MISSOURI RIVER OPERATIONAL SETTING AND BACKGROUND

An R&D Perspective

Cary Talbot, PhD, PE
Coastal & Hydraulics Laboratory
US Army Engineer Research & Development Center, Vicksburg, MS

Improving Sub-Seasonal to Seasonal (S2S) Precipitation Forecasting
San Diego, CA
23 May 2019

"The views, opinions and findings contained in this report are those of the authors(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation."

US Army Corps of Engineers ®

U.S.ARMY

ACKNOWLEDGEMENTS

John Remus – Chief, Missouri River Basin Water Management Division, US Army Corps of Engineers, Omaha, NE

Chris Purzer – Chief, Water Management Section, Kansas City District, US Army Corps of Engineers, Kansas City, MO

Sean Smith - Principal Hydrologic & Hydraulic Engineer, US Army Corps of Engineers, Headquarters, Washington DC

US Army Corps of Engineers ®

U.S.ARMY

MAY 2016 UPDATE TO ENGINEER REGULATION (ER) 1110-2-240 WATER CONTROL MANAGEMENT

Section 3.3 Evacuation of Impounded Water.

Consistent with the authorized purposes of a project and affected interests in the project area, any water impounded in the flood control space defined by the plan of regulation shall be evacuated as rapidly as can be accomplished without causing downstream flows to exceed the controlling rates and not releasing more than peak inflow or in accordance with reservoir regulation schedules. That is, releases from reservoirs shall be restricted insofar as practicable to quantities that, in conjunction with uncontrolled runoff downstream of the dam, will not cause water levels to exceed the controlling maximum non-damaging stages currently in effect. This implies making decisions based on the principle of water on the ground which is observed precipitation or observed snowpack.

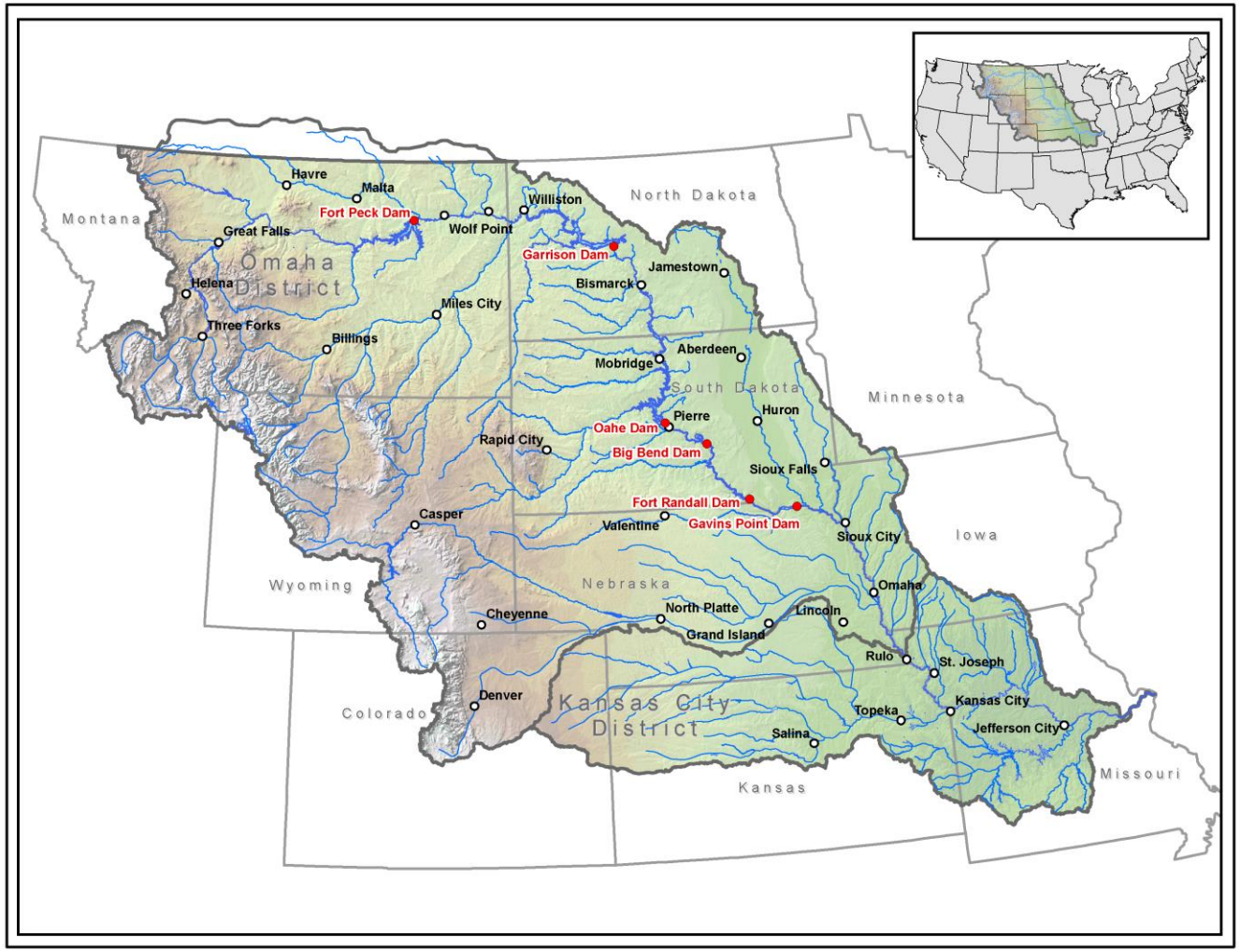
Emphasis added

US Army Corps of Engineers ®

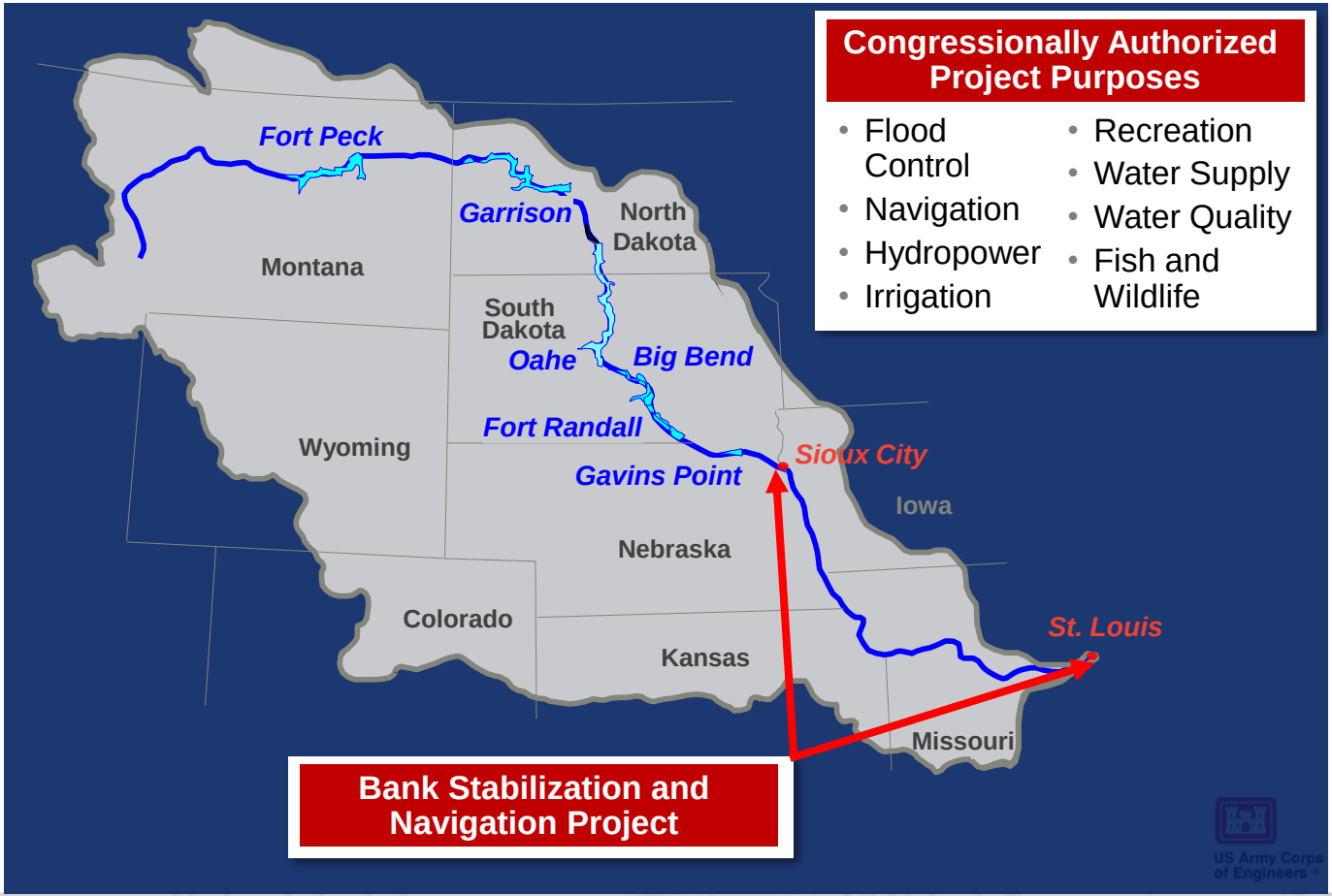
U.S.ARMY

THE MISSOURI RIVER SYSTEM

Background information on the USACE Missouri River mainstem reservoir system


Havre
Malta
Fort Peck Dam
Williston
Wolf Point
Great Falls
Garrison Dam
Jamestown
Helena
Bismarck
Miles City
Three Forks
Billings
Aberdeen
Mobridge
Pierre
Oahe Dam
Rapid City
Big Bend Dam
Huron
Sioux Falls
Fort Randall Dam
Gavins Point Dam
Casper
Valentine
Sioux City
Omaha
Cheyenne
North Platte
Lincoln
Grand Island
Rulo
St. Joseph
Denver
Kansas City
Topeka
Jefferson City
Salina
Montana
North Dakota
South Dakota
Minnesota
Iowa
Wyoming
Nebraska
Colorado
Kansas
Missouri
Omaha District
Kansas City District

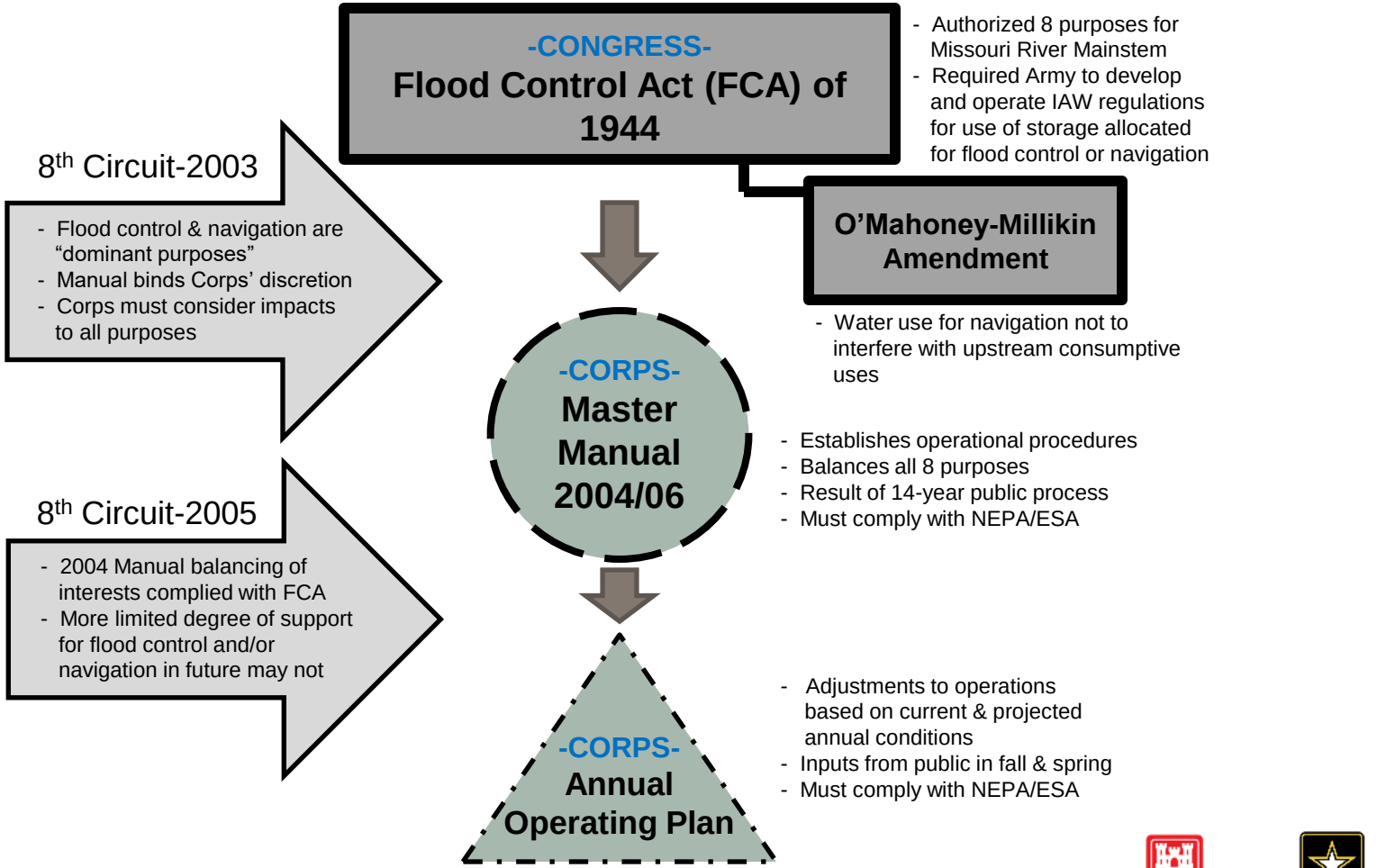
MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM



Congressionally Authorized Project Purposes

- Flood Control
- Navigation
- Hydropower
- Irrigation
- Recreation
- Water Supply
- Water Quality
- Fish and Wildlife

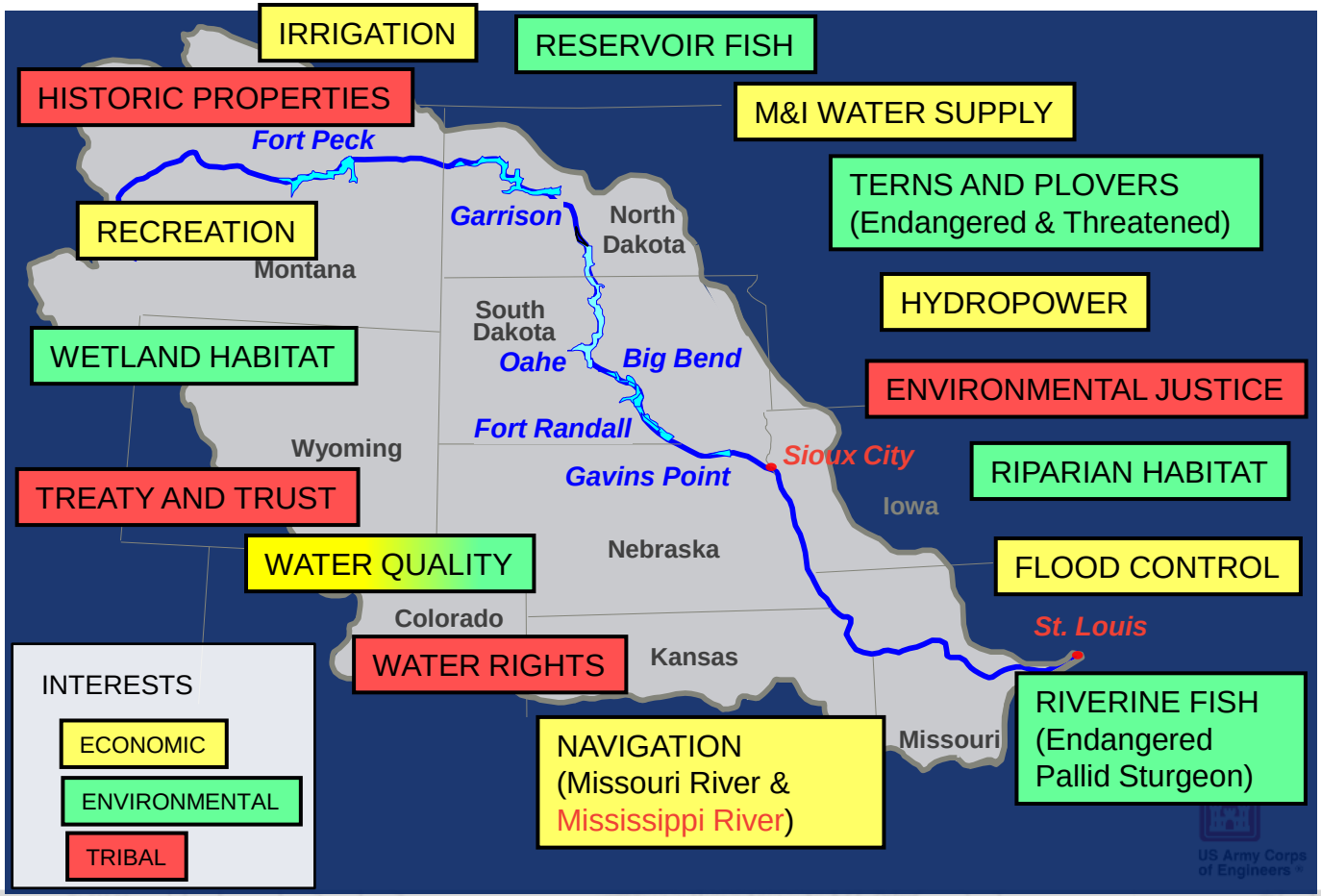
U.S.ARMY



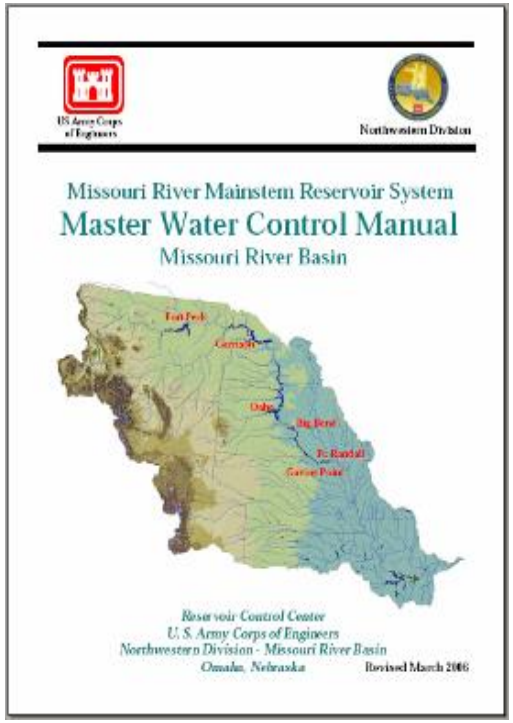
US Army Corps of Engineers ®

U.S.ARMY

MISSOURI RIVER: MULTIPLE PURPOSES, MULTIPLE INTERESTS



MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM MASTER MANUAL



- First published in 1960
- Updated in 1975 and 1979
- Master Manual Review and Update began in November 1989 in response to late 1980's / early 1990's drought
- Amended Biological Opinion received from USFWS in December 2003
- Master Manual was revised for drought conservation in March 2004
- Revised again in March 2006 for Gavins Point spring pulse
- Annual Operating Plan (AOP) developed annually in accordance with Master Manual

US Army Corps of Engineers ®

U.S.ARMY

RESERVOIR REGULATION DURING EXTREME EVENTS

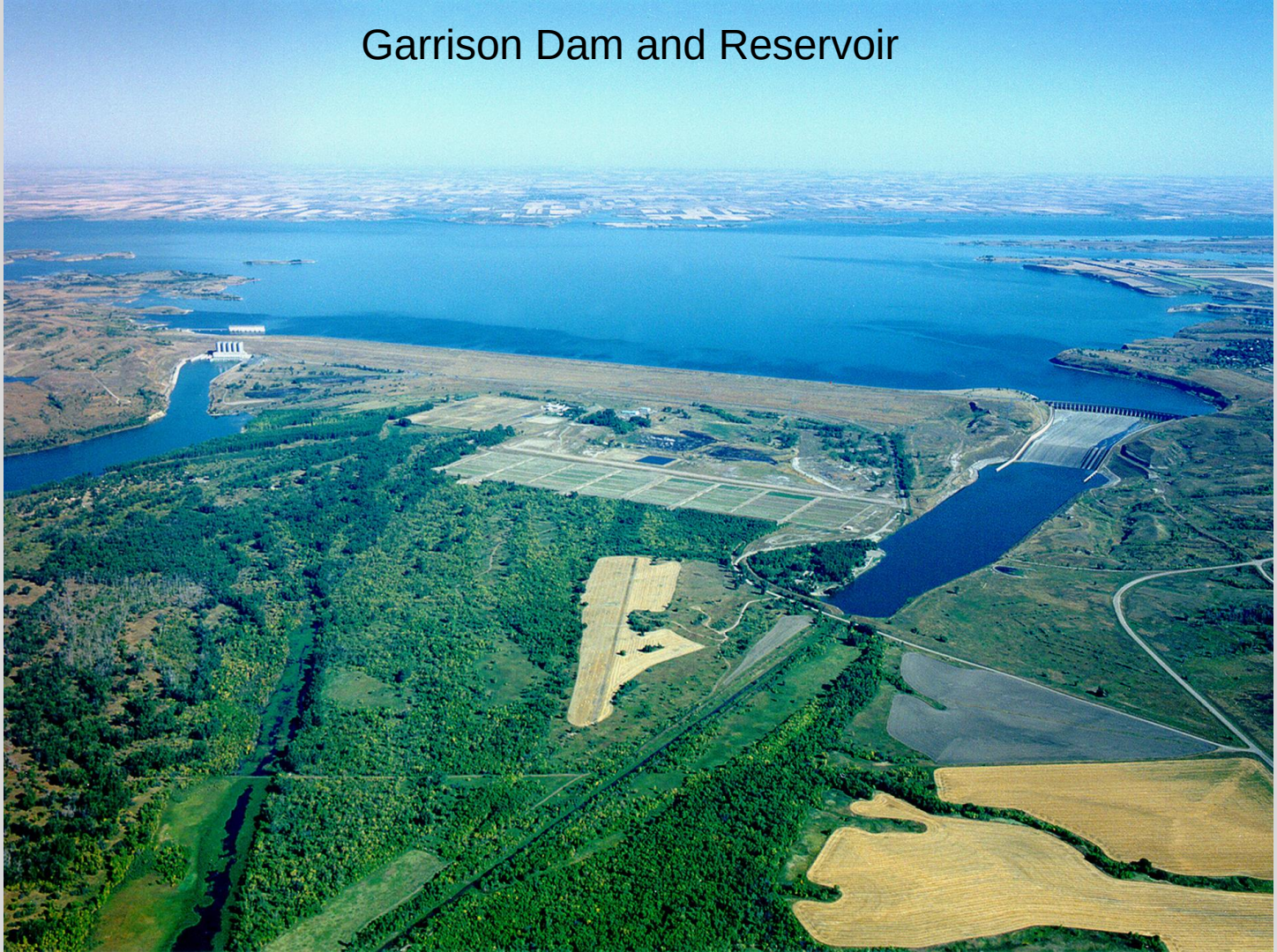
- Flexibility built into Mainstem Reservoir System
  - Reservoir system designed for extreme floods and extended droughts
  - Master Manual provides seamless transition between droughts and floods
  - Operations tweaked over the years to meet new requirements such as the Endangered Species Act and Clean Water Act, but the Missouri River remains a runoff driven system
- Changing conditions on the ground
  - Infrastructure has developed around our projects
    - Municipal and industrial water intakes
    - Recreation facilities
    - Encroachment into flood plain
  - River channel continues to evolve
- Changing Climate
  - Potential to spend more time on both ends of the hydrologic spectrum

US Army Corps of Engineers ®

U.S.ARMY

Fort Peck Dam and Reservoir

Garrison Dam and Reservoir

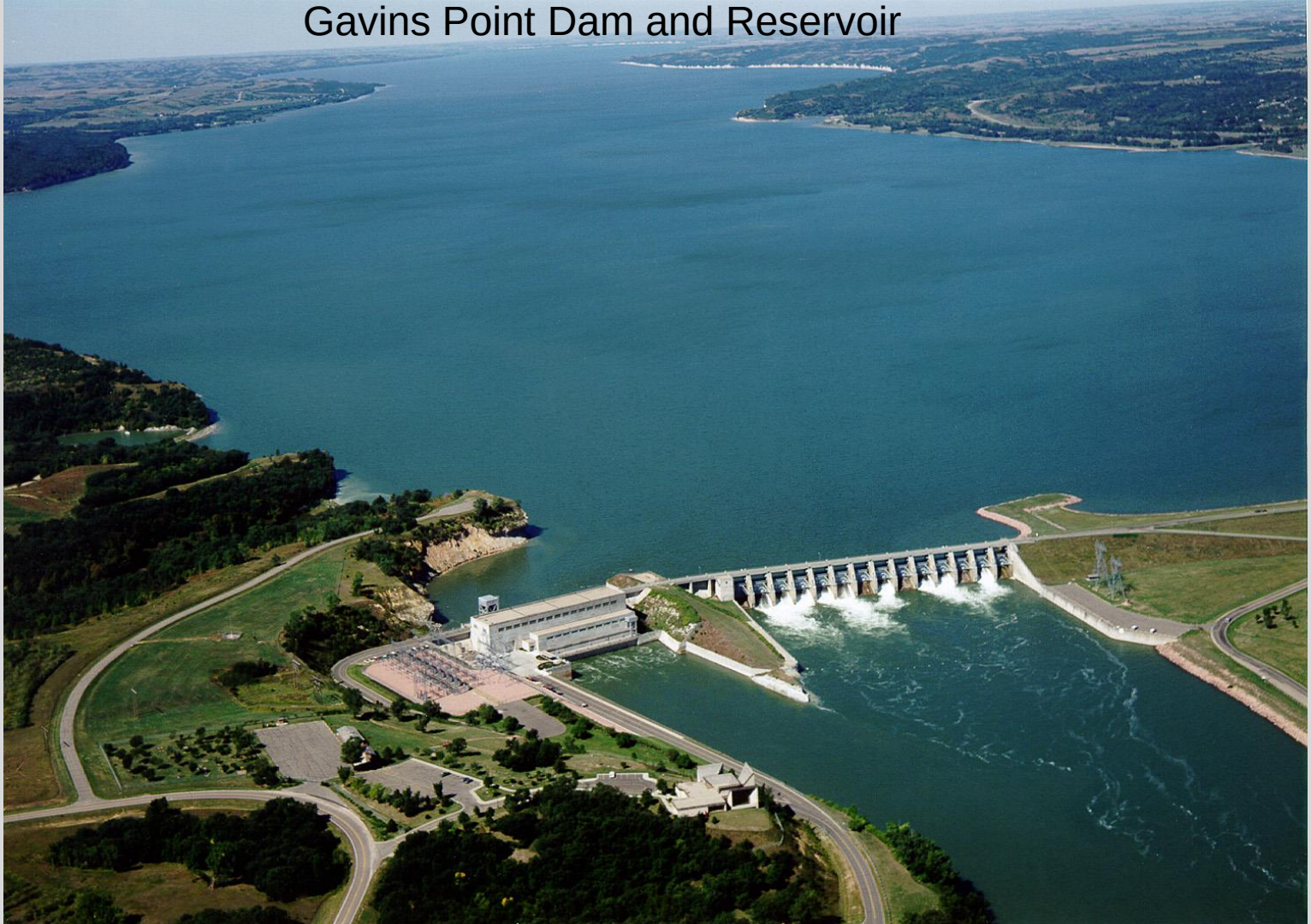


Oahe Dam and Reservoir

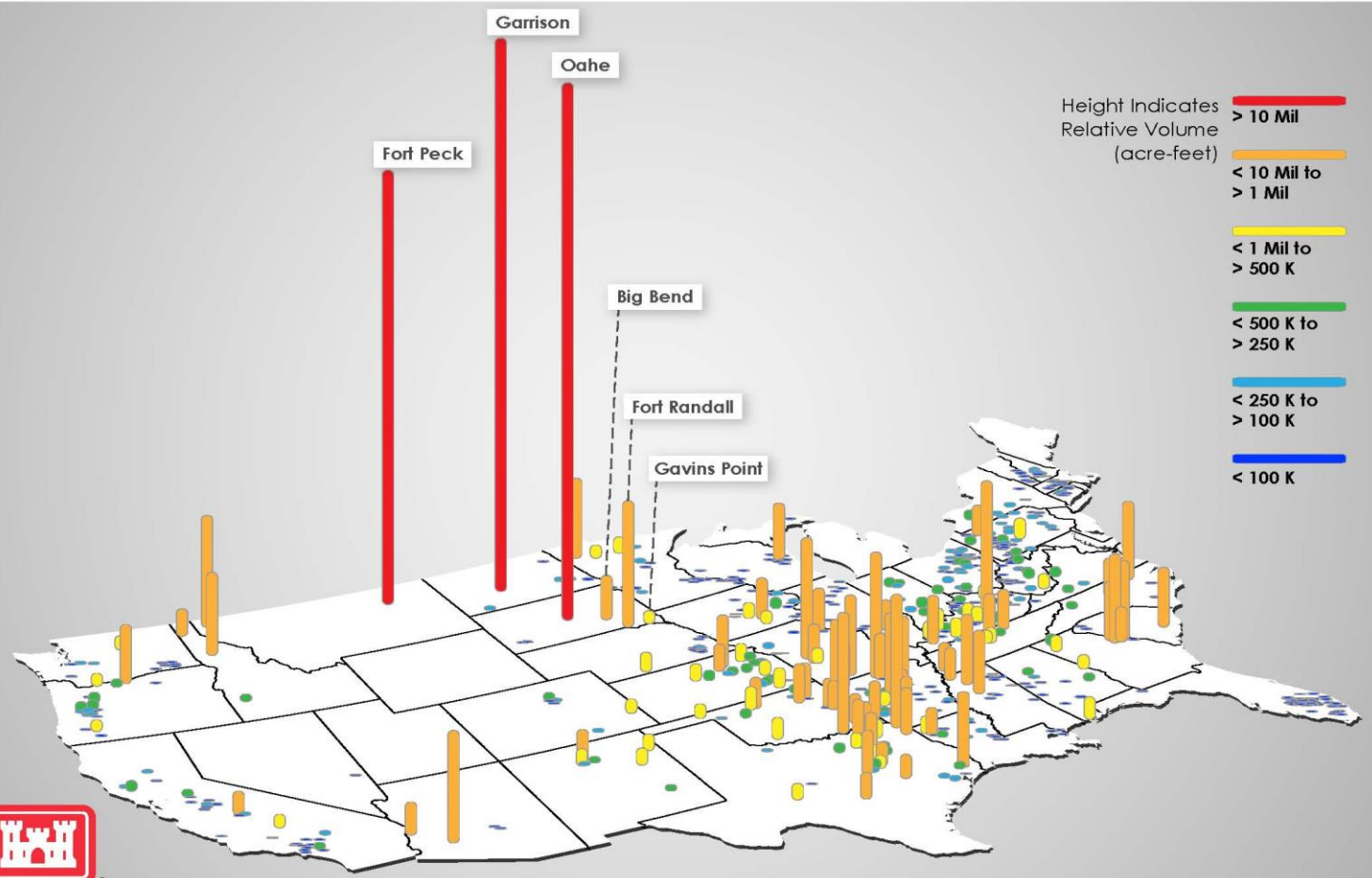
Fort Randall Dam and Reservoir

Big Bend Dam and Reservoir

Gavins Point Dam and Reservoir



Storage Capacity of Corps Reservoirs

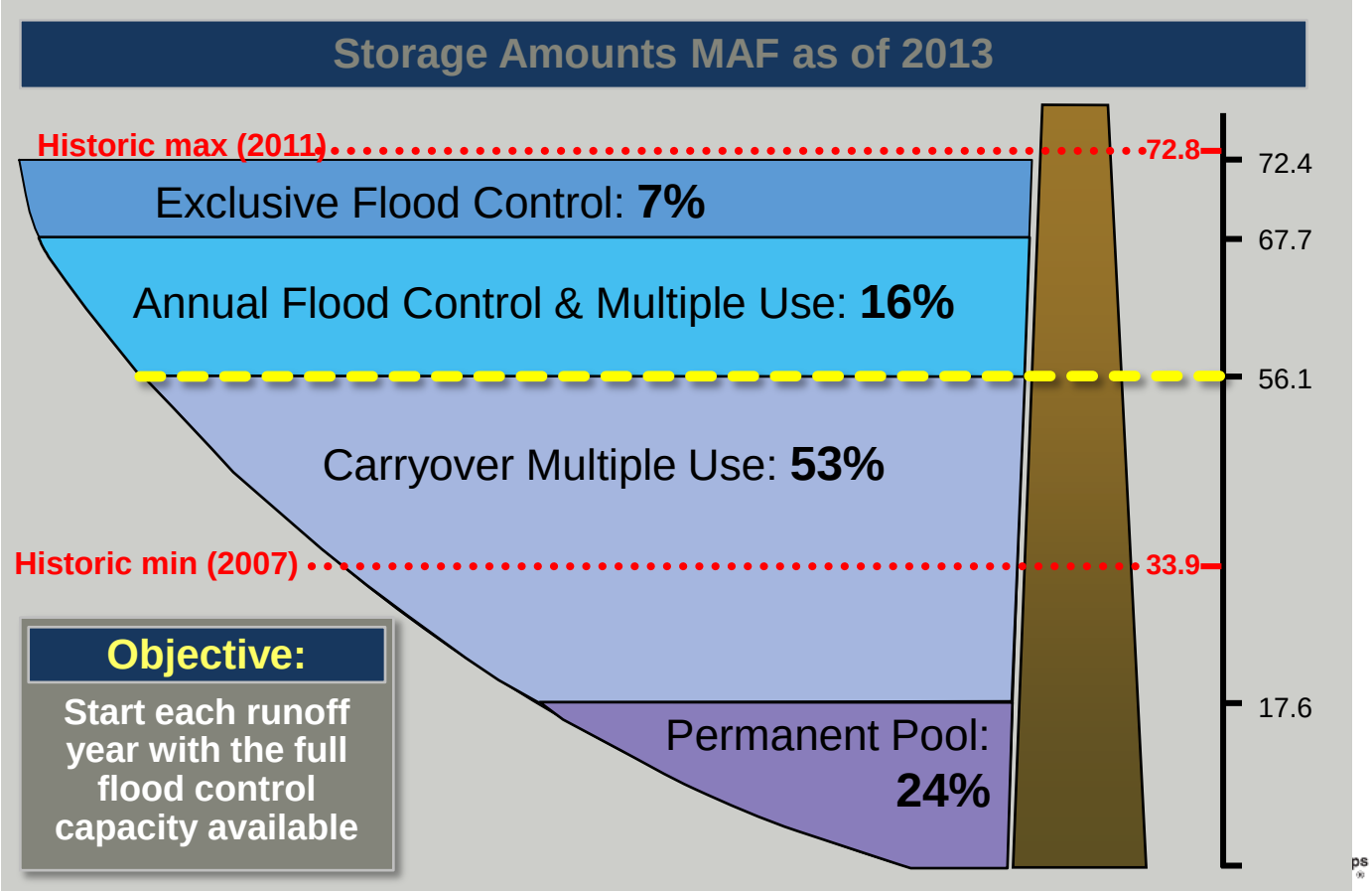


US Army Corps of Engineers
BUILDING STRONG

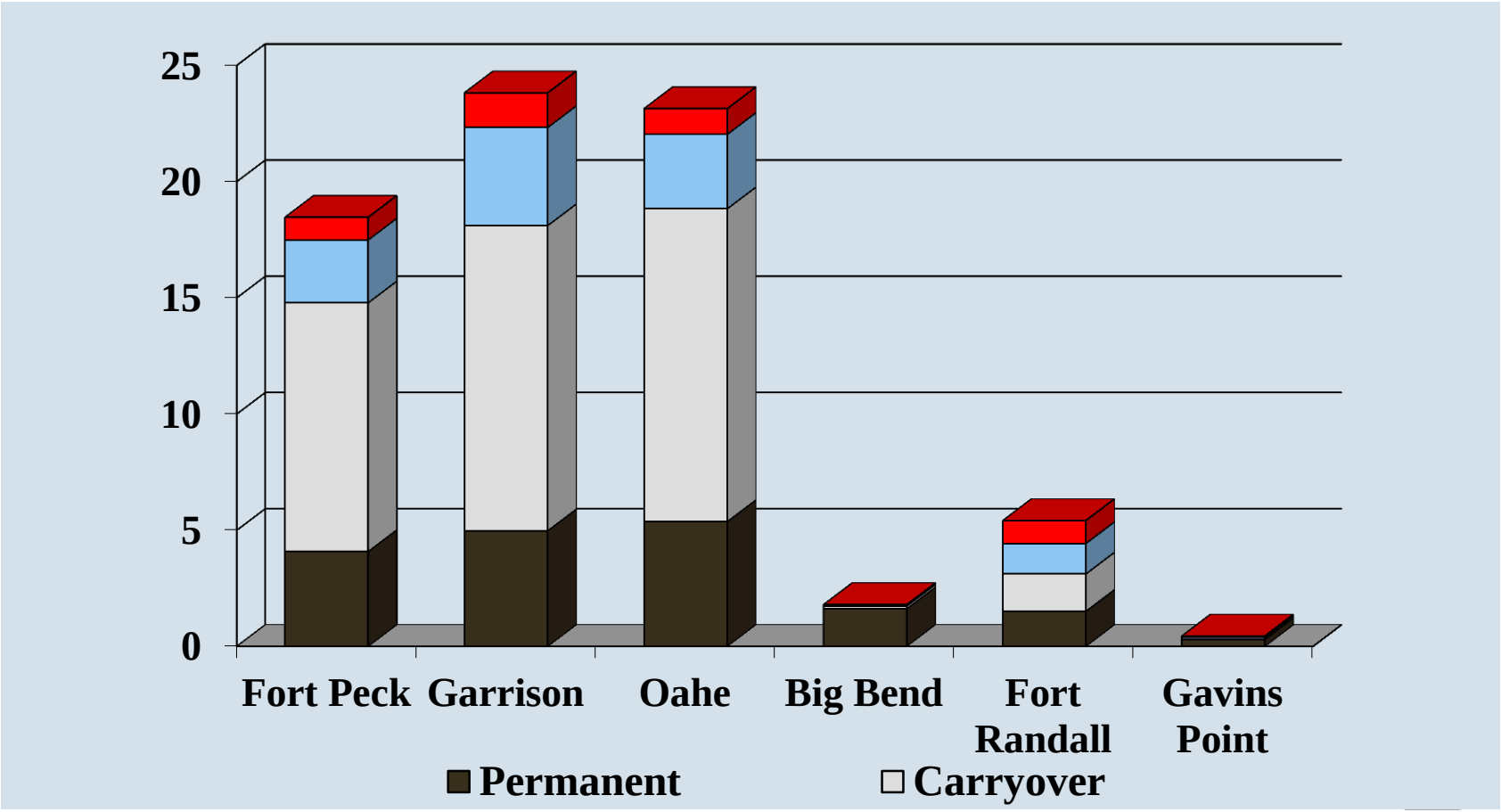
Prepared and Produced by the U.S. Army Corps of Engineers Omaha District 2010


Mississippi River Basin
Stream Network
SOURIS-RED-RAINY
PACIFIC NORTHWEST
GREAT LAKES
NEW ENGLAND
GREAT BASIN
UPPER COLORADO
MID ATLANTIC
CALIFORNIA
LOWER COLORADO
RIO GRANDE
TEXAS-GULF
SOUTH ATLANTIC-GULF

STORAGE ZONES

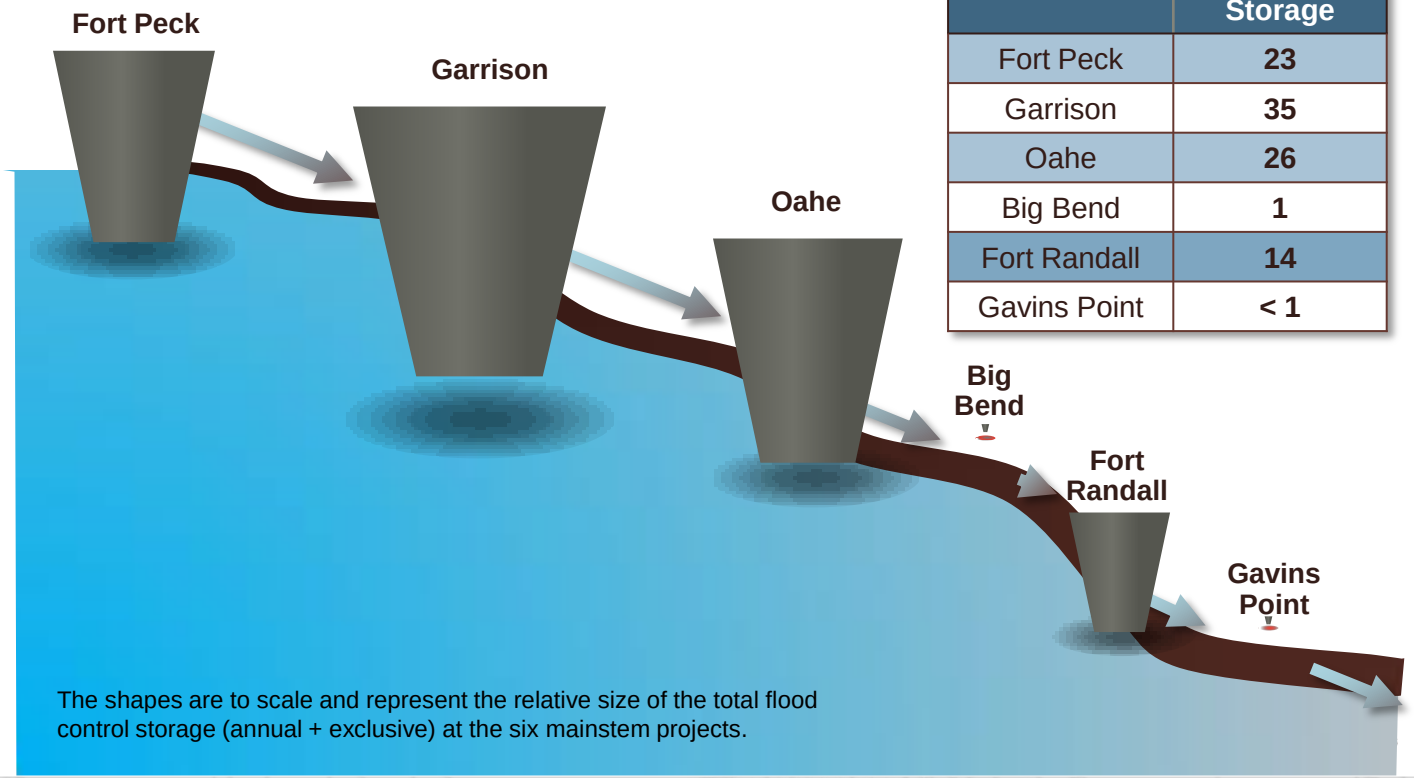


MAINSTEM RESERVOIR STORAGE CAPACITY BY PROJECT



MAINSTEM RESERVOIR SYSTEM FLOOD CONTROL STORAGE

Project	% of Total Flood Storage
Fort Peck	23
Garrison	35
Oahe	26
Big Bend	1
Fort Randall	14
Gavins Point	< 1

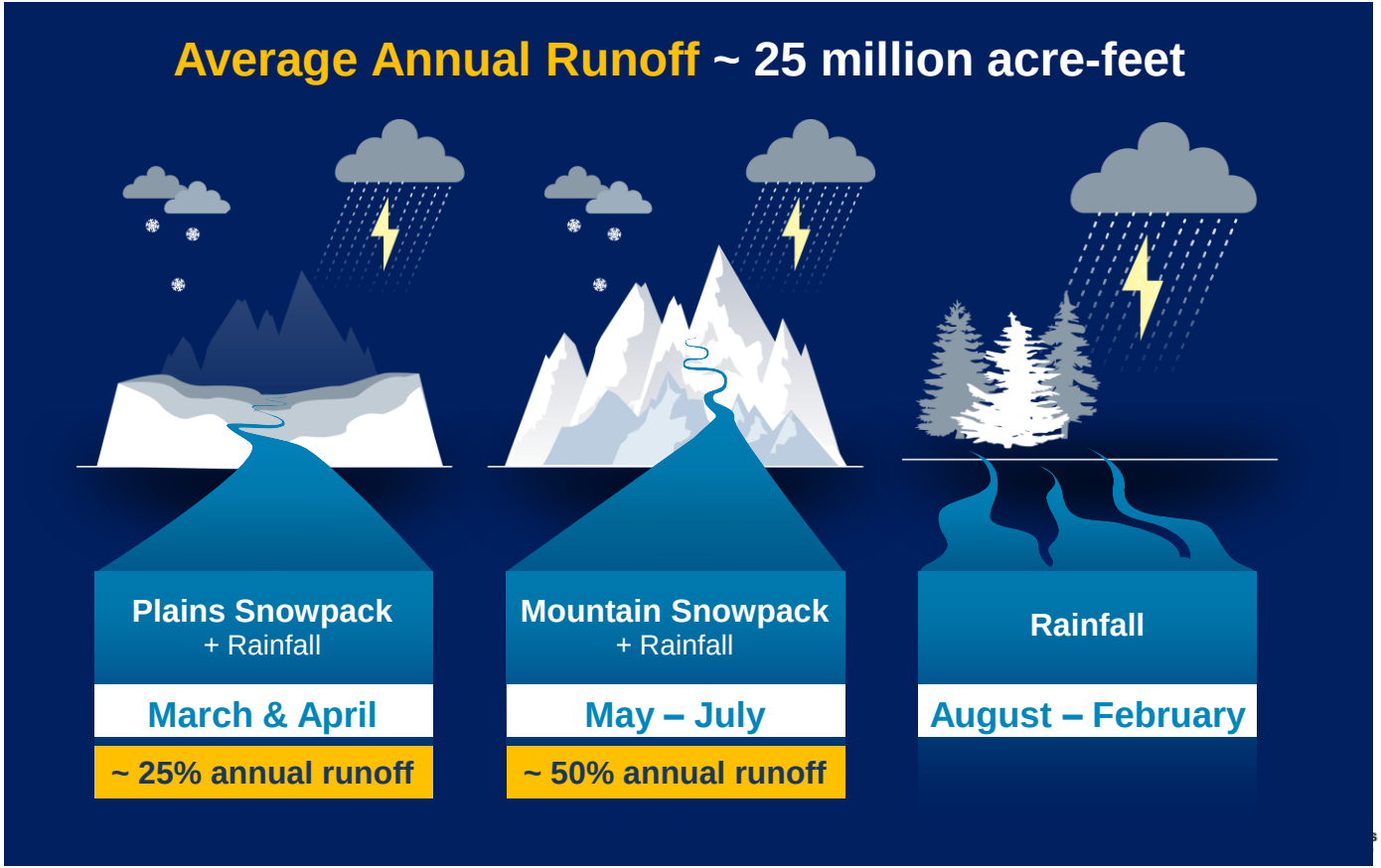


The shapes are to scale and represent the relative size of the total flood control storage (annual + exclusive) at the six mainstem projects.

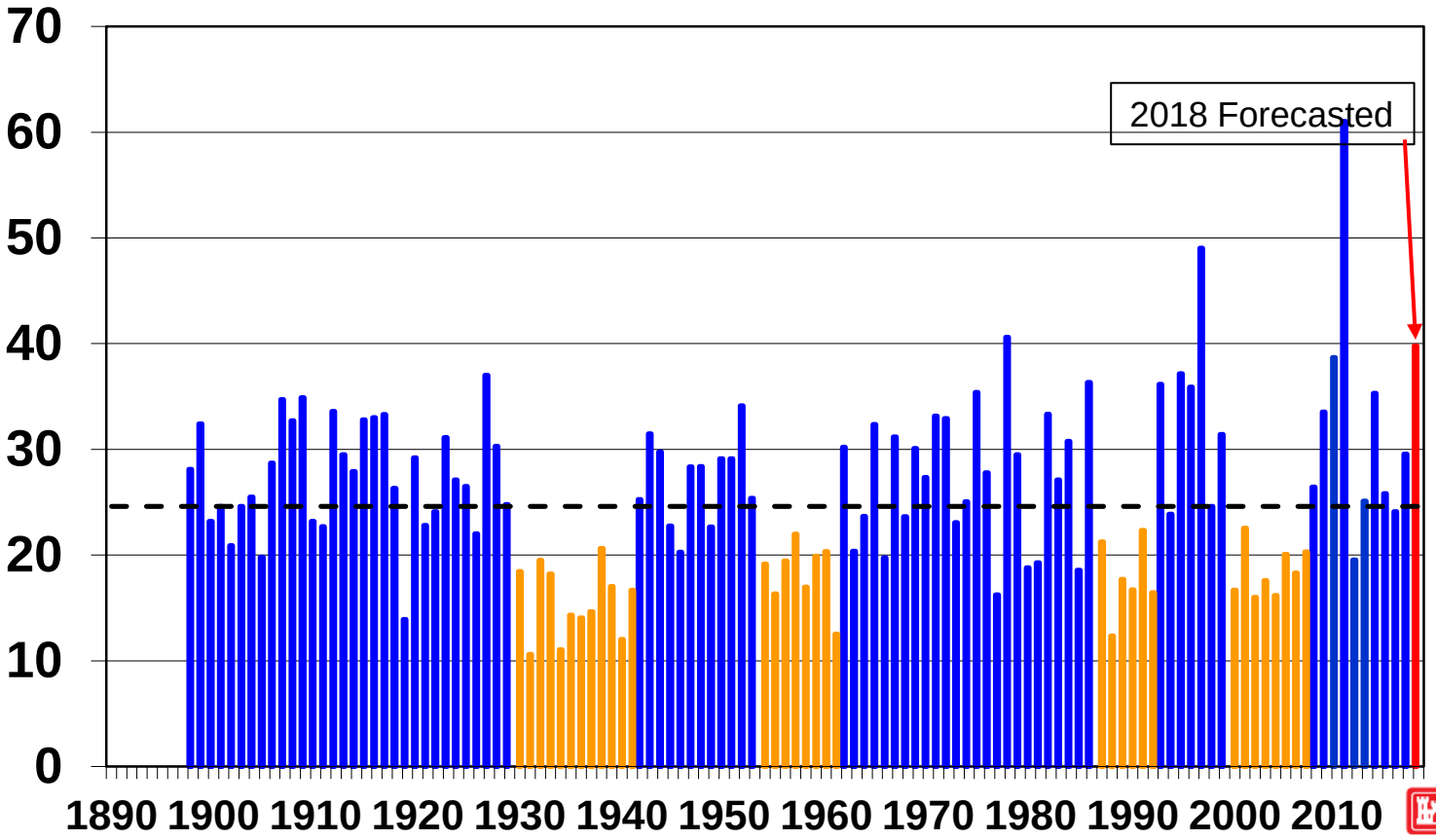
RUNOFF

WHERE THE WATER IN THE SYSTEM COMES FROM

COMPONENTS OF RUNOFF ABOVE SIOUX CITY, IA



HISTORIC ANNUAL RUNOFF ABOVE SIOUX CITY, IA



US Army Corps of Engineers ®

U.S.ARMY

USACE MISSOURI RIVER ACTIVITIES

- **Annual Operating Plan; Master Manual**

- **Run various models and analyses on a daily, weekly and monthly basis - most likely, wetter than expected, drier than expected**

- **Continually communicate with partners/stakeholders**
  - AOP Meeting (bi-annually)
  - Monthly CODEL Calls (Jan – June)
  - Weekly Update Summary
  - Attend stakeholder meetings
  - Press releases (monthly)/interviews/etc.
  - Maintain Web Page

- **Update Technical Studies**

- **Update Forecasting Techniques/Tools**

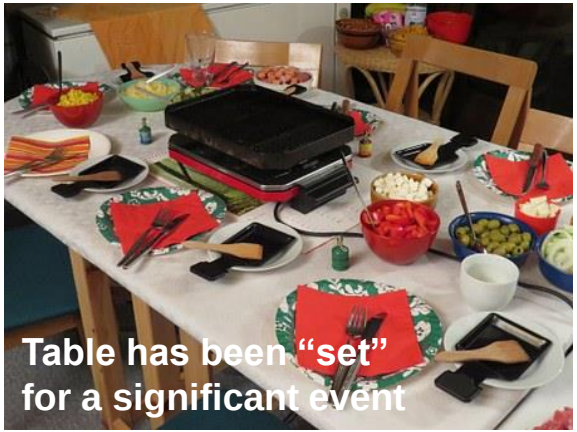
- **Update Water Control Manuals**

US Army Corps of Engineers ®

U.S.ARMY

TRIGGERS FOR HEIGHTENED AWARENESS

- **Antecedent (Fall) Conditions**
- **Mountain Snowpack**
- **Plains Snowpack**
- **Monthly Studies**
- **Climate Condition Outlooks**



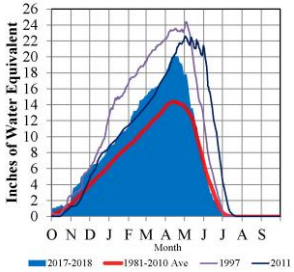
US Army Corps of Engineers ®

U.S.ARMY

TRIGGER SPECIFICS

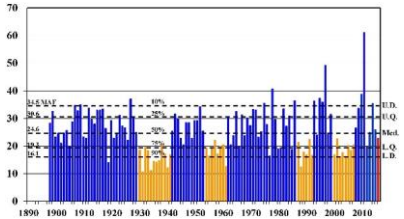
- **Antecedent Conditions**
  - 1995-96-97, 2009-10-11 – consecutive years of high runoff
  - Wet fall/winter soil conditions = increased spring runoff

- **Mountain Snowpack – peak SWE**
  - ± 10% - within normal ranges
  - ± 20% - will affect total runoff
  - ±> 30% - will significantly affect total runoff



- **Plains Snowpack Classification**
  - “heavy” – will affect total runoff
  - “very heavy” – will significantly affect total runoff

- **Monthly Studies**
  - Runoff estimate > Upper Decile (34.5 MAF)
  - Service level adjustments in March-April-May
  - Full conservation pool at start of runoff season



- **Spring Climate Conditions**
  - ENSO Neutral and/or Weak La Niña - normal precip variability
  - Moderate or Strong La Niña – higher precip variability
  - Oscillations - North Atlantic/Arctic

US Army Corps of Engineers ®

U.S.ARMY

KANSAS CITY DISTRICT RESERVOIR SYSTEM

US Army Corps of Engineers ®

U.S.ARMY

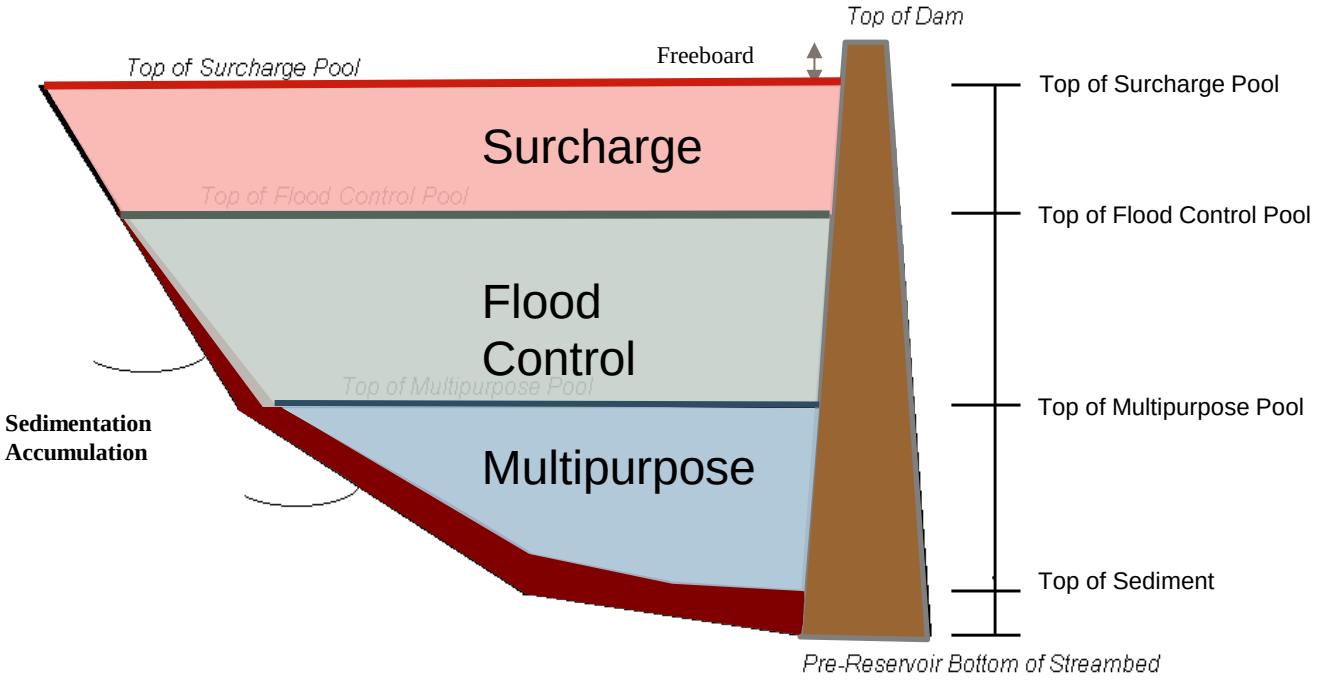
KANSAS CITY DISTRICT RESERVOIR SYSTEM

- 18 USACE Reservoirs
- 11 Bureau of Reclamation Reservoirs (not shown)

US Army Corps of Engineers ®

U.S.ARMY

TYPICAL RESERVOIR STORAGE ALLOCATIONS



US Army Corps of Engineers ®

U.S.ARMY

WATER MANAGEMENT

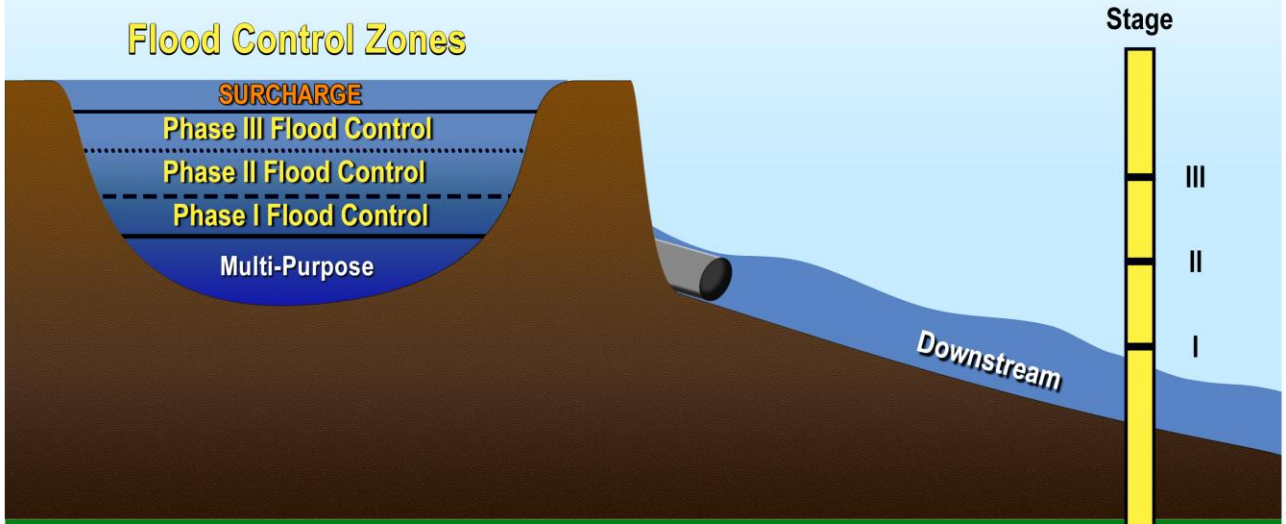
- Balance upstream and downstream
- Water on the ground
- Control points downstream
- Flood control zone
- System storage balance
  - Parallel Balance
  - Tandem Balance

Release decisions are never arbitrary or random but are result of extensive analysis and communication

US Army Corps of Engineers ®

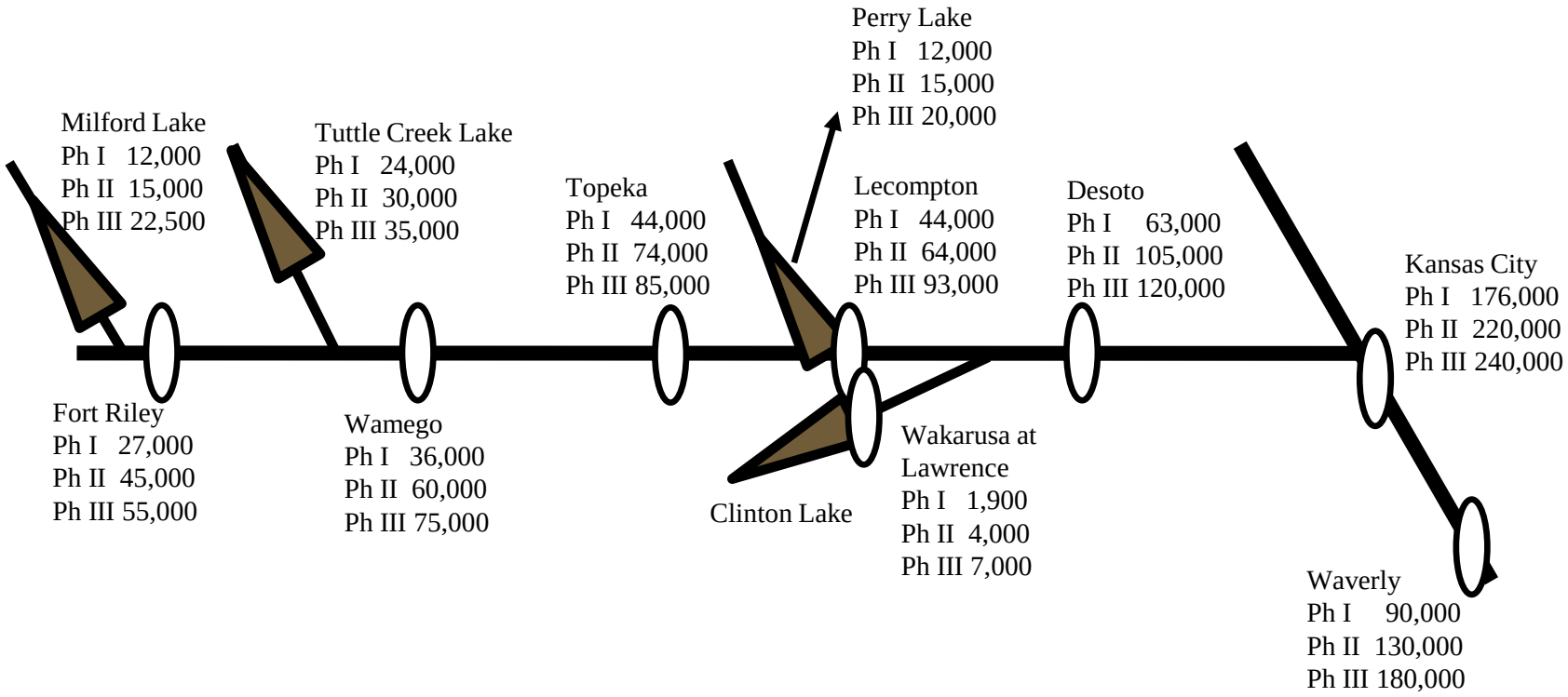
U.S.ARMY

Relationship between Control Points and Flood Control Zones



Water Management schedules releases from Flood Control Storage based on current pool elevation and flows/levels at the Downstream Target (control point) gage location. Downstream flow increases as reservoir pool elevation increases.

KANSAS RIVER CONTROL POINT GAGES

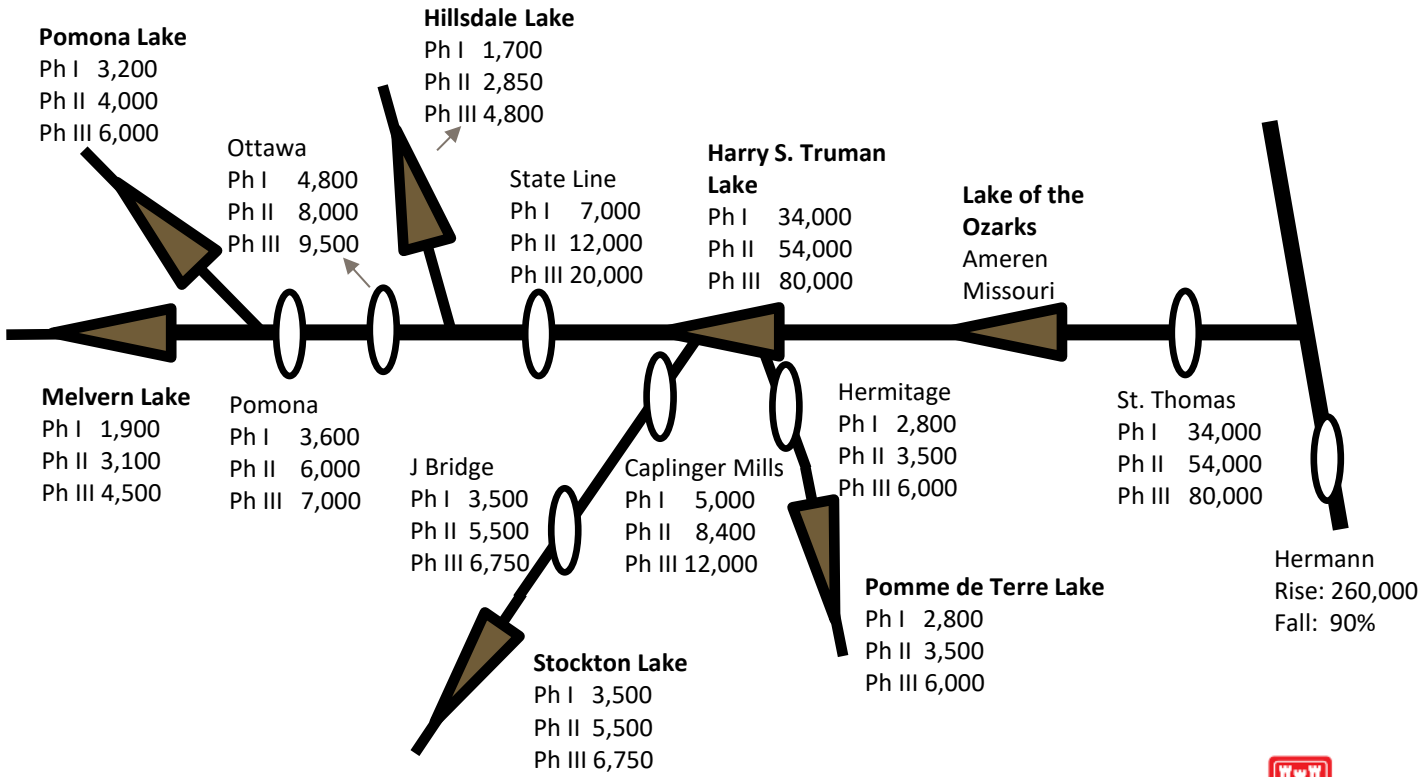


All flows are in cfs; schematic is not to scale.

US Army Corps of Engineers

U.S.ARMY

OSAGE RIVER BASIN CONTROL POINT GAGES

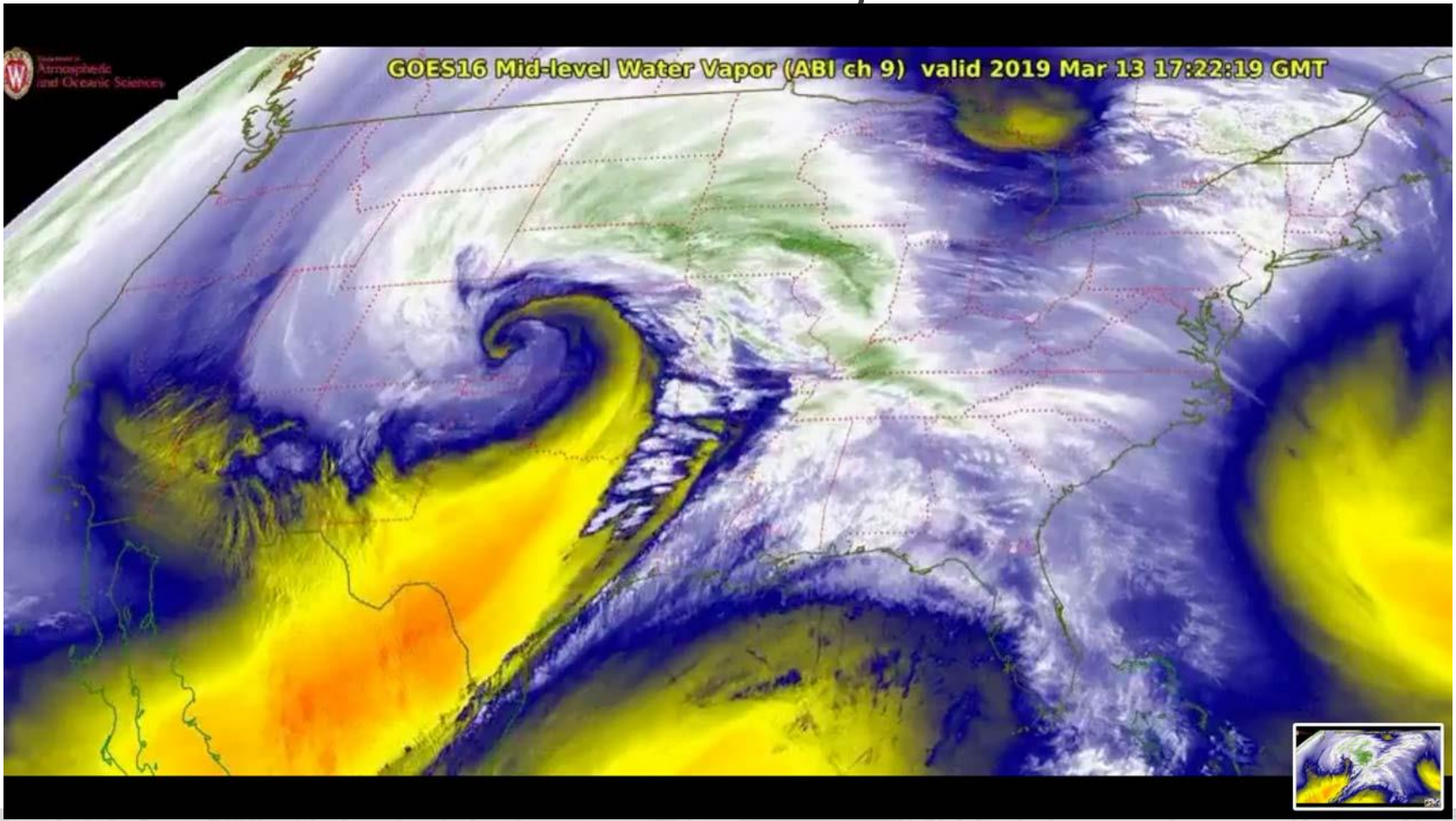


All flows are in cfs; schematic is not to scale.

US Army Corps of Engineers ®

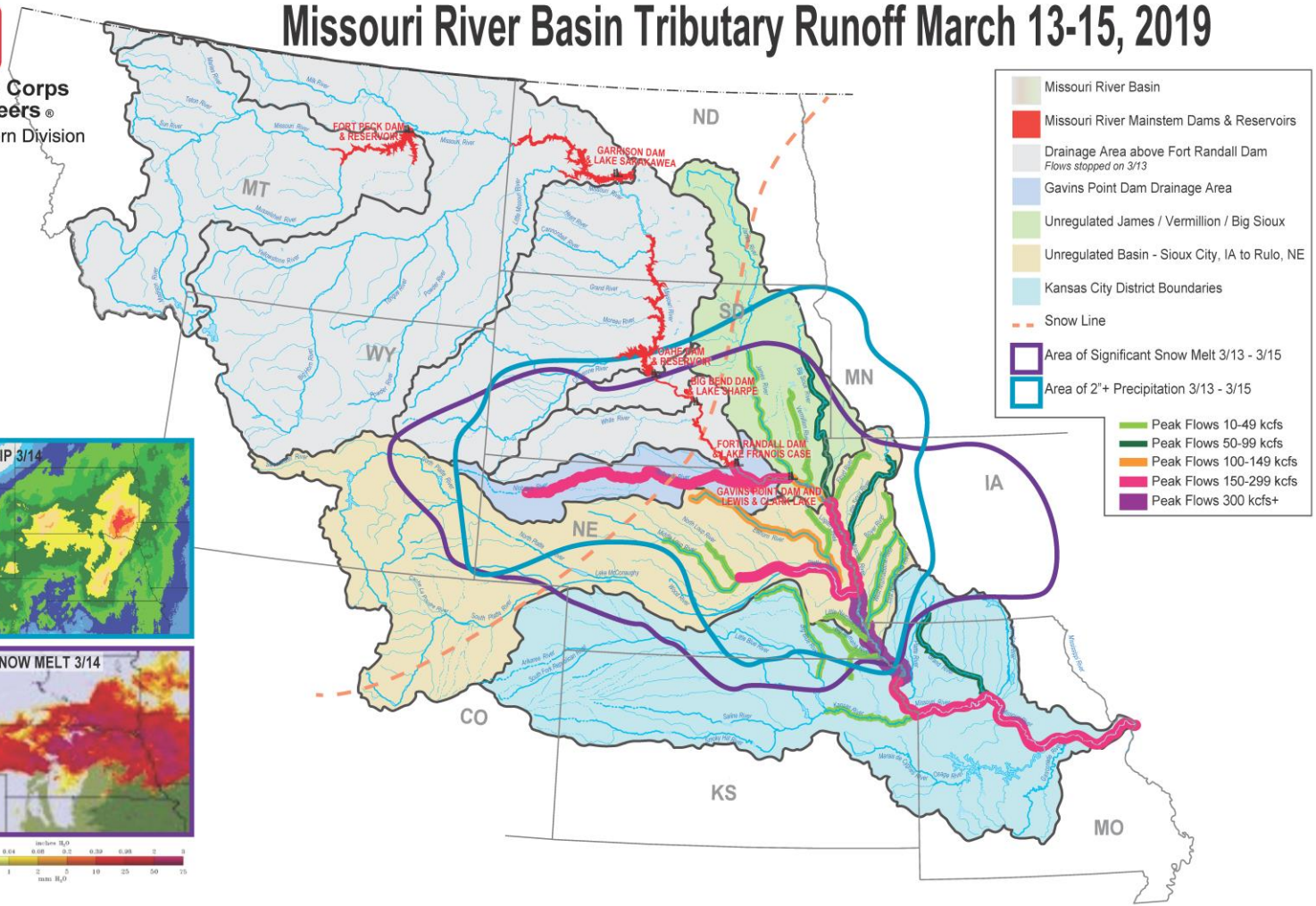
U.S.ARMY

MARCH 13-15, 2019



Missouri River Basin Tributary Runoff March 13-15, 2019

US Army Corps of Engineers®
Northwestern Division



MISSOURI RIVER BASIN TRIBUTARY RUNOFF MARCH 13-15, 2019

- Enormous inflows came from every major tributary that enters Missouri River from Niobrara, Nebraska to confluence of Platte and Missouri Rivers
- Niobrara River quickly filled very limited flood storage capacity at Gavins Point Dam forcing increased releases
- Missouri River flood levels dramatically increased south of Omaha due to record flows in Platte River
- Combined flows of Platte and Missouri Rivers greatly exceeded capacity of several levee systems

“If we had known in November 2018 that March 2019 was going to happen as it did, we couldn’t have done anything about it.
If next year is going to be like this year was, we need to know that about now.”

John Remus
Chief, Missouri River Basin Water Management Division, USACE

US Army Corps of Engineers ®

U.S.ARMY