

# Missouri River Mainstem Reservoir System

US Army  
Corps of Engineers

## 2011 Flood Regulation and a Glimpse at 2012

**Doug Latka**  
**Northwestern Division**  
**Missouri River Basin Water Management**

**June 12, 2012**



US Army Corps of Engineers  
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# Missouri River Mainstem Reservoir System

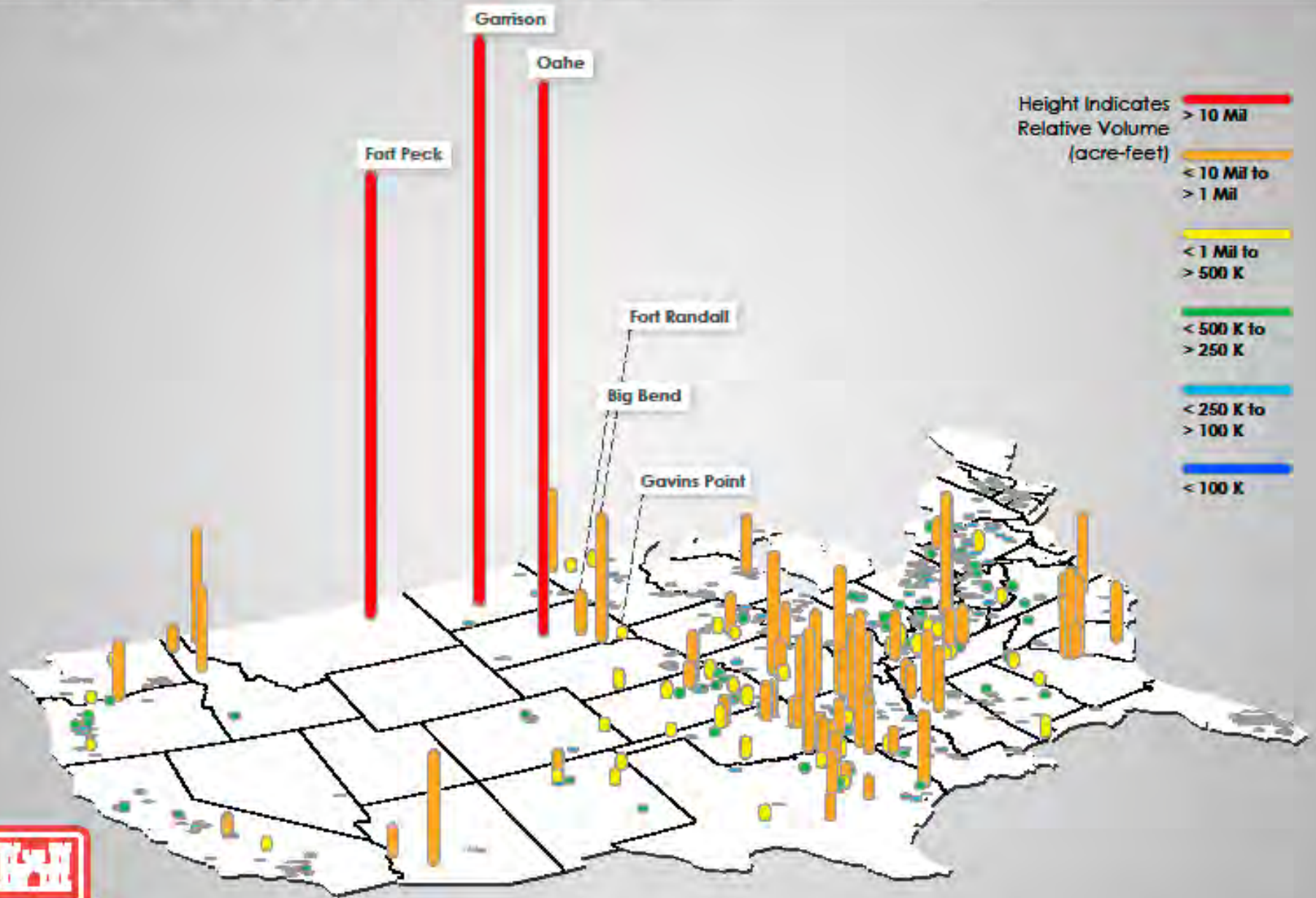


## Congressionally Authorized Project Purposes

- Flood Control
- Navigation
- Hydropower
- Irrigation
- Recreation
- Water Supply
- Water Quality
- Fish and Wildlife  
(Including endangered species)

**Bank Stabilization and Navigation Project  
Sioux City, IA – St. Louis, MO**

# Storage Capacity of Corps Reservoirs

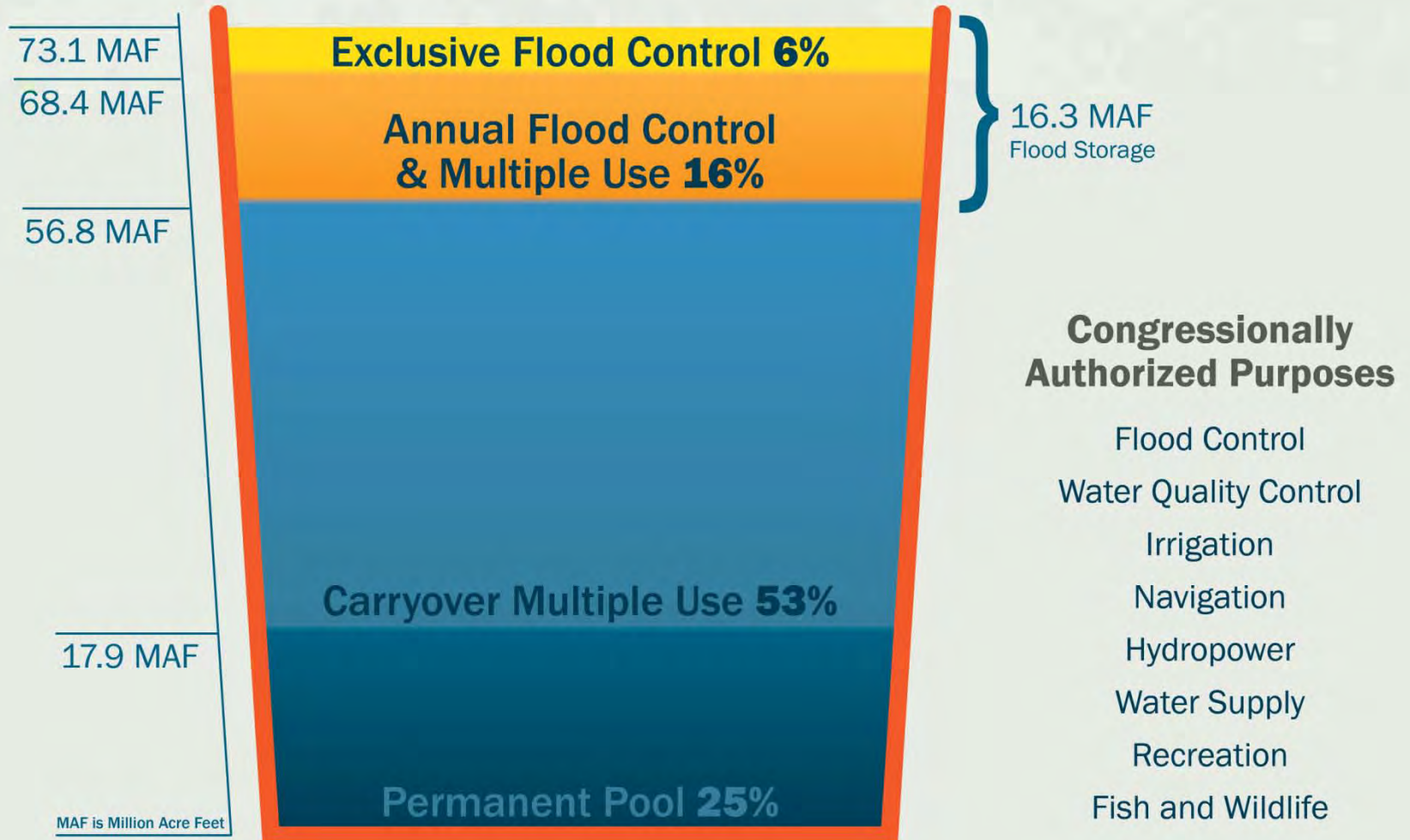




US Army Corps of Engineers  
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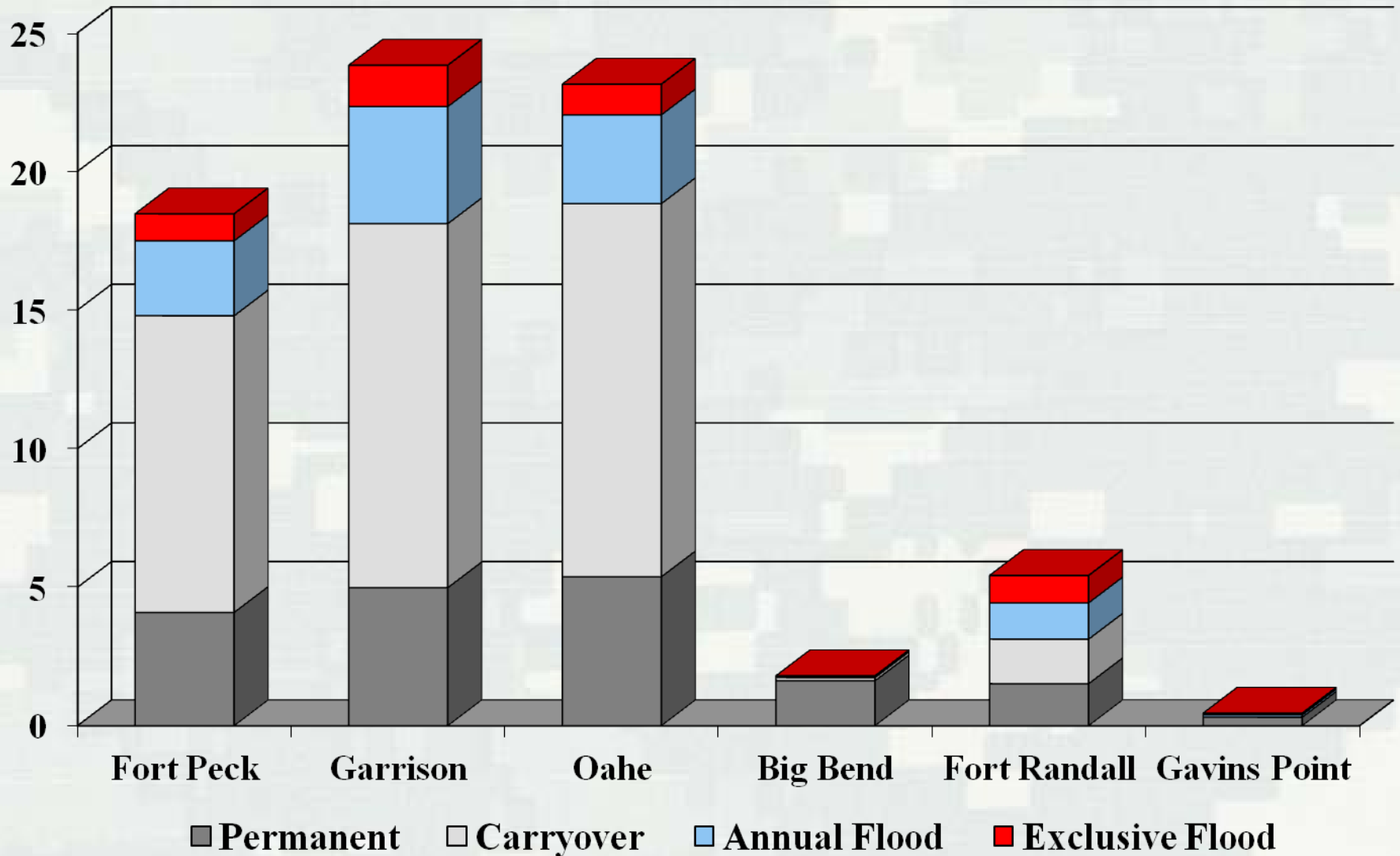
# Missouri River Mainstem Reservoir System

## Zones & Allocations of the Total Storage Capacity

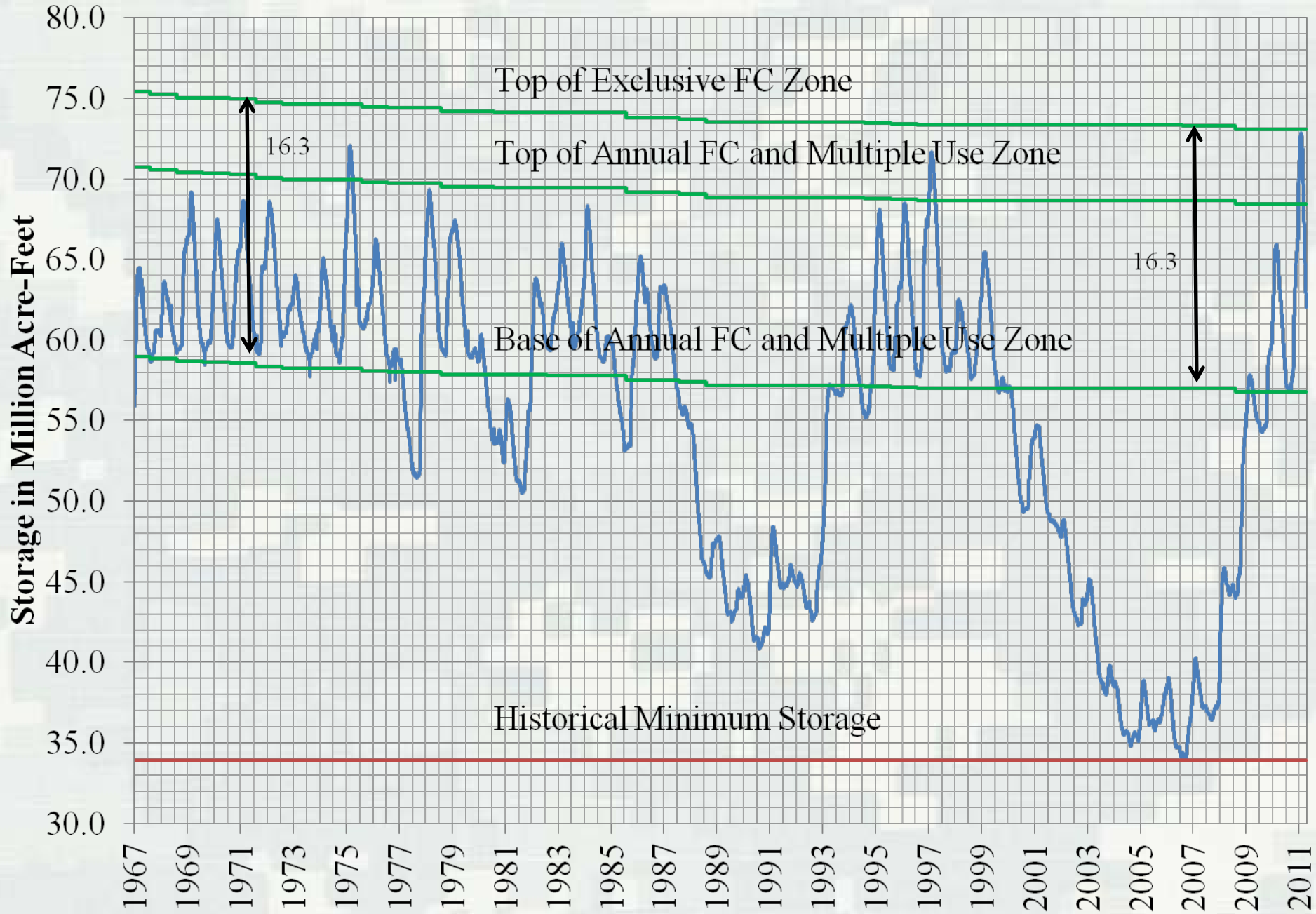


# Mainstem Reservoir Storage Capacity

Million Acre-Feet

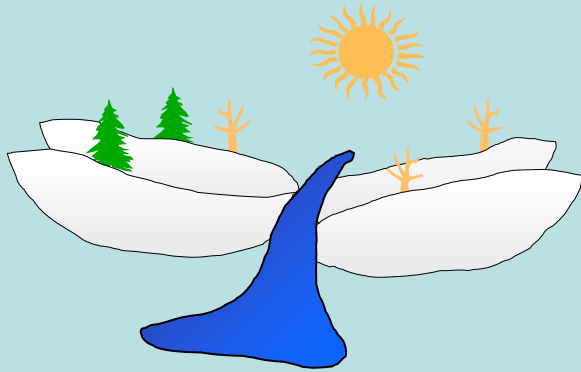


# Missouri River Mainstem Reservoir System



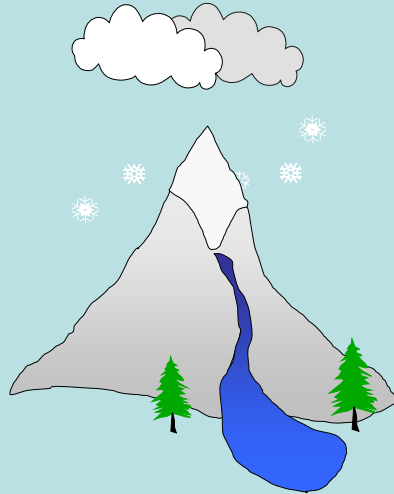
# Runoff Components

Plains Snowpack



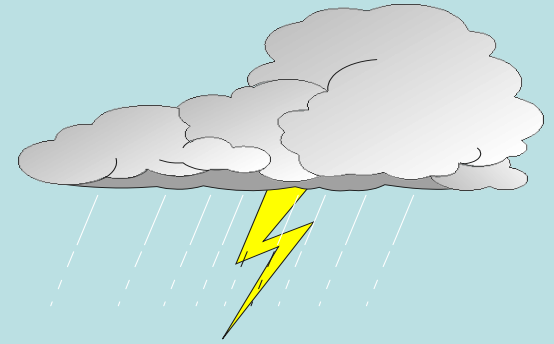
March and April

Mountain Snowpack



May, June and July

Rainfall



March through October

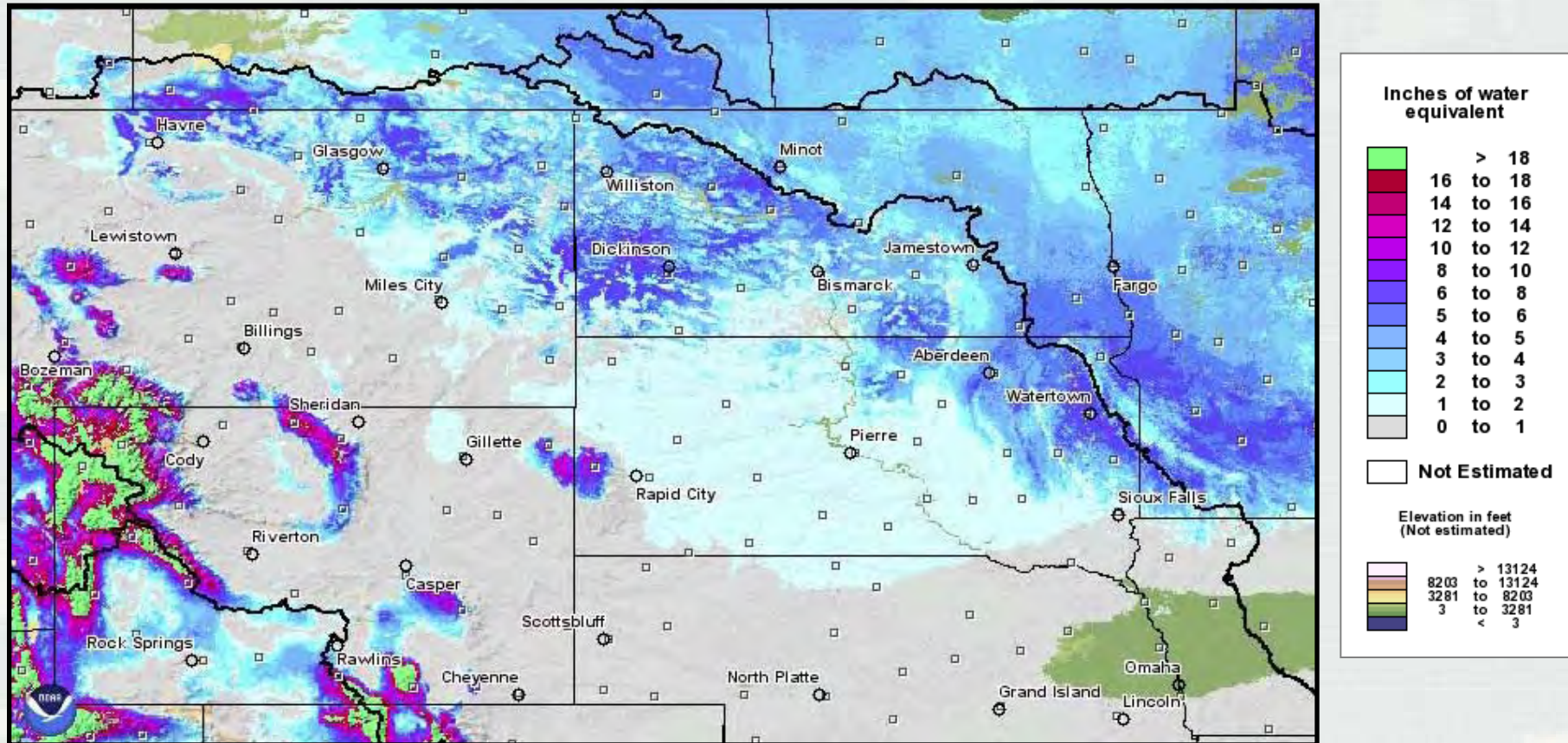
2011 Runoff = **61.0** MAF

Highest runoff since 1898

Previous Record was 49.0 MAF in 1997

# Plains Snowpack

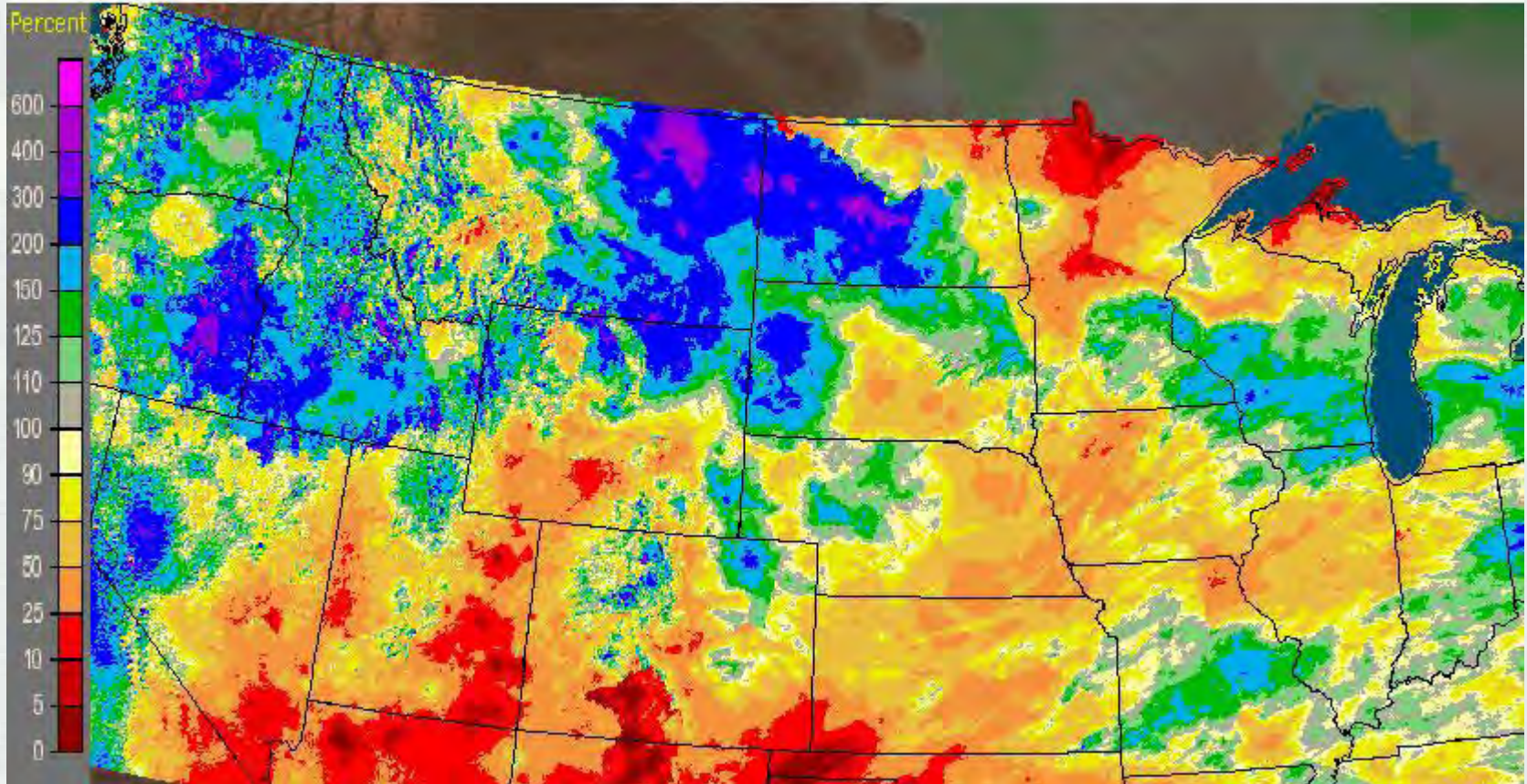
25 February 2011





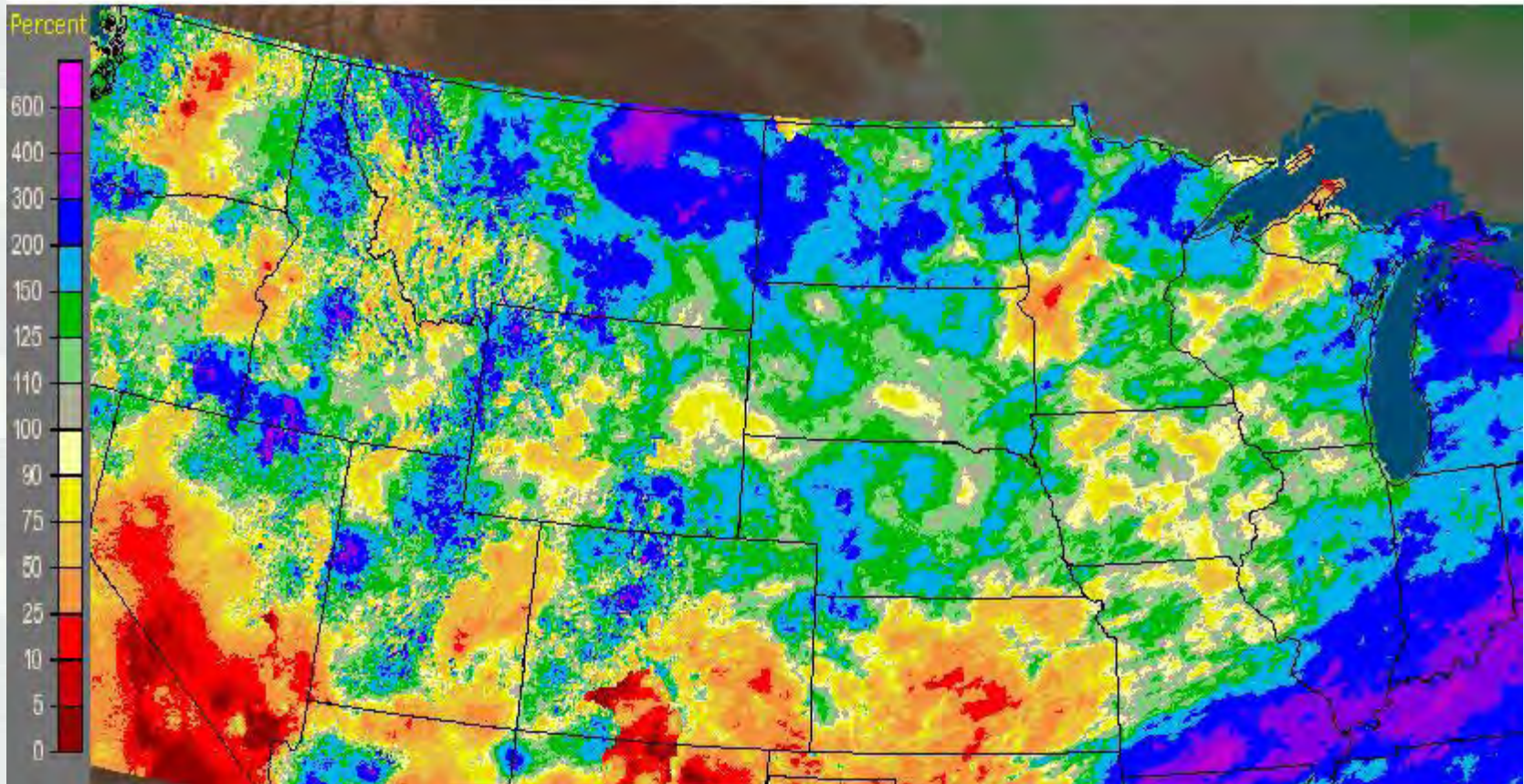
# March 2011 Precipitation (% normal)

Missouri Basin RFC Pleasant Hill, MO: March, 2011 Monthly Percent of Normal Precipitation  
Valid at 4/1/2011 1200 UTC- Created 7/2/11 1:08 UTC



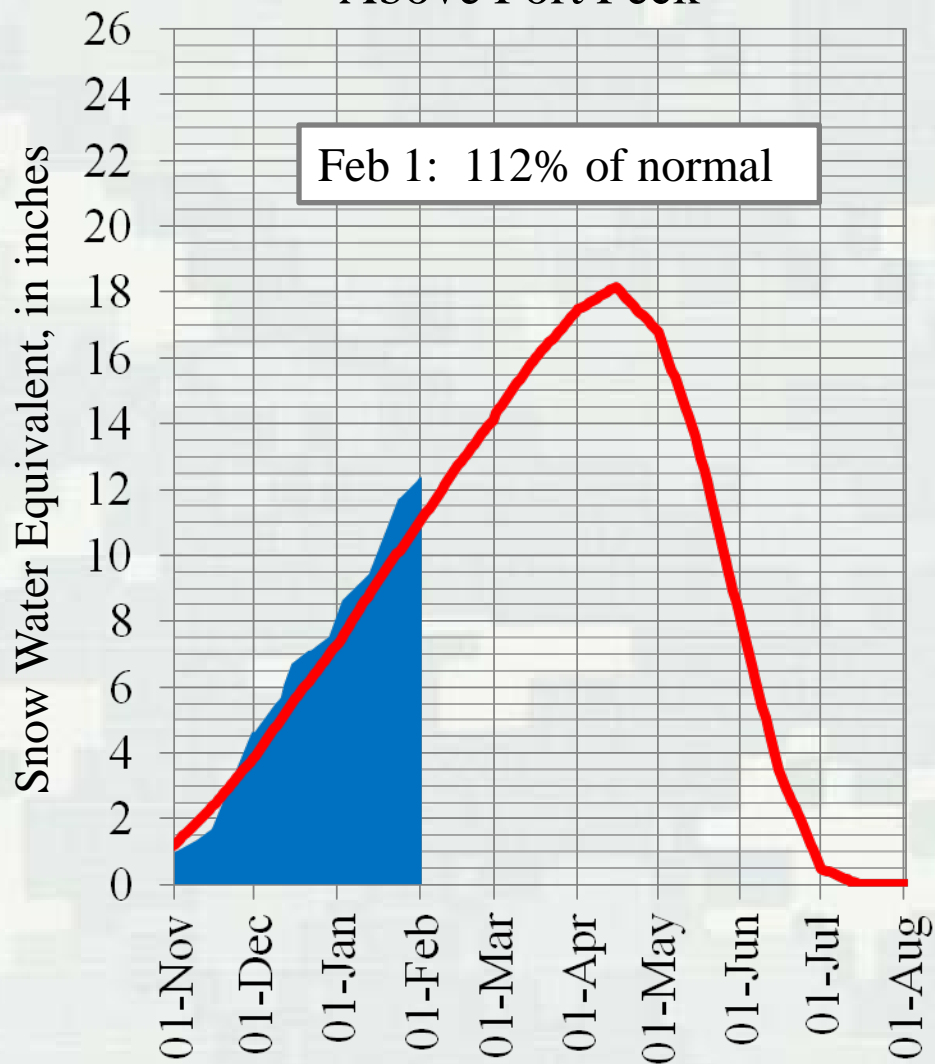
# April 2011 Precipitation (% normal)

Missouri Basin RFC Pleasant Hill, MO: April, 2011 Monthly Percent of Normal Precipitation  
Valid at 5/1/2011 1200 UTC- Created 7/6/11 15:27 UTC



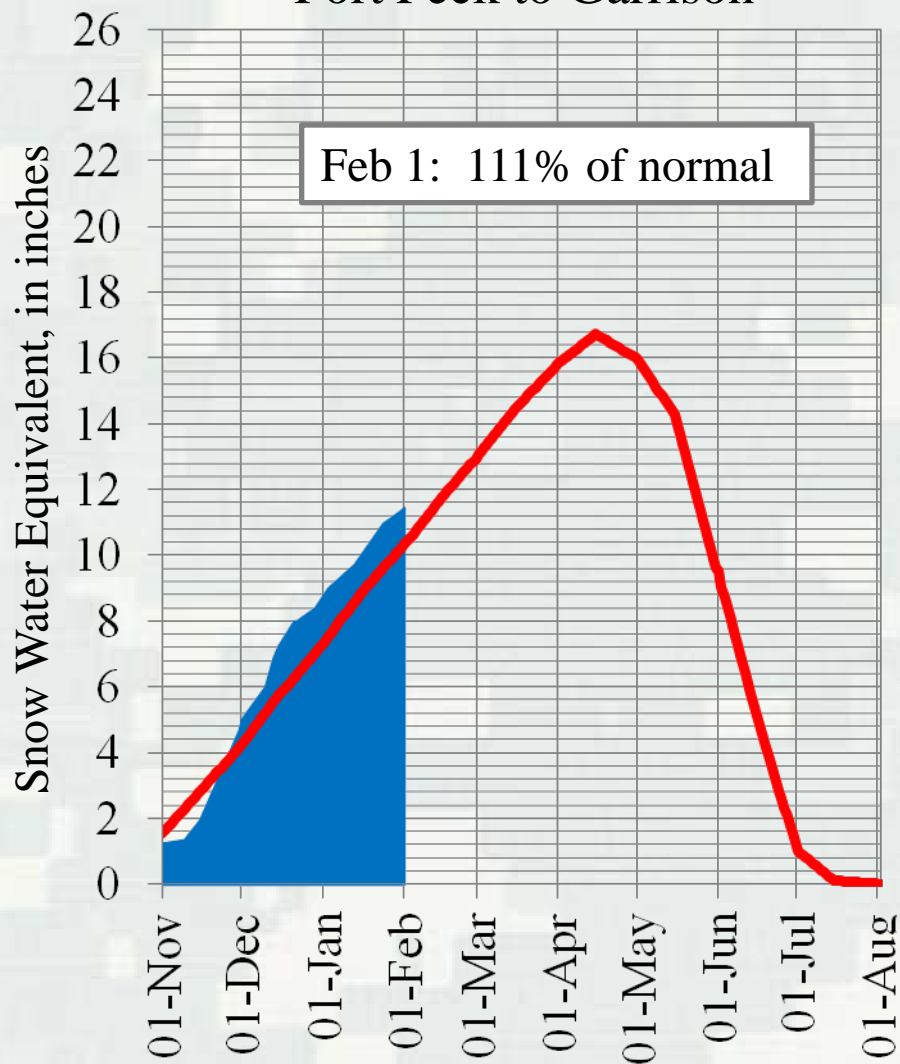
# 2010 – 2011 Mountain Snowpack

## Above Fort Peck



2010-2011 30-Yr Average

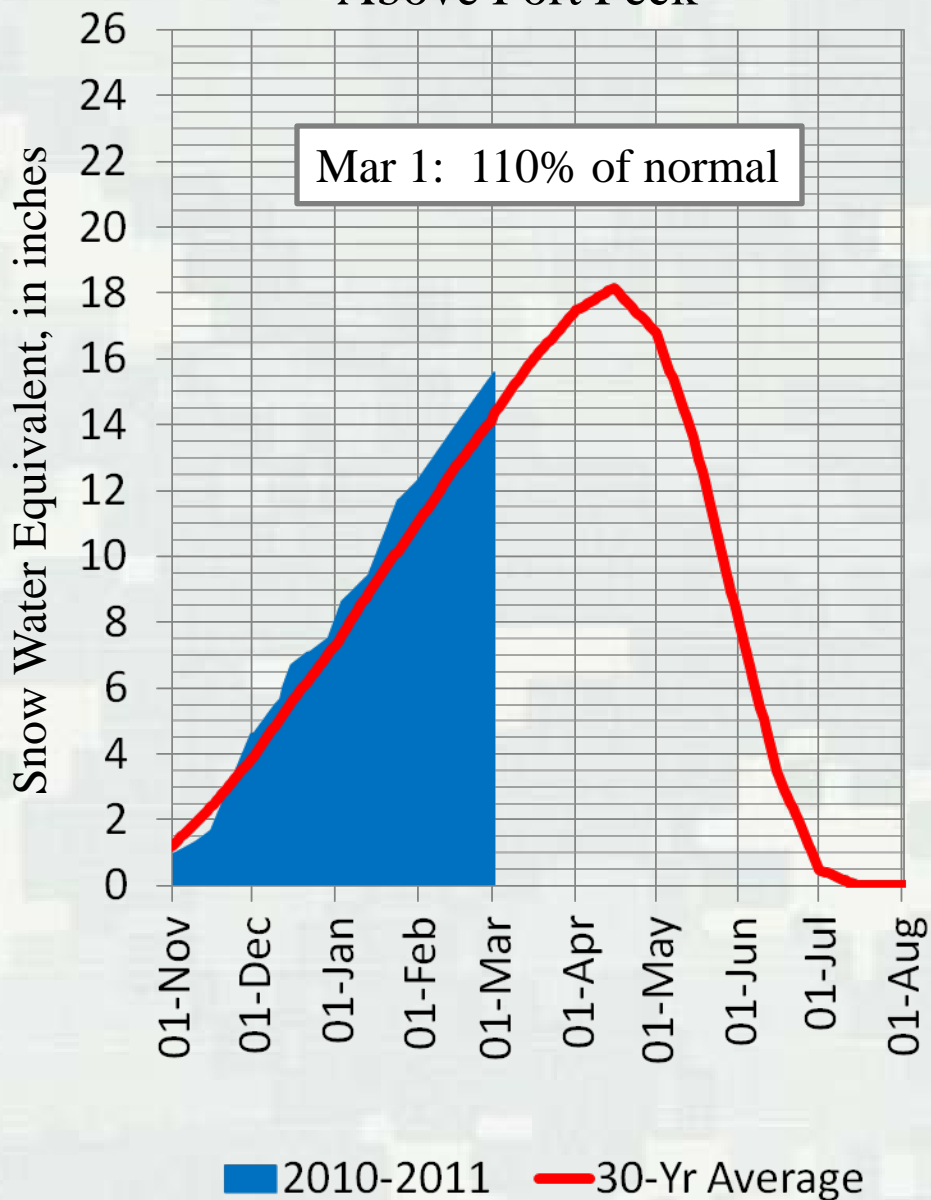
## Fort Peck to Garrison



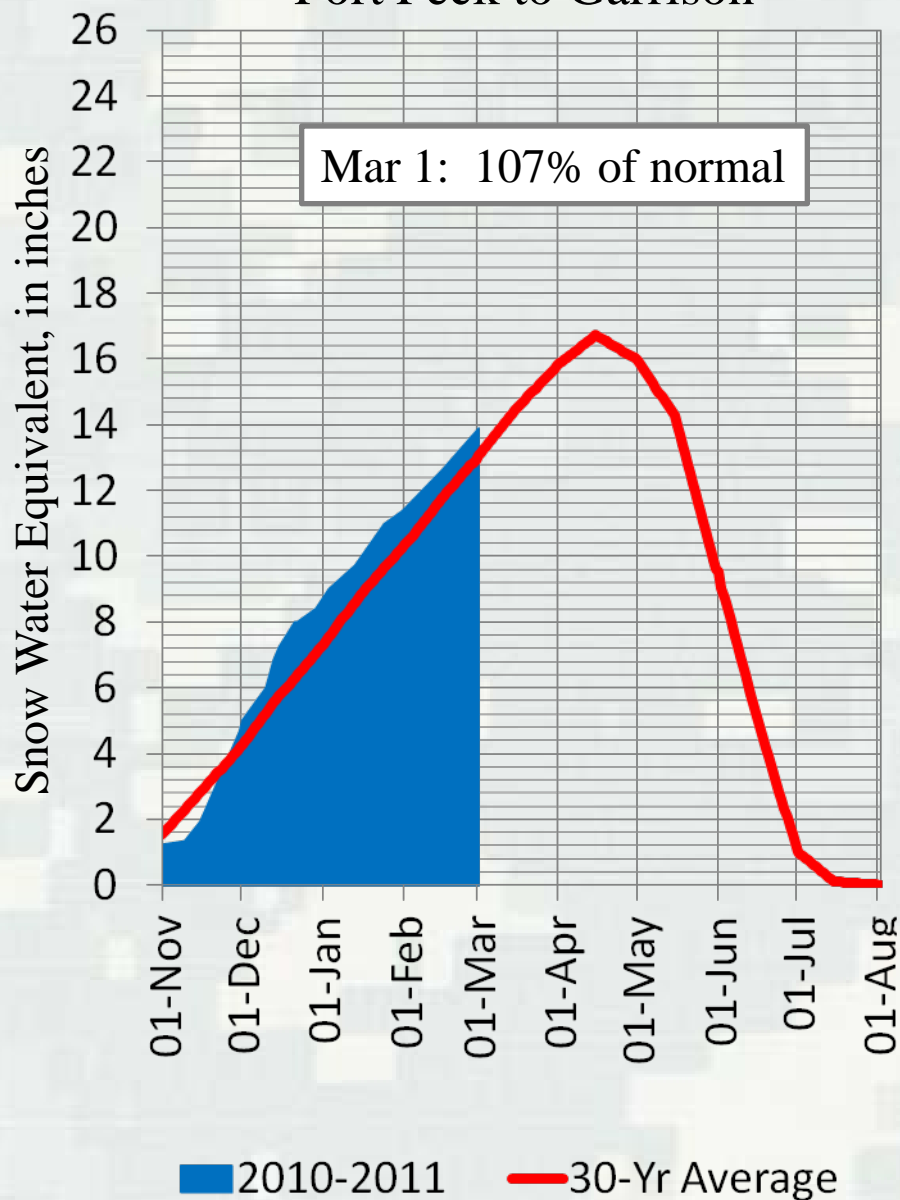
2010-2011 30-Yr Average

# 2010 – 2011 Mountain Snowpack

## Above Fort Peck

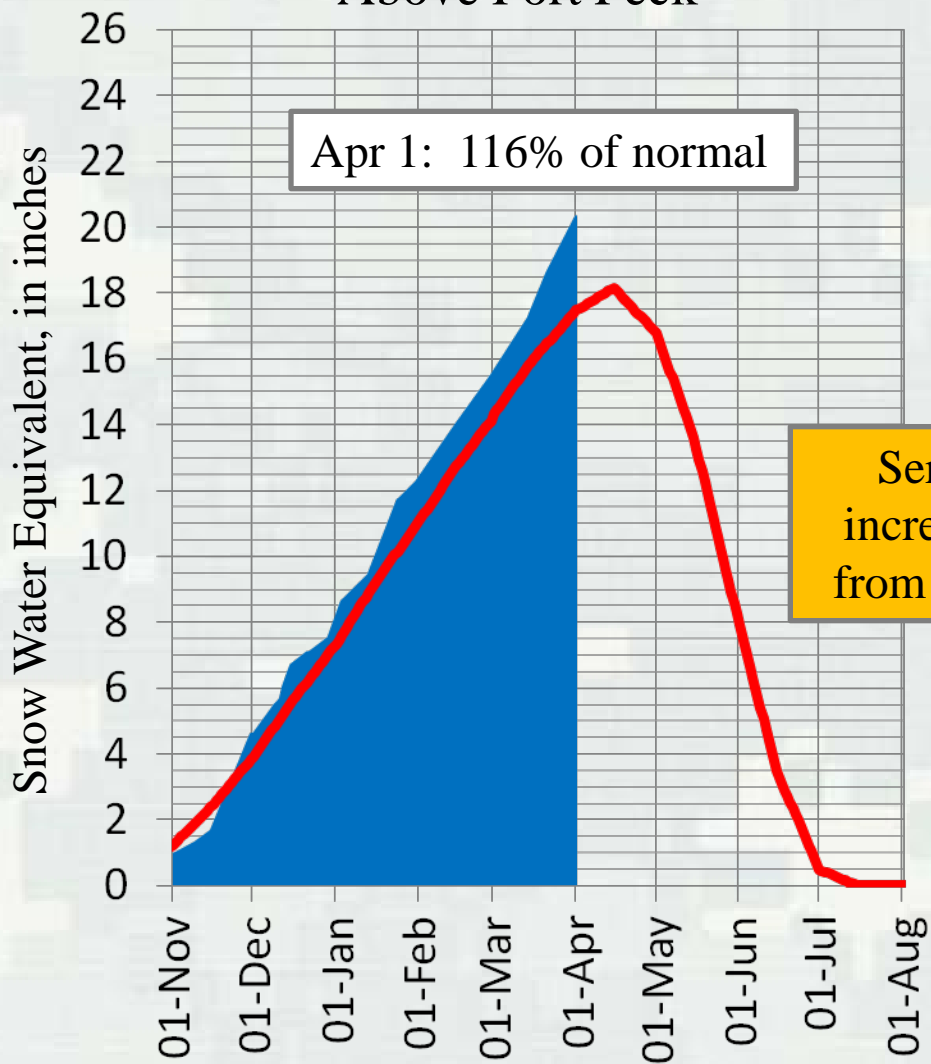


## Fort Peck to Garrison

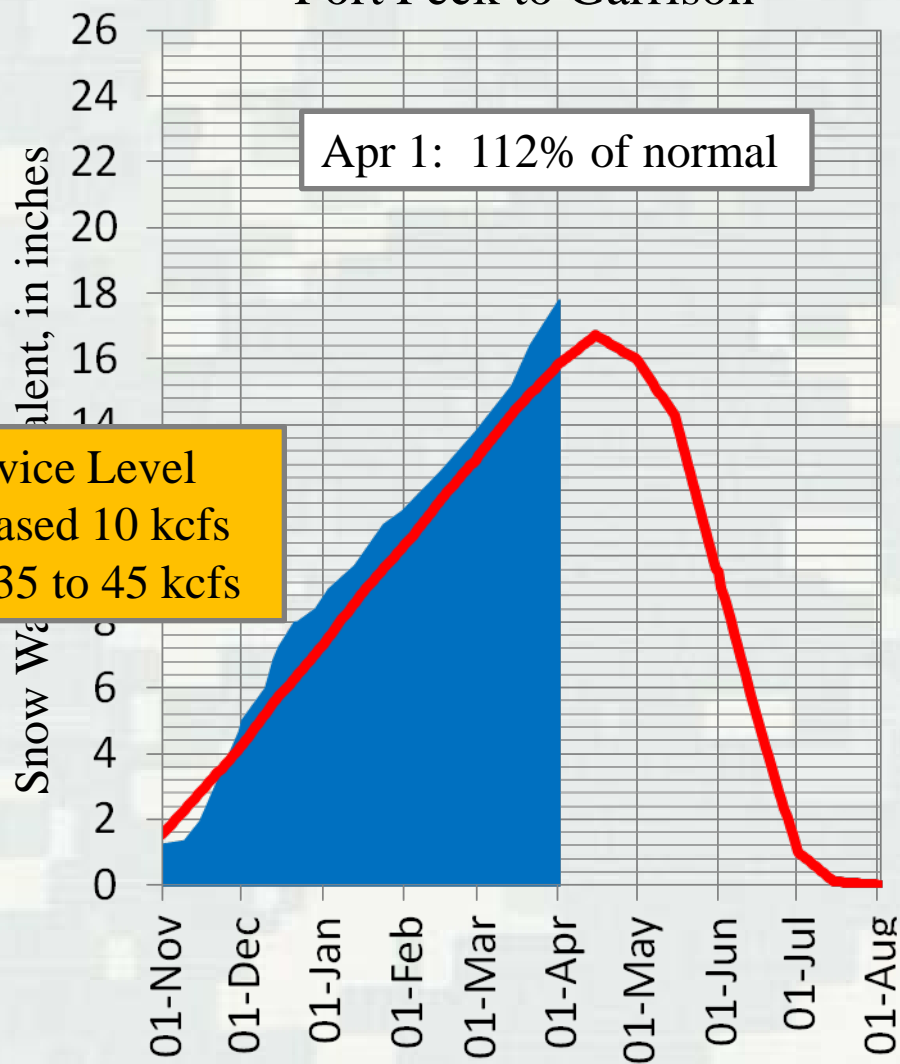


# 2010 – 2011 Mountain Snowpack

## Above Fort Peck



## Fort Peck to Garrison



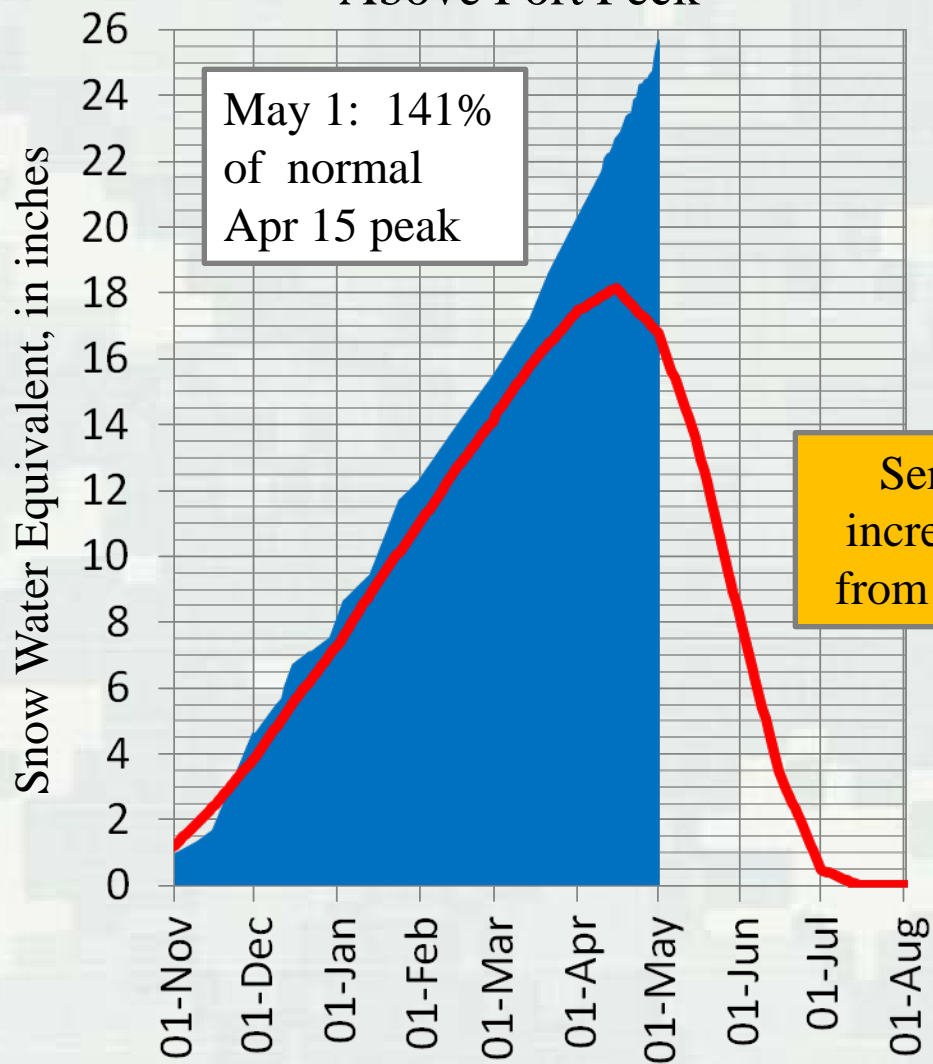
Service Level increased 10 kcfs from 35 to 45 kcfs

2010-2011 30-Yr Average

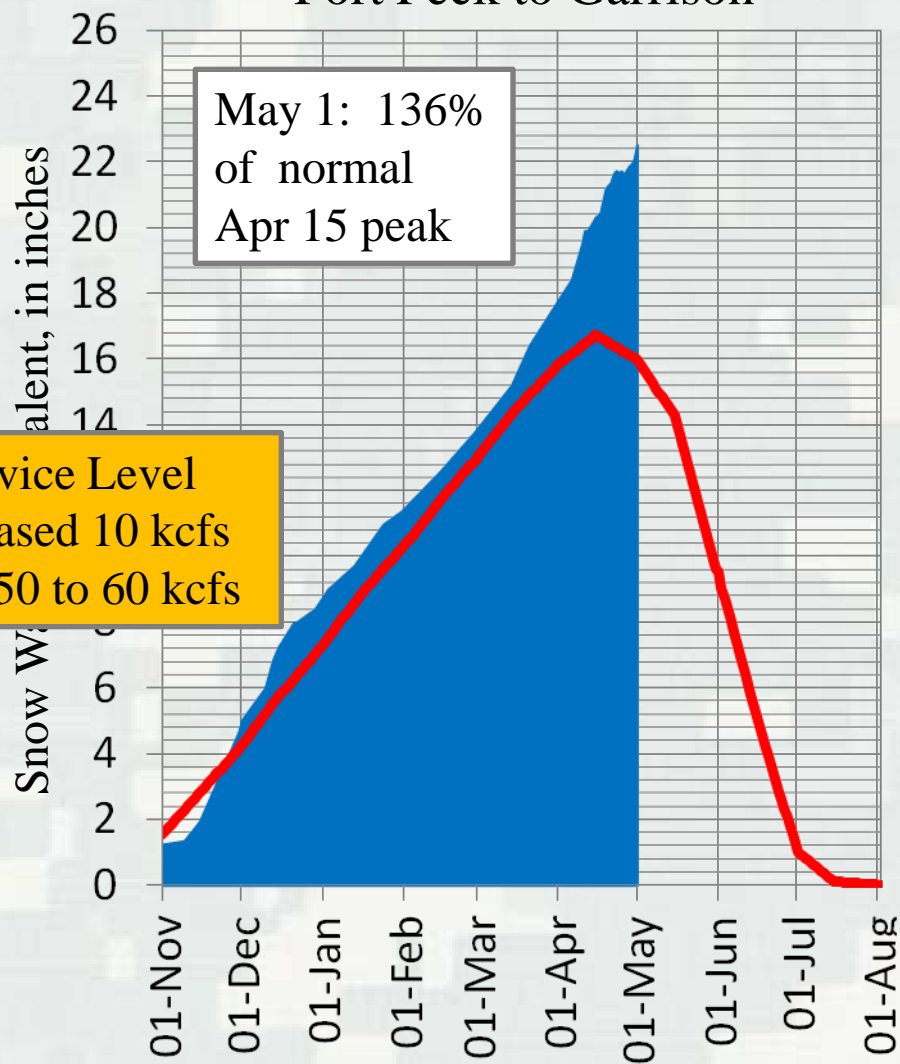
2010-2011 30-Yr Average

# 2010 – 2011 Mountain Snowpack

## Above Fort Peck



## Fort Peck to Garrison



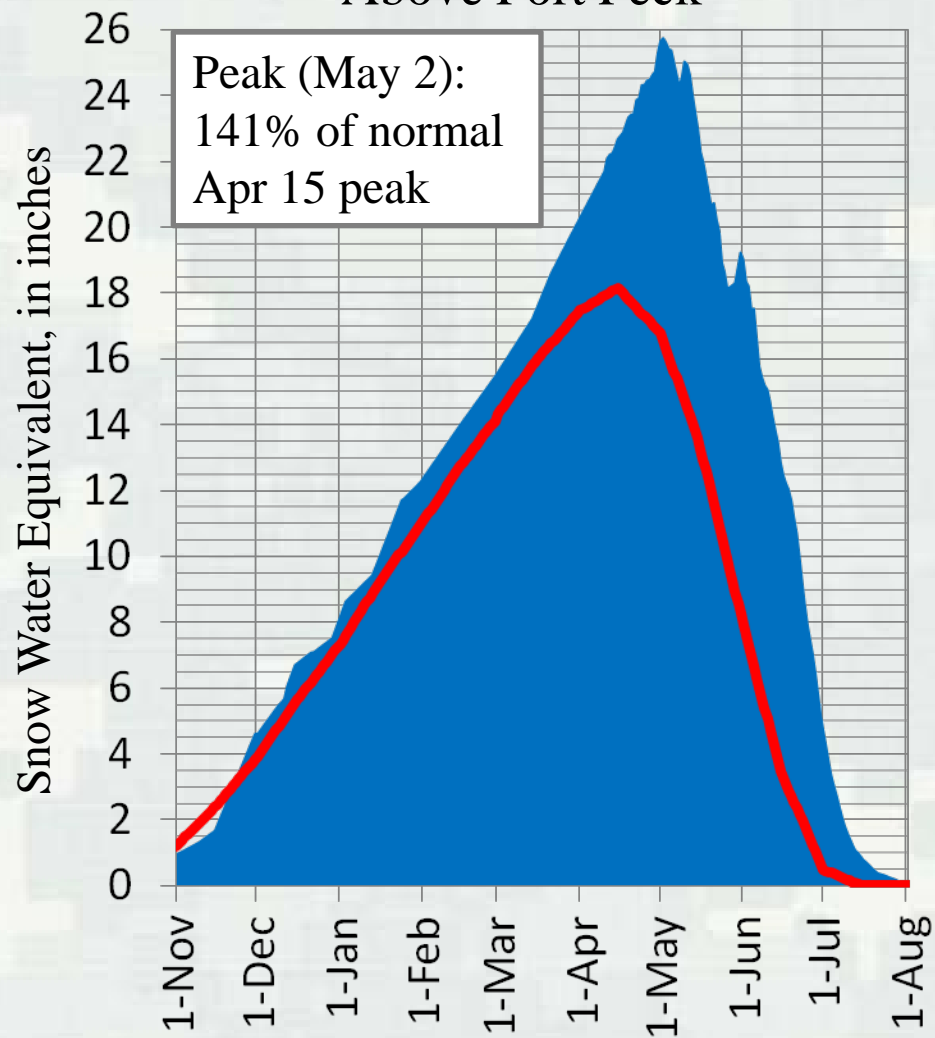
Service Level increased 10 kcfs from 50 to 60 kcfs

2010-2011 30-Yr Average

2010-2011 30-Yr Average

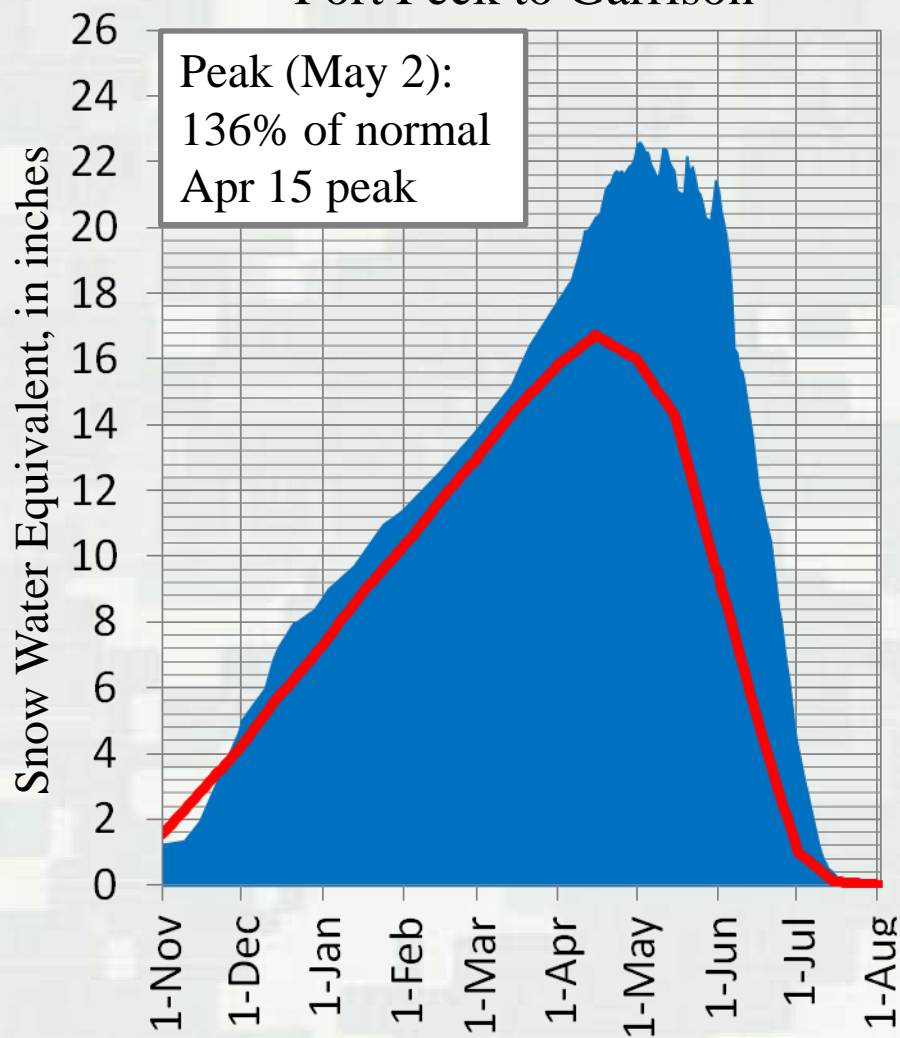
# 2010 – 2011 Mountain Snowpack

## Above Fort Peck



2010-2011 30-Yr Average

## Fort Peck to Garrison



2010-2011 30-Yr Average

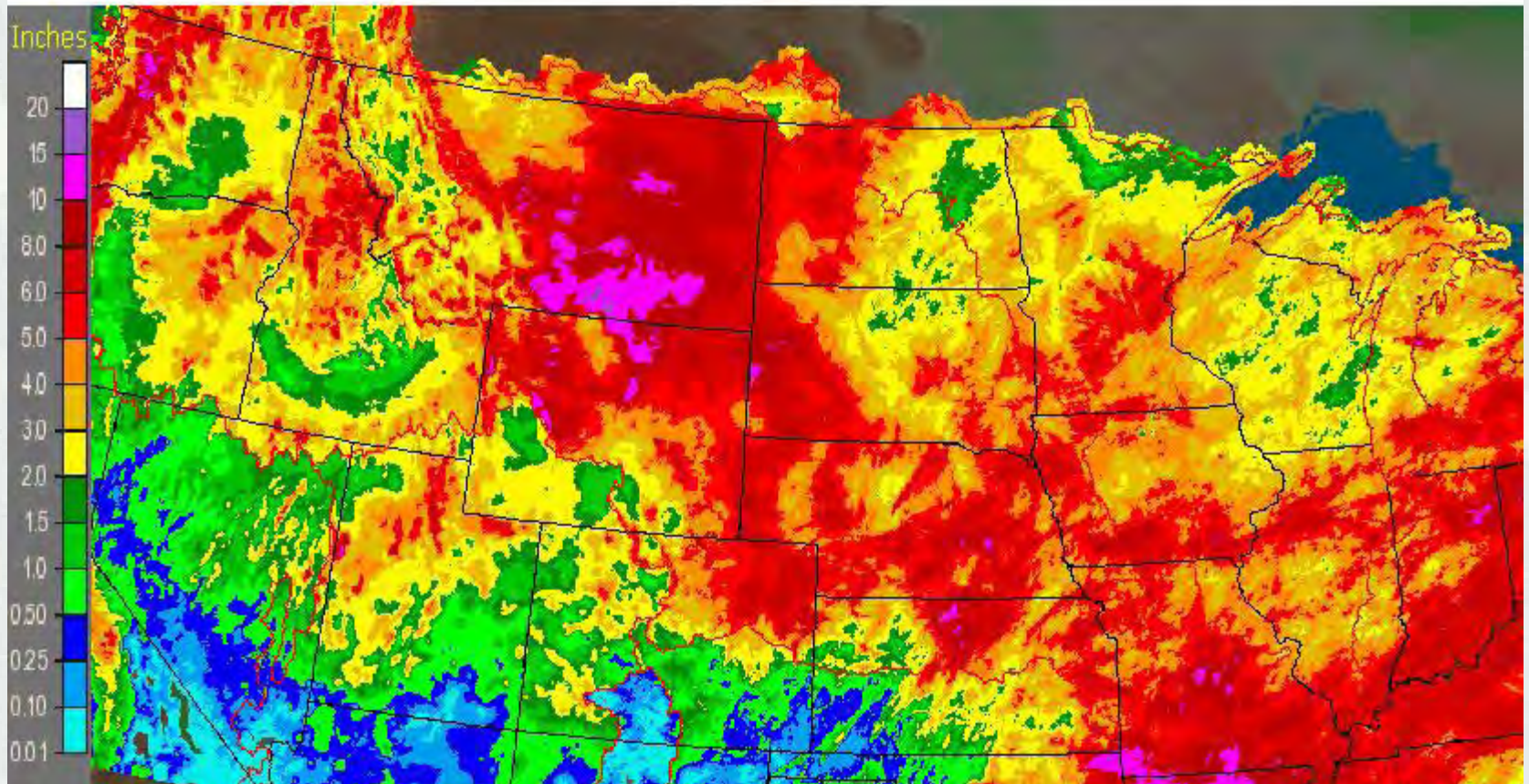
# Bear Tooth Pass – June 12, 2011





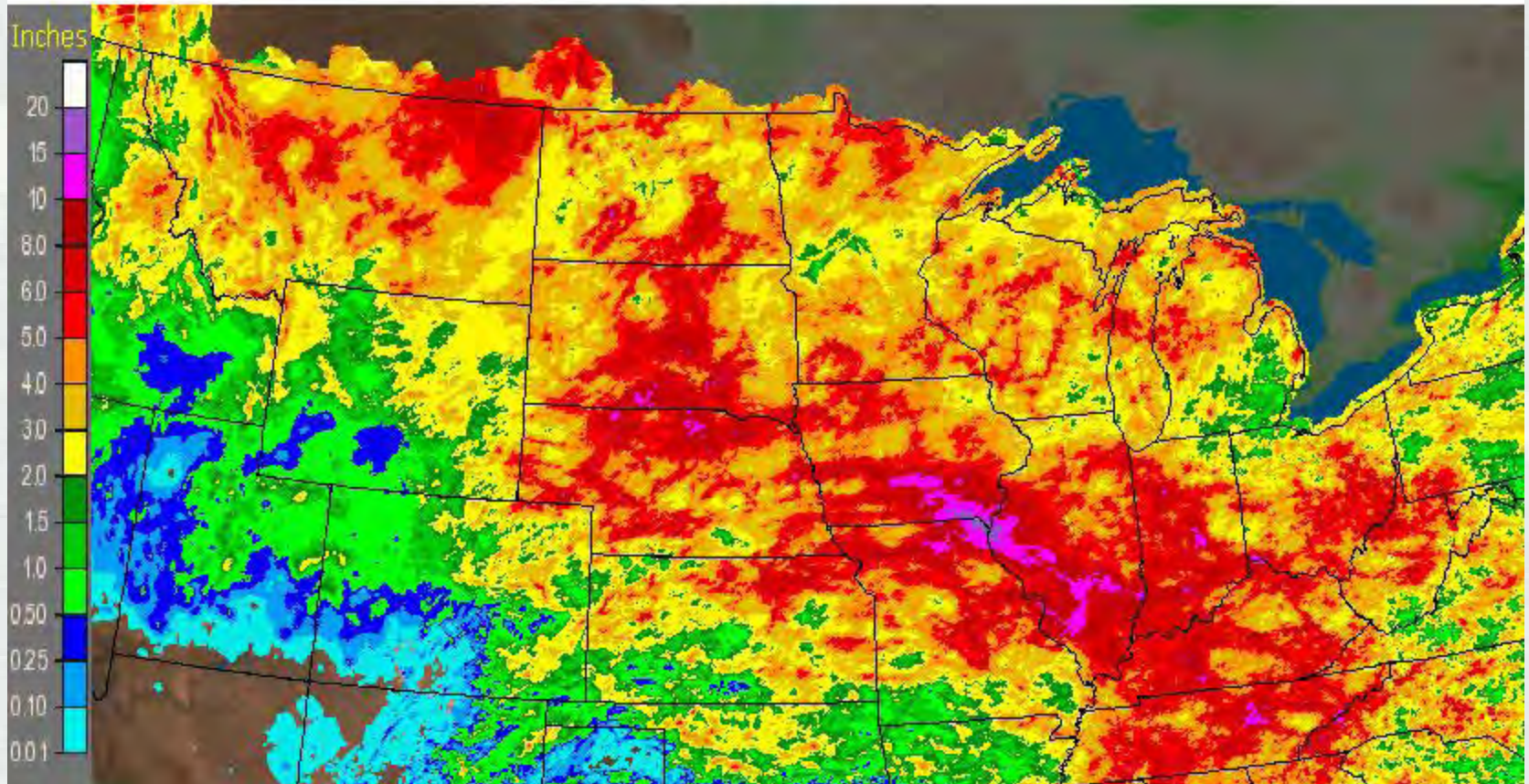
# May 2011 Precipitation (inches)

Missouri Basin RFC Pleasant Hill, MO: May, 2011 Monthly Observed Precipitation  
Valid at 6/1/2011 1200 UTC- Created 6/2/11 17:40 UTC



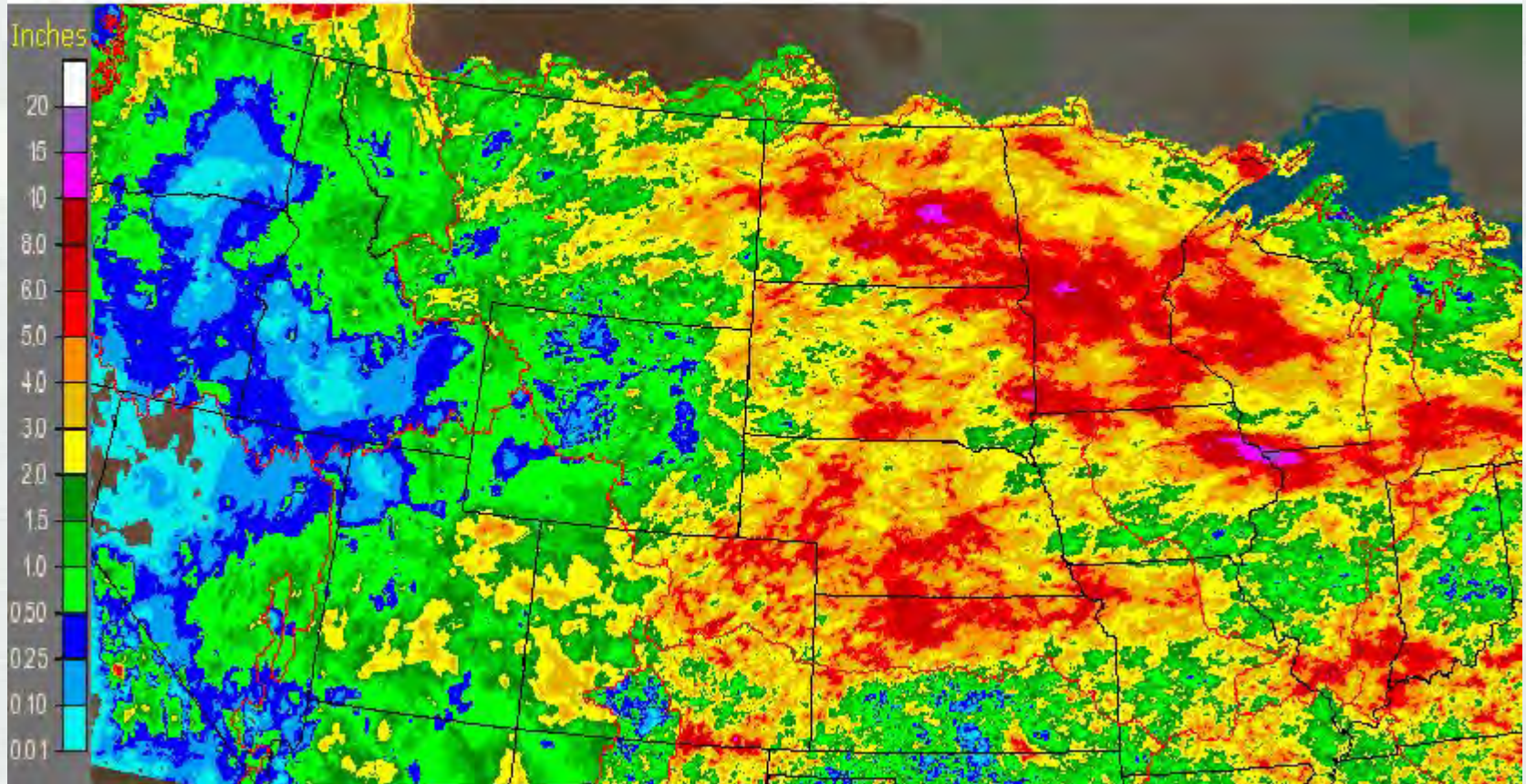
# June 2011 Precipitation (inches)

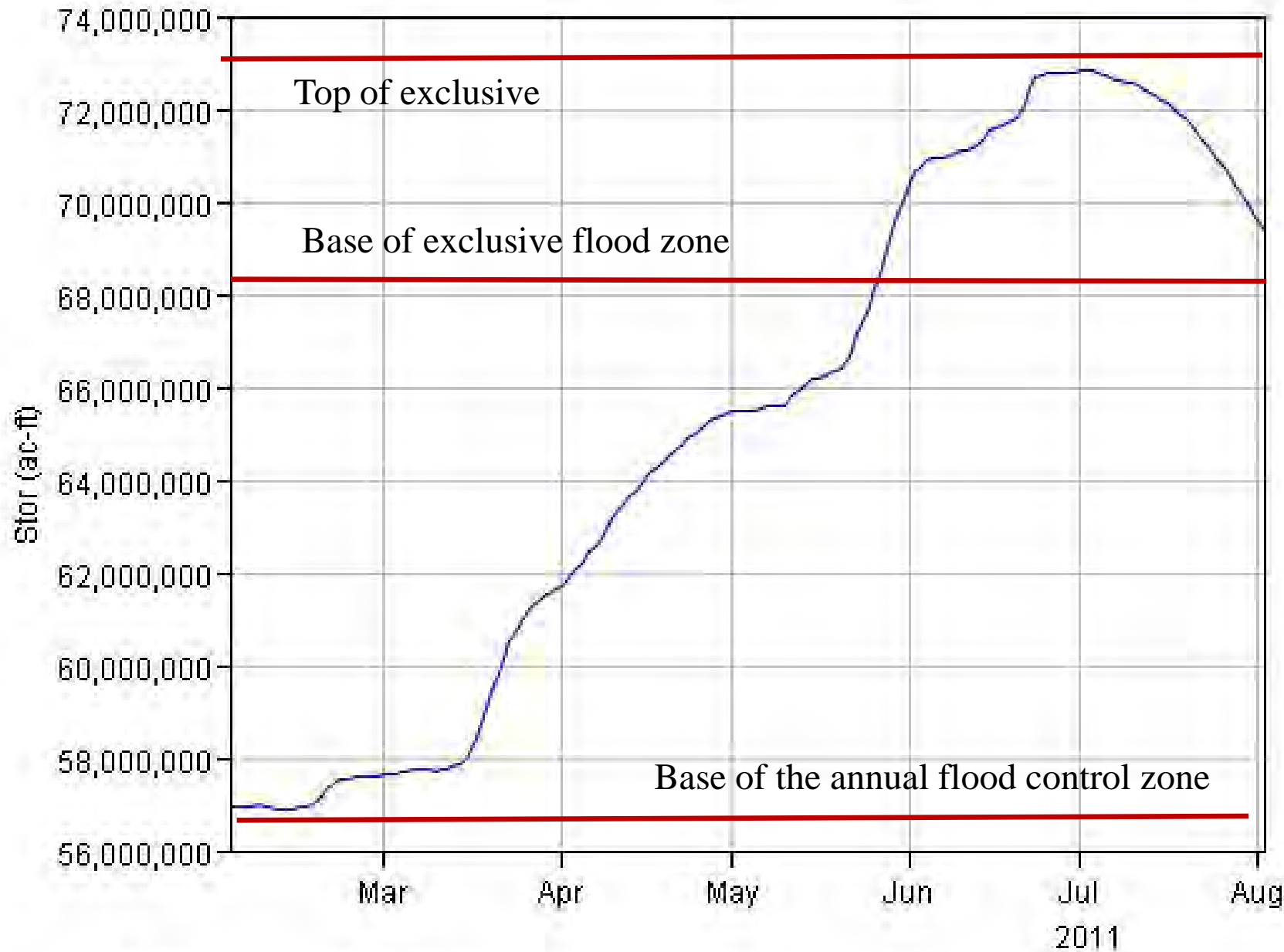
NWS Central Region: June, 2011 Monthly Observed Precipitation  
Valid at 7/1/2011 1200 UTC- Created 7/2/11 17:40 UTC



# July 2011 Precipitation (inches)

Missouri Basin RFC Pleasant Hill, MO: July, 2011 Monthly Observed Precipitation  
Valid at 8/1/2011 1200 UTC- Created 8/2/11 17:40 UTC





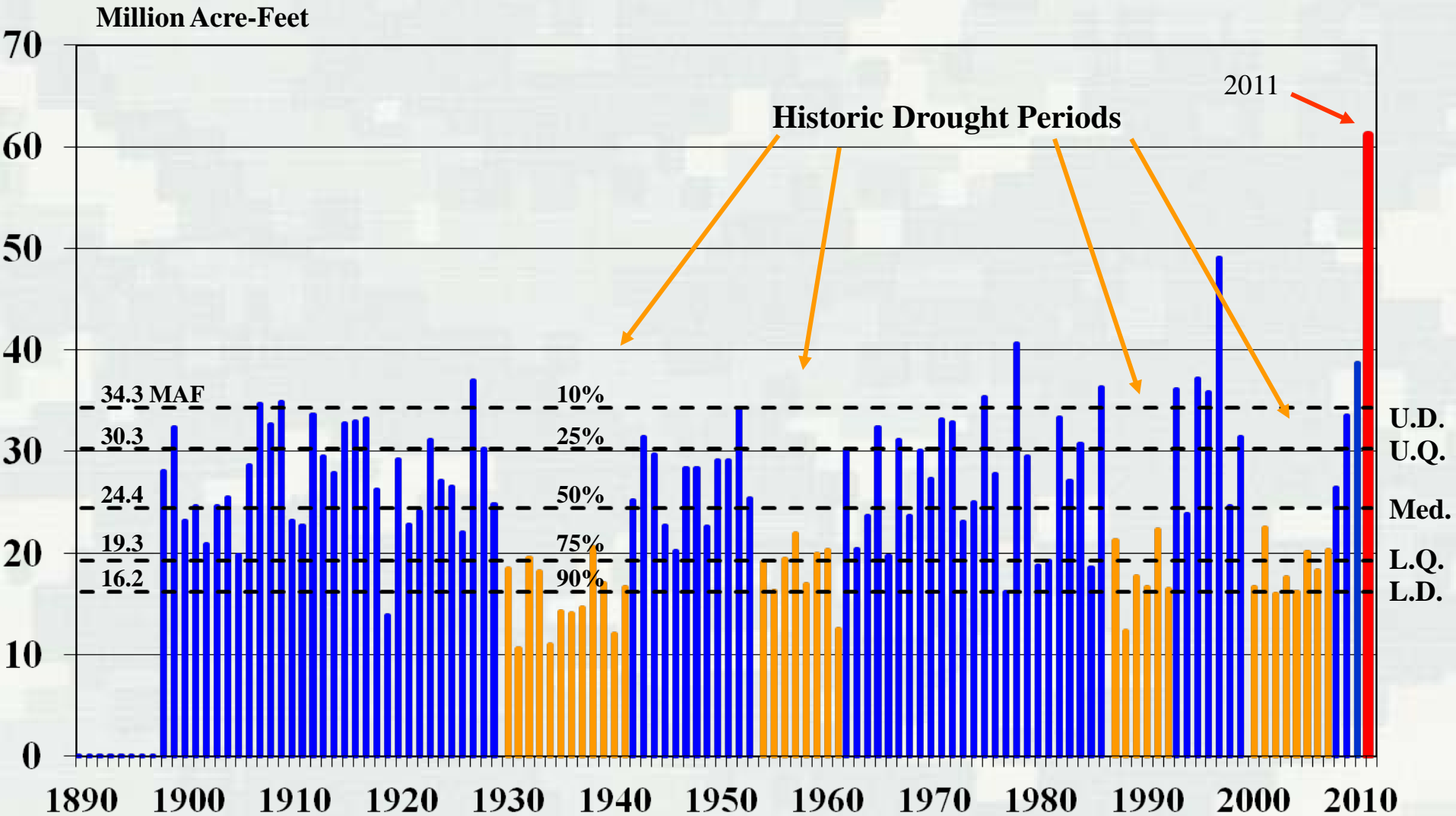
— SYS-Missouri River Mainstem mmpocs-rev Stor

# What Actually Happened

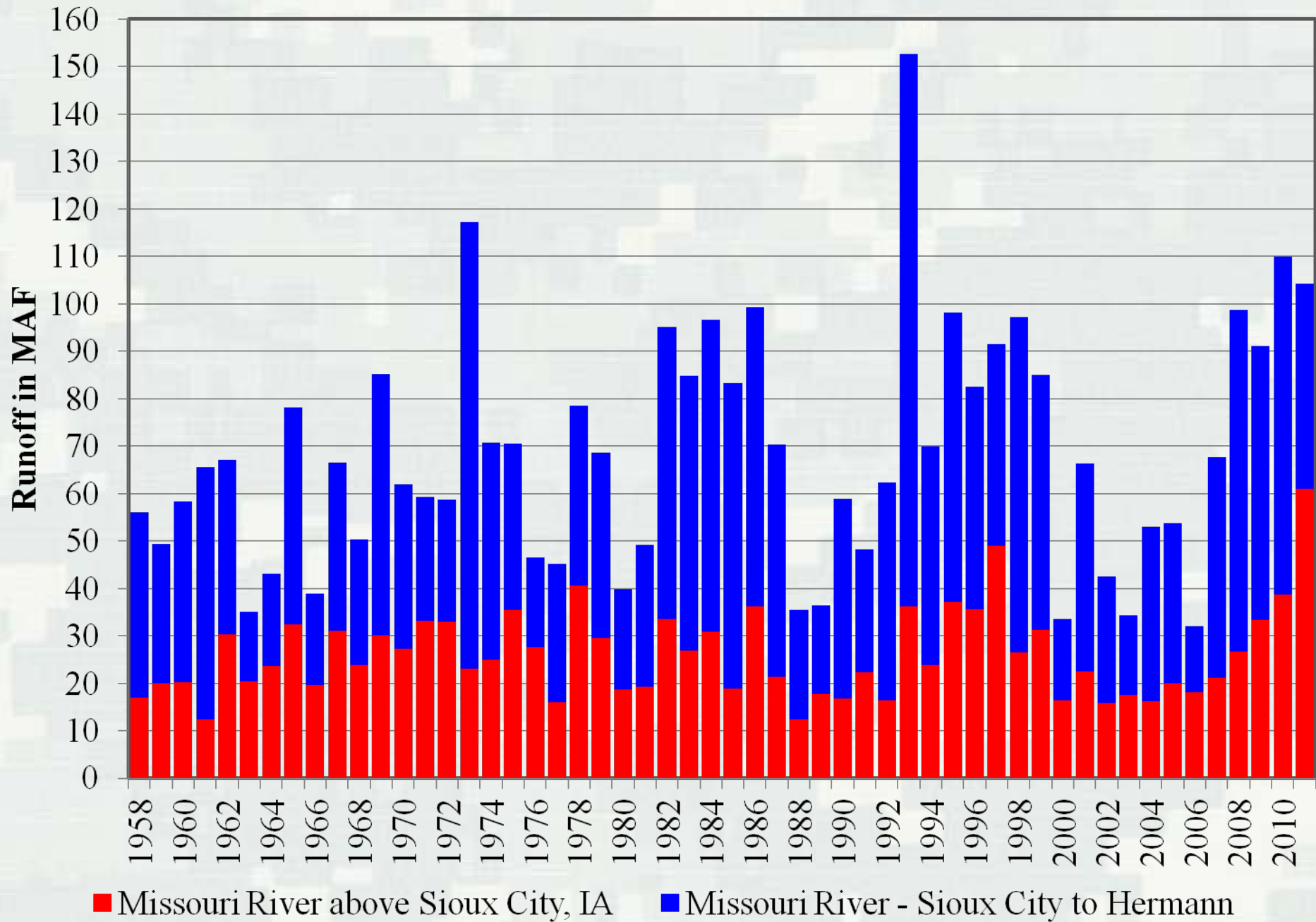
- Runoff in 2011 was 61.0 million acre-feet (MAF), 246 percent of normal and the highest runoff in 114 years
  - ▶ June was the single wettest month on record with 14.8 MAF of runoff, surpassing the old record of 13.2 MAF set in April 1952.
  - ▶ July was the fourth wettest single month on record with 10.2 MAF
- Combined May through July runoff of 34.3 MAF is higher than the total annual runoff in 102 of 113 years in the period of record
- 1881 Design Event Was Exceeded



# Missouri River Mainstem System Annual Runoff above Sioux City, IA

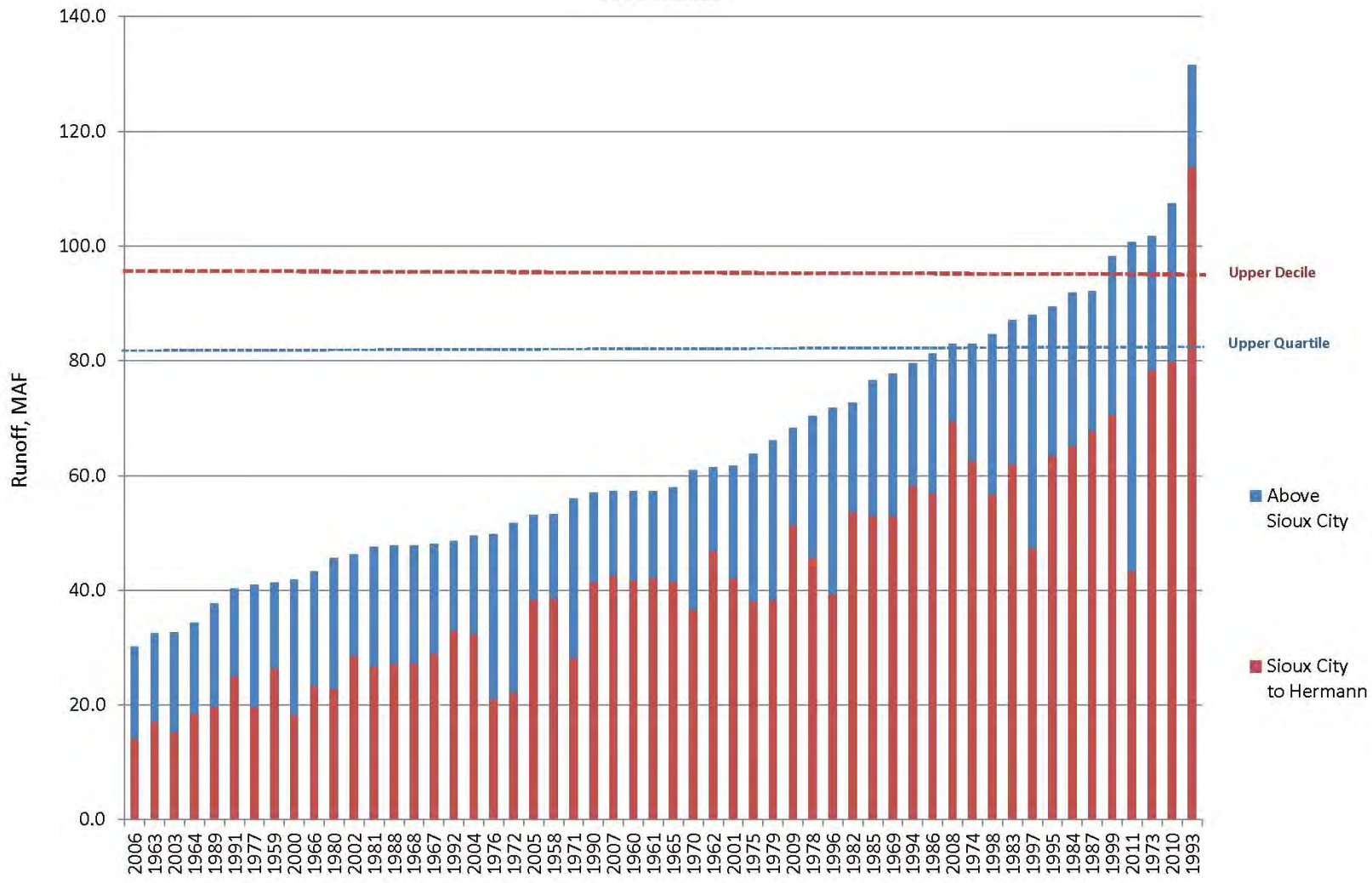


# Missouri River Basin Runoff



# Ranked Annual Missouri River Runoff

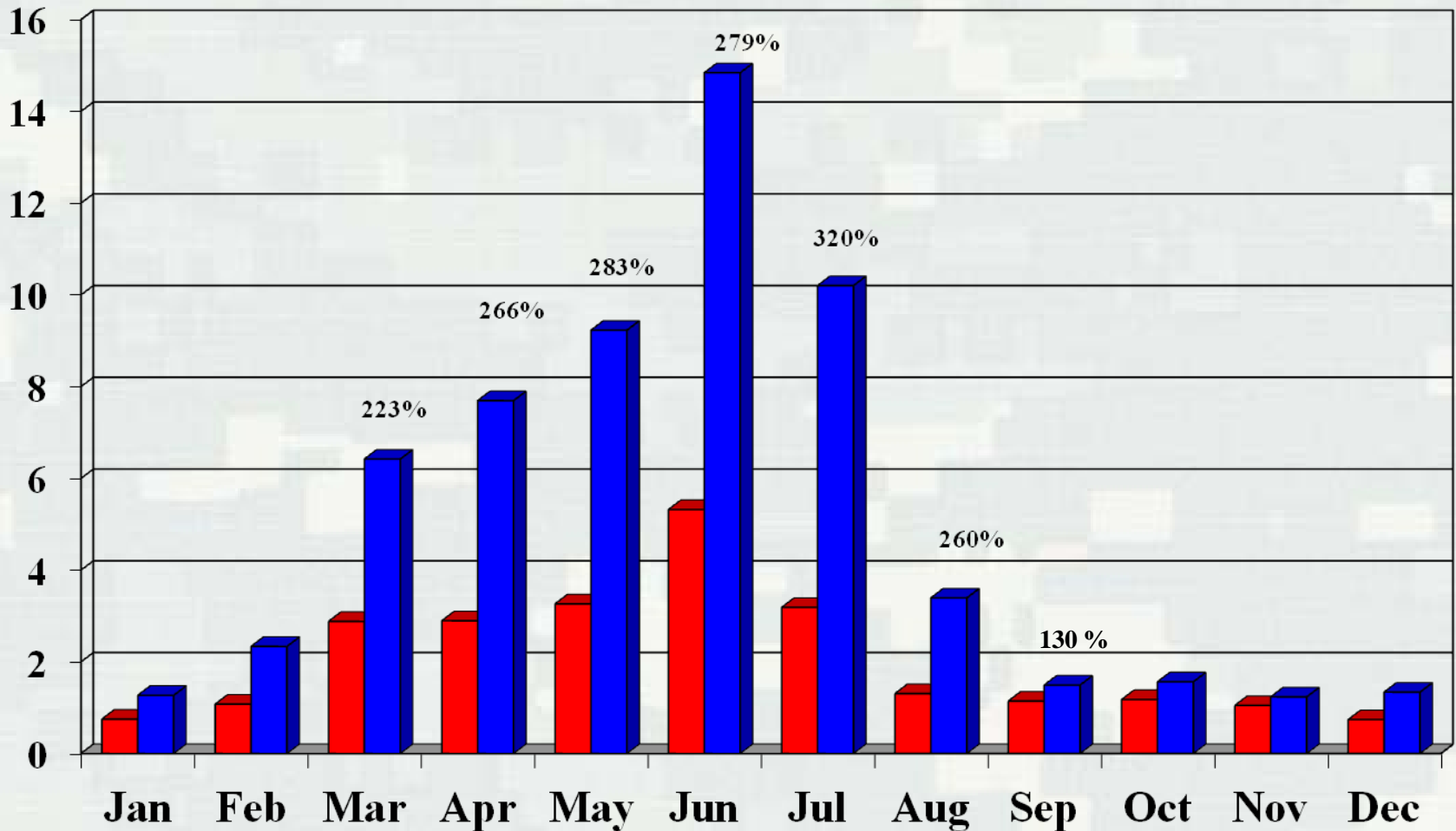
1958 to 2011





# Missouri River Runoff above Sioux City 2011 Actual/Forecasted versus Normal

Million Acre-Feet



25

■ Normal

■ 2011 Actual/Forecasted

2011 Actual/Forecasted

# Fort Peck

Spillway

Construction Started: 1935  
In Operation: 1940

5 Francis turbine  
power units; ~ 15 kcfs  
2 regulating tunnels ~  
45 kcfs

Length of Dam = 21,030 ft; ~ 4 miles

2011 Peaks  
release – 65,000 cfs  
elevation – 2252.3 (2.3' surcharge)  
storage – 19.0 MAF

Previous Peaks  
release – 35,000 cfs (1975)  
elevation – 2251.6 (1.6' surcharge, 1975)



\*Capacity at max operating pool

# Garrison

Construction Started: 1946

In Operation: 1955

3 regulating  
tunnels; ~ 98 kcfs

Length of Dam = 11,300 ft

Spillway capacity\*

~ 660 kcfs

Never used prior to  
2011

5 Francis turbine  
power units; ~ 41 kcfs

## 2011 Peaks

release – 150,000 cfs

elevation – 1854.4 (0.4' surcharge)

storage – 24.0 MAF

## Previous Peaks

release – 65,000 cfs (1975)

elevation – 1854.8 (0.8' surcharge, 1975)

\*Capacity at max operating pool



06/04/2011 10:04

Construction Started: 1948  
In Operation: 1962

# Oahe



Spillway (highly erodible,  
has never been used)

Length of Dam = 9,300 ft

6 regulating  
tunnels; ~ 110 kcfs

7 Francis turbine  
power units; ~ 54 kcfs

## 2011 Peaks

release – 160,000 cfs  
elevation – 1619.6 (top of spillway gates – 1620')  
storage – 23.0 MAF

## Previous Peaks

release – 59,000 cfs (1997)  
elevation – 1618.7 (1995, 1996)



# Big Bend

Construction Started: 1959

In Operation: 1964

2011 Peaks

release – 166,000 cfs

Spillway capacity\* ~

270 kcfs

Previous Peaks

release – 74,000 cfs (1997)

Never used prior to

2011

8 Fixed Blade turbine  
power units; ~ 103 kcfs

Length of Dam = 10,570 ft

\*Capacity at max operating pool

# Fort Randall

## 2011 Peaks

release – 160,000 cfs

elevation – 1374.0 (top of spillway gates – 1375')

## Previous Peaks

release – 67,000 cfs (1997)

elevation – 1372.2 (1997)

8 Francis turbine  
power units; ~ 44 kcfs

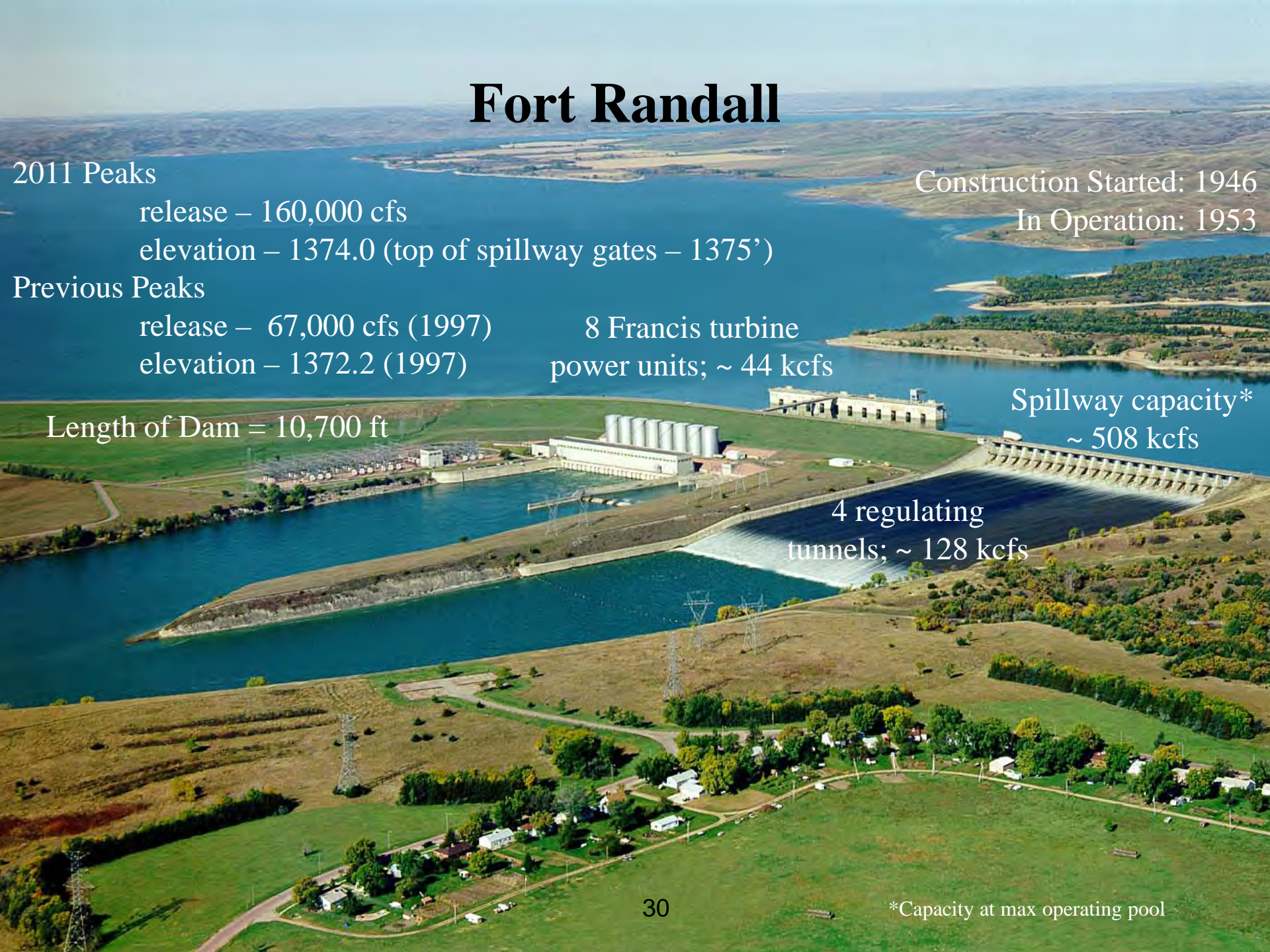
Length of Dam = 10,700 ft

Construction Started: 1946

In Operation: 1953

Spillway capacity\*  
~ 508 kcfs

4 regulating  
tunnels; ~ 128 kcfs



# Gavins Point

2011 Peaks

release – 160,000 cfs

Previous Peaks

release – 70,000 cfs (1997)

Construction Started: 1952

In Operation: 1955

Length of Dam = 8,700

Spillway capacity\*

~ 345 kcfs

3 Kaplan turbine  
power units; ~ 34 kcfs

\*Capacity at max operating pool

# Pierre, South Dakota



Marions Garden

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# Dakota Dunes, South Dakota



# Fort Calhoun, Nebraska

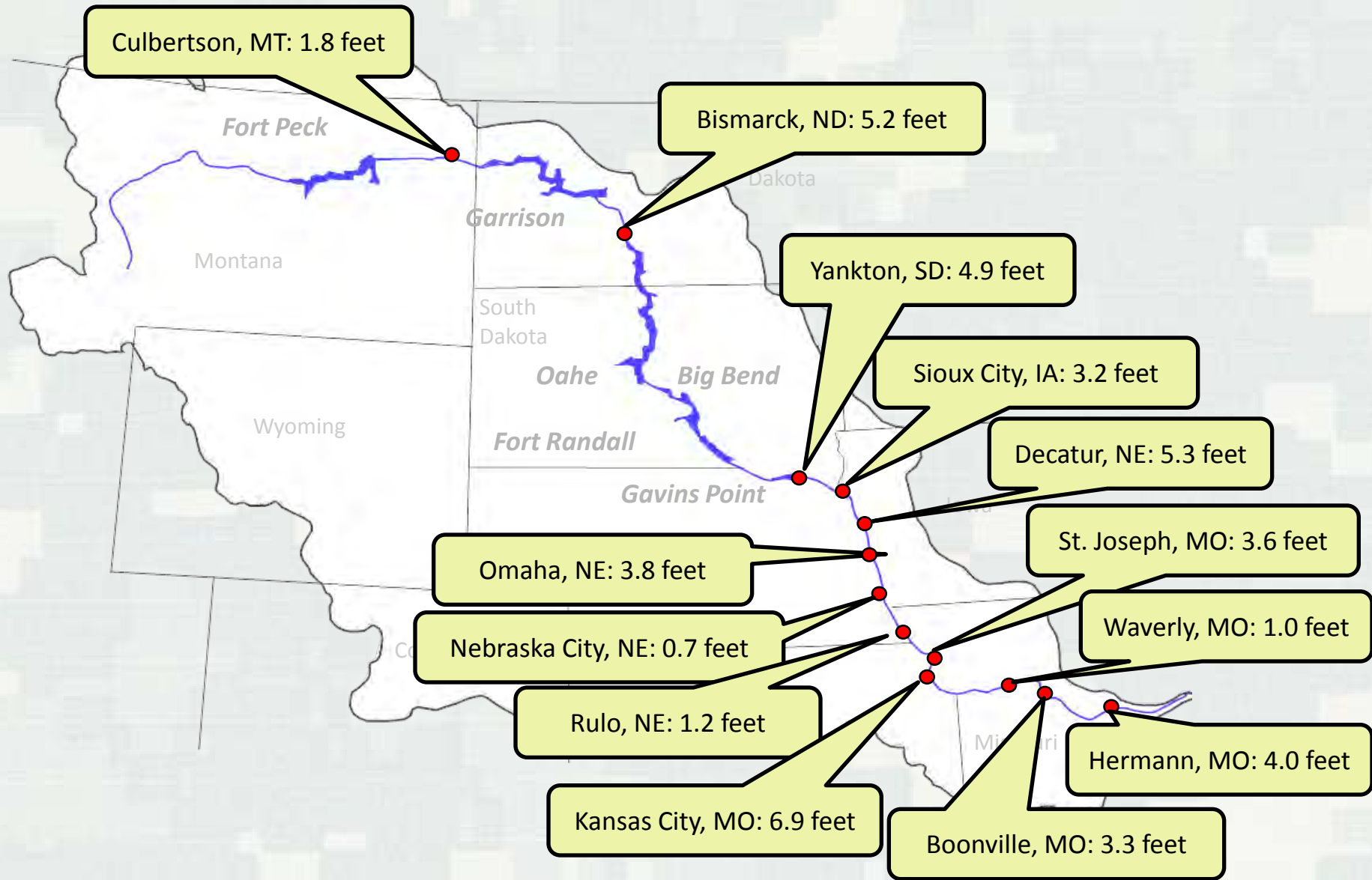


# Omaha, Nebraska

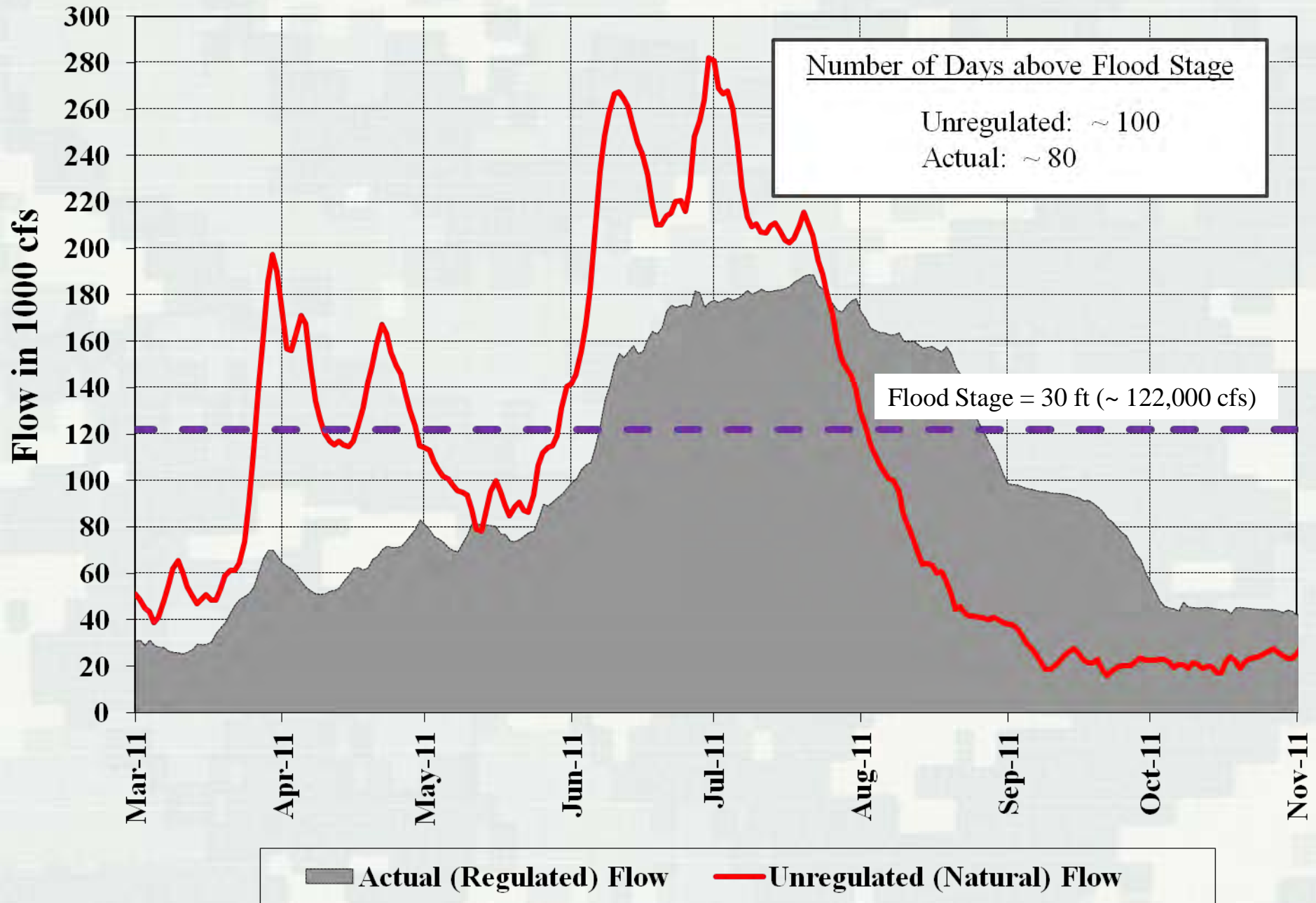


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# Missouri River Stage Reduction Due to Reservoir Operations



# Missouri River at Sioux City, IA – Actual and Unregulated Flows

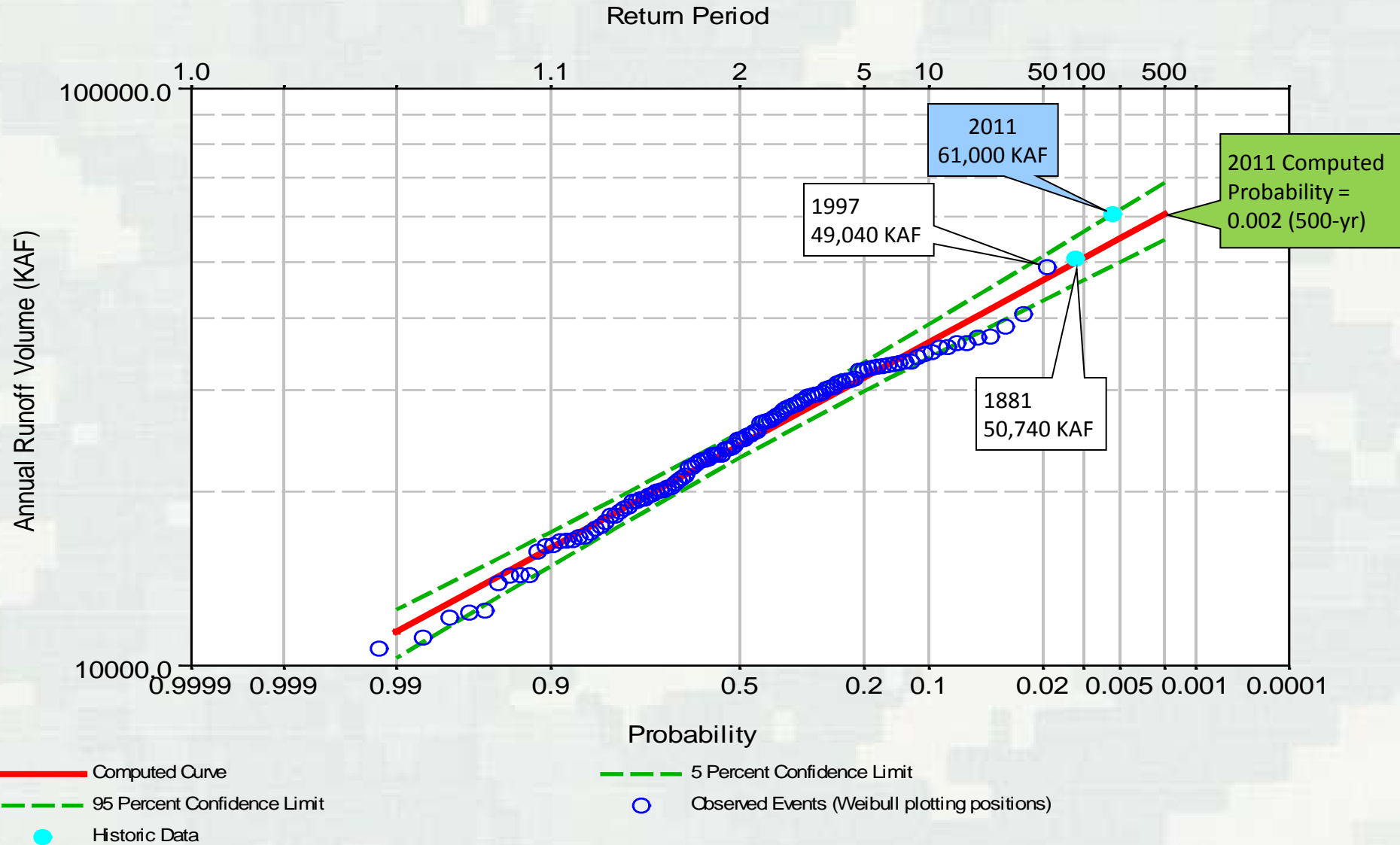


# Damages Prevented

Corps Mainstem Projects	\$5.5 billion
Corps Tributary Projects	\$0.2 billion
USBR Projects	\$0.2 billion
Mainstem Urban Levees	\$1.5 billion
Mainstem Nonurban Levees	\$0.1 billion
Corps Local Protection	
Channels and Levees	\$0.2 billion
Emergency Measures	\$0.5 billion
 Total	 \$8.2 billion



# Annual Runoff Volume Frequency



# System Tested as Never Before...

- System storage peaked at a record 72.8 MAF on 1 July
  - ▶ 16 MAF stored flood waters in mainstem reservoirs
  - ▶ Corps and Bureau of Reclamation tributary reservoirs also utilized
- Four mainstem reservoirs utilized exclusive flood control zone
  - ▶ Fort Peck, Garrison, Oahe and Fort Randall
- Three mainstem reservoirs set record pool levels
  - ▶ Fort Peck, Oahe and Fort Randall
- Two mainstem reservoirs utilized surcharge storage
  - ▶ Fort Peck and Garrison
- Spillways at two mainstem dams were operated for the first time
  - ▶ Garrison and Big Bend
- Record releases from all mainstem reservoirs





# Independent External Review Panel

## Panel Recommendations

1. Support a program of infrastructure enhancement.
2. Update hydrologic studies to include 2011.
3. Review of System storage allocations.
4. Improved cooperation/collaboration with NWS, USGS and NRCS.
5. Studies to enhance data collection and forecasting (especially plains snow).
6. Implement modern interactive, graphics decision support system.



# Analysis of Missouri River Mainstem Flood Control Storage

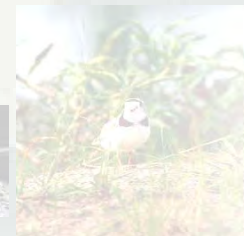
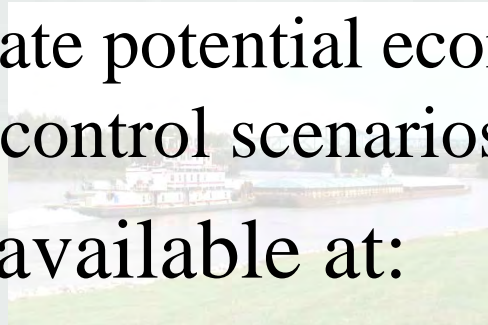
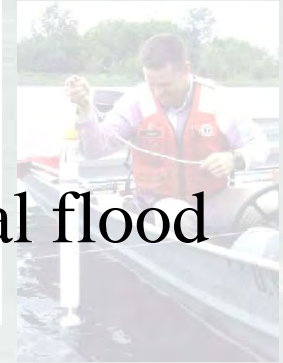
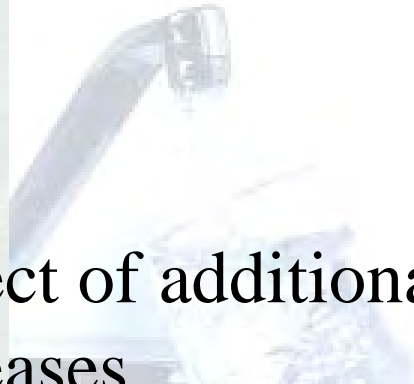
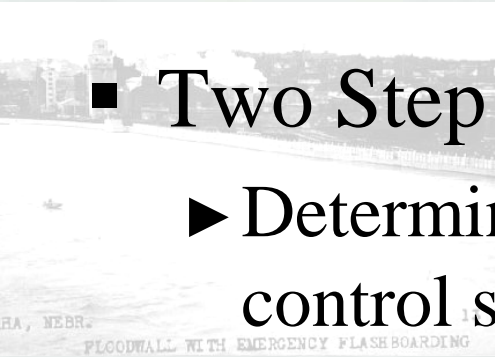
- Two Step Process

- ▶ Determine the potential effect of additional flood control storage on 2011 releases.

- ▶ Evaluate potential economic impacts of alternative flood control scenarios.

- Report available at:

<http://www.nwd-mr.usace.army.mil/rcc/>



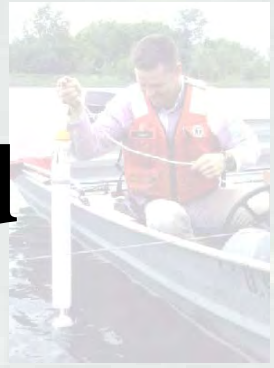
# Analysis of Missouri River Mainstem Flood Control Storage

## ■ Conclusions

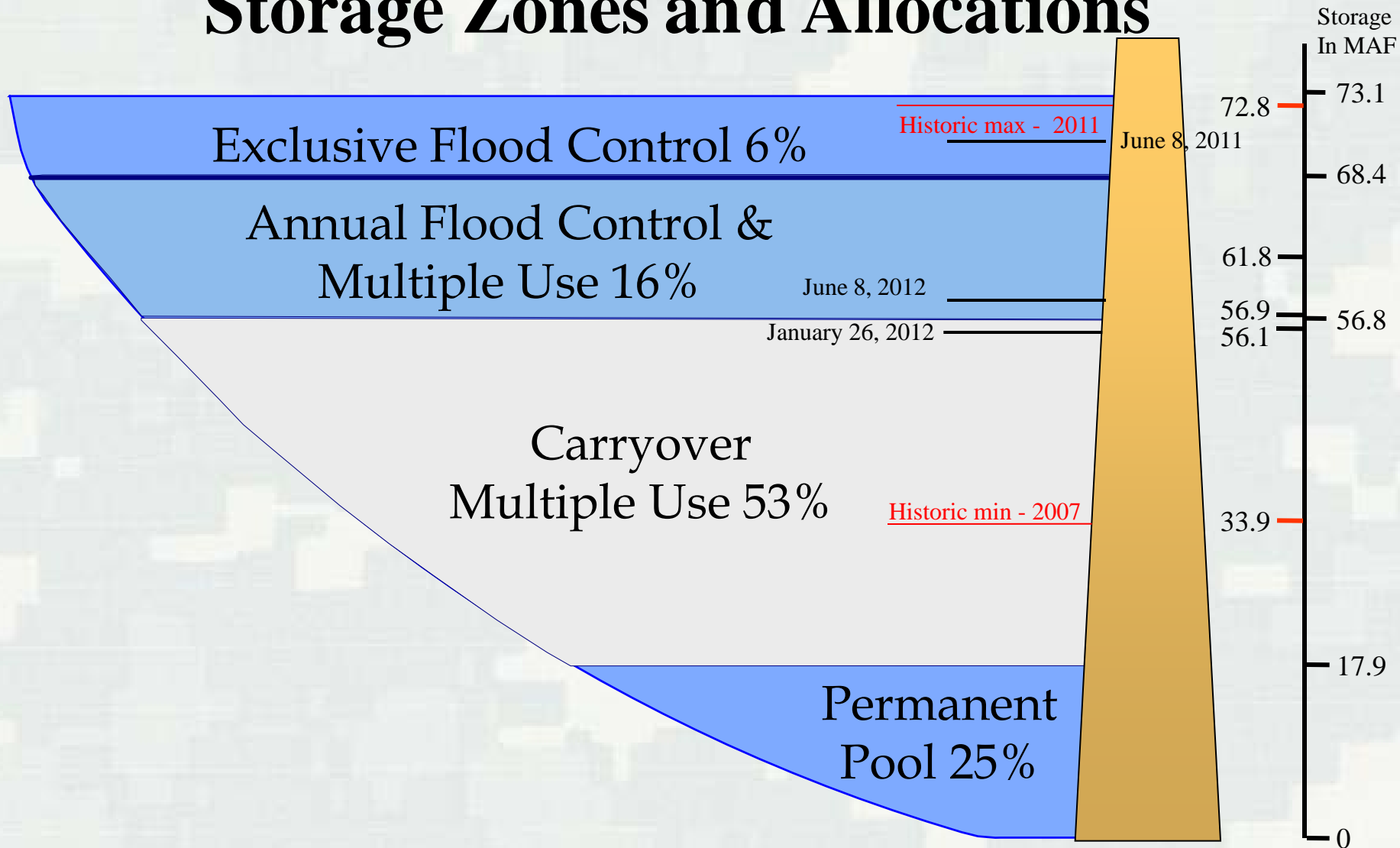
- ▶ Additional flood control storage would enhance flood risk reduction in a repeat of the 2011 flood, but would not have prevented record releases in 2011.
- ▶ Additional flood control storage would have a negative impact on other authorized purposes.
- ▶ Additional flood control storage would have little impact on lower basin rainfall driven flood events such as 2010.
- ▶ Flood control storage is one piece of the solution; increasing channel capacity and reducing encroachment in the flood plain would further enhance flood risk reduction.



# Current Conditions and Expected Results for Authorized Purposes in 2012

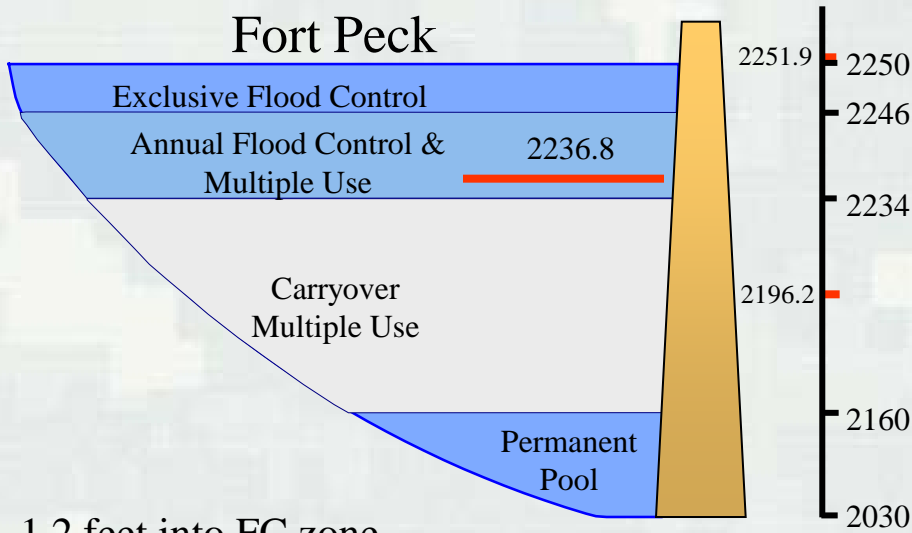


# Missouri River Mainstem System Storage Zones and Allocations



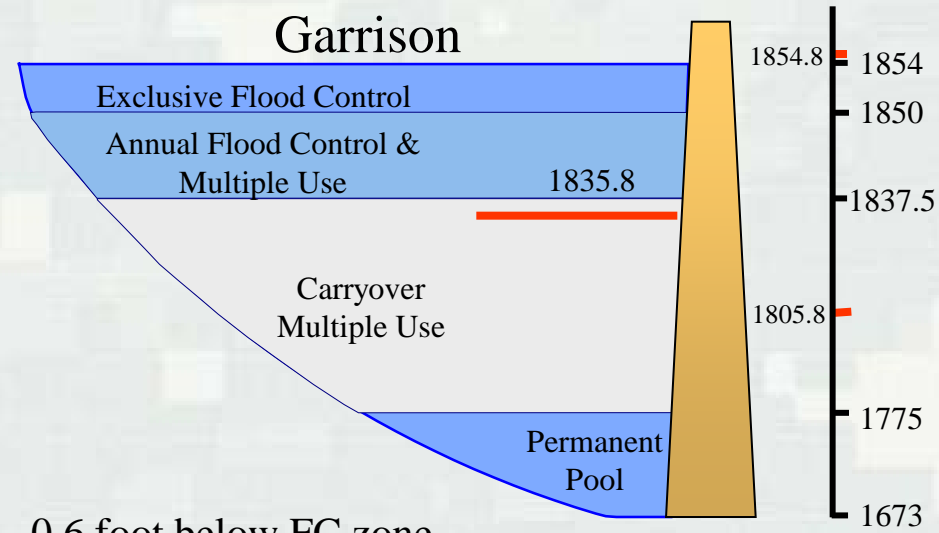
# Current Reservoir Levels – June 8, 2012

## Fort Peck



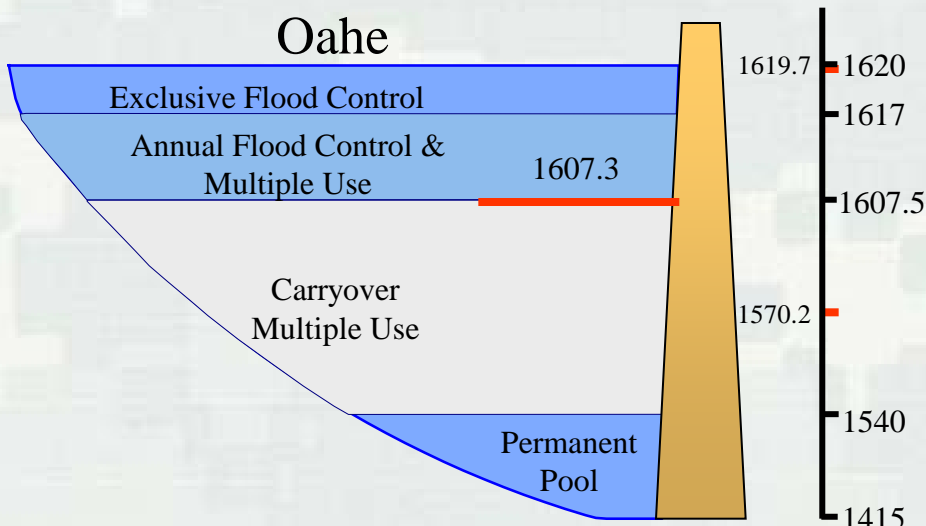
1.2 feet into FC zone.

## Garrison



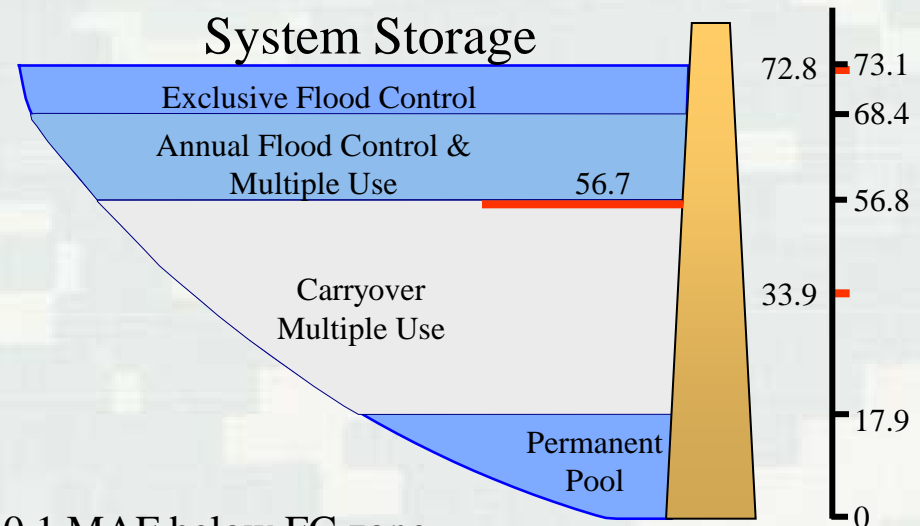
0.6 foot below FC zone.

## Oahe



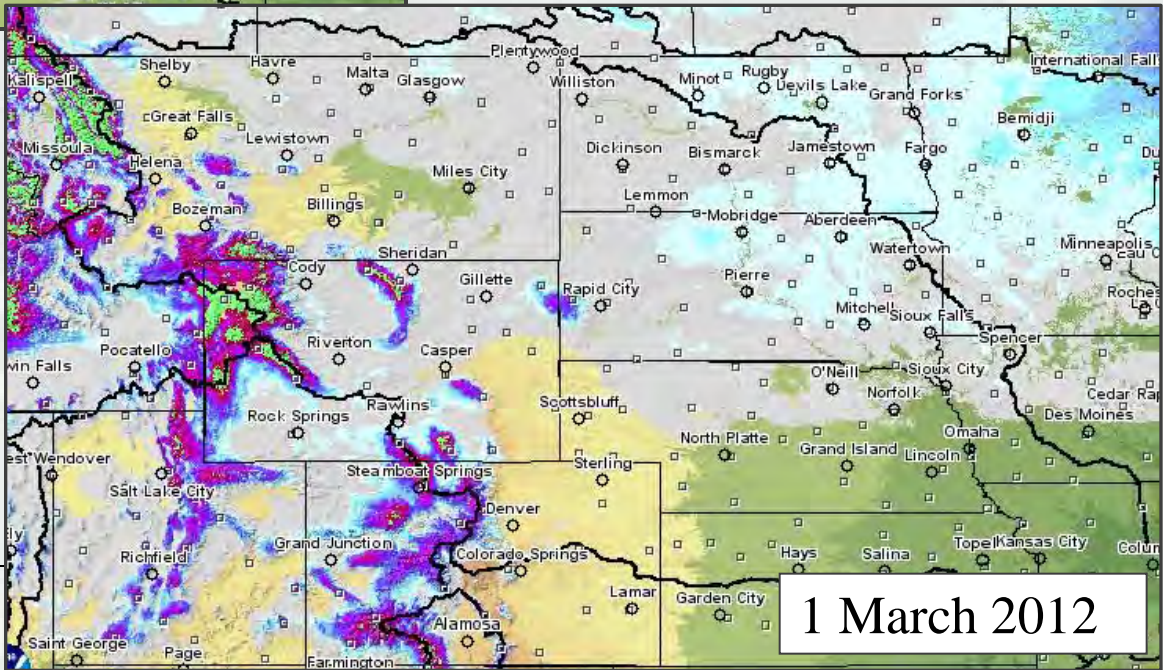
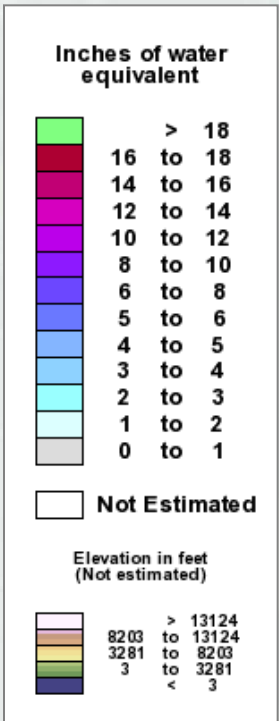
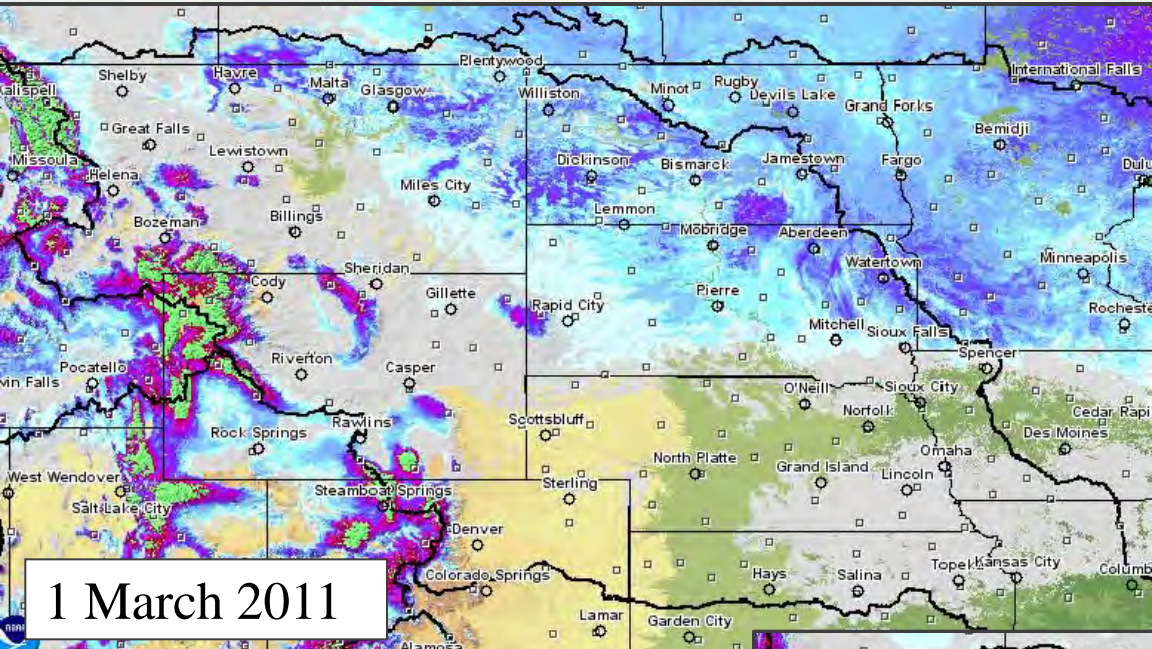
1.4 feet below FC zone.

## System Storage



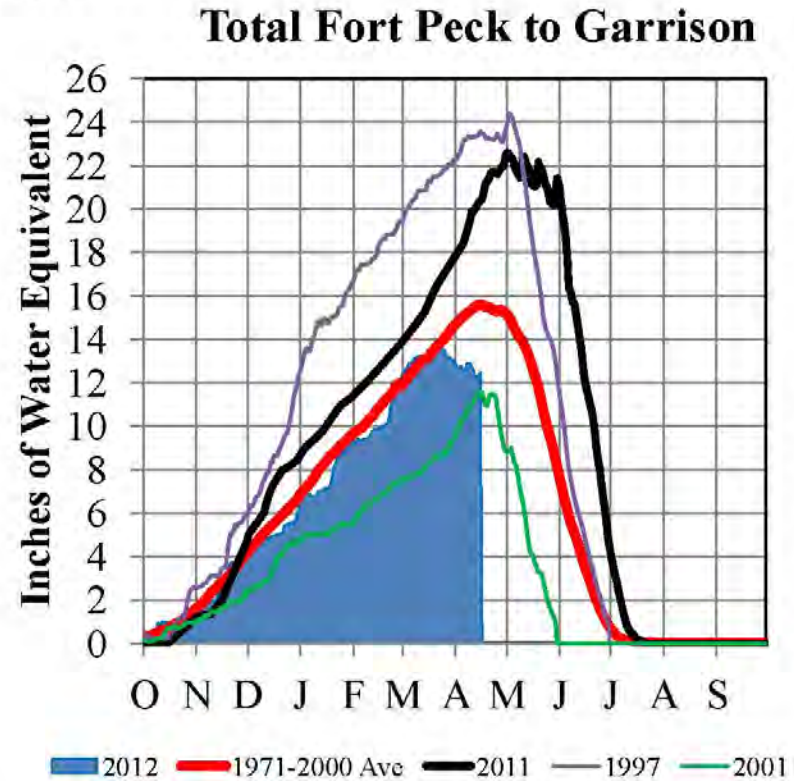
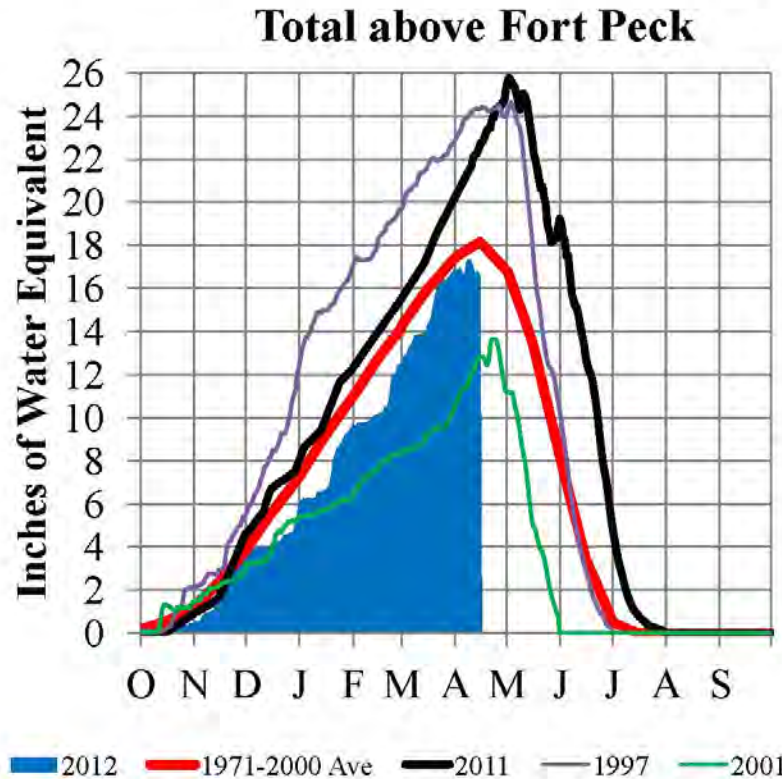
0.1 MAF below FC zone.

# Plains Snowpack



# Missouri River Basin – Mountain Snowpack Water Content 2011-2012 with comparison plots from 1997\*, 2001\* and 2011

April 15, 2012



The Missouri River basin mountain snowpack normally peaks near April 15. Normally, 100 percent of the peak accumulation has occurred by April 15. On April 15 the mountain snowpack in the “Total above Fort Peck” reach is currently 92 percent of normal and the “Total Fort Peck to Garrison” reach is currently 80 percent of normal.

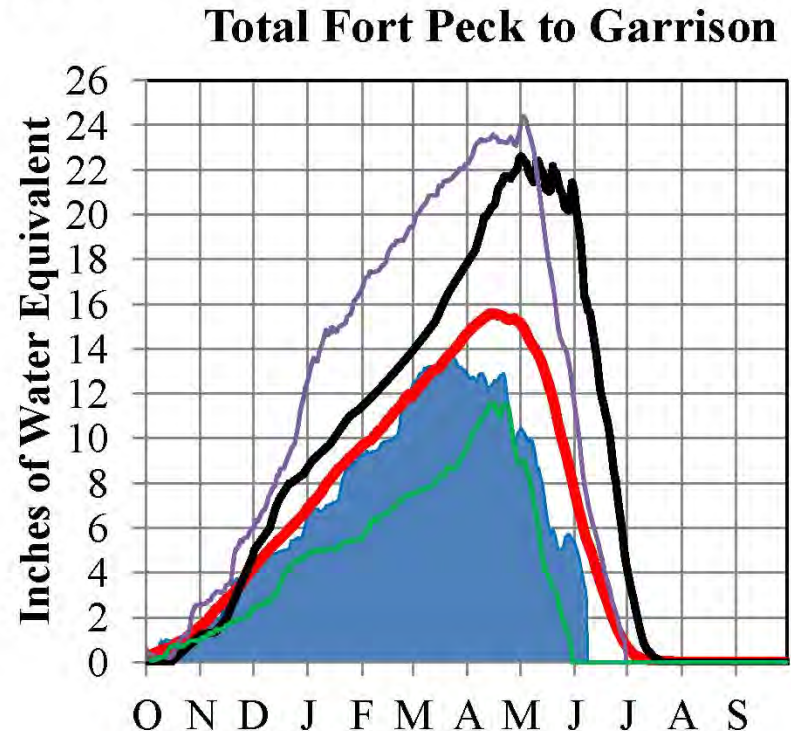
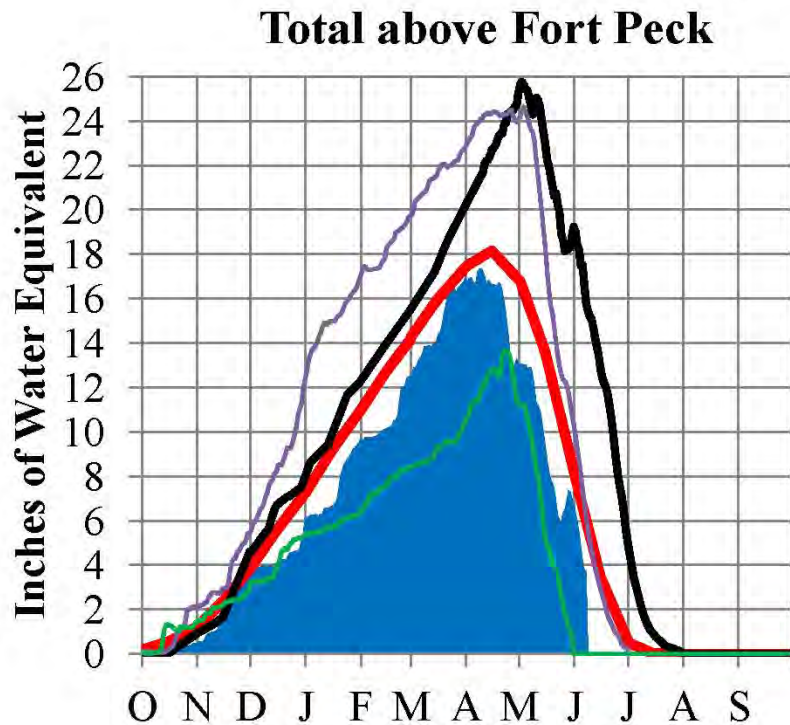
\*Generally considered the high and low year of the last 20-year period.

Provisional data. Subject to revision.



# Missouri River Basin – Mountain Snowpack Water Content 2011-2012 with comparison plots from 1997\*, 2001\* and 2011

June 7, 2012



■ 2012   ■ 1971-2000 Ave   ■ 2011   ■ 1997   ■ 2001

■ 2012   ■ 1971-2000 Ave   ■ 2011   ■ 1997   ■ 2001

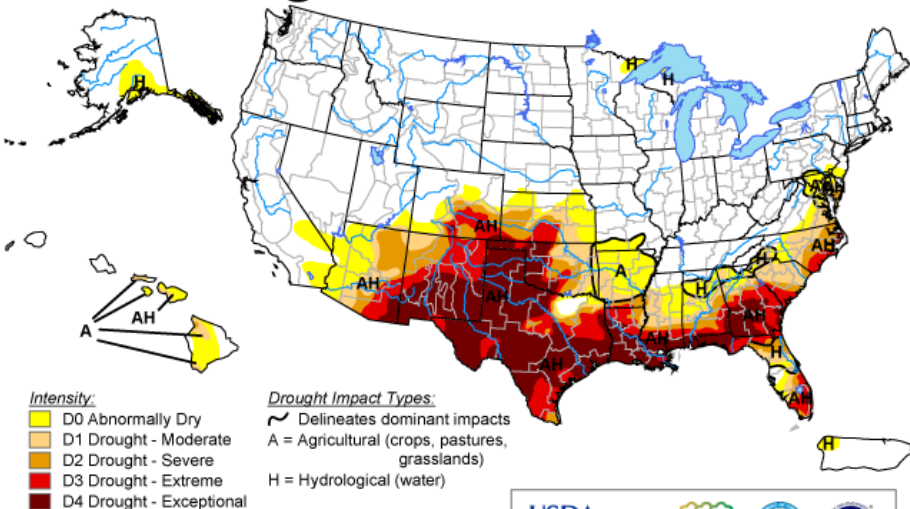
The Missouri River basin mountain snowpack normally peaks near April 15. By June 15, normally 25% of the peak remains. On June 7 the mountain snowpack SWE in the “Total above Fort Peck” reach is currently 3.7”, 70% of normal and 21% of the normal April 15 peak. The mountain snowpack SWE in the “Total Fort Peck to Garrison” reach is 3.2”, currently 58% of normal and 21% of the normal April 15 peak. The snowpack peaked in the “Total above Fort Peck” reach on April 9 at 97% of the normal April 15 peak. The snowpack peaked in the “Total Fort Peck to Garrison” reach on March 22 at 88% of the normal April 15 peak.

\*Generally considered the high and low year of the last 20-year period.

Provisional data. Subject to revision.

# U.S. Drought Monitor

July 5, 2011  
Valid 8 a.m. EDT



**Intensity:**  
 D0 Abnormally Dry  
 D1 Drought - Moderate  
 D2 Drought - Severe  
 D3 Drought - Extreme  
 D4 Drought - Exceptional

**Drought Impact Types:**  
 ~ Delineates dominant impacts  
 A = Agricultural (crops, pastures, grasslands)  
 H = Hydrological (water)



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

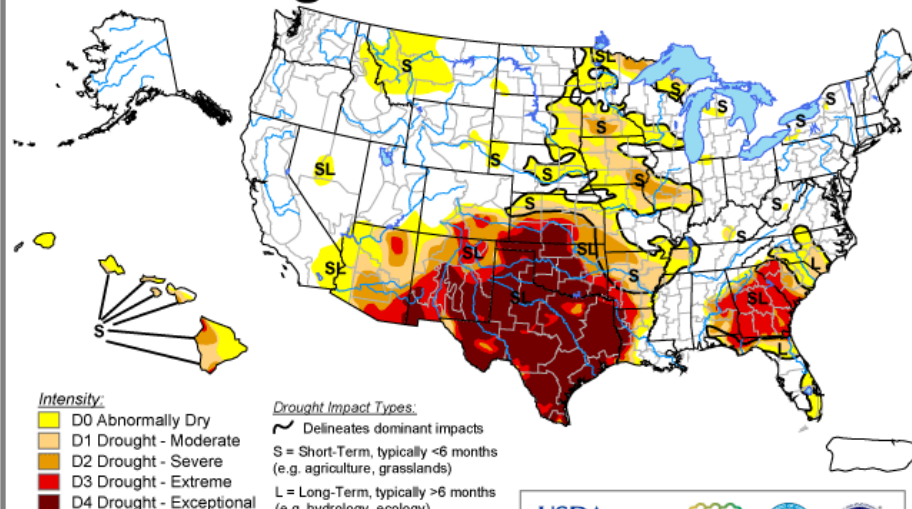
Released Thursday, July 7, 2011

Author: Richard Heim/Liz Love-Brotak, NOAA/NESDIS/NCDC

<http://drought.unl.edu/dm>

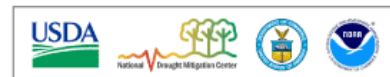
# U.S. Drought Monitor

October 4, 2011  
Valid 8 a.m. EDT



**Intensity:**  
 D0 Abnormally Dry  
 D1 Drought - Moderate  
 D2 Drought - Severe  
 D3 Drought - Extreme  
 D4 Drought - Exceptional

**Drought Impact Types:**  
 ~ Delineates dominant impacts  
 S = Short-Term, typically <6 months (e.g. agriculture, grasslands)  
 L = Long-Term, typically >6 months (e.g. hydrology, ecology)



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

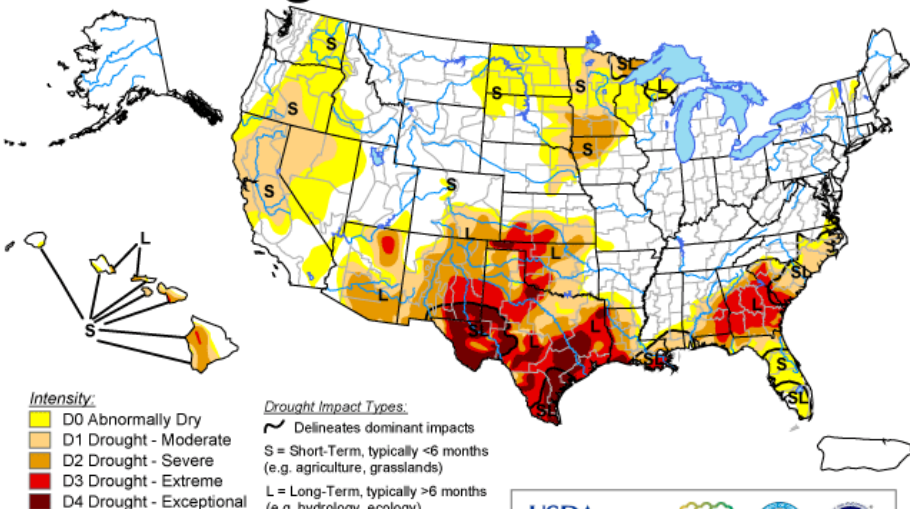
Released Thursday, October 6, 2011

Author: Rich Tinker, CPC/NCEP/NWS/NOAA

<http://droughtmonitor.unl.edu/>

# U.S. Drought Monitor

January 3, 2012  
Valid 7 a.m. EST



**Intensity:**  
 D0 Abnormally Dry  
 D1 Drought - Moderate  
 D2 Drought - Severe  
 D3 Drought - Extreme  
 D4 Drought - Exceptional

**Drought Impact Types:**  
 ~ Delineates dominant impacts  
 S = Short-Term, typically <6 months (e.g. agriculture, grasslands)  
 L = Long-Term, typically >6 months (e.g. hydrology, ecology)



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

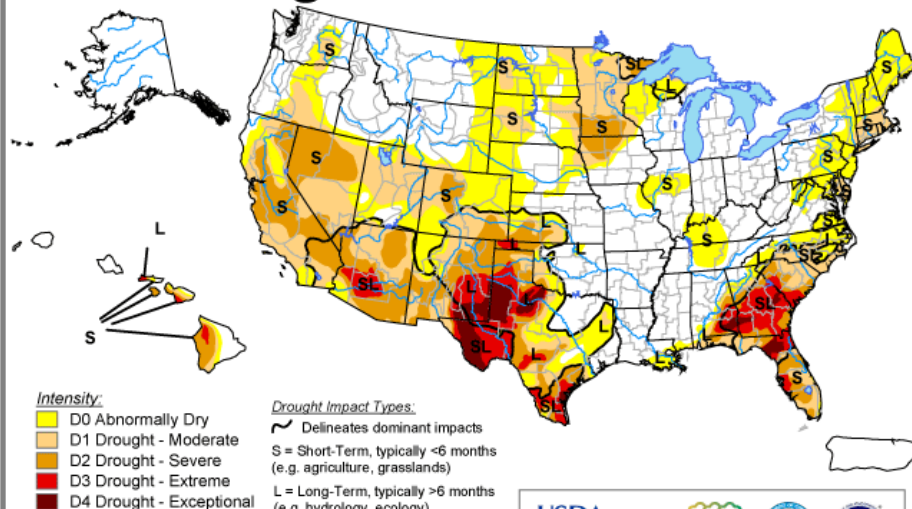
Released Thursday, January 5, 2012

Author: Brad Rippey, U.S. Department of Agriculture

<http://droughtmonitor.unl.edu/>

# U.S. Drought Monitor

April 3, 2012  
Valid 7 a.m. EDT



**Intensity:**  
 D0 Abnormally Dry  
 D1 Drought - Moderate  
 D2 Drought - Severe  
 D3 Drought - Extreme  
 D4 Drought - Exceptional

**Drought Impact Types:**  
 ~ Delineates dominant impacts  
 S = Short-Term, typically <6 months (e.g. agriculture, grasslands)  
 L = Long-Term, typically >6 months (e.g. hydrology, ecology)



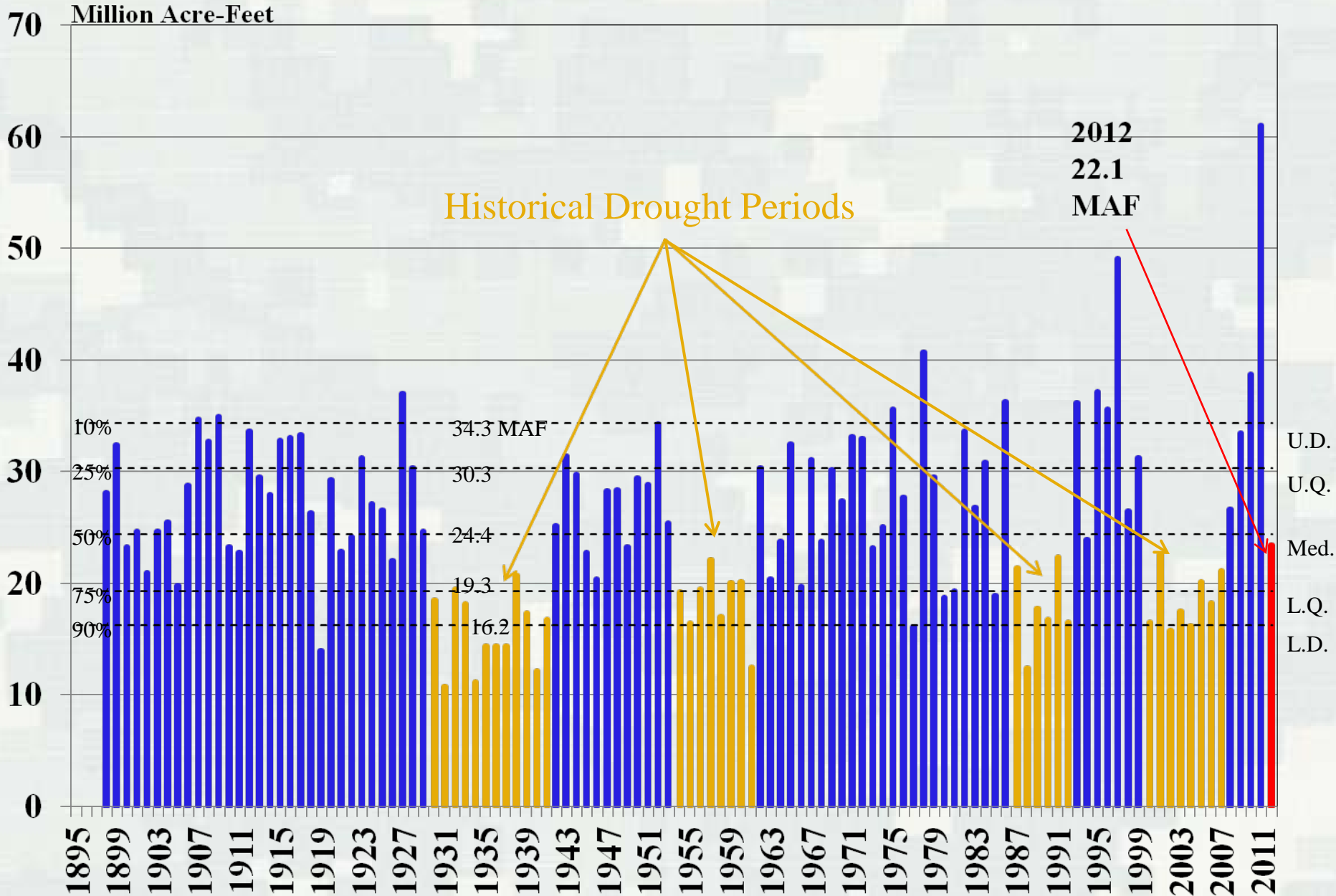
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Released Thursday, April 5, 2012

Author: Brian Fuchs, National Drought Mitigation Center

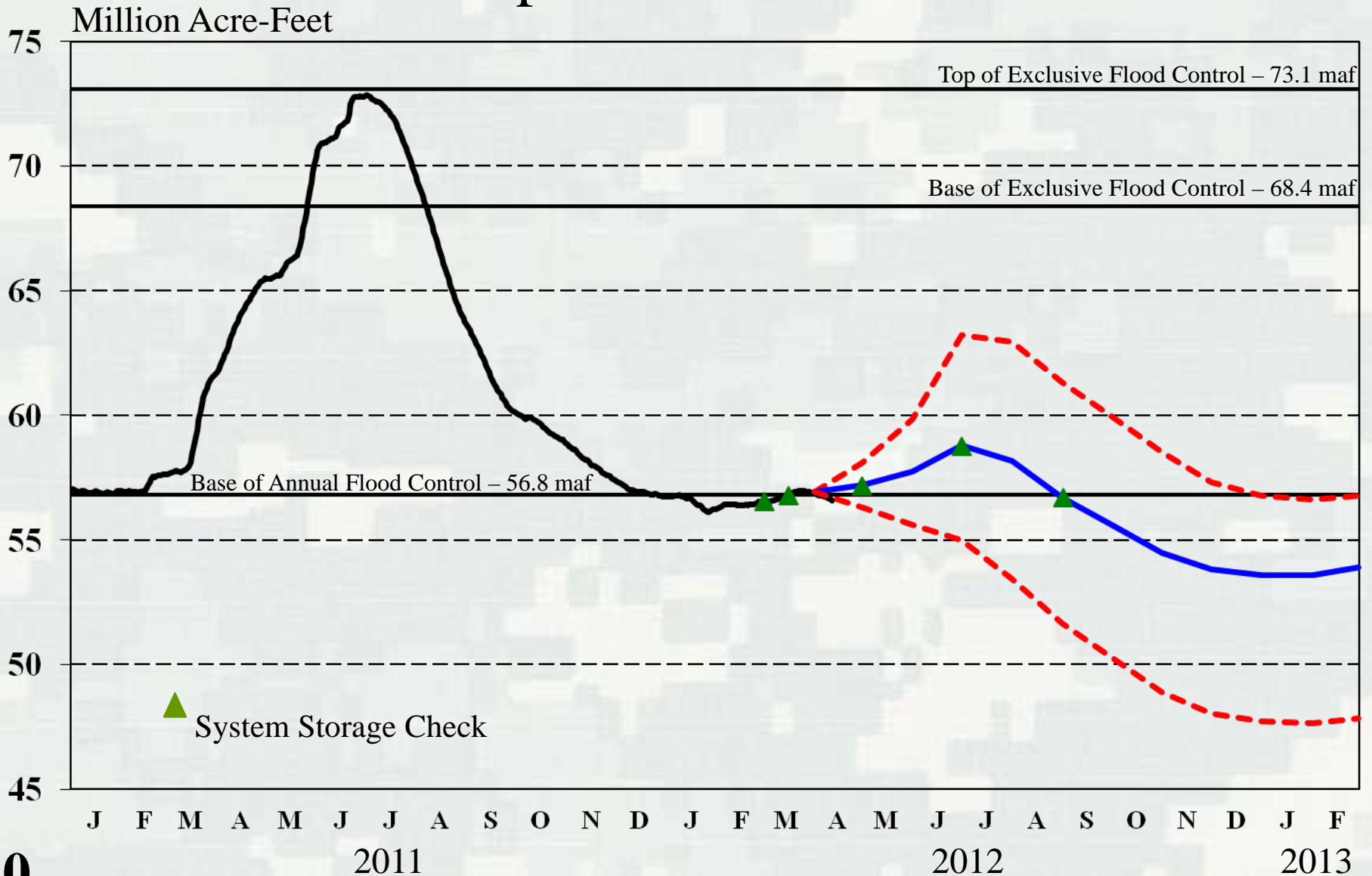
<http://droughtmonitor.unl.edu/>

# Annual Runoff above Sioux City, IA



# System Storage

## April 1 Forecast



# Flood Control

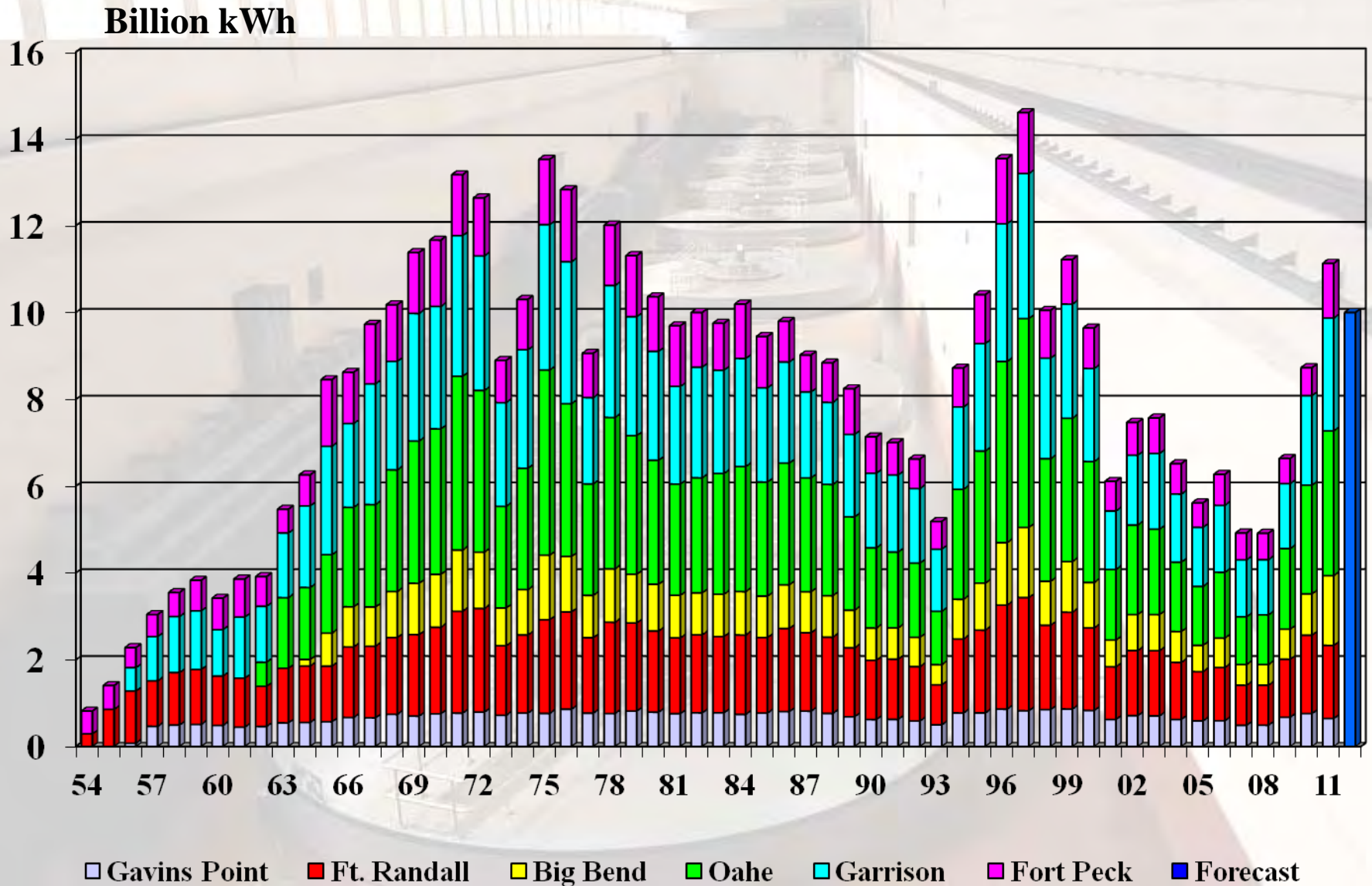
- All flood storage space available at start of runoff season (plus 0.7 MAF)
- Risk of snowmelt driven flooding is low, however rainfall driven flooding can still occur

FA, NEBR.

13

FLOODWALL WITH EMERGENCY FLASH BOARDING

# Hydropower



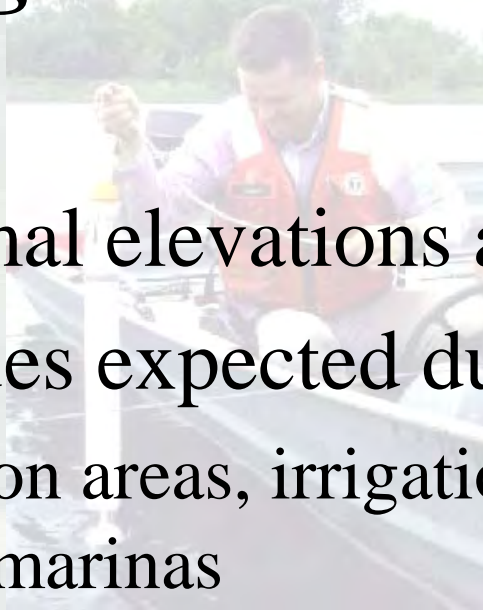
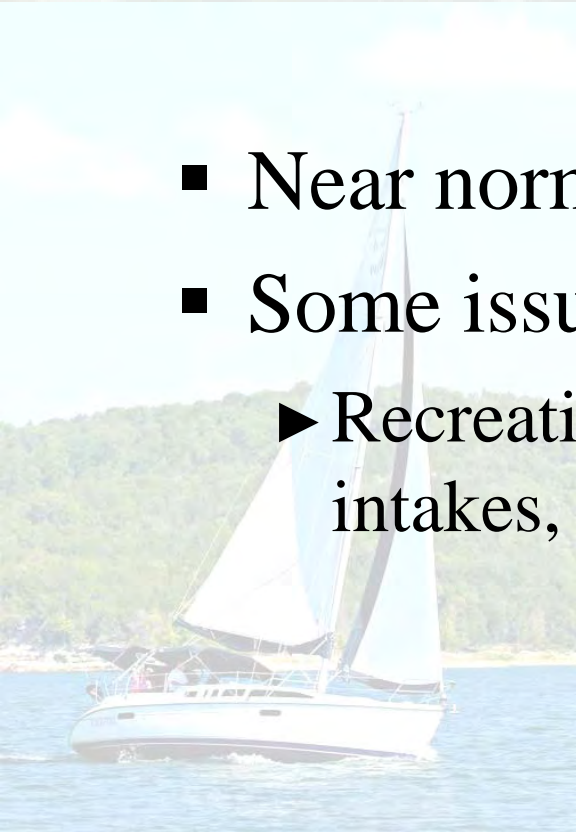
# Navigation

- **March 15 storage check**
  - ▶ Full service flow support
  - ▶ Target locations
    - Sioux City (31,000 cfs)
    - Omaha (31,000 cfs)
    - Nebraska City (37,000 cfs)
    - Kansas City (41,000 cfs)
- **July 1 storage check**
  - ▶ Full service support for Basic and Upper Basic
  - ▶ 1,600 cfs below Full Service for Lower Basic
  - ▶ Full length season Basic and Lower Basic
  - ▶ 10-Day extension for Upper Basic

# Water Supply – Water Quality

## Irrigation – Recreation

- Near normal elevations and releases
- Some issues expected due to 2011 flood
  - ▶ Recreation areas, irrigation, water supply intakes, marinas





# Fish and Wildlife

- Steady to rising levels at upper three reservoirs during forage fish spawn
  - ▶ Favor Fort Peck and Oahe if runoff not sufficient
- Minimize zero releases at Fort Randall

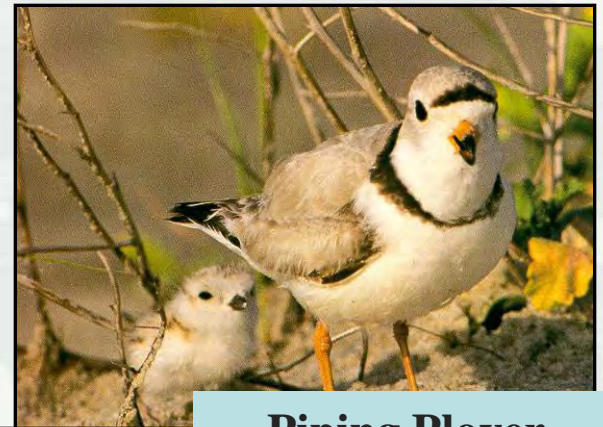


# Endangered Species Act of 1973

Each Federal Agency shall... ensure that any action authorized, funded, or carried out by such agency... is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat...



**Interior Least Tern**  
Listed "Endangered" 1986



**Piping Plover**  
Listed "Threatened" 1986



**Pallid Sturgeon**  
Listed "Endangered" 1990

# Threatened and Endangered Species

## Piping Plover and Least Tern

- Gavins Point
  - ▶ Steady release – flow to target
  - ▶ Cycle Gavins Point releases
- Intra-day peaking patterns – Garrison & Fort Randall
- Measures to minimize take



# Threatened and Endangered Species

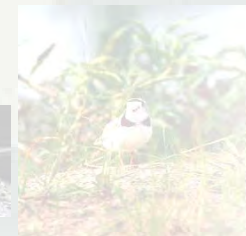
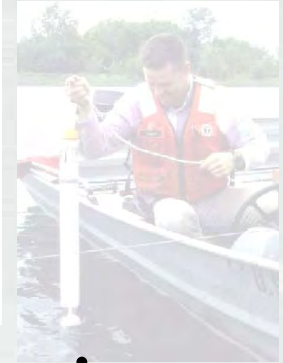
## Bi-Modal Spring Pulse – Pallid Sturgeon

- 2003 Amended Biological Opinion – Reasonable and Prudent Alternative
- March and May pulses – not implemented in 2012
- Working with US Fish and Wildlife Service on path forward



# Summary

- Slightly below normal runoff
- Meet all authorized purposes
- Addressing panel recommendations
- Flood repair work on-going



Thank you.



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