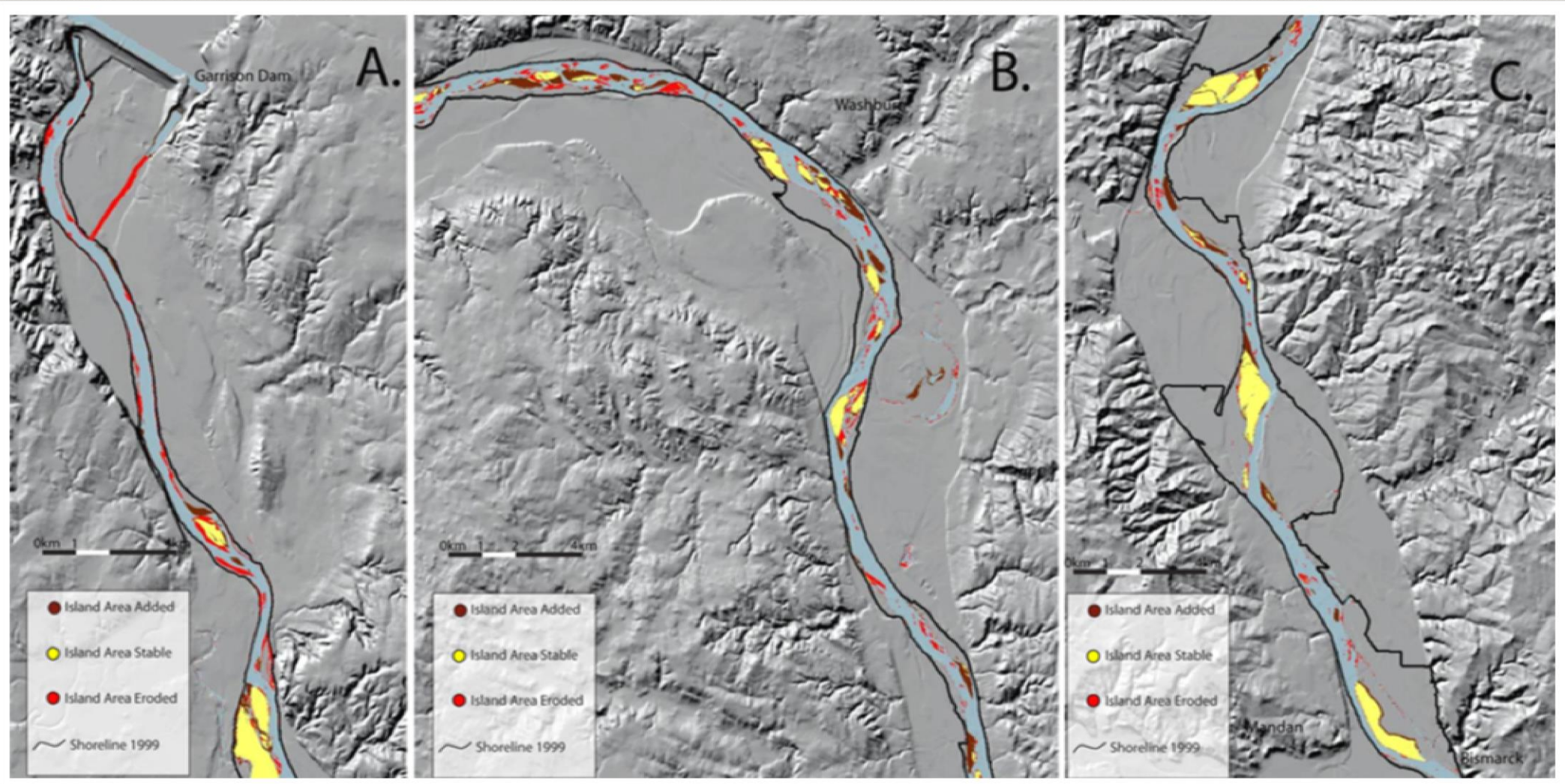


# MISSOURI RIVER 2011 FLOOD



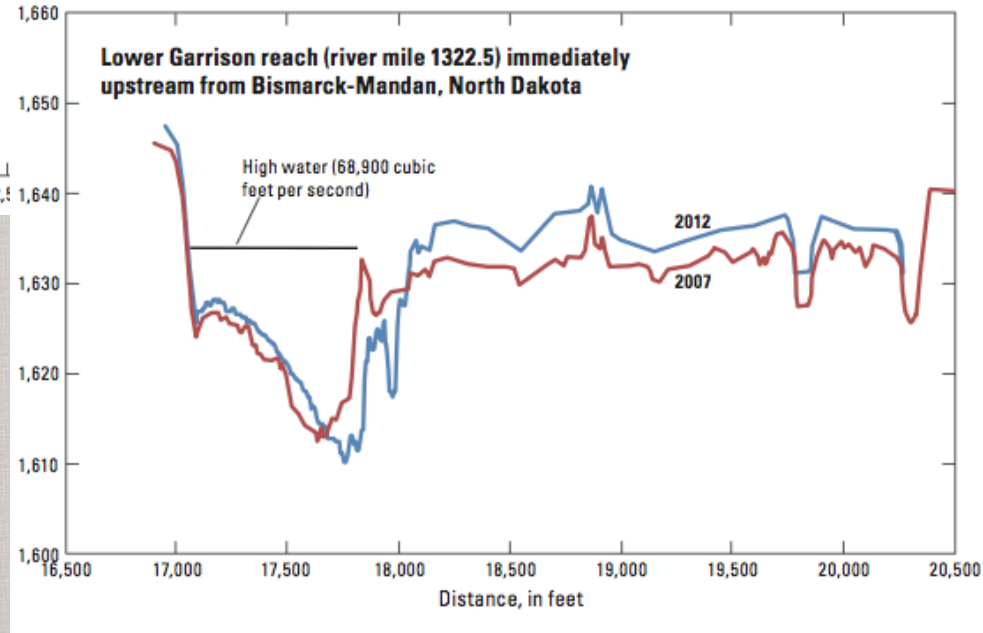
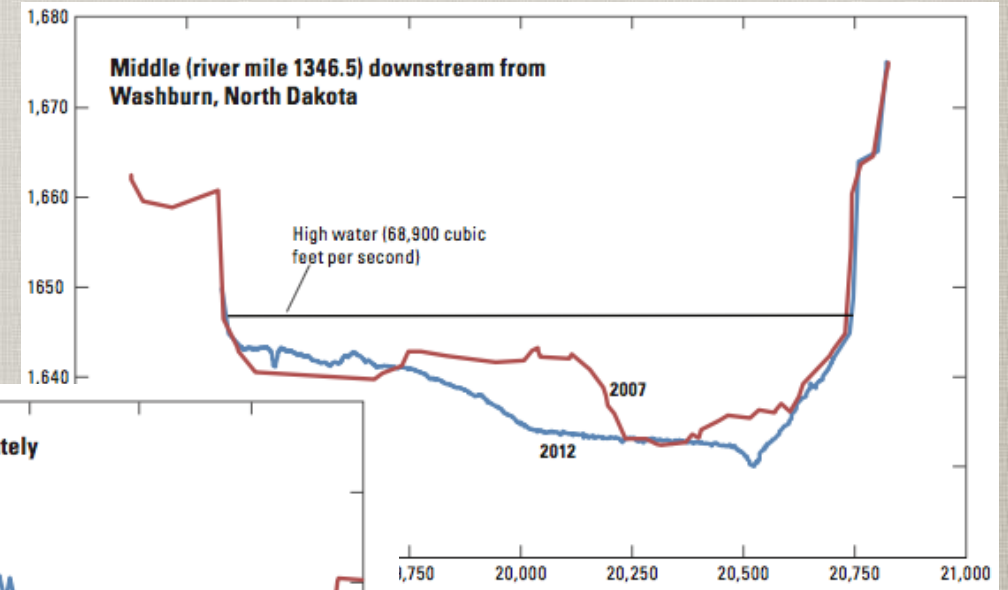
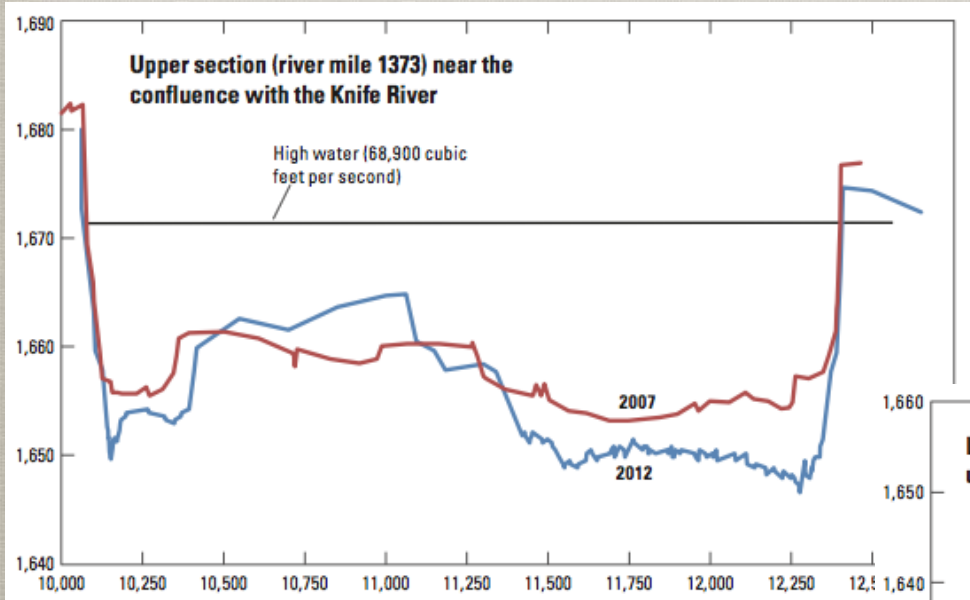


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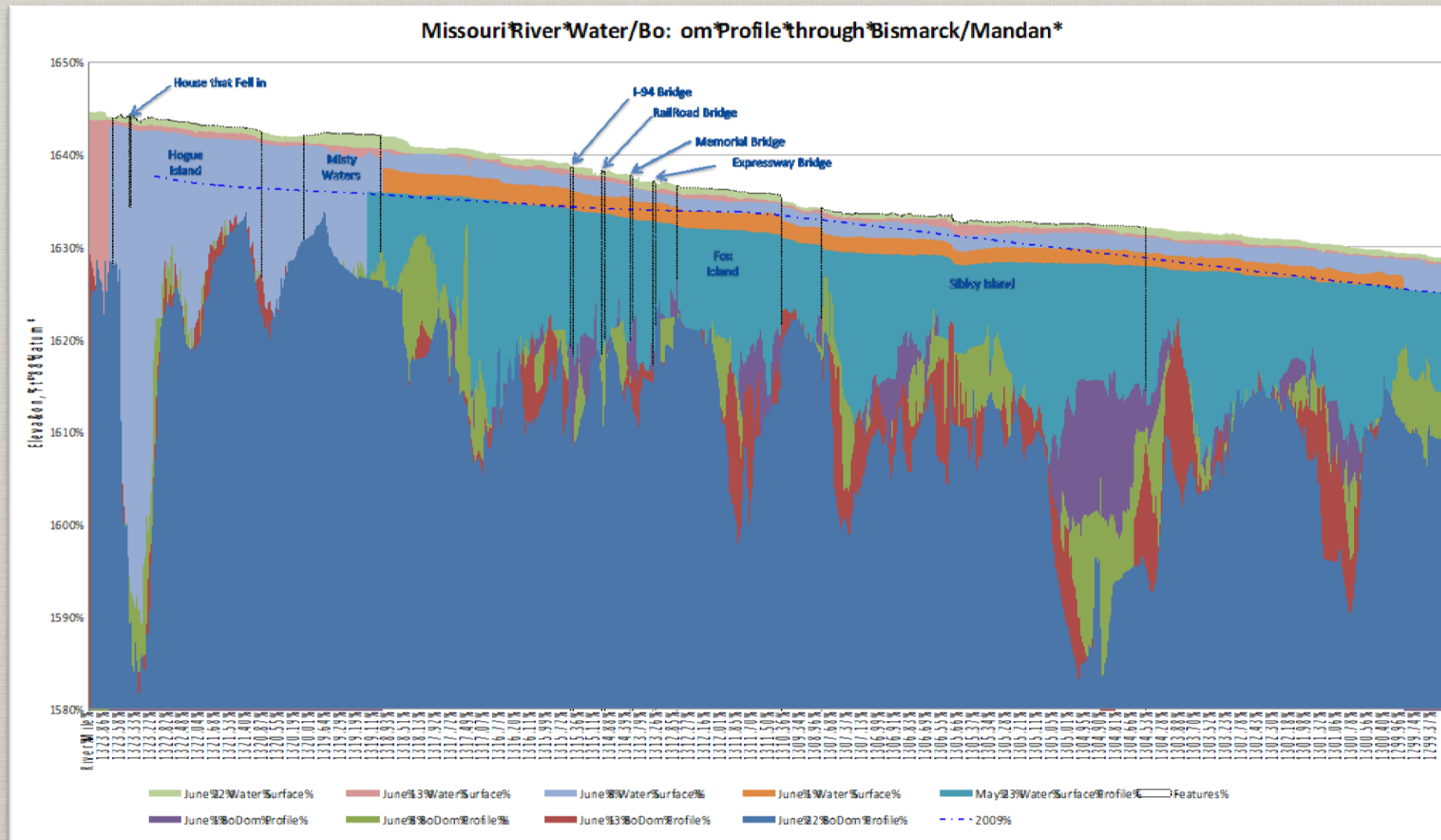


# MISSOURI RIVER 2011 FLOOD





# MISSOURI RIVER 2011 FLOOD





# MISSOURI RIVER 2011 FLOOD





# MISSOURI RIVER 2011 FLOOD





# MISSOURI RIVER FLOODING 2011

What I think of living on the river...



What the river thinks of living on the river...



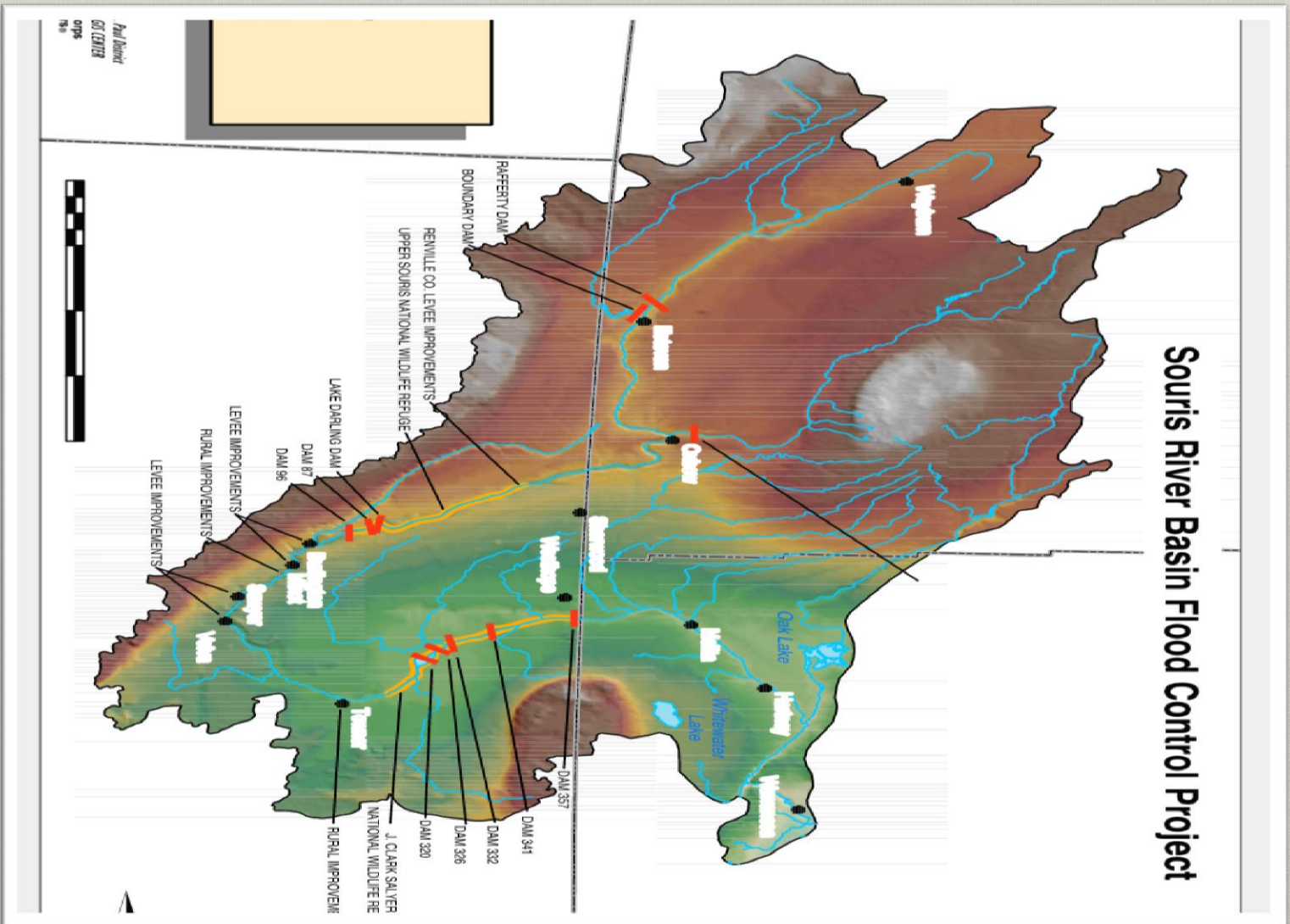


# MISSOURI RIVER 2011 FLOOD

<http://www.nd.gov/gis/apps/Missouri2011/>



# MOUSE RIVER FLOODING 2011





# MOUSE RIVER FLOODING 2011

- Canadian Dams
  - Alameda, Rafferty, Boundary
- US Dams
  - Lake Darling (Mouse), Burlington (De Lacs)
- Purpose
  - 1% (100 Yr) Flood Protection At Minot
    - ~ 5,000 cfs
  - Maintain Water Supply & River Flow
- Operations
  - Saskatchewan Watershed Authority, USACE, NDSWC, USFWS
  - Operations Plan From 1989



# MOUSE RIVER FLOODING 2011



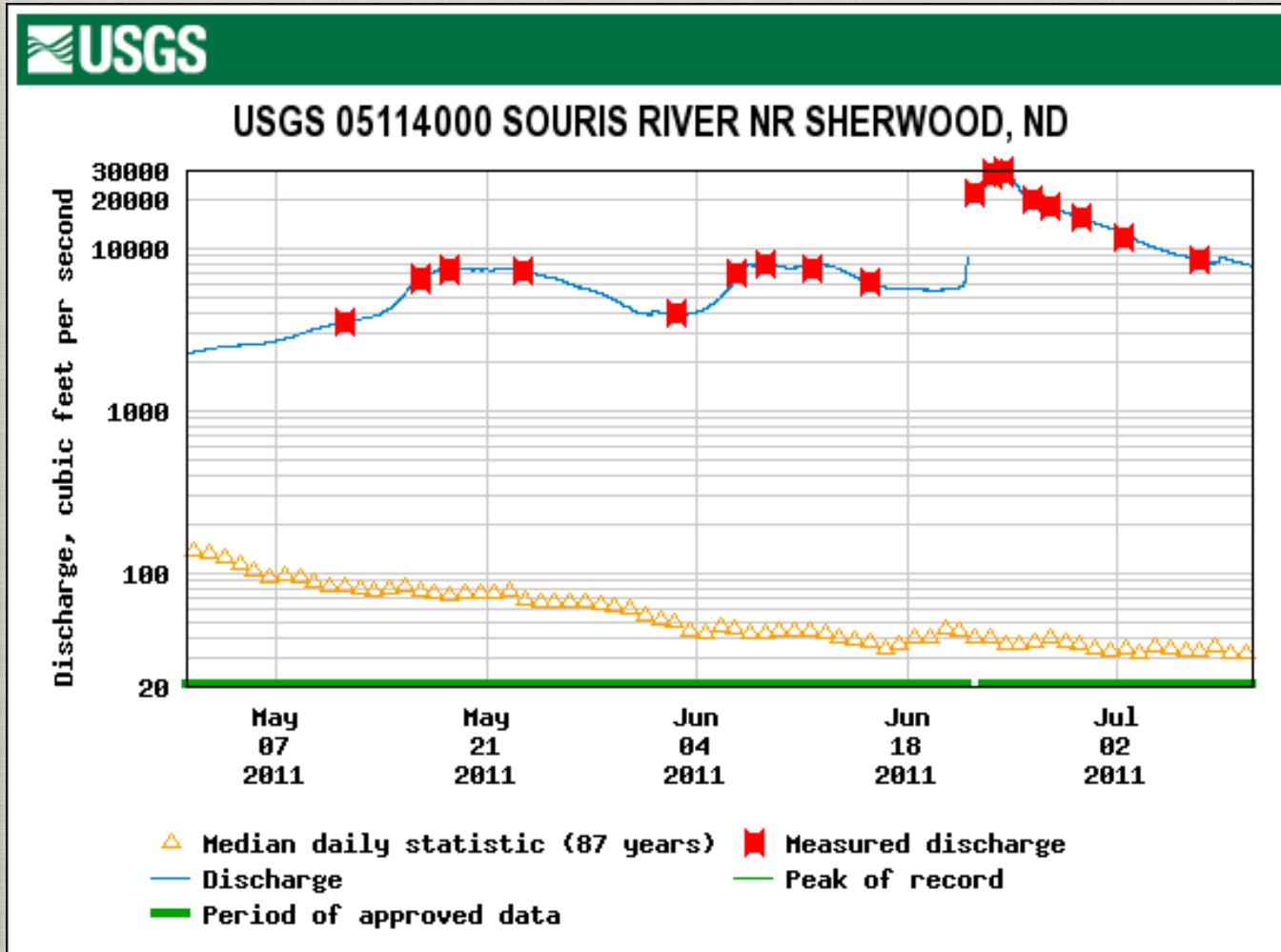


# MOUSE RIVER FLOODING 2011

- April 12<sup>th</sup> – Burlington evacuates with anticipation of dam breaks
- April 13<sup>th</sup> – Minot prepares levees for 7,000 cfs
- April 20<sup>th</sup> – Canadian dams releasing 3,200 cfs, Darling @ 5,000 cfs
- May 31<sup>st</sup> – Minot flood zones evacuated
- June 1<sup>st</sup> – Minot prepares for 10,000 cfs, city bridges close
- June 7<sup>th</sup> – Minot residents allowed back, flow at 7,100 cfs
- June 20<sup>th</sup> – Minot told to prepare for 30,000 cfs, raise levees by 7ft
- June 22<sup>nd</sup> – Sirens sound the overtopping of Minot levees (12:57 pm)
- June 24<sup>th</sup> – Lake Darling releases at 28,000 cfs
- June 26<sup>th</sup> – Mouse River crests @ 1561.72



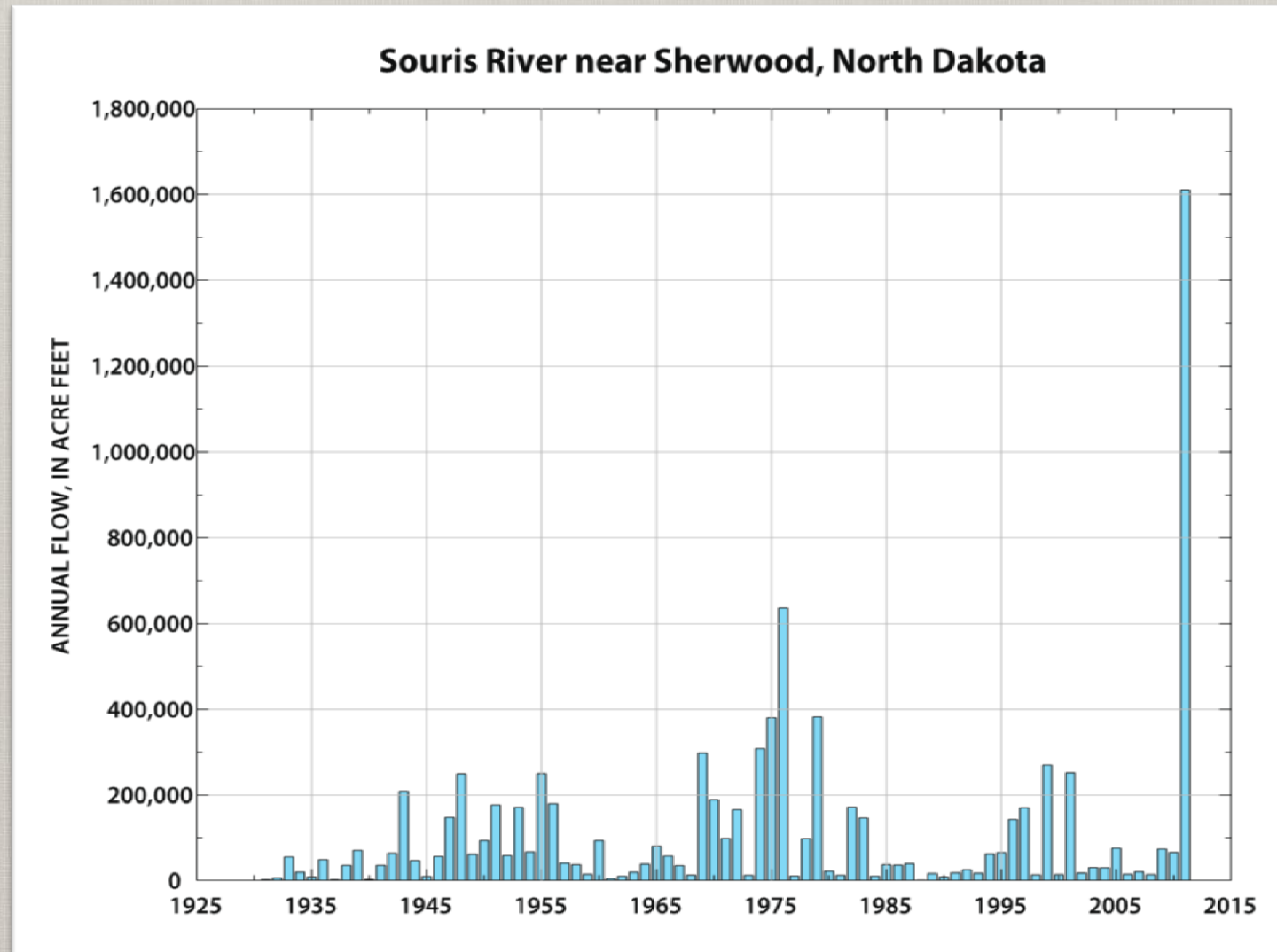
# MOUSE RIVER FLOODING 2011



- June 2011
  - USGS Gauge At Sherwood Peak Flow 29,700 cfs On June 24, 2011
    - Previous Recorded Peak Flow 14,800 Cfs (1976)
  - June 24, 2011, More Water Passed The Sherwood Gauge Than Was Recorded In 45 Out Of 82 Years Of Record
  - Total Flow Volume For June 2011 Was 632,800 ac-ft
  - ~ = Largest Total Annual Flow Volume (1976)

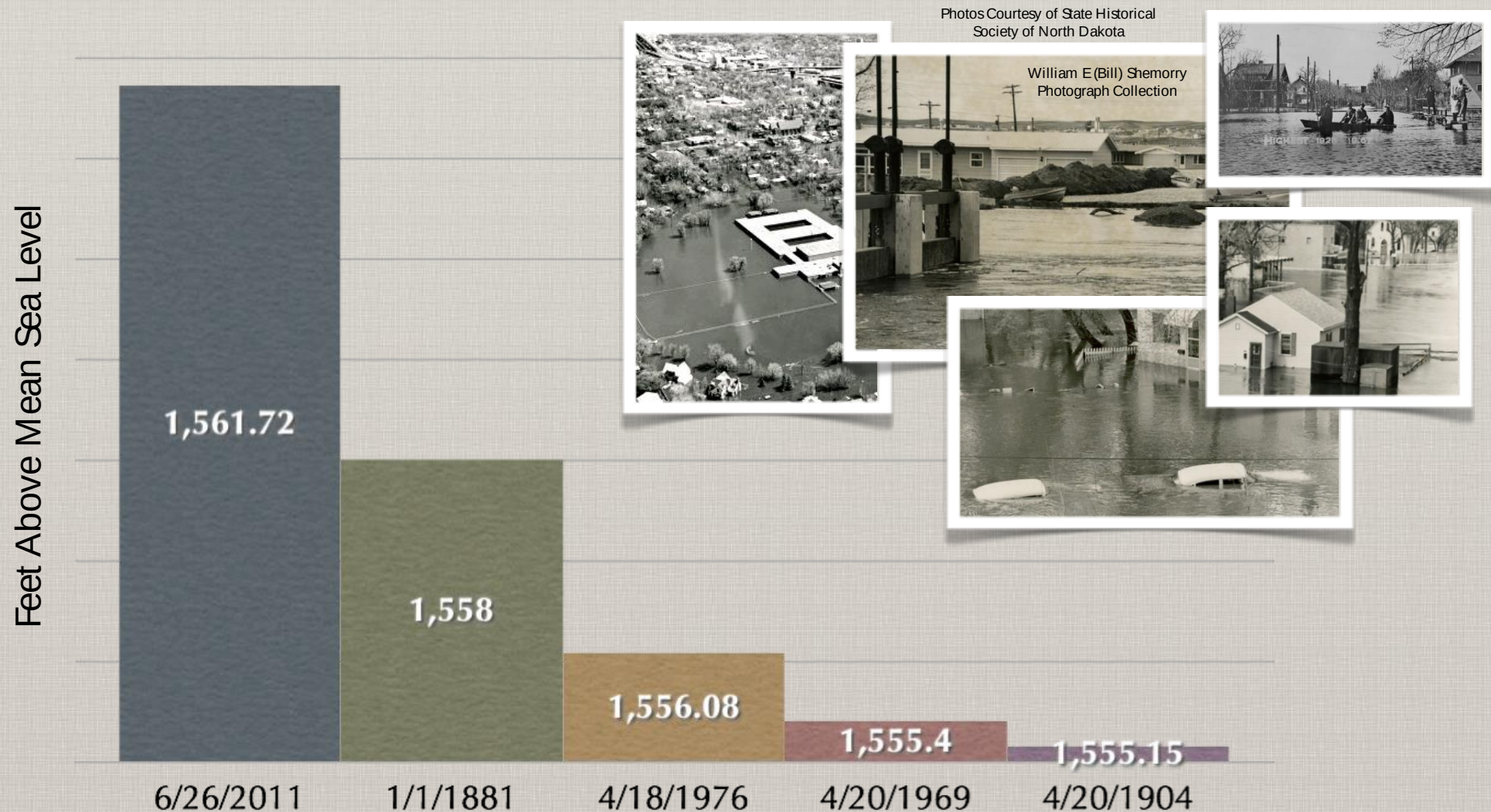


# MOUSE RIVER FLOODING 2011





# HISTORIC MOUSE RIVER CRESTS AT MINOT





# MOUSE RIVER FLOODING 2011



USArmy Corps

- 4,115 Flooded Homes In Ward County
- Over 11,000 People Evacuated



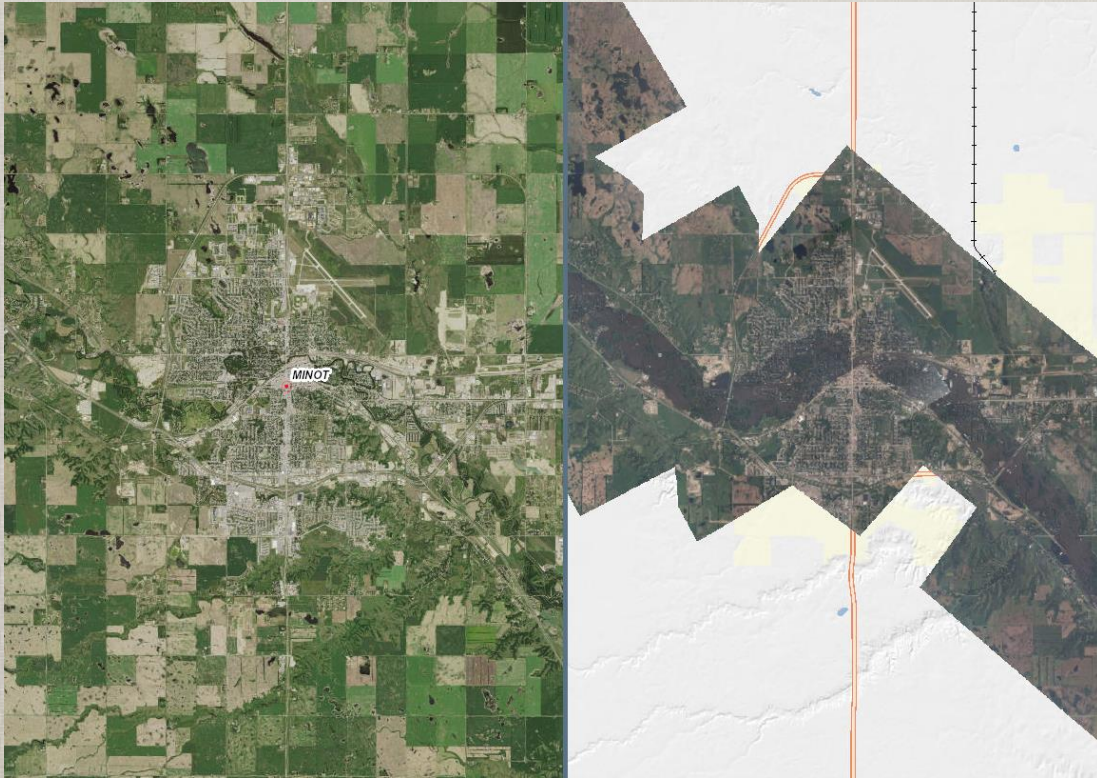
# MOUSE RIVER FLOODING 2011



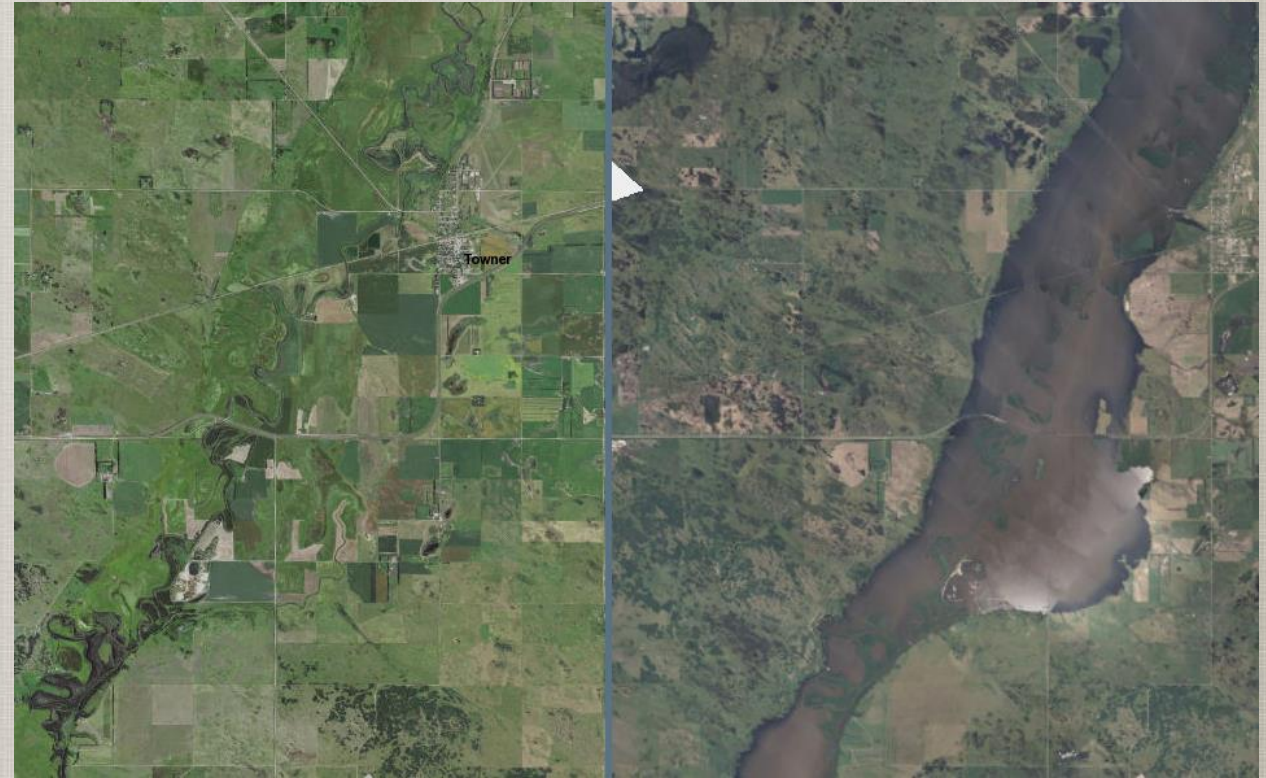


# MOUSE RIVER FLOODING 2011

Minot, ND 2010 vs 2011 peak flow



Towner, ND 2010 vs 2011 peak flow





# MOUSE RIVER FLOODING 2011

<http://www.nd.gov/gis/apps/Mouse2011/>



# NORTH DAKOTA FLOODING 2011

- Red River of the North at Fargo – 4<sup>th</sup> Highest, 38.75 ft., April 9, 2011
- Red River of the North at Grand Forks – 3<sup>rd</sup> Highest, 49.87 ft., April 14, 2011
- Red River of the North at Pembina – 3<sup>rd</sup> Highest, 51.97 ft., April 24, 2011
- Devils Lake Basin at Creel Bay – **New Record**, 1,454.30 ft. msl, June 27, 2011
- Devils Lake Basin, near Lakota – **New Record**, 1,454.37 ft. msl, July 1, 2011
- James River at Grace City – 3<sup>rd</sup> Highest, 15.37 ft., April 13, 2011
- James River at Jamestown – 5<sup>th</sup> Highest, 12.98 ft., September 20, 2011
- Souris River at Sherwood – **New Record**, 28.03 ft., June 24, 2011
- Souris River at Foxholm – **New Record**, 17.74 ft., June 22, 2011
- Souris River at Minot 4-NW – **New Record**, 24.39 ft., June 25, 2011
- Souris River at Minot Broadway Bridge – **New Record**, 1,561.72 ft. msl, June 26, 2011



- Souris River at Logan – **New Record**, 40.86 ft., June 26, 2011
- Souris River at Sawyer – **New Record**, 29.25 ft., June 26, 2011
- Souris River at Towner – **New Record**, 60.5 ft., June 28, 2011
- Souris River at Bantry – **New Record**, 16.84 ft., June 28, 2011
- Souris River at Westhope – **New Record**, 20.09 ft., April 21, 2011
- Sheyenne River at Valley City – 2<sup>nd</sup> Highest, 20.57 ft., April 17, 2011
- Sheyenne River at Lisbon – 2<sup>nd</sup> Highest, 21.61 ft., April 20, 2011
- Sheyenne River at Harwood – 2<sup>nd</sup> Highest, 891.80 ft. msl, April 10, 2011
- Maple River at Mapleton – 4<sup>th</sup> Highest, 23.23 ft., April 7, 2011
- Missouri River at Bismarck – 5<sup>th</sup> Highest, (**Highest Post Dam**) 19.23 ft., July 1, 2011
- Missouri River at Williston – **New Record**, 30.61 ft., June 21, 2011



# NORTH DAKOTA STATE RESPONSE

- Minot
  - Total project ~ \$1 Billion
  - Buyout of structures
  - Flood protection design/construction
    - levee/bypass/channelization
- Fargo
  - Total project ~ \$2 Billion
  - Buyout of structures
  - Flood protection design/construction
    - levee/bypass/channelization/dam
- Grafton
  - Flood protection design/construction
    - levees
- Valley City
  - Flood protection design/construction
    - Levees/embankment armoring



# REFERENCES

- Schenk, E., et al., 2014, Geomorphic Change on the Missouri River During the Flood of 2011: U.S. Geological Survey Professional Paper 1798-I
- Skalak, K., et al., 2016, Flood Effects Provide Evidence of an Alternate Stable State from Dam Management on the Upper Missouri River. River Res. Applic. DOI: 10.1002/rra.3084.
- United States Army Corps of Engineers, “Missouri River Mainstem Reservoir System – 2011 Flood Regulation”, October 2011.
- <https://www.drought.gov/drought/soil-moisture-map>