State Interagency Missouri River Authority (SIMRA) Meeting
Thursday, June 18, 2015; 10:00 a.m. – 3:00 p.m.
Iowa Western Community College
Looft Hall Conference Center, 2700 College Road, Council Bluffs, IA

SIMRA member attendees: Doug Hoelscher (IGOV); Chuck Gipp, Bill Ehm, Sharon Tahtinen, Tim Hall (DNR); Craig Markley, Sam Hiscocks (DOT); Geri Huser, Scott Bents (IUB); Jake Hansen, Harold Hommes (IDALS); Rita Grimm, Sherry Timmins (EDA); Tim Kautza (HSEM); Shawn Shouse (MRRIC/ISU)

Guests: Adel Haj (USGS); Rep. Charlie McConkey; Don Meisner (SIMPCO); Leo Ettleman, Brian Johnson and Scott Olson (Responsible River Management); Matt Noor (USGS); Jody Farhat (USACE) Stu Maas; Mel Houser (Pottawattamie Co.); Chris Larson (DNR); Bill Anderson (Congressman King);Colleen Horihan (USACE); Jacob Bossman (Sen. Grassley); Twila Larson (Fremont Co.); Cara Morgan (Fremont Co.); Donna Barry (Sen. Grassley); Matt Walsh (Council Bluffs); Mike Collison (Monona Co.); Emily Clark (Sen. Ernst); Rep. Hanusa; Charlie Johnson (Congressman Young)
Via Phone: Rick Robinson (IA Farm Bureau); John Pylelo (Woodbury Co. Planning & Zoning)

AGENDA
Welcome – Mayor Matt Walsh, City of Council Bluffs

Introductions and Business Items – Chuck Gipp, Director – Department of Natural Resources
--Approve Agenda – Approved Unanimously
--Approve Meeting Summaries – November 2014; December 2014 – Approved Unanimously

Agency Director Comments: "Further Leadership Perspective on the Importance of the Missouri River"

Freight Network Optimization Study – Craig Markley, Director, Office of Systems Planning, Iowa DOT
A study to effectively identify and prioritize investment opportunities for an optimized freight transportation network to lower transportation costs for Iowa's businesses and to promote business growth in Iowa. This will be done by applying a demand-based supply chain network design and optimization approach to the state's transportation network and creating short- and long-term freight transportation network optimization strategies.

M29 Marine Corridor Update – Sam Hiscocks, Freight Coordinator, Iowa DOT
America's Marine Highway System consists of over 29,000 nautical miles of navigable waterways including rivers, bays, channels, the Great Lakes, the Saint Lawrence Seaway System, coastal, and open-ocean routes. The Marine Highway Program, established under the Energy Independence and Security Act of 2007, works to further incorporate these waterways into the greater U.S. transportation system to give shippers more efficient and sustainable options and to reduce landside congestion on other modes. The M-29 Marine Highway Connector establishes a connection between the middle section of the Missouri River in Sioux City, Iowa and the M-70 Marine Highway Corridor in Kansas City, Missouri. This 366-mile route provides a third major transportation option, in addition to highway and rail, for regional freight movement between Iowa, Kansas, Missouri, and Nebraska. Increasing freight transportation on this portion of the Missouri River can serve to slow freight traffic growth on local roads, interstate highways, railroads, and bridges. There is growing interest in increasing the utilization of the Missouri River for freight transport but some shippers are hesitant to be the first.

Missouri River Outlook – Jody Farhat, P.E.; Chief, Missouri River Basin Water Management Northwestern Division, USACE; & Shallow Water Habitat Updates – Colleen Horihan, USACE Shallow Water Habitat Program Manager
Significant changes have taken place in the conditions of the Missouri River Basin over the last two months. April runoff in the basin was only about 50% of normal, and with the limited snowpack, the predictions were for an annual runoff of 22.5 MAF – or less than 90% of normal runoff. However, the very wet May and early June has resulted in the annual runoff estimate being raised to 28 MAF, or more than 110% of normal. As a result of this increased runoff, as of June 16, 2015 the reservoirs on the Missouri River were using 25% of their flood control capacity of the mainstem system. Higher releases from the system may be required in the fall to evacuate all of the flood water from the system by January 2016. Winter releases from Gavins Point are expected to be 17,000 to 20,000 cfs, with full service flow support and a full navigation season.

Shallow Water Habitat project status for 2014 and 2015 projects were presented, including 2014 Ongoing Construction Projects, 2015 New Construction Projects, and 2015 Projects in Plan Formulation. 2014 Ongoing Construction Projects include Hole-in-the-Rock and Middle Decatur, the Little Sioux Chute, the Louisville Backwater, and River Structure Modifications (including Fremont and Mills Counties Iowa). 2015 New Construction Projects include Middle Decatur Top Width Widening and Adaptive Management at Sandy Point. 2015 Projects in Plan Formulation include Plattsmouth, Langdon Bend, Copeland Bend, and the Middle Decatur Backwater Structure.

Water Science Center Report on 2011 Flooding – Daniel Christiansen, Supervisory Hydrologist, Iowa Water Science Center, U. S. Geological Survey
USGS described a recent project, which included subdividing the Missouri Basin into 16 subbasin models at dams and USGS Missouri River Streamflow gages, and then using existing measurements from stream gages to calibrate a model using temperature and precipitation information. Once the model was constructed, the mainstem dams were "removed" to determine what the 2011 floods would have been like without any structures. The results show that the mainstem structures negated spring flood peaks, decreased the summer flood peaks, decreased the severity of the flooding, and decreased the number of days of severe flooding.

Flood Control and Levee Accreditation – Bill Cappuccio, Environmental Engineer Sr.
Flood Plain Management and Dam Safety Section, Iowa DNR
Due to time limitations, Bill Cappuccio briefly introduced the Flood Control and Levee Accreditation topic. FEMA has re-initiated several floodplain mapping projects in Iowa for communities that include levees that do not satisfy FEMA's requirements for accreditation as providing protection from the 100-year flood. Several of these mapping projects are for counties located along the Missouri River. FEMA plans to address the areas located behind de-accredited levees using the procedures outlined in its "Analysis and Mapping Procedures for Non-Accredited Levees (LAMP)". LAMP outlines 5 procedures that can be considered for defining the flood risk for each individual levee reach. The implications for the areas located behind de-accredited levees – in regard to land use and flood insurance requirements – will depend on the conditions and circumstances associated with each levee reach, and the LAMP procedure chosen to analyze them. Bill will be invited to the next SIMRA meeting to provide a full presentation on this topic.

Missouri River Recovery Implementation Committee (MRRIC) Report – Shawn Shouse, MRRIC Representative

Shawn Shouse gave a very brief summary of the goals of the Missouri River Recovery Program. Science indicates that the piping plover and least tern would benefit most from additional emergent sandbar nesting habitat, created either by mechanical construction or altered river flows. The needs of the pallid sturgeon are less clear, but the predominant evidence is that additional shallow water habitat for intercepting and feeding of larval stage pallid is the primary need. This shallow water habitat is created primarily with constructed side channels (chutes). In preparation for program planning decisions, Shouse posed three questions: What range of river flows would be acceptable? How much land are we willing to commit to shallow water habitat, and with what impacts to other river uses? Can Iowa interests present a uniform voice on the first two questions?

Next Meeting

SIMRA members discussed next meetings and mentioned that the fall meeting would be held in western Iowa.

Lunch at Caddy's Riverside Grille; 2 Harrah's Blvd, Council Bluffs.

1:30 p.m. – 3:00 p.m. – Tours (instructions provided at meeting)

--Tom Hanafan River's Edge Park

-- Shallow Water Habitat and Levee

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Conference Call Instructions:
Dial (866) 685-1580. When the call is answered follow the prompts by entering the conference code of **4510673319** followed by #.

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Other

Next Meeting

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1:30 p.m. – 3:00 p.m. – Tours (instructions provided at meeting)
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--Walking tour Shallow Water Habitat and Levee

Iowa Department of Natural Resources

Leading Iowans in caring for our natural resources

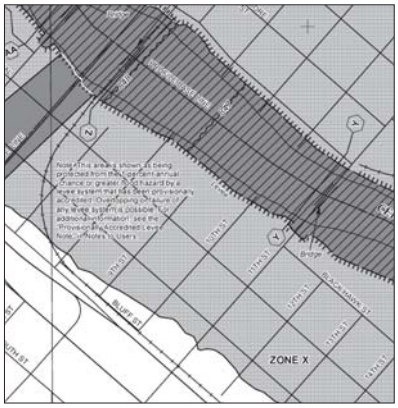
Impacts of Levee De-Accreditation on Communities

Acronyms

- NFIP – National Flood Insurance Program
- FIRM – Flood Insurance Rate Map
- SFHA – Special Flood Hazard Area
- Map Mod – FEMA's Flood Map Modernization Program
- PAL – Provisionally Accredited Levee
- LAMP – Analysis and Mapping Procedures for Non-Accredited Levee Systems
- LLPT – Local Levee Partnership Team

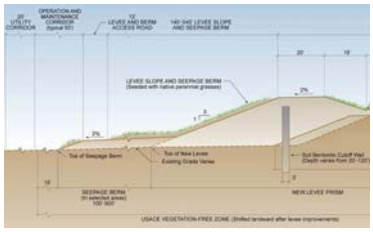
Representation of Flood Control Levees on FIRM's

Since the mid-1980's, FEMA has required certification that a levee provides protection from the 1% annual chance (i.e., 100-year frequency) flood before mapping it as providing flood protection on a Flood Insurance Rate Map (FIRM).



Representation of Flood Control Levees on FIRM's (cont.)

- Criteria for levee certification/accreditation is listed in 44 CFR 65.10
  - Design Criteria
    - Freeboard
    - Closures
    - Embankment Protection
    - Embankment & Foundation Stability
    - Settlement
    - Interior Drainage
  - Operations Plan
  - Maintenance Plan
- Documentation submitted must be certified by a registered professional engineer



FEMA Requirements vs. Corps Levee Safety Program

- FEMA requirements for accreditation differ from those for USACE Levee Safety Program
  - FEMA requirements are intended to determine whether a levee is designed/constructed to provide protection from the 1% annual chance flood.
    - Determines how the area landward of a levee is mapped
    - Depends on documentation provided by others
  - Corps Levee Safety Program includes ~2000 levee systems nationwide (~14,000 mi.)
    - Inspections assess levee integrity and identify deficiencies
    - Determine if the levee is being properly operated and maintained
    - Determine eligibility for federal rehabilitation funding (PL 84-99)

FEMA Requirements vs. Corps Levee Safety Program (cont.)

- Corps Levee Safety Program Inspections do not directly affect levee accreditation
  - An "Acceptable" inspection rating does not equate to levee accreditation.
  - An "Unacceptable" inspection does not automatically de-accredit a levee
- Information provided by Corps Levee Safety Program can supplement documentation submitted by community for levee accreditation.

Map Modernization

- In 2003, Congress funded FEMA's Map Modernization Program (Map Mod)
- Tasked with remapping entire country
- Concerned with how to deal with levees/floodwalls shown on existing FIRM's as providing flood protection
  - Many had not been re-accredited for decades
- 2005 – flood protection levees failed at New Orleans

Map Modernization (cont.)

- 2006 – FEMA informed communities being remapped that, in order for levees/floodwalls to be shown as providing flood protection, they must be re-accredited.
- Provisionally Accredited Levee (PAL) Agreement
  - Allows FEMA to continue a mapping project while community is collecting accreditation documentation
  - Allows community 2 years to provide accreditation documentation

"Without Levee" Analysis

- Where a levee could not be accredited, FEMA mapped it as though levee provided no protection at all (i.e., without levee)
- Implications development located in the newly mapped special flood hazard area (SFHA)for the community
  - Buildings located there would be subject to the Mandatory Purchase Requirement
    - Federally insured lenders must require the purchase of flood insurance as a condition of any loan for a building or contents
  - New development would be require local and state floodplain development permits
    - The lowest floors for new buildings must be elevated 1 ft. above the 1% annual chance flood

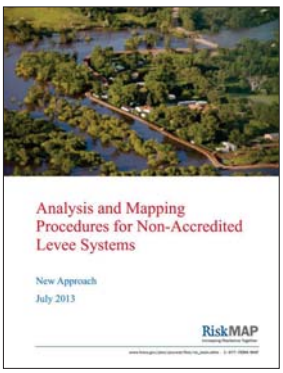
"Without Levee" Analysis (cont.)

- February 2011 – 27 Senators and 49 Members of the House signed letters to the FEMA Administrator asking that he discontinue use of the "without levee" analysis for de-accredited levees

- FEMA Administrator halted progress for all mapping projects that involved de-accredited levees until new procedures for dealing with them could be developed

Analysis and Mapping Procedures for Non-Accredited Levee Systems (LAMP)

- Finalized in July 2013
  - Stakeholder Engagement
    - Local Levee Partnership Team (LLPT)
  - More Robust Analysis and Mapping
    - Select analysis procedures that best reflect unique circumstances
  - Recognition of Uncertainty Associated with Levee Systems
    - Use "Zone D" designation on FIRM to identify areas of undetermined, but possible, flood hazards
  - Analysis of Levee Reaches
    - Apply appropriate procedure to individual reaches within the levee system

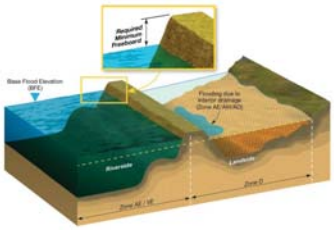


Analysis and Mapping Procedures for Non-Accredited Levee Systems (LAMP)

- LAMP outlines 5 procedures that can be used to analyze/map unique circumstances for each individual levee reach
  - Sound Reach
  - Freeboard Deficient
  - Overtopping
  - Structural-Based Inundation
  - Natural Valley

LAMP Procedures

1. **Sound Reach**
2. Freeboard Deficient
3. Overtopping
4. Structural-Based Inundation
5. Natural Valley

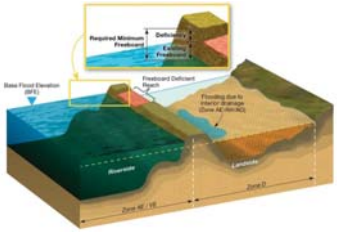


- Only applies where at least one reach satisfies CFR 65.10, but the entire levee system does not.*
- Mapped area behind the Sound Reach is based on a system-wide "Natural Valley" procedure and is labeled Zone D.

*If entire levee system met definition of Sound Reach, the levee system would satisfy CFR 65.10 and be accredited.

LAMP Procedures (cont.)

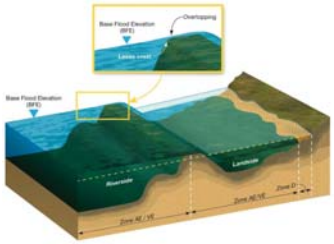
1. Sound Reach
2. **Freeboard Deficient**
3. Overtopping
4. Structural-Based Inundation
5. Natural Valley



- Levee reach does not satisfy freeboard requirements of CFR 65.10, but does satisfy all other structural requirements of CFR 65.10 .
- Mapped area behind the Freeboard Deficient reach is based on a system-wide "Natural Valley" procedure and is labeled Zone D.

LAMP Procedures (cont.)

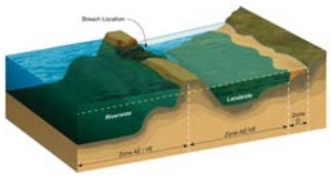
1. Sound Reach
2. Freeboard Deficient
3. **Overtopping**
4. Structural-Based Inundation
5. Natural Valley



- Levee reach is overtopped in at least one location, but satisfies all other structural requirements of CFR 65.10 and is armored to withstand overflows.
- Mapped area behind the levee is based on routing only the overtopping flows and is labeled Zone AE.
- Land areas not included in the area affected by the overtopping but affected by the system-wide "Natural Valley" procedure are labeled Zone D.

LAMP Procedures (cont.)

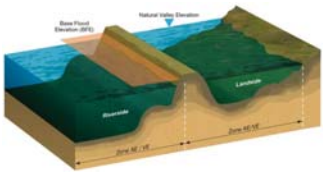
1. Sound Reach
2. Freeboard Deficient
3. Overtopping
4. **Structural-Based Inundation**
5. Natural Valley



- Levee reach does not satisfy the structural requirements of CFR 65.10 and, in the case of overtopping, is also not armored.
- Mapped area behind the levee is based on breaching the levee at more than one location and is labeled Zone AE
- Land areas not included in the area affected by the structural-based inundation but affected by the system-wide "Natural Valley" procedure are labeled Zone D.

LAMP Procedures (cont.)

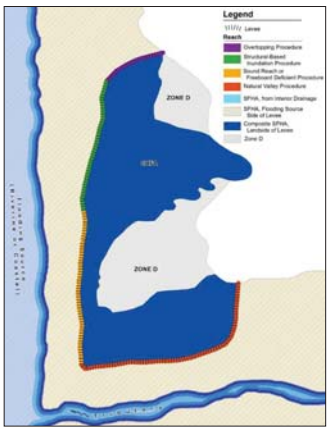
1. Sound Reach
2. Freeboard Deficient
3. Overtopping
4. Structural Based Inundation
5. **Natural Valley**



- Used for those non-accredited levee reaches where none of the other 4 LAMP procedures apply.
- Modeled by allowing the flood discharge to flow on both sides of the levee
- Mapped area behind the levee is labeled Zone AE
- Also used to determine the extent of the area landward of the non-accredited levee to be mapped as Zone D for other LAMP procedures.

LAMP Procedures (cont.)

Use of more than one LAMP procedure within a levee system will result in a composite map



Advantages/Disadvantages of Zone D

- Advantages
  - No local Floodplain Development Permit required
  - Lenders are not required to make the purchase of flood insurance a condition of a loan for a building and/or its contents
- Disadvantages
  - Cost associated with providing documentation needed for levee to qualify for Freeboard Deficient procedure
  - Lenders have option to require purchase of flood insurance for loans involving buildings and/or their contents
  - Cannot lower flood insurance rates by elevating/floodproofing a building
  - Zone D rates are increasing by as much as 25% annually (as per NFIP reform legislation passed by Congress in 2012 & 2014)

LAMP Process

- FEMA held initial meetings with 4 Local Levee Partnership Teams for the Left Bank Missouri River
  - Rock Port – May 4th
  - Hamburg – May 4th
  - Glenwood – May 5th
  - Council Bluffs – May 5th
- FEMA's next meetings with LLPT's to be sometime in July

Left Bank Missouri River Meeting

- Levee districts, communities and landowners have requested a meeting to discuss questions resulting from the May 4th & 5th LLPT meetings
- Scheduled for July 6th, AgriVision Building, Glenwood.

Left Bank Missouri River Meeting

- Questions listed on the draft agenda include:
  - What are the impacts of levee de-accreditation on:
    - Land use development
    - Agricultural insurance (e.g., crops, machinery, outbuildings)
    - Flood Insurance (NFIP)
    - PL 84-99 eligibility

Questions?

Bill Cappuccio
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M-29 MARINE HIGHWAY CONNECTOR

State Interagency Missouri River Authority

June 18, 2015

IOWA DOT

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M-29 overview

- Length: 366 miles
- Port of Kansas City, MO to Sioux City, IA
- Major cities: Kansas City, Omaha, Sioux City
- Landside corridor served: I-29, I-35, I-70, I-49
- Marine highway connections: M-70

Sponsors and supporters

- Sponsors
  - PortKC
  - Missouri DOT
- Supporters
  - Kansas DOT
  - Mid-America Regional Council
  - St. Joseph Area Transportation Study Organization
  - Inland River Ports and Terminals Association
  - Nebraska City Dock Board

Barge terminals

- 5 in Iowa (April 2011)
  - Cargill (milepost 614.3)
  - Ag Processing, Inc. (milepost 716.6)
  - Koch Nitrogen Co. LLC (milepost 717.0)
  - Jebro, Inc. (milepost 727.5)
  - Big Soo Terminal (milepost 728.0)

Iowa River Barge Terminal Directory
http://www.iowadot.gov/barge.htm

Cargill	**River Mile:** 614.3
Address: 2401 South 37th Street Council Bluffs, IA 51501	**Phone:** 712-325-2701 **FAX:** 712-325-2730
Contact Person: Mathew Wallace	**E-Mail:**
Facility Owner: Cargill	
Railroad Service: UP, BNSF, IAIS, and KCS	
Services Provided: Rail Car Storage Capacity: 104 cars Barges Worked Capacity: 3 Barges Stored Capacity: 3 Dry Storage Facilities: 2.2 million bushels	
Major Commodities Handled: Soybeans, yellow corn and white corn	

Ag Processing, Inc.	River Mile: 716.6
Address: 2753 Port Neal Circle Sergeant Bluff, IA 51054	**Phone:** 712-943-4282 **FAX:** 712-943-1476
Contact Person: Wayne Johnson	**E-Mail:** wjohnson@agp.com
Facility Owner: Ag Processing, Inc.	
Railroad Service: UP	
Services Provided: Rail Car Storage Capacity: 250 cars Barges Worked Capacity: 1 Barges Stored Capacity: 3 Dry Storage Facilities: 3.5 million bushels Liquid Storage Facilities: 36 million pounds	
Major Commodities Handled: Soybeans and soybean products, and biodiesel	

Koch Nitrogen Co. LLC	River Mile: 717.0
Address: 2735 Port Neal Circle Sergeant Bluff, IA 51054	**Phone:** 712-943-5684 **FAX:** 712-943-5625
Contract Person: Bill Johnson	**E-Mail:** johns27b@kochind.com
Facility Owner: Koch Nitrogen Company	
Railroad Service: UP	
Services Provided: Rail Car Storage Capacity: 55 cars Barges Worked Capacity: 1 Barges Stored Capacity: 3 Dry Storage Facilities: 20,000 tons Liquid Storage Facilities: 20,000 tons	
Major Commodities Handled: Anhydrous ammonia, urea, urea ammonium, and nitrate	

Jebro, Inc.	River Mile: 727.5
Address: 2303 Bridgeport Drive Sioux City, IA 51111	**Phone:** 712-277-8855 **FAX:** 712-277-8451
Contact Person: Bob Cheever Phone: 712-234-2805	**E-Mail:** bob.cheever@jebro.com
Facility Owner: Jebro, Inc.	
Railroad Service: UP	
Major Commodities Handled: Asphalt and petroleum products	

Big Soo Terminal	River Mile: 728.0
Address: 4101 Harbor Drive Sioux City, IA 51102	**Phone:** 712-258-0537 **FAX:** 712-258-4649
Contact Person: Kevin Krepper	**E-Mail:** Kevin@BigSoo.com
Facility Owner: Tegra Corporation	**Web-site:** www.bigsoo.com
Railroad Service: UP	
Services Provided: Rail Car Storage Capacity: 75 cars Barges Worked Capacity: 2 Barges Stored Capacity: 12 Dry Storage Facilities: 120,000 tons Liquid Storage Facilities: 22,000 tons 20 acre lay down yard	
Major Commodities Handled: Dry bulk fertilizer, grain, soybean meal and oil, steel, l stuffs, and wind energy components with heavy lifts	

Navigation season

- Generally – 8 month season (March 23-November 22)
- Based on total water in storage each year
  - March 15
    - <31 MAF = no navigation season
    - 31 to 49 MAF = minimum service level
    - >51.5MAF = full 8 month maximum service season
  - July 1
    - > 51.5 MAF = 8 month season
    - 46.8 to 41 MAF = 7 month season
    - < 36.5 MAF = 6 month season
- Authorized to provide a 9-foot deep by minimum of 300-foot wide navigation channel depending on water in storage plus downstream tributaries flow and flood conditions

Recent trends

- Historically – inconsistent water levels and navigation seasons
- 2013-2014

  harsh winter

  shale oil shipments

  \+ abundant crop harvest

  strain on entire freight transportation network
- Effected cost and availability of barges
  - May 2014: $140/day chartered for 6 months
  - Nov 2014: $900+/day with no certainty on commitment

Recent activities

- Central plains cement
  - Rehabbing loading dock
  - Plan to move barges between KC, Omaha, Peoria
- Cargill and Bartlett Grain
  - Rehabbing KC facility
  - Plan to move freight this year
- Kinder Morgan
  - Actively promoting terminal in Omaha
- Holt County, MO
  - Exploring forming a Port Authority to ship ag products
- CF Industries
  - Moving equipment to Sioux City again this year
- PortKC
  - Has operator and cargo moving

Future opportunities

- Kansas City area
  - Potential for more inbound than outbound
  - Increased barge availability for grain/ag products
- US Corp of Engineers, Omaha District
  - Will support appropriate flows for commerce
- Sioux City traffic
- Highway and rail congestion

"Consensus with shippers appears to be that they want to use the Missouri but not be the first to take the initial step"

Sam Hiscocks

Office of Systems Planning

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Iowa DOT Project Overview
Development of A Statewide Freight Transportation Network Optimization Strategy

June 18, 2015

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Presentation Overview

- Project Vision and Approach
- Examples of the Analysis Results

Project Background

3

- ***Vision**: To effectively identify and prioritize investment opportunities for an optimized freight transportation network to lower transportation costs and promote business growth in Iowa.*
- Iowa DOT can optimize statewide freight transportation network to reduce transportation costs
  - Traditional approach focuses on capacity planning
  - Traditional methods don't quantify cost saving opportunities in a multimodal network
- This project uses a demand-based supply chain network design and optimization approach to Iowa DOT planning

IOWA DOT

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Supply Chain Network and Optimization

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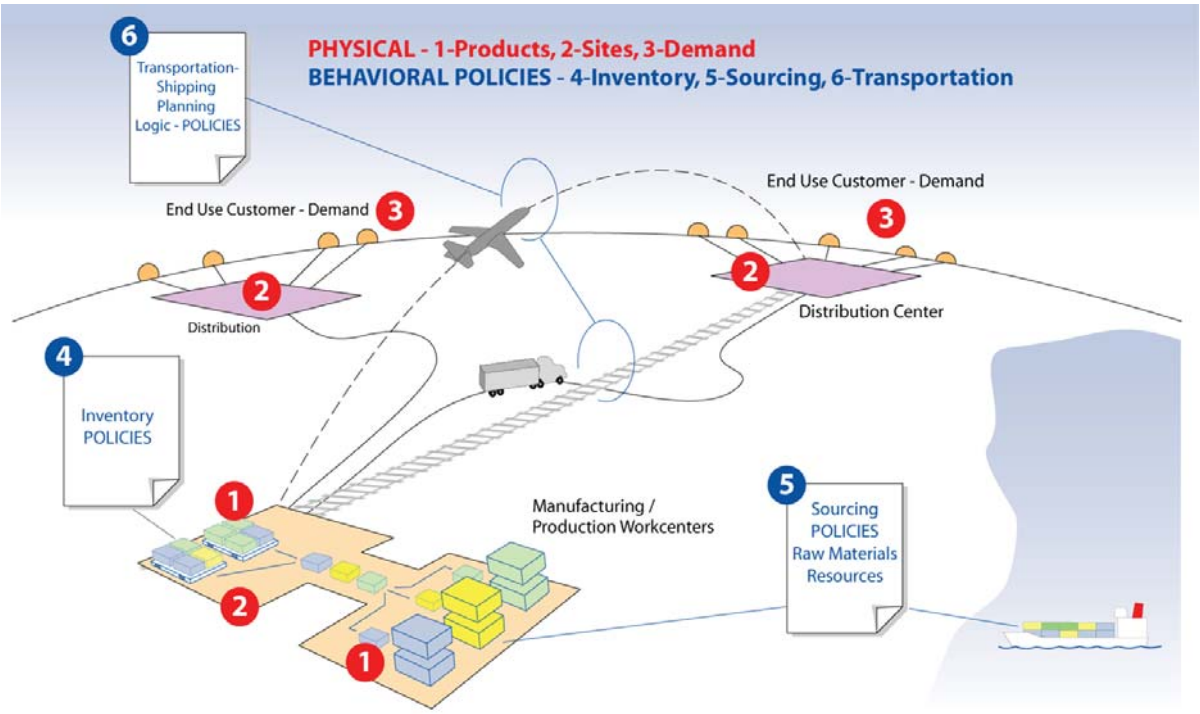
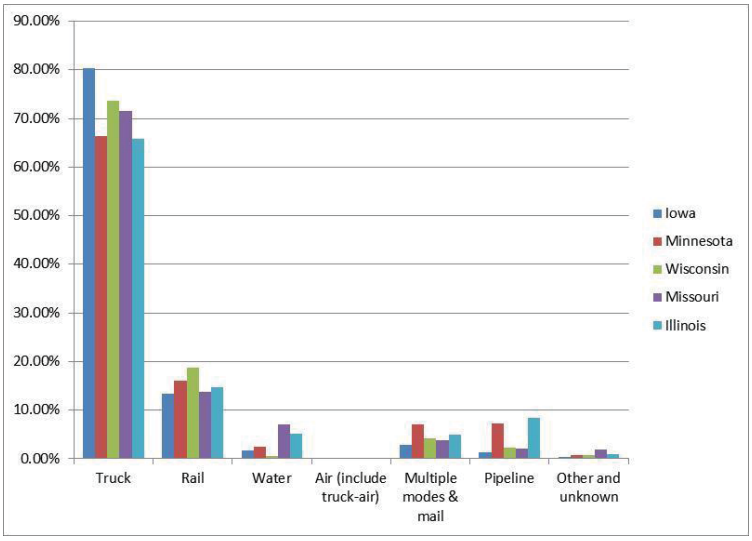
- ~80% of the landed costs are locked in with the supply chain network



Opportunities in Current Freight Flow

- The chart shows the percentage breakdown of tonnage by mode in 2012 domestic freight in 5 states
- Iowa has the highest % of tonnage in truck among the five states
- Iowa has opportunities to improve rail and intermodal transportation to reduce transportation costs for Iowa businesses



Data Source: FAF 3.5, Federal Highway Administration

Optimization Analysis

- Quantitative Analysis
  - Cost, capacity, etc.
  - Economic viability
- Qualitative Analysis
  - Strategic alignment
  - Increasing freight network resiliency
  - Tax incentive / funding availability
  - Job creation and local buy-in
  - Service levels / transportation time
  - Road mile reduction
  - Project implementation risks

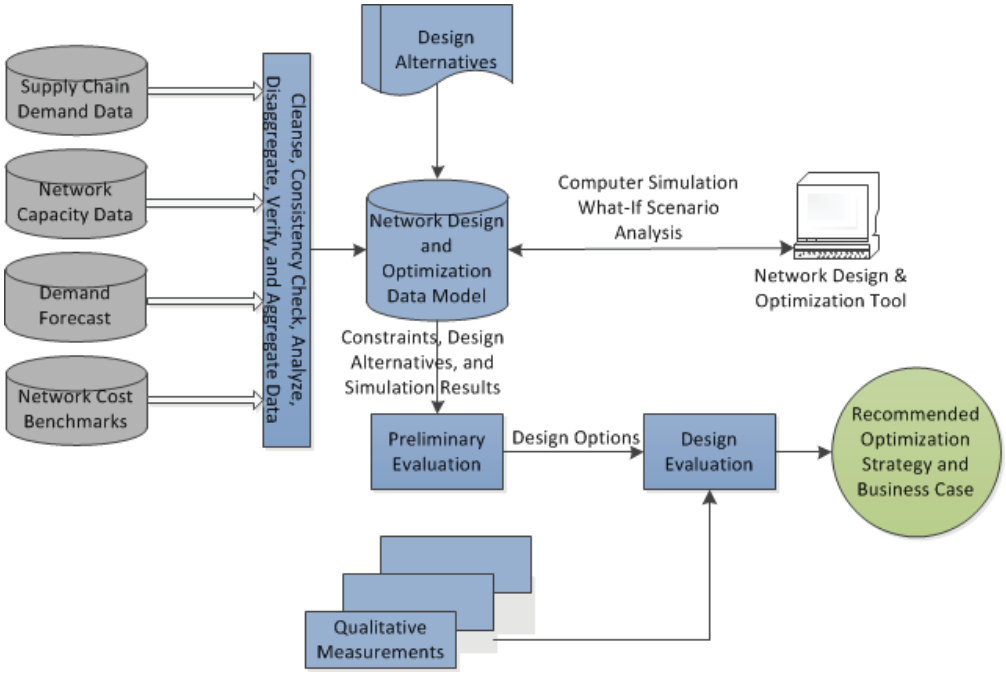
Benefits of Multi-Modal Freight Optimization

- Effectively identify and prioritize investment opportunities to lower transportation costs for businesses
  - Leverage current transportation network to deliver optimized results
  - Identify new infrastructure opportunities to optimize freight transportation network
- Identify economic development opportunities to recruit new companies to Iowa
- Provide a foundation model to help existing Iowa businesses optimize their supply chains
- Identify opportunities to improve network resiliency

Network Optimization Approach

Analysis of Freight Network Demand and Capacity	• Analyze high priority demand and freight network capacity
Performance Measurement and Constraints Analysis	• Use quantitative and qualitative measurements • Identify and prioritize current and forecasted performance constraints
Creating and Prioritizing Optimization Strategies	• Develop pragmatic optimization strategies • Focuses on optimization strategies with high Return on Investment
Business Case Development	• Conduct financial analysis and develop financial models • Develop actionable recommendations with justifications

Conceptual Architecture Overview



Input Data

- Product
  - The products that businesses deliver to their customers
  - Product dimension, weight, and other physical characteristics
- Transportation Demand
  - The desire to ship products from origin to destination
  - Includes the quantity of the products to be shipped, the mode of transportation, the value of the products, and any lead time or distance requirement
- Transportation Network
  - Highway, rail, and water network and capacity data
- Manufacturing and Customer Location
  - Includes the geographic location information of origin and destination points
  - Includes facility capacity
- Transportation Infrastructure Cost
  - Includes the costs associated with construction and operation
- Transportation Cost
  - Includes all cost components associated with shipping a specific product from origin to destination

Examples of Analysis Results

- Cross-dock facilities to consolidate freight shipments and reduce transportation costs
- Intermodal facility to leverage railroad transportation and reduce transportation costs and truck miles
- Transload facilities to enable additional railroad freight transportation

Example 1 – Cross-Dock Facility

Cross Dock Overview

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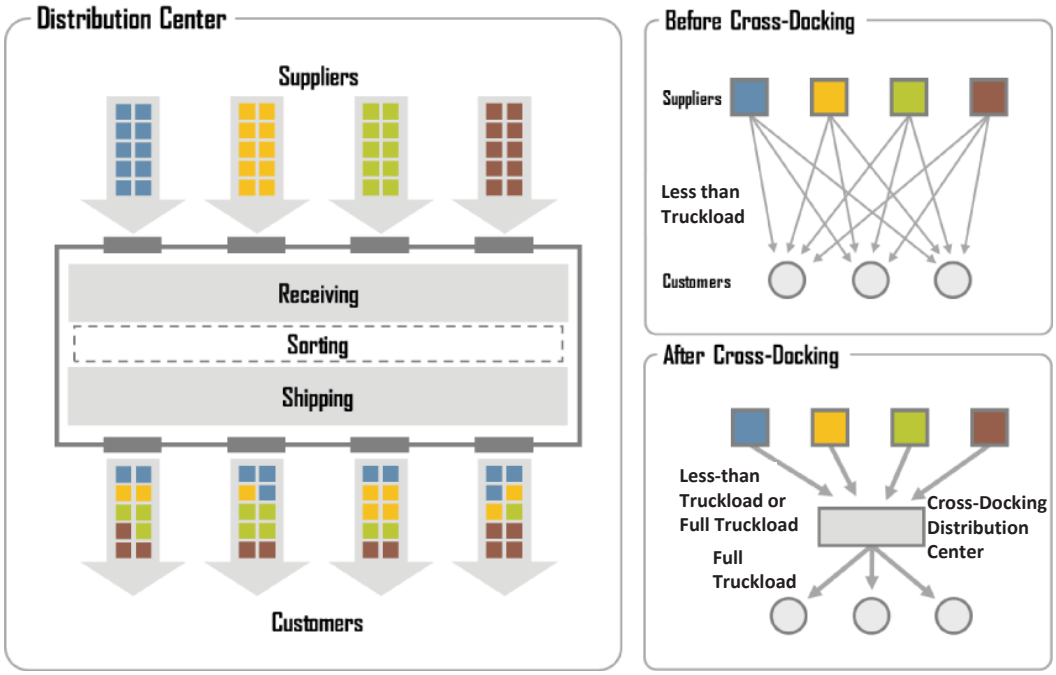

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Case Study 1 - Cross-Docking Analysis

14

- Evaluated total cost saving opportunities in four regions
- Region 1 has the highest cost saving, but Regions 2 & 3 are more viable options because of existing access to interstate highways
- Selected Region 2 as the primary site candidate with the concept to co-locate cross-dock and intermodal facilities in a logistics park

Location	Total Annual Saving Opportunity
Region 1	$909 Million
Region 2	$883 Million
Region 3	$908 Million
Region 4	$713 Million

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Impact on Freight Transportation

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Current State

Future State

- Benefits:
  - Leverage freight consolidation to reduce transportation costs
  - Reduce long distance truck traffic and improve environmental sustainability

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Investment Analysis – A Cross Dock in Region 2

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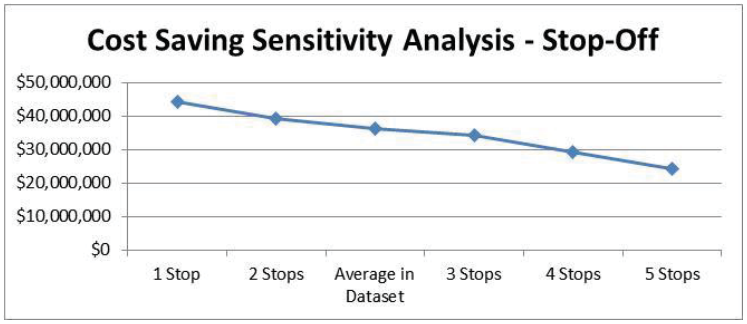
- Assumption
  - Build a 150-door, 600 trailer parking, 120,000 sq. ft. cross dock facility on 15 acres
  - 200 truck pickups daily, 52,000 truck pickups yearly (5 days a week, 52 weeks a year)
  - Capture 5.30% of overall market opportunity
  - Cross-docking fee ($450/truck) covers all operational expenses and profit margin
- Initial Investment: **$21 million**
- Annual Net Saving Opportunities: **$24.4 to $44.3 million**; Average **$36.2 million**

Item	Cost
Construction Cost	$ 5 million
Doors	$1 million
15 acres of land	$5 million
Sortation and support systems	$10 million



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Comparable Cross-Dock - Memphis

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- Carrier-owned transportation cross-docking
- Old Dominion, a $535.5 million trucking company, operates a 150-door cross-docking facility on ~16 acres in Memphis employing 308 people
- Old Dominion plans to replace the 150-door site by building a 229-door cross-docking facility, creating 188 new jobs and spending $31.3 million
- The average salary of the new hires will be $52,111

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Comparable Cross-Dock – Breinigsville, PA

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- Provider-owned transportation cross-docking
- NFI is $1billion provider of logistics, warehousing, transportation, and distribution services
- Facility Features:
  - Square Footage: 254,000
  - Building Height: 38'-47'
  - Trailer Spots: 550
  - Dock Doors: 150
  - ~40 acres
  - Close proximity to CSX and Norfolk Southern intermodal rail yards
- Other value added services provided: Custom and Promotional Packaging, Light Manufacturing / Assembly, Product Labeling, etc.
- Breinigsville was an agriculture and mining town in 19th century and early 1900s. It turned into a logistics hub (Home Depot, Amazon, Shoprite, etc.) starting in 1970s and 80s

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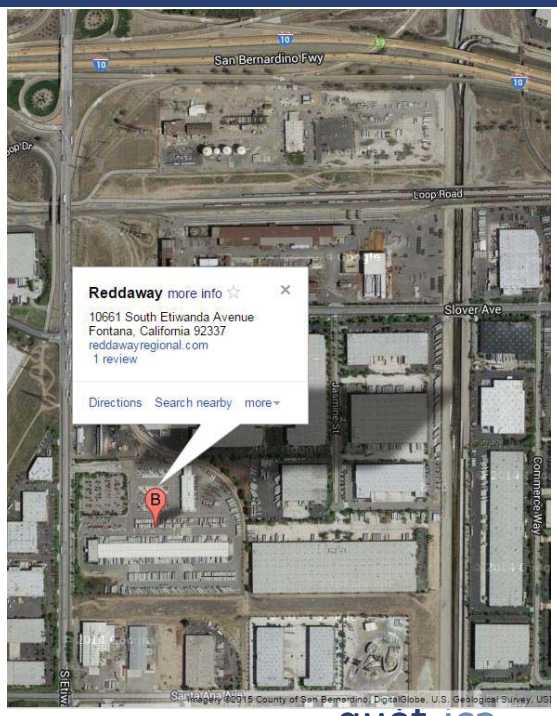
Comparable Cross-Dock – Fontana, CA

- Provider-owned distribution cross-dock provided to L&L Nursery Supply to consolidate shipments from over 60 manufacturers to deliver full truckloads to major retailer
- L&L is West Coast's leading manufacturer and distributor of lawn and garden products
- Reddaway Fontana Service Center is owned by Reddaway, a $335 million subsidiary of YRC Worldwide
- The 160-door facility is located on 17.6 acres



Cross-Docking Models

- Transportation Cross-Docking
  - Transportation companies sort and consolidate parcels and pallet loads based on geographic destination
  - The cross-docking warehouse can be a pure provider of cross-docking services
- Manufacturing Cross-Docking
  - Cross Docking is used for the receipt, consolidation, and shipment of raw materials or component parts from many suppliers to a manufacturing plant
- Distributor Cross-Docking
  - Various manufacturers ship their merchandise to a common distributor's cross dock
  - The distributor assembles the products on a multi-SKU (stock keeping unit) pallet before delivery to the next level of the supply chain
- Retail Cross-Docking
  - Products are received at a retailer's distribution center, moved across the dock, and married with other products bound for the same store

Cross-Dock Ownership Models

- Owned and operated by large shippers in manufacturing, distribution, and retail models. Examples are
  - Home Depot, computer parts distributors, etc.
- Owned and operated by carrier in transportation model
  - Examples: Old Dominion, a $535.5 million trucking company, owns and operates a 150-door cross-docking in Memphis
- Third-party logistics companies handling transportation management, warehousing, order management, etc. Examples are:
  - UPS Logistics provides cross-docking solutions to Harley-Davidson in WI
  - Ryder manages cross dock operation for Chrysler in Mexico
  - Schneider Logistics provides shared LTL/cross-docking service for shippers willing to share the ride
- Viable options for a cross dock in Region 2
  - Transportation cross-docking owned by a cross-docking service provider, a third-party logistics company, or a transportation company

Example 2 - Intermodal Facility

Opportunity Size – Focusing on High Volume Origin-Destination Pairs

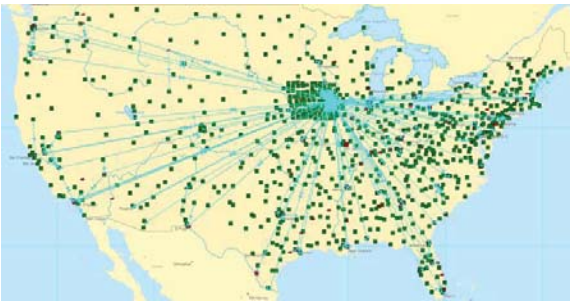
The total market opportunity for high volume origin-destination pairs: $289 million net annual savings

Item	Opportunity
Annual Gross Transportation Saving	$412 Million
Empty Container Reposition Cost	($123 Million)
Total Outbound Container Number	247,000
Total Inbound Container Number	42,000
Total Container Shortage	205,000
Annual Net Saving	**$289 Million**
Annual Lift Number	**494,000**

Example 2 – a New Intermodal Facility

Current State

Future State



- Optimization Benefits:
  - Leverage rail network to reduce transportation costs
  - Reduce truck traffic and improve environmental sustainability

Investment Analysis – a New Intermodal Facility

- Conservative case vs. Base case

	Annual Lift No.	Annual Net Cost Saving	Facility Size	Initial Investment
Conservative Case	32,000	**$23 million**	16 to 20 acres	< $15 million
Base Case	56,000	**$40 million**	30 to 35 acres	$15 million

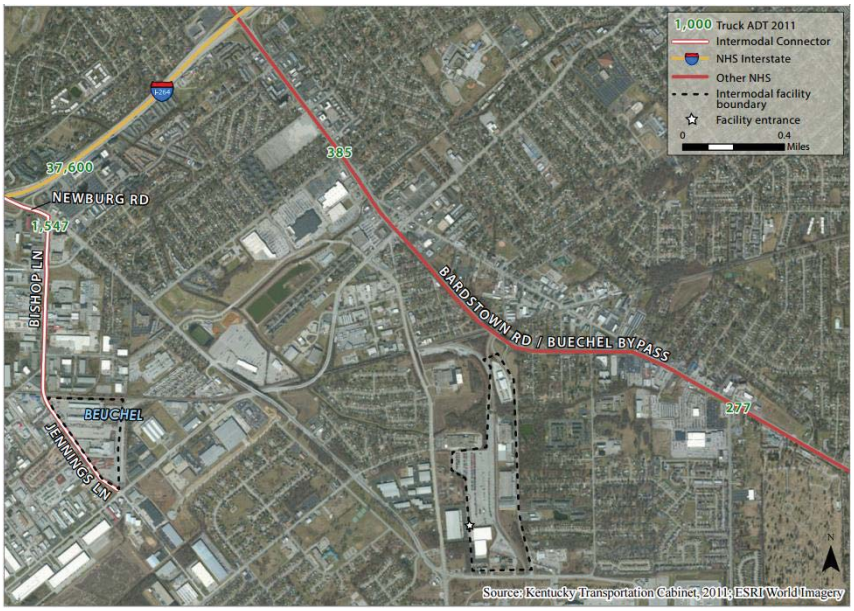
Comparable Facility – CSX in Louisville, KY

- Investment Example
  - In 2011, CSX invested $15 million to build a facility in Louisville, KY
  - 34-acre intermodal facility – capacity to handle 68,000+ lifts per year

Comparable Facility – NS in Louisville, KY

One of the three intermodal terminals in KY, 9 miles away from CSX terminal

- 30-acre facility
- The capacity of the terminal is ~55,000 lifts per year
- In 2012, the intermodal facility handled 40,000 lifts



Comparable Facility – UP in Council Bluffs, IA

- Existing Council Bluffs Intermodal Facility
  - Shared by UP and Iowa Interstate Railroad System
  - Container-on-flatcar facility processing <65,000 lifts per year (62,000 in 2012)

Intermodal Facility Size

Intermodal facilities do not have to be built on a grand scale. Some successful facilities are small:

Facility	City, State	Size (Acres)
CSX Intermodal Terminal	Mobile, AL	10
Port of Pasco Intermodal Terminal	Pasco, WA	15
Port of Quincy Intermodal Terminal	Quincy, WA	16
Charlotte Inland Terminal	Charlotte, NC	16
CSX Intermodal Terminal	Charlotte, NC	21
Start County Neomodal Terminal	Startk County, OH	28
CSX Intermodal Terminals	Memphis, TN	30
Norfolk Southern Appliance Park	Louisville, KY	30
CSX Louisville Intermodal Terminal	Louisville, KY	34

Intermodal Facility Size (cont'd)

- Sizing an intermodal facility
  - Minimum number of lifts to keep an existing intermodal facility viable:
    - 13,000 to 20,000 lifts per year – based on a 2006 MN Dept. of Ag study
    - 15,000 to 18,000 lifts per year – based on a 2006 report from Canadian Pacific
    - 2,000 lifts per acre – based on quotes from Des Moines MPO intermodal study in 2011
- Volumes required to induce a Class I railroad to establish a new intermodal facility
  - BNSF recommended 100,000+ lifts per year
  - Equivalent to 1 train/day for 365 days with 250 containers/train
- Solutions to build a new, lesser volume intermodal facility
  - Involve a class 2 or 3 railroad in developing an intermodal facility
  - Use new bimodal technology such as RailRunner
    - https://www.youtube.com/watch?v=XUgi4lQKmF8
    - RailRunner enables containers to be placed onto rail without the need for heavy lifting machinery
    - Only requirement for intermodal transfer is a railroad siding, some gravel or concrete and grading by the tracks, and 75 feet of operating room
    - No expensive cranes or lifting equipment is needed

Intermodal Facility Business Models

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- Landlord Intermodal Facility
  - Intermodal facilities are built by the government and leased out to operators on a landlord-tenant basis
  - Do not aim for profit maximization, but focus on other objectives, such as economic development, traffic decongestion, pollution reduction, and the creation of efficient supply chain for industries in the area
  - Landlord intermodal facilities are self-sustaining on land rents and dues on the facilities
  - Example: Virginia Inland Port (VIP)
    - Owned by Virginia Port Authority, built on 161 acres of land
    - Serviced by 17,820 feet of rail track that runs adjacent to Norfolk Southern's Crescent Corridor
    - Used by Home Depot, Kohl's, Rite Aid, Red Bull, etc.
  - Research shows public landlord model facility creates more jobs than the private operator model
- Operator Intermodal Facility - owned and operated by rail companies
- Developer Model Intermodal Facility – built by real estate developers.
  - Examples: CenterPoint has developed the facility in Joliet, Illinois; Hillwood Investment Properties has established the Charleston Trade Center logistics and light manufacturing park near the Port of Charleston, South Carolina

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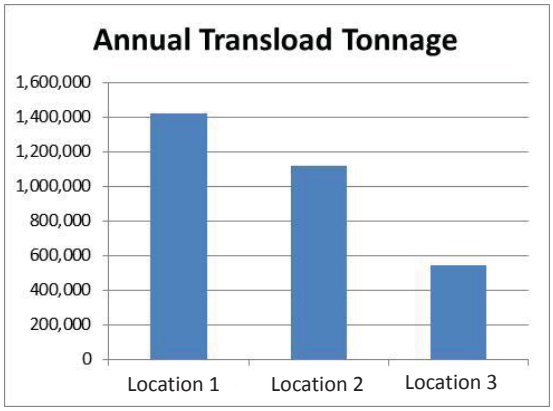
Example 3 - Transload Facility

Transload Facility Analysis

- Transload facilities allow shippers to transfer freight between two modes and leverage lower cost shipment options
- In the statewide model, three locations are identified as candidates for transload facilities to provide largest cost saving opportunities



Investment Analysis – 3 Transload Facilities

- Base case financial

Region	Annual Railcars	% of Tonnage	Annual Saving	Facility Investment	Land Cost	Total Investment
Location 1	1,634	11.98%	$5,462,720	$4.2 Million	$1.31 Million	$5.5 Million
Location 2	1,634	15.17%	$4,966,715	$4.2 Million	$1.31 Million	$5.5 Million
Location 3	817	15.65%	$2,611,274	$4.2 Million	$1.31 Million	$5.5 Million

- Conservative case financial

Region	Annual Railcar	% of Tonnage	Annual Saving	Facility Investment	Land Cost	Total Investment
Location 1	583	4.27%	$2,788,109	$4.2 Million	$1.31 Million	$5.5 Million
Location 2	427	3.97%	$1,885,382	$4.2 Million	$1.31 Million	$5.5 Million
Location 3	317	6.08%	$1,402,065	$4.2 Million	$1.31 Million	$5.5 Million

- Recommendations: develop transload facilities in Location 1 and Location 2

Comparable Transload Facility – Trans Load Carriers, Inc.

- Served and switched by BNSF, Norfolk Southern and CSX
- Located within two miles of the major highways and interstates in Birmingham, AL
- Approximately 30 acres, 130,000 sqft of enclosed warehouse space, two rail spurs providing 8 boxcar spots and 12 combined centerbeams and flatcar spots

Comparable Transload Facility – Patriot Rail

- Along the 68-mile Louisiana and North West Railroad that connects with Kansas City Southern and Union Pacific
- Near I-20 in Gibsland, LA, about 100 miles east of Shreveport
- Approximately 40 acres, expected to handle over 5,000 carloads in the first year
- Patriot Rail invested $3.3 million in developing the facility in 2011

Next Steps

- Finalize report and use results to make infrastructure improvements – potentially with the Linking Iowa's Transportation Infrastructure Fund
- Work with Iowa Economic Development Authority to recruit new businesses to Iowa and assist existing businesses with optimizing their supply chains

Questions?

Missouri River Recovery Program (MRRP)

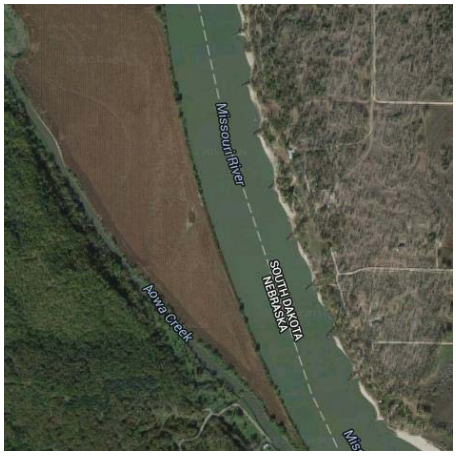
An effort to replace lost habitat and avoid a finding of **jeopardy** to threatened and endangered species (**pallid sturgeon**, **least tern** and **piping plover**) resulting from U.S. Army Corps of Engineers (Corps) projects on the Missouri River.

This program includes development of **emergent sandbar habitat**, **shallow water habitat**, and wetland and terrestrial habitat. It also includes ongoing data collection and **monitoring** to determine if these actions are effective.

For the Tern and Plover, science says the primary driver is amount of emergent sandbar habitat available for nesting & foraging (April-August).

Almost all of the emergent sandbar habitat effort is located in the un-channelized river between Gavins Point Dam and Ponca State Park (20-110 miles upstream from Sioux City), and on the shorelines of the larger reservoirs.

Un-channelized

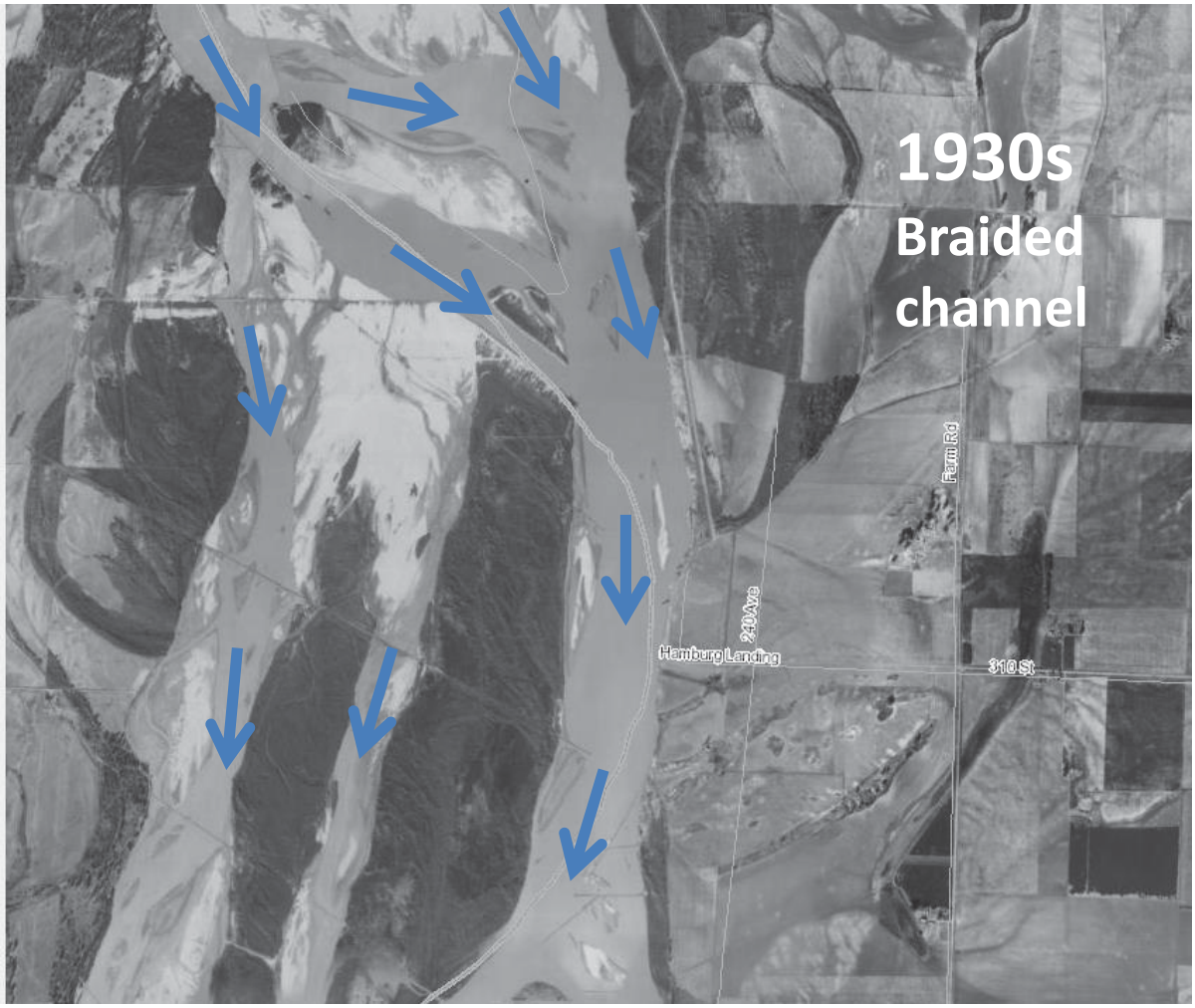


Channelized

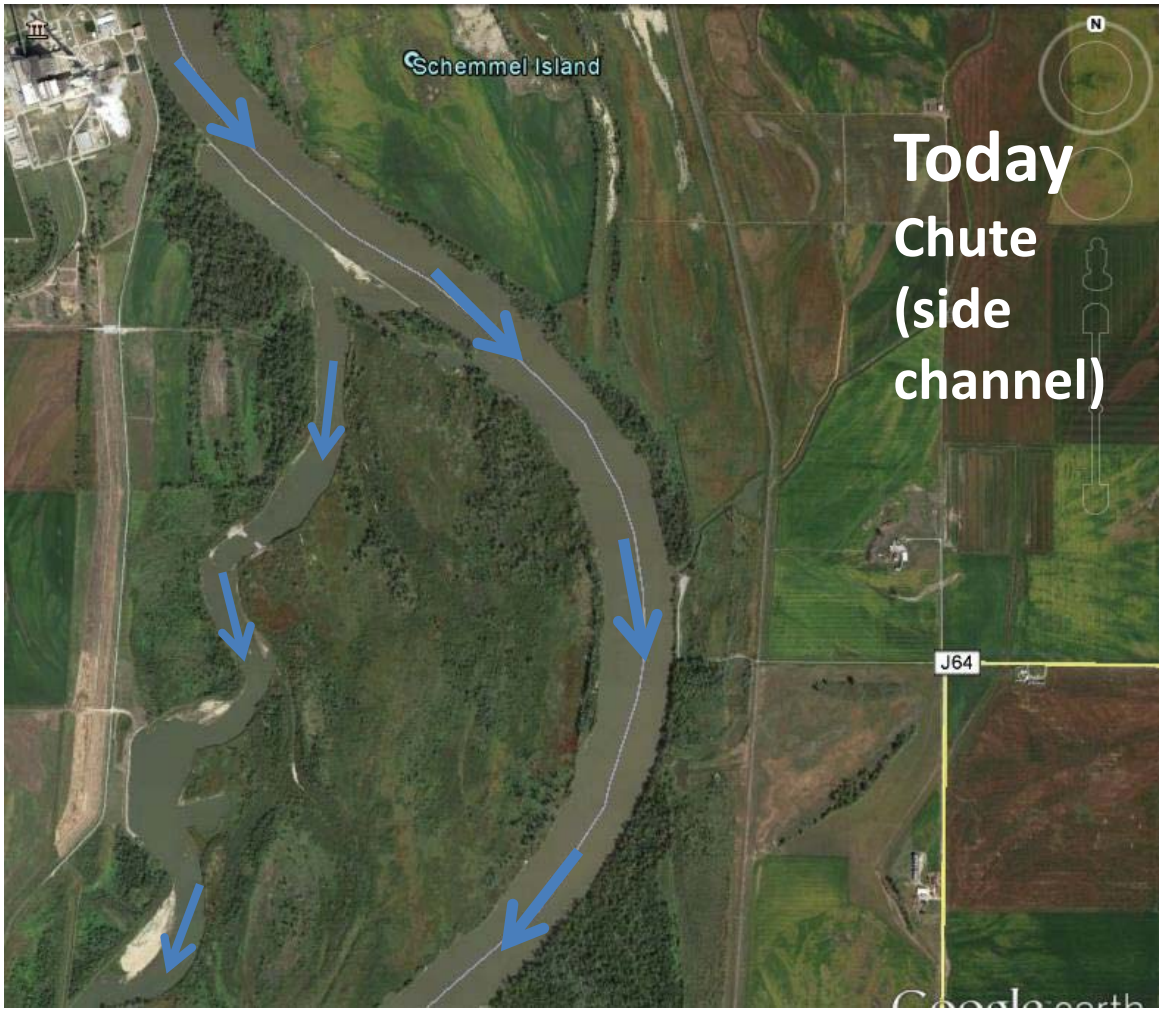
For the Pallid Sturgeon, science says survival from larvae to age 1 is the primary challenge. But <u>why</u> is less certain.

It seems most likely that loss of shallow water habitat for intercepting drifting larvae and providing protection and feeding areas is the weak link.

Rebuilding shallow water habitat is a major lower river emphasis.



Schemmel Island
1990s
Confined channel
J64


Schemmel Island
Today
Chute (side channel)
J64

Status, summer 2015:
Birds: Using river and weather models we can predict emergent sandbar creation with stream flows, then model bird response.

Balancing bird benefits with other river uses for flow modifications (high spring/fall flows to create sandbars, low summer flows to keep them emerged) is the current effort.

Q for Iowa: What flows are acceptable?

Status, summer 2015:
Sturgeon: More monitoring of shallow water habitat response is needed. Adaptive management will help us learn as we build.

Balancing fish benefits of shallow habitat with other effects of these river modifications (chutes, side channels, dike notching, channel widening) is the current effort.

Q for Iowa: How much land are we willing to dedicate to SWH, and with what side effects?

Status, summer 2015:
My challenge: MRRIC would like me to provide one perspective (vote) that represents all the interests of the people of Iowa (transportation, agriculture, power, recreation, water supply, fish/wildlife, economic development, local governments, etc.).

Q for Iowa: Can you provide me sufficient input to present one voice for all our interests?

Contact me with any input or questions:

Shawn Shouse
Iowa State University Extension & Outreach
53020 Hitchcock Avenue
Lewis, IA 51544
Office 712-769-2650
Cell 712-250-0135
Email sshouse@iastate.edu

Missouri River Basin Water Management

Water Management Update
SIMRA
June 18, 2015

Jody Farhat, P.E.
Chief, Missouri River Basin Water Management

US Army Corps of Engineers
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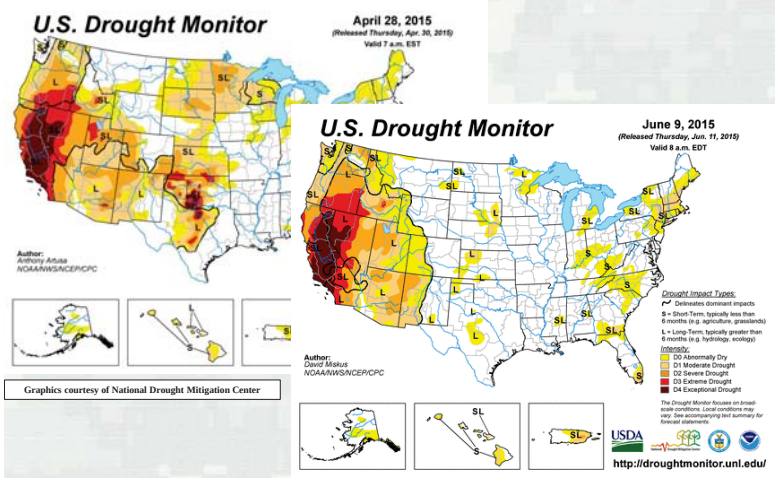
Missouri River Mainstem Reservoir System

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

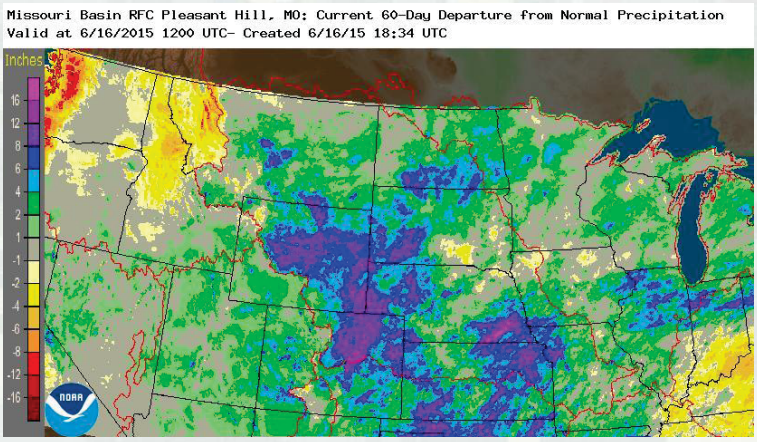
Bank Stabilization and Navigation Project
Sioux City, IA – St. Louis, MO

US Drought Monitor

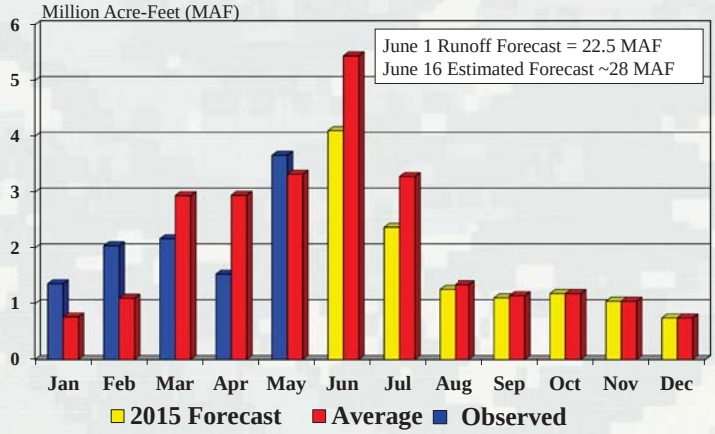


Graphics courtesy of National Drought Mitigation Center

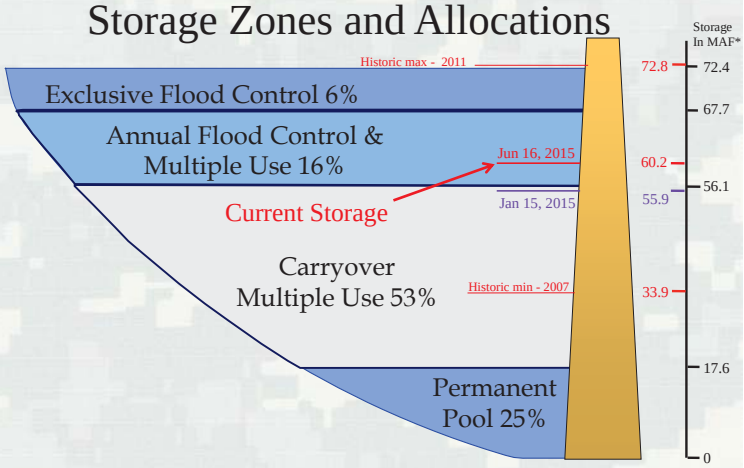
60-day Precipitation – Departure from Normal



Missouri River Runoff above Sioux City, Iowa 2015 Forecast



Missouri River Mainstem System Storage Zones and Allocations



2015 Reservoir Operations

- Flood Control
  - All 2014 flood water evacuated from reservoir system by early January
  - Currently utilizing 25 percent of flood control capacity of mainstem system
  - Releases are being adjusted to reduce downstream flood risk while maintaining ability to meet navigation targets and protect endangered species
  - Higher releases may be required in the fall to evacuate flood water if wet conditions persist
- Navigation
  - Full service flow support and a full length navigation season
- Hydropower
  - Annual generation forecast is 9.1 BkWh; long term average is 9.4 BkWh
- Recreation, Water Supply and Irrigation
  - Winter release of 17,000-20,000 cfs from Gavins Point
- Fish and Wildlife / Endangered Species
  - No spring pulses from Gavins Point Dam
  - Tern and plover operations ongoing

Questions?

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

Or Google “Corps Missouri River”

Omaha District Construction Activities and Habitat Design Update

June 2015

Colleen Horihan, P.E., CFM
Habitat Project Manager

US Army Corps of Engineers
BUILDING STRONG®

TOPICS

- 2014 Ongoing Construction Projects
- 2015 New Construction Projects
- 2015 Projects in Plan Formulation

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FY14 AWARDED CONSTRUCTION PROJECTS

- Hole-in-the-Rock and Middle Decatur ($972,147)
- Little Sioux Chute ($3,796,880)
- Louisville Backwater ($693,500)
- River Structure Modifications ($797,480)

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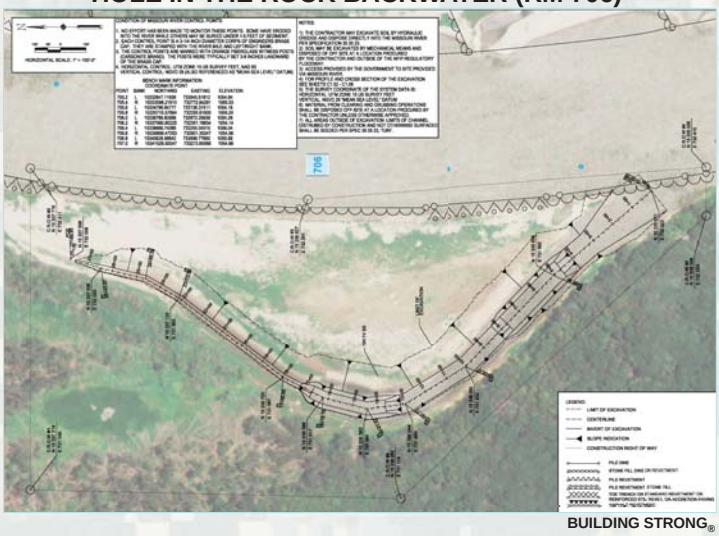
HOLE IN THE ROCK BACKWATER (RM 706)



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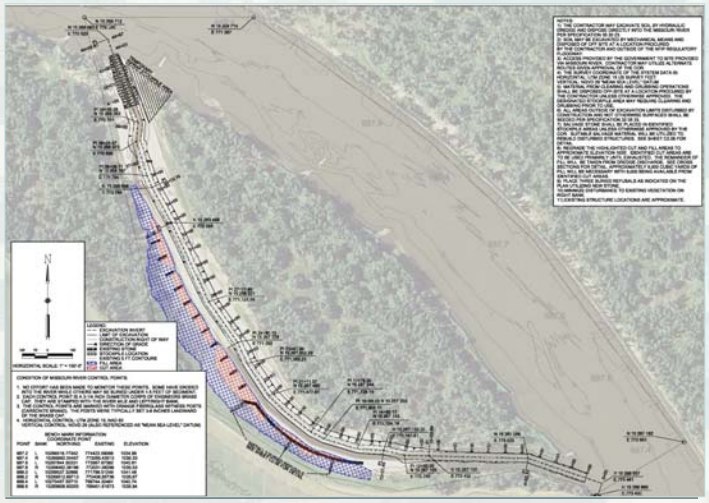
HOLE IN THE ROCK BACKWATER (RM 706)

BUILDING STRONG®

MIDDLE DECATUR CHUTE (RM 688)



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MIDDLE DECATUR CHUTE (RM 688)

PHOTO BY DAVE CRANE
OCTOBER 2014

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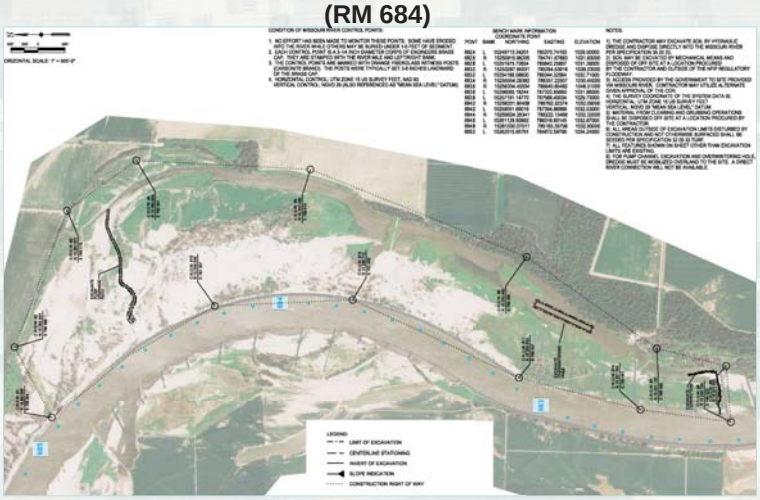
LOUISVILLE BACKWATER AND PUMP CHANNEL CLEANOUT (RM 684)



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LOUISVILLE CONSTRUCTION (RM 684)

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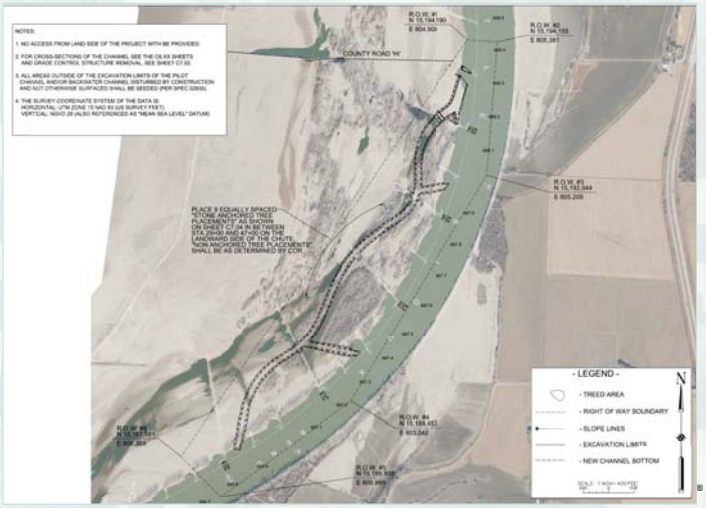
LITTLE SIOUX CHUTE (RM 668)



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RIVER STRUCTURE MODIFICATIONS

- Modifications to BSNP structures for habitat benefit purposes
- Sarpy and Cass Counties-NE
- Fremont and Mills Counties-IA
- Dike degradation, upgrading, and extension

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FY15 CONSTRUCTION

- Construction Contract Awarded April 2015 for Middle Decatur Top Width Widening for $1,747,090-RM 688.5
- Proposed FY15 Adaptive Management at Sandy Point-RM 657

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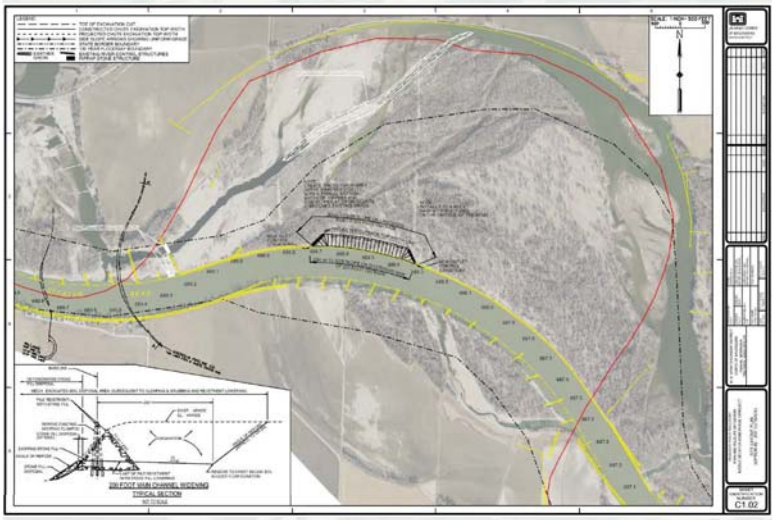
MIDDLE DECATUR TOP WIDTH WIDENING (RM 688.5)



SANDY POINT (RM 657)

FY15 PLAN FORMULATION

- Plattsmouth-RM 593 (Adaptive Management on Existing Chute)
- Langdon Bend-RM 530 (Top Width Widening)
- Copeland Bend-RM 563 (Top Width Widening)
- Middle Decatur Backwater Structure-RM 687

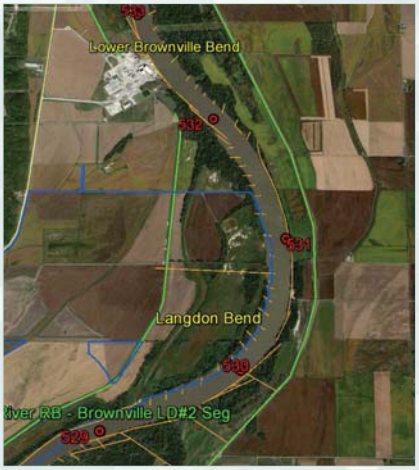
PLATTSMOUTH BEND CHUTE

- Original design noted a likely periodic need for maintenance with sediment removal
  - ► Major Depositional Events in 2010 & 2011

PLATTSMOUTH – OCT 2012

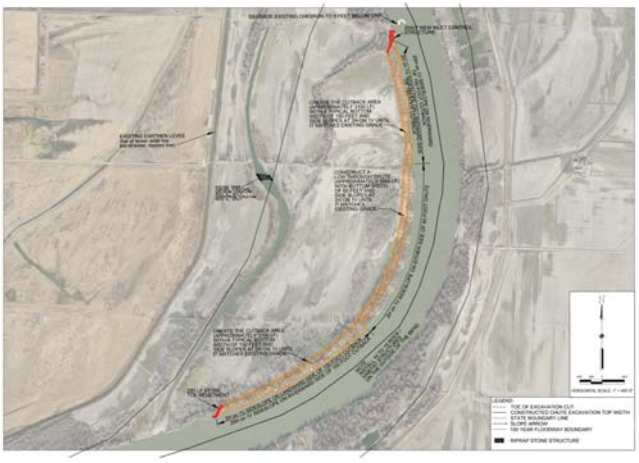
PLATTSMOUTH – OCT 2012

LANGDON BEND (RM 530)



BUILDING STRONG®

LANGDON BEND-RM 530



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COPELAND BEND (RM 563)

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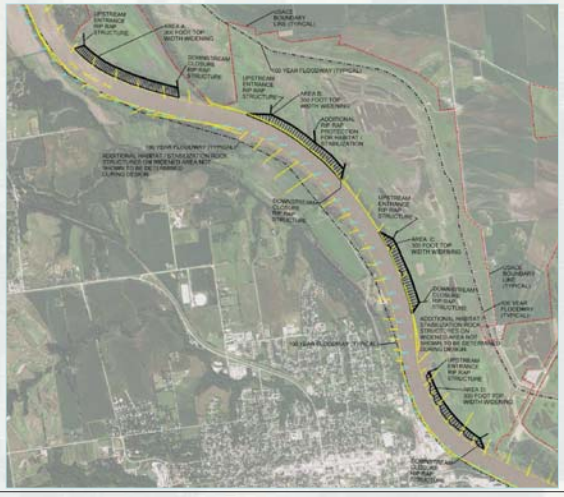
COPELAND BEND-RM 563



BUILDING STRONG®

MIDDLE DECATUR BACKWATER STRUCTURE-RM 687

The Effects of Missouri River Mainstem Reservoir System Operations on 2011 Flooding Using a Precipitation-Runoff Modeling System Model

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Roland Viger

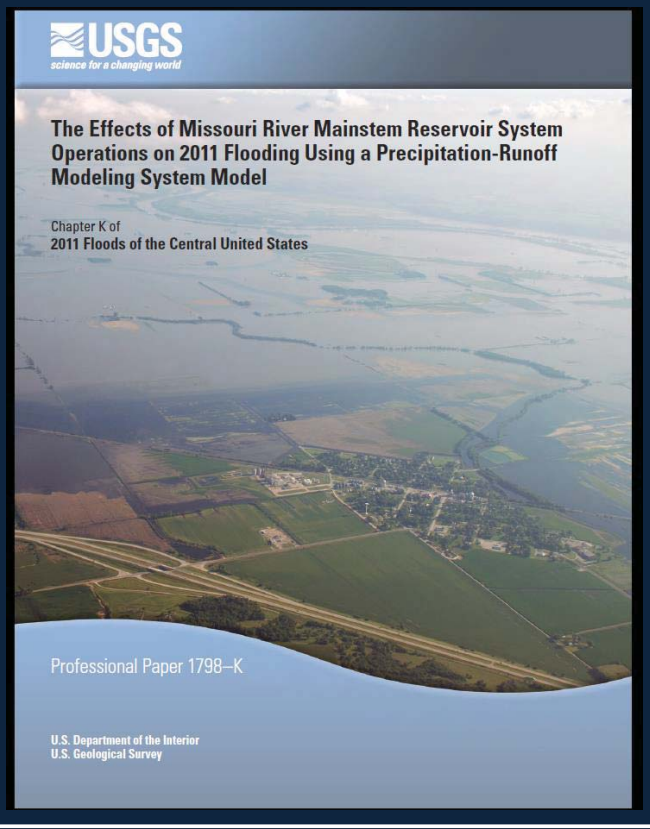
Iowa Water Science Center
National Research Program

U.S. Department of the Interior
U.S. Geological Survey

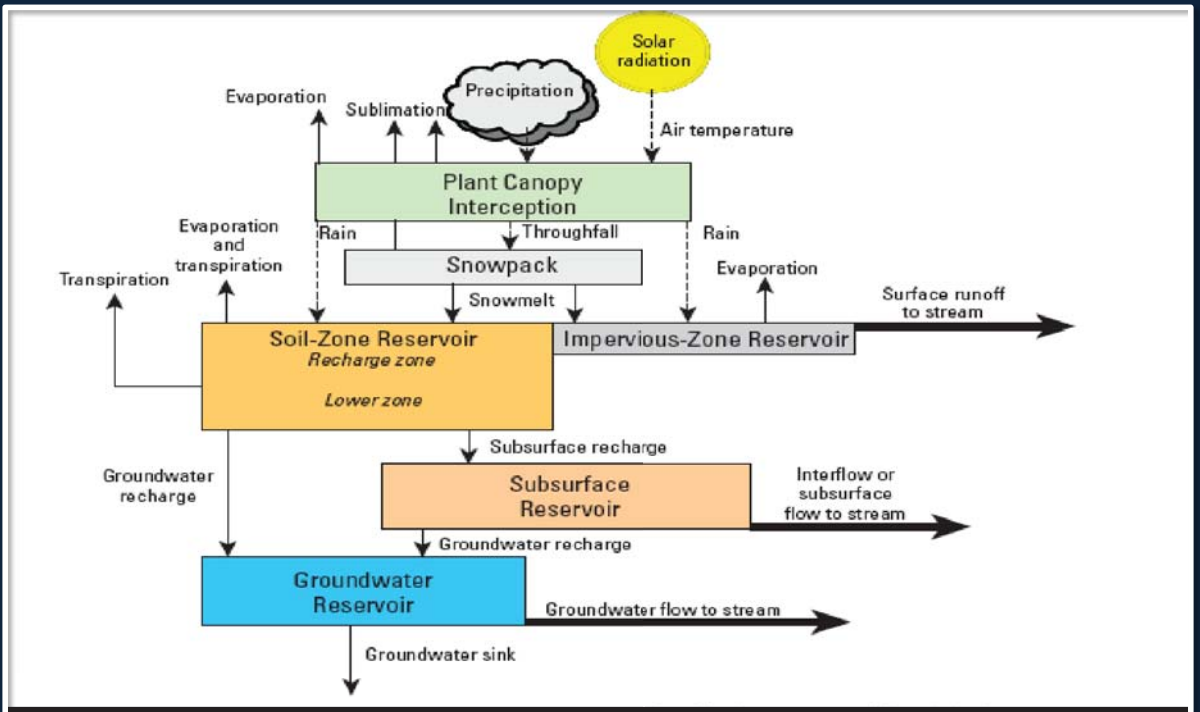
Introduction

**Chapter K of
2011 Floods of the
Central United States**

http://pubs.usgs.gov/pp/1798k/

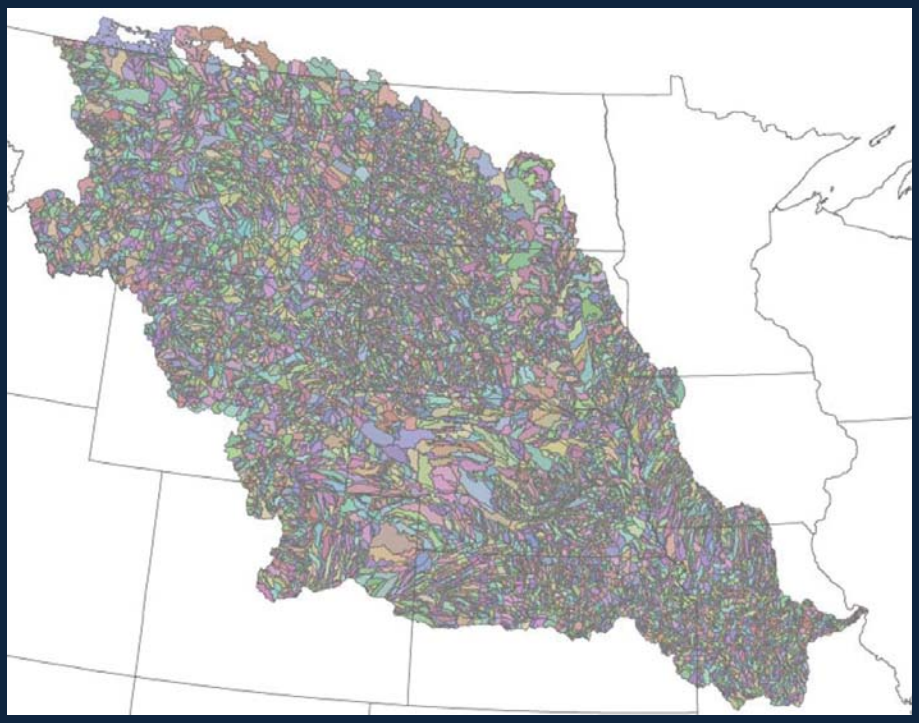


PRMS



PRMS Conceptualization of Basin Components

Missouri River PRMS Framework



National Hydrological Model "Geospatial Fabric"

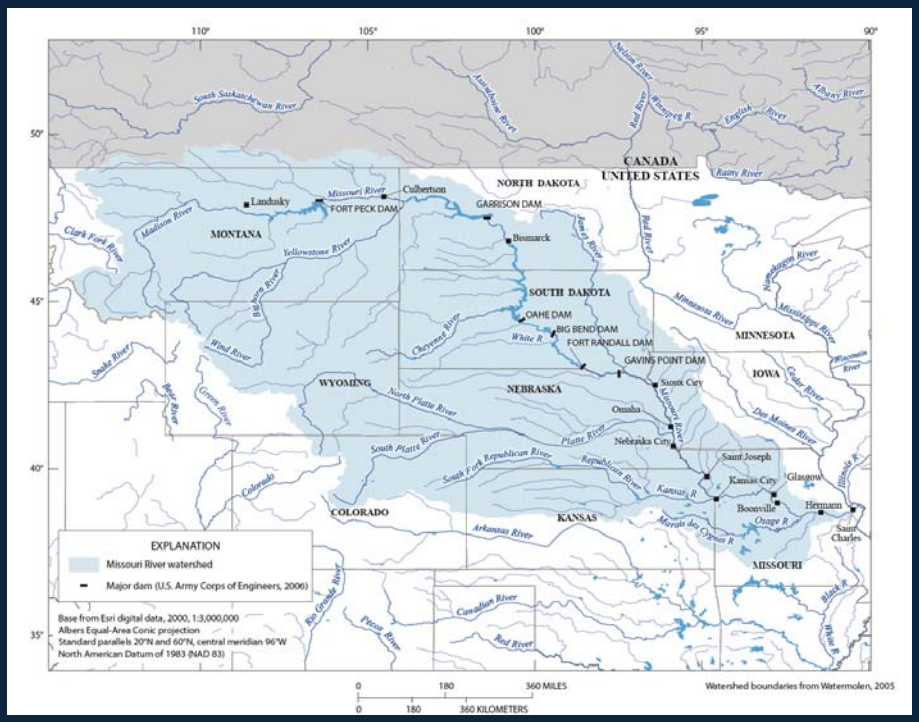
18,840 HRUs and 9,454 segments

Uses NHD Plus catchments and stream segments

Parameters determined from geodatabase containing various landscape datasets (SSRUGO, STATSGO, NLCD, and others.)

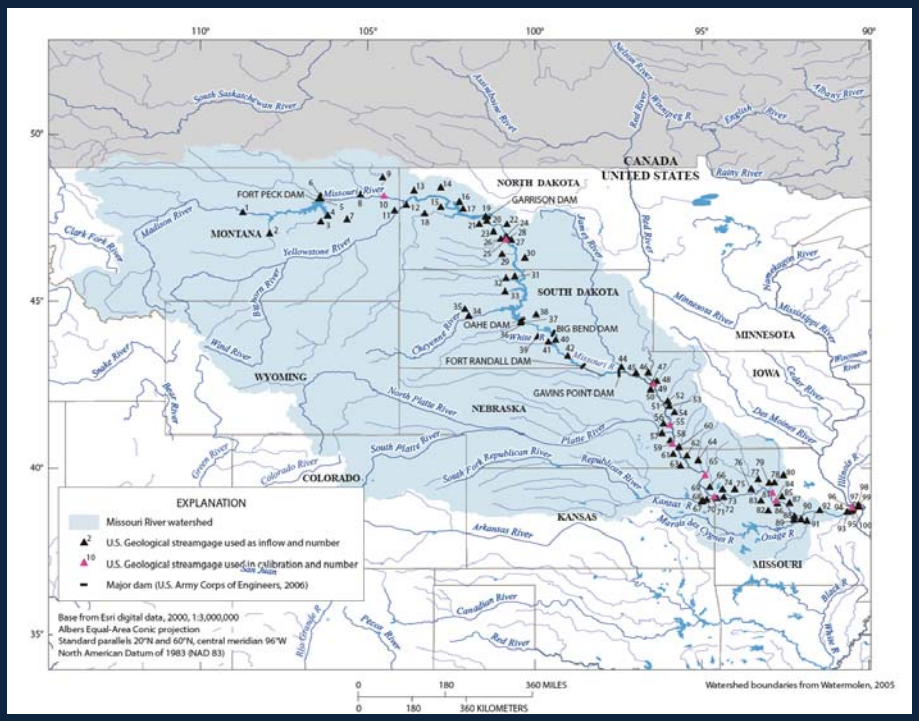
Climate input data: Daymet Data (Daily Tmin, Tmax, Precip)

Subbasin Models



Basin was divided into 16 subbasin models at Dams and USGS Missouri River Streamflow gages.

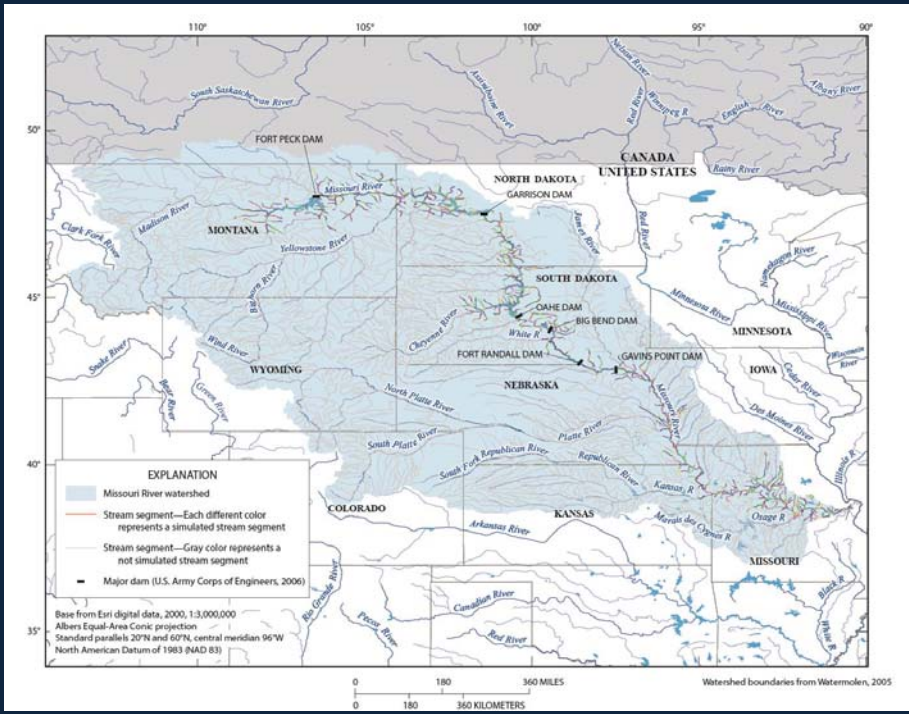
Subbasin Model Gages



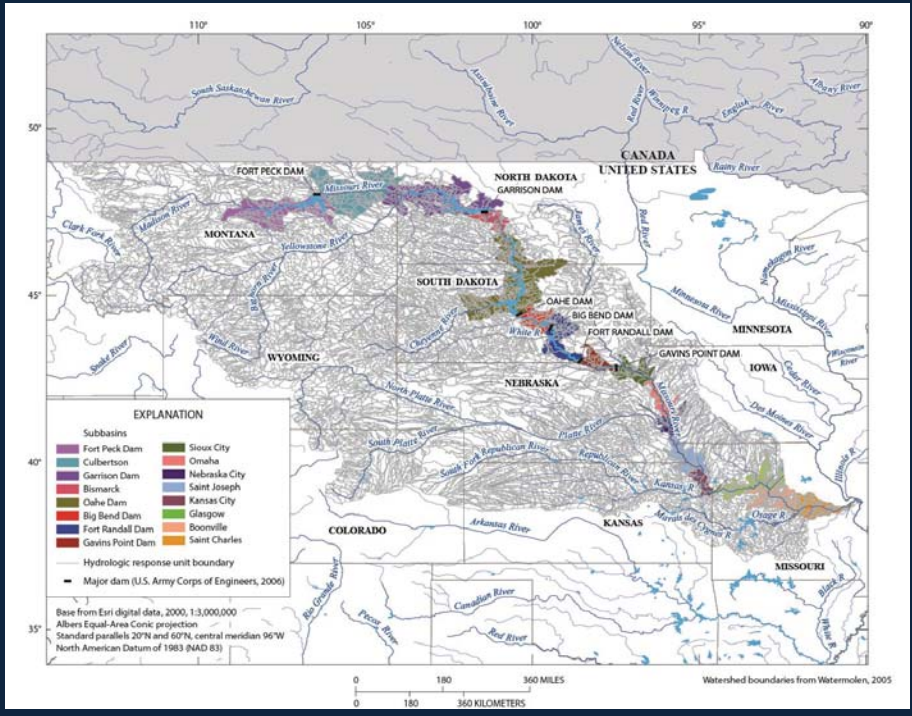
Basin was divided into 16 subbasin models at Dams and USGS Missouri River Streamflow gages.

Subbasin models were calibrated using measured daily streamflow data from:
1) outlet gage
2) upstream inflow gage
3) tributary inflow gages

Subbasin Model Stream Segments



Subbasin Model HRUs



Calibration Statistics: Summary

Statistic	WY	October	November	December	January	Feburary	March	April	May	June	July	August	September
Water Year and Monthly Statistics													
06342500 Missouri River at Bismarck, North Dakota													
PBIAS	1.20	3.80	2.40	2.40	6.30	6.60	-2.30	-8.60	5.20	2.40	0.500	-1.80	-1.10
RSR	0.0653	0.949	0.218	0.456	0.774	6.77	0.820	0.654	0.178	0.316	0.257	0.208	0.114
NSE	0.996	0.0691	0.951	0.785	0.382	-46.5	0.305	0.558	0.967	0.896	0.932	0.956	0.987
R^2	0.996	0.824	0.991	0.868	0.999	0.728	0.327	0.881	0.986	0.965	0.939	0.980	0.992
06486000 Missouri River at Sioux City, Iowa													
PBIAS	0.100	0.500	-0.400	2.80	6.10	9.00	1.90	-0.400	1.10	-3.00	1.00	-1.80	-0.100
RSR	0.0522	0.221	0.205	0.190	1.40	0.668	0.142	0.153	0.218	0.227	0.730	0.184	0.0996
NSE	0.997	0.949	0.957	0.963	-1.02	0.538	0.979	0.976	0.951	0.947	0.450	0.965	0.990
R^2	0.998	0.981	0.960	0.973	0.457	0.791	0.992	0.981	0.974	0.985	0.687	0.988	0.991
06610000 Missouri River at Omaha, Nebraska													
PBIAS	-0.100	-3.10	-2.60	-2.40	4.60	-1.30	4.90	-3.30	-3.60	-0.400	0.300	2.80	1.30
RSR	0.0753	0.498	0.666	0.251	1.94	0.544	0.284	0.508	0.526	0.129	0.715	0.344	0.235
NSE	0.994	0.744	0.541	0.935	-2.91	0.693	0.917	0.733	0.714	0.983	0.471	0.877	0.943
R^2	0.994	0.937	0.848	0.952	0.115	0.745	0.958	0.791	0.887	0.984	0.490	0.957	0.965
06807000 Missouri River at Nebraska City, Nebraska													
PBIAS	-1.90	-1.70	-0.800	-2.70	-8.40	-0.100	-2.30	-0.900	-1.50	-3.80	-1.60	-1.00	-1.60
RSR	0.0892	0.168	0.267	0.142	3.37	0.129	0.114	0.111	0.323	0.285	1.68	0.246	0.185
NSE	0.992	0.971	0.927	0.979	-10.7	0.983	0.987	0.987	0.892	0.916	-1.93	0.938	0.965
R^2	0.994	0.992	0.956	0.993	0.142	0.985	0.995	0.992	0.956	0.971	0.00	0.948	0.989
06818000 Missouri River at St. Joseph, Missouri													
PBIAS	2.20	0.700	2.30	1.60	9.70	6.20	3.80	1.40	2.00	-4.90	6.50	0.400	3.20
RSR	0.151	0.284	0.604	0.352	3.78	0.519	0.367	0.464	0.486	0.445	1.15	0.401	0.306
NSE	0.977	0.917	0.623	0.872	-13.7	0.721	0.861	0.778	0.756	0.796	-0.366	0.834	0.903
R^2	0.979	0.964	0.794	0.905	0.502	0.765	0.910	0.790	0.792	0.837	0.382	0.865	0.972
06893000 Missouri River at Kansas City, Missouri													
PBIAS	-2.20	-1.80	-0.600	-2.60	-4.50	-1.70	2.30	-2.20	-0.500	-3.90	-6.00	-1.60	1.30
RSR	0.120	0.185	0.235	0.188	1.48	0.190	0.195	0.233	0.282	0.893	1.50	0.359	0.164
NSE	0.986	0.965	0.943	0.964	-1.26	0.963	0.961	0.944	0.918	0.175	-1.34	0.867	0.972
R^2	0.991	0.997	0.953	0.986	0.633	0.964	0.992	0.978	0.920	0.907	0.944	0.982	0.988
06906500 Missouri River at Glasgow, Missouri													
PBIAS	0.00	2.20	-2.60	-1.50	-1.70	2.80	3.50	2.20	1.70	-0.800	-3.00	0.500	-0.400
RSR	0.0895	0.203	0.446	0.127	0.571	0.250	0.413	0.278	0.256	0.249	0.675	0.303	0.101
NSE	0.992	0.958	0.794	0.983	0.663	0.935	0.823	0.920	0.933	0.936	0.529	0.905	0.990
R^2	0.992	0.992	0.911	0.991	0.948	0.940	0.883	0.933	0.940	0.942	0.972	0.959	0.991
06909000 Missouri River at Booneville, Missouri													
PBIAS	0.800	1.60	1.40	1.20	0.900	-0.100	-1.20	1.90	0.200	1.40	1.00	-0.200	1.90
RSR	0.0487	0.145	0.208	0.0906	0.309	0.0759	0.234	0.185	0.110	0.177	0.221	0.130	0.172
NSE	0.998	0.978	0.955	0.992	0.901	0.994	0.943	0.965	0.987	0.968	0.950	0.983	0.969
R^2	0.998	0.992	0.988	0.996	0.959	0.994	0.972	0.975	0.988	0.982	0.989	0.986	0.999
06935965 Missouri River at St. Charles, Missouri													
PBIAS	0.300	0.900	-2.00	-0.600	-0.400	4.90	1.50	-0.600	-0.900	-0.200	1.00	0.600	-0.500
RSR	0.0697	0.119	0.801	0.108	0.549	0.146	0.244	0.0758	0.151	0.297	0.221	0.448	0.174
NSE	0.995	0.985	0.336	0.988	0.688	0.978	0.939	0.994	0.976	0.909	0.950	0.792	0.969
R^2	0.995	0.988	0.741	0.989	0.892	0.988	0.949	0.995	0.982	0.912	0.972	0.823	0.977

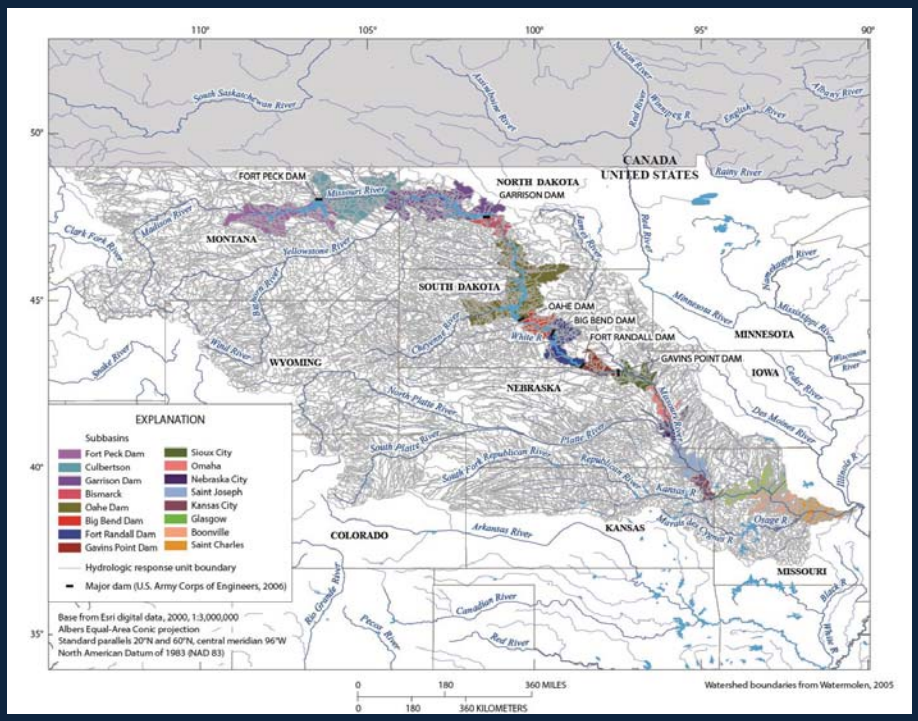
Based on statistical results, the Missouri River model is a good fit for annual stream flow estimation at all locations.

Some monthly statistics show unsatisfactory ratings, in particular, the months of January and July

Model was calibrated to Summer peak flows.

Model cannot simulate overbank storage.

Model Simulated flow w/o Dams



Subbasin simulation with dams removed completed in a step-wise process from headwater to mouth…

replacing measured streamflow at inflow locations on the mainstem with simulated output from the upstream subbasin model.

Tributary inflows unchanged.

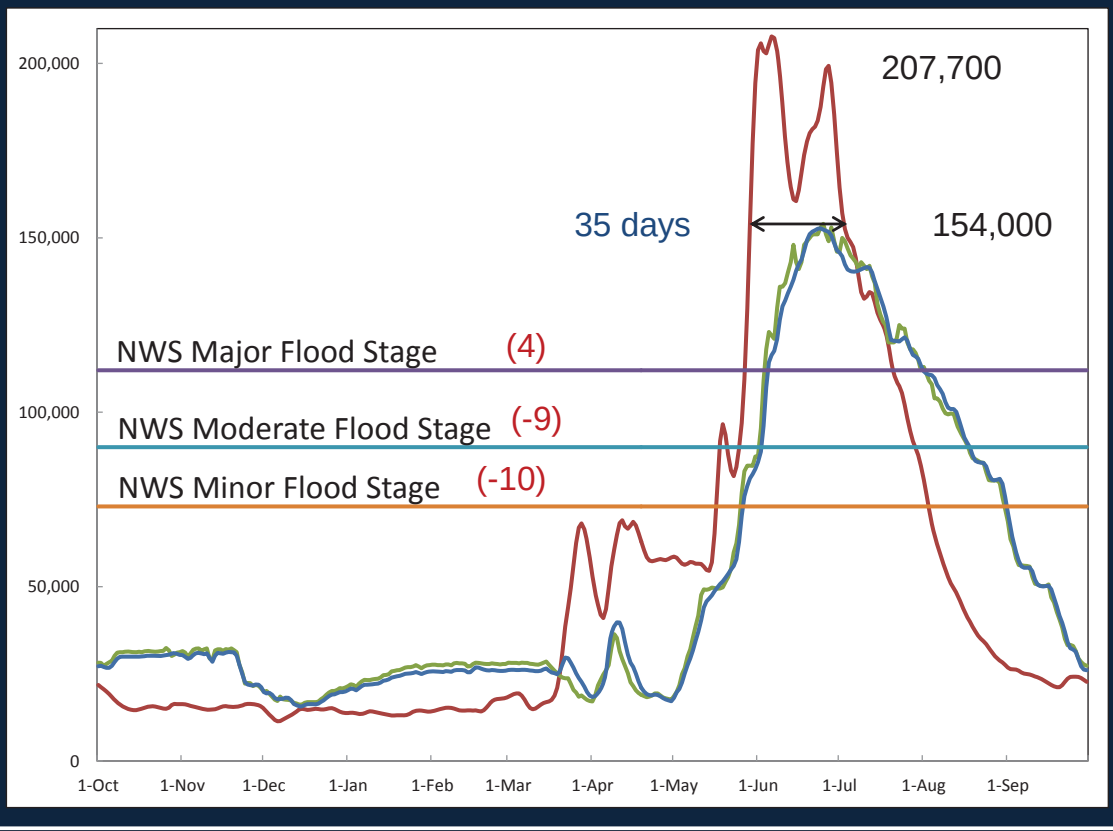
Metrics for Comparison

1) Maximum daily mean discharge values, measured and simulated

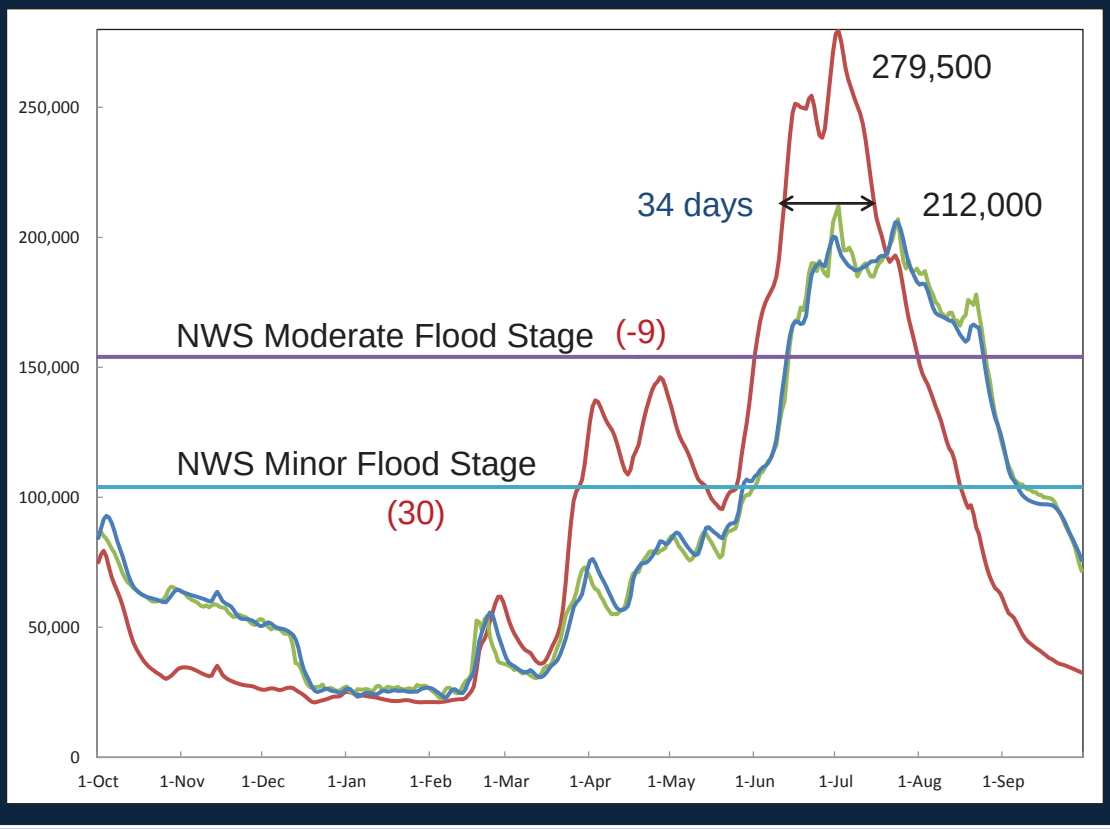
2) Number of days simulated flow exceeded peak measured flow

3) Difference (measured and simulated) in the number of days above NWS flood stage
X-ref'd 2011 stage records with discharge

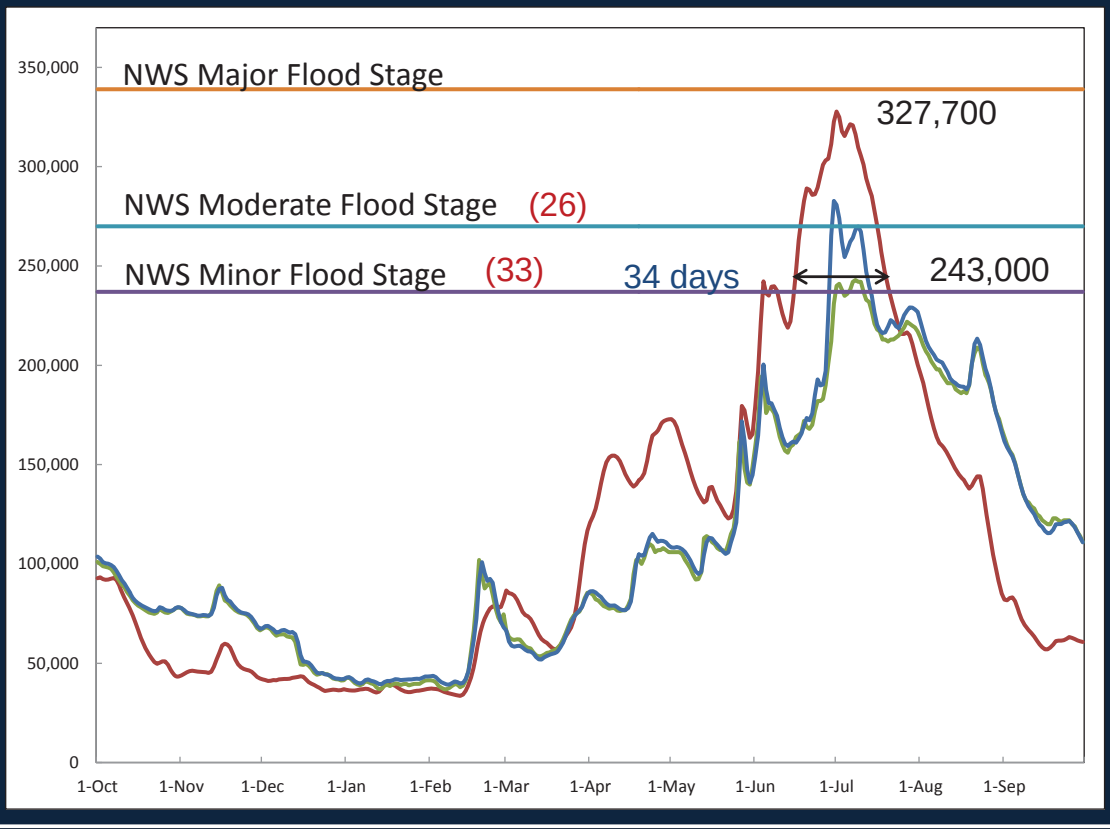
Missouri River Hydrograph @ Bismarck, ND



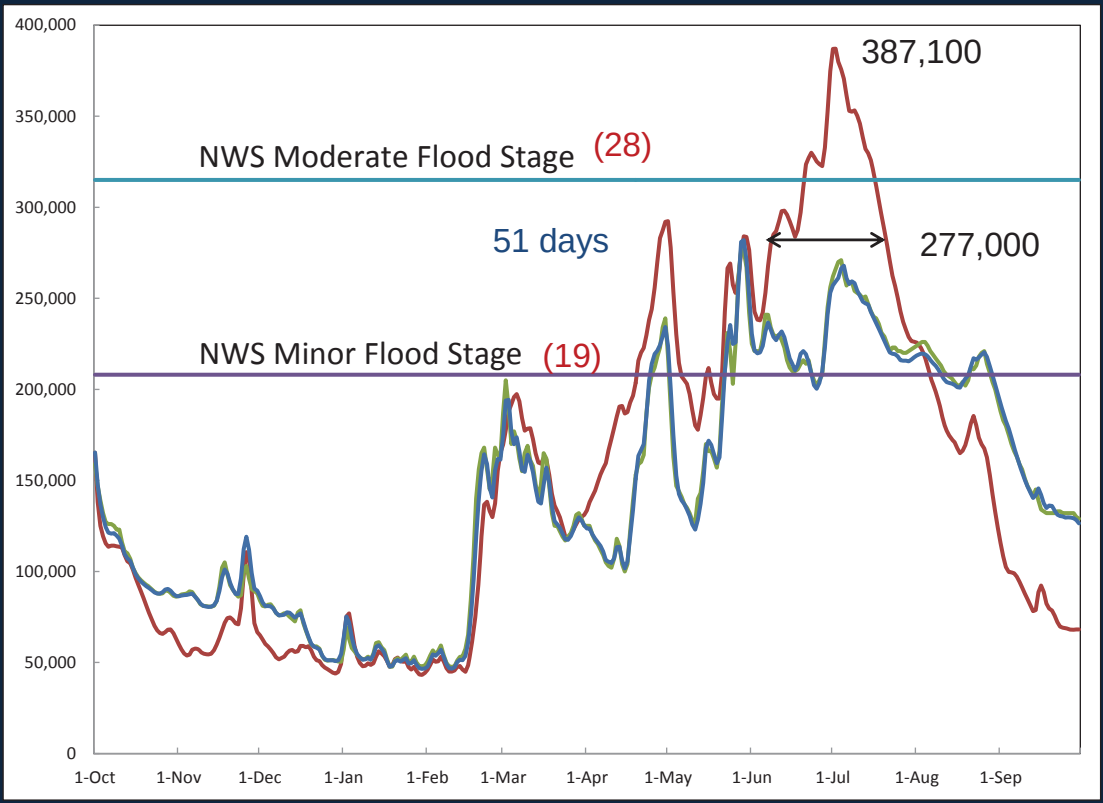
Missouri River @ Omaha, NE



Missouri River @ Kansas City

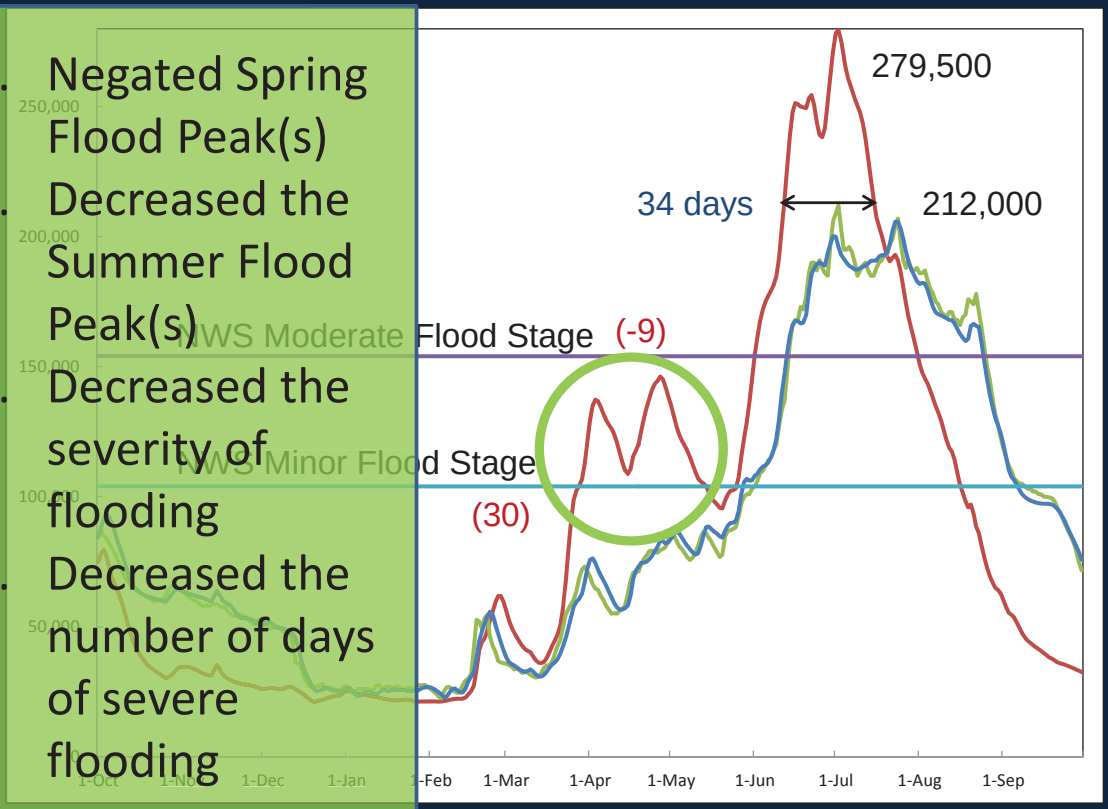


Missouri River @ St. Charles



Summary Results

1. Negated Spring Flood Peak(s)
2. Decreased the Summer Flood Peak(s)
3. Decreased the severity of flooding
4. Decreased the number of days of severe flooding



Future Work

Calibration of Tributary streams

Coupling PRMS with HEC-RAS models

Driving coupled model with future climate model results/ senarios

USGS

Thanks and Questions

Thanks to the MOWS group for their help in tackling a model of this scale.

Lauren Hay

Steve Regan

Steve Markstrom

Roland Viger

USGS