Mouse River Enhanced Flood Protection Project

Rural Alternatives Flood Risk Reduction Assessment

January 29, 2013

BARR

ACKERMAN-ESTVOLD
engineering and management consulting, inc.

ACKERMAN SURVEYING & ASSOCIATES, INC.

CPS

moore engineering, inc.

Purpose and Outline of Today's Presentation

- **Purpose**
  - A working meeting to provide status updates, interactive dialogue, and coordination of Rural Area efforts associated with the Mouse River Enhanced Flood Protection Project
- **Outline**
  - Overall project scope for the Mouse River Enhanced Flood Protection Project
  - Preliminary Engineering Phase
    - Part 1 : Burlington through Velva
    - Part 2: Rural Areas
  - Rural Areas Assessment
    - Discuss the primary objectives of this phase
    - Briefly describe the alternatives to be evaluated

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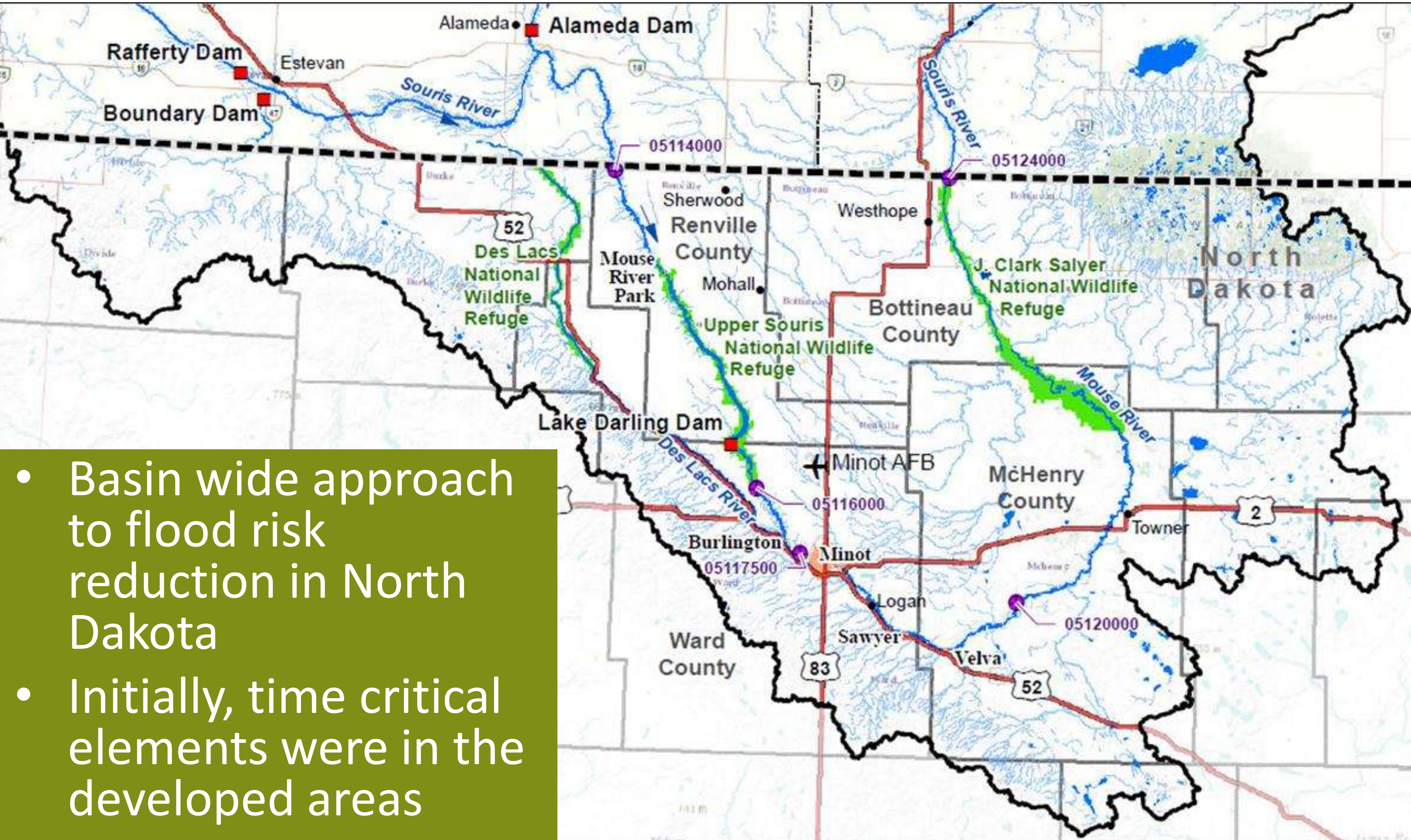
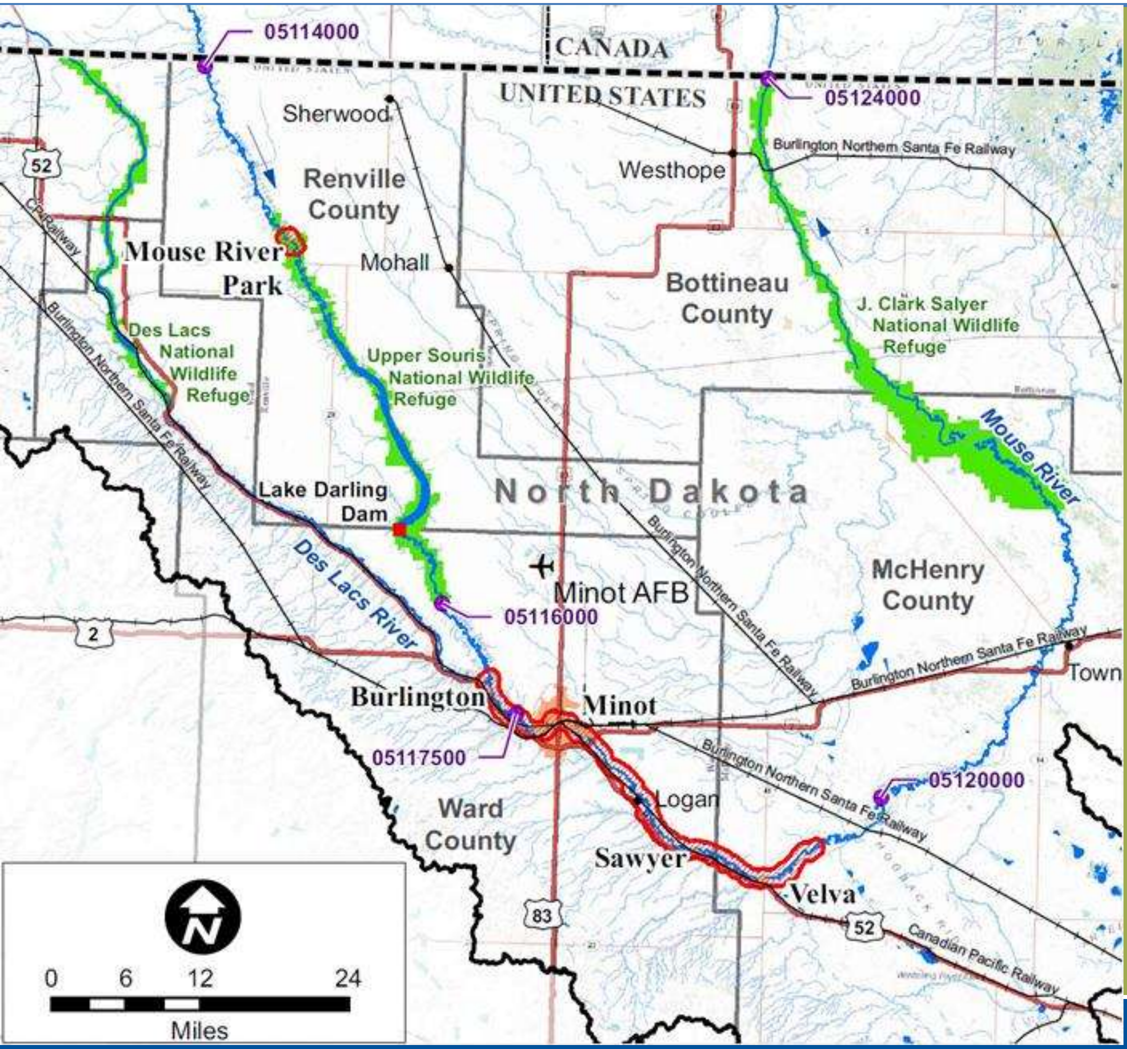
Overall Mouse River Enhanced Flood Protection Project Scope



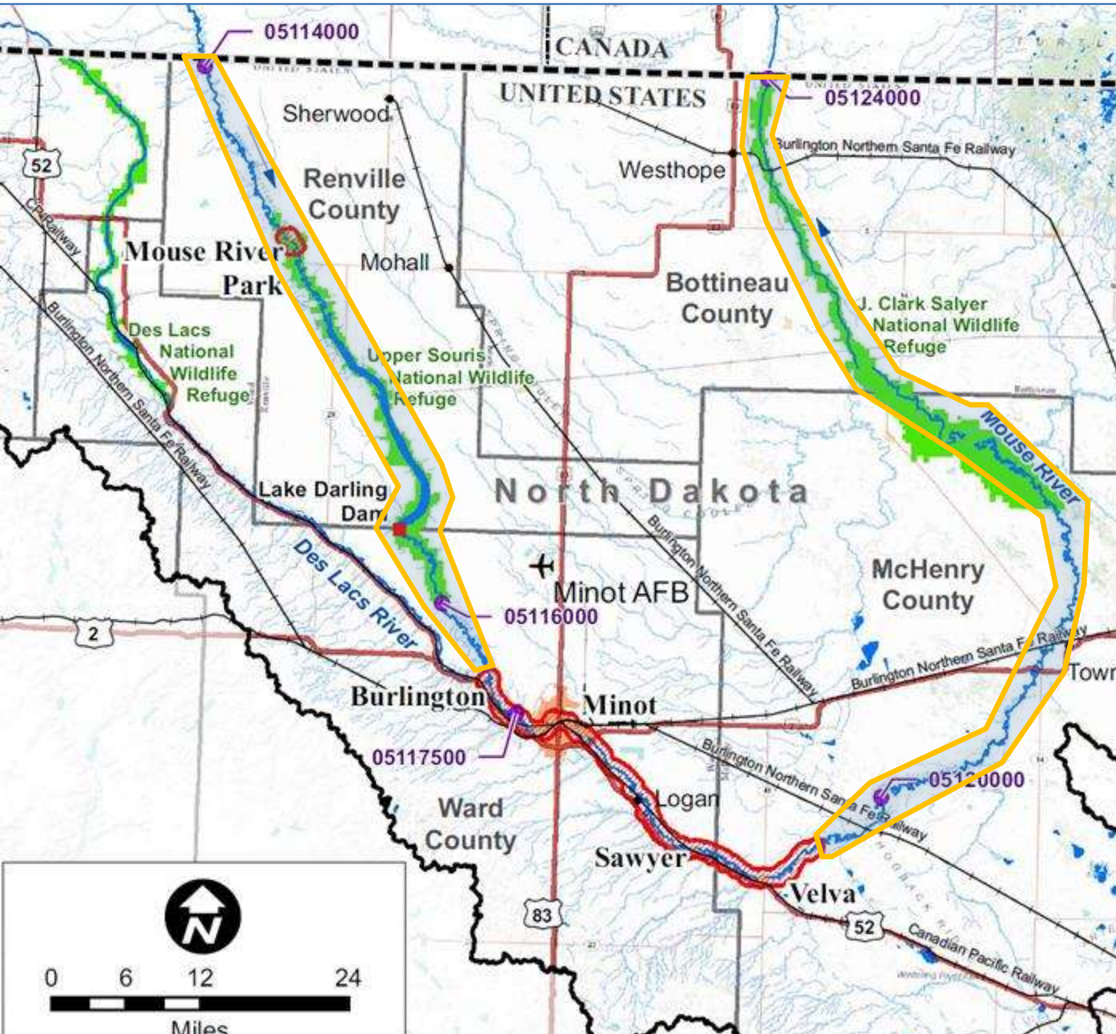
- Basin wide approach to flood risk reduction in North Dakota
- Initially, time critical elements were in the developed areas

Initial Preliminary Engineering Report (PER) Finalized in February 2012



- Phase 1: Preliminary Engineering
  - Part 1 : Burlington to Velva
  - Part 2 : Rural Areas
- Phase 2: Design
- Phase 3: Implementation

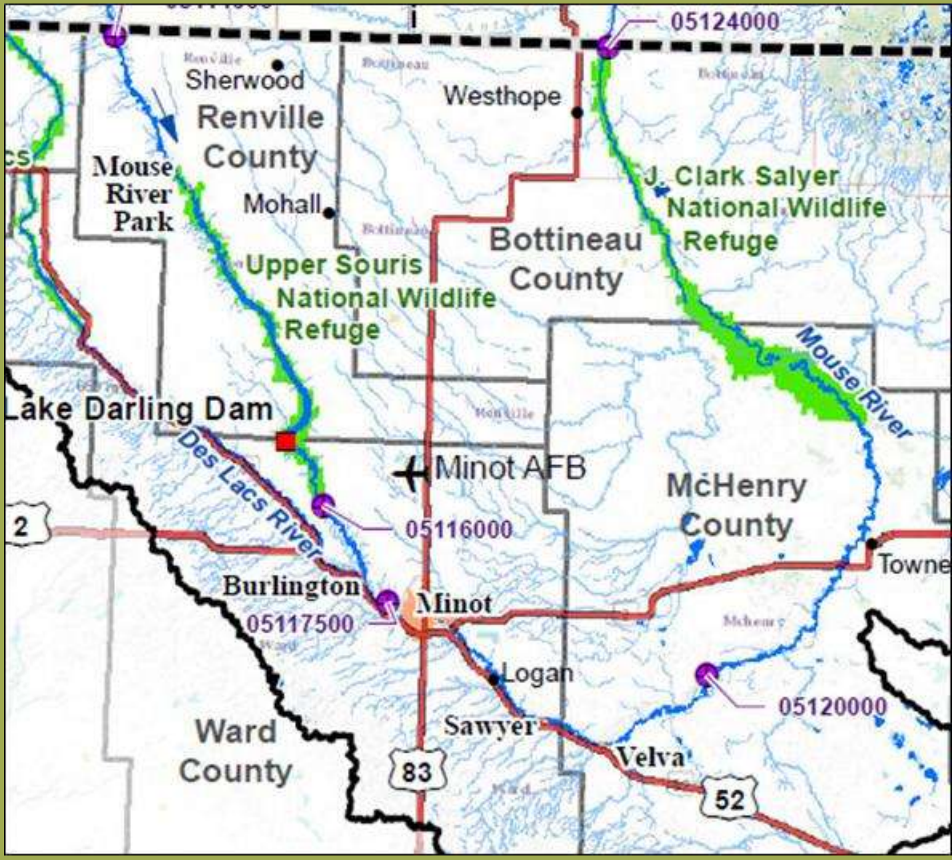
Early/Mid 2012 the Engineering Team Shifted Focus to Rural Areas



- Phase 1: Preliminary Engineering
  - Part 1 : Burlington to Velva
  - Part 2 : Rural Areas
- Phase 2: Design
- Phase 3: Implementation

Rural Reaches Workshop (Feb. 16, 2012) Used to Identify Primary Concerns

- Identify issues for flow rate ranges
  - 500 cfs, 1,500, 3,000, 5,000, >7,000
- Timing of dam releases
- Infrastructure issues
- Perceived impacts of wildlife refuges
- County-specific issues
  - Renville Co: Transportation
  - Ward Co.: Rural Subdivisions
  - McHenry Co.: Cropland and Hayland flooding & Sedimentation
  - Bottineau Co.: Conveyance



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Target Flows – Feb. 16, 2012 Rural Reaches Workshop

Agricultural Impacts

Flow Classification	Velva Area (cfs)	Towner Area (cfs)
Bankfull	1,500	500
Problematic	3,000	3,000
Catastrophic	10,000	10,000

Infrastructure Impacts

Flows (cfs)	Degree of Severity
2,000 to 5,000	Manageable and relatively minor
5,000 to 7,000	Major
7,000 and up	Catastrophic

Target Flows at the Verendrye Gage

Date	Target Flow (or less)
May 1	1,500
May 30 through November 1	500

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Evaluate 12 Potential Flood Risk Reduction Alternatives in Rural Areas

Alternative	
0a –No Action – Existing Conditions	6-Boundary diversion
0b-PER Project In Place (Baseline for Comparisons)	7-Improve channelization downstream of Velva
1-Advanced discharge from Lake Darling	8-Bridge Modifications
2-Increased target discharge at Minot	9-Modify JCS refuge operations
3-Nonstructural flood storage increase in Lake Darling	10-Modify JCS refuge hydraulic structures
4-Structural flood storage increase In Lake Darling	11-Remove trapped floodwater after the flood recedes
5-Ring Dikes	12-Flood storage on tributaries to the Mouse River

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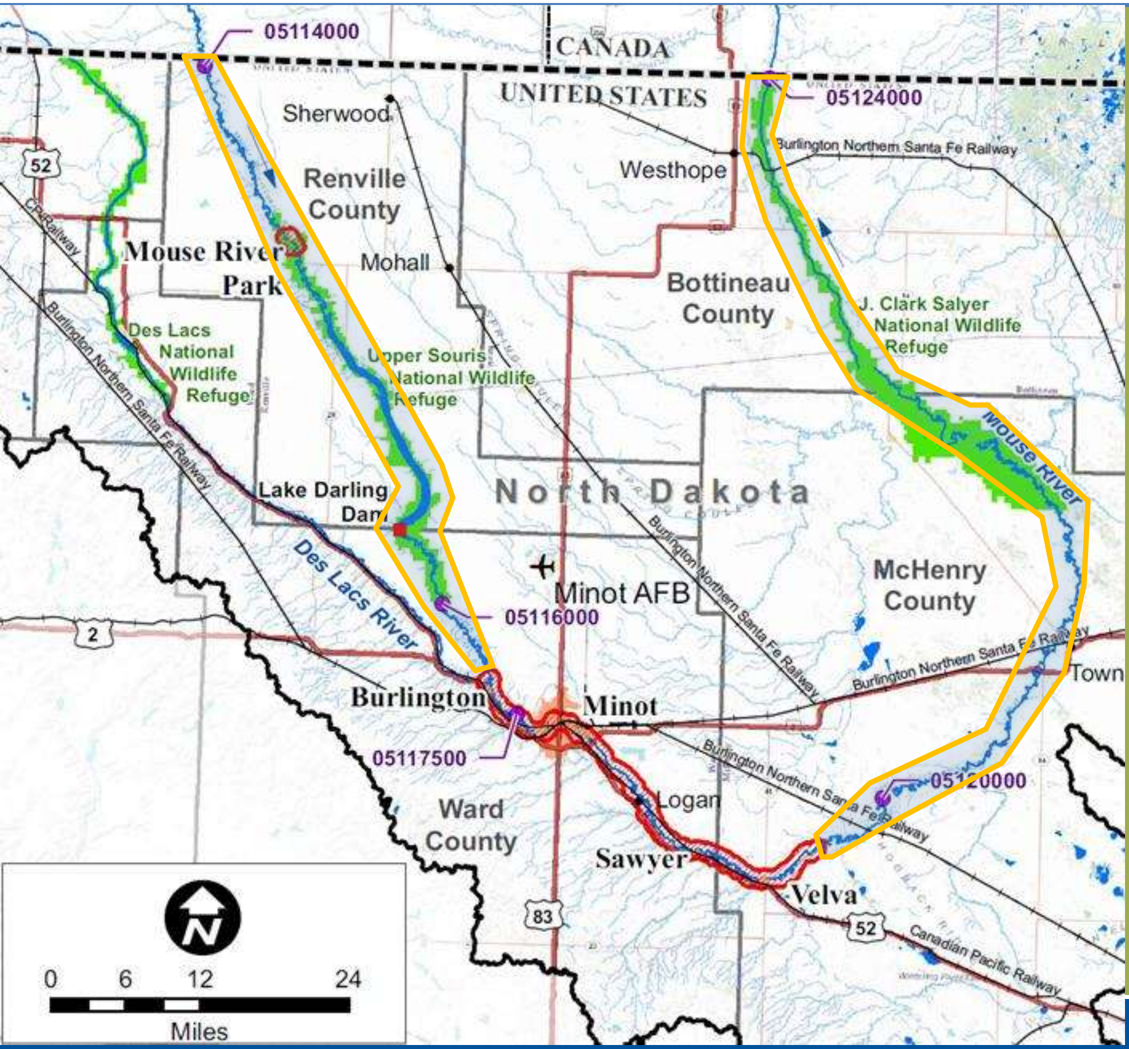
Mid-2012 NDSWC Authorized Rural Reaches Scope



- Evaluation of Alternatives to Reduce Flooding Impacts in Rural Areas
- Hydrologic and Hydraulic Modeling of Mouse River in ND
- Desktop Evaluation of Erosion and Sedimentation
- On-going meetings and coordination

Approach to the Alternatives Evaluation:

- **Need to obtain answers for three primary questions:**
  1. Is the alternative effective at reducing the risk of flood impacts? (impacts to agriculture and/or infrastructure)
  2. Are there potential impacts to key resources or concerns if the alternative is implemented or constructed?
  3. What is the relative cost of the alternative, as compared to the other alternatives?

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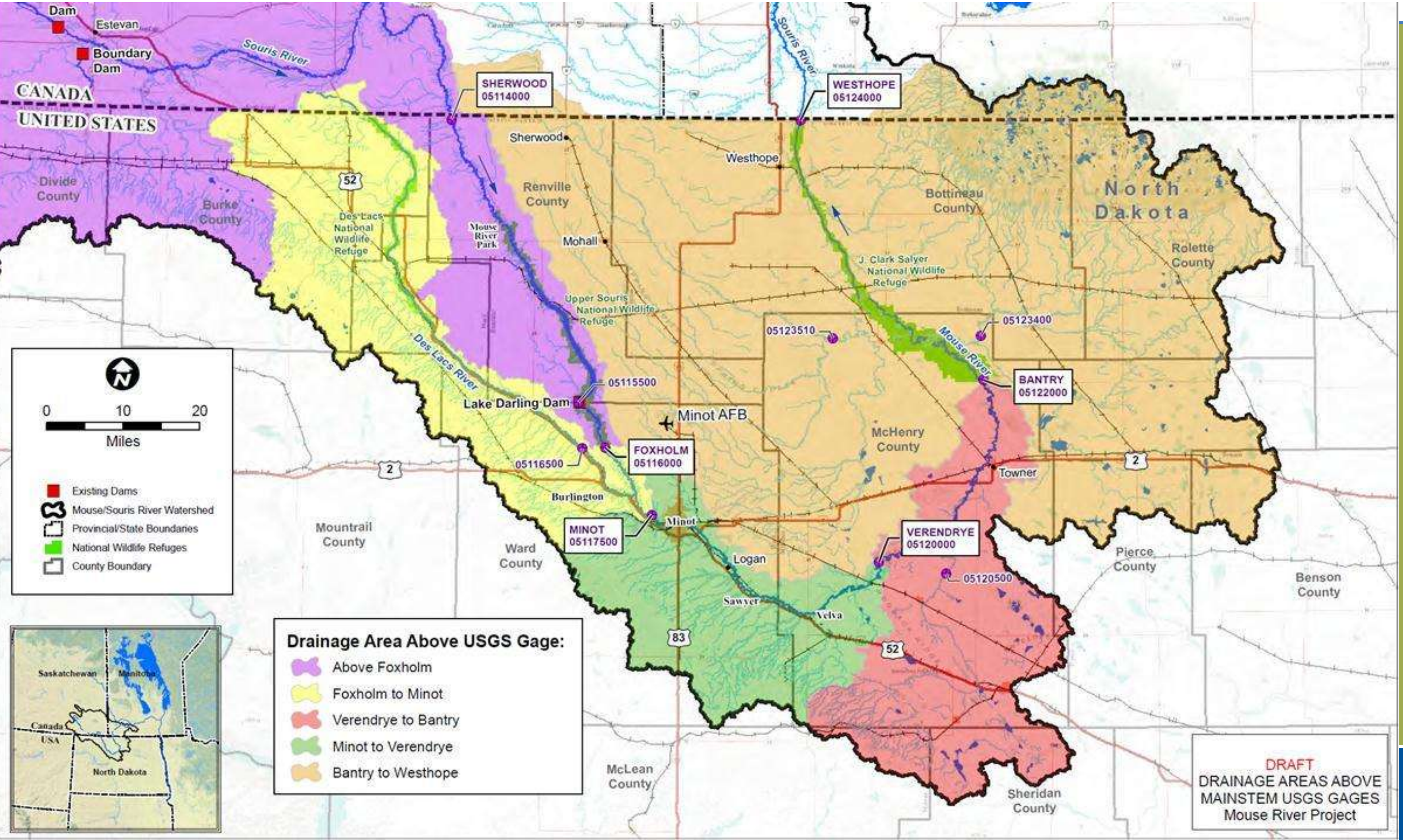
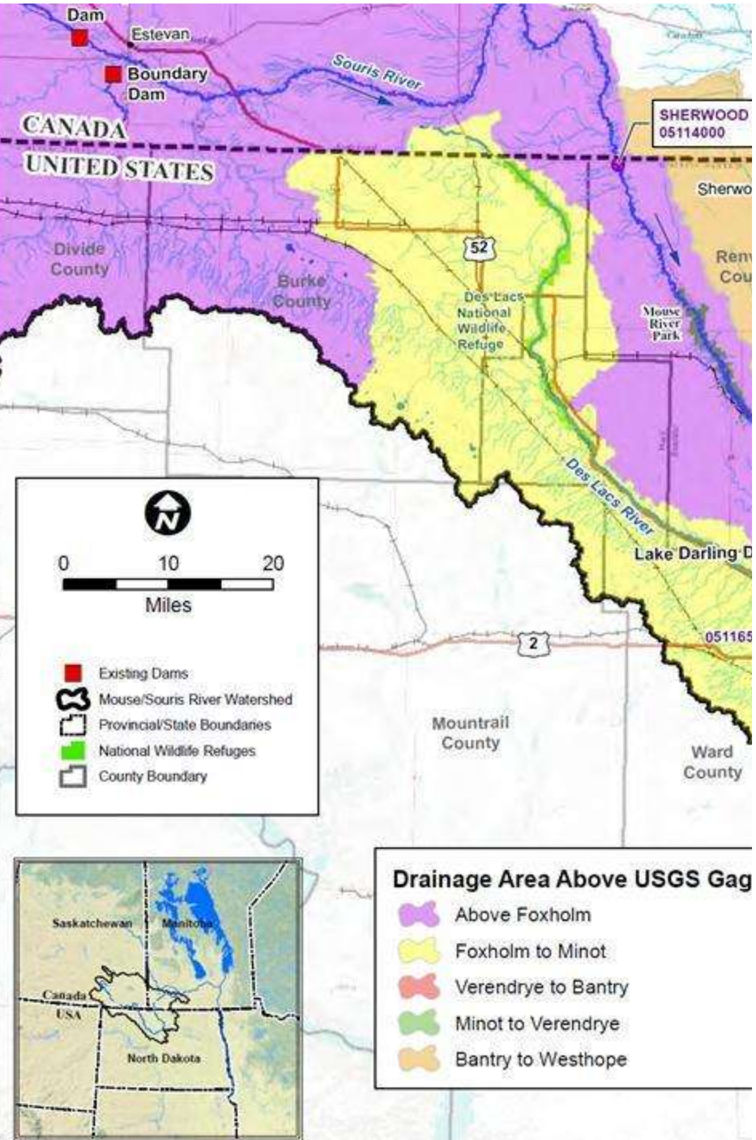
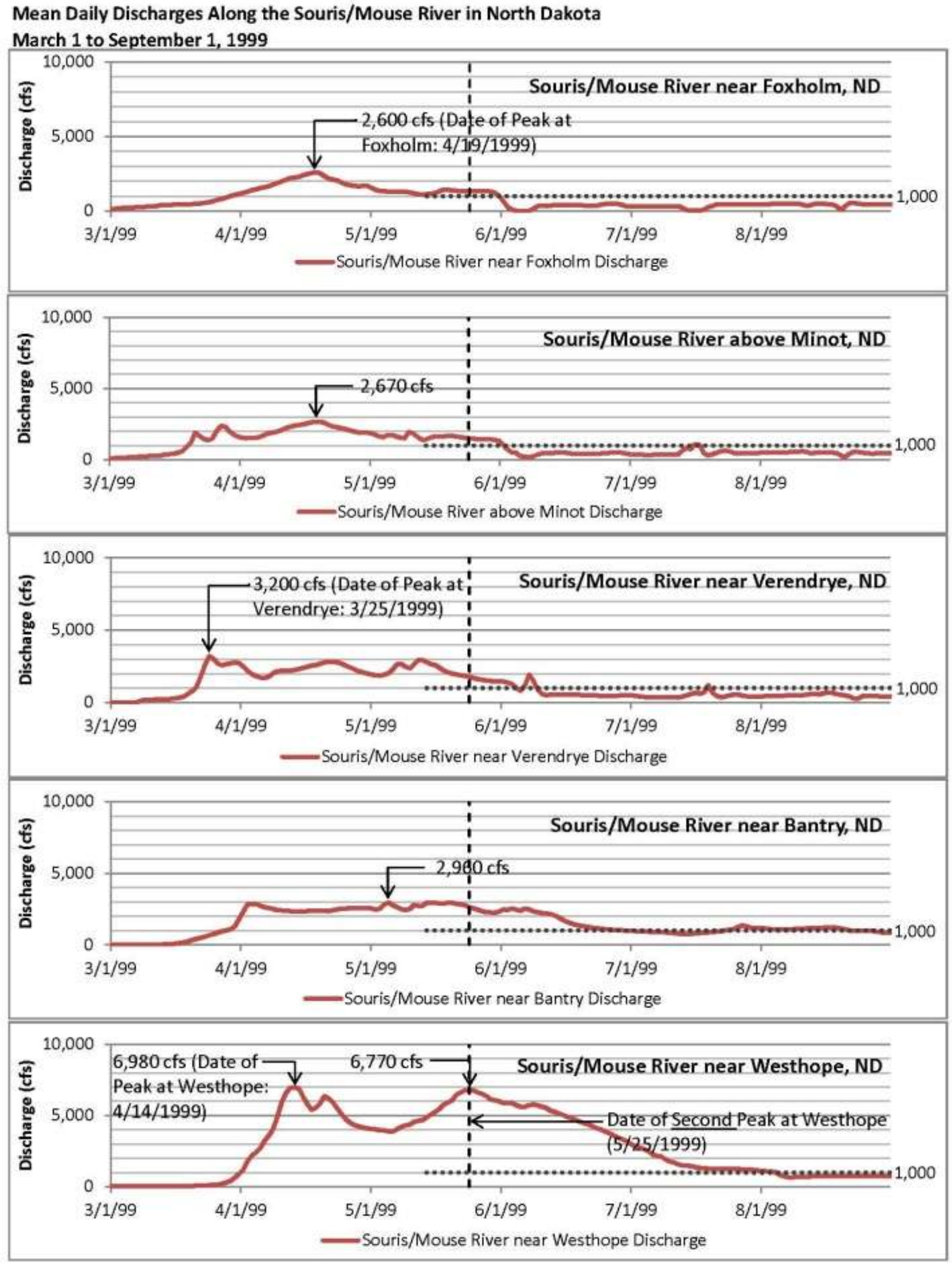
USGS Gage Analysis Improves Understanding of Mouse River flows



USGS Gage Analysis Improves Understanding of Mouse River flows



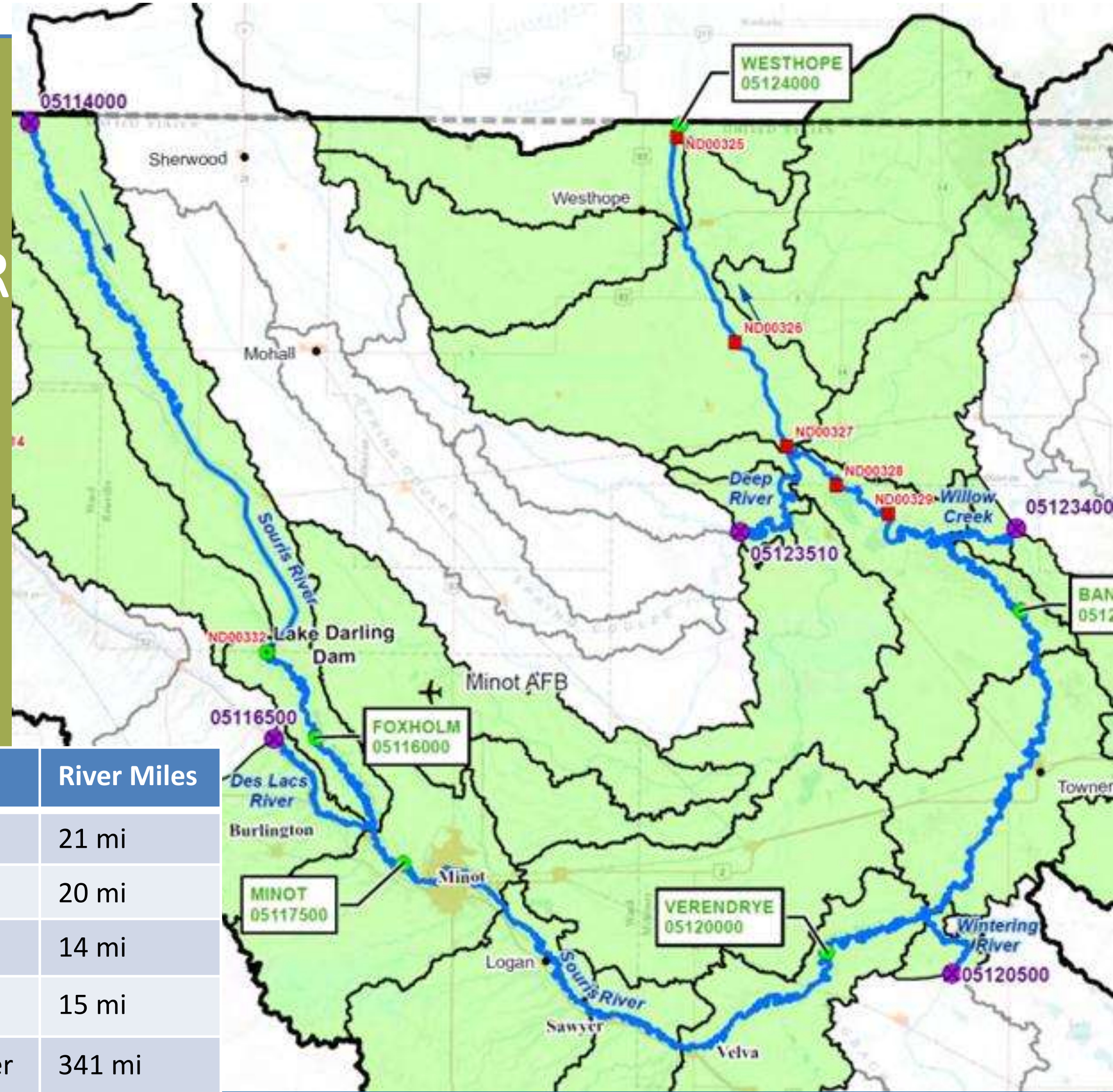


Hydrologic and Hydraulic Models Essential to Identify Project Effectiveness

- Models will be Used for
  - Assessment of PER Project Elements on Downstream Areas
  - Rural Alternatives Evaluation

	Modeled Area and Length
HEC-HMS	4,278 mi^2
HEC-RAS	411 mi

Waterbody	River Miles
Deep River	21 mi
Des Lac River	20 mi
Willow Creek	14 mi
Wintering River	15 mi
Mouse/Souris River	341 mi



Varying Levels of Information will be Developed for the Rural Area Flood Risk Reduction Alternatives

- Inundated Ag Land (Acres), with breakdown by major land use or crop type
- Inundated or Affected Public Infrastructure (roads, bridges, utilities)
- Inundated Residences
- Inundated Outbuildings
- Capital Cost Range (qualitative)
- Operation and Maintenance Requirements
- Anticipated Erosion and Sedimentation Effects
- Anticipated Environmental Effects
- Anticipated Social Effects
- Anticipated Permit Requirements
- Comparison with Impacts from Feb 29 PER Preliminary Alignment Plan

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Relative Cost Of The "Likely" Beneficial Alternatives Will Be Used in the Assessment Process

- **Evaluate Cost:**
  - A high level range of potential construction costs will be prepared for feasible alternatives
  - Unit costs developed during preparation of the PER will be utilized
  - Costs will be compared among the alternatives on a relative basis

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Tying it All Together in a Rural Alternatives Report

- **Executive Summary**
  - High level summary of the report
- **Rural Alternatives Analysis Report**
  - Assessment of each alternative
  - Will summarize the results of the primary evaluations:
    - Effectiveness Evaluation
    - Cost Evaluation
    - Evaluation of Impacts to Key Resources/Concerns
- **Technical Appendices as needed**

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Mouse River Part 2 Schedule

Key Milestones	Anticipated Completion
Part 2 Authorization	Mid-June 2012
Field Reconnaissance	August 2012
Renville County Hydrology and Hydraulic Modeling	October 15, 2012
Availability of LiDAR data for McHenry and Bottineau Counties	November 30, 2012
Erosion and Sedimentation Evaluation Summary Report	January 15, 2013
McHenry and Bottineau County Hydrology and Hydraulic Models	February 15, 2013
Rural Area Alternatives Analysis Report	May 1, 2013

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Q & A Framework

- Please remain respectful of others opinions, questions, and comments
- Due to time constraint please limit questions and comments to 1-2 min
- If we are unable to get to your question or hear you input, please complete the comment form at the back of the room
- Comments can also be submitted at www.mouseriverplan.com

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Description of Alternatives

- **Alt 0a--No action (Baseline – Existing Conditions)**
  - This alternative will include the existing conditions HEC-RAS model
  - General Approach:
    - Calibrate the unsteady hydraulic model to existing conditions based on high water marks and gage data for the three runoff events (2011, 2010, & 2009)

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Description of Alternatives

- **Alt 0b--No action and implement PER Plan (Burlington to Velva)**
  - This alternative consists of the HEC-RAS model that includes the PER project geometry, plus existing conditions outside of the PER project footprint
  - The model will define conditions that may develop in rural areas if the proposed PER preliminary alignment project is implemented
  - General Approach:
    - Incorporate the PER hydraulic model into the unsteady existing conditions hydraulic model and model the three runoff events.

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Description of Alternatives

- **Alt 1—Advance Discharge Schedule—Lake Darling**
  - Look at effects of higher or earlier discharge (up to 5,000 cfs above Minot) during the months of January, February, & March
  - The objective is to evaluate the effects of discharging more water earlier in the year:
    - Will discharges be reduced later in the spring (after May 1)?
  - The goal is to reduce impacts to agriculture and possibly to infrastructure

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Description of Alternatives

- **Alt 2—Increased Target Discharge from Lake Darling**
  - Look at effects of higher target discharges (e.g. 8,000, 12,000, or 15,000 cfs) above Minot (current target is a maximum of 5,000 cfs)
  - The objective is to evaluate the effects of passing the discharge hydrograph faster, but no earlier than normal:
    - Will discharges be reduced later in the spring (after May 1)?
  - The goal is to reduce impacts to agriculture

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Description of Alternatives

- **Alt 3—Non-Structural Flood Storage Increase—Lake Darling**
  - Look at effects of increasing the storage capacity of Lake Darling by lowering the Max Drawdown Level (currently El. 1591.0')
  - The objective is to evaluate the effects of having greater storage capacity in Lake Darling:
    - Will discharges be reduced later in the spring (after May 1)?
    - Will peak discharges be less?
  - The goal is to reduce impacts to agriculture and infrastructure

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Description of Alternatives

- **Alt 4—Structural Flood Storage Increase—Lake Darling**
  - Look at effects of increasing the storage capacity of Lake Darling by raising the Max Storage Level (currently El. 1601.0’)
  - The objective is to evaluate the effects of having greater storage capacity in Lake Darling:
    - Will discharges be reduced later in the spring (after May 1)?
    - Will peak discharges be less?
  - The goal is to reduce impacts to agriculture and infrastructure

Description of Alternatives

- **Alt 5—Ring Dikes**
  - Look at the effects of providing ring dikes around homes and farmsteads in the rural areas
  - Approach:
    - Identify all areas to be enclosed by ring dikes (GIS task)
    - Apply a typical ring dike design
    - Estimate range of construction costs to provide ring dikes at the selected locations
    - Determine cost share breakdown
    - Detailed design is not included
  - It is assumed that ring dikes will provide infrastructure impact reduction, but not agriculture impact reduction.

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Description of Alternatives

- **Alt 6—Boundary Diversion**
  - Look at effects of providing a boundary diversion that diverts high flows away from the Minot area
  - The objective is to evaluate the effects of having reduced inflow into Lake Darling, but only for inflows above 5,000 cfs:
    - Will discharges be reduced later in the spring (after May 1)?
    - Will peak discharges be less?
  - The goal is to reduce impacts to agriculture and infrastructure

Description of Alternatives

- **Alt 7—Channelization improvements downstream of Velva**
  - Look at effects of providing improved channelization in select areas D/S of Velva
  - Approach:
    - Identify candidate reaches for improvement (up to 6 areas)
    - RAS Model of improvements for the 3 events
    - Compare results to baseline conditions (W.S. profiles and/or inundated areas)
    - Evaluate D/S impacts
  - The objective is to evaluate the effects of increased channel capacity downstream of Velva
  - The goal is to reduce impacts to agriculture and infrastructure

Description of Alternatives

- **Alt 8—Bridge Modifications**
  - Look at effects of modifying bridges to increase the discharge capacity of the channel downstream of Velva.
  - The objective is to identify the crossings that will benefit from a larger conveyance area so that water surface profiles can be reduced.
  - The scope for this alternative assumes general changes to bridge widths and elevations.
  - Specific design or development of drawings of individual bridge modifications is not included in this task.
  - Bridge modifications will be modeled in HEC-RAS assuming that the bridge no longer controls conveyance capacity.

Description of Alternatives

- **Alt 9—Modify JCS Refuge Dam Operations**
  - Look at effects of modifying the operation of JCS dams during flood conditions
  - Approach:
    - Compute W.S. profiles and/or inundation for the baseline for each design event, using observed water levels throughout JCS Refuge
    - Compute W.S. profiles and/or inundation for current structures, assuming they are wide open during the design events
    - Compare results of the above to each other to evaluate if there is any flood reduction benefit, and also to evaluate impacts D/S to Canada

Description of Alternatives

- **Alt 10—Modify JCS Hydraulic Structures**
  - Look at effects of modifying the physical parameters of the structures– a comparison of pre-90's conditions to current conditions
  - Approach:
    - Compute W.S. profiles and/or inundation for pre-90's conditions for each design event, assuming they are wide open during the design events
    - Compute W.S. profiles and/or inundation for current conditions, assuming they are wide open during the design events
    - Compare results of the above to each other to evaluate if there is any flood reduction benefit, and also to evaluate impacts D/S to Canada

Description of Alternatives

- **Alt 11—Remove trapped floodwater after the flood recedes**
  - Look at effects of improving drainage of low areas (used for agriculture) located on the floodplain
  - The objective is to remove trapped floodwater that remains on the fields after floodwaters recede
  - The goal is to remove the trapped water as quickly as possible, impacts to the agricultural use of the land are minimized.
  - Approach:
    - Compute volumes and areas inundated by trapped water
    - Rough estimate of size and number of drainage structures and ditches needed to alleviate the problem
    - Provide range of construction costs
    - Do not drain natural wetlands

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Description of Alternatives

- **Alt 12—Flood storage on tributaries**
  - Look at effects of providing new flood storage on key tributaries
  - Approach:
    - ID the tributaries that could provide the most benefit
    - Determine what area-storage would be needed to provide the peak flow reduction needed
    - Modify the hydrographs; use as input to the RAS model
    - Compare modeling results to the baseline model to determine impacts and benefits

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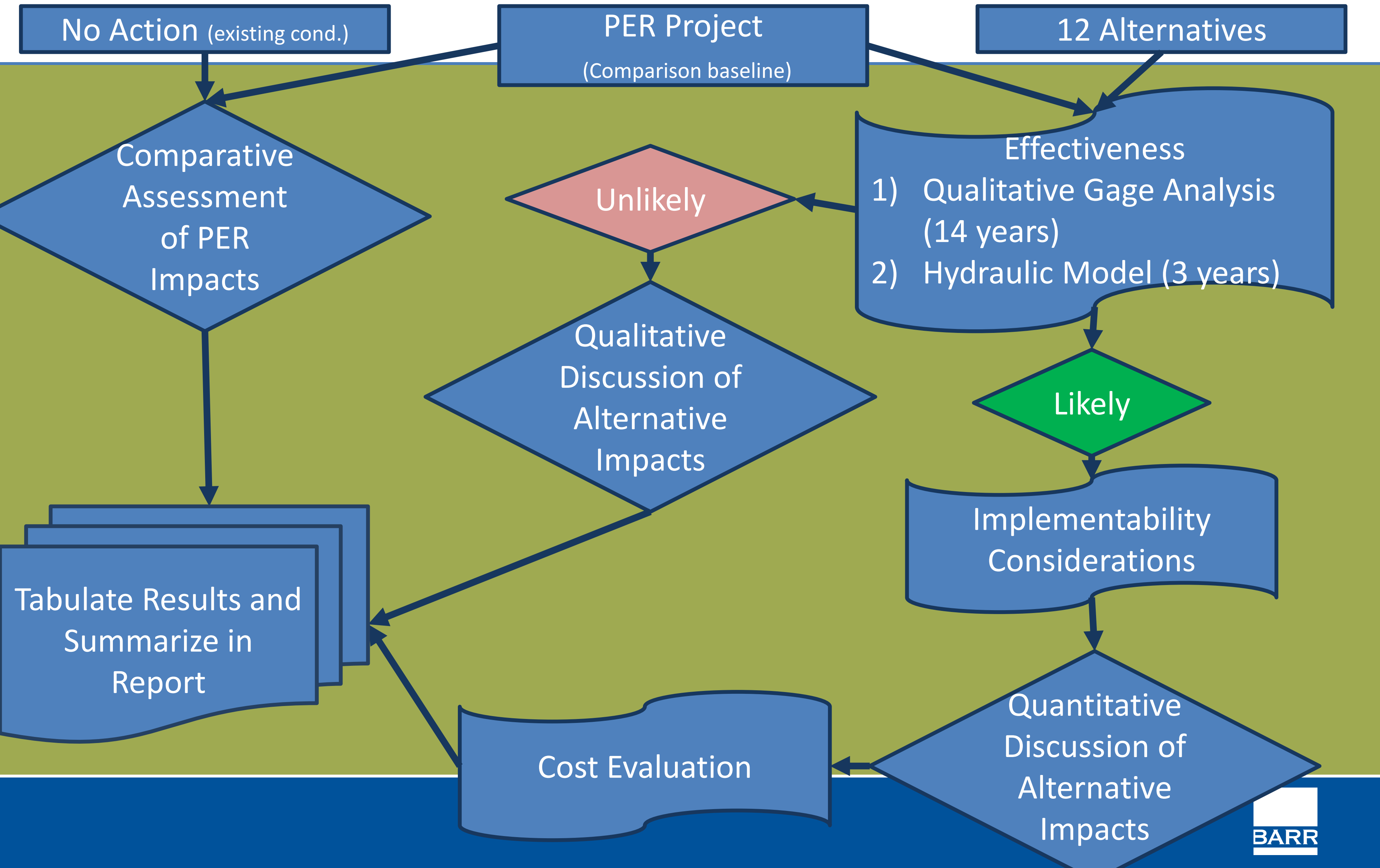
Alternative Evaluation Process Employs Various Level of Complexity



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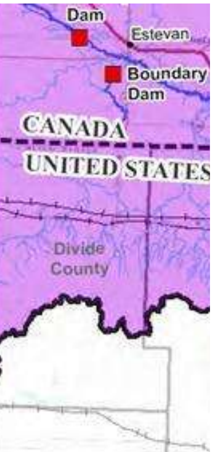
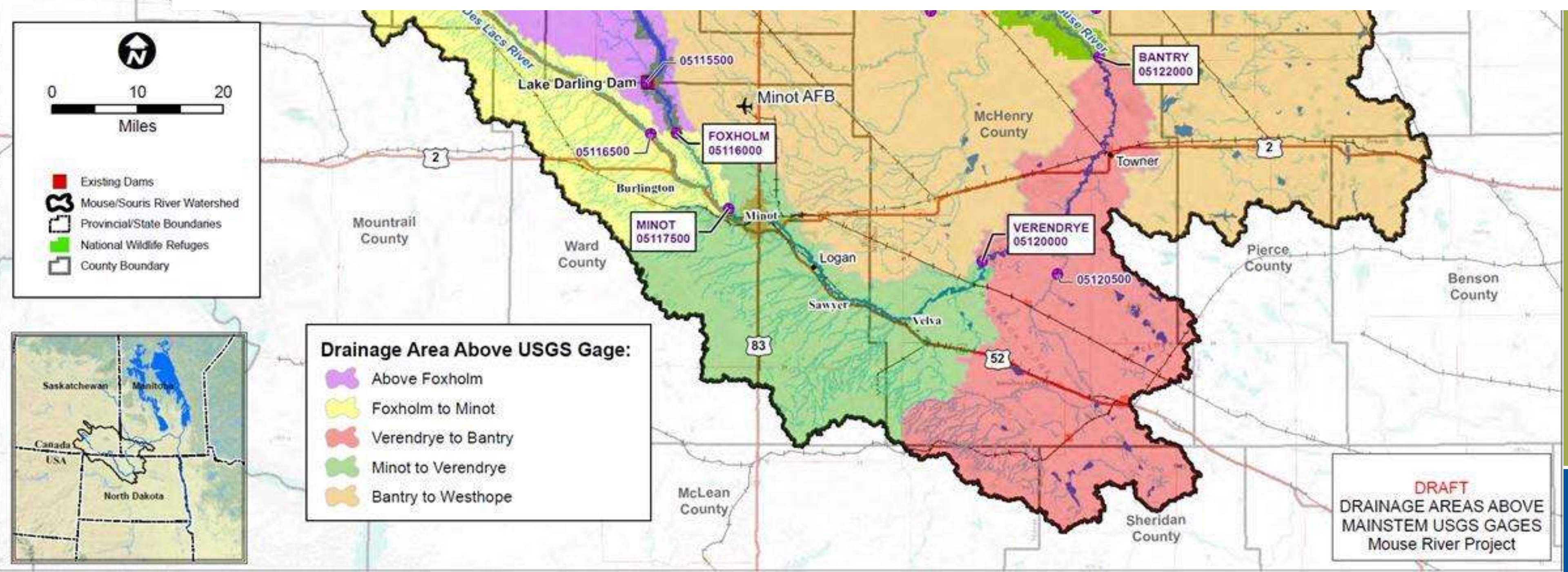
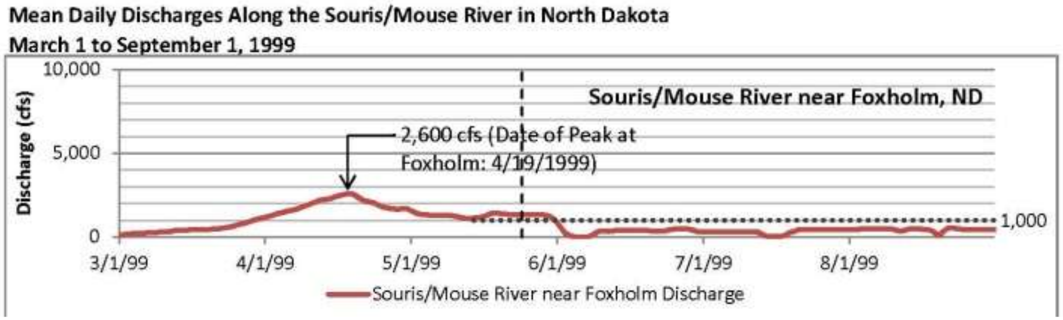


Summary of Key USGS Stream Gage Data Mouse/Souris River Basin

Qualitative Gage Analysis

Gage Number	Gage Location/Name	Discharge Data Start	Elevation Data Start	Total Drainage Area sq.mi.	Contributing Drainage Area sq.mi.	Ungaged Area between Souris River Gages sq.mi.
05114000	Souris River near Sherwood	1930	2000	8,940	3,040	-
05115500	Lake Darling near Foxholm	-	1991			-
05116000	Souris River near Foxholm	1936	2000	9,470	3,270	230
05116500	Des Lacs River at Foxholm	1904	2000	939	539	-
05117500	Souris River above Minot	1903	2000	10,600	3,900	91
05120000	Souris River near Verendrye	1937	2000	11,300	4,400	500
05120500	Wintering River near Karlsruhe	1937	2000	705	285	-
05122000	Souris River near Bantry	1937	2000	12,300	4,700	15
05123400	Willow Creek near Willow City	1956	2000	1,160	730	-
05123510	Deep River near Upham	1957	2001	975	370	-
05124000	Souris River near Westhope	1929	2000	16,900	6,600	800





Gaging Analysis Reviews Historic Floods

Foxholm

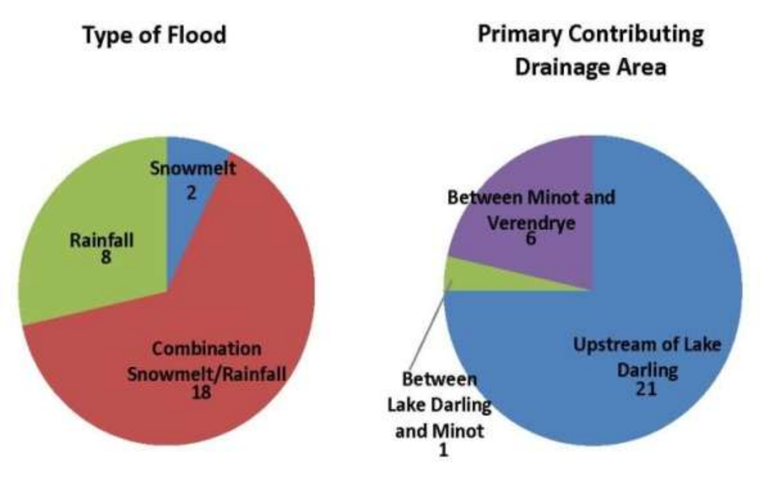
1999 Flood
Souris River Main Stem

Verendrye – Time of Year

Year	Date of Maximum Peak	Maximum Mean Daily Peak Discharge (cfs)	Ranking of Peak Discharge	Overall Degree of Exceedance and Impacts			Periods when Discharge is > 1,000 cfs; Light Pink 1,000 cfs to 3,000 cfs; Pink 3,000 cfs to 5,000 cfs; Dark Pink > 5,000 cfs							
				Moderate	High	Extreme	March	April	May	June	July	Aug	Sept	Oct
2011	Jun 27	25,700	1			X								
2010	Apr 02	2,180		X										
2009	Apr 15	8,840	3		X									
2005	Jul 02	2,480		X										
2001	May 13	2,210		X										
1999	Mar 25	3,200		X										
1997	Apr 02	2,500		X										
1996	Apr 13	4,800	7	X										
1994	Jun 21	1,980		X										
1993	Jul 29	1,460		X										
1982	Apr 26	2,330		X										
1979	May 11	6,000	4		X									
1976	Apr 20	9,700	2			X								
1975	May 24	5,480	6		X									
1974	May 17	3,420	10		X									
1972	Apr 16	2,450		X										
1970	May 15	3,680	9		X									
1969	Apr 30	5,890	5		X									
1965	Jun 20	1,140		X										
1956	Apr 29	1,790		X										
1955	Apr 27	1,960		X										
1953	Jul 07	2,140		X										
1951	Apr 12	2,650		X										
1950	May 16	2,120		X										
1949	Apr 08	4,000	8	X										
1948	May 21	2,290		X										
1944	Jul 02	1,450		X										
1943	May 02	2,220		X										
							March	April	May	June	July	Aug	Sept	Oct

Existing Conditions Gaging Analysis Summary

- About 75% of damaging floods (e.g., 2011, 1976) caused by
  - Drainage area upstream of Lake Darling
  - Snowmelt combined with rainfall with peak flows in April or May (June for 2011)
- About 25% of damaging floods caused by
  - Drainage areas downstream of Lake Darling (e.g., 2009)
  - For these events, Lake Darling current or modified storage provided little or no benefit
  - Rainfall only OR snowmelt only



Events used for Gaging Analysis of Rural alternatives

Effectiveness

1) **Qualitative Gage Analysis (14 yrs)**
2) Hydraulic Model (3 years)

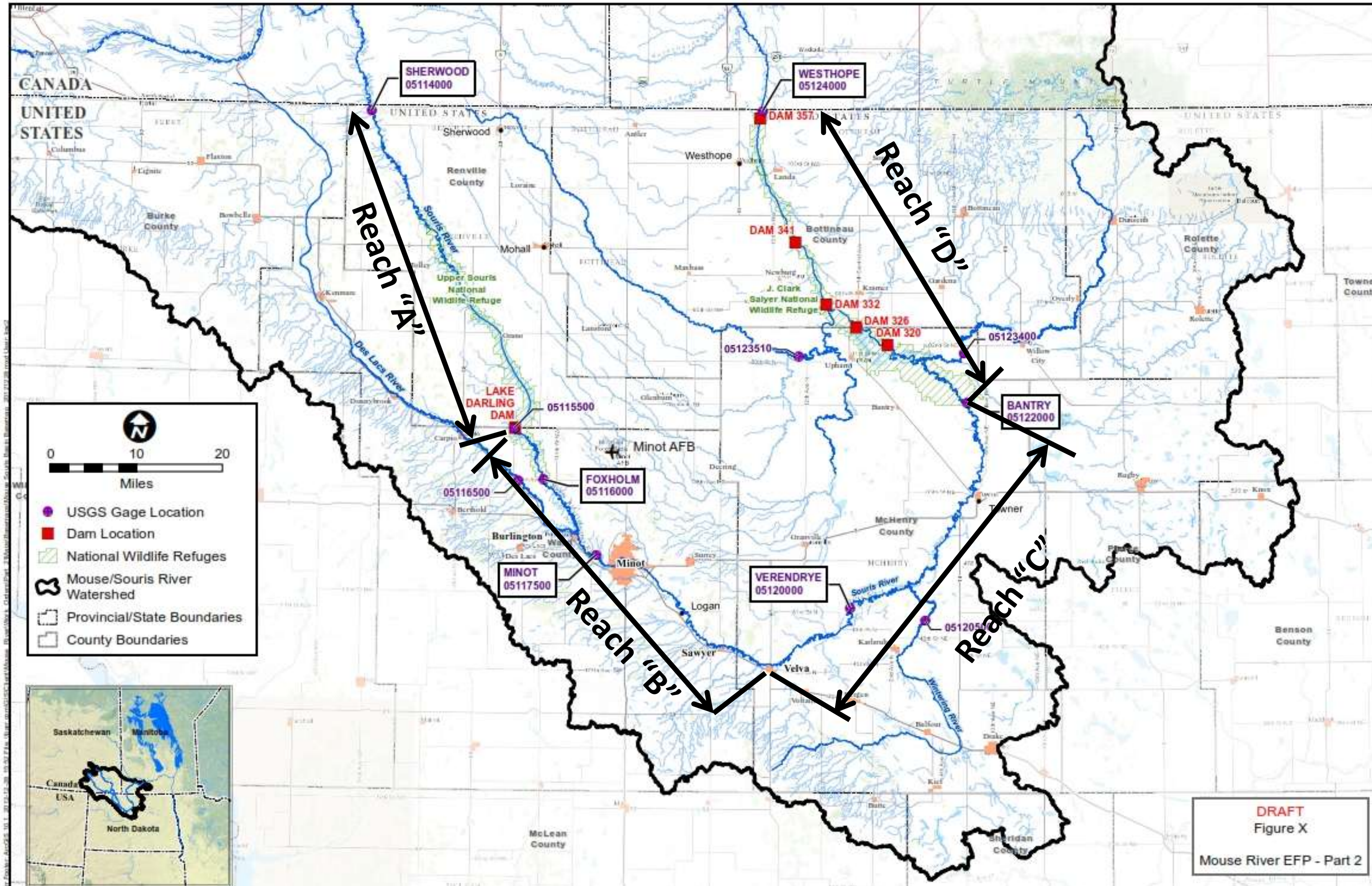
Verendrye Peak Discharge

Year	Mean Daily Peak Discharge at Verendrye (cfs)	Date of Peak at Verendrye	Primary Drainage Area Causing Discharges which Cause Impacts
2011	25,700	6/27/2011	U/S Lake Darling
2010	2,180	4/2/2010	Minot to Verendrye
2009	8,840	4/15/2009	Minot to Verendrye
2005	2,480	7/2/2005	Minot to Verendrye
2001	2,210	5/13/2001	U/S Lake Darling
1999	3,200	3/25/1999	U/S Lake Darling
1996	4,800	4/13/1996	U/S Lake Darling
1995	2,300	3/18/1995	U/S Lake Darling
1979	6,000	5/11/1979	U/S Lake Darling
1976	9,700	4/20/1976	U/S Lake Darling
1975	5,480	5/24/1975	U/S Lake Darling
1974	3,420	5/17/1974	U/S Lake Darling
1970	3,680	5/15/1970	U/S Lake Darling
1969	5,890	4/30/1969	U/S Lake Darling

Westhope Peak Discharge

Year	Mean Daily Peak Discharge at Westhope (cfs)	Date of Peak at Westhope	Primary Drainage Area Causing Discharges which Cause Impacts
2011	29,500	7/6/2011	U/S Lake Darling
2010	1,630	6/26/2010	Bantry to Westhope
2009	5,700	4/30/2009	Bantry to Westhope
2005	3,260	7/20/2005	Bantry to Westhope
2001	3,290	4/11/2001	U/S Lake Darling
1999	6,980	4/14/1999	Bantry to Westhope
1996	5,240	4/23/1996	U/S Lake Darling
1995	3,770	4/10/1995	Bantry to Westhope
1979	5,830	5/21/1979	U/S Lake Darling
1976	12,400	4/26/1976	U/S Lake Darling
1975	6,600	5/7/1975	U/S Lake Darling
1974	5,590	4/25/1974	U/S Lake Darling
1970	3,110	6/6/1970	U/S Lake Darling
1969	6,200	4/22/1969	U/S Lake Darling

Rural Alternatives Analysis Split into 4 Reaches for Evaluation Purposes



Gaging Analysis of Rural Alternatives

Effectiveness

1) **Qualitative Gage Analysis (14 yrs)**
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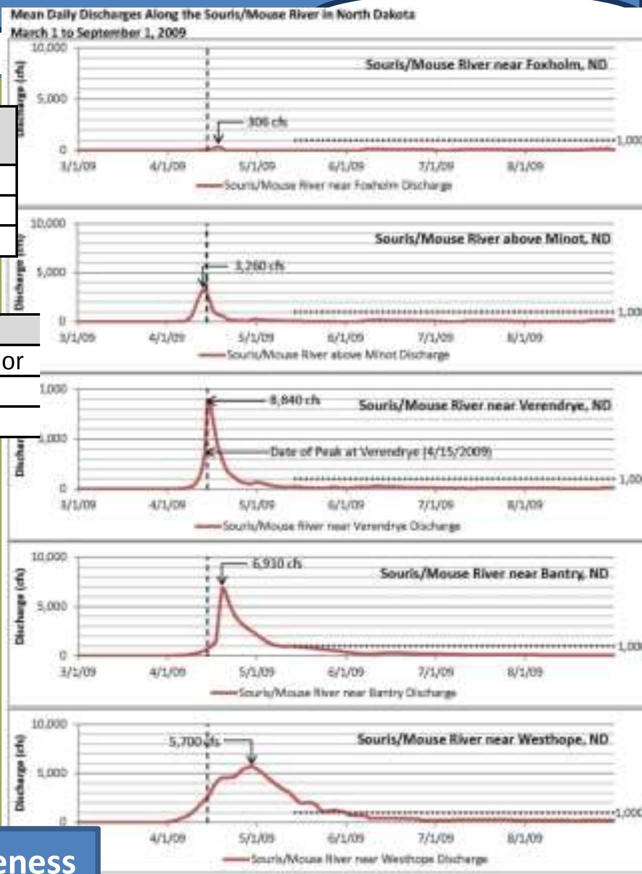

Agricultural Considerations

1) Peak discharge
2) Target discharge
3) Timing of peak discharge
4) Duration discharge exceeds target

Agricultural Impacts

Flow Classification	Velva Area (cfs)	Towner Area (cfs)
Bankfull	1,500	500
Problematic	3,000	3,000
Catastrophic	10,000	10,000

Infrastructure Impacts

Flows (cfs)	Degree of Severity
2,000 to 5,000	Manageable and relatively minor
5,000 to 7,000	Major
7,000 and up	Catastrophic

Target Flows at the Verendrye Gage

Date	Target Flow (or less)
May 1	1,500
May 30 through November 1	500

Infrastructure Consideration

1) Peak discharge
2) Target discharge
3) Timing of peak discharge unimportant

Subjective Assessment of Alternative Impact reduction effectiveness

L = Likely to Reduce Impacts or Damages
Q = May reduce impacts or damages, but is questionable
U = Unlikely or will not reduce impacts or damages

Compile and tabulate the number of events that received an "L" or "Q" rating and express as a percentage of the total number of events analyzed.

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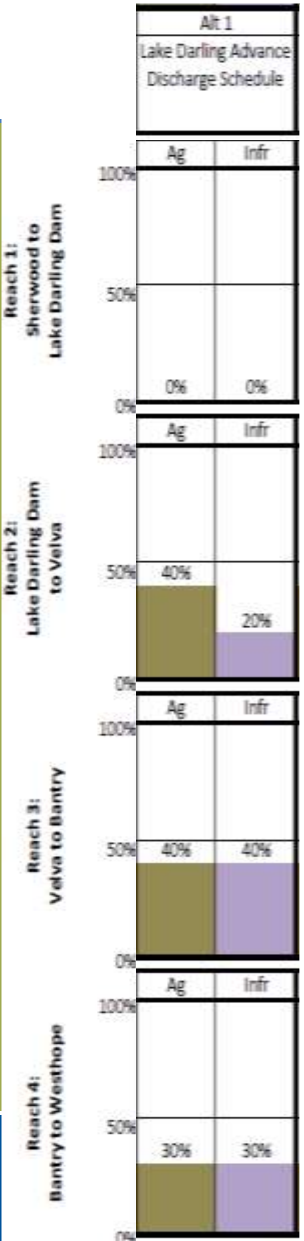
Draft Preliminary Summary of Rural Area Alternatives Gaging Analysis

Effectiveness

1) **Qualitative Gage Analysis (14 yrs)**
2) Hydraulic Model (3 years)



Hydraulic Modeling Analysis of Rural Alternatives

Effectiveness
1) **Qualitative Gage Analysis (14 yrs)**
2) Hydraulic Model (3 years)

Agricultural Considerations
1) Peak discharge
2) Target discharge
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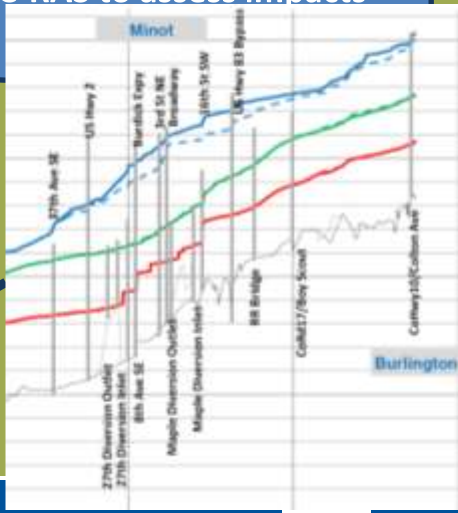
Infrastructure Consideration
1) Peak discharge
2) Target discharge
3) Timing of peak discharge unimportant

Develop Spreadsheet Routing Model or HEC-RAS Model of alternative for 2009, 2010, & 2011 events (if applicable)

Develop Water surface profiles and floodplain top widths from HEC-RAS to assess impacts



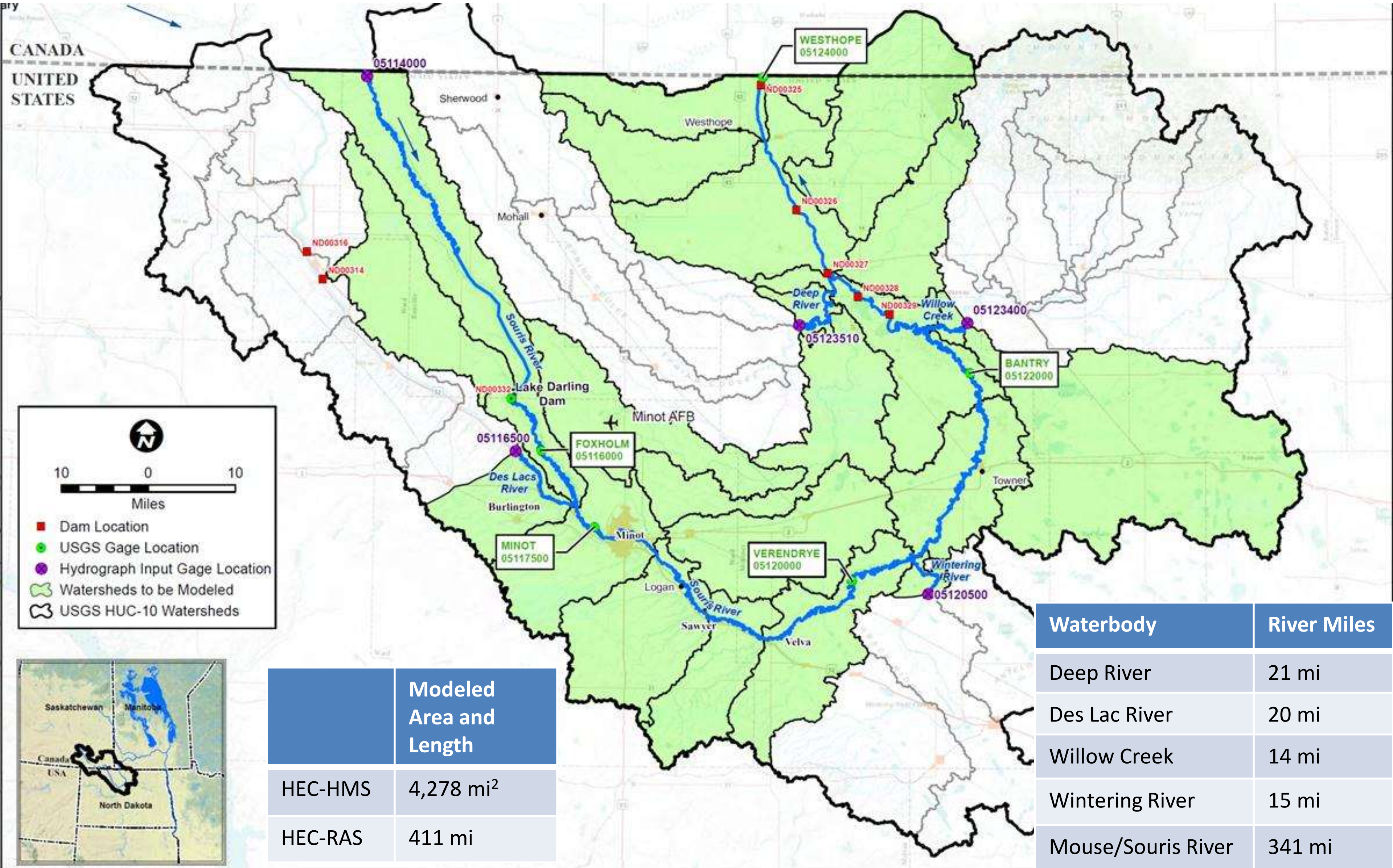
Summarize and tabulate impacts on water surface profile, top widths, timing and duration of flooding for 2009, 2010, and 2011 events and assign "L",, "Q", or "U"

L = Likely to Reduce water surface depth > 1 foot, top widths >10% duration of flooding

Q = May reduce impacts or damages, but is questionable

U = Unlikely or will negatively impact WSE or timing

Hydrologic and Hydraulic Modeling Focus on Ungaged Areas and the Mouse River

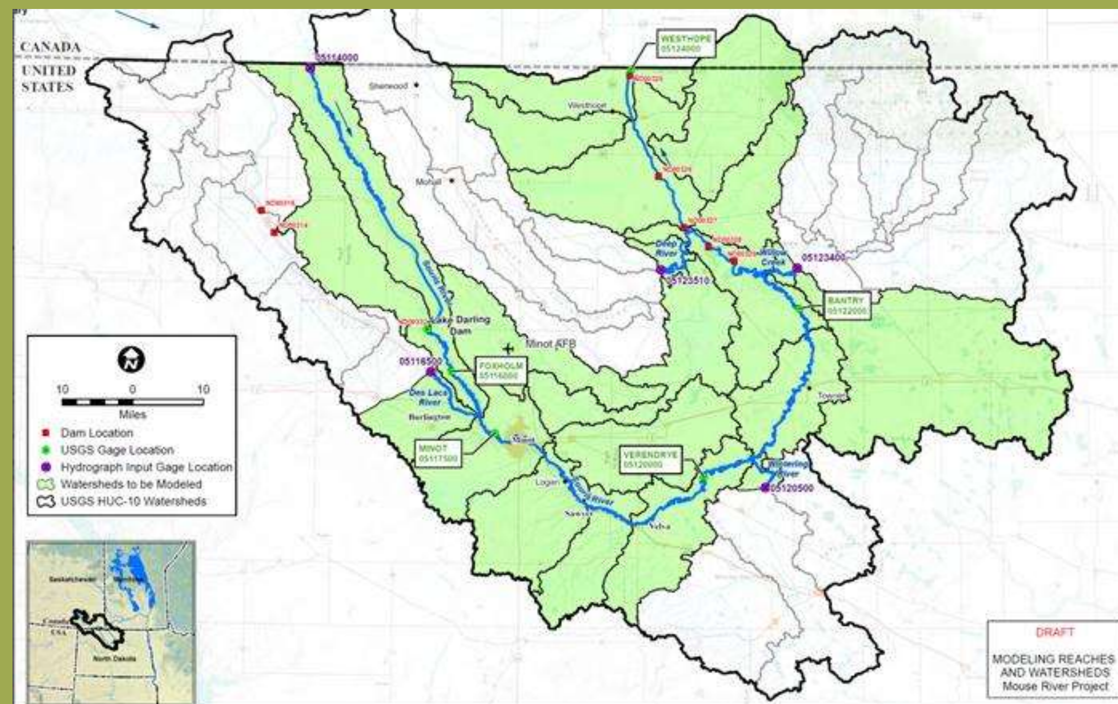


	Modeled Area and Length
HEC-HMS	4,278 mi^2
HEC-RAS	411 mi

Waterbody	River Miles
Deep River	21 mi
Des Lac River	20 mi
Willow Creek	14 mi
Wintering River	15 mi
Mouse/Souris River	341 mi

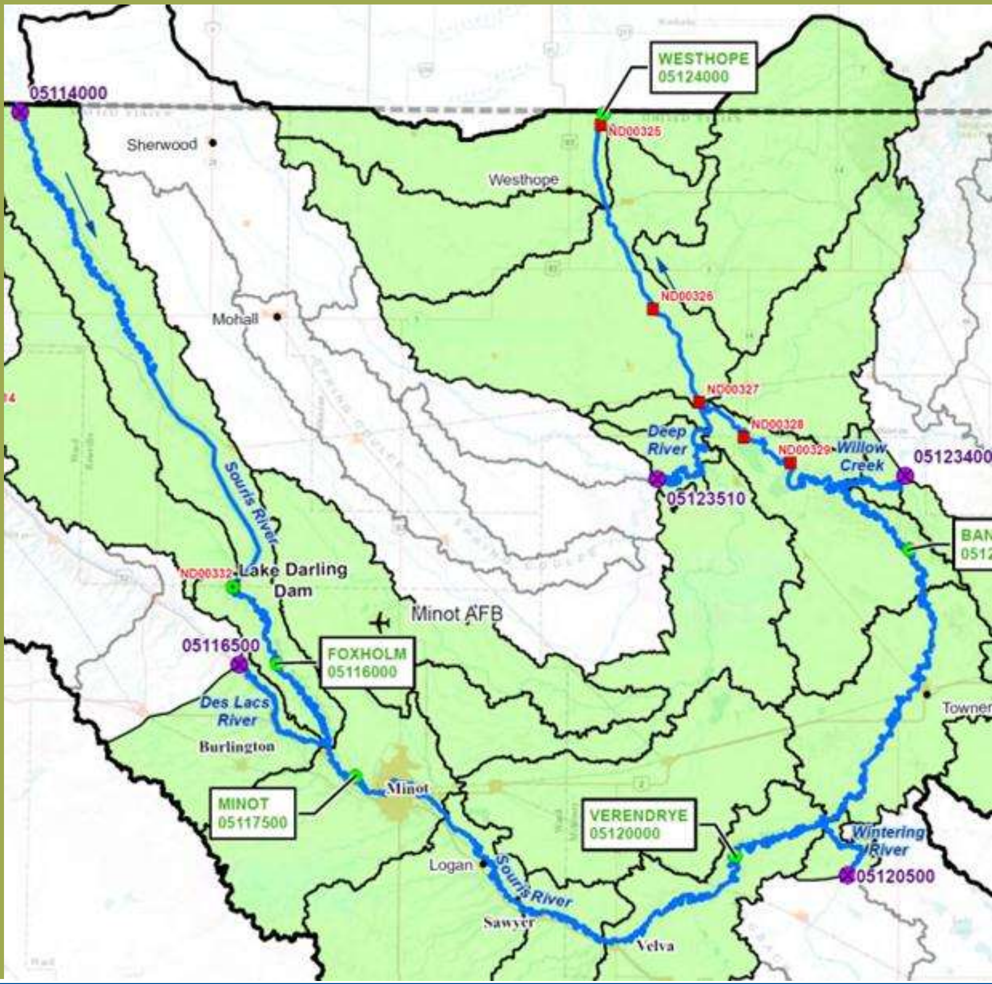
Hydrologic Model Needed to Develop Hydrologic Input Data for the Unsteady State HEC-RAS Model

- USGS HUC 10 watersheds will be used for ungaged areas and contributing area estimated
- Three historic events are being analyzed (2009, 2010, & 2011)
- USGS gage data are being used to develop inflow hydrographs for the upstream ends of the Mouse River and its tributaries
- Mouse River USGS gaging data are being used for calibration



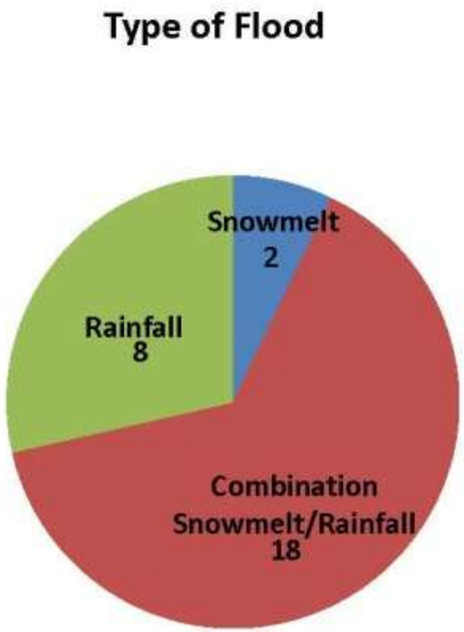
HEC-RAS Unsteady Flow Models will Account for Timing and Attenuation of Flows

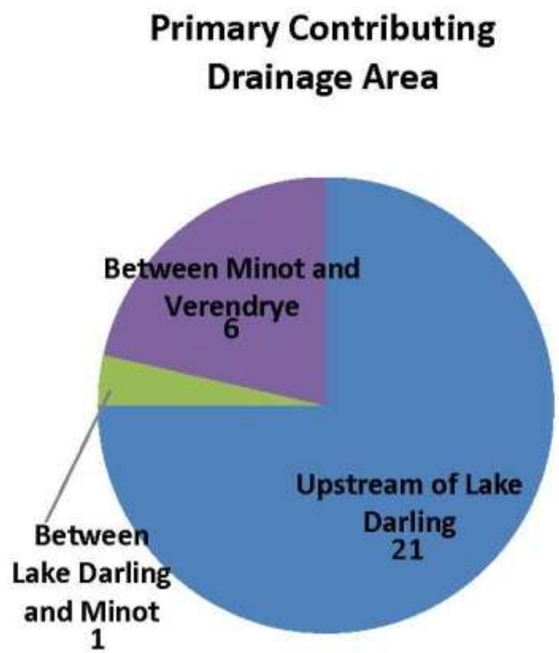
- Unsteady HEC-RAS model used to assess:
  - effects of existing storage within the floodplain
  - evaluation of the downstream impacts (elevations, durations, etc.)
  - operating plans for the high flow diversions in Minot,
  - effects of generating additional storage capacity
  - other conditions or impacts for use in future permitting efforts
  - identify what if any alternatives have the greatest potential to relieve inundation during critical periods for crops

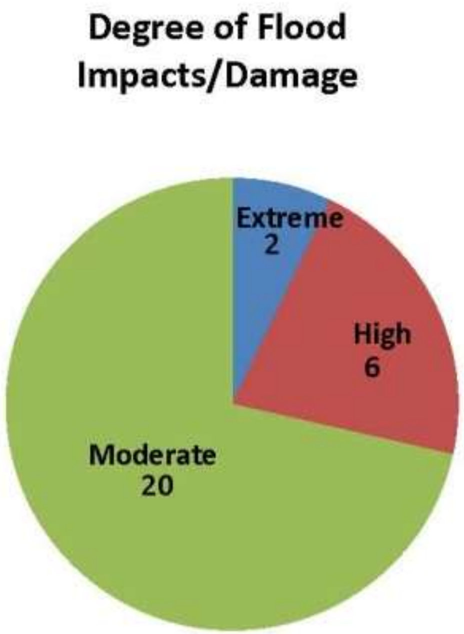


BARR

Figure A-11 Characteristics of Top Floods at Verendrye, ND (1937-2011) that Have Caused Moderate or Greater Impacts







Type of Flood

2	Snowmelt
18	Combination Snowmelt/Rainfall
8	Rainfall

Primary Contributing Drainage Area

21	Upstream of Lake Darling
0	Des Lacs River
1	Between Lake Darling and Minot
6	Between Minot and Verendrye

Degree of Flood Impacts/Damage

2	Extreme
6	High
20	Moderate