Supplemental Draft Feasibility Report and Environmental Impact Statement

Fargo-Moorhead Metropolitan Area Flood Risk Management

April 2011

US Army Corps of Engineers®

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Cover Sheet
SUPPLEMENTAL DRAFT FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

FARGO-MOORHEAD METROPOLITAN AREA FLOOD RISK MANAGEMENT

LEAD AGENCY: U.S. Army Corps of Engineers, Mississippi Valley Division, St. Paul District (CEMVP)

ABSTRACT: This Supplemental Draft Feasibility Report and Environmental Impact Statement (SDEIS) documents the analysis of alternatives developed to reduce flood risk in the entire Fargo-Moorhead Metropolitan area. The Tentatively Selected Plan is the Locally Preferred Plan (LPP) and includes a North Dakota diversion channel and associated structures, non-structural features, recreation features and environmental mitigation.

Privacy Notice: Persons submitting comments are advised that all comments received will be available to the public, to include the possibility of posting on a publicly accessible website. Commenters are requested not to include personal privacy information, such as home addresses, or home phone numbers, in their comments unless they do not object to such information being made available to the public

Comments: Please direct inquiries on this Supplemental Draft Feasibility Report and Environmental Impact Statement (SDEIS) to the U.S. Army Corps of Engineers, St. Paul District, Attention: Aaron M. Snyder, 180 E. 5th Street, Suite 700, St. Paul, MN 55101-1678. Telephone (651) 290-5489; Fax (651) 290-5258. **The official closing date for receipt of comments will be 45 days from the date on which the Notice of Availability of the SDEIS appears in the Federal Register (scheduled for May 6, 2011).**

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Items designated with a * are sections related to the Environmental Impact Statement

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Supplemental Draft Feasibility Report and Environmental Impact Statement Fargo-Moorhead Metropolitan Area Flood Risk Management

EXECUTIVE SUMMARY

STUDY AUTHORITY AND HISTORY

The St. Paul District, Corps of Engineers, and the sponsor cities of Fargo, North Dakota and Moorhead, Minnesota began the Fargo-Moorhead Metro Feasibility Study in September 2008. The study was authorized by a September 30, 1974, Resolution of the Senate Committee to Public Works. Prior to 2008, the Corps conducted numerous studies and projects in the study area. The Fargo-Moorhead metropolitan area was included in the Red River Reconnaissance Study approved in 2002; that study was not to a sufficient level of detail to recommend a feasibility study specifically for measures in Fargo and Moorhead. A supplemental reconnaissance report recommended this feasibility study and was approved by the Mississippi Valley Division on April 8, 2008.

Based on the reconnaissance study findings, the city of Fargo, the city of Moorhead and the federal government entered into a Feasibility Cost Share Agreement on September 22, 2008. The study cost share was 50/50 between the federal government and the two non-federal sponsors. The Corps of Engineers issued a notice of intent to prepare an environmental impact statement in the Federal Register on May 5, 2009. The Draft Feasibility Report and Environmental Impact Statement (DEIS) was published in the Federal Register for a 45 day public review period on June 11, 2010. The review period closed on August 9, 2010 after being extended by 14 days. In response to comments and to more fully study upstream and downstream impacts, the Corps has made the decision to prepare a Supplemental DEIS. The notice of intent to prepare a Supplemental DEIS was published in the Federal Register on December 27, 2010.

PURPOSE AND SCOPE

The purpose of the feasibility study was to investigate flood issues in the Fargo-Moorhead Metropolitan Area, identify flood risk management measures that could be implemented, document findings and, if appropriate, recommend implementation of a federal project. The planning objectives were specified as follows:

- Reduce flood risk and flood damages in the Fargo-Moorhead metropolitan area.
- Restore or improve degraded riverine and riparian habitat in and along the Red River of the North, Wild Rice River (North Dakota), Sheyenne River (North Dakota), and Buffalo River (Minnesota) in conjunction with other flood risk management features.
- Provide additional wetland habitat in conjunction with other flood risk management features.
- Provide recreational opportunities in conjunction with other flood risk management features.

The study product is a decision document in the form of an integrated feasibility report and National Environmental Policy Act (NEPA) document in accordance with the Corps' Planning

Guidance Notebook, Engineer Regulation (ER) 1105-2-100. The feasibility study investigated measures to reduce flood risk and analyzed the potential for federal participation in implementing a flood risk management project in the Fargo-Moorhead Metropolitan Area. This report allows for tiering supplemental NEPA documentation as permitted by Council on Environmental Quality (CEQ) Regulation 40 C.F.R. 1508.28.

The feasibility study team collected pertinent engineering, economic, social and environmental information needed to accomplish the study objectives. Interagency and public stakeholders and potentially affected landowners were identified. Potential issues and opportunities were defined. An array of possible flood risk management plans was considered and screened to define the costs, benefits, and impacts to the study area.

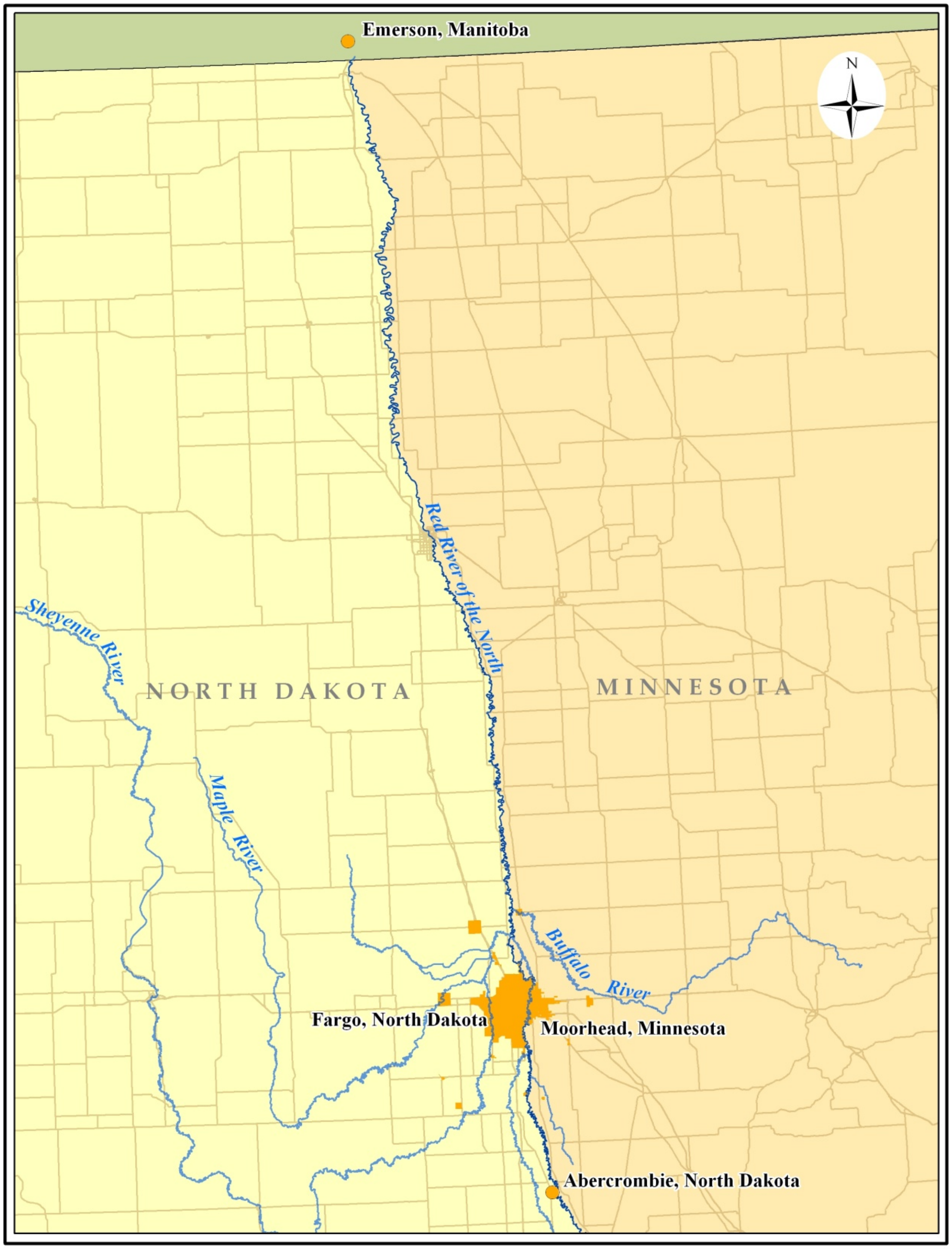
LOCATION OF STUDY AREA

The geographic scope of analysis for the environmental impacts of the proposed action and alternatives encompasses the Fargo-Moorhead Metropolitan area plus areas in the floodplain of the Red River from approximately 300 river miles north of Fargo near Emerson, Manitoba to approximately 30 miles south of Fargo near Abercrombie, ND. The Wild Rice, Sheyenne, Maple, Rush and Lower Rush Rivers in North Dakota and the Buffalo River in Minnesota also cross the study area.

The Fargo-Moorhead metropolitan area is located within the area from approximately 12 miles west to 5 miles east of the Red River and from 20 miles north to 20 miles south of Interstate Highway 94. The metropolitan area is approximately 600 square miles, encompassing several smaller communities within ten miles of the Red River from Hickson, North Dakota to Georgetown, Minnesota. The metropolitan area has a population of approximately 200,000. Fargo-Moorhead is a gateway to the west and a hub of educational and health-related industries. The metropolitan area is the largest urban area in North Dakota and a principal regional economic and social center.

Figure 1 shows the location of the study area.

Figure 1 - Fargo-Moorhead study area location



FLOOD HISTORY

Because of its relatively low elevation and flat topography, the majority of the study area is located in the regulatory floodplain. The Red River of the North has exceeded the National Weather Service flood stage of 18 feet in 48 of the past 109 years, and every year from 1993 through 2011. Flooding in Fargo-Moorhead typically occurs in late March and early April. The flood of record at Fargo-Moorhead was the 2009 spring flood with a stage of 40.8 feet on the Fargo gage. With an estimated peak flow of 29,200 cubic feet per second (cfs), the 2009 flood was approximately a 2-percent chance (50-year) event. Equivalent expected annual flood damages in the Fargo-Moorhead metropolitan area are estimated to be over $194.8 million in the future without project condition. Although emergency measures have been very successful, they may also contribute to an unwarranted sense of security that does not reflect the true flood risk in the area.

ALTERNATIVES CONSIDERED

The study analyzed a number of possible types of measures and alternative plans that could reduce the flood risk in the Fargo-Moorhead metropolitan area. These measures and plans included:

- No Action - Continue emergency measures
- Non-structural measures
- Flood barriers (including levees)
- Increase conveyance (including diversion channels)
- Flood storage

The alternatives went through an initial screening that used the following criteria: Effectiveness, Environmental Effects, Social Effects, Acceptability, Implementability, Cost, Risk, Separable Mitigation, and Cost Effectiveness. The initial screening analysis was published in the Alternatives Screening Document dated December 2009. The analysis resulted in two diversion concepts being carried forward: a diversion in Minnesota and a diversion in North Dakota.

Diversion channel alternatives following alignments primarily in either Minnesota or North Dakota were considered. Channels ranging in capacity from 20,000 to 45,000 cubic feet per second (cfs) were analyzed in detail. The alternatives were named for their location and capacity, for example, the 20,000 cfs channel located in Minnesota was named the “MN20K plan.”

STUDY CONCLUSIONS

May 2010 Draft Feasibility Report and Environmental Impact Statement (DEIS)

For the DEIS, the designs, alignments, and features of several diversion channel alternatives were refined, and cost estimates for each alternative were completed. The expected future without project conditions were assessed and compared to the expected future conditions with each alternative in place. The hydraulic and associated economic effects of each alternative were quantified so that the alternatives could be compared. The various alternatives were compared on their ability to meet the goals of the non-federal sponsors as well as cost-effectiveness and environmental impacts.

Table 1 summarizes the results of the economic cost-effectiveness analysis.

Table 1 - Phase 3 cost-effectiveness analysis results

Screened Alternatives Ranked by Net Benefits with Cost and Schedule Risk Assessment					
Alternative	Cost [1]	Avg Annual Net Benefits [1]	Avg Annual Benefits [1]	Residual Damages [1]	B/C Ratio
MN Short Diversion 20K	$1,032	$87.0	$140.0	$55.9	2.64
MN Short Diversion 25K	$1,121	$98.8	$156.4	$39.5	2.71
MN Short Diversion 30K	$1,194	$101.7	$163.1	$32.8	2.66
MN Short Diversion 35K	$1,286	$104.9	$171.0	$24.9	2.59
MN Short Diversion 40K [2]	$1,367	$105.6	$175.9	$20.0	2.50
MN Short Diversion 45K [2]	$1,450	$104.9	$179.5	$16.4	2.41
ND East Diversion 35K	$1,462	$95.4	$171.1	$24.8	2.26
1. In millions of dollars with interest during construction and discounting included					
2. Estimate based on linear extrapolation					
Expected average annual damages without a project were $195.9 million.					

Table 2 summarizes the estimated flood stages at the Fargo gage that would be delivered by each of the alternatives if they were operated during a 1-percent chance event or a 0.2-percent chance event.

Table 2 - Phase 3 estimated flood stages assuming various diversion capacities.

	Stage at Fargo Gage (ft)	
	1% Chance (100- year)	0.2% Chance (500- year)
Existing Condition Stage (ft)	42.4	46.7
Existing Condition Flow (cfs)	34,700	61,700
Work Group Goal	30	36
MN20K Diversion Channel	36.9	43.7
MN25K Diversion Channel	34.8	42.4
MN30K Diversion Channel	33.6	41.9
ND35K Diversion Channel	30.6	40.0
MN35K Diversion Channel	31.9	39.6
MN40K Diversion Channel	31.9	37.6
MN45K Diversion Channel	31.9	35.3

Prior to release of the May 2010 DEIS, the study identified three plans of significance to decision makers:

- The National Economic Development plan (NED)
- The Locally Preferred Plan (LPP)
- The Federally Comparable Plan (FCP)

The NED plan was the MN40K diversion. The NED plan provides the greatest net national economic benefit consistent with protecting the Nation's environment.

The LPP was the ND35K diversion. The LPP is the plan that, in the opinion of the non-federal sponsors, best meets the needs of the local community. The cities of Fargo and Moorhead, Cass County, North Dakota and Clay County Minnesota jointly requested that the ND35K plan be pursued as the LPP on March 29, 2010. The request to designate the LPP as the tentatively selected plan was approved by the Assistant Secretary of the Army for Civil Works on April 28, 2010.

The FCP was the MN35K diversion. Normally the NED plan establishes the basis for federal cost sharing of a locally preferred plan, but in this case the LPP provided fewer total annual economic benefits than the NED plan. Therefore, the FCP was used as the basis for federal cost sharing instead of the NED plan. The FCP is a plan that provides comparable total annual economic benefits to the LPP.

The May 2010 DEIS was released for public review on June 11, 2010. In September 2010 hydraulic modeling indicated that the ND35K plan would have more extensive downstream impacts than previously anticipated. Because of that, the decision was made to conduct additional analyses to identify ways to minimize downstream impacts from the LPP.

<u>April 2011 Supplemental Draft Feasibility Report and Environmental Impact Statement (SDEIS)</u>

Beginning in September 2010, several concepts to minimize downstream impacts of a North Dakota diversion plan were considered and studied. The final LPP and tentatively recommended plan is a revised version of the North Dakota diversion channel following the same basic alignment as the ND35K plan, but including additional features to minimize downstream impacts. The primary changes include reducing the diversion channel capacity, raising upstream tie-back levee elevations, adding a 50,000 acre-foot storage area and a 150,000 acre-foot staging area, and compensating most affected landowners within the storage and staging areas. The revised LPP minimizes downstream impacts, causes upstream impacts, and provides the same level of risk reduction to the Fargo-Moorhead Metropolitan area as the original LPP (ND35K).

The NED plan is the MN40K plan, and the FCP is the MN35K plan, as discussed above.

DESCRIPTION OF THE ND35K PLAN

The ND35K diversion alignment would start approximately four miles south of the confluence of the Red and Wild Rice Rivers and extend west and north around the cities of Horace, Fargo, West Fargo and Harwood. It ultimately would re-enter the Red River north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, MN. Along the 36 mile path it would cross the Wild Rice, Sheyenne, Maple, Lower Rush and Rush rivers and incorporate the existing Horace to West Fargo Sheyenne River diversion channel.

The basic North Dakota alignment is the same for the ND35K plan and the LPP; the alignment remained the same as in the earlier screening phase, except where it was adjusted northwest of Harwood, ND to avoid Drain 13.

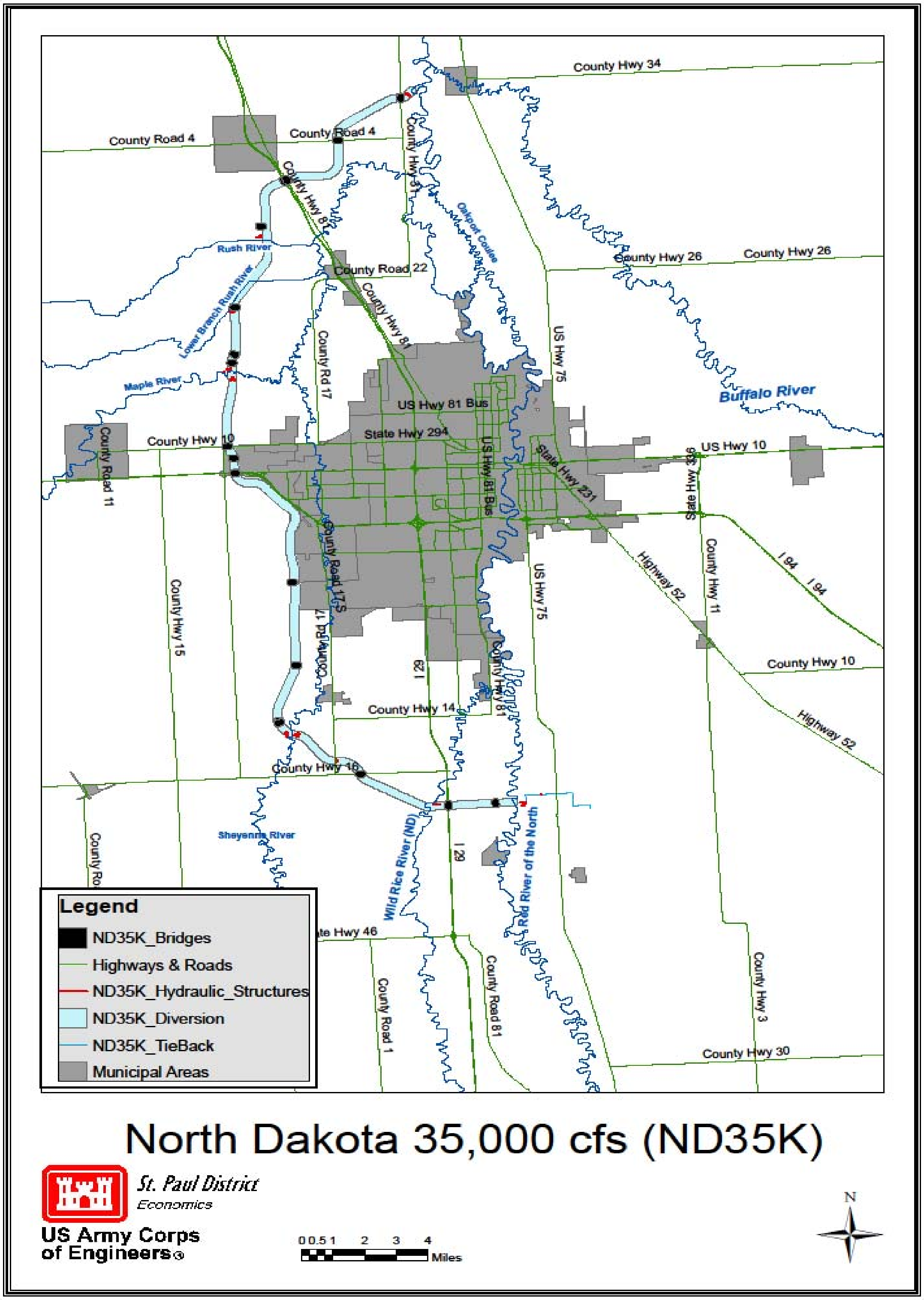
Two hydraulic structures would control the flows passing into the protected area during larger flood events; one on the Red River and the other on the Wild Rice River, with effective flow widths of 120 feet and 60 feet respectively. Both structures would become operable when the forecasted peak flow of the incoming hydrograph in the Red River of the North at the USGS gage in Fargo is greater than 9,600 cfs.

At the Sheyenne and Maple rivers, aqueduct structures would allow base flows to follow the natural river channels to maintain habitat in the natural channels. Flows in excess of a 50-percent chance event would be diverted into the diversion channel. The Lower Rush and Rush rivers would have drop structures that would drop the entire flow of those rivers into the diversion channel. The ND35K diversion channel would also have a tie-back levee that connects the Red River control structure to high ground approximately 2.5 miles to the east and prevents flood water from flowing over land to the north and east into the protected area.

The channel bottom width varies on the channel from 100 to 300 feet and has a maximum depth of 29 feet. The plan includes 18 highway bridges and 4 railroad bridges. The affected acreage is approximately 6,560 acres.

The ND35K plan provides the locally desired level of benefits and follows the locally preferred alignment in North Dakota. The ND35K plan would cause stage increases downstream. Figure 2 shows the alignment of the ND35K plan.

Figure 2 - ND35K Diversion Alignment.



DESCRIPTION OF THE MN35K PLAN (FEDERALLY COMPARABLE PLAN)

The MN35K diversion channel, the FCP, starts just north of the confluence of the Red River and Wild Rice Rivers and extends a total of 25 miles east and north around the cities of Moorhead and Dilworth, ultimately re-entering the Red River near the confluence of the Red and Sheyenne Rivers.

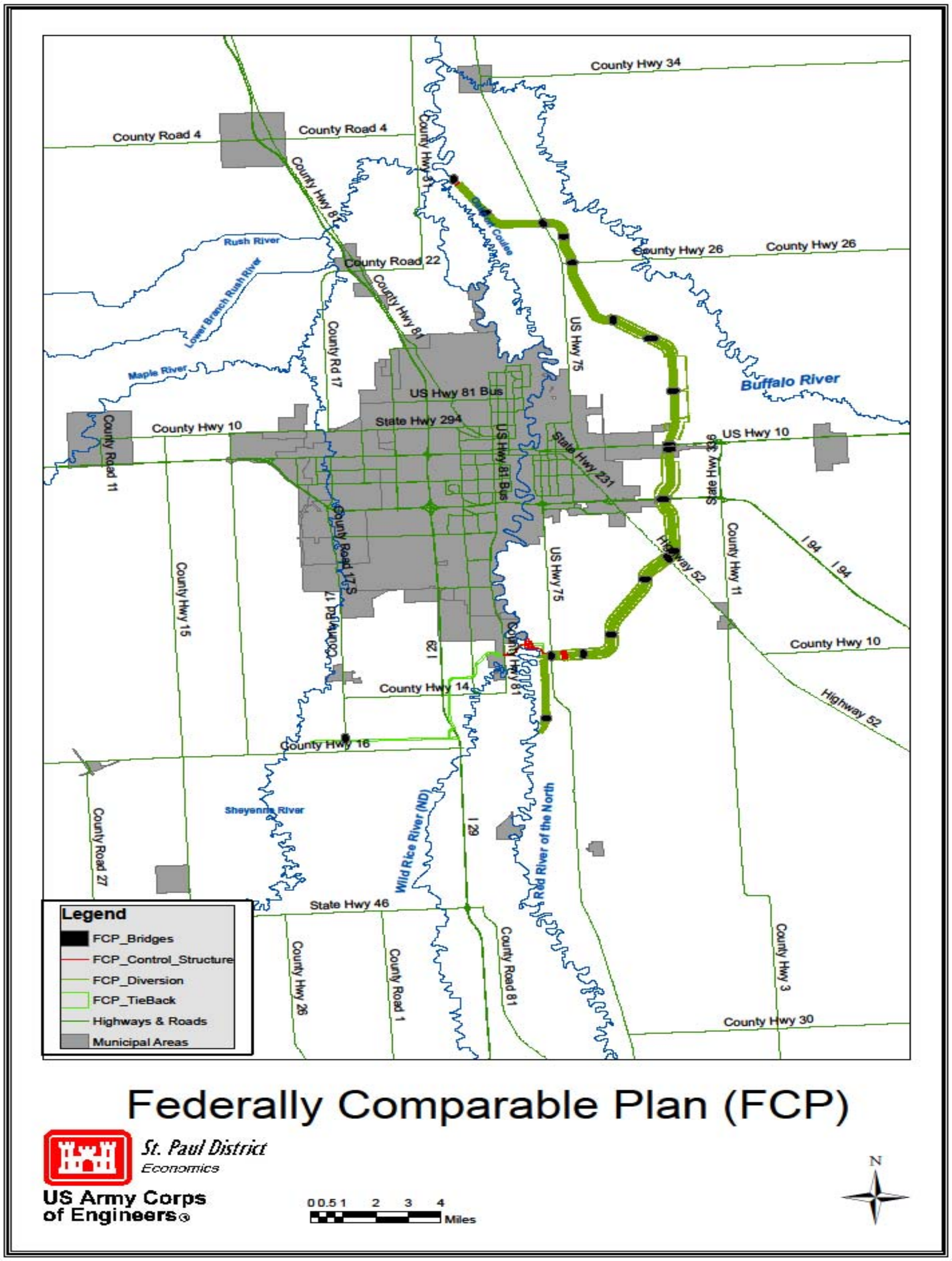
The plan includes a large control structure on the Red River which is an operable structure with three tainter gates. The gates would normally be fully open, and the structure would not impede flow up to a 9,600 cfs flow event when the structure would be put into operation.

The diversion channel has a maximum excavation depth of 30 feet with a maximum bottom width of 400 feet. The total footprint of the diversion channel and soil disposal piles has a maximum width of 2,800 feet, and will affect 6,415 acres of land.

In addition to the diversion channel, the plan includes two smaller channels upstream of the Red River control structure to prevent stage increases upstream of the project along the Red and Wild Rice Rivers. The plan also includes a 9.9 mile tie-back levee at the southern limits of the project. The tie-back levee connects the Red River control structure to high ground and prevents flood water from flowing overland to the north and west into the protected area.

Figure 3 shows the alignment of the FCP.

Figure 3 – Federally Comparable Plan (FCP) Diversion Alignment.



DESCRIPTION OF THE TENTATIVELY SELECTED AND LOCALLY PREFERRED PLAN (LPP)

The revised LPP diversion channel is the tentatively selected and locally preferred plan (LPP).

The LPP diversion alignment would start approximately four miles south of the confluence of the Red and Wild Rice Rivers and extend west and north around the cities of Horace, Fargo, West Fargo and Harwood. It ultimately would re-enter the Red River north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, MN. Along the 36 mile path it would cross the Wild Rice, Sheyenne, Maple, Lower Rush and Rush rivers and incorporate the existing Horace to West Fargo Sheyenne River diversion channel.

The basic North Dakota alignment is the same for the ND35K plan and the LPP; the alignment remained the same as in the earlier screening phase, except where it was adjusted northwest of Harwood, ND to avoid Drain 13. Some significant design changes were made for the LPP including the addition of staging and storage, along with optimization of the channel cross section. The plan includes 19 highway bridges and 4 railroad bridges that cross the diversion channel.

The LPP channel capacity was modified from previous phases to account for the storage and staging areas that were included. The inclusion of these areas allowed for the capacity of the diversion channel to be reduced to approximately 20,000 cfs. The diversion channel was designed to keep the 1-percent chance event flood flows below existing ground in the diversion channel as much as possible to limit impacts to drainage outside the channel.

Two hydraulic structures would control the flows passing into the protected area during larger flood events; one on the Red River and the other on the Wild Rice River, with effective flow widths of 150 feet and 60 feet, respectively. Both structures would become operable when the forecasted peak flow of the incoming hydrograph in the Red River of the North at the USGS gage in Fargo is greater than 9,600 cfs.

The diversion inlet structure is located where the diversion channel crosses Cass County Highway 17 south of Horace, ND. The outlet structure located where the diversion returns to the Red River of the North would be a concrete spillway.

At the Sheyenne and Maple rivers, aqueduct structures would allow base flows to follow the natural river channel. Flows in excess of a 50-percent chance event would be diverted into the diversion channel. The Lower Rush and Rush rivers would have drop structures that would drop the entire flow of those rivers into the diversion channel.

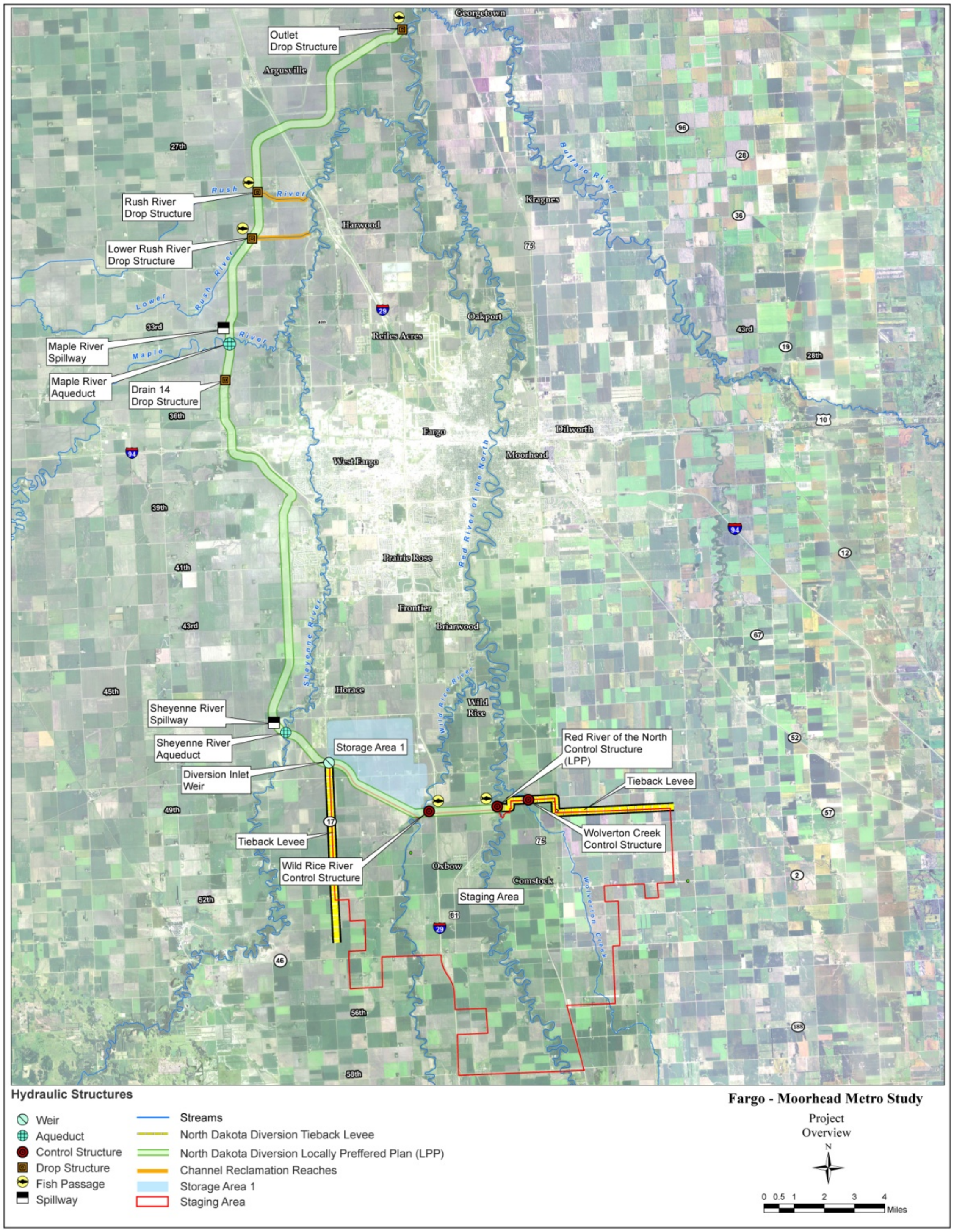
The depth of the diversion channel is approximately 20 feet, with a maximum depth of 35 feet. The channel bottom width varies on the channel from 100 to 250 feet. The total footprint of the LPP diversion channel has a maximum width of 2,200 feet including areas for soil disposal piles. The affected acreage is 8,054 acres.

The main line of flood protection at the south end of the project includes the embankments adjacent to the diversion channel, Storage Area 1 embankments, and a tie-back levee from the Red River control structure to high ground in Minnesota.

In order to eliminate downstream impacts, upstream staging and storage of approximately 200,000 acre-feet immediately upstream of the diversion channel inlet would be required. Figure 4 shows the area that would be affected by staging. Storage Area 1 is a 4,360-acre area on the north side of the LPP diversion channel between the Wild Rice River and the Sheyenne River that will be formed by nearly 12 miles of embankments and will provide 50,000 ac-ft. of storage. Storage Area 1, combined with staging in the floodplain, will nearly eliminate impacts from the project on flood levels downstream of the diversion channel outlet. A tie-back levee along Cass County Road 17 (CR17) would be included to keep staged water from crossing overland into the Sheyenne River.

Figure 4 shows the alignment and major features of the LPP.

Figure 4 – LPP Diversion Alignment and Features



The total estimated first cost (without interest during construction) of the LPP based on October 2011 price levels is $1,769,689,000, with the federal and non-federal shares of total first cost estimated at $785,106,000 and $984,583,000, respectively. The flood risk management features have an estimated total first cost of $1,733,834,000, with the federal and non-federal shares estimated at $767,178,000 and $966,656,000, respectively. The recreation features have an estimated total first cost of $35,855,000, with the federal and non-federal shares estimated at $17,927,000 and $17,927,000 respectively. The annual operation and maintenance costs are $3,664,000. The tentatively selected plan has an overall benefit-cost ratio of 1.77 and would provide in excess of 1-percent chance level of risk reduction for the Fargo-Moorhead Metro Area. Table 3 shows the breakout of the project first costs, interest during construction, and the project benefit cost ratio. Table 4 shows the breakout of project costs split between the non-federal sponsors and the federal government, along with the estimated cash contribution that is required.

Table 3 - Estimated Project Costs for the LPP (including interest during construction)

Estimate of Project First Costs LPP				
Account	**Item**	**Flood Risk Management**	**Recreation**	**Total**
01	Lands & Damages	273,172		273,172
02	Relocations	151,917		151,917
06	Fish and Wildlife Facilities	64,998		64,998
08	Roads, Railroads and Bridges	59,121		59,121
09	Channels & Canals	775,208		775,208
11	Levees and Floodwalls	141,376		141,376
14	Recreation Facilities		29,275	29,275
Subtotal		$ 1,465,792	$ 29,275	$ 1,495,067
30	Planning, Engineering and Design	182,753	4,486	187,239
31	Construction Management	85,289	2,094	87,383
Subtotal		$ 268,042	$ 6,580	$ 274,622
	Interest During Construction	295,008	740	295,749
	Total Investment Costs	**$ 2,028,843**	**$ 36,595**	**$ 2,065,438**
Estimate of Annual Costs				
	Annualized Project Costs	96,473	1,740	98,214
	Annual OMRR&R Cost	3,617	47	3,664
	Annual Induced Damages	-		-
	Total Annual Costs	**$ 100,090**	**$ 1,787**	**$ 101,878**
Average Annual Benefits				
	Flood Risk Management	162,800	0	162,800
	Flood Proofing Cost Savings	10,430	0	10,430
	Flood Insurance Administrative Costs	960	0	960
	Non Structural Flood Risk Benefit	627		627
	Recreation	-	5,130	5,130
	Total Annual Benefits	**$ 174,817**	**$ 5,130**	**$ 179,947**
	Net Annual Benefits	$ 74,727	$ 3,343	$ 78,069
	Benefit to Cost Ratio	1.75	2.87	1.77
All costs and benefits in thousands ($1,000)				

Table 4 – Allocation of funds table (first costs).

LPP			
Item	Federal ($)	Non-Federal ($)	Total ($)
Flood Risk Management			
Lands and Damages		273,172	273,172
Relocations	59,121	151,917	211,038
Fish and Wildlife Facilities	64,998		64,998
Channels and Canals	775,208	0	775,208
Levees and Floodwalls	141,376	0	141,376
Planning, Engineering, & Design	159,474	23,279	182,753
Construction Management	74,425	10,864	85,289
Cash Contribution	-507,424	507,424	0
Total FRM	767,178	966,656	1,733,834
Recreation			
Lands and Damages	0	0	0
Relocations	0	0	0
Recreation Facilities	29,275	0	29,275
Planning, Engineering, & Design	4,486	0	4,486
Construction Management	2,094	0	2,094
Cash Contribution	-17,927	17,927	0
Total Recreation	17,927	17,927	35,855
Total Project	785,106	984,583	1,769,689
All costs in thousands ($1,000)			

EFFECTS OF THE PROJECT

Implementing any of the diversion channel alternatives would result in a substantial beneficial effect on the local economy by significantly reducing flood damages and flood risk, improving public safety and peace of mind. All of the plans would remove much of the Fargo-Moorhead area from the regulatory floodplain. The LPP and ND35K would benefit a larger geographic area and more people than the FCP would. All of the diversion channel alternatives would significantly reduce flood damage and flood risk, but neither of the plans would completely eliminate the flood risk.

The diversion channel alternatives would change the flow and timing of water during flood events, significantly reducing the quantity of water flowing through the communities of Fargo-Moorhead. As a result, all alternatives will increase flood elevations and alter the timing of flooding for areas downstream and/or upstream of the Fargo-Moorhead Metropolitan Area. For the LPP, downstream impacts are nearly eliminated with the addition of upstream staging and storage. Upstream staging under the LPP diversion alternative will not substantially change flow velocities near the Red River channel banks during conditions when water is staged.

There are 4,626 acres of wetlands in the project area, which is less than 0.05% of the area within the project boundary. The FCP could impact approximately 906 acres of wetlands. The LPP and ND35K could impact approximately 998 acres and 895 acres, respectively. Any alternative would include appropriate measures to minimize and mitigate potential losses of wetland areas.

Groundwater resources in the project area include the Buffalo Aquifer and the West Fargo Aquifer. The Buffalo Aquifer, located five to seven miles east of Moorhead and a mile east of the Minnesota alignment, is not expected to experience measureable effects from the diversion channel. The West Fargo Aquifer appears to be deep enough to avoid adverse impacts from the North Dakota alignment. The three diversion channel alternatives are not expected to have adverse impacts to significant groundwater resources in the study area.

All of the diversion channel alternatives could alter hydraulic conditions for the Red River. The ND35K and LPP would also affect five tributaries and Wolverton Creek. However, none of the diversion channel alternatives would substantially alter sediment transport or other key geomorphic properties. Ultimately, it is not anticipated that any of the alternatives would substantially contribute to any adverse geomorphic conditions either downstream or upstream of the study area. And while channel slope could be increased for short areas adjacent to several project structures, careful project design should minimize any potential for destabilization of the stream bed or stream banks.

Connectivity and habitat for fisheries is a concern throughout the river basin and for all three diversion channel alternatives. Habitat connectivity is important in terms of fulfilling seasonal and life stage-specific habitat needs for river fish. The LPP could have a potentially significant impact to aquatic habitat connectivity on the Red and Wild Rice rivers. As such, the LPP includes several minimization and mitigation measures to reduce the level of this impact. The FCP and ND35K could slightly reduce the level of biological connectivity relative to existing conditions; however, any effects would be small. The FCP and ND35K include measures to minimize impacts to connectivity to levels that would be less than significant in terms of impacts to long-term Red River fish populations and community trends. The FCP will have the least impact to connectivity, as impacts are limited to the Red River mainstem. The ND35K would be slightly worse as connectivity could affect the Red and Wild Rice rivers. However, under these two alternatives, efforts were made to minimize impacts to connectivity. Any reductions to biological connectivity would be small and not anticipated to noticeably affect fish populations or communities of the Red River or associated tributaries. Ultimately, the LPP, FCP and ND35K could slightly reduce levels of biological connectivity to varying degrees. However, with proposed minimization and mitigation measures for each alternative, these reductions would be negated, and not significantly affect fish populations or communities, relative to existing conditions. The risk to fish stranding in the floodplain for the LPP will require additional consideration during development of the project operating plan, to include observation during the first few flood events to determine resulting stranding.

The FCP, LPP and ND35K would remove approximately 5,889, 6,878 and 6,540 acres of prime and unique farmland from operation, respectively. The plans would result in acquisition of farmland in Clay County, MN or Cass County, ND. All three diversion channel alternatives would result in a great deal of prime and unique farmland being impacted but the impact is considered to be less than significant based on the large quantity of farmland in the study area and the fact that over 90-percent of all farmland is considered prime and unique in this region.

Both the Minnesota and North Dakota alignments would require dwelling relocation and cause direct impacts to affected landowners. The LPP will require a substantial number of relocations for communities in the staging area. Owners would be justly compensated for their property and relocation.

Recreational features are included in all three diversion channel alternatives. Recreation features would include, but not be limited to, multipurpose trails, interpretive signage, benches, and trail heads with parking facilities. The recreation plan could result in a healthier, more vibrant community. The plantings associated with the recreation would aesthetically improve the area and enhance the overall experience. Recreational features could also add social and economic benefits to the metropolitan region.

RECOMMENDATIONS

The St. Paul District Engineer, after considering the environmental, social, and economic effects, the engineering feasibility, and comments received from the other resource agencies, the non-federal sponsors, and the public, has determined that the tentatively selected plan presented in this report is in the overall public interest and is technically sound, environmentally acceptable, and economically feasible. The St. Paul District Engineer recommends that the North Dakota East 20,000 cfs diversion channel with upstream staging and storage, and associated features described in this report be authorized for implementation as a federal project. This plan is being recommended with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

1.0 STUDY INFORMATION

1.1 STUDY AUTHORITY

The Fargo-Moorhead Metropolitan Area is part of the Red River of the North Basin. The Red River Reconnaissance Study was authorized by a September 30, 1974, Resolution of the Senate Committee on Public Works:

> *RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review reports on the Red River of the North Drainage Basin, Minnesota, South Dakota and North Dakota, submitted in House Document Numbered 185, 81st Congress, 1st Session, and prior reports, with a view to determining if the recommendations contained therein should be modified at this time, with particular reference to flood control, water supply, waste water management and allied purposes.*

The Fargo-Moorhead metropolitan area was included in the Red River Basin Reconnaissance Study approved on September 19, 2002, but the level of detail in that report was insufficient to recommend a feasibility study specifically for measures in Fargo, North Dakota, and Moorhead, Minnesota. A supplemental Reconnaissance Study for Fargo-Moorhead was approved by the Mississippi Valley Division on April 08, 2008.

Based on the recommendations contained in the Reconnaissance Report the City of Fargo, the City of Moorhead and the federal government entered into a Feasibility Cost Share Agreement on September 22, 2008. The study was cost shared 50/50 between the two non-federal sponsors and the federal government. Funds to initiate the feasibility study were provided in the Consolidated Appropriations Act, 2008, approved December 26, 2007 (Public Law 110-161). The Corps of Engineers issued a Notice of Intent to prepare an environmental impact statement (EIS) in the Federal Register on May 5, 2009.

The Federal Water Project Recreation Act of 1965 (Public Law 89-72), as amended, requires an agency to fully consider recreational features that may be associated with Federal flood risk management projects.

1.2 PURPOSE AND SCOPE

The purpose of this feasibility study was to identify measures to reduce flood risk in the entire Fargo-Moorhead Metropolitan Area. This report documents the plan formulation studies conducted by the St. Paul District of the U.S. Army Corps of Engineers in close cooperation with the non-federal sponsors.

The study objectives were as follows:

1) To understand the flood problems in the greater Fargo-Moorhead Metropolitan area and develop a regional system to reduce flood risk.

2) To determine the federal government's role in implementing flood risk management measures in Fargo-Moorhead.
3) To document study findings in a Feasibility Report and Appropriate National Environmental Policy Act (NEPA) document (either an Environmental Assessment or an Environmental Impact Statement).
4) If appropriate, recommend implementation of a federal project to the U.S. Congress.

The study team collected and evaluated pertinent engineering, economic, social, and environmental information needed to accomplish the study objectives. An array of possible flood risk management plans were considered and screened to define the costs, benefits, and impacts to the project area.

The study product is a decision document in the form of an integrated feasibility report and NEPA document in accordance with the Corps' Planning Guidance Notebook, Engineer Regulation (ER) 1105-2-100. The feasibility study investigated measures to reduce flood risk and analyzed the potential for federal participation in implementing a flood risk management project in the Fargo-Moorhead Metropolitan Area. This report will allow for tiering supplemental NEPA documentation as permitted by Council on Environmental Quality (CEQ) Regulation 40 C.F.R. 1508.28.

1.3 LOCATION OF THE STUDY AREA

The study location is shown on Figure 5. The geographic scope of analysis for the environmental impacts of the proposed action and alternatives encompasses the Fargo-Moorhead Metropolitan area plus areas in the floodplain of the Red River from approximately 300 river miles north of Fargo near Emerson, Manitoba to approximately 30 miles south of Fargo near Abercrombie, ND. The Fargo-Moorhead Metropolitan area is located within the area from approximately 12 miles west to 5 miles east of the Red River and from 20 miles north to 20 miles south of Interstate Highway 94. The Fargo-Moorhead area is shown on Figure 6.

The study area is located in the At Large Congressional District of North Dakota (Congressman Rick Berg - R) and Minnesota's Seventh Congressional District (Congressman Collin Peterson – D).

Fargo-Moorhead is located along the banks of the Red River of the North. The Wild Rice, Sheyenne, Maple and Rush Rivers in North Dakota and the Buffalo River in Minnesota also cross the study area. Fargo and Moorhead are on the west and east banks of the Red River of the North, respectively. The Red River of the North flows north approximately 453 river miles to Lake Winnipeg in Manitoba, Canada. The drainage area of the Red River of the North above the U.S. Geological Survey gauging station at Fargo is approximately 6,800 square miles, of which about 2,175 square miles do not contribute to runoff.

Figure 6 shows the Fargo-Moorhead Metro area and the topography on a color-shaded plot. Dark blue represents the lowest elevations and dark brown represents the highest elevations. This plot illustrates that the land, while generally very flat, slopes down from South to North.

Figure 5 - Fargo-Moorhead Location

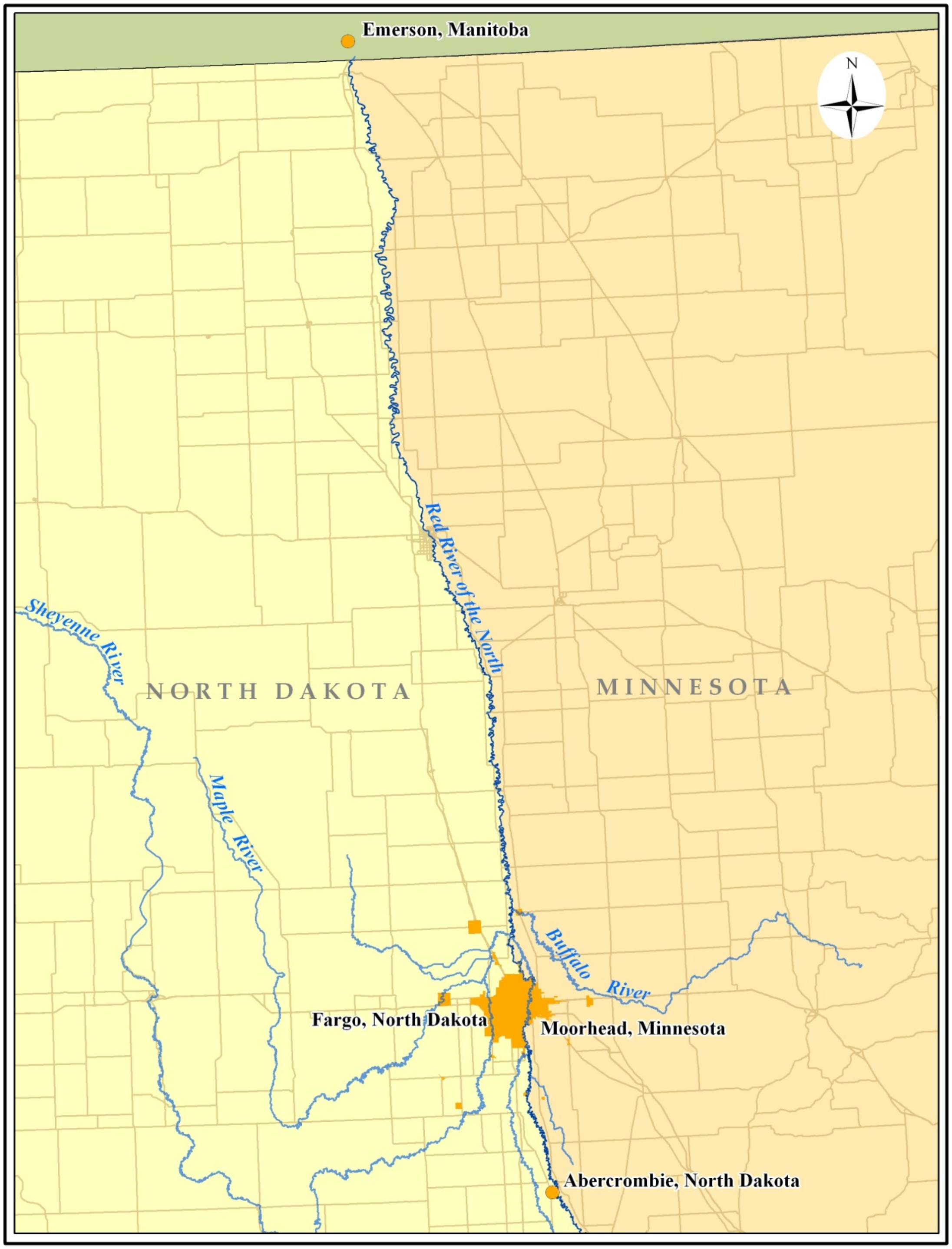
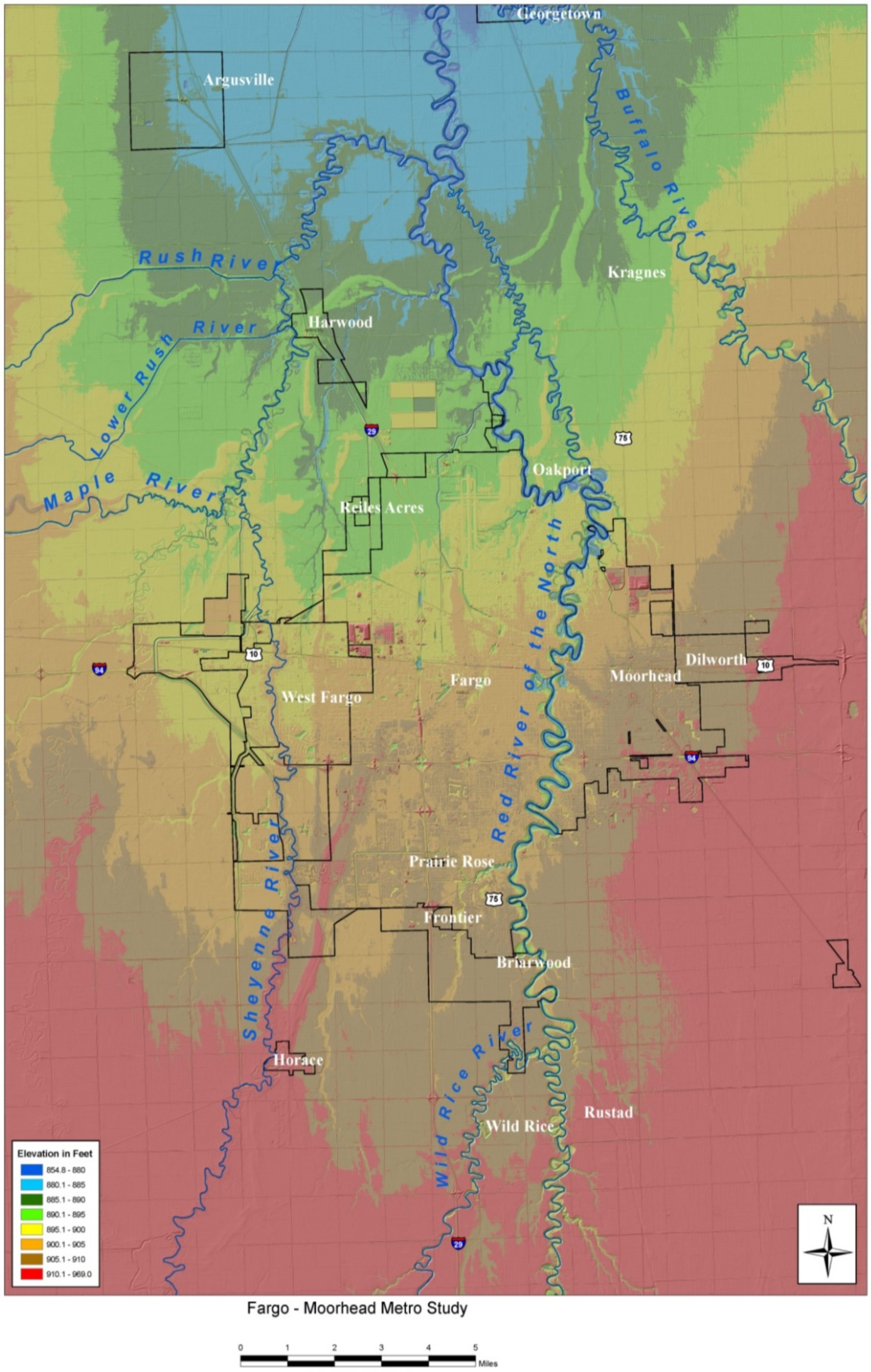


Figure 6 – Metro Area topography



1.4 HISTORY OF THE INVESTIGATION

The Fargo-Moorhead metropolitan area has a relatively high risk of flooding. The highest river stages usually occur as a result of spring snowmelt, but summer rainfall events can also cause significant flood damages. The Red River of the North has exceeded the National Weather Service flood stage of 18 feet in 48 of the past 109 years, and every year from 1993 through 2011. The study area includes the Wild Rice River, the Sheyenne River, and the Red River of the North; interbasin flows complicate the hydrology of the region and contribute to extensive flooding. Current estimates of the average annual flood damages in the Fargo-Moorhead metropolitan area are over $194.8 million.

In June, 2006, the City of Fargo requested that the Corps study a floodwall concept along 2nd Street near City Hall under the Section 205 continuing authority. Discussion with the cities of Fargo and Moorhead led to an expansion of the scope of study to include the entire metropolitan area. Funds to conduct a Reconnaissance study were received in April 2007, and the Reconnaissance study was completed in April 2008. The Corps and the cities of Fargo and Moorhead began the Fargo-Moorhead Metro feasibility study in September 2008. The flood of 2009 heightened awareness of the flood risk in the study area and significantly increased public and political interest in study activities.

Fargo, Moorhead and the other communities in the study area have become accustomed to dealing with flooding. Sufficient time is usually available to prepare for flood fighting, because winter snowfall can be monitored to predict unusual spring runoff. The communities have well documented standard operating procedures for flood fights. Fargo and Moorhead avoided major flood damages in the historic floods of 1997 and 2009 by either raising existing levees or building temporary barriers. After the 1997 flood, both communities implemented mitigation measures including acquisition of nearly 100 floodplain homes, raising and stabilizing existing levees, installing permanent pump stations and improving storm sewer lift stations and the sanitary sewer system. These actions paved the way for a successful flood fight during the record-setting 2009 flood event. The communities have continued to buy flood-prone homes and improve flood-related infrastructure in the wake of the 2009 flood. Although emergency measures have been very successful, they may also contribute to an unwarranted sense of security that does not reflect the true flood risk in the area.

1.5 PRIOR REPORTS AND EXISTING PROJECTS

1.5.1 Reports

Since the 1940s, the Corps of Engineers and others have prepared numerous reports on the Red River of the North basin. The following reports contain the most relevant information for the current effort:

1.5.1.1 House Document 185, 81st Congress, 1st Session, dated May 24, 1948. This report proposed a comprehensive plan for the Red River of the North basin. The plan included channel improvements, levees and floodwalls in Fargo and Moorhead. Other components of the plan included the Orwell Reservoir on the Ottertail River in Minnesota; channel improvements on the lower Sheyenne, Maple and Rush Rivers in North Dakota; channel improvements on the Mustinka, Ottertail, Wild Rice, Marsh and Sand Hill Rivers in Minnesota; channel improvements along the Bois de Sioux and upper Red Rivers near Wahpeton, North Dakota/Breckenridge, Minnesota; and local flood protection works on the Red River in Grand Forks, North Dakota/East Grand Forks, Minnesota. The study found that channel improvements along the lower 31.6 miles of the Wild Rice River in North Dakota were economically justified, but the majority of affected local interests did not support the project, so it was not recommended. The report specifically recommended no further investigations in the Buffalo River basin and several other basins in Minnesota.

1.5.1.2 Section 205, Flood Control Reconnaissance Report, Red River of the North at Fargo, North Dakota, Corps of Engineers, May 1967. This study evaluated the potential to build a portion of the levee in Fargo that had been approved as part of the 1948 comprehensive plan but was later omitted from the constructed project. The study concluded that the proposed project was not economically feasible and did not warrant further Federal involvement at that time.

1.5.1.3 Fargo-Moorhead Urban Study, Corps of Engineers, May 1985. This study was a cooperative Federal, State and local planning effort aimed at developing viable solutions to water and related land resource problems, needs and concerns for 1980 to 2030. The study area encompassed 13 townships in Cass County, North Dakota and Clay County, Minnesota. The study addressed water supply, water conservation, flood risk management, energy conservation and water resources data management. The study evaluated the potential to construct levees, floodwalls and channel modifications in Fargo and Moorhead. The report concluded that extremely long levees or floodwalls would be required to ring the urban areas to provide adequate protection from larger floods and the costs would greatly exceed the damages prevented. Therefore, Federal participation in Fargo and Moorhead flood risk management projects was not recommended. However, the report did support further studies for flood control in Harwood and Rivertree Park, North Dakota.

1.5.1.4 "Living with the Red," International Joint Commission, November 2000. In June 1997, following record-setting flooding on the Red River of the North, the governments of Canada and the United States asked the International Joint Commission (IJC) to examine and report on the causes and effects of damaging floods in the Red River basin and to make recommendations on means to reduce, mitigate and prevent harm from future flooding." The IJC established the International Red River Basin Task Force to undertake the necessary studies. The task force produced its report in April 2000. The IJC's report, entitled "Living with the Red," was completed in November 2000. These reports included discussion of the flooding in the Fargo-Moorhead area. The report cited hydraulic and hydrologic analyses conducted after the 1997 flood that indicated flood risks in the Fargo-Moorhead area were likely greater than previously thought. The report supported a basin-wide flood mitigation approach including reduction in flows, strengthening of existing protection structures and use of other techniques. The report recommended that Federal, State and local governments should "expedite the study of flood risk potential and implement plans for flood protection measures for the Fargo-Moorhead area."

1.5.1.5 Reconnaissance Study, Red River Basin, Minnesota, North Dakota, South Dakota, Corps of Engineers, September 2001. This study, supported by supplemental information, was approved in October 2002. The study recommended three initial feasibility studies to be followed by additional studies throughout the basin. Only the initial three studies were approved in 2002. The additional proposed studies would be considered for approval on the basis of additional 905(b) analyses. The Fargo-Moorhead and Upstream feasibility study, currently underway, was one of the initial studies recommended and approved in the reconnaissance study.

1.5.1.6 Final Environmental Impact Statement (FEIS) for the Red River Valley Water Supply Project, U.S. Department of the Interior, Bureau of Reclamation, December 21, 2007. The purpose of the proposed project is to meet the comprehensive water quality and quantity needs of the Red River Valley through the year 2050. The needs were identified as municipal, rural and industrial water; water quality; aquatic environment; recreation; and water conservation measures. The preferred alternative would import water to the Red River basin from the Missouri River via the Garrison Diversion and the Sheyenne River.

1.5.1.7 Fargo-Moorhead Downtown Framework Plan Update, Fargo-Moorhead Council of Governments, City of Fargo, and City of Moorhead, June 2007. This report builds upon earlier planning efforts in both Fargo and Moorhead. Many of the concepts presented depend on implementation of effective flood risk management strategies.

1.5.2 Current Studies

The following studies are being conducted:

1.5.2.1 Fargo-Moorhead and Upstream Feasibility Study, Corps of Engineers. The study began in August 2004. The study area is the entire headwaters of the Red River of the North upstream (south) of the Fargo-Moorhead metropolitan area. The major tributaries are the Mustinka, Bois de Sioux and Ottertail Rivers in Minnesota and the Wild Rice River in North Dakota. The study is evaluating alternatives that would restore wetland habitat and reduce flood damages. The major underlying assumption is that a system of surface water storage sites upstream of Fargo-Moorhead would reduce flood stages and flood damages downstream. It is also assumed that water storage could be accomplished in ways that would restore aquatic ecosystems and increase habitat for wildlife. Phase 1 analyses, completed in June 2005, showed that distributed flood storage could provide significant economic benefits, but additional study of environmental benefits is needed to justify a Federal project. The North Dakota State Water Commission and the City of Moorhead are jointly sponsoring the study. Additional cost-share partners include the Southeast Cass Water Resource District; Richland County Water Resource District; Red River Joint Water Resource District; city of Fargo; Buffalo-Red River Watershed District; Bois de Sioux Watershed District; Minnesota Department of Natural Resources; Minnesota Board of Water and Soil Resources; Minnesota Pollution Control Agency; South Dakota Department of Game, Fish, and Parks; and Red River Basin Commission.

1.5.2.2 Fargo Southside Flood Control Project, City of Fargo, North Dakota. After the 1997 flood, the city of Fargo and the Southeast Cass County Water Resource District conducted planning for a flood risk management project to protect developments in the area south of Fargo and north and west of the Wild Rice River up to 4 miles south of its confluence with the Red River. Several alternatives were explored, including combinations of levees, diversion channels, channel modifications and flood storage. The Southside study was discontinued when it was overcome by the Fargo-Moorhead Metro feasibility study (the subject of this report). The Southside study will resume only if no federal project is recommended to address flooding in the area south of Fargo.

1.5.2.3 Oakport Township, Minnesota. The Buffalo-Red River Watershed District is working on a flood risk management project for Oakport Township. The project is designed to protect areas of town to a level equal to the 2009 flood plus 3 feet. The project includes ring levees on either side of Oakport Coulee and buying several homes that cannot be protected by the levee system. A Corps of Engineers study performed under the Section 205 Continuing Authority was terminated in December 2002 after it was determined that national economic benefits were insufficient to support further Federal efforts.

1.5.2.4 Flood Insurance Study Update, Federal Emergency Management Agency (FEMA). FEMA is updating the flood insurance maps for the Fargo-Moorhead area. As a result of recent flood events and revised hydrologic and hydraulic modeling, FEMA is likely to increase the 1-percent-chance flood elevation on the order of 1 foot above the current administratively determined elevation. Two studies have defined the hydraulics and hydrology in the area. The Stanley and Pleasant Townships, Cass County, ND and Holy Cross and Kurtz Townships, Clay County, MN Flood Insurance Study addresses the area south of Fargo, ND. The City of Fargo, North Dakota Flood Insurance Study addresses the Fargo-Moorhead area.

1.5.2.5 Non-federal studies. There are a number of ongoing non-federal studies in the watershed upstream of the study area analyzing the potential for flood storage on the Wild Rice River, Sheyenne River, Maple and Rush rivers.

1.5.3 <u>Existing Water Resource Projects</u>

1.5.3.1 The Lake Traverse project, including White Rock Dam and Reservation Dam, provides flood storage at the headwaters of the Bois de Sioux and Red River of the North. The project was authorized by the 1936 Flood Control Act and construction was completed in 1948. The project is operated by the Corps of Engineers, St. Paul District.

1.5.3.2 Baldhill Dam and Lake Ashtabula provide water storage for flood control and water supply on the Sheyenne River. The project was authorized by the 1944 Flood Control Act and construction was originally completed in 1951. The dam was modified in 2004 to raise the flood control pool by 5 feet. (The pool raise was part of the Sheyenne River project described in section 1.5.3.10 below.)

1.5.3.3 The Orwell Dam provides water storage for flood control and water supply on the Otter Tail River. The dam was included in the Corps' 1947 comprehensive plan for the Red River basin and authorized by the Flood Control Acts of 1948 and 1950. Construction of the dam was completed in 1953; it provides 8,600 acre-feet of flood storage.

1.5.3.4 Fargo levees: The Corps participated in a permanent flood control project completed in Fargo in 1963. The project was recommended in the Corps' 1948 comprehensive plan for the

Red River basin and authorized by the Flood Control Acts of 1948 and 1950. The project included four channel cutoffs, the Midtown Dam and a 3,500-foot levee east of Fourth Street South between First Avenue South and Tenth Avenue South. The top of levee is at approximately a 40.0-foot stage. The city later extended the levee south to Thirteenth Avenue. Fargo has several other publicly and privately owned sections of levee and floodwall throughout the city. The current line of protection has top elevations that vary from a stage of 30 feet to 42 feet, but most reaches are at or below 37 feet. (Note: the proposed new FEMA 1-percent-chance flood stage is expected to be approximately 39.3 feet.)

1.5.3.5 Moorhead levees: There are no federally constructed levees in Moorhead. The Corps proposed a 1,800-foot-long levee in the 1948 comprehensive plan for the Red River basin. It was authorized by the Flood Control Acts of 1948 and 1950, but the city declined to participate in the project. The city has built four small levees and several lift stations and control structures on storm water lines that can be closed or operated during high-water events. The city has also installed valves on the sanitary sewer lines at several individual flood-prone residences to prevent floodwater from inundating the system. The city also builds emergency levees when necessary.

1.5.3.6 Rush River Channel Improvement: The Corps participated in the channel improvement project completed in 1956. The improvement was authorized by the Flood Control Acts of 1948 and 1950. The project extends along the Rush River from a point near Amenia, North Dakota to the mouth at the Sheyenne River. The improvements consist of channel clearing, enlargement and straightening. Appurtenant construction in connection with the project includes stone riprap at bridges, a drop structure, stone protection at three culvert outlets and ditching. The project provides flood risk management for the flood plain lying adjacent to the channel improvement by confining all flood levels up to those having an occurrence frequency of about once in 10 years.

1.5.3.7 Lower Rush River Channel Improvement: The improvements were authorized under provisions of Section 205 of the 1948 Flood Control Act, as amended. The project, constructed to provide agricultural flood risk management, was completed in November 1973. The improvements consist of channel enlargement and straightening along the Lower Branch of the Rush River. The work extends from mile 17.3 to the confluence with the Sheyenne River.

1.5.3.8 Argusville, ND Levee: The project was authorized under Section 205 of the 1948 Flood Control Act, as amended. Construction was completed in 1990. The flood risk management consists of about 1.9 miles of earth levees with an average height of 8 feet that encircles the city of Argusville. This includes sandbag closures at two railroad and four road crossings and raised roadways at three locations. Levees on the north and east sides of the city have a design top elevation of 891.1 feet including 3 feet of freeboard above design flood level. Levees on the south and west sides of the city have a design top elevation of 888.6 feet. The project is designed to provide the city with protection against the estimated 1 percent chance flood event.

1.5.3.9 Halstad, MN Levee: The project was authorized under the provisions of Section 205 of the Flood Control Act of 1948, as amended. The flood barrier consists of 2.41 miles of earth levee, eight emergency closures and road raises on Trunk Highways 75 and 200. Interior flood control facilities consist of 4 ponding areas with gravity outlets and sluice gates, 464 feet of twin 66-in interceptor pipes and 350 feet of interceptor ditch. Additionally, there are small ditches and drainage swales alongside the toe of the levees. Once the closures are in place the city is provided with flood risk management against a 250-year flood event on the Red River of the North.

1.5.3.10 The Sheyenne River project was authorized by the 1986 Water Resources Development Act. The project originally included four components: a 5-foot raise of the Baldhill Dam flood control pool; a dam on the Maple River to provide approximately 35,000 acre-feet of; a 7.5-mile flood diversion channel from Horace to West Fargo, North Dakota; and a 6.7-mile flood diversion channel at West Fargo. The Southeast Cass Water Resource District and the St. Paul District, Corps of Engineers, signed cost-share agreements for the West Fargo Diversion project in 1988 and the Horace to West Fargo Diversion in 1990. The diversion projects were substantially completed in 1993 and 1994. A pump station was added to the West Fargo project in 2003 and emergency generators were provided in 2007. The Maple River dam was de-authorized in 2002 for federal participation, and the Southeast Cass Water Resource District completed the project without federal assistance in 2007. The Maple River dam has a storage capacity of 60,000 acre-feet. These projects reduce flood risk for the cities of Horace and West Fargo and the west side of Fargo from Sheyenne River flooding. From Horace to West Fargo, the system is designed for a 1-percent chance event plus 2 feet. At West Fargo, the channel and left descending bank levee contain the 1-percent chance event plus 2 feet, and the right descending bank levee is higher, providing the city with protection from the Standard Project Flood plus 3 feet. The Standard Project Flood is defined as the volume of streamflow expected to result from the most severe combination of meteorological and hydrologic conditions which are reasonably characteristic of the geographic region involved, excluding extremely rare combinations. Although these features reduce the risk associated with Sheyenne River flooding, these cities are still potentially affected by floods on the Wild Rice and Red Rivers that are larger than approximately a 0.5-percent chance event.

1.5.3.11 A Section 208 (1954 Flood Control Act) clearing and snagging project was completed in Fargo-Moorhead in 1991. The project cleared and snagged trees affected by Dutch elm disease that would otherwise have caused stage increases in the Red River. Dead and dying trees were removed along a 9.7-mile reach of the Red River of the North.

1.5.3.12 Three Section 14 (1946 Flood Control Act) emergency streambank protection projects were completed in Fargo between 2001 and 2003. Erosion from the Red River of the North occurred at three separate project locations. At Reach A, erosion along 4,100 feet of riverbank threatened a levee near 37th Avenue. At Reach B, erosion along a 950-foot reach threatened Kandi Lane and North Broadway and utilities located beneath them. At Reach C, erosion along a 1,900-foot reach threatened Elm Street between 13th and 17th Avenues North and the utilities located beneath it. The erosion progressed to within 50 feet of the roadway. The projects involved shaping the banks and placing rockfill or granular fill and riprap along the eroded areas.

1.5.3.13 Two Section 206 (1996 Water Resource Development Act) aquatic ecosystem restoration projects were implemented to improve fish passage over two dams on the Red River within the metropolitan area. Rock slope fishways were constructed at the 12th Avenue North Dam and the 32nd Avenue South Dam in 2002 and 2004, respectively. A similar fishway was constructed at the Midtown Dam in 1998 without Corps construction assistance.

1.5.3.14 A Section 205 (1948 Flood Control Act) project known as the Fargo-Ridgewood project is located on the north side of Fargo in the Ridgewood area, along the west bank of the Red River of the North. The project consists of levees, floodwalls, pump stations and associated interior drainage structures along a line of protection 4,200 linear feet long. The project is designed to provide flood risk management to the Ridgewood neighborhood and a Department of Veterans Affairs (VA) hospital. The project will reduce risk to the Department of Veterans Affairs (VA) hospital and that portion of Fargo between 15th Avenue North and 22nd Avenue North. High ground at the ends of the project is at elevation 899.5 feet. However the top elevation of the levees is at elevation 902.6 feet. The construction of this project was substantially complete in the fall of 2010. The project successfully provided a line of protection during the March 2010 flood event.

1.5.3.15 Non-federal emergency levees:
Georgetown, MN: The existing levee in Georgetown has a minimum top elevation of 883.3 (NAVD 1988). The levee was raised by the Corps during the 2009 flood. The Corps hired a contractor to restore the dike so that now west of Highway 75 the levee varies from 883.3 to 884.2 (NAVD1988). East of Highway 75, the levee was restored to 884.4. Highwater marks taken after the 1997 flood were used to set the elevation for the levee. There is no written operation plan for this levee. The 23 culverts through the levee are equipped with flapgates and close automatically. The locals place sandbags over these gates to ensure their closure and minimize leakage during large flood events.

Perley, MN: The current system consists of emergency flood levees built in 1970 after extensive damage occurred during the 1969 spring flood. Improvements were made in 1975 and 1997. The levee consists of two reaches and 2 closures. Reach 1 is constructed to elevation 877.5 ft (NGVD 29), and Reach 2 is constructed to elevation 878.4 feet (NGVD 29). The design is to a level of 2 feet above the 1997 flood. Currently the city is working on raising the levee to 3 feet above the 2009 flood.

Hendrum, MN: Two separate reaches were constructed in anticipation of flooding from the Red River in July 1975 and the levee was most recently modified in 1998. The levee consists of 3 reaches and requires 4 closures. The minimum levee elevations for reaches 1, 2, and 3, are 873.7, 873.1, and 873.1 feet, respectively (NGVD 29). The current design is to a level of 2 feet above the 1997 flood. Currently the city is working on raising the levee to 3 feet above the 2009 flood.

Kragnes, MN: After the Spring 2009 flood, most of the project embankments that could be raised were raised. The current elevation of the embankments is 893.5 (NAVD1988). However, Highway 75 provides protection to roughly elevation 892.5 (NAVD1988). The roads in the area - County State Aid Highway (CSAH) 26, County Road 96, and Highway 75 - provide most of the embankments that protect Kragnes. The pipes through these roads have been installed with screwgates to prevent water from flowing into the triangular area formed by these three roads. In general, to provide protection in excess of 892.5 (NAVD1988) requires building embankments along the roads. County Road 96 provides protection that is slightly higher than this elevation and CSAH 26 is a few feet higher still. The Highway 75 overtopping elevation had to be raised by building a clay embankment along a stretch of the east shoulder in the spring of 2009 to prevent the floodwaters from overtopping the highway to the west. Water breaks out of the Buffalo River and floods northwesterly toward Kragnes. 2009 is the first flood that would have overtopped Highway 75 between CSAH 26 and CSAH 5.

Shelly, MN: The city's levee system consists of two reaches. Reach 1 is a 2000 foot levee constructed to an elevation 868.8 (NGVD 29). It protects the property north of Highway 3 that runs through town. Reach 2, which is 545 feet long, protects the portion of the city located south of Highway 3. Reach 2 is constructed to an elevation of 867.0 feet (NGVD 29). The last modification to this system was made in 1999 and the design is to a level of 2 feet above 1997 flood. However, the levee does not encircle the town and fill needs to be placed to complete the protection. The city is currently contemplating raising the level of protection to 3 feet above the 2009 flood.

Harwood, ND: The city's levee system consists of two main reaches and several smaller reaches along Interstate 29, including one sandbag closure and a breach controlled section. The system provides protection up to a flood elevation of 892.8 (NAVD88). When the flood elevation reaches 891.0 (NAVD88) and is projected to reach above the elevation of 892.8, additional work is done within the I-29 right-of-way. The highest record peak flood elevation on the Sheyenne River at Harwood, ND reached an elevation of 892.02 (NAVD88) in April of 1997.

Oxbow, ND: The city has a levee system. *More information on the levee system will be included in the Final EIS.*

1.5.3.16 Other non-Federal projects. There are a number of local retention projects that have been constructed upstream of the study area including: Three dams constructed on the upper portion of the Wild Rice River, Dead Colt Creek Dam on a tributary of the Sheyenne, the T-180 dam on a tributary of the Maple, three dams on tributaries of the Maple River, Erie Dam located on the upper portion of the Rush River, and three dams located on Elm River.

1.6 PLANNING PROCESS AND REPORT ORGANIZATION

The planning process consists of six major steps which are generally taken in order and are an iterative process. The steps are: (1) Specification of water and related land resources problems and opportunities; (2) Inventory, forecast and analysis of water and related land resources conditions within the study area; (3) Formulation of alternative plans; (4) Evaluation of the effects of the alternative plans; (5) Comparison of the alternative plans; and (6) Selection of the recommended plan based upon the comparison of the alternative plans.

The chapter headings and order in this report generally follow the outline of an Environmental Impact Statement. Chapters of the report relate to the six steps of the planning process as follows:

- The second chapter of this report, Need for and Objectives of Action, covers the first step in the planning process (Specification of water and related land resources problems and opportunities).

- The third chapter of this report, Alternatives, is the heart of the report and is therefore placed before the more detailed discussions of resources and impacts. It covers the third step in the planning process (Formulation of alternatives), the fifth step in the planning process (Comparison of alternative plans), and the sixth step of the planning process (Selection of the recommended plan based upon the comparison of the alternative plans).

- The fourth chapter of this report, Affected Environment, covers the second step of the planning process (Inventory, forecast and analysis of water and related land resources in the study area).

- And, the fifth chapter of this report, Environmental Consequences, covers the fourth step of the planning process (Evaluation of the effects of the alternative plans).

2.0 NEED FOR AND OBJECTIVES OF ACTION *

This chapter presents the results of the first step of the planning process, the specification of water and related land resources problems and opportunities in the study area. The chapter concludes with the establishment of planning objectives and planning constraints, which is the basis for the formulation of alternative plans.

2.1 NATIONAL OBJECTIVES

The national or federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. Contributions to national economic development (NED) are increases in the net value of the national output of goods and services expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation as a result of the project.

The Corps has added a second national objective for Ecosystem Restoration in response to legislation and administration policy. This objective is to contribute to the nation's ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

2.2 PUBLIC CONCERNS

A number of public concerns have been identified during the course of the study. Initial concerns were expressed in the Sponsors' study request. Additional input was received through coordination with the sponsors, coordination with other agencies, public review of draft and interim products, and through public meetings. A discussion of public involvement is included in Chapter 6, Public Involvement, Review and Consultation. The public concerns that are related to the establishment of planning objectives and planning constraints are as follows:

- Flooding and impacts to rural and urban infrastructure
- Potential for flood risk management measures employed in one place to increase flood stages or impact water quality elsewhere
- Desire for additional flood storage in the watershed
- Desire for wetland and grassland restoration in the watershed
- Desire for increased recreational opportunities in the study area
- Need to protect limited groundwater resources
- Need to protect riverine habitat and connectivity

2.3 HISTORY AND FUTURE WITHOUT PROJECT CONDITIONS

2.3.1 Flood History

The Fargo-Moorhead metropolitan area has a relatively high risk of flooding; average annual flood damages in the metropolitan area are estimated at more than $194.8 million (see Appendix C, Economics). The highest river stages usually occur as a result of spring snowmelt. Summer rainfall events have also caused significant flood damages, although this flooding is usually related to the capacity of the storm sewer system rather than high river stages.

The Red River of the North has exceeded the National Weather Service flood stage of 18 feet in 48 of the past 109 years, and every year from 1993 through 2011. The study area includes the Buffalo River, Wild Rice River (ND), the Sheyenne River and the Red River of the North as shown in Chapter 1, Figure 1; interbasin flows complicate the hydrology of the region and contribute to extensive flooding. The record-setting Red River of the North flood stage in 2009 at Fargo was 40.82 feet on the Fargo gage.

Official estimates vary for the 1-percent chance event flow and stage. The current base flood elevation (1-percent chance event) established by the Federal Emergency Management Agency (FEMA) corresponds to a stage of 38.3 feet on the Fargo gage. FEMA is proposing a revised 1-percent chance event flow of 29,300 cubic feet per second (cfs) and stage of 39.3 feet based on flood insurance studies completed after the 1997 flood event. The hydrologic record of the Red River of the North shows a trend of increasing magnitude and frequency of flooding in recent decades. Figure 7 – Natural annual maximum mean daily flow on the Red River at Fargo shows the natural annual maximum mean daily flow on the Red River at Fargo for the period of record. Figure 8 – Annual peak stages on the Fargo gage (Gage 0 = elev. 862.74 NAVD 1988) shows annual peak stages for the period of record.

Figure 7 – Natural annual maximum mean daily flow on the Red River at Fargo

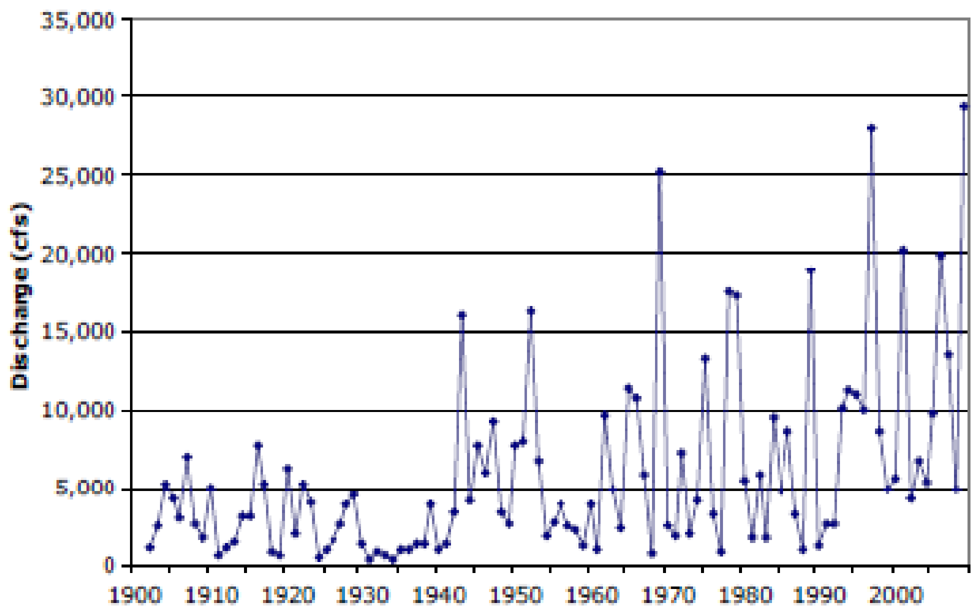
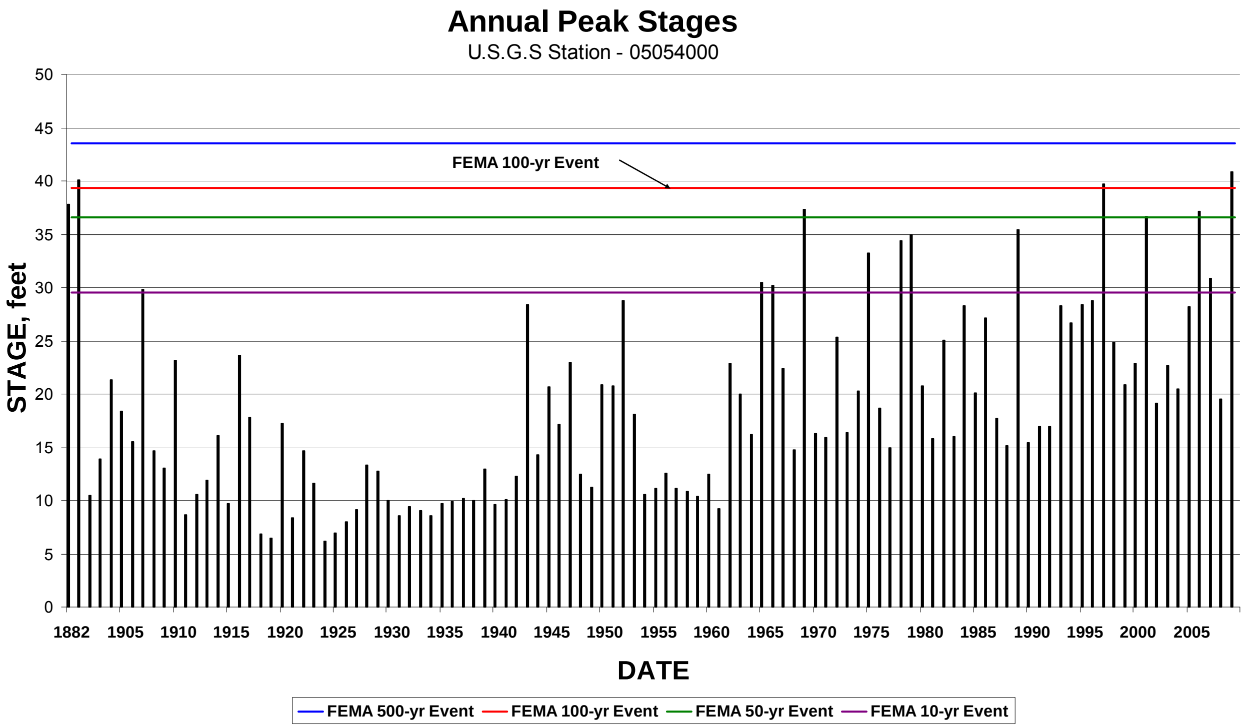


Figure 8 – Annual peak stages on the Fargo gage (Gage 0 = elev. 862.74 NAVD 1988)



A panel of experts in hydrology and climate change was convened to elicit opinions on how to appropriately reflect this trend in the current analysis (see Appendix A, Hydrology). The panel concluded that the hydrologic record showed a “dry” period in the early decades and a “wet” period in later years continuing to the present. The panel recommended developing revised flow frequency curves separately for the dry and wet periods and then combining the curves using probabilistic assumptions about future conditions. On the basis of the panel’s recommendations, revised flow frequency curves were developed which show the 1-percent chance event flow to be approximately 34,700 cfs at present; 32,900 cfs in 2035; and 31,300 cfs in 2060. The hydraulic modeling developed for this feasibility study and calibrated to the 2009 flood event indicated that a flow of 34,700 cfs at the Fargo gage would produce a stage of 42.4 feet (See Appendix B, Hydraulic Engineering). The analyses described in Section 3.4 of this report were based upon the Expert Opinion Elicitation (EOE) panel’s hydrologic recommendations, which result in significantly higher stages for the 1-percent chance event than what FEMA is proposing to use for the National Flood Insurance Program.

Figure 9 through Figure 12 show the proposed FEMA 10, 50, 100 and 500-year existing flooded areas truncated to the area inside the proposed diversion alignments. Note: the following figures illustrate the areas potentially benefited by the project, but they do not show the entire floodplain in the study area. This was done to focus on the benefits the project would provide to the Fargo-Moorhead Metropolitan area.

Figure 9 – Existing 10-Year floodplain (10-percent chance)

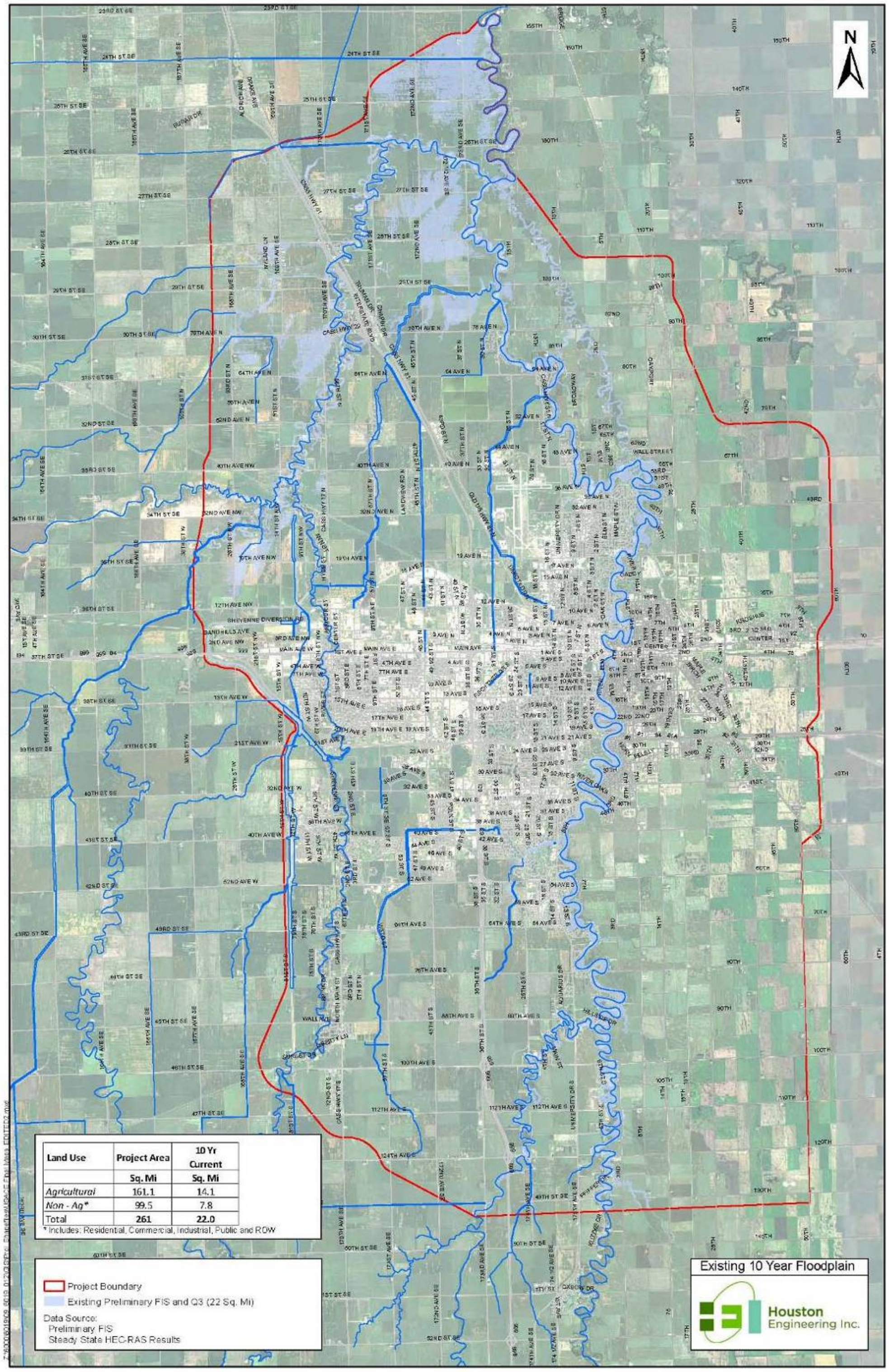


Figure 10 – Existing 50-year floodplain (2-percent chance)

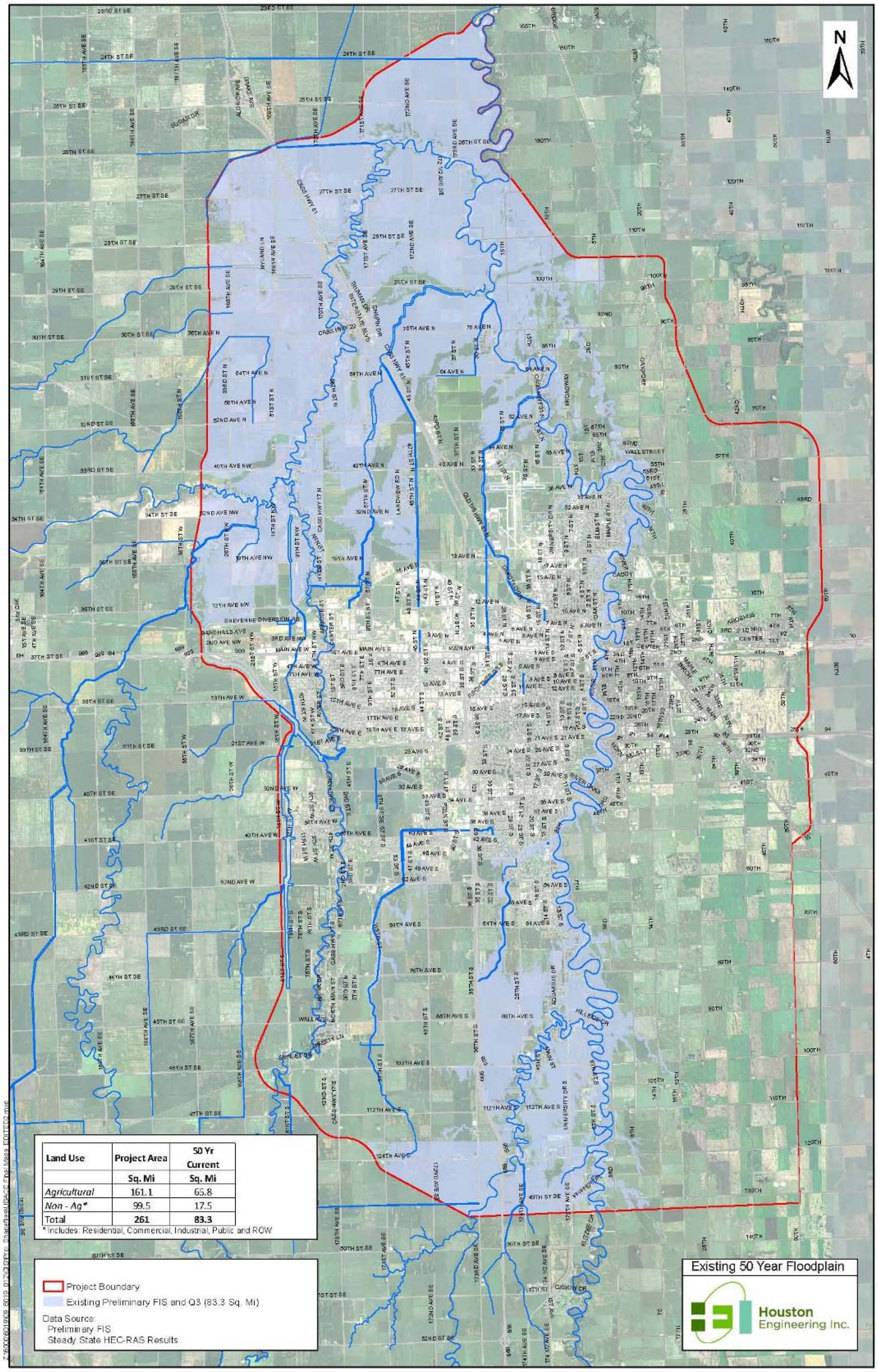


Figure 11 – Existing 100-year floodplain (1-percent chance)

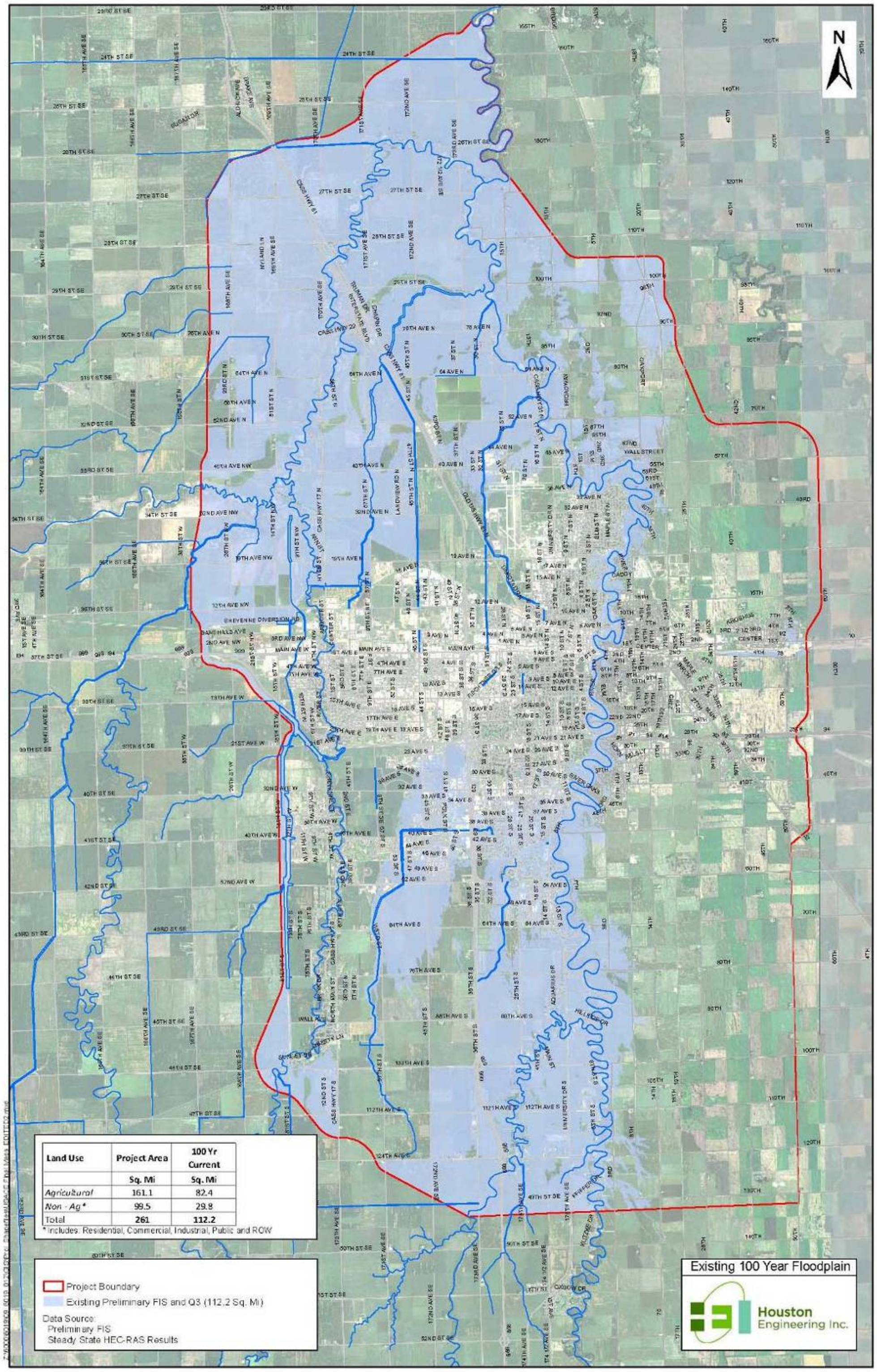
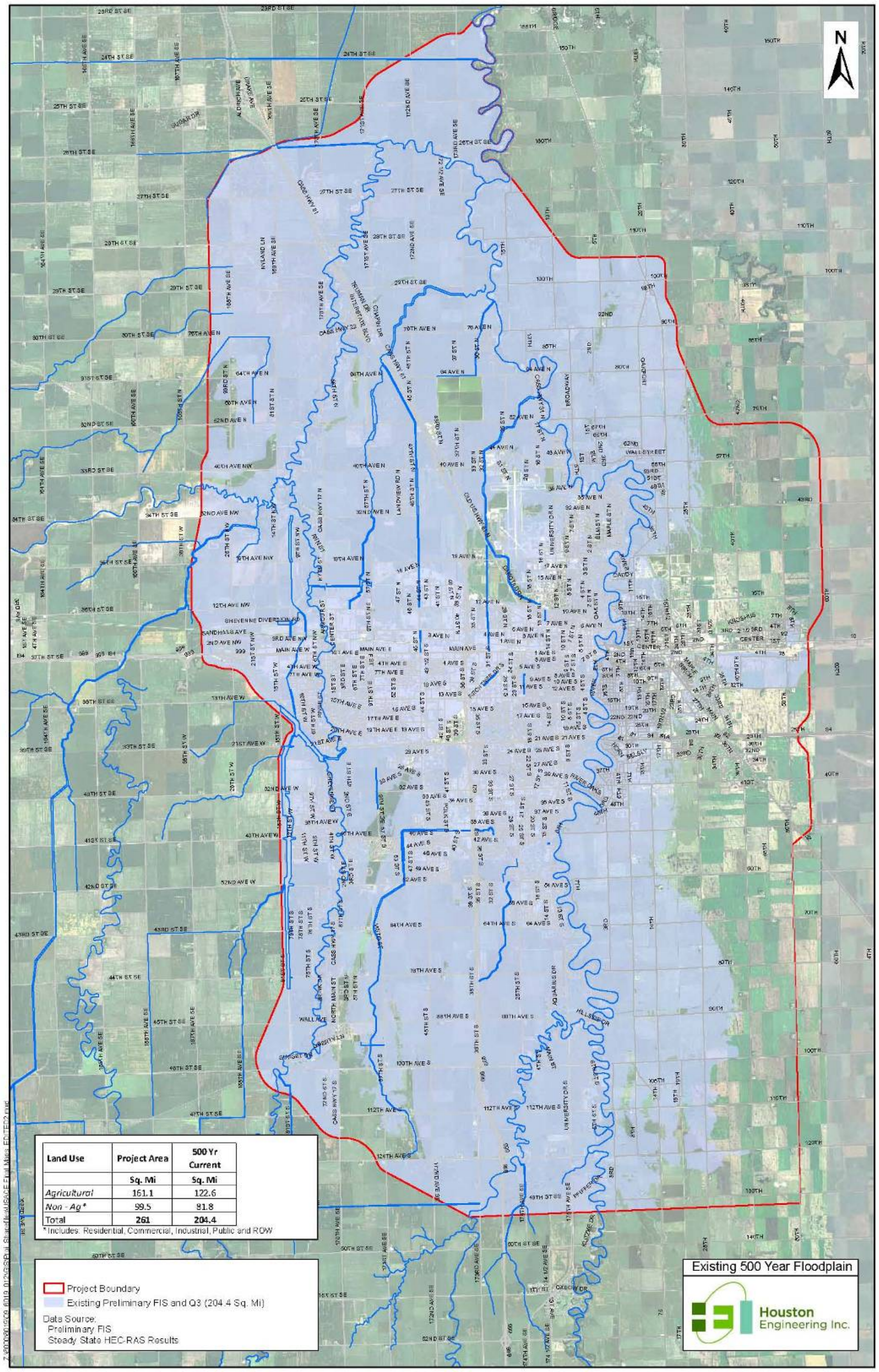


Figure 12 - Existing 500-year floodplain (0.2-percent chance)



2.3.2 Existing infrastructure

Existing projects in the study area are described earlier in this report in Section 1.5, Prior Reports and Existing Projects. The information below supplements the earlier discussion. Information related to existing levees including photos and locations can be found in Appendix H.

Flood impacts in Fargo begin at a stage of about 18 feet, when Elm Street is closed to traffic. The City of Fargo's existing levees have top elevations that vary from a stage of 30 feet to 42 feet, but most reaches are at or below 37 feet. The Second Street area near Fargo City Hall begins to flood at a stage of approximately 30 feet, and emergency levees have been built there 12 times since 1969. Many places along the line of protection rely on private sandbag levees which begin to be needed at a stage of about 33 feet, with an exceedence frequency between 10-percent and 20-percent. Newer developments in the southern part of the study area have been elevated above the base flood elevation, but the city infrastructure (roads, sewers, etc.) is still at risk.

Rural areas and developed subdivisions in Cass County, North Dakota are susceptible to flooding from the Sheyenne, Maple, Rush, Lower Rush, Wild Rice and Red Rivers. During the 2009 flood, many homes north and west of Fargo were surrounded by flood waters. Although most structures in this area were elevated above the flood level and escaped major damage, residents were not able to access their homes for up to six weeks except by boat. The rural road network was significantly damaged by overland flows that washed out portions of roads. There were approximately 200 damage sites on the Cass County highway system and 1000 damage sites on the township road system in Cass County. Cities and subdivisions south of Fargo, including the cities of Briarwood, Chrisan, Forest River, Heritage Hills, Hickson and Oxbow were also at risk of flooding from the Wild Rice and Red Rivers. Private sandbag levees and emergency clay levees constructed by the Corps of Engineers protected many areas, but the areas closest to the rivers were hard hit. Significant damage occurred to five of 27 homes in Briarwood, 60 homes in the Chrisan and Heritage Hills area, seven of fourteen homes in Butch-R-Block subdivision, and fifteen of 140 homes in Oxbow.

The West Fargo and Horace to West Fargo diversions of the Sheyenne River Flood Control Project, completed in 1994, prevented breakout flows from the Sheyenne River from flooding Fargo and West Fargo in 1997, 2009 and 2010. While these existing diversions provide significant benefit from Sheyenne River flooding, Horace and West Fargo are vulnerable to flooding from the Red River during events larger than the 1-percent chance (100-year) event.

The City of Moorhead sits on relatively higher ground compared to Fargo. At a stage of 31 feet, Moorhead's First Avenue North is closed. Homes begin to be threatened at stages of 32 to 35 feet. Most of Moorhead's developed areas are above the proposed FEMA 1-percent chance flood stage, but the 0.2-percent chance event floodplain south of Interstate 94 (I-94) extends east almost to 20th Street South. North of I-94 the 0.2-percent chance event floodplain generally extends east of 14th Street. During flood events larger than a 1-percent chance, it is anticipated that I-94 would be inundated, eliminating a major thoroughfare and possible evacuation route. Moorhead has no permanent federal flood risk management project. Most of the land along the river is residential development, and private sandbag levees or other private measures provide most of the line of protection. Flooding through the sanitary sewer system is a significant concern in Moorhead, because several residences have walkout basements adjacent to the river. If these basements are flooded, water can enter the sanitary sewer and affect homes far from the surficial floodplain. Flooding from the Buffalo River to the east of Moorhead is not a significant concern in the city. Drainage projects in this area have been improved to address any historic flooding issues.

Oakport Township (population 1,689) is located north of Moorhead. Oakport sustained $3.7 million in damages in the 1997 flood. High water from the Red River of the North and Oakport Coulee damaged 150 homes and isolated 200 others. Oakport was severely affected during the 2009 flood as well. The Buffalo-Red River Watershed District is currently constructing a permanent levee system with a top elevation three feet above the 2009 event, which is expected to be certifiable to the 1-percent chance level. Portions of Oakport Township will be annexed by the City of Moorhead in 2015.

Since the 1997 flood, Fargo and Moorhead have implemented mitigation measures, including acquisition of floodplain homes, building levees and floodwalls, raising and stabilizing existing levees, installing permanent pump stations and improving storm sewer lift stations and the sanitary sewer system. Moorhead has a list of several low elevation properties adjacent to the river that it would like to buy to install higher levels of flood risk management; to date, 65 properties have been purchased. Moorhead has a draft plan for a voluntary program for assistance to build private levees/floodwalls, but reaction to the proposed program has been mixed, and the city has not yet officially adopted it. Fargo maintains a prioritized list of potential buyouts and actively seeks to purchase and remove floodplain homes. Fargo has purchased 125 homes from willing sellers since 1997. Fargo also adopted a flood risk management incentive program in 2006 and amended it in 2009. The program provides for a cost share of up to 75-percent by the city in improvements made by the individual homeowners to improve their level of flood risk management. The homeowner must enter into an elevation agreement to be eligible.

The Department of Veterans Affairs and the City of Fargo worked with the Corps of Engineers to construct a floodwall and levee system in the Ridgewood neighborhood of Fargo, which is discussed in Section 1.5.3.14 of this report.

2.3.3 Flood fighting activities

The Fargo-Moorhead area has become accustomed to dealing with flooding. Time is usually available to prepare for flood fighting because winter snowfall can be monitored to predict unusual spring runoff. But the time required to build emergency works depends on the anticipated flood crest elevation, with higher crests requiring significantly more construction time and effort. Fargo and Moorhead have well-documented standard operating procedures for flood fights. Both communities avoided major flood damages in the historic floods of 1997 and 2009 through the use of extreme emergency measures. These emergency measures included such actions as temporarily raising existing levees, constructing temporary levees and floodwalls in various areas and sandbagging.

The residents of Fargo-Moorhead have been successful at preventing significant damages during past flood events by constructing emergency levees along large portions of the Red River. Constructing the emergency levees takes significant financial and human resources, causes business and traffic disruptions and is taxing to the social fabric of the communities. Although the emergency levees have been successful in the past, there is a high risk of a catastrophic failure which would result in significant damages and loss of life to the area.

Significant costs are incurred during emergency flood fighting efforts. During large flood events, the cities build as many as 80 miles of emergency levees through town in an effort to retain flood waters. Businesses, residents, federal agencies, local and state governments, as well as humanitarian organizations such as the Red Cross and Salvation Army all contribute to the flood fight, rescue and clean-up efforts. These costs are estimated to be $2,883,000 on an average annual basis.

During the 2009 flood, more than 80 miles of temporary protection measures were built in less than two weeks, including the placement of more than three million sandbags by thousands of volunteers. Picture 1 – Thousands of residents from the region assisted with building miles of sandbag levees in 2009
through Picture 6 – Sand filled barriers were backed with clay and used as a second line of defense after the sandbags in 2009
show the conditions and flood fighting activities that took place during the 2009 flood event.

Picture 1 – Thousands of residents from the region assisted with building miles of sandbag levees in 2009

Picture 2 – Various temporary measures were used as barriers in difficult winter conditions in 2009

Picture 3 – Citizens set up steel frames to hold back the water in 2009

Picture 4 – Roads were closed throughout the region making travel difficult in 2009

Picture 5 – Agricultural lands, sport facilities, and public areas were dug up for levee material in 2009

Picture 6 – Sand filled barriers were backed with clay and used as a second line of defense after the sandbags in 2009

Floods in the Fargo-Moorhead area typically occur in late March and early April. During this time, temperatures vary from sub-zero (°F) to well above freezing. In March the average monthly temperature is 27.2 °F, with an average daily high of 35.3 °F and an average daily low of 19.0 °F. In April the average monthly temperature is 43.5 °F, with an average daily high of 54.5 °F and an average daily low of 32.4 °F. The ground is still frozen, with average frost penetration estimated at about 4.5 feet in early April. The extreme range of temperatures results in varying precipitation conditions ranging from blizzards with heavy snowfall to soaking rains.

These conditions impede flood fighting by hampering earth-moving and levee construction. Emergency levees must often be constructed on frozen ground with frozen materials. Many portions of the line of protection are located in private yards with little or no access for construction equipment. Borrow sites for clay material become inaccessible when the soil is saturated by melting snow or rain. The logistics required for successful emergency actions under these conditions cannot be overestimated.

The extremely variable weather conditions also complicate efforts of the National Weather Service to predict the flood crest. Accurate crest predictions are needed to establish the elevation of emergency levees, but it is difficult to anticipate rates of snowmelt and effects of additional precipitation when temperatures hover around the freezing point. There is considerable uncertainty surrounding every crest prediction. Both the 1997 and 2009 flood events were affected by sudden cold snaps that served to temporarily halt melting and likely contributed to lower peak stages than would have occurred if slightly warmer temperatures had prevailed.

Because emergency measures have been very successful in the past, they may also contribute to an unwarranted sense of security that does not reflect the true flood risk in the area. History has shown that the people in the study area will stay to fight a flood rather than evacuate to safer locations. A loss of life analysis conducted for this feasibility study estimated that as many as 200 people could perish if emergency levees failed suddenly during a 1-percent chance event (See Appendix O, Plan Formulation). Flood water would be extremely cold, just above freezing, and anyone caught in the water would suffer hypothermia in a short time.

Due to all of the factors mentioned above, the probability of having consistently successful emergency efforts in the future must be considered extremely low, especially for events larger than the 1-percent chance event. However, it is acknowledged that the probability of success with an emergency flood fight is not zero. To account for this, a sensitivity analysis was performed on the recommended plan to determine how successful flood fights could impact the project benefits. (See Appendix C, Economics.)

Although the economic analyses conducted for this study assumed no credit for emergency actions, credit was given to existing permanent levees in accordance with applicable Corps of Engineers guidance. (See Appendix H, Credit to Existing Levees.)

2.3.4 Future Without Project condition (No Action alternative)

Without a comprehensive flood risk management project in the area, the metropolitan region will continue to be subject to flooding and will rely on emergency responses to ensure the safety of the community. These emergency efforts will eventually be overwhelmed, and the area could experience a disaster similar to the 1997 flood in Grand Forks and East Grand Forks. A disaster of that magnitude would cause significant damage and would impact the entire region. It is expected that the average annual damages of more than $194.8 million will continue and increase as a result of additional development between the 1-percent chance and 0.2-percent chance flood elevations.

The Oakport, MN levee project is the only major levee project that will be completed in the metropolitan area in the near future. The City of Fargo has developed plans for a Southside levee project, however those plans have been put on hold indefinitely, pending the outcome of this feasibility study. It is possible that without a federal project the Southside levee plan could be pursued in the future, but it would face many challenges before being realized. It is assumed that the Southside project is not in place for the future without-project condition. This is consistent with guidance in IWR 88-R-2, National Economic Development Procedures Manual - Urban Flood Damage, Volume 1, Page VI-3, paragraph 6 which states: "If local action is planned to occur only as the result of no federal action, the project should not be assumed as part of the "without" condition. Local interests should not be penalized for their own incentive."

It is anticipated that the metropolitan communities will continue to use best practices and make minor modifications to enhance their overall flood risk management whenever possible. This includes construction of short sections of levees and floodwalls that do not tie into high ground but would be augmented with emergency measures. Communities downstream on the Minnesota side, including Georgetown, Perley and Hendrum, are planning to construct levees to bolster their flood defenses if funding for the projects can be obtained.

Local communities and the Corps are also evaluating efforts to reduce flood stages through upstream water storage. Phase 1 of the Corps' Fargo-Moorhead and Upstream feasibility study determined that stage reductions up to about 1.6 feet could be obtained using storage during a 1-percent chance event, but the economic benefits would not likely support federal participation solely for flood risk management. The study is now considering the potential for ecosystem restoration and looking for synergistic solutions to both flooding and historic loss of native aquatic habitat. It is anticipated that some impoundments will be constructed by non-federal entities in the upstream watershed, however, reductions to flood stages in the Fargo-Moorhead area would be relatively small. For purposes of this feasibility study and evaluating the economics of alternatives, we cannot assume that upstream flood retention will be built in the future to a sufficient extent to significantly reduce the flood risk in the study area.

2.3.5 Environmental conditions

Existing and expected future environmental conditions are discussed in detail in Chapter 4, Affected Environment. The Red River basin lies within the Prairie Pothole Region, which has been dramatically affected by drainage and tillage predominantly related to this region's urban development and agriculture-based economy. According to the 1997 Minnesota Wetlands Conservation Plan, over 95 percent of the native wetlands in the Minnesota portion of the Fargo-Moorhead and upstream subbasin have been lost. The North Dakota portion of the study area has also experienced a similar amount of lost wetlands. The resulting habitat loss has caused a dramatic decline in wetland-dependent wildlife populations. Because the Red River basin lies within a major waterfowl and shorebird migration route, the loss of permanent and seasonal wetlands has had a measurable adverse impact on migratory success.

There are numerous wetland restoration programs within the Red River Basin, but implementation has often been hindered by cost and/or land availability. The objectives of the wetland restoration programs include providing flood storage, improving water quality, and increasing wildlife and recreation opportunities.

Due to increasing pressure to either urbanize or improve drainage on cropland, it is anticipated that wetland acreage will either remain the same or decrease within the study area under the without project condition.

Upland habitat in the study area is mainly cropland, with a mixture of hayed pasture, hobby farms and suburban dwellings. Wooded areas include mostly a mixture of bottomland hardwood tree species and low vegetation. The narrow riparian zone is in a relatively natural condition. The remaining wooded riparian areas are an important wildlife and aesthetic resource. The riparian woodlands are essentially the only wooded habitat remaining in this predominantly agricultural area. Tree species identified in these areas include bur oak, American linden, eastern cottonwood, American elm, boxelder, green ash, silver maple, buckthorn, and hackberry. Woodland was never very common in the prairie environment, but it is extremely important as nesting, breeding, and overwintering habitat for a number of birds, mammals, and reptiles.

2.4 PROBLEMS AND OPPORTUNITIES

The evaluation of public concerns reflects a range of needs and desires perceived by the public. This section describes these needs in the context of problems and opportunities that can be addressed through water and related land resource management. The problems and opportunities are based upon the flood history and future without project conditions.

2.4.1 Problems

The primary problem identified in the study area is a high risk of flood damage to urban infrastructure from the Red River of the North, the Wild Rice River (ND), the Buffalo River, and the Sheyenne River and its tributaries, the Maple River, Lower Rush River and Rush River. Flooding also causes damage to rural infrastructure and agricultural land and disrupts transportation and access to properties within the study area. The study area has estimated average annual flood damages of more than $194.8 million.

2.4.2 Opportunities

There are opportunities to increase and improve wildlife habitat in conjunction with the measures used to reduce flood risk. Wildlife habitat in the study area has been significantly altered by various human activities associated with conversion of native prairie for agricultural uses and urban development.

Flood risk management measures that involve land use changes could provide opportunities to increase recreation in conjunction with reducing flood risk.

2.5 PURPOSE AND NEED

The purpose of the proposed action is to reduce flood risk, flood damages and flood protection costs related to the flooding in the Fargo-Moorhead Metropolitan Area.

2.6 PLANNING OBJECTIVES

The national objectives are general statements that are not specific enough for direct use in plan formulation; maximizing national economic development (NED) and restoring ecosystem functions are the overarching goals for this study. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities in the study area and represent desired positive changes from the future without-project conditions. The planning objectives are specified as follows:

- Reduce flood risk and flood damages in the Fargo-Moorhead metropolitan area.
- Restore or improve degraded riverine and riparian habitat in and along the Red River of the North, Wild Rice River (North Dakota), Sheyenne River (North Dakota), and Buffalo River (Minnesota) in conjunction with other flood risk management features.
- Provide additional wetland habitat in conjunction with other flood risk management features.
- Provide recreational opportunities in conjunction with other flood risk management features.

2.7 PLANNING CONSTRAINTS

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in this study are as follows:

- Avoid increasing peak Red River flood stages, either upstream or downstream
- Comply with the Boundary Waters Treaty of 1909 and other pertinent international agreements.
- Avoid negatively impacting the Buffalo Aquifer in Minnesota.
- Minimize loss of floodplain in accordance with Executive Order 11988, Floodplain Management

2.8 NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

Federal policy requires that the feasibility study must identify the plan that reasonably maximizes net national economic development (NED) benefits consistent with protecting the environment. That plan, the “NED plan,” must be recommended for implementation unless there are overriding reasons for recommending another plan based on other Federal, State, local and international concerns. A different plan may be recommended as a “locally preferred plan” if it has positive net economic benefits and is approved by the Assistant Secretary of the Army for Civil Works (ASA(CW)).

3.0 ALTERNATIVES*

This chapter describes the development of alternative plans that address the planning objectives, the comparison of those plans and the *tentative* selection of a plan. It also describes the *tentatively* selected plan and its implementation requirements.

3.1 PLAN FORMULATION RATIONALE

A wide variety of management measures were developed that would address one or more of the planning objectives. These measures were evaluated and then screened. Alternative plans were then developed which comprised of one or more of the management measures.

3.2 MANAGEMENT MEASURES AND PRELIMINARY PLANS

<u>3.2.1 No Action</u>

The Corps is required to consider the option of “No Action” as one of the alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). With the No Action alternative, which is synonymous with the “Without Project Condition,” it is assumed that no project would be implemented by the federal government to achieve the planning objectives. The No Action alternative forms the basis against which all other alternative plans are measured. The No Action alternative was described in detail in Chapter 2. Critical assumptions in defining the no action alternative include:

- Emergency flood fighting activities would continue to occur
- Emergency flood fighting measures have low reliability
- A failure of emergency measures could result in loss of life
- Urban areas will expand into the floodplain
- Development in the floodplain will comply with floodplain regulations; floodplain development will be elevated above the FEMA 1-percent chance event in accordance with local standards
- Equivalent expected annual damages greater than $194.8 million will continue

<u>3.2.2 Measures to address identified planning objectives</u>

A management measure is a feature or activity at a site which addresses one or more of the planning objectives. Several alternative measures were identified for consideration in evaluating future possible actions in the Fargo-Moorhead Metropolitan Area. Direct input provided during the reconnaissance and feasibility phases from sponsors and stakeholders, at public meetings and through written public comments, provided a wide array of potential measures. Each measure was assessed using screening criteria (see section 3.4.2), and a determination was made regarding whether it should be retained in the formulation of alternative plans.

3.2.2.1 Non-structural measures reduce flood risk by modifying the characteristics of the buildings and structures that are subject to floods or modifying the behavior of people living in or near floodplains. In general, non-structural alternatives do not modify the characteristics of floods nor do they induce development in a floodplain that is inconsistent with reducing flood risk. Some non-structural measures that can be formulated into non-structural alternatives include removing buildings from floodplains by relocation or acquisition; flood proofing buildings; placing small levees, berms or walls around buildings; implementing flood warning and preparedness activities; and implementing floodplain regulation. The National Flood Insurance Program (NFIP) is considered among non-structural alternatives since it contains programs to provide minimum standards for floodplain regulation, to provide flood insurance, and to provide flood hazard mitigation. Many non-structural measures are already in place throughout the study area, primarily in newer developments built in accordance with floodplain regulations. The Corps must develop and present at least one plan that is primarily non-structural in nature. Non-structural measures will also be considered for integration with structural measures to maximize effectiveness of all alternatives.

3.2.2.2 Structural measures reduce flood risk by modifying the characteristics of the flood; they are often employed to reduce peak flows (flood storage), direct floodwaters away from damageable property (flood barriers), or facilitate the flow of water through or around an area (channel modifications or diversions). Several structural measures have already been implemented to provide benefits to the study area, as described earlier in this report.

3.2.2.3 The measures that were considered in this study are listed below. Detailed descriptions of the measures are included in Appendix O, Plan Formulation.

- No Action: Continue emergency measures

- Non-structural measures
    - Buy and relocate flood-prone structures
    - Flood proofing
    - Elevate structures
    - Flood warning systems
    - Flood insurance
    - Wetlands
    - Grasslands
    - Pay landowners for water retention

- Flood barriers
    - Levees
    - Floodwalls
    - Invisible floodwalls
    - Gate closures
    - Pump stations

- Increase conveyance
    - Diversion channels around the study area
        - In Minnesota
        - In North Dakota
    - Increase conveyance in Oakport Coulee
    - Cutoff channels (to short-cut existing meanders)
    - Flattening the slopes on river bank

- Replacing bridges
- Underground tunnels
- Interstate 29 viaduct
- Dredge river deeper and wider

- Flood storage
  - Large dams upstream
  - Distributed storage
  - Controlled field runoff
  - Storage ponds, also used for water conservation

3.3 FEASIBILITY PHASE 1

3.3.1 General

This feasibility study was conducted in an iterative fashion. A wide array of potential measures was identified during the reconnaissance phase and expanded during the feasibility study. As the study progressed, additional data were produced that allowed the narrowing of alternatives. The planning steps of formulating, evaluating and comparing alternative plans were accomplished iteratively as information about the alternatives was developed.

3.3.2 Phase 1

Feasibility Phase 1 occurred from September 2008 through May 2009. In Phase 1 the study team gathered information to assess existing conditions in the study area and worked to understand the potential for economic justification of a large regional flood risk management project. Hydraulic models were built to determine expected water surface elevations for a full range of possible flood events. A structure inventory was conducted focusing on both residential and commercial structures within the study area. This information was used to calculate expected annual flood damages without federal action. Conceptual designs and cost estimates were prepared for two structural alternatives: a diversion alternative without a control structure and a levee/floodwall alternative. In March 2009 the study area experienced the flood of record, which produced a maximum stage of 40.8 feet on the Fargo gage. The results of the preliminary study were released in May 2009. The preliminary analyses indicated that a levee plan could be economically justified. The preliminary diversion plan was shown to be very effective at reducing flood stages, but it was not cost-effective. Additional study was needed to refine these alternatives. On the basis of this preliminary information, and in the wake of the record-setting flood of 2009, the study team decided to continue planning efforts.

3.4 FEASIBILITY PHASE 2, SCREENING #1

3.4.1 General

Feasibility Phase 2, Screening #1 occurred from May 2009 through November 2009. The study team performed cursory technical analysis of all proposed measures and developed screening criteria to focus evaluation and design efforts on the most implementable alternatives. Preliminary results were presented at public meetings in October 2009. Phase 2 activities included updating both the hydrologic record and hydraulic modeling to reflect the 2009 event However, since the updated information was not available for use during the first screening,

screening #1 analyses were based on Phase 1 traditional hydrology (without the 2009 flood event) and steady-state hydraulic modeling calibrated to the 2006 flood event.

3.4.2 Screening criteria

Corps planning guidance requires that plans be evaluated against four criteria listed in the United States Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G): completeness, effectiveness, efficiency and acceptability. Other criteria deemed significant by participating stakeholders are also used to evaluate alternatives. The screening criteria represent the most critical factors to be considered in selecting plans for further evaluation. The following criteria were used to assess the overall characteristics of each alternative measure to identify those most likely to meet the project purpose and objectives.

Effectiveness: Whether the measure or alternative would be effective in maintaining an acceptable level of flood risk management for the Fargo-Moorhead Metropolitan Area. This is one of the P&G criteria. The team assessed conceptual measures for their potential to contribute substantially to the overall effectiveness of any alternative.

Environmental Effects: Direct and indirect effects of natural resources and cultural resources. Direct effects are those effects associated with the construction. Indirect effects are those effects that occur as a result of a change in environmental conditions resulting from the construction or operation of the project. This criterion is related to the planning objectives to restore or improve riverine, riparian and wetland habitat, and a desire to minimize environmental impacts and produce an environmentally sustainable project. It is also a component of overall effectiveness.

Social Effects: Direct and indirect effects on socio-economic resources such as transportation, regional growth, public safety, employment, recreation, public facilities, and public services. This criterion is a component of overall effectiveness.

Acceptability: Controversy and potential effects on community cohesion and compliance with policy are indicators of acceptability. This criterion is one of the P&G criteria.

Implementability: This criterion considers the existence of significant outstanding technical, social, legal or institutional issues that could affect the ability to implement the alternative. This is related to the P&G criterion for acceptability.

Cost: The first cost of the project, costs of local operations and maintenance and long-term residual costs. Cost is related to two P&G criteria: efficiency and acceptability. Cost alone is not used to eliminate any alternatives, but is considered in relation to the other criteria.

Risk: The uncertainties, vulnerabilities and potential consequences of the alternative. Risk is related to the P&G criteria of effectiveness and acceptability.

Separable Mitigation: This criterion considers the potential need for mitigation resulting from the project's implementation to address environmental, hydraulic or other impacts. Is mitigation possible and how does it impact the project cost? This criterion is related to all four of the P&G criteria.

Cost Effectiveness: This criterion is a comparison of expected economic benefits and estimated costs for each alternative and between alternatives. This is a primary consideration in determining whether there is a federal interest in the project, and to what extent federal participation can be justified. This is a component of the P&G criteria of efficiency.

3.4.3 Screening #1 Process

Using the preliminary technical information, the team applied professional judgment in order to assess the measures against the screening criteria. Those measures that appeared to be most viable were refined and further developed so that accurate costs and economic benefits could be determined. Several different scales of non-structural measures, flood barriers and diversion channels were evaluated during this phase of study. The initial diversion channel concept referred to in Section 3.3.2 was improved upon to make it a more economically justifiable solution as described in Section 3.4.7.3.1. Using all of the information developed, the team compared the alternatives to each other to screen out inferior plans and identify the optimal plans. Initial screening results were presented at public meetings in October 2009. Subsequent discussions with the non-federal sponsors narrowed the alternatives to various capacities and locations of diversion channels.

3.4.4 Screening #1 Results

The initial screening process and results are fully described in Appendix O, Plan Formulation and the December 2009 Alternatives Screening Document attached to Appendix O. A summary of the screening conclusions is provided in sections 3.4.5 through 3.4.7 of this report. The initial design and economic analyses of the levee and diversion channel alternatives were based on Phase 1 hydrology (without the 2009 flood event) and steady-state hydraulic modeling calibrated to the 2006 flood event. During this screening, 11 separate plans were analyzed based on five alignments and various sizes: Minnesota Long Diversion (25,000, 35,000, and 45,000 cfs), Minnesota Short Diversion (25,000, 35,000 and 45,000 cfs), North Dakota East Diversion (35,000 cfs), North Dakota West Diversion (35,000 and 45,000 cfs), and in-town levees (2-percent and 1-percent chance level of protection).

Table 5 presents the results of the initial cost-effectiveness analyses of the alternatives. Table 6 presents the expected flood stages with diversion channels of varying capacities for either the North Dakota or Minnesota alignments. Figure 13 shows the alignments of the alternatives considered in the initial screening.

Table 5 – Phase 2, Screening #1 cost-effectiveness analysis results

Fargo-Moorhead Metro Feasibility Study
Initial Screening Results, October 2009
Screened Alternatives Ranked by Net Benefits

Alternative	First Cost *	Avg Annual Net Benefits *	Residual Damages *	B/C Ratio
MN Short Diversion 25K	962	11.0	14.3	1.22
MN Short Diversion 35K	1,092	9.4	9.3	1.17
Levee 1% chance (100-year)	902	7.7	20.9	1.17
MN Long Diversion 25K	1,055	5.6	15.0	1.10
MN Short Diversion 45K	1,264	2.5	7.4	1.04
MN Long Diversion 35K	1,260	0.3	9.8	1.00
ND East Diversion 35K	1,337	-3.1	9.2	0.95
ND West Diversion 35K	1,363	-4.4	9.2	0.94
Levee 2% chance (50-year)	840	-5.3	37.1	0.88
ND West Diversion 45K	1,439	-6.7	7.6	0.91
MN Long Diversion 45K	1,459	-8.3	8.2	0.89

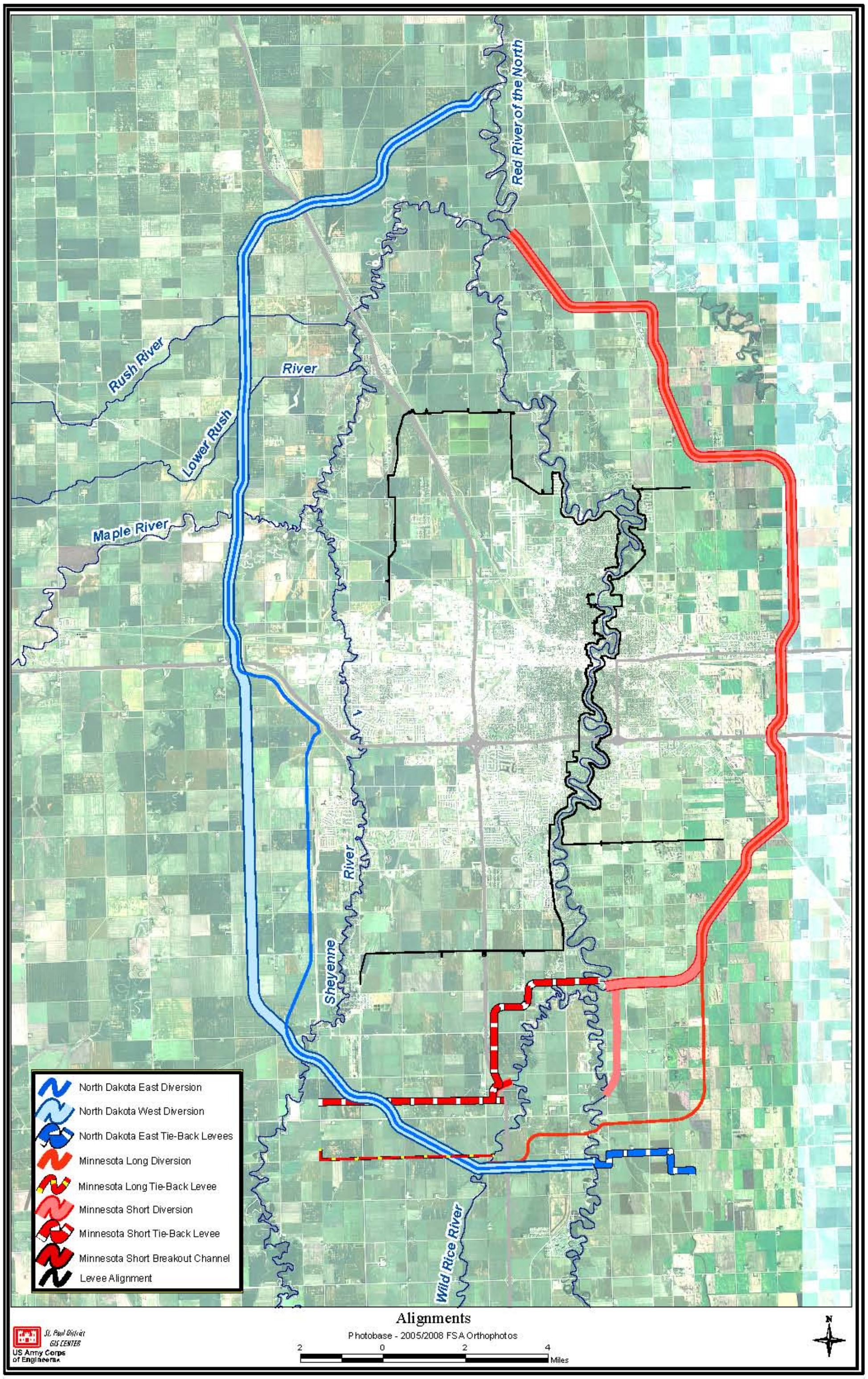
* In millions of dollars

Note: Expected average annual damages without a project were $73.7 million.

Table 6 –Phase 2, Screening #1 estimated flood stages assuming various diversion capacities

	STAGE at the FARGO GAGE		
	2% Chance (50-year)	**1% Chance** (100-year)	**0.2% Chance** (500-year)
Existing Condition	37.8	39.5	43.9
25k Diversion	29.1	30.4	39.2
35k Diversion	28.8	29.2	35.9
45k Diversion	27.1	27.2	30.4

Figure 13 – Phase 2, Screening #1 alternatives alignments



3.4.5 Preliminary Plans Eliminated from Further Consideration

The following alternatives were not recommended for further evaluation as stand-alone alternatives for this project:

- Flood Barriers
- Tunneling
- Interstate 29 Viaduct
- Dredging and Widening the River
- Increase conveyance in Oakport Coulee

Appendix O, Plan Formulation, contains a complete discussion of the screening process and the consideration given to each preliminary measure. The following paragraphs summarize the screening effort.

3.4.5.1 Flood barriers (including levees) were eliminated because they were both less effective and less cost effective than diversion plans in providing a high level of risk reduction. The top elevation of flood barrier alternatives is limited to the highest natural ground available to begin and end the levee. Within the study area, flood barriers could not be certified to contain floods larger than about a 30,000 cfs event. Such a plan would leave unacceptably high residual risk. The flood barrier plans that have been evaluated would also have caused large short-term social impacts due to the need to remove over 1,000 structures in the urban floodplain. The flood barrier plans are eliminated with knowledge of a number of uncertainties which would likely increase the overall cost, including: possible upstream impacts, the use of floodwalls versus earthen levees, geotechnical concerns, uncertainties with local pump stations, impacts to historical properties and possible mitigation.

3.4.5.2. Tunneling was eliminated from consideration due to low cost effectiveness. Tunneling would be used to divert flows under the communities; this would function similar to a diversion channel, but underground. It was estimated that at least three 30-foot diameter tunnels approximately 25 miles long would be needed to provide approximately 25,000 cubic feet per second capacity. The cost of such a plan was estimated to be $3.75 billion, which is significantly higher than the cost of a comparably-sized diversion channel.

3.4.5.3 Reconstructing the Interstate 29 (I-29) corridor to serve as an open viaduct during floods was also considered. The system would function as an interstate highway during non-flood times. It would essentially be a diversion channel with an interstate highway either on the bottom or elevated. Demolition and reconstruction of the existing Interstate highway structures and pavement would cost at least $400 million. Excavation costs would be similar to diversion channels. Real estate would be required to dispose of the excavated material. Total cost of this alternative was estimated at $1.4 billion to $4.0 billion. Operation and maintenance costs of the corridor and the roadway would be high as well. Concerns with this alternative included ice jams, access to evacuation routes during flood events, and long term maintenance of the structures. Local drainage and snow melt year-round and backwater into the channel during minor flood events would inundate the highway if it was located at the bottom of the channel.

This alternative was dropped from consideration due to low cost-effectiveness, operation and maintenance concerns and impacts to transportation.

3.4.5.4 Digging the Red River channel deeper and wider to allow for more flow to pass through the Fargo-Moorhead Metropolitan Area was considered, including work on Oakport Coulee. This alternative could also be looked at underneath existing bridges to prevent the damming effect the bridges can create. This alternative would have very limited hydraulic effectiveness and would likely have negative effects on the stability of the riverbanks throughout the length of the project. Dredging and widening the channel would have a variety of potential adverse environmental effects. Increased sedimentation, displacement of mussels, erosion issues, riparian forest habitat loss, aquatic habitat, and wildlife mortality issues would need to be addressed. This alternative would also have a large potential impact on archeological resources, which are typically located on riverbanks and would be disturbed. Because of the extreme environmental impacts, this alternative would violate many local and national policies and is not acceptable. The alternative was dropped due to its relative ineffectiveness and overall unacceptability.

3.4.6 Preliminary plans dropped as stand-alone plans but retained for possible inclusion

The following measures were retained for possible inclusion as features of the alternative plans where they could be incrementally economically justified:

- Non-Structural Measures
- Flood Storage
- Wetland and Grassland Restoration
- Bridge Replacement or Modification
- Cut-Off Channels
- Levees

3.4.6.1 Non-structural measures were eliminated as stand-alone plans because they were not found to be cost effective. Additionally non-structural measures would provide protection from property damage but evacuation would be required due to impacts on local infrastructure. This would cause large disruptions to transportation and businesses, and these impacts could last more than a month. Three levels of comprehensive, stand-alone, non-structural plans were investigated for the study area: 1-percent chance, 0.5-percent chance and 0.2-percent chance (based on Phase 1 hydrology). None of the plans were cost-effective, with total costs of $1.6 billion, $3.3 billion and $4.7 billion and benefit/cost ratios of 0.35, 0.37 and 0.31, respectively. Due to the extremely flat nature of the floodplain, it appears that it is not efficient to address flooding on an individual structure basis over the entire Fargo-Moorhead study area. Non-structural measures were retained for possible application in smaller areas not benefited by other features of the final plan where they could be economically justified. The entire non-structural analysis can be found in Appendix P.

3.4.6.2 Flood storage and wetland and grassland restoration were eliminated as stand-alone alternatives because they would be both less effective and less cost effective than diversion plans in providing a high level of risk reduction. Flood storage involves both preserving natural floodplain areas and building dams and other water retention facilities to hold water during flood events. Flood storage concepts include large dams, distributed smaller storage sites, controlled field runoff, use or modification of the constructed road network to store water (the "waffle plan"), storage ponds used for water conservation, and payment to landowners for water retention. These facilities could be located in any watershed upstream of the Fargo-Moorhead Metropolitan Area and be distributed throughout that area. Estimates of potential stage reduction that could be achieved with flood storage varied from less than 1.6 feet to 5 feet for approximately a 1-percent chance event, depending on various assumptions. The Corps' Fargo-Moorhead and Upstream Feasibility Study found that 200,000 to 400,000 acre feet of storage would need to be constructed to achieve a stage reduction of 1.6 feet at the Fargo gage for a 32,000 cfs event. If the pool was assumed to be 10 feet deep it would require 40,000 acres of land upstream of the Fargo-Moorhead area to achieve 400,000 acre feet of storage. Stage reductions during floods larger than the 1-percent chance event would be less than 1.6 feet. The study team and sponsors agreed that such a level of stage reduction would leave unacceptable residual flood risk in the study area and would not be able to meet the purpose and need of this study. The diversion plans could provide much larger and more reliable stage reductions for a similar financial investment. These measures were retained for possible application where they could be economically justified.

3.4.6.3 Bridge replacement or modification was eliminated as a stand-alone alternative because it would not be effective in substantially reducing flood risk in the study area. This concept was retained for possible application as part of an overall plan where it could be economically justified.

3.4.6.4 Cut-off channels were eliminated as a stand-alone alternative because they would not be effective in substantially reducing flood risk in the study area. This concept was retained for possible application as part of an overall plan where it could be economically justified.

3.4.6.5 Levees were retained for inclusion in diversion alternatives. Tie-back levees at the inlet of diversion alternatives are crucial for diverting flows into the diversion channel. Small in-town levees could be used to allow more flows through the existing Red River channel and could be part of an overall plan where it could be economically justified.

3.4.7 Preliminary plans retained for further evaluation

The following stand-alone alternatives were recommended for further evaluation:

- Future without Project Condition--No Action (continue emergency measures)
- Diversion Channels

3.4.7.1 The no action alternative was retained as the baseline condition to which all other alternatives are compared.

3.4.7.2 The diversion channel concept was retained for further refinement. The preliminary analysis indicated that the Minnesota Short diversion was the most cost effective of all plans considered and would be implementable and highly effective. All of the diversions studied produced lower residual damages than the levee alternatives. Since the most cost effective plan identified was the smallest capacity diversion considered, it was noted that a smaller capacity might be optimal. It was also noted that none of the North Dakota alignments provided positive net benefits, but the preliminary economic analyses omitted potential economic benefits from tributary flooding that would be uniquely addressed by a North Dakota diversion. The preliminary analyses omitted other benefit categories that could significantly increase the benefits for any diversion plan. Potential benefit categories included transportation and flood proofing cost avoidance. Any diversion could impact fish passage and riverine habitat. Further analysis was needed to optimize the capacity and alignment of the diversion concept and address potential impacts to the aquatic habitat.

3.4.7.3 The preliminary analyses produced information that supported further screening of the diversion alternatives at this screening step. The following paragraphs discuss conclusions drawn from the preliminary analyses that reduced the number of diversion plans retained for further analysis.

3.4.7.3.1 The initial diversion concept presented in May 2009 was a passive diversion channel without an operable river control structure; this concept was not economically justified with a benefit to cost ratio of approximately 0.65. All of the subsequent diversion concepts included a river control structure that dramatically improved performance with a modest increase in cost. Therefore, no diversion alternatives lacking a control structure were carried forward.

3.4.7.3.2 The Minnesota Short alignment outperformed the Minnesota Long alignment. There were no significant unique benefits or avoidance of any adverse environmental effects associated with the Minnesota Long alignment, so that alignment was dropped from consideration.

3.4.7.3.3 The North Dakota East alignment outperformed the North Dakota West alignment. There were no significant unique benefits or avoidance of any adverse environmental effects associated with the North Dakota West alignment, so the west alignment was dropped from consideration.

3.5 PHASE 2, SCREENING #2

3.5.1 Refined Array of Alternatives

An array of remaining alternatives was formulated using those management measures or plans that remained following the screening described above. Between November 2009 and February 2010 these plans were refined in order to determine the NED plan and to develop a locally preferred plan to more fully address the planning objectives. The second screening in Phase 2 incorporated a traditional hydrologic analysis based on the full period of record, including the 2009 event. Phase 2 hydrology indicated that at the Fargo gage a flow of 30,000 cfs had a 1-percent chance of exceedance, and a flow of 25,500 cfs had a 2-percent chance of exceedance. For reference, the 2009 flood had a flow of approximately 29,200 cfs at the Fargo gage. The hydraulic modeling was calibrated to the 2006 flood event. The alternatives were differentiated by 1) their location in either Minnesota or North Dakota, and 2) their capacity. Non-structural measures were considered as additional features in the areas immediately upstream of the diversions and in the areas near the downstream end of the diversions, where the diversions provided little or no benefit. The array of alternatives developed to greater detail was as follows:

- MN20K: Minnesota Short Diversion, 20,000 cubic feet per second (cfs) capacity
- MN25K: Minnesota Short Diversion, 25,000 cfs capacity
- MN30K: Minnesota Short Diversion, 30,000 cfs capacity
- MN35K: Minnesota Short Diversion, 35,000 cfs capacity
- ND30K: North Dakota East Diversion, 30,000 cfs capacity
- ND35K: North Dakota East Diversion, 35,000 cfs capacity
- The preceding plans with the addition of non-structural measures

3.5.1.1 Minnesota versus North Dakota location: There were several issues related to the location of the diversion that were pertinent to plan formulation:

- Phase 2, Screening #1 showed that the Minnesota alignment appeared to provide optimal net benefits (noting that additional analysis was needed to capture known but omitted benefits of the North Dakota plans).
- The Minnesota alignment was constrained on the east by the Buffalo Aquifer and on the west by the city of Dilworth, Minnesota.
- The Minnesota alignment crosses a railyard east of Dilworth, Minnesota
- Significantly more economic benefits accrue to properties in North Dakota regardless of channel location. That led to a public perception that Minnesota would suffer disproportionate harm if the diversion were located in Minnesota.
- North Dakota alignments cross five tributaries (Wild Rice, Sheyenne, Maple, Lower Rush, and Rush Rivers); Minnesota alignments cross none.
    - Tributary crossings introduce additional environmental impacts.
    - Tributary crossings provide flood risk reduction for flood events on the tributaries as well as the Red River.
- The North Dakota alignment benefits a greater geographic area and removes 50 more square miles from the 1-percent chance event floodplain than the Minnesota alignment.
- The sponsors and a majority of stakeholders preferred a North Dakota alignment.

3.5.1.2 The Phase 2, Screening #1 analysis completed in October 2009 indicated that the smallest capacity Minnesota plan considered (25,000 cfs) provided the largest net economic benefits. That suggested that an even smaller plan could optimize the net economic benefits. The final array of plans must include at least one plan smaller than the National Economic Development (NED) plan to show that the benefits cannot be maximized at a lower cost. To address this issue, a 20,000 cfs capacity Minnesota alternative was added to the array. Channel capacity is directly related to the project's effectiveness in reducing flood stages. The initial design data (presented in Table 6, above), indicated that a capacity of approximately 30,000-35,000 cfs would be needed to reduce the 0.2-percent chance event at the Fargo gage to a stage of 36 feet. The non-federal sponsors indicated that a project of that size would be needed to provide a tolerable level of residual risk, and they requested that these capacities be included in the array for both Minnesota and North Dakota alignments as potential locally preferred alternatives.

3.5.2 No Action

The “no action” alternative assumes that no project would be implemented by the federal government to achieve the planning objectives. The “no action” alternative is described in section 3.2.1 and in Chapter 2.

3.5.3 Minnesota Short Diversion alternatives

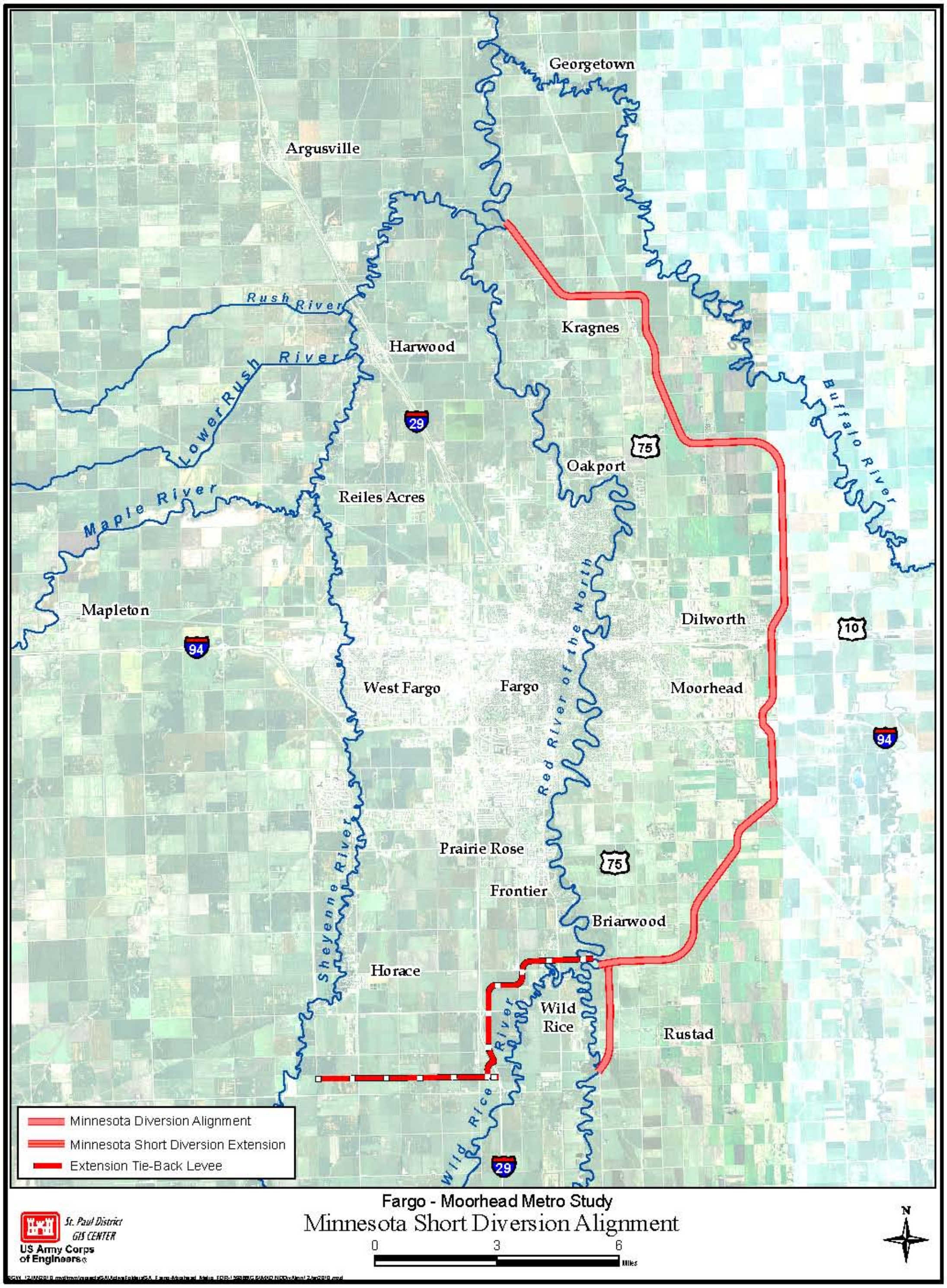
3.5.3.1 Diversion system features

The Minnesota short diversion alignment started just north of the confluence of the Red and Wild Rice Rivers and extended east and north around the cities of Moorhead and Dilworth and ultimately re-entered the Red River near the confluence of the Red and Sheyenne Rivers. The alignment of the main diversion channel was approximately 25 miles long. All four of the Minnesota plans followed the same alignment and differed only in their hydraulic capacity. The alignment and basic design features remained the same as in the earlier screening phase. The alternative consisted of the following primary features:

- Red River control structure
- Diversion inlet weir
- Main diversion channel
- Supplemental diversion channels
- Tie-back levee
- Side ditch inlet structures
- Highway bridges
- Railroad bridges

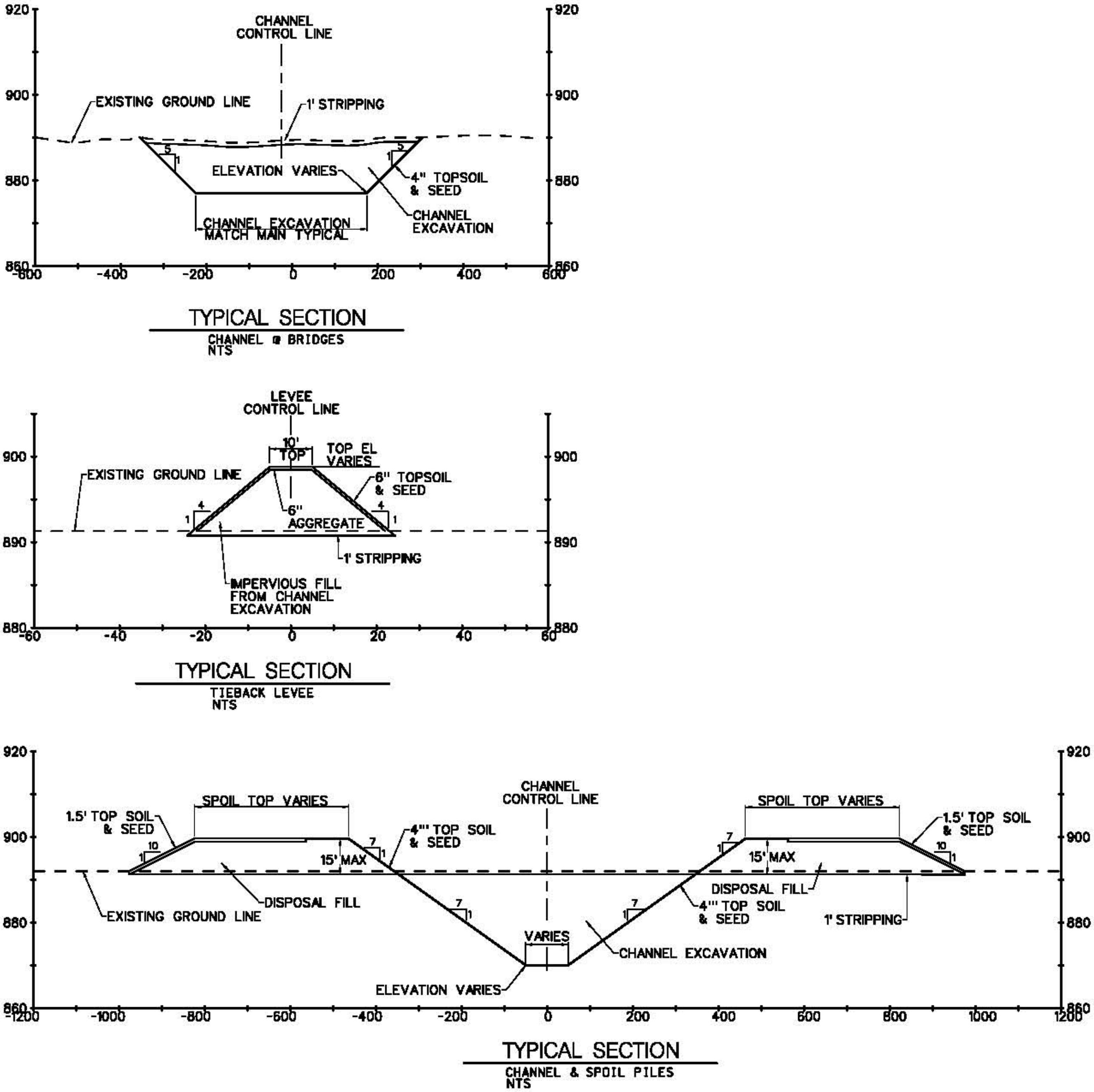
Figure 14 shows the alignment of the major features.

Figure 14 - Minnesota Short Diversion alignment



3.5.3.2 Four separate diversion capacities were initially analyzed for the Minnesota short alignment including 20,000 cfs, 25,000 cfs, 30,000 cfs and 35,000 cfs. At the end of Phase 2, two additional capacities were evaluated in an effort to bracket the NED plan: 15,000 cfs and 10,000 cfs. The channel configuration for each alternative was largely determined by constraining the maximum excavation depth to approximately 30 feet. This constraint was imposed to address geotechnical concerns based upon preliminary slope stability analyses. The channel bottom widths for the 20,000 cfs, 25,000 cfs, 30,000 cfs, and 35,000 cfs channels were 175 feet, 240 feet, 300 feet, and 360 feet respectively. Side slopes on the excavation were generally set at 1 vertical on 7 horizontal (1V on 7H) except at bridges where slopes were steeper at 1V on 5H and short reaches where other exceptions were required to achieve slope stability. Excavation quantities, being the largest portion of the construction for the diversion alternatives, were approximately 36 million, 42 million, 49 million, and 55 million cubic yards for the 20,000 cfs, 25,000 cfs, 30,000 cfs, and 35,000 cfs channels respectively. The Minnesota short alignment also included 20 highway bridges and four railroad bridges. Cross sections of the typical bridges, tie-back levees, and diversion channels can be seen in Figure 15.

Figure 15 – Typical cross section, bridges, tieback levee, and diversion channel.



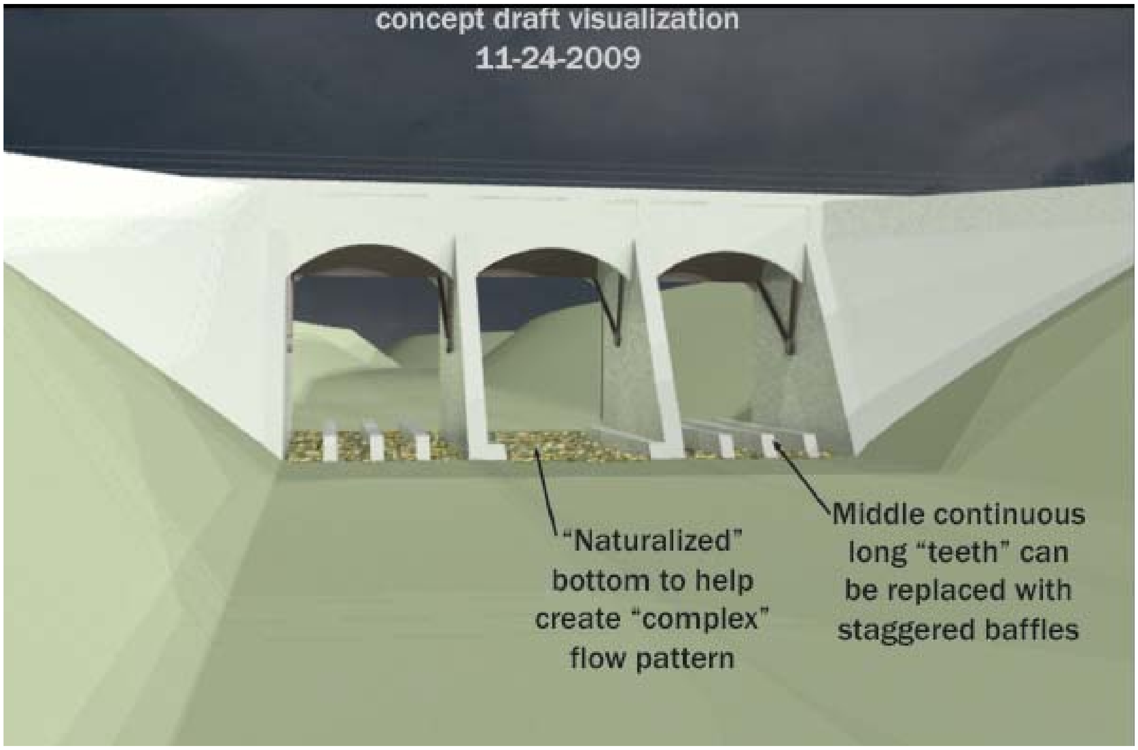
3.5.3.3 Soil excavated to construct the channel would be piled adjacent to the channel to a maximum height of 15 feet. The soil disposal piles would be as wide as necessary to contain the excavated material. The spoil slopes were 1V on 7H and 1V on 10H for the diversion side and outside slopes respectively. Portions of the soil disposal piles would be constructed to serve as levees when the water surface in the channel is higher than the natural grade. The total footprint of the MN35K plan had a maximum width of 2150 feet including areas for spoil piles. The affected acreages ranged from 4,485 acres to 6,415 acres for the MN20K and MN35K plans, respectively.

3.5.3.4 In addition to the main diversion channel, the Minnesota plans included two smaller channels upstream of the Red River control structure to prevent stage increases upstream of the project along the Red and Wild Rice Rivers. A supplementary channel paralleled the Red River upstream of the entrance to the diversion channel to allow for additional capacity to offset the breakouts to Drains 27 and 53. This secondary "Minnesota short extension channel" was approximately 3 miles long and had a 215 foot bottom width. A second, shorter channel, the Wild Rice River breakout channel, was added near the intersection of I-29 and Cass County Highway 16. The breakout channel was less than one mile long and had a 50 foot bottom width. It crossed under I-29 to convey water across I-29 that would have naturally broken out to Drain 27. These two supplemental features were also included in the previous analysis of this alignment.

3.5.3.5 The plan included a control structure on the Red River at the south end of the project. The Red River control structure allowed for the maximum benefit for a given diversion channel capacity by reducing water surface elevations immediately downstream of the structure. Additionally, the control structure allowed the water surface elevation upstream of the project to remain at a near natural elevation to prevent erosion-causing velocities in the Red River at the upstream end of the project. The flow split between the diversion channel and the Red River would be controlled by a combination of the control structure on the Red River and a weir at the entrance to the diversion channel. The diversion inlet weir crest would be set at an elevation that would allow all flows up to 9,600 cfs (between the 50-percent chance and the 20-percent chance events) to pass through Fargo-Moorhead. The weir would be constructed of sheet pile and rock.

3.5.3.6 The proposed Red River control structure would be an operable structure with three tainter gates 40 feet wide and 40 feet high. The gates would normally be fully open, and the structure would not impede flow more than a typical highway bridge up to a flow of 9,600 cfs. At that flow, the gates would be lowered to direct some of the flow into the diversion channel. The lowest four feet of each gate bay would remain open even when the gates were closed to allow flow into the natural channel under all conditions. The structure would allow small boat navigation when the gates are open. Figure 16 illustrates the conceptual control structure.

Figure 16 – Conceptual Red River control structure, looking upstream



3.5.3.7 The Red River control structure was designed with consideration for fish passage during most flow conditions. The bottom of the structure would be constructed to simulate natural roughness. The openings would be sized to maintain passable flow velocities until the gates were put into operation. After the gates were closed, smaller openings through the structure would direct some water into a fish ramp system (not shown) that would continue to allow fish passage during flood events up to about the 2-percent chance event.

3.5.3.8 The plan also included a tie-back levee at the southern limits of the project. The tie-back levee would connect the Red River control structure to high ground and prevent flood water from flowing overland to the north and west into the protected area. Figure 14 shows the alignment for the tie-back levee. No tie-back levees at the north end of the project were included. The typical section for the tie-back levee had a top width of ten feet and side slopes of 1V on 4H. The tie-back levee would be constructed of impervious fill obtained from the channel excavation and covered with topsoil and turf.

3.5.3.9 A number of side ditch inlet drop structures would be included where the diversion crossed existing agricultural and highway drainage ditches. These structures would allow drainage to enter the channel and prevent water in the diversion channel from escaping to adjacent areas during high flow events.

3.5.3.10 The downstream end of the diversion channel would be protected with rock riprap where it returned to the Red River.

3.5.3.11 The primary constraints on the Minnesota alignment were the city of Dilworth, Minnesota, located immediately east of Moorhead, and the Buffalo Aquifer, located approximately 2.5 miles east of Dilworth. Two railroad switchyards were further considerations in determining the channel alignment in this area. The proposed alignment balanced these three constraints to minimize potential impacts to existing structures in Dilworth, avoid excavating into the aquifer, and minimize the number of railroad bridges and related impacts to the railyards.

3.5.3.12 A critical path analysis was completed on the Minnesota diversion channel, and it was determined that the Dilworth railyard relocation would be on the critical path. This resulted in an estimated construction period of 7.5 years for all of the Minnesota diversion alternatives, assuming funding was available as needed. The various sized plans would not have different construction schedules, because the railyard would be the controlling factor rather than the excavation of the diversion channel.

3.5.3.13 There were opportunities to incorporate wetland creation into the bottom of portions of the channel. These features could be developed at little to no cost and could provide additional wildlife habitat for the region.

3.5.4 North Dakota East Diversion

3.5.4.1 Diversion system features

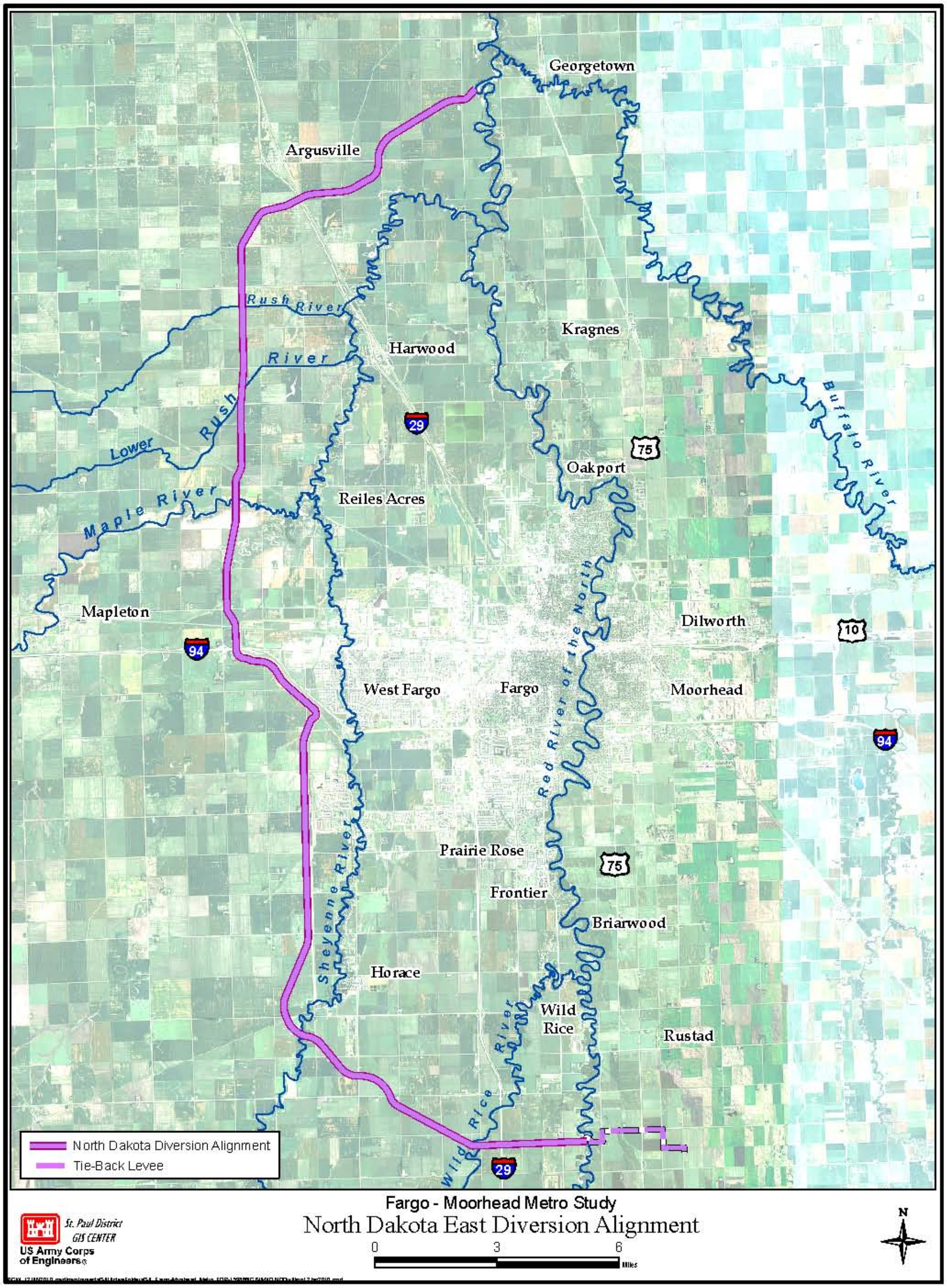
The North Dakota east diversion alignment started approximately four miles south of the confluence of the Red and Wild Rice Rivers and extended west and north around the cities of Horace, Fargo, West Fargo, and Harwood and ultimately re-entered the Red River north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, MN. The alignment was approximately 36 miles long and incorporated the existing Horace to West Fargo Sheyenne River diversion channel. The basic alignment remained the same as in the earlier screening phase, but significant changes were made to optimize the channel cross section, reduce cost, and improve the efficiency of the hydraulic structures. The plans consisted of the following primary features:

- Red River control structure
- Connecting channel (Red River to Wild Rice River)
- Wild Rice River control structure
- Diversion inlet weir (at Wild Rice River)
- Main diversion channel
- Sheyenne River crossing structure
- Maple River crossing structure
- Lower Rush River diversion structure
- Rush River diversion structure
- Tie-back levee
- Side ditch inlet structures
- Highway bridges

- Railroad bridges

Figure 17 shows the alignment of the major features.

Figure 17 - North Dakota East diversion alignment



The North Dakota east alignment was analyzed at 30,000 cfs and 35,000 cfs capacities based on the non- federal sponsors' request for them to be considered as a locally preferred plan. The channel configuration for each plan was largely determined based on the minimum excavation quantity for a given capacity rather than by the maximum recommended excavation depth as was used for the Minnesota alignment. The maximum depth for the North Dakota plans was 32 feet, as opposed to 30 feet for the Minnesota plans. The channel bottom width between the Red and Wild Rice Rivers was 300 feet for both capacities. For the ND30K plan, the channel bottom width was 80 feet between the Wild Rice River and the downstream end of the diversion. For the ND35K plan, the channel bottom width was 100 feet between the Wild Rice and Sheyenne Rivers and 125 feet between the Sheyenne River and the downstream end of the diversion. Side slopes on the excavation were set at 1V on 7H except at bridges where slopes were steeper at 1V on 5H. Both North Dakota plans included 18 highway bridges and four railroad bridges. Cross sections of the typical bridges, tie-back levees, and diversion channels can be seen in Figure 15.

Soil excavated to construct the channel would be piled adjacent to the channel to a maximum height of 15 feet. The soil disposal piles would be as wide as necessary to contain the excavated material. The spoil slopes were 1V on 7H and 1V on 10H for the diversion side and outside slopes respectively. Portions of the soil disposal piles would be constructed to serve as levees when the water surface in the channel is higher than the natural grade. The total footprint of the ND35K plan had a maximum width of 2150 feet including areas for spoil piles. The affected acreage was 6,105 acres and 6,560 acres for the ND30K and ND35K plans, respectively.

Because this alignment began south of the confluence of the Red and Wild Rice Rivers, a connecting channel was included between the Red and Wild Rice Rivers. The connecting channel would convey flow from the Red River to the diversion channel inlet on the west side of the Wild Rice River.

A combination of control structures on the Red and Wild Rice Rivers at the south end of the project, along with weirs at the west end of the connecting channel and at the entrance to the diversion channel near the Wild Rice River, would control the flow split between the Red and Wild Rice River channels and the diversion channel. The diversion inlet weir crest would be the controlling weir and would be set to allow flows up to 9,600 cfs to pass through Fargo-Moorhead. The 9,600 cfs flows were intended to maintain existing geomorphologic processes and existing habitat conditions in the natural channels.

The proposed Red River control structure would be an operable structure similar to the one proposed for the Minnesota diversion plans, except the three tainter gates would be 40 feet wide and 30 feet high. (See Figure 16 and discussion in section 3.5.3.6 and 3.5.3.7)

The proposed Wild Rice River control structure, similar to the Red River control structure, would be an operable structure with two tainter gates 30 feet wide and 20 feet high. The gates would normally be fully open, and the structure would not impede flow more than a typical highway bridge. The gates would be operated to allow flows up to 9,600 cfs to pass through Fargo-Moorhead. At that flow, the gates would be lowered to direct some of the flow into the diversion channel. The lowest two feet of each gate bay would remain open even when the gates were closed to allow flow into the natural channel under all conditions. The structure would allow small boat navigation when the gates were open. The Wild Rice River control structure would be conceptually the same as the Red River control structure illustrated in Figure 16, except that the Wild Rice structure would have only two gates. This structure also incorporates features for fish passage as generally described in section 3.5.3.7.

The tie-back levee associated with this alternative would connect the Red River control structure to high ground approximately 2.5 miles to the east and prevent flood water from flowing over land to the north and east into the protected area. No tie-back levees at the north end of the project were included. The typical section for the tie-back levee had a top width of ten feet and side slopes of 1V on 4H. The tie-back levee would be constructed of impervious fill obtained from the channel excavation and covered with topsoil and turf.

The ND30K and ND35K plans crossed the Sheyenne, Maple, Lower Rush, and Rush Rivers. Systems of hydraulic structures were necessary at the points where the diversion channel crossed these rivers. The tributary crossing structure systems would limit the amount of water that could pass over the diversion channel with the rest of the water being diverted into the diversion channel. This resulted in additional flood damage reduction benefits adjacent to the tributaries downstream of the intersection. Careful consideration was given to the crossing structure systems to minimize impacts to fish passage on the tributary streams. This is described in Chapter 5 of this report, Environmental Consequences.

The Rush and Lower Rush Rivers, which currently consist of constructed trapezoidal channels, would flow into the diversion channel, resulting in abandonment of the downstream portion of these rivers. The structures at the junction of the Rush and Lower Rush Rivers and the diversion channel were also designed to allow fish passage from the diversion channel into the upstream tributary channels during most flow conditions. From the Lower Rush River to the Red River the bottom of the diversion channel would be designed to provide wildlife habitat. This would be accomplished by including a meandering pilot channel and using native species. There would also be opportunities to incorporate wetland creation into the bottom of other portions of the channel. These features could be developed at little to no cost and could provide additional wildlife habitat for the region.

The hydraulic structure systems proposed on the Sheyenne and Maple Rivers would allow a minimum of a 50-percent chance event flow to continue down the rivers while diverting excess water during flood events to the diversion channel. The 50-percent chance event flows are intended to maintain existing geomorphologic processes and existing habitat conditions in the natural channels. The Sheyenne and Maple River structures would remain biologically connected and maintain fish passage to those rivers nearly all of the time, except possibly for events larger than the 1-percent chance event. The two crossing structure systems were similar in concept; each included a drop structure to prevent headcutting on the tributary, a spillway and channel to control diversion of tributary flows, and a hydraulic structure to pass a limited flow over the diversion channel to maintain the desired flow in the tributary beyond the diversion channel. The primary difference between the Sheyenne system and the Maple system was the presence of gated openings on the Maple system's hydraulic structure. The gates were necessary because the structure was designed to allow flows in the diversion channel to overtop the Maple River crossing structure. The gates would operate to prevent excessive flows from passing into the Maple River during extreme flood events. Figure 18 through Figure 24 illustrate the conceptual structures on the Sheyenne and Maple Rivers.

Figure 18 – Flow in Sheyenne River, no flow over spillway or in diversion

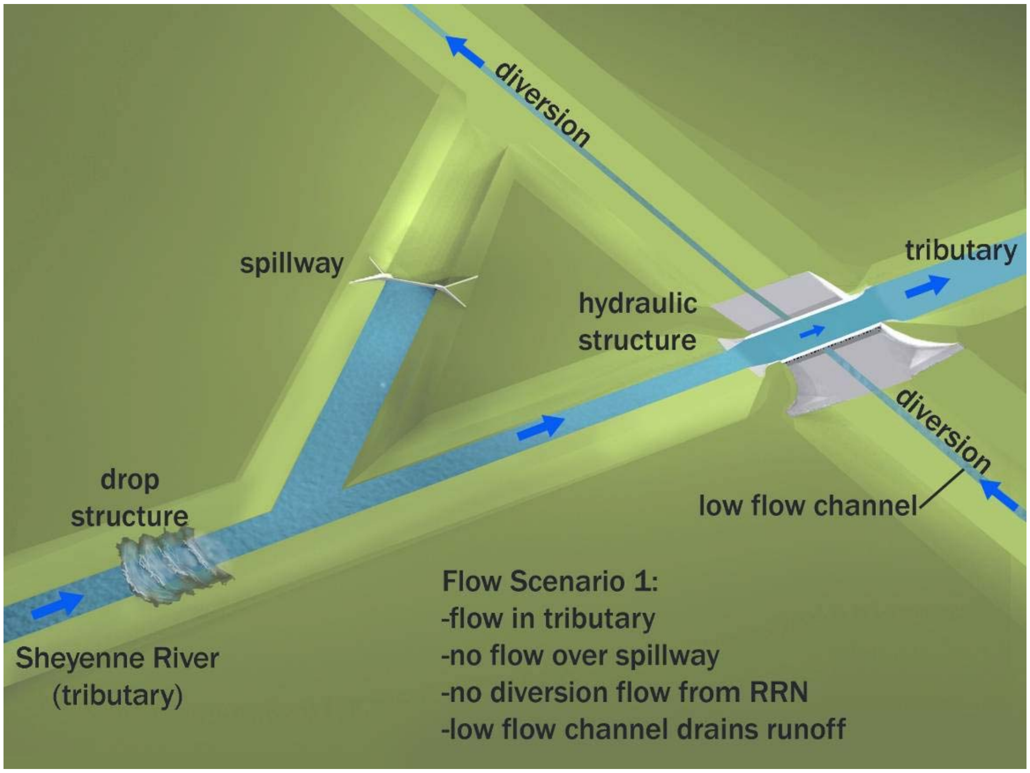


Figure 19 – Flow in Sheyenne, flow over spillway and flow in diversion

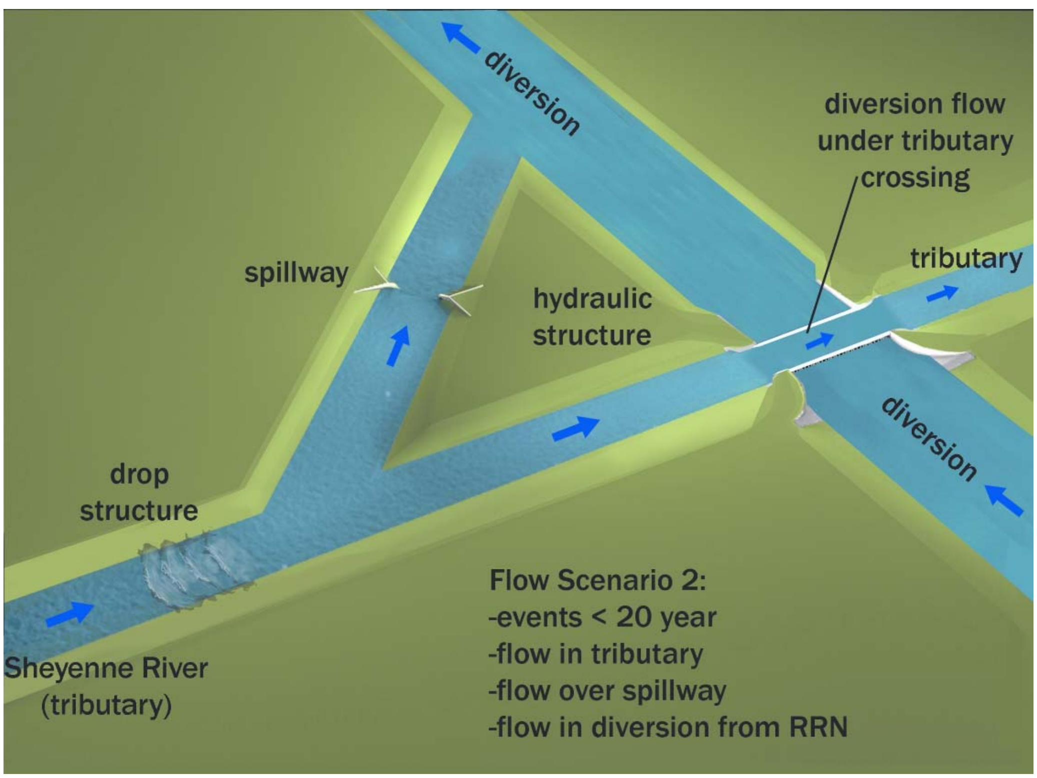


Figure 20 - Flow in Sheyenne River, no flow over spillway or in diversion looking at structure

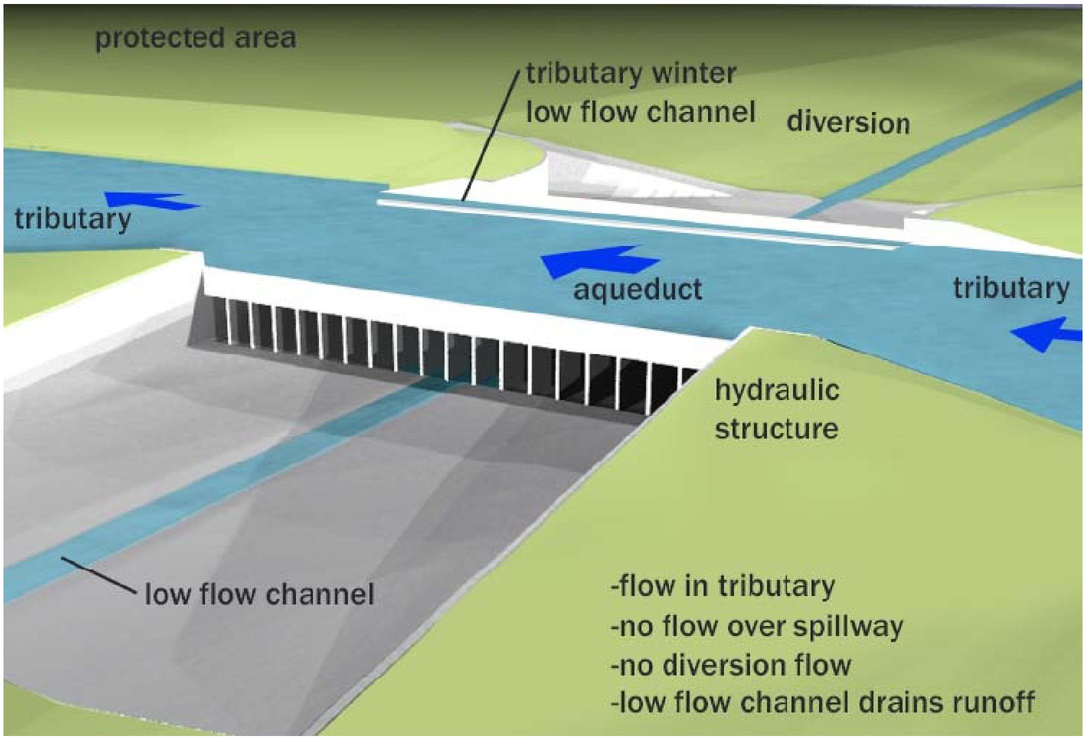


Figure 21 - Flow in Maple River, no flow over spillway or in diversion.

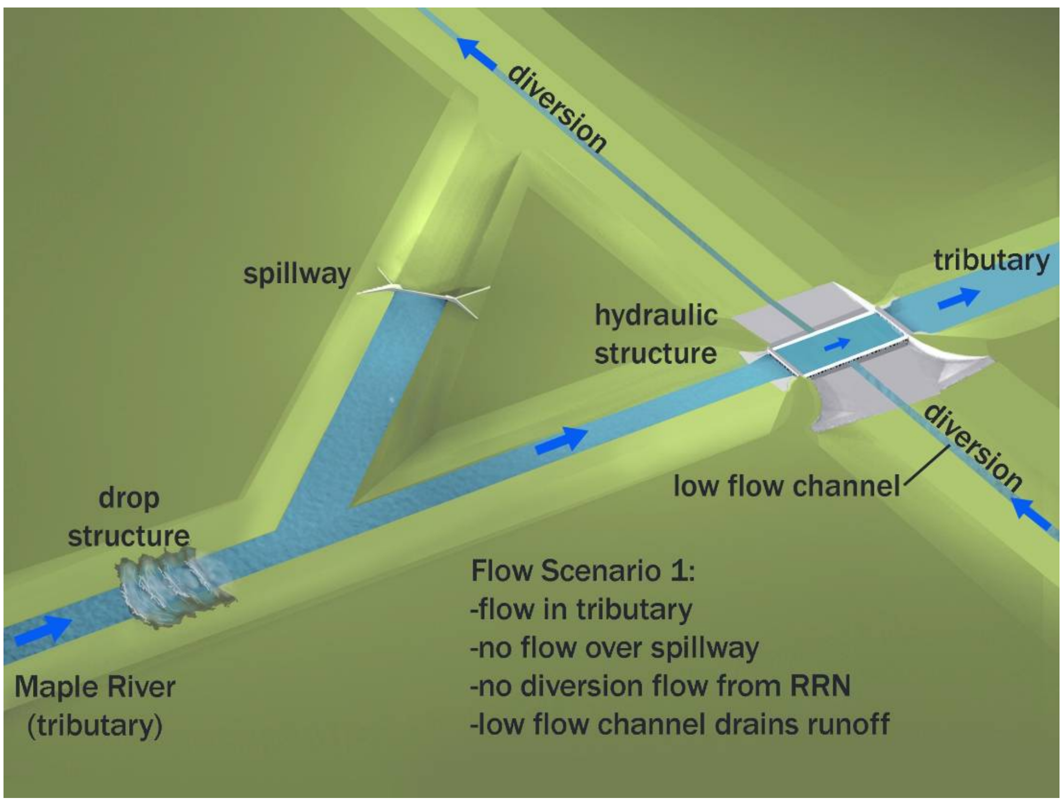


Figure 22 – Flow in Maple River, flow over spillway, and flow in diversion

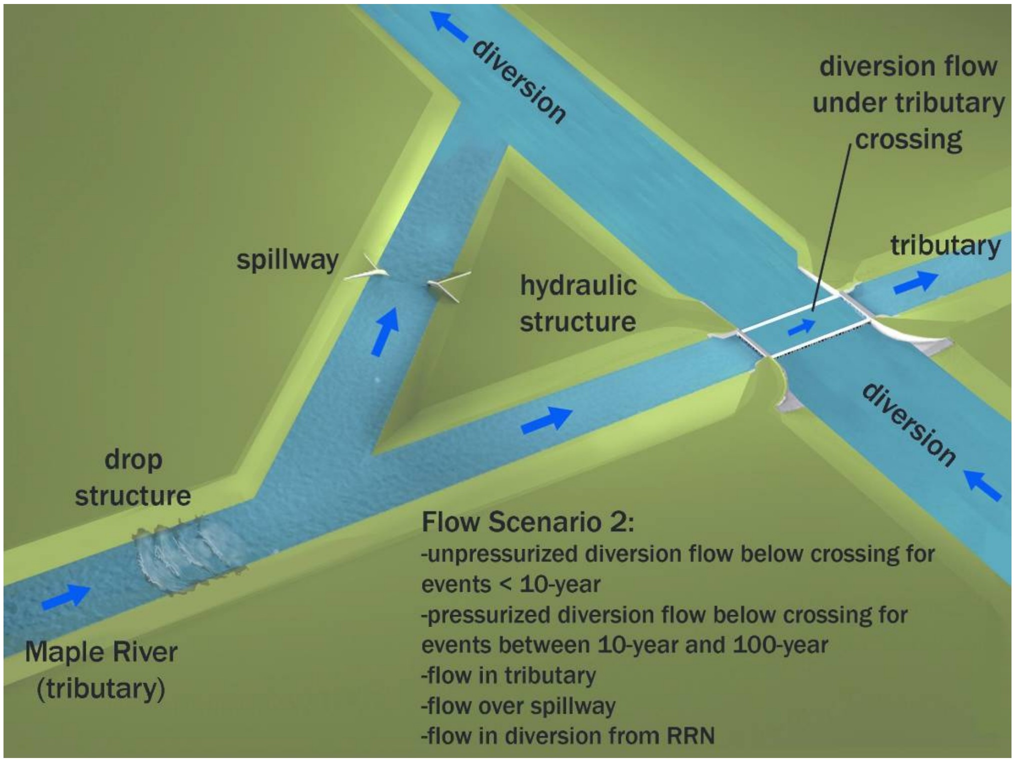


Figure 23 – Maple River and Diversion flows, Diversion overtops Maple River.

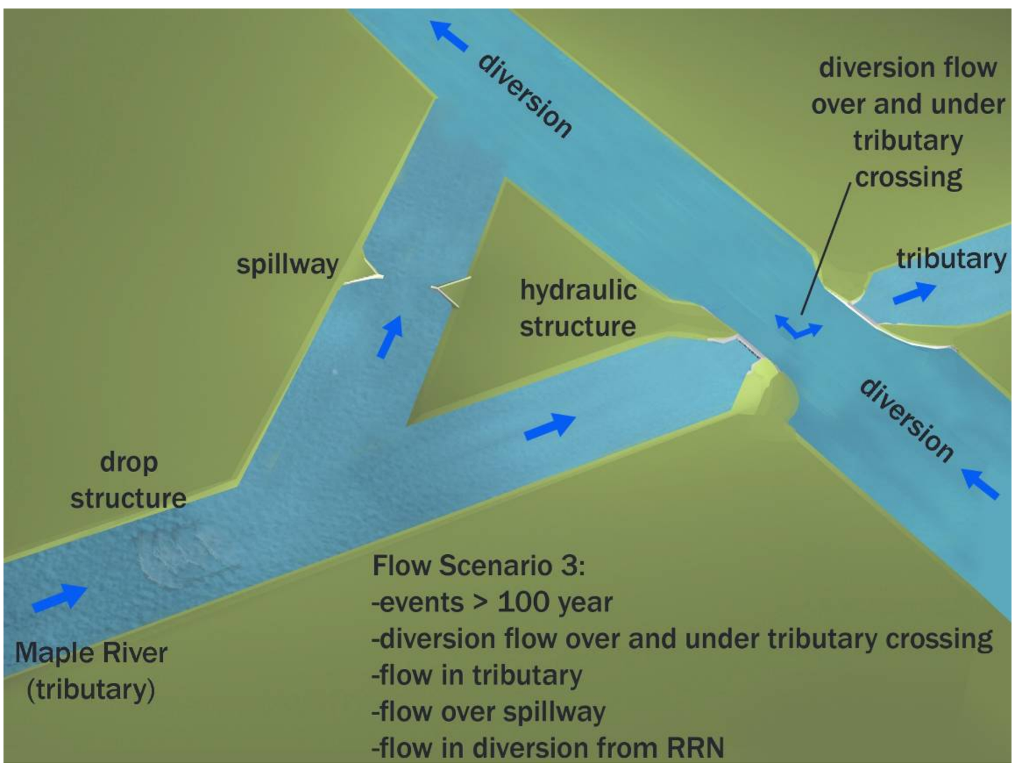
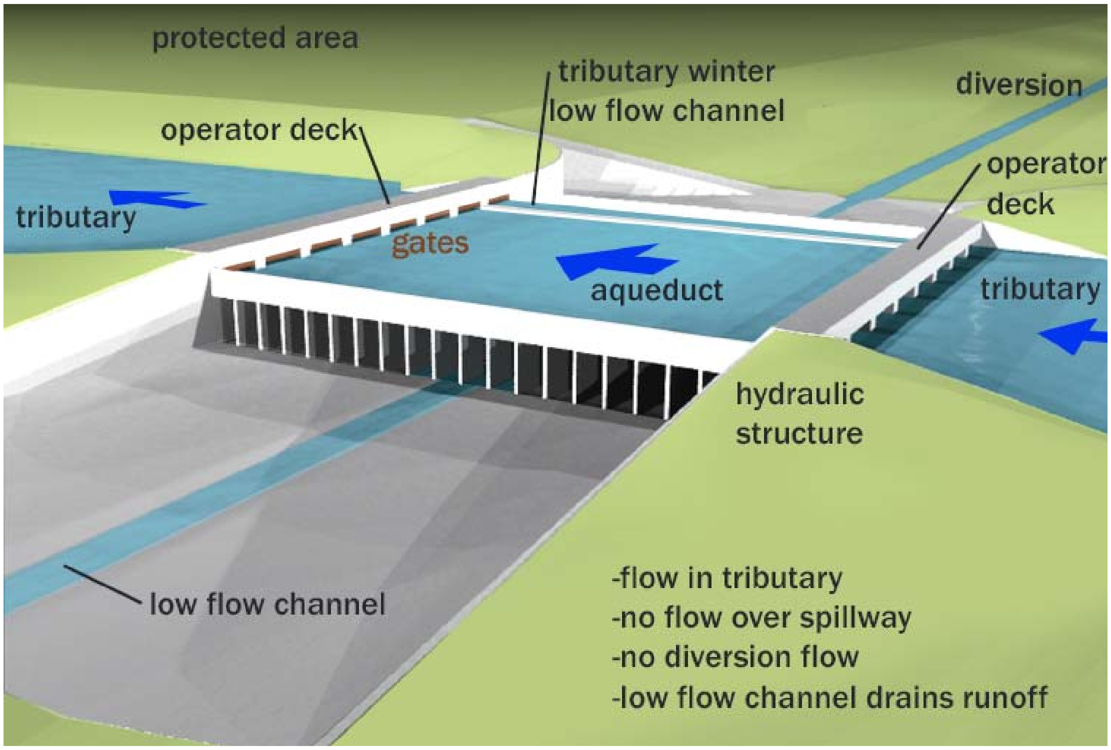


Figure 24 – Flow in Maple River, no flow over spillway or in diversion, looking upstream at structure.



A number of side ditch inlet drop structures would be included where the diversion crosses existing agricultural and highway drainage ditches. These structures would allow drainage to enter the channel and prevent water in the diversion channel from escaping to adjacent areas during high flow events.

The downstream end of the diversion channel would be protected with rock riprap where it returned to the Red River.

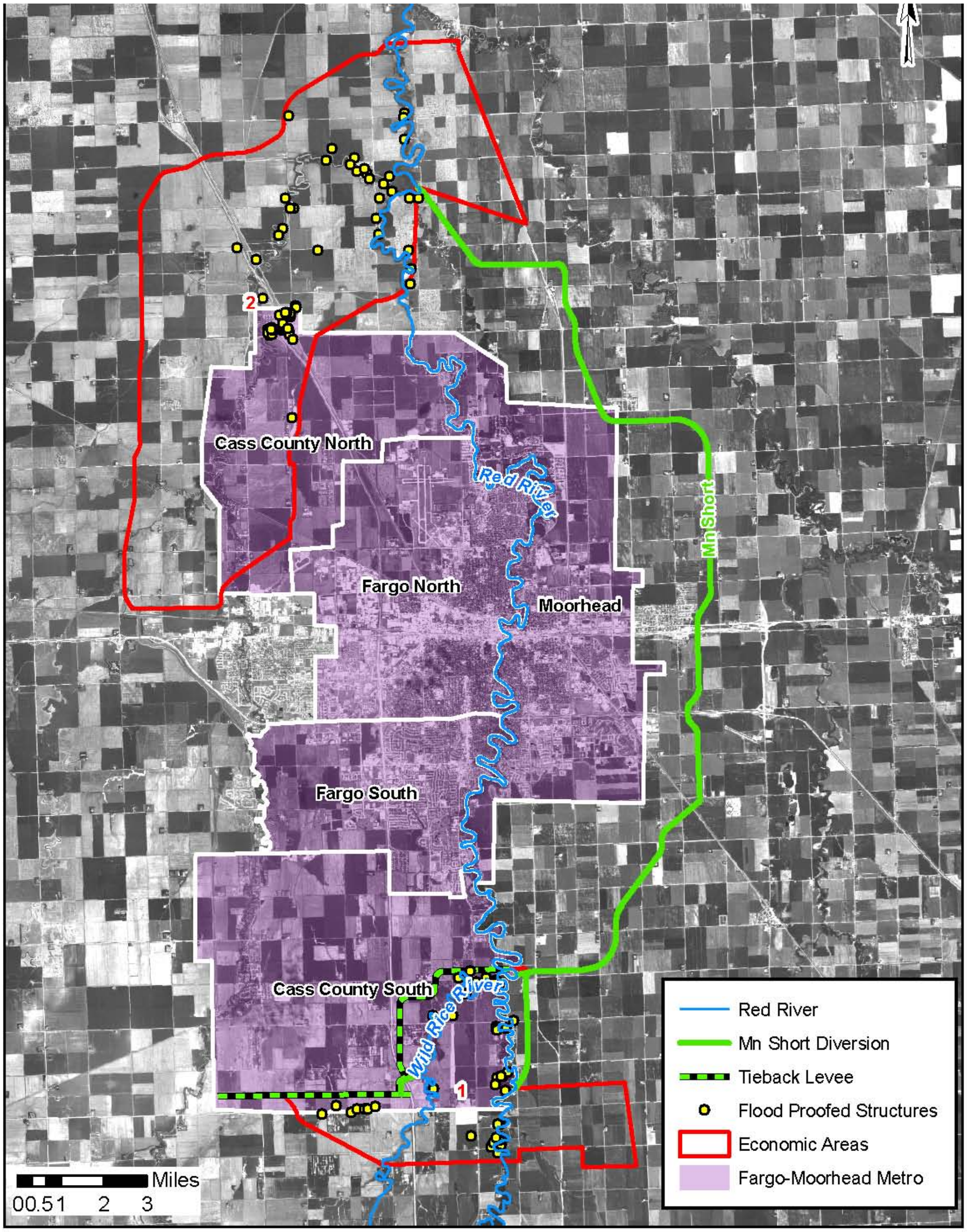
3.5.4.2 A critical path analysis was completed on the North Dakota diversion channel, and it was determined that the Maple River structure would be on the critical path. This resulted in an estimated construction period of 8.5 years for all of the North Dakota diversion alternatives, assuming funding was available as needed. The various sized plans would not have different construction schedules, because the Maple River structure would be the controlling factor rather than the excavation of the diversion channel.

<u>3.5.5 Non-structural measures</u>

Non-structural measures were analyzed as an additional incremental feature to be included in any of the diversion plans. Two areas were evaluated for residual flood impacts that could be addressed with non-structural measures: Economic Area 1 upstream and Economic Area 2 downstream. Economic Area 1 was the area upstream of the proposed Minnesota diversion channel inlet to approximately four miles south of the Wild Rice River confluence with the Red

River. Economic Area 2 was the area along the downstream reach of the Sheyenne River near the proposed diversion channel outlets. The areas analyzed are shown on Figure 25.

Figure 25 - Location of potential non-structural measures



Economic Area 1 included 48 residential structures. Potential non-structural measures applicable in this area were fee acquisitions and elevation of structures. This area was only considered in conjunction with the Minnesota plans, because the area is located downstream of the North Dakota diversion inlet, meaning it would be within the area benefited by the diversion and non-structural measures would not be necessary. It was determined that non-structural measures for Economic Area 1 were not justified for the Minnesota diversion alignments and had a benefit to cost ratio of 0.45 with net benefits of negative ($314,313).

The non-structural mitigation measures proposed for Economic Area 2 consisted of fee acquisitions, elevation of structures and construction of flood walls. For the MN20K plan there were 57 residential structures, one commercial structure and one critical facility (ID 400802 public school) included. For the larger Minnesota plans there are 51 residential structures and one critical facility (ID 400802 public school) included. For the ND30K and ND35K plans, there were 29 residential structures included.

Non-structural measures were incrementally justified for Economic Area 2 in conjunction with all Minnesota alternatives. The non-structural measures had benefit to cost ratios of 1.04 for the MN20K plan and 1.14 for the MN25K, MN30K and MN35K plans. The non-structural features would add average annual net benefits of $17,156 for MN20K and $49,903 for the other three Minnesota plans (see Appendix P). Therefore, with the selection of any Minnesota diversion alternative the non-structural measures in Economic Area 2 would be added as a justified increment to that plan and would become part of the NED plan.

Non-structural measures were not economically justified for either North Dakota alternative. With the North Dakota diversions in place, additional non-structural measures had a benefit to cost ratio of 0.64 and net benefits of negative ($73,354) (see Appendix P).

3.5.6 Incremental measures eliminated from further consideration

Following the development of the diversion alternatives, additional consideration was given to flood storage, wetland and grassland restoration, bridge replacement or modification and the use of cut-off channels. It was determined that these measures would not provide any additional economically justified benefits. This is due to the fact that the diversion alternatives provided a very high level of flood risk reduction, and they captured a large portion of the benefits that could be captured by a project.

The concept of using a shorter diversion to intercept only the Maple, Rush and Lower Rush rivers northwest of Fargo was considered as a potential additional feature of a Minnesota diversion plan. A preliminary analysis showed that the northwest diversion was not economically justified, so the concept was not carried forward.

3.5.7 Phase 2, Screening #2 Results

The results from the second Phase 2 screening are presented in Table 7.

Table 7 – Phase 2, Screening #2 cost-effectiveness analysis results

Screened Alternatives Ranked by Net Benefits with Cost and Schedule Risk Assessment				
Alternative	Cost [1]	Avg Annual Net Benefits [1]	Residual Damages [1]	B/C Ratio
MN Short Diversion 10K[2]	$730	$1.3	$40.3	1.03
MN Short Diversion 15K[2]	$800	$11.4	$31.0	1.28
MN Short Diversion 20K	$871	$16.2	$22.7	1.41
MN Short Diversion 25K	$980	$15.5	$18.1	1.36
MN Short Diversion 30K	$1,050	$15.1	$14.8	1.33
MN Short Diversion 35K	$1,143	$12.2	$13.3	1.26
ND East Diversion 30K	$1,231	$13.3	$11.4	1.26
ND East Diversion 35K	$1,295	$11.7	$9.7	1.22

1. In millions of dollars
2. Linear Cost Extrapolations used.
Expected average annual damages without a proejct were $77.1 million.

3.5.8 Phase 2, Screening #2 Conclusions

The key findings of the second screening were:

- The Minnesota 20K plan was the apparent NED plan.
- The difference in net benefits between the Minnesota plans was relatively small, so minor changes to costs or benefits could affect identification of the NED plan.
- The North Dakota plans had positive net economic benefits, so they were economically viable as potential locally preferred plans.

3.5.9 Hydraulic and Hydrologic assumptions

Throughout the second part of Phase 2, work continued to update the hydraulic models and hydrologic data to reflect the 2009 flood event. At the completion of Phase 2, it was determined that a non-traditional hydrologic method (see Appendix A, Hydrology) would most accurately represent the expected future flow conditions during the period of analysis. In addition, the hydraulic model was re-calibrated to the 2009 event. Both changes were expected to increase estimated flood stages for any given frequency of event and potentially affect the economic analyses.

3.5.10 Selection of alternatives for further analysis

The results of the second screening were presented to the public in February 2010 and discussed with the non-federal sponsors and stakeholders at several subsequent meetings. On March 29, 2010, the cities of Fargo and Moorhead, Cass County, North Dakota and Clay County Minnesota jointly requested that the ND35K plan be pursued as a locally preferred plan (LPP). Because of the relatively small magnitude of the differences in net benefits between the Minnesota plans, and the potential impacts of the revised hydrology and hydraulic models, it was necessary to retain the MN20K, MN25K, MN30K and MN35K plans as possible NED plans to be considered in the final array in Phase 3.

3.6 FEASIBILITY PHASE 3

3.6.1 General

Phase 3 began in March 2010. Primary activities were to refine the plans and identify which of the Minnesota plans would maximize net economic benefits. These refinements included additional analysis of the impacts to the railroads and to the cross sections on the diversion channels. This analysis used the hydrologic assumptions recommended by the EOE panel and the hydraulic model which was calibrated to the 2009 event, which increased estimated flood stages for the larger flood events. The analysis was completed on the MN20, 25, 30, 35, 40 and 45K alternatives and the ND35K alternative. The ND30K alternative was dropped from further consideration when the non-federal sponsors identified the ND35K as the Locally Preferred Plan as indicated in section 3.5.10.

3.6.2 Revised Cross Section for North Dakota Diversion

The cross section of the North Dakota diversion as described in section 3.5.4.1 was modified to account for weak soils that were identified as part of the soil investigations. This resulted in the depth of the channel being raised three feet, to a maximum depth of approximately 29 feet. The channel bottom widths remained unchanged. Side slopes on the excavation were modified to be 1V on 10H up to a 10 foot high 50 foot wide bench then 1V on 7H to the top of the channel.

Soil excavated to construct the channel would be piled and set back 50 feet from the top of the diversion channel to a maximum height of 15 feet. The soil disposal piles would be as wide as necessary to contain the excavated material. The spoil slopes were 1V on 7H and 1V on 10H for the diversion side and outside slopes, respectively. Portions of the soil disposal piles would be constructed to serve as levees when the water surface in the channel is higher than the natural grade. The total footprint of the ND35K plan would have a maximum width of approximately 2450 feet including areas for spoil piles.

3.6.3 Phase 3 Economic Analysis Results

3.6.3.1 The Phase 3 final array of alternatives was analyzed in May 2010 to identify the NED plan. The initial Phase 3 work showed that the MN35K plan, the largest plan analyzed in detail, maximized net economic benefits. As a result, it was necessary to consider larger alternatives to identify the NED plan. Hydraulic models were developed for the MN40K and MN45K alternatives to fully define the with-project flood stages and economic benefits for those alternatives. Table 8 shows the estimated peak stage at the Fargo gage.

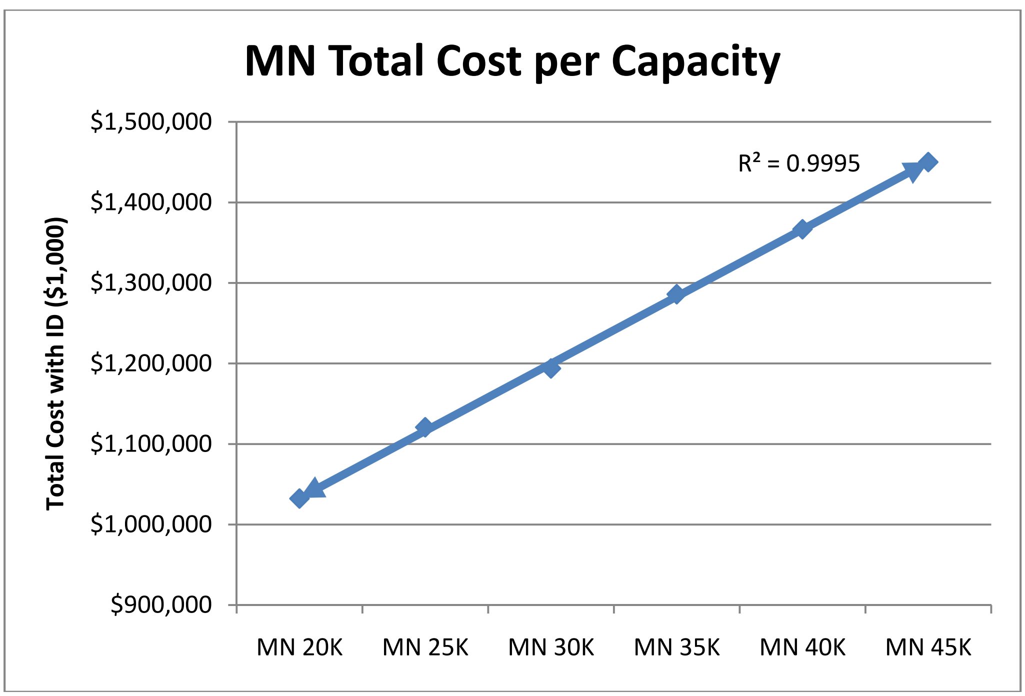
Table 8 – Phase 3 estimated flood stages assuming various diversion capacities.

	Stage at Fargo Gage (ft)	
	1% Chance (100- year)	0.2% Chance (500- year)
Existing Condition (Stage)	42.4	46.7
Existing Condition (CFS)	34,700	61,700
Work Group Goal	30	36
20K Diversion Channels	36.9	43.7
25K Diversion Channels	34.8	42.4
30K Diversion Channels	33.6	41.9
35K ND Diversion Channel	30.6	40.0
35K MN Diversion Channel	31.9	39.6
40K Diversion Channels	31.9	37.6
45K Diversion Channels	31.9	35.3

3.6.3.2 Costs for the MN40K and MN45K plans were estimated based upon linear extrapolation from the detailed estimates of the smaller Minnesota alternatives.

Figure 26 illustrates the linear nature of the cost curve for these alternatives and supports the methodology used.

Figure 26 - Linear Extrapolation of Costs for the MN40K and MN45K Alternatives



The Phase 3 analyses determined that the NED plan was the MN40K plan, with maximum average annual net benefits of $105.6 million. The results of the Phase 3 cost-effectiveness analysis are presented in Table 9.

Table 9 – Phase 3 cost-effectiveness analysis results

Screened Alternatives Ranked by Net Benefits with Cost and Schedule Risk Assessment					
Alternative	Cost [1]	Avg Annual Net Benefits [1]	Avg Annual Benefits [1]	Residual Damages [1]	B/C Ratio
MN Short Diversion 20K	$1,032	$87.0	$140.0	$55.9	2.64
MN Short Diversion 25K	$1,121	$98.8	$156.4	$39.5	2.71
MN Short Diversion 30K	$1,194	$101.7	$163.1	$32.8	2.66
MN Short Diversion 35K	$1,286	$104.9	$171.0	$24.9	2.59
MN Short Diversion 40K [2]	$1,367	$105.6	$175.9	$20.0	2.50
MN Short Diversion 45K [2]	$1,450	$104.9	$179.5	$16.4	2.41
ND East Diversion 35K	$1,462	$95.4	$171.1	$24.8	2.26

1. In millions of dollars with interest during construction and discounting included
2. Estimate based on linear extrapolation
Expected average annual damages without a project were $195.9 million.

3.6.3.3 It is interesting to note that the NED plan does not produce the highest benefit-cost ratio. The definition of the NED plan is based upon maximizing average annual net benefits rather than maximizing benefit-cost ratio.

3.6.4 Reconsideration of the ND35K plan as the Locally Preferred Plan (LPP)

On April 28, 2010, the Assistant Secretary of the Army for Civil Works authorized the Corps to recommend the ND35K plan as the non-federal sponsors' LPP, as described in section 3.9.3.2 of this report. After considering the Phase 3 results, the non-federal sponsors reaffirmed their preference for the ND35K plan. It was noted that the revised hydrology and hydraulics affected the nominal performance of the ND35K plan, and it would no longer produce the locally desired stage of 36.0 on the Fargo gage for a 0.2-percent chance event.

3.6.5 Screening of the MN40K (NED) plan and the MN45K plan

Selection of the ND35K plan as the LPP made further consideration of the NED plan (MN40K) unnecessary. Federal cost sharing for the ND35K plan could not be based on the NED plan, because the ND35K plan produced fewer total average annual benefits than the NED plan, at $171.1 million and $175.9 million, respectively. Instead, federal cost sharing would be based upon a smaller Minnesota alternative that produced a comparable level of benefits to the ND35K plan. Table 9 shows that the MN35K plan and the ND35K plan produced comparable benefits, at $171.0 million and $171.1 million respectively. Since the MN35K plan would serve as the basis for federal cost sharing, there was no need to fully develop the MN40K (NED) plan. For purposes of the feasibility study, it was only necessary to demonstrate that the NED plan was larger than the MN35K plan. For that reason, the MN40K (NED) plan and the MN45K plan were dismissed from further consideration, and the MN35K plan would be refined for comparison with the ND35K plan for cost-sharing purposes. The MN35K plan was therefore identified as the Federally Comparable Plan (FCP).

3.6.6 Validation of earlier screening steps

The Phase 3 economic analyses completed in May 2010 validated the October 2009 and January 2010 screening steps. Decisions made at earlier steps were based on the best available hydraulic and hydrologic data available at that time. Subsequent information indicated that the earlier assumptions underestimated both the flow frequency and expected flood stages. As a result, all of the plans previously considered and screened out during the earlier screening steps, including levee and storage alternatives, would provide more benefits but would leave higher residual flood risk than was identified at the time. The best available data at the conclusion of Phase 3 confirmed that the diversion channel concept was the only concept that could achieve the planning objective to provide a high level of flood risk reduction in the study area.

3.6.7 Downstream and upstream impacts

At the end of Phase 3, there were two primary issues related to downstream impacts of the diversion plans. The first issue was the potential effect of induced economic damages on identification of the NED plan. The second issue was the inability to determine the full extent of the impacts and identify the location where impacts dissipated to a negligible amount, which made it necessary to modify the LPP. These issues are discussed below.

3.6.7.1 No effects on selection of NED plan: At the end of Phase 3, the analysis of downstream impacts of the diversions was incomplete. However, it was determined that downstream impacts would not affect the selection of the NED plan. All of the Minnesota diversions would have similar performance up to their design capacity; for any given flood, each channel would divert the same amount of water up to its full capacity. All of the diversions would convey similar flows for more frequent events, and differences in downstream impact would primarily occur in the larger less frequent events. Economic damages due to downstream impacts would not vary significantly with the size of channel, because the infrequent events would add relatively little to the annualized damages. Since downstream impacts would be relatively similar for all of the alternatives, downstream impacts would not affect the identification of the NED plan, and it was not necessary to quantify the impacts from the smaller plans in order to identify the NED plan. During Phase 3, downstream impacts were only modeled for the MN35K and ND35K plans.

3.6.7.2 Effects on the LPP: Throughout Phases 1-3 of the study, the diversion alternatives were designed to have only downstream stage increases and it was expected that any downstream stage increases would be relatively small and dissipate relatively quickly. Prior to release of the Draft Report and Environmental Impact Statement in May 2010, the unsteady HEC-RAS models showed downstream impacts to Halstad, MN. Following the release of the Draft Report the models were extended downstream to Thompson, ND (101 river miles downstream of the diversion outlet). The models showed impacts at Thompson of nearly 16 inches for a 1-percent chance event with the ND35K diversion. Based on these results, it was determined that additional modeling was required to identify a point downstream with minimal to no impacts and that consideration would need to be given to other options such as upstream staging.

3.6.8 Phase 3 Conclusions

3.6.8.1 NED Plan: Based on the Phase 3 analyses, the MN40K plan was the plan that reasonably maximized the net national economic development benefits and was therefore the NED plan. No further analysis was needed to define the NED plan.

3.6.8.2 Locally Preferred Plan (LPP): The ND35K plan was identified as the LPP and the tentatively selected plan in the May 2010 Draft Report and Environmental Impact Statement. However, due to the extent of the downstream impacts, it was necessary to consider modifications to the ND35K plan, including options that would cause upstream impacts.

3.6.8.3 Federally Comparable Plan (FCP)

The LPP provided fewer total average annual benefits than the NED plan. Therefore, as described in section 3.6.5, it was necessary to develop a plan smaller than the NED plan that could be compared to the LPP for cost-sharing purposes. Table 9 shows that the MN35K plan would provide similar total average annual benefits and residual damages compared to the LPP. Therefore, the federal investment in the LPP should be capped at the investment that would have been made for the comparable MN35K plan.

3.7 FEASIBILITY PHASE 4

Phase 4 focused on extending and refining the unsteady HEC-RAS hydraulic models and using the models to assess several strategies to minimize project impacts. The strategies that were considered included shifting the diversion further north (to near the MN35K plan's inlet), staging water upstream on the Red and Wild Rice rivers, passing additional water through the protected area in the Maple River's natural channel, and using off-channel storage areas along the diversion channel. The study team assessed several different channel sizes and slopes in combination with various amounts of upstream staging and temporary storage within the protected area to achieve a definable impacted area. The control structures in the design were operated as necessary to achieve the desired hydraulic conditions in the Red River channel through Fargo-Moorhead.

This ultimately resulted in 3 plans being considered: the FCP as defined in Phase 3 (see section 3.12 below), the ND35K as defined in Phase 3 (the LPP in the May 2010 Draft Environmental Impact Statement; see section 3.11 below), and the redefined LPP, which is the North Dakota diversion with upstream storage and staging (see section 3.13 below).

3.7.1 NED Analysis

The steps leading to the identification of the NED plan were revisited to determine if the NED plan was likely to change. Additional measures were developed as part of Phase 4, and additional hydraulic modeling was conducted. Therefore, it was necessary to review the NED analysis. The Phase 4 NED analysis focused on logic checking based on the new information, and showed that the MN40K as defined in Phase 3 was likely still the NED plan. This analysis is presented in detail in section 8.4 of Appendix O.

3.7.2 Description of the LPP (North Dakota diversion with upstream staging and storage)

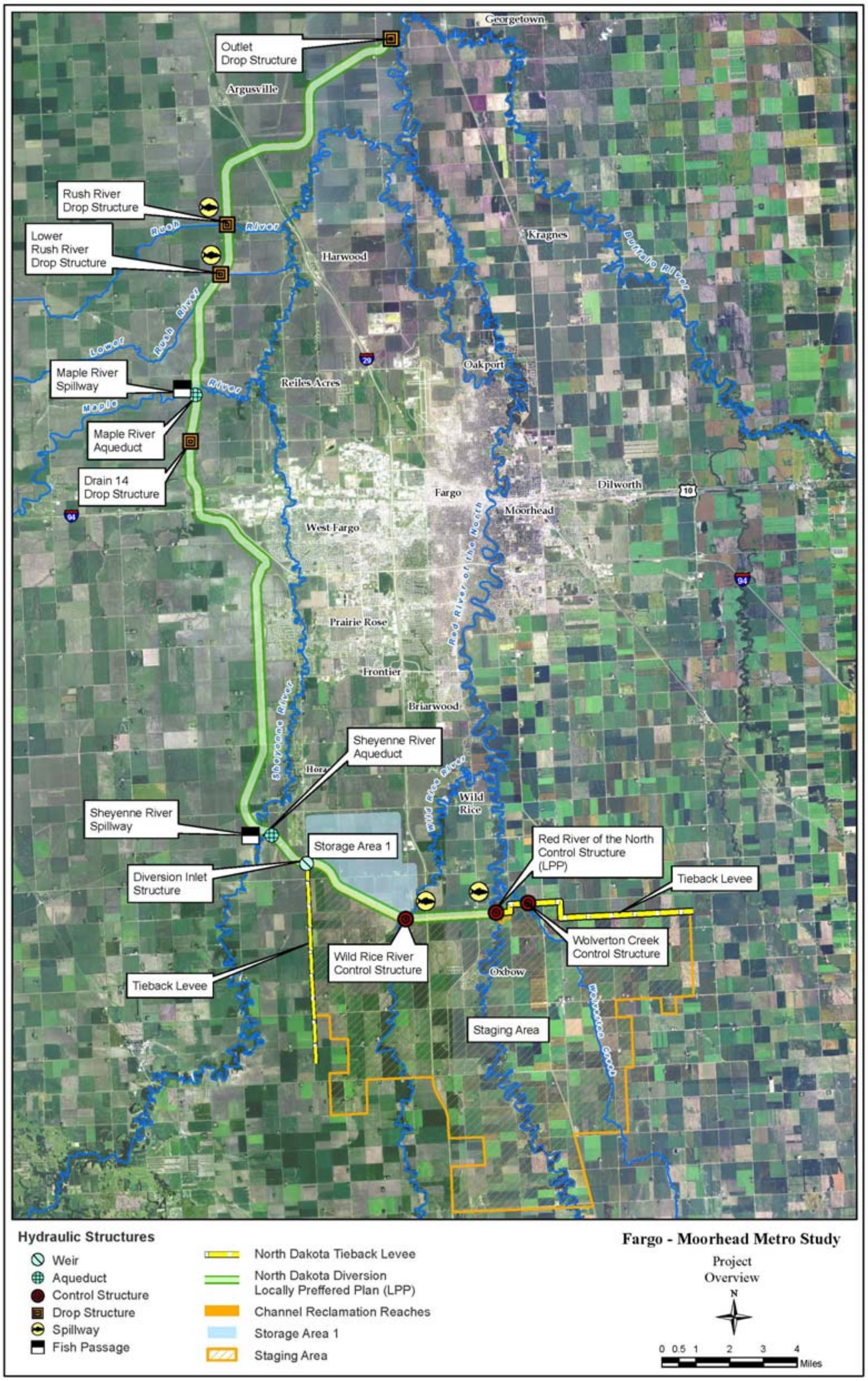
The LPP diversion alignment starts approximately four miles south of the confluence of the Red and Wild Rice Rivers and extends west and north around the cities of Horace, Fargo, West Fargo, and Harwood and ultimately re-enters the Red River north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, MN. The alignment is approximately 36 miles long and incorporates the existing Horace to West Fargo Sheyenne River diversion channel. The basic North Dakota alignment is the same for the ND35K plan and the LPP; the alignment remained the same as in the earlier screening phase, except where it was adjusted northwest of Harwood, ND to avoid Drain 13. Some significant design changes were made for the LPP including the addition of staging and storage, as well as additional changes to optimize the channel cross section. The LPP includes 19 highway bridges and 4 railroad bridges that cross the diversion channel. Interstate Highway 29, U.S. Highway 75 and a BNSF railroad line would be raised within the staging area to maintain transportation during flood events.

The plan consists of the following primary features:

- Red River control structure
- Connecting channel (Red River to Wild Rice River)
- Wild Rice River control structure
- Diversion inlet weir (at Cass County Road 17)
- Storage Area 1 (levees and flowage area)
- Upstream staging area (with non-structural mitigation)
- Main diversion channel
- Sheyenne River aqueduct and spillway structures
- Maple River aqueduct and spillway structures
- Lower Rush River drop structure with fish passage
- Rush River drop structure with fish passage
- Outlet drop structure (with adjacent fish passage)
- Wolverton Creek control structure
- Tie-back levees
- Side ditch inlet structures
- Highway bridges
- Railroad bridges
- I-29, US75 road raises and BNSF railroad raise in staging area

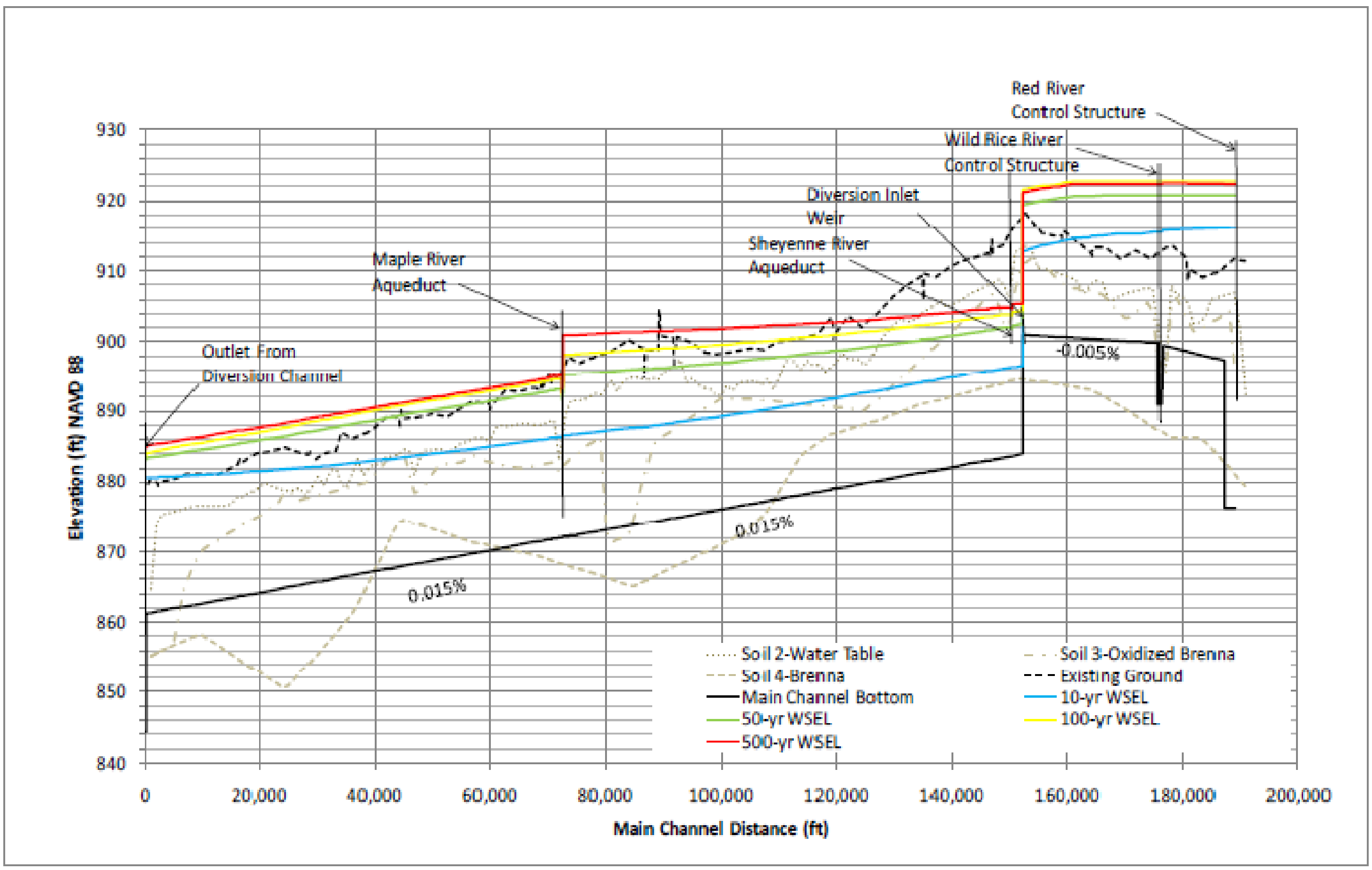
Figure 27 shows the alignment of the major features.

Figure 27 – LPP Diversion Alignment and features



The LPP channel capacity was modified from previous phases to account for the storage and staging areas that were included. The inclusion of these areas allowed for the capacity of the diversion channel to be reduced to approximately 20,000 cfs. The diversion channel geometry was refined from Phase 3 based on required conveyance capacity, water surface elevation in the diversion, and limiting the excavation quantities of Brenna clays. The channel was designed to keep the 1-percent chance event flood flows below existing ground in the diversion channel as much as possible to limit impacts to drainage outside the channel. Figure 28 shows the channel profile, existing ground surface elevations, and the water surface elevations during various flood events. The right side of the figure is the upstream (south) end.

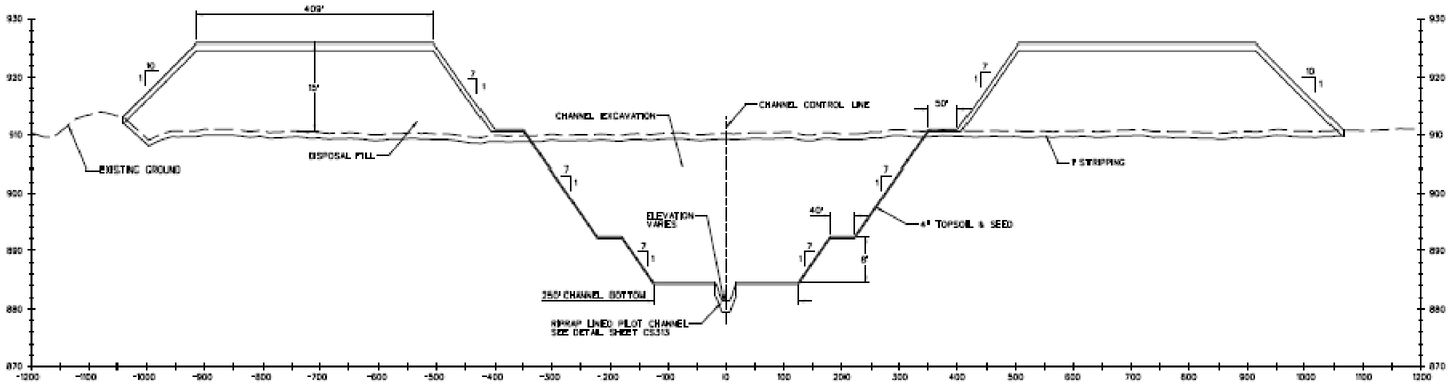
Figure 28 – LPP Channel Profile



The typical depth for the diversion is approximately 20 feet, with a maximum depth of 35 feet near the inlet weir. The channel bottom width between the Red and the Wild Rice rivers is 250 feet. Between the Wild Rice River and the diversion inlet weir, the bottom width is 100 feet, and downstream of the diversion inlet weir the width is 250 feet.. Generally all side slopes are 1V on

7H and some slopes include benching of varying widths, see Figure 29. A low flow pilot channel would run along the bottom of this reach, and erosion protection at the toe of the main channel side slopes would be provided. Soil excavated to construct the channel would be piled adjacent to the channel to a maximum height of 15 feet. The soil disposal piles would be as wide as necessary to contain the excavated material. The spoil slopes are 1V on 7H and 1V on 10H for the diversion side and outside slopes respectively. Portions of the soil disposal piles would be constructed to serve as levees when the water surface in the channel is higher than the natural grade. The total footprint of the LPP diversion channel has a maximum width of 2200 feet including areas for soil disposal piles. The affected acreage is 8054 acres.

Figure 29 – LPP Typical Cross Section



The main hydraulic structures controlling the flows passing into the protected area during the larger flood events are the control structures proposed on the Red River of the North and Wild Rice River, with effective flow widths of 150 feet and 60 feet, respectively. The Red River Control Structure is illustrated in Figure 30 and Figure 31. These gated structures would be operated only when the forecasted peak flow of the incoming hydrograph in the Red River of the North at the USGS gage in Fargo is greater than 9,600 cfs (approximately a 28-percent chance event). Otherwise, the structure (with fully open gates) resembles a bridge. Secondary by-pass channels for fish passage are included at both of these structures.

Figure 30 - Red River Control Structure visualization (normal conditions—no flooding)

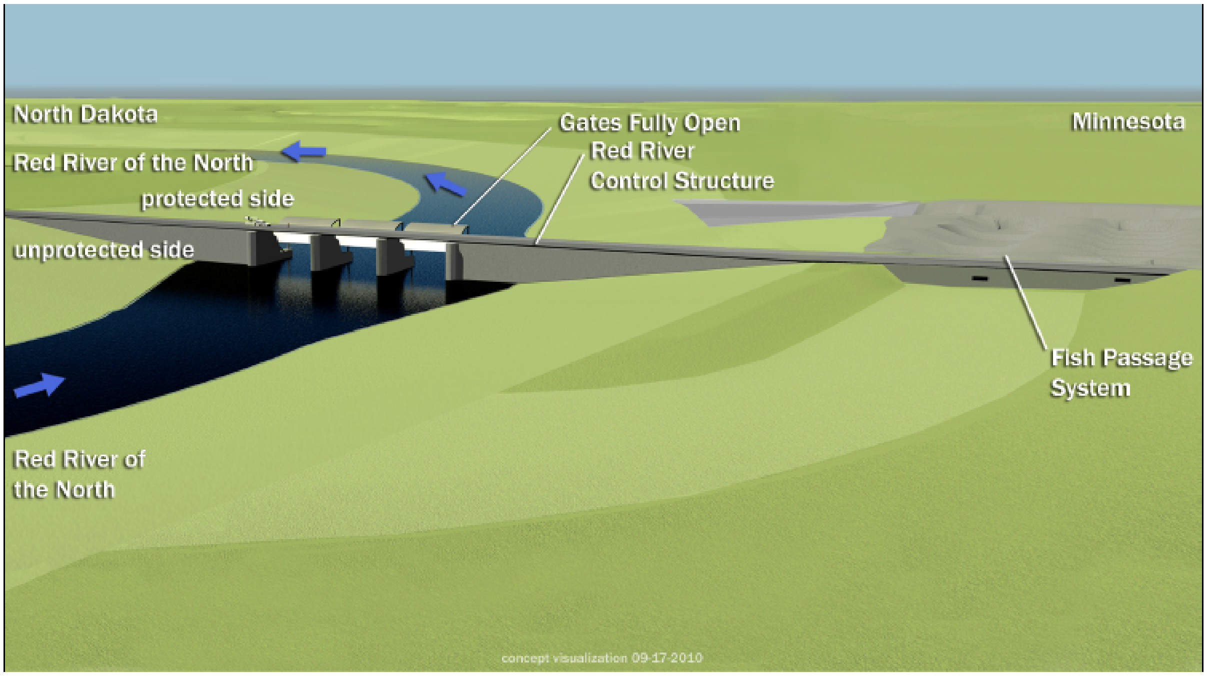
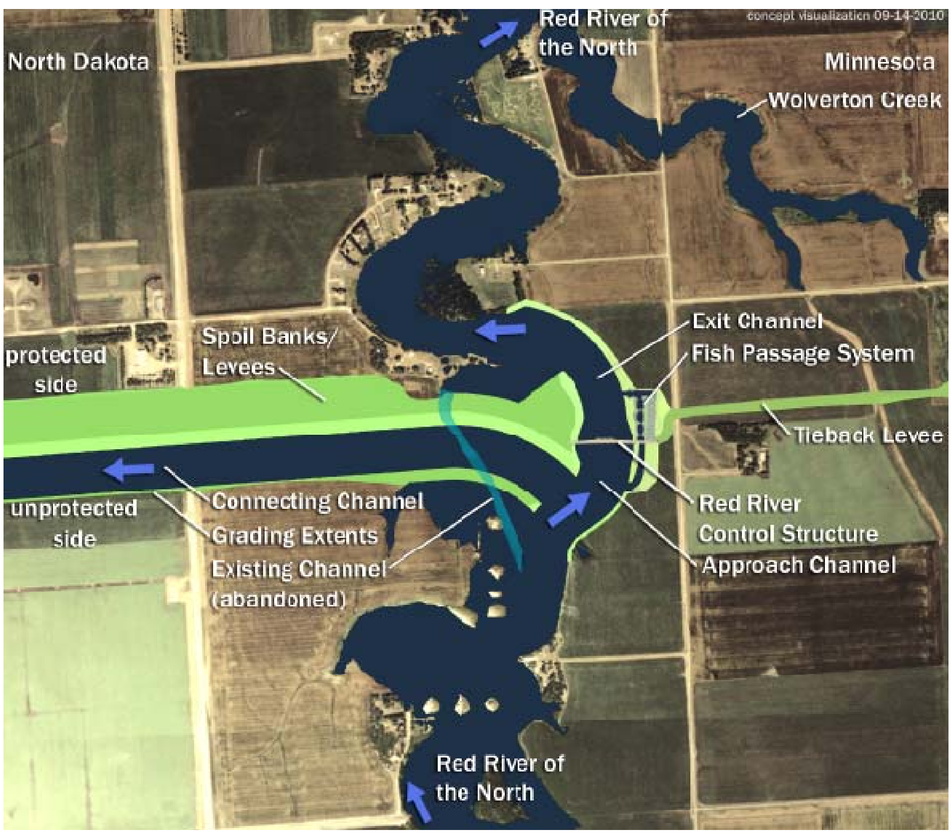


Figure 31 – Red River Control Structure visualization with flooding.

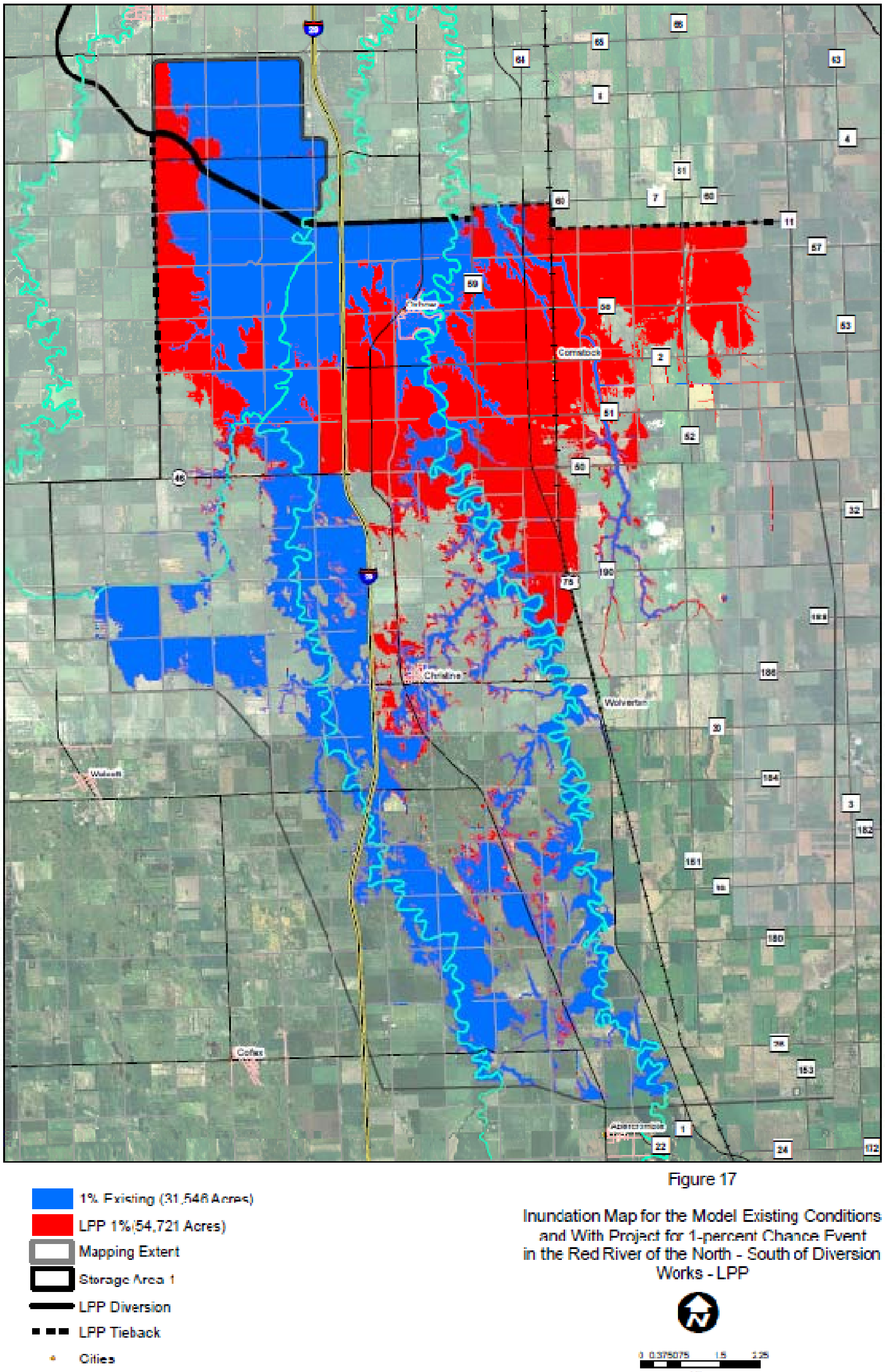


The diversion inlet structure is a passive weir (no gates or other regulation controls) with an effective flow width of 90 feet and a concrete spillway. The inlet weir is located where the diversion channel crosses Cass County Highway 17 south of Horace, ND.

The main line of flood protection at the south end of the project includes the embankments adjacent to the diversion channel, Storage Area 1 embankments, and a tie-back levee from the Red River control structure to high ground in Minnesota. A small control structure consisting of two 10-foot by 10-foot gated box culverts would be used where Wolverton Creek crosses the Minnesota tie-back levee. The structure would normally be open to allow the creek to pass through the levee, but during floods the structure would be closed to prevent flood flows from passing.

In order to eliminate downstream impacts, upstream staging and storage of approximately 200,000 acre-feet immediately upstream of the diversion channel inlet would be required. Figure 32 shows the area that would be affected by staging during a 1-percent chance flood event. The Red River and Wild Rice River control structures would be operated to limit flows in the natural channels and raise water surface elevations in the upstream staging and storage areas. Water levels would rise to 922.8 feet at the inlet during a 1-percent chance event. The diversion inlet weir elevation is 903.25 feet. Storage Area 1 is a 4360-acre area on the north side of the LPP diversion channel between the Wild Rice River and the Sheyenne River that will be formed by nearly 12 miles of embankments. Storage area 1, combined with staging in the floodplain, will nearly eliminate impacts from the project on flood levels downstream of the diversion channel outlet. The diversion works would be operated not only based on peak flows but primarily based on total hydrograph volumes, in particular those during the rising limb of the hydrograph. A tie-back levee along Cass County Road 17 (CR17) would be needed to keep staged water from crossing overland into the Sheyenne River. A portion of the CR17 tieback levee would be at an elevation lower than the other tie-back levees in order to act as an emergency spillway for extreme events that exceed the 0.2-percent chance event design capacity of the project.

Figure 32 – 1-percent chance event inundation map showing existing conditions (blue) and with LPP (red)



Hydraulic structures, known as aqueducts, would be located where the diversion crosses the Sheyenne and Maple rivers. The Maple River structure is illustrated in Figure 33 and Figure 34; the Sheyenne River aqueduct would be similar. The aqueducts would allow flows in the diversion to pass underneath the existing river channel, while allowing non-flood flows to continue down the Sheyenne and Maple rivers. During floods on the Sheyenne and Maple rivers, flows in excess of a 50-percent chance event would be diverted into the diversion channel. The 50-percent chance event flows are intended to maintain existing geomorphologic processes and existing habitat conditions in the natural channels. The Sheyenne and Maple River structures would remain biologically connected and maintain fish passage to those rivers nearly all of the time. The two crossing structure systems are similar in concept; each include a drop structure to prevent headcutting on the tributary, a spillway and channel to control diversion of tributary flows, and a hydraulic structure to pass a limited flow over the diversion channel to maintain the desired flow in the tributary beyond the diversion channel.

The structures located at the Lower Rush River and Rush River would include a combination of a vertical drop (also proposed for Drain 14), with a total width of 60 feet and 100 feet at the Lower Rush River and Rush River, respectively; and a fishway consisting of 40 feet wide riffle-pool sequences that would extend from the tributary channel down to the low flow pilot channel of the diversion channel. Both tributaries would be diverted into the diversion channel during all flow conditions, and to compensate for the loss of less than 4 miles of existing channelized tributaries, the lower 11 miles of the low flow pilot channel in the diversion channel would be constructed with meanders.

The outlet structure located where the diversion returns to the Red River of the North would be a concrete spillway with a width of 250 feet. Although the maximum diversion flows at this location are smaller in Phase 4 than in Phase 3, the LPP channel invert was raised above the invert of the ND35K plan, so there is greater vertical drop which required a change in the design at the outlet. A fishway would be constructed at the diversion channel outlet to allow fish access to the Rush and Lower Rush rivers via the low-flow channel in the diversion channel.

Figure 33 - Maple River crossing conceptual drawing

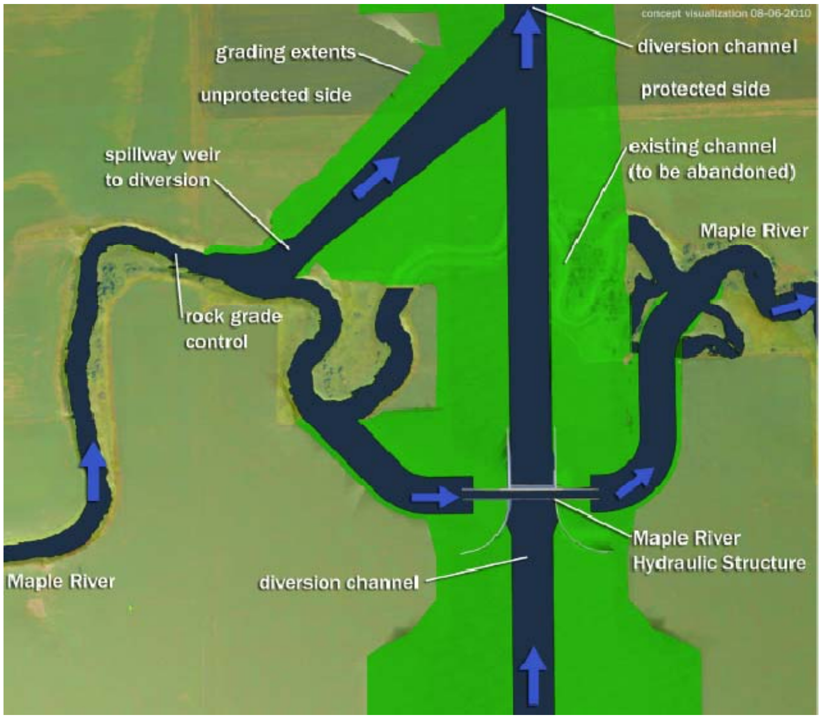


Figure 34 - Maple River Aqueduct visualization

3.7.3 North Dakota West and East Alignments

Prior to finalizing the North Dakota diversion alignment, it was proposed that the North Dakota West diversion alignment be given additional consideration based on information provided by a number of local entities. The North Dakota West alternative was initially eliminated from further consideration because it was believed at the time that there were no significant unique benefits or avoidance of any adverse environmental effects associated with the North Dakota West alignment (see section 3.4 for more details).

The North Dakota West alignment generally runs 1.5 miles to the west of the North Dakota East Diversion between Horace, ND and West Fargo. A formal request to consider moving the diversion to the West alignment was based on local concerns that were identified during the comment period that was held for the Notice of Intent to prepare a Supplemental Draft Environmental Impact Statement, which was published in the Federal Register on December 27, 2010.

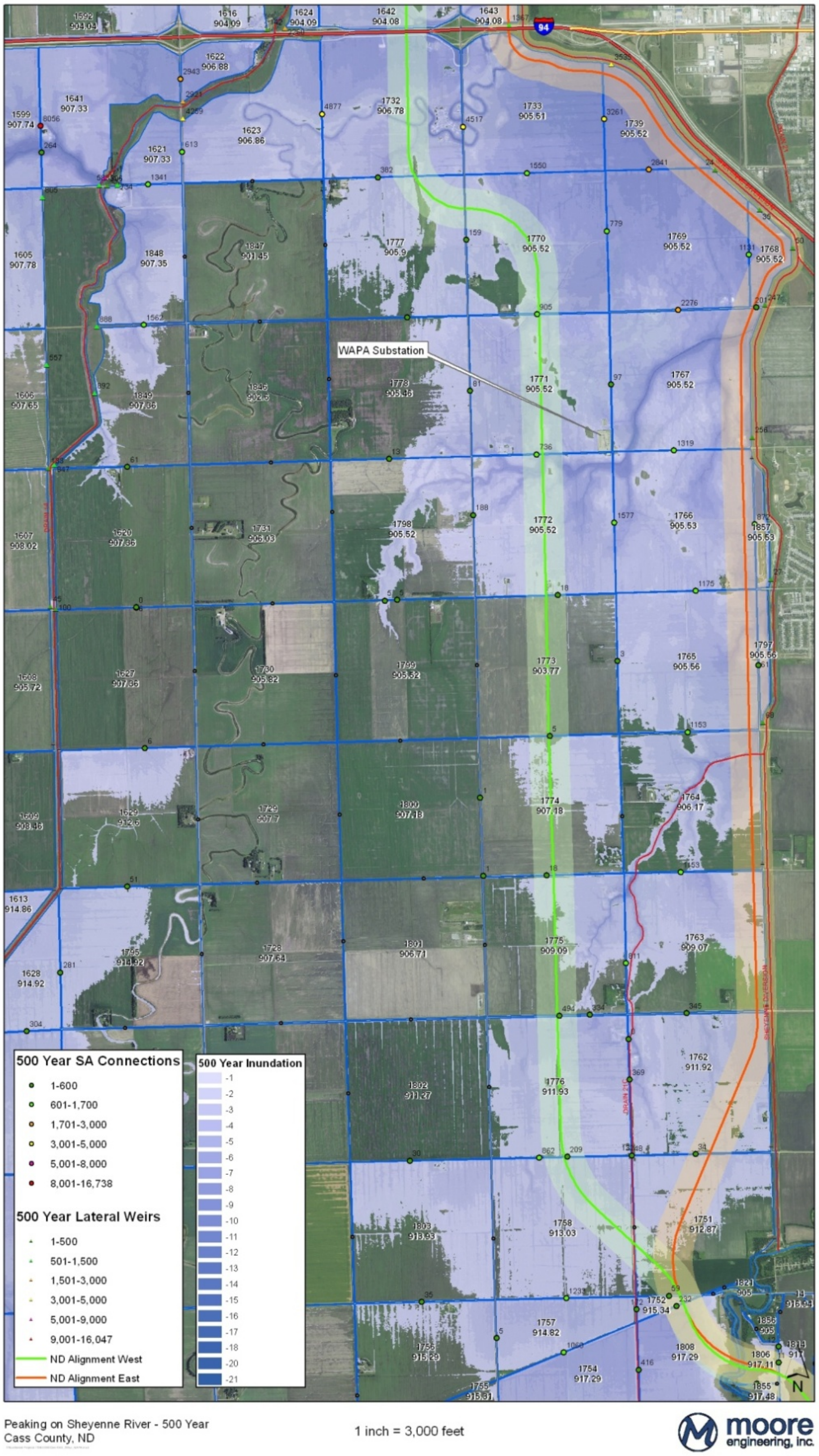
Comparisons between the East and West alignments were based on the following:

- Western Area Power Administration substation
- Impacts to natural resources including wetlands and floodplains
- Benefits to additional homes and emergency access
- Benefit of a straighter channel and interaction with existing diversions
- Level of protection for the existing community of West Fargo
- Benefits to local communities of developing in former floodplain areas

3.7.3.1 Western Area Power Administration substation

The Western Area Power Administration (WAPA) substation is located approximately 1 mile to the west of the existing Horace to West Fargo diversion and 3 miles to the south of I-94. The substation serves the Fargo-Moorhead Metro area with power and is a critical piece of infrastructure. The Fargo-Moorhead Metro area also has two other substations serving the area that are currently flood prone and are benefited with either North Dakota diversion alignment. The WAPA substation was constructed to an elevation between 907 and 909. Although the facility has been built to a relatively high elevation, access to the facility during flood events can be limited. The facility has built in redundancy including back-up transformers, and the critical aspects of the facility are all overhead. The overall power system in the region also has redundancy built in; however during large flood events there would likely be threats to other facilities that serve the region.

Figure 35 – Sheyenne River Floodplain – 0.2-percent chance event.



The Sheyenne River floodplain can be seen in Figure 35 for the 0.2-percent chance event (500-year). Although not clear on the map, the WAPA substation is not flooded. During the Sheyenne River 0.2 percent chance event flood levels near the WAPA substation reach an elevation of 905.5. Therefore the WAPA substation is 1.5 feet higher than the 0.2-percent chance event and generally not subject to direct flooding except from extremely large and infrequent flood events.

Access to the facility can be limited during flood events and this occurred during the flood of 2009 when access was limited from all directions. During flood events up to nearly the 1-percent chance event, access to the substation is open from the west, however events exceeding the 1-percent chance would result in no road access from any direction.

Due to the relatively high elevation of the WAPA substation, the fact that two other substations will be protected in the region, and that access is maintained up to nearly a 1-percent chance event there would be limited risk reduction to the facility by locating it within the protected area. The WAPA is responsible for the facility; if WAPA believes there is a significant risk to the facility or the region's power supply, measures could be taken that address the situation much sooner than they could be addressed by the proposed diversion project.

3.7.3.2 Impacts to natural resources including wetlands and floodplains

The West alignment would impact 208 acres of wetlands; the East alignment would impact 150 acres of wetlands. Although either plan has impacts to wetlands, they are primarily farmed wetlands. Therefore the general quality of these wetlands is poor and they provide minimal habitat value.

The West alignment would remove 9.2 square miles of the 1-percent chance event Sheyenne River floodplain. Removing this area from the floodplain essentially results in lost storage. As was found with previous modeling of the downstream impacts, when areas were removed from the floodplain and storage was lost there were downstream impacts. Therefore the removal of this area would likely cause downstream impacts during a 1-percent chance event on the Sheyenne River with a coincidental flow event on the Red River. The study has been primarily focused on the Red River event with coincidental flow events on the tributaries and no models have been developed to assess the exact impact, however it can be said with certainty that there would be impacts.

3.7.3.3 Benefits to additional homes and emergency access

The West alignment would provide benefits to additional homes as a result of removing the 9.2 square miles from the floodplain. This includes the Willow Creek subdivision with 24 homes. The homes in the area would be benefited by relocating the diversion to the West alignment.

Emergency access during flood events is critical both to ensure that the public can be assisted by emergency personnel and to ensure they can evacuate the area during flood events. Interchange 324 on I-94 was identified by local officials as critical to the emergency services in the area. The elevations of the interchange are all above the existing 1-percent chance event Sheyenne River floodplain, however the roadways to the north and south would be inundated by flood waters. The exception to this would be for the additional 9.2 square miles of benefited area that could be accessed during a flood event with the West alignment.

Properties to the northeast of the interchange would be within the benefited area of either alignment and access to these areas can be obtained by other routes such County Road 10 or 17.

3.7.3.4 Benefit of a straighter channel and interaction with existing diversions

The existing Sheyenne Diversion project consists of two parts: the Horace to West Fargo diversion and the West Fargo diversion. Both the East and West Fargo-Moorhead Diversion alignments make the existing Horace to West Fargo diversion channel unnecessary. With either alignment the existing Horace to West Fargo diversion would be abandoned. The portion of the existing Sheyenne Diversion from West Fargo to its outlet (the West Fargo diversion) would remain to divert Sheyenne River flows around West Fargo.

Significant analysis and data collection has gone into the development of the diversion channel design. As can be seen in Appendix I, Geotechnical Engineering, direction changes in the alignment are not anticipated to have significant erosion or operational issues; neither alignment would be considered superior to the other from a technical standpoint. Lessons learned from the existing Sheyenne Diversion project have been incorporated to ensure that any diversion channel will be stable.

In sum, either the East or West alignment will provide a significantly greater level of risk reduction from flooding from the Sheyenne River, and both alignments would include similar modifications to the existing Sheyenne Diversion project.

3.7.3.5 Level of protection for the existing city of West Fargo

The city of West Fargo is subject to flooding from the Red River for events larger than the 1-percent chance event and would be entirely inundated during a 0.2-percent chance Red River flood event. Either diversion channel alignment would provide a significant level of flood risk reduction to the community of West Fargo from the Red River flooding.

West Fargo is also threatened from Sheyenne River flooding. The existing Sheyenne Diversion consists of two portions, the Horace to West Fargo diversion and the West Fargo diversion. The Horace to West Fargo portion can safely pass approximately a 1-percent chance Sheyenne River flood event. The West Fargo portion can safely pass a Sheyenne River flood event in excess of the 0.2-percent chance event. Either the proposed North Dakota East or West diversion would significantly reduce the flood risk along the Sheyenne River between Horace and West Fargo.

3.7.3.6 Benefits to local communities of developing in former floodplain areas

The Corps of Engineers and other federal agencies must comply with Executive Order (EO) 11988 Floodplain Management when designing or permitting projects. One goal of EO 11988 is to “avoid direct or indirect support of floodplain development wherever there is a practicable alternative.” If avoiding the floodplain altogether is not practicable, EO 11988 requires federal agencies to “minimize potential harm to or within the floodplain.” The communities of West Fargo, Horace, and Cass County have indicated a desire to develop into areas that are currently floodplain and subject to regular flooding. They have developed long term goals to develop in the floodplain areas that would be between the East and West diversion alignments and would like to see these areas removed from the floodplain. While the West diversion alignment would significantly reduce flood risk from riverine flooding, much of the area between the East and West alignments is extremely low and would still be threatened during large rain events. Allowing citizens to build in the existing floodplain would increase overall flood damages in the future. Flooding could also impact emergency access in these areas and cause catastrophic loss during rainfall flood events. As can be seen in Figure 35 the area proposed for development has significant flooding today, however there are areas depicted on the map just to the west that would not be in the existing 0.2-percent chance event floodplain and would provide practicable alternatives for future development.

3.7.3.7 Conclusion on East Alignment versus West Alignment

Based on the items listed above that have been individually and collectively considered, the North Dakota West diversion channel is screened from further consideration. The East alignment will have less impact to the floodplain, less overall impact to wetlands, and will provide no appreciable benefits to the WAPA substation. Although the West alignment would reduce flood risk to existing homes, the loss of floodplain and the likelihood of future damages in low-lying areas outweighs the potential economic benefits from the federal perspective.

The East alignment minimizes floodplain impacts, provides a reasonable balance between protecting existing development and preserving the floodplain, and is a practicable alternative to the West alignment.

3.7.4 Southern Alignment for North Dakota Diversion

Local entities including Oxbow, ND and Cass County requested that consideration be given to moving the inlet of the North Dakota diversion south of Oxbow to reduce flood risk for the towns of Oxbow and Hickson, as well as the Bakke Subdivision.

An initial assessment was completed. It was determined that moving the diversion alignment south would have several adverse consequences. These consequences are due in part to the fact that moving the diversion south of Oxbow would take additional land out of the floodplain, which would require additional storage. South of Oxbow, the land rises more quickly, which reduces the available storage volume on each acre of land. To get an equivalent storage volume and to account for the additional land taken out of the floodplain, the depth of staging would need to be increased approximately 2.5 feet, requiring higher control structures and tie-back levees. This would impact communities further upstream and raise additional technical challenges associated with the higher structures and levees. Moving the alignment south from its proposed location would also have implications under EO 11988 which could make it unacceptable from a federal perspective, as the proposed alignment is a practicable alternative to the Southern alignment.

3.8 COMPARISON OF ALTERNATIVES

Comparison of alternatives is the fifth step in the planning process, which is based on the evaluation of the impacts of the alternatives, the fourth step in the planning process. The more detailed evaluations of the impacts of the alternatives are presented in Chapter 5, Environmental Consequences.

3.8.1 Comparison of Plan Features

Features of the alternative plans (LPP, FCP, and ND35K) are displayed in a comparative format on Table 10. The costs of these features are included on Table 11, also in a comparative format.

Table 10 – Final Comparison of Alternative Plan Features

CHANNEL ALIGNMENT PARAMETERS	LPP	FCP	ND35K
Maximum top width (feet)	2200	2800	2450
Bottom width (feet)			
Maximum	250	400	300
Minimum	100	225	100
Diversion			
Maximum depth (from natural ground)	28	30	29
Excavation (million cu. yards)	55	55	67
Low flow channel (3 ft X 10 ft)	√	√	√
Length of diversion channel (miles)	36	25	36
Channel extension (miles)	--	3.69	--
Length of tie back levee (miles)	10.1	9.86	3.26
Height of levee (feet)	17	8	8
Length of Storage Area 1 levee (miles)	12	--	--
Height of Storage Area 1 levee (feet)	17	--	--
Acres of flood storage area	4360	--	--
Number of houses in diversion footprint	6	5	6
Acres in project footprint (diversion & levees)	8054	6415	6560
Acres of wetlands impacted - worst case	1161	972	1058
Hydraulic structures			
Drop structures	4	1	3
River crossings	6	0	6
Highway bridges	19	20	18
Railroad bridges	4	4	4
Stage at Fargo gage			
0.2 % chance event (500yr) (ft)	40	39.6	40
1% chance event (100yr) (ft)	30.8	31.9	30.6
Stage impacts for 1% chance event			
Downstream max stage increase (inches)	3.5	12.5	25
Number of structures impacted downstream	10	1039*	1039*
Upstream max stage increase (inches)	98.8	6.8	0.2
Number of structures impacted upstream	1055**	346	--
Land removed from 1% floodplain (sq. miles)	69	30	80

* only calculated to Thompson, ND at this time

** Including Storage Area 1, Staging Area and structures upstream of the Staging Area

Table 11 – Final Comparison of Alternative Plan Costs including Recreation (October 2011 Price Level)

Account	Item	LPP	FCP	ND35k
01	Lands & Damages	273,172	69,655	66,076
02	Relocations	151,917	108,020	110,444
06	Fish and Wildlife Facilities	64,998	14,706	100,261
08	Roads, Relocations and Bridges	59,121	161,853	65,590
09	Channels & Canals	775,208	597,296	877,583
11	Levees, Floodwalls, & Floodproofing	141,376	24,927	3,983
14	Recreation Facilities	29,275	25,390	31,832
30	Planning, Engineering and Design	187,239	142,859	182,714
31	Construction Management	87,383	66,665	85,265
	Total First Costs	**$1,769,689**	**$1,211,371**	**$1,523,748**
	Annual OMRR&R Diversion Cost	$3,617	$3,494	$3,436
	Annual OMRR&R Recreation Cost	$47	$47	$47
	Toal Annual OMRR&R	$3,664	$3,541	$3,483
	All costs in thousands ($1,000)			

3.8.2 System of Accounts

3.8.2.1 Methodology

The Economic and Environmental Principles for Water and Related Land Resources Implementation Studies, established by the Water Resources Council in 1983, created four accounts to facilitate evaluation and effects of alternative plans:

- The national economic development (NED) account displays changes in the economic value of the national output of goods and services
- The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources
- The regional economic development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan.
- The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

3.8.2.2 National Economic Development (NED)

The intent of comparing alternative flood risk management plans in terms of national economic development is to identify the beneficial and adverse effects that the plans may have on the national economy. Beneficial effects are considered to be increases in the economic value of the national output of goods and services attributable to a plan. Increases in NED are expressed as the plan's economic benefits, and the adverse NED effects are the investment opportunities lost by committing funds to the implementation of a plan. Comparison of the plans under consideration using the NED account is shown in Table 12. The values for net benefits shown on the tables are the differences between the average annual economic benefits and the average annual cost associated with each plan. As shown in Table 9 – Phase 3 cost-effectiveness analysis results the current annual net benefits of the MN40K plan are the greatest, and the MN40K plan is therefore the NED plan. However, as explained in section 3.6.5, it was not necessary to fully describe the NED plan once it was demonstrated that the LPP was a smaller capacity plan, and the NED plan was dropped from further consideration. The MN35K plan, the FCP, was kept for comparison to the LPP for cost-sharing purposes.

The no action alternative has zero net benefits and results in equivalent annual damages in excess of $194.8 million.

Table 12 - National Economic Development (NED) Account (all dollar values in thousands)

	LPP	FCP	ND35k
Total Diversion First Cost	$1,733,834	$1,180,274	$1,484,913
Interest During Construction and Discounting	$295,008	$227,597	$252,655
Present worth of Investment	$2,028,843	$1,407,871	$1,737,568
Annualized Investment Cost	$96,473	$66,946	$82,623
Annual OMRR&R Cost	$3,617	$3,494	$3,436
Induced Damages	$0	$153	$153
Average Annual Diversion Charges	$100,090	$70,593	$86,212
Total Recreation First Cost	$35,855	$31,097	$38,835
Interest During Construction and Discounting	$740	$1,951	$801
Present worth of Investment	$36,595	$33,048	$39,636
Annual Recreation First Cost	$1,740	$1,571	$1,885
Annual Recreation OMRR&R Cost	$47	$47	$47
Average Annual Recreation Charges	$1,787	$1,618	$1,932
Flood Damage Reduction Benefit	$162,800	$164,800	$162,800
Flood Proofing Cost Savings	$10,430	$6,240	$10,017
Flood Insurance Adminstrative Cost Saving	$960	$1,000	$960
Incremental Non-Structural Flood Risk Benefit	$627	$414	$0
Avg. Annual Diversion Benefit	$174,817	$172,454	$173,777
Avg. Annual Recreation Benefit	$5,130	$5,355	$5,130
Annual Net Diversion Benefit	**$74,727**	**$101,861**	**$87,565**
Annual Net Recreation Benefit	$3,343	$3,737	$3,198
Total Annual Net Benefit	$78,069	$105,598	$90,763
Diversion Benefit-Cost Ratio	**1.75**	**2.44**	**2.02**
Recreation Benefit-Cost Ratio	2.87	3.31	2.66
Benefit-Cost Ratio	**1.77**	**2.46**	**2.03**

1. Costs and Benefits are given in $1,000's
2. Assumes a 50 year period of analysis - 4 1/8% interest rate.
3. Assumes a 7.5 year period of construction for MN diversions and 8.5 years for ND diversions
4. No credit is given to flood fight reliability
5. Base Year is 2019.
6. All figures in October 2011 dollars
7. Non-Structural Costs are included in Diversion Costs

3.8.2.3 Environmental Quality (EQ)

The environmental quality account is another means of evaluating the alternatives to assist in making a plan recommendation. The EQ account is intended to display the long-term effects that the alternative plans may have on significant environmental resources. Significant environmental resources are defined by the Water Resources Council as those components of the ecological, cultural and aesthetic environments which, if affected by the alternative plans, could have a material bearing on the decision-making process. Significance is derived from institutional, public or technical recognition that a resource or an effect is significant. A comparison of the effects that the diversion channel alternatives may have on the EQ resources is shown in Table 13.

Table 13 – Environmental Quality (EQ) Account

	Alternatives			
Resources	**No Action**	**LPP**	**FCP**	**ND35K**
Flooding	Expected Annual Flood Damage of $194.8 million	Expected Annual Flood Damage reduced by $162.8 million	Expected Annual Flood Damage reduced by $164.8 million	Expected Annual Flood Damage reduced by $162.8 million
Air Quality	No Effect	Minor degradation from extensive and lengthy construction period	Minor degradation from extensive and lengthy construction period	Minor degradation from extensive and lengthy construction period
Water Quality	No Effect	Temporary minor adverse impacts on surface water quality during construction.	Temporary minor adverse impacts on surface water quality during construction.	Temporary minor adverse impacts on surface water quality during construction.
Erosion and Sedimentation	Continued Erosion during flooding	No significant geomorphic issues	No significant geomorphic issues	No significant geomorphic issues
Water Quantity	No Effect	Downstream stage increase 0.5-3.5 inches, upstream stage increase 1.3-98.8 inches, 1 percent event	Downstream stage increase 0.7-12.5 inches, upstream stage increase 6.8 inches, 1 percent event	Downstream stage increase 7.6-25.4 inches, upstream stage increase 0.1-0.2 inches, 1 percent event
Ground Water	No Effect	Slightly lowered water table near diversion channel	Slightly lowered water table near diversion channel	Slightly lowered water table near diversion channel
Aquifers	No Effect	Small potential to influence aquifers	Small potential to influence aquifers	Small potential to influence aquifers
Aquatic Habitat	Improved due to ongoing efforts to improve fish passage	Loss of 46 acres of habitat with structures at Red River and tributaries. Potentially significant impacts to aquatic species migrational corridors	Loss of 10 acres of habitat with large closure structure at Red River. Less than significant impacts to aquatic species migrational corridors	Loss of habitat of approximately 37 acres with large structures at 6 rivers. Less than significant impacts to aquatic species migrational corridors

	Alternatives			
Resources	**No Action**	**LPP**	**FCP**	**ND35K**
Riparian Habitat	No Effect	Increase in habitat value for approximately 1900 acres in the form of grass swale near the bottom of the diversion. Loss of 118 acres at river connections and along channel.	Increase in habitat value for approximately 2,000 acres in the form of grass swale near the bottom of the diversion. Loss of 42 acres at river connections	Increase in habitat value for approximately 1900 acres in the form of grass swale near the bottom of the diversion. Loss of 118 acres at river connections and along channel.
Wetlands	No Effect	Could directly impact approximately 1161 acres of wetlands	Could directly or indirectly impact approximately 972 acres of wetlands	Could directly impact approximately 1058 acres of wetlands
Upland Habitat	No Effect	Potential for increased habitat benefit	Potential for increased habitat benefit	Potential for increased habitat benefit
T and E species	No Effect	No Effect	No Effect	No Effect
Floodplains (E.O. 11988)	112 sq miles in floodplain during .01 year event out of 261 sq miles in project area	37.5 sq miles remain in floodplain. 69.8 sq miles taken out of floodplain during 1-percent chance event	80.9 sq miles remain in floodplain, 31.3 sq miles taken out during a 1-percent chance event	30.7 sq miles remain in floodplain. 81.3 sq miles taken out of floodplain during 1-percent chance event
Cultural Resources	No Effect	Potential for impacts along diversion channel. Higher potential for impacts along the river banks	Potential for impacts along diversion channel. Higher potential for impacts along the river banks	Potential for impacts along diversion channel. Higher potential for impacts along the river banks
Prime and Unique Farmland	No Effect	Approximately 6878 acres of prime and unique farmland will be removed	Approximately 5889 acres of prime and unique farmland will be removed	Approximately 6540 acres of prime and unique farmland will be removed
Economic Resources	Continued potential for property damage and business losses due to damaging flood events.	Significant reduction in property damage and lost business.	Significant reduction in property damage and lost business.	Significant reduction in property damage and lost business.

3.8.2.4 Regional Economic Development (RED)

The regional economic development account is intended to illustrate the effects that the alternatives would have on regional economic activity, specifically, regional income and regional employment. The comparison of possible effects that the plans may have on these resources is shown in Table 14. The completed RED analysis is included in Appendix C, Economics. The RED analysis only analyzed the MN20K, MN35K and ND35K plans. These plans were selected for analysis based on the likelihood of one of those plans ultimately being selected as the recommended plan. This analysis was completed based on the information contained in Table 7 and was not updated to reflect the final analysis. The RED analysis shows that the regional changes in economic output for the MN20K, MN35K and ND35K range between $323 and $332 million annually.

Table 14 – Regional Economic Development (RED) Account

	Without Project Conditions	North Dakota East 35K cfs	Minnesota Short 35K cfs	Minnesota Short 20K cfs
Changes in Economic Output*		$332,455	$329,715	$323,755
Annual Net Change in Employment	(1,665)	895	815	677
Changes in Tax Revenues*	$(5,900) - (18,600)	$12,109	$11,968	$10,922
Average Annual Benefits*		$67,355	$63,795	$54,390
Annual Regional Flood Damages*	$61,676	$8,007	$11,042	$18,666
Changes in Annual Tax Revenue *	$(7,781)	$4,327	$3,917	$3,140
Annual Loss of Business Income*	$65,000			
Gross Regional Product Annual Growth Rate^	1.29 - 2.18	3.09 - 4.11	3.09 - 4.11	3.09 - 4.11

* $1,000 ^ %

3.8.2.5 Other Social Effects (OSE)

This section describes the Other Social Effects (OSE) component of the Fargo-Moorhead Flood Risk Management Feasibility Study. Implementing flood risk management alternatives could have varying impacts on the life of the residents and the social fabric of the communities in the study area. By considering the human impact and evaluating alternatives from an OSE perspective, the analysis can be used in alternative plan formulation and in the decision making process for choosing an alternative that maximizes social benefits.

Social well-being factors are constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness. The distribution of resources; the character and richness of personal and community associations; the social vulnerability and resilience of individuals, groups, and communities; and the ability to participate in systems of governance are all elements that help define well-being and influence to what degree water resources solutions will be judged as complete, effective, acceptable, and fair. It is the OSE account that considers these elements and assures that they are properly weighted, balanced, and considered during the planning process under the Corps' Four Accounts Planning Framework.

A loss of life analysis was completed for the future without project condition. (See Appendix D, Other Social Effects). The analysis showed that a failure of emergency levees during large flood events could cause considerable loss of life. Assuming that the floodplains were 98% evacuated prior to an anticipated levee breach or overtopping, four deaths could be expected during a 1-percent chance event; the toll increases to 12 deaths for a 0.2-percent chance event. History has shown that residents in the study area do not evacuate, preferring to stay and maintain the emergency flood barriers. Assuming that the floodplains were not evacuated and an unanticipated failure of emergency levees occurred, expected deaths were estimated at 200 and 594 for the 1-percent chance and 0.2-percent chance events, respectively. With a diversion project in place, the potential for loss of life is expected to be significantly lower. An engineered permanent project would be far less likely to fail and would significantly reduce the frequency, duration and magnitude of flood events in the developed areas.

The Corps uses seven social factors to describe the social fabric of a community. The social factors are based on conventional psychological Human Needs Theory and Abraham Maslow's Hierarchy of Needs. Table 15 lists and describes the social factors.

Table 15 – Social Factors

Social Factor	Description
Health and Safety	Refers to perceptions of personal and group safety and freedom from risks
Economic Vitality	Refers to the personal and group definitions of quality of life, which is influenced by the local economy's ability to provide a good standard of living
Social Connectedness	Refers to a community's social networks within which individuals interact; these networks provide significant meaning and structure to life
Identity	Refers to a community member's sense of self as a member of a group, in that they have a sense of definition and grounding
Social Vulnerability and Resiliency	Refers to the probability of a community being damaged or negatively affected by hazards, and its ability to recover from a traumatic event
Participation	Refers to the ability of community members to interact with others to influence social outcomes
Leisure and Recreation	Refers to the amount of personal leisure time available and whether community members are able to spend it in preferred recreational pursuits

Source: Handbook on Applying "Other Social Effects" Factors in Corps of Engineers Water Resources Planning (USACE, 2009).

A comparison of the effects that the diversion channel alternatives would have on OSE resources is shown on Table 16. The diversion channel alternatives considered all provide a high level of flood risk management, which results in the OSE impacts being similar for all of the diversion channel alternatives.

Table 16 – Other Social Effects (OSE) Account

	No Action	LPP	FCP	ND 35K
Public Health and Safety	High level of flood risk in entire region with associated stress and anxiety, risk to regional health care system, and impacts to emergency access during floods. High potential for loss of life during floodfights.	Project would significantly reduce risk to regional health care system and stress in F-M. No change to flood risk downstream. Overall reduction in upstream flood risk due to relocations out of the floodplain. Moderate increase in flood risk upstream where homes remain.	Project would significantly reduce risk to regional health care system and stress in F-M. Flood risk would slightly increase upstream and moderately increase downstream.	Project would significantly reduce risk to regional health care system and stress in F-M. Would increase flood risk downstream. No change to upstream flood risk.
Economic Vitality	Current regional economy is strong. If a catastrophic flood occurs, economic impacts will be extensive and long-lasting.	Project would significantly benefit the regional economy, especially in the F-M metro area. Minimal changes downstream. Significant impacts upstream in staging area and Storage Area 1--businesses would be relocated; agricultural use of land impacted; reduction of local tax base.	Project would significantly benefit the regional economy, especially in the F-M metro area. Slightly decreased economic vitality downstream due to increased flood stages. Slight decrease upstream due to increased flood stages. Reduction of local tax base due to loss of ag land due to channel construction.	Project would significantly benefit the regional economy, especially in the F-M metro area. Decreased economic vitality downstream due to increased flood stages. Little change upstream. Reduction of local tax base due to loss of ag land due to channel construction.
Social Connectedness	High levels of instrumental social support will continue throughout the region. Population of downstream communities will continue to decline following the historic trend.	Project would cause significant social disruption for communities within the staging area and Storage Area 1 (Oxbow, Hickson, Bakke Addition, Comstock). Metro area would see less frequent disruptions due to floodfights. Impacts to local road network could increase social separation for rural residents. Little change downstream.	F-M metro area would see less frequent disruptions due to floodfights. Impacts to local road network could increase social separation for rural residents. Slight change upstream in area with upstream impacts. Downstream residents would experience some increased social disruption during floods.	F-M metro area would see less frequent disruptions due to floodfights. Impacts to local road network could increase social separation for rural residents. Little change upstream. Downstream residents would experience some increased social disruption during floods.
Identity	Strong European heritage, welcome attitude toward immigration, work ethic and "fight and recover attitude" toward flood fighting will continue throughout the region.	Project would be detrimental for communities within the staging area and Storage Area 1 (Oxbow, Hickson, Bakke Addition, Comstock). Elsewhere, the project would not likely affect cultural and community identity significantly. Perception of metro versus rural bias may increase.	Project would not likely affect cultural and community identity significantly. Perception of metro versus rural bias may increase.	Project would not likely affect cultural and community identity significantly. Perception of metro versus rural bias may increase.
Social Vulnerability and Resilience	F-M Region is highly vulnerable to catastrophic flood damage, but residents would likely band together during recovery. Resilience of rural communities may be lower due to lack of temporary housing options. Low-income residents are more vulnerable to short-term impacts of flood fighting.	Project would significantly reduce the F-M metro area's vulnerability to floods, allowing them to focus on other social needs. Little change downstream. Overall reduction in upstream vulnerability due to relocations out of the floodplain. Moderate increase in vulnerability upstream where homes remain.	Project would significantly reduce the F-M metro area's vulnerability to floods, allowing them to focus on other social needs. Slight change upstream in areas with upstream impacts. Downstream vulnerability would increase slightly. Resilience of rural communities may be lower due to lack of temporary housing options.	Project would significantly reduce the F-M metro area's vulnerability to floods, allowing them to focus on other social needs. Little change upstream. Downstream vulnerability would increase. Resilience of rural communities may be lower due to lack of temporary housing options.
Civic Participation	Residents in the study area exhibit a high rate of participation in civic activities like flood fights, elections and public meetings.	Project would negatively affect civic participation of residents in upstream communities within the staging area and Storage Area 1. Little effect on participation by F-M metro and downstream residents.	Project has perceived disporportionate impacts to Minnesota residents that could affect civic participation. Slight impacts on upstream residents in area with upstream impacts. Downstream flood stage impacts could lead to a decrease in participation downstream.	Project has little effect on participation by F-M metro and upstream residents. Downstream flood stage impacts could lead to a decrease in participation downstream.
Leisure and Recreation	Residents of the region are active. Recreational facilities would continue to be provided in the communities as currently planned.	Project features would increase recreational opportunities and reduce time spent on flood fighting in the F-M metro area. Little change downstream.	Project features would increase recreational opportunities and reduce time spent on flood fighting in the F-M metro area. Little change upstream in areas with upstream impacts. Would slightly increase flood fighting downstream.	Project features would increase recreational opportunities and reduce time spent on flood fighting in the F-M metro area. Little change upstream. Would increase flood fighting downstream.

3.8.3 Formulation Criteria

The final array of alternative plans is compared using four formulation criteria established by the United States Water Resources Council in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G). These criteria are completeness, effectiveness, efficiency and acceptability.

3.8.3.1 Completeness

The P&G defines completeness as the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. A complete plan includes all elements necessary to function independently to achieve the planning objectives. It is an indication of the degree to which the outputs of the plan are dependent upon the actions of others or on factors beyond the control of the planners.

The no action alternative requires extensive emergency construction to prevent flood damage for all floods larger than a 10-percent chance event.

All three of the diversion channel alternatives (LPP, FCP, and ND35K) have a high likelihood of significantly reducing flood damage and flood risk, but none of the plans will eliminate flood risk. Any of the three diversion channel alternatives would substantially reduce the need for emergency floodfighting up to the 1-percent chance event on the Red River. For larger and less frequent events, diversion plans allow for additional in-town flood barriers (either permanent or temporary) to be constructed. The combination of the diversion channel and emergency flood fighting for those extremely rare events provides a very high level of risk reduction to the communities of Fargo and Moorhead.

The North Dakota diversions (LPP and ND35K) are more complete solutions to the regional flood problem, because they would reduce the risk of flooding from the major tributaries in the North Dakota portion of the study area that are not addressed by the Minnesota diversion (FCP).

The diversion channel alternatives require relatively minimal operations. Operations are necessary at the control structure on the Red River for the FCP. The LPP and ND35K plans will require operations at the Red River control structure, the Wild Rice River control structure, and closure of a structure on Wolverton Creek. The operations and maintenance of these structures and all project features will be dictated in the Operation and Maintenance manual that will be provided to the non-federal sponsors upon completion of the project.

The non-federal sponsors will be responsible for the long-term maintenance of the project along with the eventual repair, rehabilitation, and replacement of project features. Maintenance would include but not be limited to mowing and vegetation management, repair of erosion, debris removal and routine maintenance of mechanical equipment. Failure to maintain the project over the long-term could impact the completeness of the plan. It is unlikely that the non-federal sponsors would neglect the long-term maintenance requirements for any of the plans considered in the final array of alternatives.

The diversion plans are complete plans that, once constructed, would include all features necessary to produce the estimated economic benefits described in this report.

3.8.3.2 Effectiveness

The P&G defines effectiveness as a measure of the extent to which a plan achieves its objectives. All of the plans in the final array partially achieve the planning objectives.

All of the alternatives considered in the final array of alternatives meet the criteria of effectiveness to varying degrees, see Table 17. The objectives of this study as described in section 2.6 of this report and repeated here were to:

- Reduce flood risk and flood damages in the Fargo-Moorhead metropolitan area.
- Restore or improve degraded riverine and riparian habitat in and along the Red River of the North, Wild Rice River (North Dakota), Sheyenne River (North Dakota), and Buffalo River (Minnesota) in conjunction with other project features.
- Provide additional wetland habitat in conjunction with other project features.
- Provide recreational opportunities in conjunction with other project features.

Table 17 – Effectiveness in meeting planning objectives.

	No Action	LPP	FCP	ND35K
Reduce Flood Risk	No benefit	Reduces expected flood damages by 84%.	Reduces expected flood damages by 85%.	Reduces expected flood damages by 84%.
Total average annual benefits	$0	$174.8 million	$172.5 million	$173.8 million
Average annual residual damages	$194.8 million	$32 million	$30 million	$32 million
River system afforded flood risk benefits	None	Red, Wild Rice, Sheyenne, Maple, Rush and Lower Rush Rivers	Red and Wild Rice Rivers	Red, Wild Rice, Sheyenne, Maple, Rush and Lower Rush Rivers
Restore/ Improve Riverine and Riparian Habitat	None	No specific improvement to the Riverine or Riparian habitat	No specific improvement to the Riverine or Riparian habitat	No specific improvement to the Riverine or Riparian habitat
Provide additional Wetland Habitat	None	Provides additional 1450 acres of wetlands in the project area.	Provides additional 1515 acres of wetlands in the project area.	Provides additional 1527 acres of wetlands in the project area.
Provide Recreational Opportunities	None	Provides multiple recreational features including multi-purpose trails.	Provides multiple recreational features including multi-purpose trails.	Provides multiple recreational features including multi-purpose trails.

3.8.3.3 Efficiency

As defined in the P&G, efficiency is a measure of the cost-effectiveness of an alternative. Cost-effectiveness considers not only economic costs, but also other intangible costs such as environmental impacts and opportunity costs. All three of the diversion alternatives have net benefits greater than 1 and are considered to be efficient (the FCP is the most efficient). A breakdown of the net benefits and residual damages associated with each of the diversion alternatives is provided in Table 18.

Table 18 – Efficiency of plans – Net Benefits (all dollar values are in thousands)

	NO Action	LPP	FCP	ND35k
Net Benefits of Plan (NED)	$0	$74,727	$101,861	$87,565
Residual Damages	$194,800	$32,000	$30,000	$32,000

3.8.3.4 Acceptability

Acceptability is defined in the P&G as the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies. The LPP and FCP are in accordance with federal law and policy and would be considered acceptable for implementation; however there are differences in the level of acceptability. The ND35K plan has downstream impacts that make it unacceptable. This information is summarized in the sections below.

3.8.3.4.1 Alignment

There is a strong desire from the non-federal sponsors and the public to have the diversion plan constructed in North Dakota. A North Dakota alignment would be considered highly acceptable to the non-federal sponsors. The Minnesota alignment is also acceptable, as the non-federal sponsors and the public have indicated that doing nothing is not an option; however they generally prefer the North Dakota alignment and officially requested the North Dakota alignment as the locally preferred plan.

3.8.3.4.2 Upstream and Downstream Effects

The diversion plans would all have impacts either upstream or downstream, and public concerns have been raised regarding those effects. Analysis was conducted on the LPP, ND35K and FCP to determine the maximum extent of the impacts. Impacts from any of the diversion channel alternatives that are less than 0.05 feet are considered 0 due to the capabilities and variability of the model being used to assess the impacts. The estimated median stage increases (and decreases) are shown in Table 19 through Table 22.

Table 19 – Upstream and downstream stage impacts (10-percent chance event)

10% Chance (10-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	0.1	--
Pembina Gage	--	0.1	--
Drayton Gage	0.1	0.1	--
ND SH#17/MN SH317	0.2	0.1	--
Co. Hwy 15	0.1	0.1	--
Oslo Gage	0.5	0.1	--
DS Grand Forks Levees	1.0	0.2	--
Grand Forks Gage	1.3	0.2	--
LPP Maximum DS Impact Location	1.4	--	--
32nd Ave, Grand Forks	1.3	0.4	--
Thompson Gage	0.5	1.2	12.2
Hwy 25/Co.Rd 221	0.5	1.4	13.3
ND35K Maximum Impact Location	--	--	13.9
DS Sandhill River/Climax	0.4	1.6	13.6
Nielsville	0.4	1.6	12.6
DS Marsh River	0.5	1.6	11.9
US Goose River/Shelly	0.4	1.8	12.0
Halstad Gage	-1.4	1.8	7.6
Hendrum	-3.0	1.9	8.0
Perley	-6.5	2.4	11.4
Georgetown	-5.2	1.8	10.6
FCP (MN35K) Maximum Impact Location	--	2.9	--
Upstream Locations			
US FCP Diversion	--	1.6	--
US ND Wild Rice River	-61.8	-1.8	-65.2
US LPP Diversion	98.8	--	-0.6
Hickson Gage	79.0	0.5	0.6
Abercrombie	1.3	0.0	--

Table 20 – Upstream and downstream stage impacts (2-percent chance event)

2% Chance (50-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	0.7	--
Pembina Gage	--	1.3	--
Drayton Gage	1.0	1.2	--
ND SH#17/MN SH317	0.8	1.2	--
Co. Hwy 15	0.6	1.1	--
Oslo Gage	0.5	0.4	--
DS Grand Forks Levees	1.3	0.8	--
Grand Forks Gage	2.2	1.2	--
32nd Ave, Grand Forks	3.4	2.8	--
LPP Maximum DS Impact Location	4.6	--	--
Thompson Gage	2.9	6.7	20.9
Hwy 25/Co.Rd 221	2.5	8.8	26.9
ND35K Maximum Impact Location	--	--	29.4
DS Sandhill River/Climax	2.5	9.2	29.3
Nielsville	2.2	9.6	25.3
FCP (MN35K) Maximum Impact Location	--	9.7	--
DS Marsh River	1.9	8.5	22.2
US Goose River/Shelly	1.4	8.0	17.3
Halstad Gage	0.0	4.8	10.3
Hendrum	-1.4	4.9	15.1
Perley	-3.8	4.0	9.4
Georgetown	-2.8	3.6	8.0
Upstream Locations			
US FCP Diversion	--	-1.8	--
US ND Wild Rice River	-112.9	0.6	-112.2
US LPP Diversion	85.2	--	0.0
Hickson Gage	55.0	0.4	0.2
Abercrombie	1.7	0.1	--

Table 21 – Upstream and downstream stage impacts (1-percent chance event)

1% Chance (100-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	0.7	--
Pembina Gage	--	2.0	--
Drayton Gage	1.0	1.7	--
ND SH#17/MN SH317	0.8	1.6	--
Co. Hwy 15	0.6	1.8	--
Oslo Gage	0.7	1.1	--
DS Grand Forks Levees	1.8	2.5	--
Grand Forks Gage	2.9	4.1	--
LPP Maximum DS Impact Location	3.5	--	--
32nd Ave, Grand Forks	3.4	5.8	--
Thompson Gage	0.5	7.0	15.8
Hwy 25/Co.Rd 221	-0.2	10.7	23.6
ND35K Maximum Impact Location	--	--	25.4
DS Sandhill River/Climax	-0.5	11.8	25.3
FCP (MN35K) Maximum Impact Location	--	12.5	--
Nielsville	-0.5	12.4	22.8
DS Marsh River	-0.4	10.7	19.4
US Goose River/Shelly	-0.5	9.2	15.1
Halstad Gage	-0.7	6.2	10.4
Hendrum	-0.7	6.6	11.3
Perley	-3.4	6.6	7.6
Georgetown	-3.0	5.8	8.4
Upstream Locations			
US FCP Diversion	--	6.8	--
US ND Wild Rice River	-107.9	5.3	-105.1
US LPP Diversion	98.8	--	0.2
Hickson Gage	64.6	-0.1	0.1
Abercrombie	1.3	0.0	--

Table 22 – Upstream and downstream stage impacts (0.2-percent chance event)

0.2% Chance (500-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	1.0	--
Pembina Gage	--	2.2	--
Drayton Gage	1.3	1.0	--
ND SH#17/MN SH317	0.8	1.0	--
Co. Hwy 15	1.1	1.2	--
Oslo Gage	0.6	0.8	--
DS Grand Forks Levees	1.4	1.9	--
Grand Forks Gage	2.6	4.6	--
LPP Maximum DS Impact Location	3.2	--	--
FCP (MN35K) Maximum Impact Location	--	5.6	--
32nd Ave, Grand Forks	2.8	5.6	--
Thompson Gage	-0.6	2.4	7.2
Hwy 25/Co.Rd 221	-1.4	3.4	6.6
DS Sandhill River/Climax	-1.8	3.8	7.9
ND35K Maximum Impact Location	--	--	8.4
Nielsville	-1.9	4.4	7.7
DS Marsh River	-1.7	4.1	7.3
US Goose River/Shelly	-1.6	3.7	6.5
Halstad Gage	-2.6	1.7	3.7
Hendrum	-3.6	0.8	1.4
Perley	-4.3	-0.4	0.6
Georgetown	-4.0	-0.5	0.2
Upstream Locations			
US FCP Diversion	--	-2.3	--
US ND Wild Rice River	-15.7	2.9	-9.0
US LPP Diversion	78.0	--	1.7
Hickson Gage	34.2	-0.1	-0.4
Abercrombie	0.1	0.0	--

Downstream of the FCP diversion channel, the increase to the peak stage during a 1-percent chance event, with no emergency protection in place, is estimated to be 12.5 inches or less, depending upon location. The 1-percent chance event peak would arrive and recede about one day earlier than under existing conditions. The increase to the peak stage during a 10-percent chance event, with no emergency protection in place, is estimated to be 2.9 inches or less, depending upon location. The timing of the 10-percent chance event peak would be nearly unchanged. Upstream of the FCP diversion channel the impact would be 7.0 inches or less for a 1-percent chance event and 2.0 inches or less for a 10-percent chance event.

Downstream of the ND35K plan diversion channel, the increase to the peak stage during a 1-percent chance event, with no emergency protection in place, is estimated to be 25.4 inches or less, depending upon location. The 1-percent chance event peak would arrive and recede about 1.5 days earlier than under existing conditions. The increase to the peak stage during a 10-percent chance flood event, with no emergency protection in place, is estimated to be 13.9 inches or less, depending upon location. The 10-percent chance event peak would arrive and recede up to about one day earlier than under existing conditions immediately downstream of the diversion, but the timing at Halstad would be nearly unchanged. Upstream of the ND35K diversion channel the impact would be 0.2 inches or less for the 1-percent event and would have a benefit of 0.6 inches for the 10-percent chance event.

Downstream of the LPP diversion channel, the increase to the peak stage during a 1-percent chance event, with no emergency protection in place, is estimated to be 3.5 inches or less, depending upon location. The 1-percent chance event peak would arrive and recede about approximately the same as under existing conditions. The increase to the peak stage during a 10-percent chance flood event, with no emergency protection in place, is estimated to be 1.4 inches or less, depending upon location. The 10-percent chance event peak would arrive and recede approximately the same as under existing conditions downstream of the diversion. Upstream of the LPP diversion channel the impact would be 98.8 inches for the 1-percent event and 98.8 inches for the 10-percent chance event.

The acceptability of each plan from the standpoint of flood stage impacts depends on one's location: it would be expected that downstream interests would prefer the LPP with its minimal downstream impacts, but upstream interests would prefer either the FCP or the ND35K plan. Although the impacts of the ND35K plan were not fully modeled, the ND35K plan has large downstream impacts as far as Thompson, ND, and the impacts would likely extend into Canada because the FCP impact is 0.7 inch at Emerson, Manitoba for the 1-percent chance event, and the ND35K impacts are routinely larger than the FCP impacts. Preliminary legal analysis showed that most of the induced downstream impacts of the ND35K plan or the FCP would not rise to the level of a taking under the Fifth Amendment of the U.S. Constitution, and the feasibility study found few cases where mitigation would be economically justified as part of the federal project. Even though mitigation for increased stages would not be a federal requirement, the non-federal sponsors wanted to include mitigation in their desired locally preferred plan. The vast extent of the downstream impacts of the ND35K plan made it impractical to mitigate for that plan, which made the ND35K plan unacceptable to the non-federal sponsors. Although the LPP has large upstream impacts, they are in a smaller defined area that allows the sponsors to mitigate the impacts by acquiring real estate interests and employing non-structural measures effectively.

3.8.3.4.3 Tolerable level of risk

The non-federal sponsors indicated in November 2009 that a flood stage of approximately 36.0 on the Fargo gage for a 0.2-percent chance event would be tolerable because they were confident that they would be successful with flood fighting efforts up to the stage of 36.0. The analysis completed in May 2010 showed that a diversion capacity of 45,000 cfs would be required to achieve the desired stage reduction for both the Minnesota and North Dakota alignments. The information available in May 2010 showed that the 45,000 cfs alignments in both Minnesota and North Dakota would result in a 0.2-percent chance stage of 35.3 (see Appendix O, section 7.4.1).

The Metro Flood Study Work Group considered this information on May 13, 2010 and chose to support the ND35K plan with its associated performance rather than requesting a 45,000 cfs alternative that would have either cost significantly more or been located in Minnesota.

The LPP, FCP and ND35K alternatives all would result in a 0.2-percent chance stage of 40.0 or less, based on the Phase 3 analyses.

3.8.3.4.4 Natural Resource Impacts

Impacts to the natural resources are a concern to the public and many organizations. The North Dakota alternatives generally have more natural resource impacts than the FCP because they cross five tributaries. However, the North Dakota alignment provides flood benefits to a larger geographic area and for more people. See Chapter 5, Environmental Consequences, of this report for more detail.

3.8.3.4.5 Floodplain Impacts

Executive Order 11988 requires federal agencies to avoid direct or indirect support of floodplain development wherever there is a practicable alternative, and then to minimize impacts to the floodplain. This study has shown that a diversion channel in either Minnesota or North Dakota is the only feasible concept that will sufficiently reduce flood risk along the Red River in Fargo and Moorhead. Therefore, there is not a practicable alternative located outside the floodplain, and locating the project in the floodplain is necessary to achieve the project purpose. The primary planning objective is to reduce flood risk in the entire metropolitan area, including areas adjacent to the Wild Rice, Sheyenne, Maple, Rush and Lower Rush rivers. The LPP and ND35K plan significantly reduce flood frequency on approximately 70 and 80 square miles, respectively, currently located in the 1-percent chance event FEMA floodplain. The LPP and ND35K plan reduce flood risk from all of the rivers in the North Dakota portion of the study area. The FCP significantly reduces flood frequency on approximately 30 square miles currently located in the 1-percent chance event floodplain, but it does not address the Sheyenne River and its tributaries. Because of the different impacts on existing floodplain, the FCP alignment is more acceptable than the LPP or ND35K plan alignment to people and agencies concerned with expanding floodplain development and protection of existing floodplain function. However, as detailed in the Economics Appendix (Appendix C), the Fargo-Moorhead metropolitan area is expected to grow at a rate of 266 acres per year, regardless of whether a flood risk management project is constructed. Any floodplain impacts created by any of the possible alternatives will be minimized as much as possible. All three of the diversion channel alternatives (LPP, FCP or ND35K) are in compliance with Executive Order 11988 and are acceptable from that perspective.

3.8.3.5 Compliance with planning constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in section 2.7 were:

- Avoid increasing peak Red River flood stages, either upstream or downstream

- Comply with the Boundary Waters Treaty of 1909 and other pertinent international agreements.
- Avoid negatively impacting the Buffalo Aquifer in Minnesota.
- Minimize loss of floodplain in accordance with Executive Order 11988, Floodplain Management

As the study developed it was acknowledged that it would not be possible to develop a large scale regional flood risk management project without causing impacts. The LPP, FCP and ND35K plan reduce flood risk for 70, 30, and 80 square miles, respectively, of highly developed or developable land. This study has shown that there are no options that could provide a high level of flood risk reduction to the region and achieve the constraint of avoiding increasing peak Red River flood stages, either upstream or downstream. Therefore this constraint was violated by each of the remaining alternatives, the LPP, FCP, and ND35K.

The LPP and FCP do not violate the three remaining constraints. The FCP was designed to avoid impacts to the Buffalo Aquifer. The ND35K has downstream impacts that would require international coordination under the Boundary Waters Treaty of 1909.

<u>3.8.4 Trade-off Analysis</u>

The first trade-off to be considered in evaluating the final alternative plans is to distinguish between the No Action Alternative and the other action alternatives. This is followed by the trade-off between the action alternatives.

3.8.4.1 Action versus No Action

The no action alternative does not meet any of the planning objectives. It has no positive benefits or impacts since it is the basis from which the impacts and benefits are measured. The no action alternative leaves the study area at significant and unacceptable risk from flooding. Federal involvement in future flood-fighting can be expected in the absence of a federal flood risk management project. This feasibility study has shown from a variety of perspectives that there is a federal and non-federal interest in taking action to reduce the flood risk in the study area.

3.8.4.2 Trade-Offs between Action Alternatives

The second level of trade-offs to consider is those between the action alternatives.

In comparing the size of the diversion channels, each of the diversions being considered (LPP, FCP, and ND35K) provides approximately the same amount of economic benefits. Therefore there is no tradeoff that can be made based on the economic benefits.

In comparing the location of the diversion channels, the tradeoffs are not clear cut. The North Dakota plans (LPP and ND35K) meet the completeness, effectiveness, and local acceptability criteria better than the Minnesota plan (FCP). The FCP meets the criteria of efficiency better than the LPP or ND35K plan. The FCP is also more acceptable regarding natural resources and the downstream/upstream impacts.

Cost is another consideration for trade-offs. The LPP and ND35K alternatives are more expensive than the FCP. The LPP costs more than the ND35K, due to the costs related to minimizing the downstream impacts through storage and staging. Therefore, there is a trade-off between cost and both effectiveness and acceptability. Higher cost improves effectiveness, but at some point cost becomes unacceptable.

Determination of the NED plan is tied directly to costs and economic benefits, but the determination of a locally preferred plan may take other tradeoffs into consideration. Tradeoffs related to local acceptability and cost are primarily non-federal political considerations that cannot be resolved with a technical analysis.

3.9 PLAN SELECTION

The following designations were made in the selection process:

3.9.1 NED Plan

The Corps of Engineers Planning Guidance Notebook, ER 1105-2-100 states "A plan that reasonably maximizes net national economic development benefits, consistent with the Federal objective, is to be formulated. This plan is to be identified as the NED plan." Based on the current economic analysis and information contained in Table 9 the MN40K plan is the plan that reasonably maximizes the net national economic development benefits and is therefore the NED plan.

3.9.2 ND35K Plan

The ND35K plan provides the locally desired level of benefits and follows the locally preferred alignment in North Dakota. It provides fewer total average annual benefits than the NED plan. The ND35K plan would cause stage increases downstream as described in section 3.8.3.4.

3.9.3 Locally Preferred Plan (LPP) and Tentatively Selected Plan

3.9.3.1 The LPP is the plan that, in the opinion of the non-federal sponsors, best meets the needs of the local community. The LPP is a diversion channel that follows the ND35K alignment but incorporates upstream staging and storage along with a smaller-capacity channel. The revised plan provides approximately the same total average annual benefits and residual damages as both the FCP and ND35K plan.

3.9.3.2 As described in section 3.5.10, the cities of Fargo and Moorhead, Cass County, North Dakota and Clay County Minnesota jointly requested that the ND35K plan be pursued as a locally preferred plan (LPP) on March 29, 2010. The request to designate the LPP as the tentatively selected plan was approved by the Assistant Secretary of the Army for Civil Works [ASA(CW)] on April 28, 2010. The approval letter can be found in Appendix O, Plan Formulation. The request to approve the LPP (at the time the ND35K plan) as the tentatively selected plan was based on the following considerations as understood at that time:

1. The non-federal sponsors requested in writing that a LPP be pursued, and approval was obtained from the ASA(CW) to tentatively recommend the LPP.
2. The plan had net flood risk management benefits of $95,400,000 annually.

3. The plan provided average annual benefits of $171,100,000.
4. The plan provided additional benefits from multiple river systems including the Red, Wild Rice, Sheyenne, Maple, Lower Rush, and Rush Rivers.
5. The plan provided benefits to a larger area and protects a larger number of people than the NED plan.
6. It significantly reduced the expected loss of life from flooding and provided the communities with the ability to react in times of emergencies.
7. It was a more robust solution than smaller plans considering the potential for future flood flows and frequencies to be larger than reflected in the historic record.
8. It significantly reduced the risk of catastrophic damage for very large events.
9. The non-federal sponsors were prepared to pay the additional costs associated with the LPP.

3.9.3.3 A new alternative was formulated in Phase 4 that was based on the ND35K plan alignment but incorporated upstream staging and flood storage immediately upstream of the diversion channel and a reduced channel capacity. The combination of upstream staging and storage with reduced channel capacity minimized downstream impacts while providing nearly the same total average annual benefits and residual damages as the ND35K plan. The revised plan with upstream impacts became the final LPP. The cities of Fargo and Moorhead, Cass County, Clay County, the Southeast Cass Water Resource District and the Buffalo-Red River Watershed District provided a letter on April 6, 2011 endorsing the revised LPP and requesting that it be identified as the tentatively recommended plan. The Corps confirmed that ASA(CW) would support tentatively recommending the LPP in the Supplemental Draft EIS.

3.9.4 Federally Comparable Plan (FCP)

The MN35K plan is the FCP. The LPP provides fewer total average annual benefits than the NED plan. Therefore, as described in section 3.6.5, it was necessary to develop a plan smaller than the NED plan that could be compared to the LPP for cost-sharing purposes. Table 9 shows that the MN35K plan would provide similar total average annual benefits and residual damages compared to the LPP. Therefore, the federal investment in the LPP should be capped at the investment that would have been made for the comparable MN35K plan. The MN35K plan is fully developed and described below for comparison with the LPP and the ND35K plan.

3.10 RISK AND UNCERTAINTY

Areas of risk and uncertainty are analyzed and described so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans.

3.10.1 Climate Variability – Expert Opinion Elicitation

The hydrologic record of the Red River of the North shows a trend of increasing magnitude and frequency of flooding in recent decades. A panel of experts in hydrology and climate change was convened to elicit opinions on how to appropriately reflect this trend in the current analysis (see Appendix A, Hydrology). The panel concluded that the hydrologic record showed a “dry” period in the early decades of the twentieth century and a “wet” period in later years continuing to the present. The panel recommended using non-standard hydrologic methods, because it appears that the traditional analysis underestimates the expected frequency of flooding.

To account for the uncertainty in climate variability, revised flow frequency curves were developed in accordance with the expert panel's recommendations, and this analysis was used for the final screening to ensure that the tentatively selected plan would be able to adequately perform in the future. This analysis used the revised flow frequency curves which changed the 1-percent chance event flow to be approximately 34,700 cfs at present; 32,900 cfs in 2035; and 31,300 cfs in 2060.

3.10.2 Cost and Schedule Risk Assessment

A cost and schedule risk assessment was completed on all three alternatives. This assessment is in compliance with ECB No. 2007-17, dated September 2007 and was completed using the "Cost and Schedule Risk Analysis Guidance" dated May 17, 2009 and developed by the Directory of Expertise for Civil Works Cost Engineering (Walla Walla District). The Directory of Expertise completed the cost and schedule risk assessment with assistance from the study team and non-federal sponsors. This assessment was completed for the ND35K plan prior to the May 2010 Draft EIS and in Phase 4 for the LPP and FCP. This assessment identified a number of areas where future study efforts should be focused to reduce uncertainties.

For the FCP, efforts need to be focused on:

1. Project Schedule
2. Time to plan (Feasibility)
3. Number of Construction Contracts
4. Uncertainty with Geotechnical Conditions
5. Variation in estimated quantities
6. Concerns with Dilworth railyard
7. Environmental Mitigation
8. Potential fluctuation in labor costs
9. Uncertainty with funding stream – Federal and Local

For the LPP and ND35K, efforts need to be focused on:

1. Project Schedule
2. Time to plan (Feasibility)
3. Unplanned work – additional project features
4. Natural Resources Issues
5. Number of Construction Contracts
6. Uncertainty with Geotechnical Conditions
7. Variation in estimated quantities
8. Environmental Mitigation
9. Control and Diversion of water during construction
10. Potential fluctuation in labor costs
11. Uncertainty with funding stream – Federal and Local

The items in the cost and schedule risk assessment that can be minimized in the future based on technical analysis only account for 4.8 percent of the total contingencies. The remaining 95.2 percent of risk items are outside of the technical analysis, and further analysis will not be able to reduce those costs any further. Uncertainty about the future funding stream accounts for more than 70 percent of the risk addressed in the contingency amounts.

Note for April 2011 SDEIS: the cost and schedule risk analysis will be updated for the Final EIS. Contingencies of 25 percent were used for the April 2011 estimates.

3.10.3 Flood Fights and Emergency Levees

As described in the In Progress Review Memorandum for Record dated June 23, 2009, included in Appendix O - Plan Formulation, the economic analysis will not give credit to the emergency flood fighting efforts. However, it is acknowledged that the probability of long-term success with an emergency flood fight is not zero but is very low. To account for this, a sensitivity analysis was completed to determine how successful flood fights could impact the project benefits. To accomplish this task, various increments of probable failure were assigned to the flood fight. This information was included in the economic model (HEC-FDA) and additional runs were performed. It was determined that a flood fight success rate of 70% or greater would be required to make the NED plan not feasible. A success rate of 30% would be required to make the ND35K plan not feasible. The results of this are based on the hydraulic model calibrated to the 2006 event and Phase 2 hydrology, as described in Appendix A, hydrology. Although the sensitivity analysis was not refined using Phase 3 or Phase 4 hydrology, the newer information would likely make flood fight success less significant for feasibility.

3.10.4 Risk of Project Failure

The project will be designed using appropriate measures and factors of safety to ensure that the constructed system is robust and resilient. However, there will be a residual risk of a component failure or exceedance of the system's design capacity. The LPP includes an emergency spillway section as part of the County Road 17 tie-back levee that would allow floods in excess of the 0.2-percent chance event to flow to the west and north around the protected area. Neither the ND35K plan nor the FCP include a similar ability to redirect extreme events. In the case of a flood event that exceeded the design capacity of the system, the tie-back levees of the ND35K plan and FCP could be overtopped, allowing a sudden influx of flood waters within the protected area. An overtopping or breach of a tie-back levee, storage area levee, or failure of a control structure in any of the alternatives could allow flood water into the protected area during any flood event in which the failure occurred. The effects of such a failure could be catastrophic, depending on the magnitude and timing of the stage increases within the protected area.

The LPP and ND35K plan both include aqueduct structures on the Sheyenne and Maple rivers that could be affected by ice or debris during a flood event. These structures include features to deal with ice and debris within the diversion channel and the natural river channels, but there will remain a risk that these structures could be partially blocked by ice or debris which could raise water surfaces upstream of the structures.

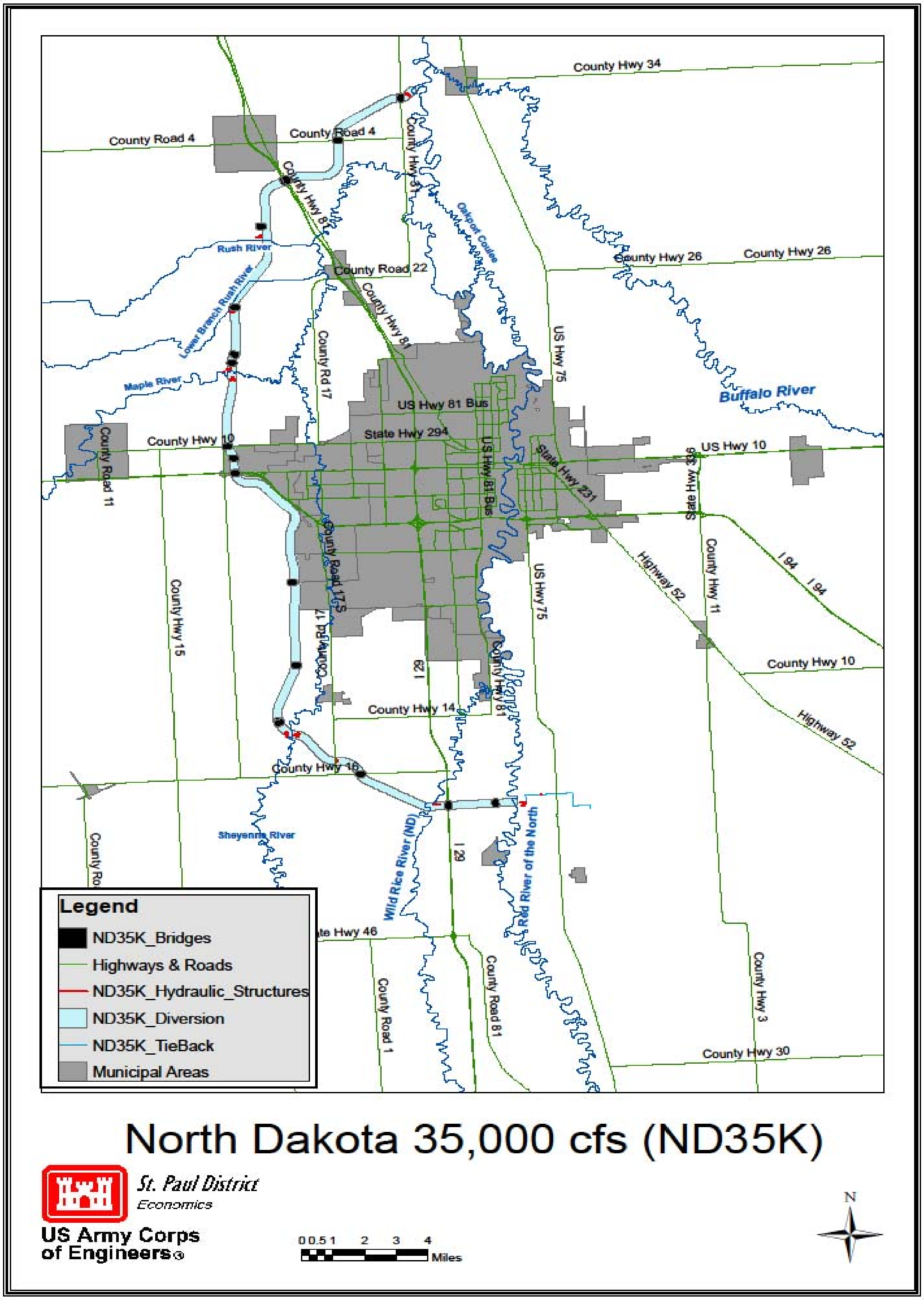
It is assumed that during floods larger than the 1-percent chance event the non-federal sponsors would augment the LPP, FCP and ND35K plans using existing flood damage reduction projects and emergency measures within the protected area. If these measures failed during a flood event, damages could be significant, although the damage would be far less than without the diversion project. (Note that the economic analyses presented in this report give no credit to emergency measures, either in the future without project condition or the with-project condition.)

Note for the SDEIS: A loss of life analysis will be developed for the Final EIS to document potential loss of life if the project failed during an extreme flood event.

3.11 DESCRIPTION OF THE ND35K PLAN

The North Dakota 35K diversion alternative was identified in the May 2010 DEIS as the LPP and the tentatively selected plan. As described in section 3.6.7.2, hydraulic modeling completed in August 2010 revealed that the ND35K plan caused far more extensive downstream impacts than had been anticipated; that information led to the development of the revised LPP described in section 3.13 below. The following description of the ND35K plan is provided as a reference only, since the plan is not supported by either the Corps or the non-federal sponsors. Figure 36 displays location of this alternative.

Figure 36- ND35K Diversion Alignment & Features



3.11.1 Plan Components (including mitigation)

Overview and list of major components:

- Diversion channel and associated structures
- Environmental mitigation
- Recreation features

3.11.1.1 Diversion channel and associated structures

The North Dakota East diversion alignment starts approximately four miles south of the confluence of the Red and Wild Rice Rivers and extends west and north around the cities of Horace, Fargo, West Fargo, and Harwood and ultimately re-enters the Red River north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, MN. Along the 36 mile path it crosses the Wile Rice, Sheyenne, Maple, Lower Rush, and Rush rivers and incorporates the existing Horace to West Fargo Sheyenne River diversion channel. The alignment of the diversion channel was modified slightly from the North Dakota alignment detailed in the DEIS in response to comments; it was adjusted northwest of Harwood, ND to avoid Drain 13.

The plan includes a large control structure on the Red River and a similar structure on the Wild Rice River. The Red River control structure would be an operable structure with three tainter gates 40 feet wide and 30 feet high. The Wild Rice River control structure would be conceptually the same as the Red River control structure, except that the Wild Rice structure would have only two gates 30 feet wide and 20 feet high. The gates on both structures would normally be fully open, and the structure would not impede flow more than a typical highway bridge. When the flow at the Fargo gage is forecasted to exceed 9,600 cfs, the gates would be lowered to restrict flow in the natural channels and redirect some of the flow over the diversion inlet weir and into the diversion channel. The lowest two feet of each gate bay would remain open even when the gates were closed to allow flow into the natural channel under all conditions.

Hydraulic structures are necessary at the points where the diversion channel crosses the Sheyenne, Maple, Lower Rush, and Rush Rivers. The tributary crossing structure systems limit the amount of water that can pass over the diversion channel with the rest of the water being diverted into the diversion channel. This results in additional flood risk reduction benefits adjacent to the tributaries downstream of the intersection. The Rush and Lower Rush Rivers, which currently consist of constructed trapezoidal channels, would be allowed to flow into the diversion channel, resulting in abandonment of the downstream portion of these rivers. The structures at the junction of the Rush and Lower Rush Rivers and the diversion channel are also designed to allow fish passage from the diversion channel into the upstream tributary channels during most flow conditions.

The hydraulic structure systems proposed on the Sheyenne and Maple Rivers would allow a minimum of a 50-percent chance event flow to continue down the rivers while diverting excess water during flood events to the diversion channel. The Sheyenne and Maple River structures would maintain fish passage to those rivers most of the time, except possibly for events larger than the 1-percent chance event. The two crossing structure systems are similar in concept; each includes a drop structure to prevent headcutting on the tributary, a spillway and channel to control diversion of tributary flows, and a hydraulic structure to pass a limited flow over the diversion channel to maintain the desired flow in the tributary beyond the diversion channel. The primary difference between the Sheyenne system and the Maple system is the presence of gated openings on the Maple system's hydraulic structure. The gates are necessary because the structure is designed to allow flows in the diversion channel to overtop the Maple River crossing structure. The gates would operate to prevent excessive flows from passing into the Maple River during extreme flood events.

The channel bottom width between the Red and Wild Rice Rivers is 300 feet. The channel bottom width is 100 feet between the Wild Rice and Sheyenne Rivers and 125 feet between the Sheyenne River and the downstream end of the diversion. Side slopes on the excavation are 1V on 10H up to a 10 foot high 50 foot wide bench then 1V on 7H to the top of the channel.

Soil excavated to construct the channel would be piled adjacent to the channel to a maximum height of 15 feet. The soil disposal piles would be as wide as necessary to contain the excavated material. The spoil slopes are 1V on 7H and 1V on 10H for the diversion side and outside slopes respectively. Portions of the soil disposal piles would be constructed to serve as levees when the water surface in the channel is higher than the natural grade. The total footprint of the plan has a maximum width of approximately 2,450 feet including areas for spoil piles. The affected acreage is approximately 6,560 acres.

The tie-back levee associated with this alternative connects the Red River control structure to high ground approximately 2.5 miles to the east and prevents flood water from flowing over land to the north and east into the protected area. The typical section for the tie-back levee has a top width of ten feet and side slopes of 1V on 4H. The tie-back levee would be constructed of impervious fill obtained from the channel excavation and covered with topsoil and turf.

A number of side ditch inlet drop structures would be included where the diversion crosses existing agricultural and highway drainage ditches. These structures would allow drainage to enter the channel and prevent water in the diversion channel from escaping to adjacent areas during high flow events.

3.11.1.2 Non-structural features

There would be no non-structural measures included in the ND35K plan.

3.11.1.3 Environmental mitigation

Mitigation actions for footprint impacts were based on the concept of replacing the value of the habitat lost with an equal or greater value of restored or improved habitat value. For geomorphic impacts, the proposed mitigation would target to improve other habitat or geomorphic functions along the same length of stream for which an impact was identified. Lastly, for impacts related to connectivity and fish passage, best professional judgment was used to further implement measures that would reduce impacts to fish connectivity to levels that were less than significant. Section 5.5 of this report contains a detailed analysis of the mitigation measures.

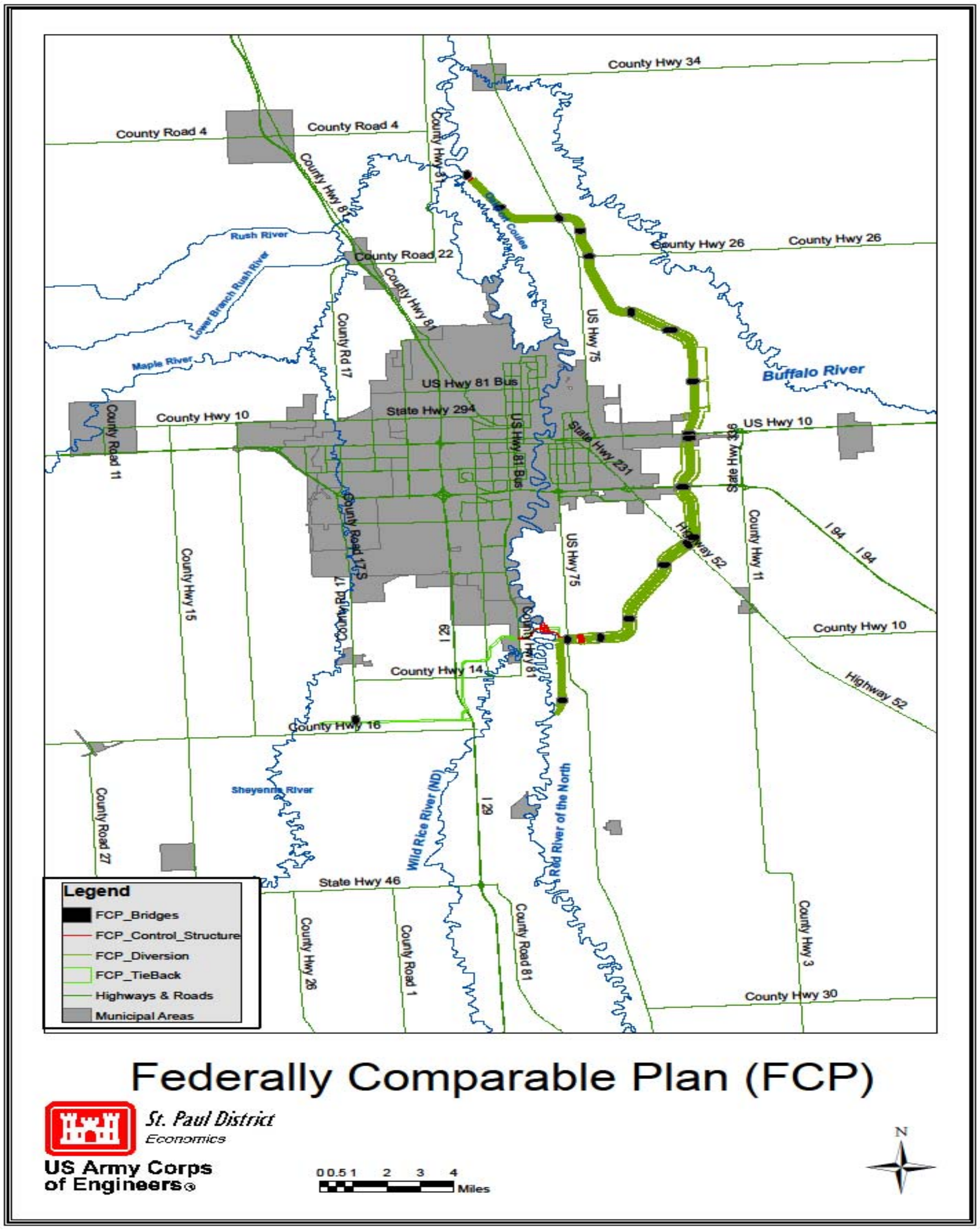
3.11.1.4 Recreation features

No specific recreation plan was developed for the ND35K plan, but recreation features would likely be similar to those described for the LPP in section 3.13.1.4 below.

3.12 DESCRIPTION OF THE MN35K PLAN (FEDERALLY COMPARABLE PLAN)

The MN35K plan is the federally comparable plan (FCP) to be compared to the locally preferred plan for purposes of cost sharing, as discussed in section 3.9.4. Figure 37 displays location of this alternative.

Figure 37 - FCP Diversion Alignment & Features



3.12.1 Plan Components (including mitigation)

Overview and list of major components:

- Diversion channel and associated structures
- Non-structural features
- Environmental mitigation
- Recreational features

3.12.2 Diversion channel and associated structures

The Minnesota 35K short diversion alignment starts just north of the confluence of the Red and Wild Rice Rivers and extends a total of 25 miles east and north around the cities of Moorhead and Dilworth, ultimately re-entering the Red River near the confluence of the Red and Sheyenne Rivers.

The plan includes a large control structure on the Red River which is an operable structure with three tainter gates 50 feet wide and 47 feet high. The gates would normally be fully open, and the structure would not impede flow more than a typical highway bridge up to about a 9,600 cfs flow event (approximately a 28-percent chance event) when the structure would be put into operation. Once upstream stages rose to an elevation of 898.3 feet (NAVD 1988), flows would begin to go over the diversion inlet weir. The weir would be constructed of sheetpile and rock.

The diversion channel has a maximum excavation depth of 30 feet with a maximum bottom width of 400 feet. The diversion has 1V on 7H side slopes at most locations with steeper 1V on 5H slopes at the 20 highway and 4 railroad bridges. The diversion channel will require the excavation of approximately 55 million cubic yards of material. The diversion channel would be protected with rock riprap at the point that it returns to the Red River,.

Soil excavated to construct the channel would be piled adjacent to the channel to a maximum height of 15 feet. The soil disposal piles would be as wide as necessary to contain the excavated material. The spoil slopes are 1V on 7H and 1V on 10H for the diversion side and outside slopes respectively. Portions of the soil disposal piles would be constructed to serve as levees when the water surface in the channel is higher than the natural grade. The total footprint of the diversion channel and soil disposal piles has maximum width of 2,800 feet, and will affect 6,415 acres of land.

In addition to the diversion channel, the plan includes two smaller channels upstream of the Red River control structure to prevent stage increases upstream of the project along the Red and Wild Rice Rivers. A supplementary channel parallels the Red River upstream of the entrance to the diversion channel to allow for additional capacity to offset the breakouts to Drains 27 and 53. This secondary “Minnesota short extension channel” is approximately 3.7 miles long and has a 215 foot bottom width, with side slopes similar to the diversion channel. A second, shorter channel, the Wild Rice River breakout channel, was added near the intersection of I-29 and Cass Highway 16. This channel, which is less than one mile long and crosses under I-29, will convey water across I-29 that would have naturally broken out to Drain 27 and has a 50 foot bottom width, with side slopes similar to the diversion channel.

The Red River control structure is designed with consideration for fish passage during most conditions. The bottom of the structure would be constructed to simulate natural roughness. The openings would be sized to maintain passable flow velocities until the gates were put into operation. After the gates were closed, smaller openings through the structure would direct some water into a fish ramp system that would continue to allow fish passage during flood events up to about the 2-percent chance event.

The plan also includes a 9.9 mile tie-back levee at the southern limits of the project. The tie-back levee connects the Red River control structure to high ground and prevents flood water from flowing over land to the north and west into the protected area. The typical section for the tie-back levee has a top width of ten feet and side slopes of 1V on 4H. The tie-back levee would be constructed of impervious fill obtained from the channel excavation and covered with topsoil and turf.

A number of side ditch inlet drop structures would be included where the diversion crosses existing agricultural and highway drainage ditches. These structures would allow drainage to enter the channel and prevent water in the diversion channel from escaping to adjacent areas during high flow events.

3.12.3 Non-structural features

The non-structural flood risk management measures recommended consist of fee acquisitions, elevation, and construction of flood walls. This includes 7 fee acquisitions, elevating the main floor on 22 structures, elevating the entire structure on 22 and construction of a flood wall around 1 critical facility, the public school in Harwood, North Dakota. The details of the proposed non-structural features are described in Appendix P – Non-Structural.

3.12.4 Environmental mitigation

Mitigation actions for impacts from the footprint of the project are based on the concept of replacing the value of the habitat lost with an equal or greater value of restored or improved habitat value. For geomorphic impacts, the proposed mitigation would target to improve other habitat or geomorphic functions along the same length of stream for which an impact was identified. Lastly, for impacts related to connectivity and fish passage, best professional judgment is used to further implement measures that would reduce impacts to fish connectivity to levels that were less than significant. Section 5.5 of this report contains a detailed analysis of the mitigation measures.

3.12.5 Recreational features

The conceptual recreation plan developed for the FCP includes one bituminous multipurpose trail loop and two aggregate multipurpose trail loops with a combined length of about 48-miles.

A thirty-mile loop of bituminous multi-purpose trails will be 10-foot wide asphalt, situated on the banks or levees of the diversion channel, and designed to be a trail system that will provide varying distances and aesthetic experiences to the users. The bituminous trail crosses the diversion channel in three locations. The crossing at 100th Ave N will be a shared-use crossing and will have a trail head with parking. The crossing at 15th Ave N will be a pedestrian bridge and will also have a trail head with parking. The last crossing is at the southern end of the bituminous trail and is located at County Hwy 52. This too will be a pedestrian bridge along with a trail head and parking.

The aggregate multi-purpose trails will be 10-foot wide compacted gravel. The north segment of trail will be an 8-mile loop from 110th Ave NW extending south to 100th Ave N. This trail will have a shared use crossing at 110th Ave NW along with car/trailer parking. The south segment of the trail will start at County Hwy 52 and will be a 10-mile loop extending south to US Highway 75 where there will be a shared use crossing along with car/trailer parking.

Along the bituminous portion of the trail, benches, trash receptacles and interpretive signage will be located approximately every mile and every 2 miles along the aggregate portion of the trail to provide the trail users information about the wildlife, history, culture and ecology of the area as well as respite. Support facilities for the trails include 3 trailheads, where restrooms, potable water, picnic facilities, interpretive kiosks and parking are proposed. Landscaping of trees and shrubs at the trail heads are also proposed along with native prairie grasses and forbs along the trail. All proposed recreation facilities will meet the guidelines for Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA) as well as the final draft of the ADA-ABA Accessibility Guidelines for Outdoor Developed Areas.

3.13 DESCRIPTION OF THE TENTATIVELY SELECTED PLAN

The tentatively selected plan is the LPP: a North Dakota diversion with upstream staging and storage. Figure 38 displays location of this alternative.

3.13.1 Plan Components (including mitigation)

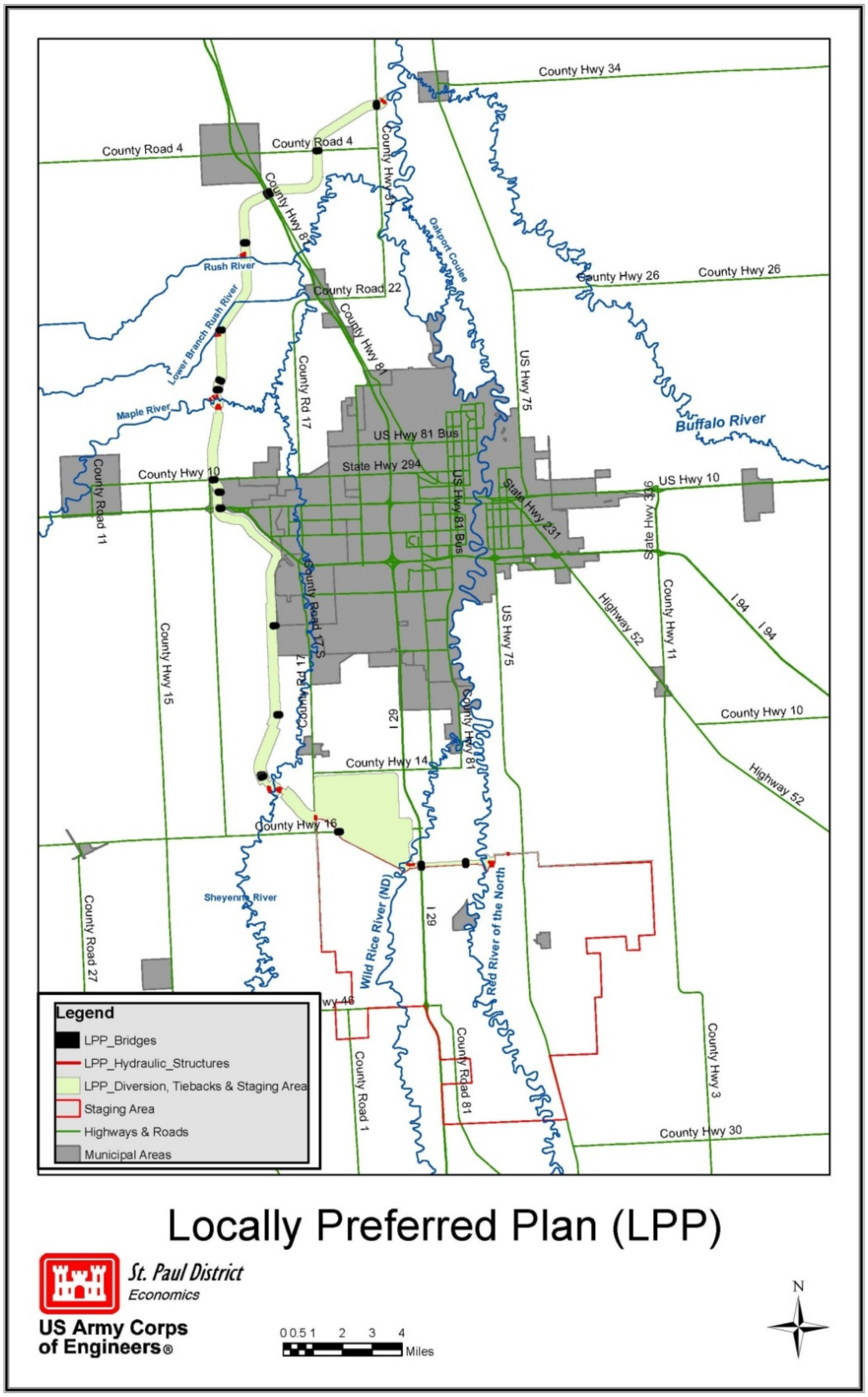
Overview and list of major components:

- Diversion channel and associated structures
- Non-structural features
- Environmental mitigation
- Recreation features

3.13.1.1 Diversion channel and associated structures

The North Dakota east diversion alignment starts approximately four miles south of the confluence of the Red and Wild Rice Rivers and extends west and north around the cities of Horace, Fargo, West Fargo and Harwood. It ultimately re-enters the Red River north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, MN. Along the 36 mile path it crosses the Wile Rice, Sheyenne, Maple, Lower Rush and Rush rivers and incorporates the existing Horace to West Fargo Sheyenne River diversion channel. The LPP alignment is identical to the ND35K alignment.

Figure 38 - LPP Diversion Alignment & Features



The plan includes a large operable control structure on the Red River with three tainter gates 50 feet wide and 47 feet high. The gates would normally be fully open. The structure would not impede flow more than a typical highway bridge when not in operation. The structure would be operated only when the forecasted peak flow of the incoming hydrograph in the Red River of the North at the USGS gage in Fargo is greater than 9,600 cfs (approximately a 28-percent chance event). When it is operated, the control structure would limit the flow passing into the natural Red River channel through the metropolitan area and would back water up into the staging area and Storage Area 1.

The proposed Wild Rice River control structure, similar to the Red River control structure, would be an operable structure with two tainter gates 30 feet wide and 30 feet high. The gates would normally be fully open. The structure would not impede flow more than a typical highway bridge when not in operation. The structure would be operated only when the forecasted peak flow of the incoming hydrograph in the Red River of the North at the USGS gage in Fargo is greater than 9,600 cfs. The Wild Rice River control structure would be conceptually the same as the Red River control structure illustrated in Figure 30, except that the Wild Rice structure would have only two gates.

The diversion inlet structure is a passive weir (no gates or other regulation controls) with an effective flow width of 90 feet and a concrete spillway with a crest elevation of 903.25 feet (NAVD1988). The inlet weir is located where the diversion channel crosses Cass County Highway 17 south of Horace, ND.

Hydraulic structures, known as aqueducts, would be located where the diversion crosses the Sheyenne and Maple rivers. The Maple River structure is illustrated in Figure 33 and Figure 34; the Sheyenne River aqueduct would be similar. The aqueducts would allow for flows in the diversion to pass underneath the existing river channel, while allowing a minimum of a 50-percent chance event flow to continue down the rivers. The excess water would be diverted into the diversion channel. The 50-percent chance event flows are intended to maintain existing geomorphologic processes and existing habitat conditions in the natural channels. The Sheyenne and Maple River structures would remain biologically connected and maintain fish passage to those rivers nearly all of the time. The two crossing structure systems were similar in concept; each included a drop structure to prevent headcutting on the tributary, a spillway and channel to control diversion of tributary flows, and a hydraulic structure to pass a limited flow over the diversion channel to maintain the desired flow in the tributary beyond the diversion channel.

The structures located at the Lower Rush River and Rush River would include a combination of a vertical drop (also proposed for Drain 14), with a total width of 60 feet and 100 feet at the Lower Rush River and Rush River, respectively; and a fishway consisting of 40 feet wide riffle-pool sequences that would extend from the tributary channel down to the low flow pilot channel of the diversion channel. Both tributaries would be diverted into the diversion channel during all flow conditions, and to compensate for the loss of less than 4 miles of existing channelized tributaries, the lower 11 miles of the low flow pilot channel in the diversion channel would be constructed with meanders.

The outlet structure located where the diversion returns to the Red River of the North would be a concrete spillway with a width of 250 feet and a crest elevation of 866.0 (NAVD 1988). Fish passage features would be included at the outlet to allow connectivity between the Red, Rush and Lower Rush rivers.

The typical depth for the diversion is approximately 20 feet, with a maximum depth of 35 feet near the inlet weir. The channel bottom width between the Red and the Wild Rice rivers is 250 feet. Between the Wild Rice River and the diversion inlet weir, the bottom width is 100 feet, and downstream of the diversion inlet weir the width is 250 feet. Generally all side slopes are 1V on 7H and some slopes include benching of varying widths, see Figure 29. A low flow pilot channel would run along the bottom of this reach, and erosion protection at the toe of the main channel side slopes would be provided. Soil excavated to construct the channel would be piled adjacent to the channel to a maximum height of 15 feet. The soil disposal piles would be as wide as necessary to contain the excavated material. The spoil slopes are 1V on 7H and 1V on 10H for the diversion side and outside slopes respectively. Portions of the soil disposal piles would be constructed to serve as levees when the water surface in the channel is higher than the natural grade. The total footprint of the LPP diversion channel has a maximum width of 2200 feet including areas for storage piles. The affected acreage is 8054 acres.

The main line of flood protection at the south end of the project includes the embankments adjacent to the diversion channel, Storage Area 1 embankments, and a tie-back levee from the Red River control structure to high ground in Minnesota. A small control structure consisting of two 10-foot by 10-foot gated box culverts would be used where Wolverton Creek crosses the Minnesota tie-back levee. The structure would normally be open to allow the creek to pass through the levee, but during floods the structure would be closed to prevent flood flows from passing.

In order to eliminate downstream impacts, upstream staging and storage of approximately 200,000 acre-feet immediately upstream of the diversion channel inlet would be required. Figure 32 shows the area that would be affected during a 1-percent chance flood event. The Red River and Wild Rice River control structures would be operated to raise water surface elevations to a maximum of 922.8 feet at the diversion inlet for all events up to a 0.2-percent chance event. Storage Area 1 is a 4,360-acre area on the north side of the LPP diversion channel between the Wild Rice River and the Sheyenne River, and will be formed by nearly 12 miles of embankments. Storage Area 1, combined with staging in the floodplain, will nearly eliminate impacts from the project on flood levels downstream of the diversion channel outlet. The diversion works would be operated not only based on peak flows but primarily based on total hydrograph volumes, in particular those during the rising limb of the hydrograph. A tie-back levee along Cass County Road 17 (CR17) would be needed to keep staged water from crossing overland into the Sheyenne River. A portion of the CR17 tieback levee would be at an elevation lower than the other tie-back levees. This portion of the levee will act as an emergency spillway for extreme events that exceed the 0.2-percent chance event design capacity of the project.

3.13.1.2 Non-structural features

The non-structural mitigation measures recommended consist of fee acquisitions, construction of ring levees and the acquisition of flowage easements. These measures are recommended within the staging area as indicated in Figure 27 and Figure 39. The staging area is defined by the red boundary contained in Figure 39; this area is needed for the operation of the project and a number of mitigation features are being recommended within this area. The proposed mitigation for the area is broken into two parts, one for homes, structures, and businesses and the other for agricultural lands. Impacted homes, structures, and businesses that have greater than 3 feet of flooding for the 1-percent chance event with the project in place would be purchased, those with 1 to 3 feet of flooding would be considered for ring levees or a purchase (a risk and safety analysis will be conducted for determination of viability of a ring levee), and those with less than 1 foot of flooding would have flowage easements purchased for the property. Impacts to agricultural lands in the staging area would be mitigated through the acquisition of flowage easements. A property-by-property analysis will be conducted to ensure that the specifics of each parcel are taken into account when determining the appropriate mitigation. Alternative mitigation options will be considered when application of the general rule does not result in adequate mitigation for a particular parcel.

Areas where fee acquisitions would occur include the communities of Oxbow, Hickson, and Bakke, ND. Comstock, MN would be impacted by the project and would generally have 1 to 3 feet of flooding with the LPP in place; a ring levee would be pursued for Comstock.

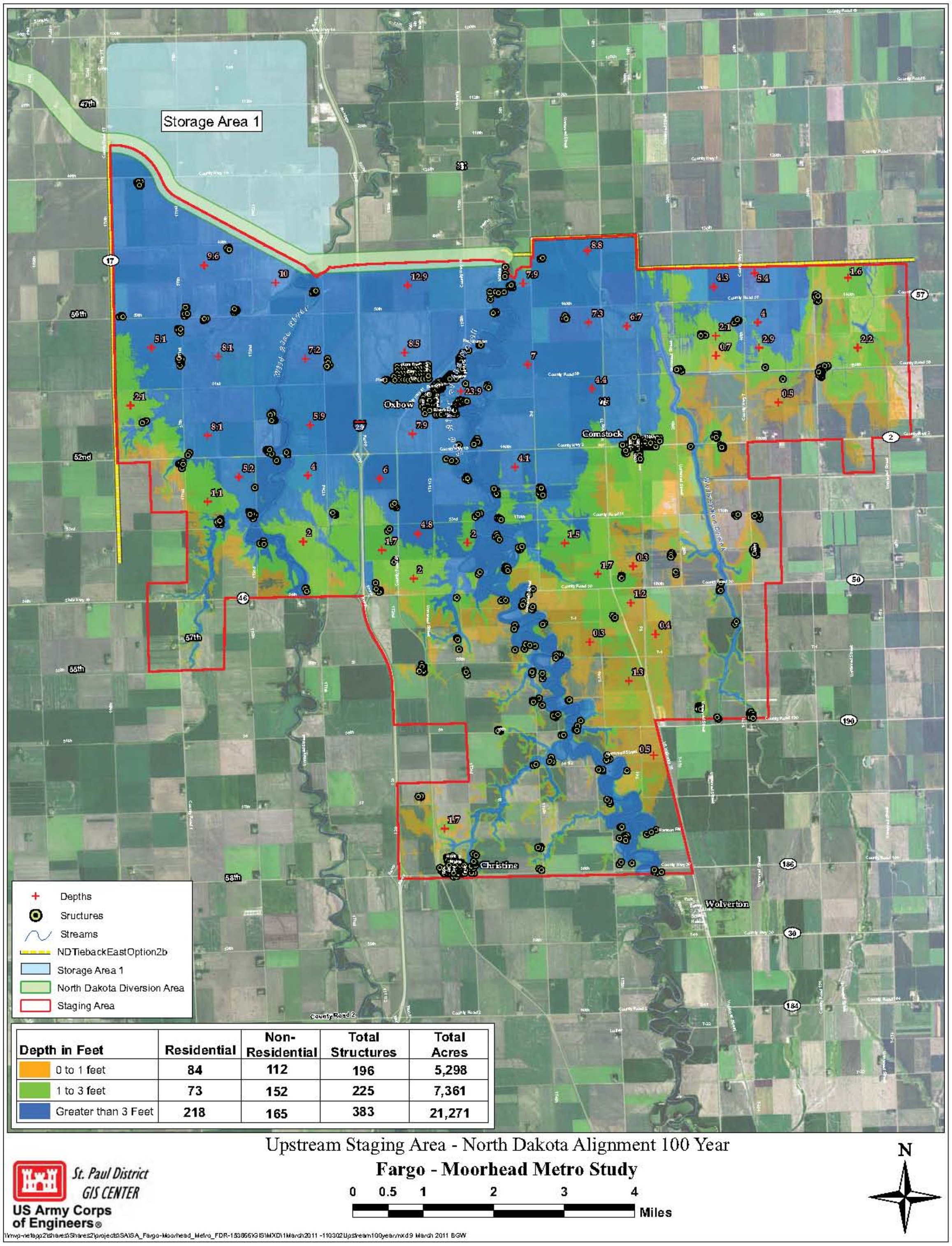
The non-structural mitigiton approach was developed based on what the actual risk to the remaining properties would be with the LPP in place. It was determined based on information from the NRCS, local ring levee programs, and Corps experience indicating that ring levees in excess of 5 feet are not practicable given the added maintenance requirement and risk of failure attendant to levees of higher elevation. Ring levees would only be pursued for flooding of up to 3 feet because 2 feet of freeboard is needed to account for risk and uncertainty, for a total ring levee height of up to 5 feet. Each parcel will be analyzed for safety concerns, and if it is determined that any property owner is subject to an unacceptable safety risk, that parcel would be eligible for fee acquisition.

Flowage easements will be acquired over agricultural land within the staging area. Agricultural lands would be impacted by the project primarily in the spring and it is anticipated that in most areas farming could continue without significant impacts. There is the potiential for summer impacts which could cause damage to agricultural properties and in the past 108 and years of record this would have occurred 4 times in 1975, 2005, 2007, and 2009. The largest summer flow occurred in 2007 with a flow of 13,500 cfs, in that situation only a small portion of the staging area would have been impacted by operation of the project. The summer operation plan will be revisited in during the design phase to determine if a different operating plan can be used in the summer to reduce agricultural impacts without causing additional damage to the Fargo-Moorhead communities. Local concerns have been raised regarding crop insurance within the storage and staging area and coordination has been ongoing with the USDA Risk Management Agency (RMA). The RMA has indicated that the purchase of crop insurance in these areas could still be obtained, however flood impacts resulting from the project may not be covered.

Some areas along the Red River, Wild Rice River and connected drains that are outside of the designated staging area will be affected by staging operations. A legal analysis will be conducted to determine if the impacts in these areas rise to the level of a taking under the Fifth Amendment of the U.S. Constitution. Outside of the designated staging area, landowners will be compensated appropriately for any takings.

Interstate Highway 29, U.S. Highway 75 and a BNSF railroad line would be raised within the staging area to maintain transportation during flood events. All other roadways and utilities within the staging area would be allowed to flood when project operations require staging of flood water.

Figure 39 – Upstream Staging and Storage Areas – Mitigation Plan



3.13.1.3 Environmental mitigation

Environmental mitigation actions for impacts from the footprint of the project are based on the concept of replacing the value of the habitat lost with an equal or greater value of restored or improved habitat value. For geomorphic impacts, the proposed mitigation would target to improve other habitat or geomorphic functions along the same length of stream for which an impact is identified. For impacts related to connectivity and fish passage, best professional judgment will be used to further implement measures that would reduce impacts to less than significant levels. Section 5.5 of this report contains a detailed analysis of the mitigation measures.

3.13.1.4 Recreation features

The conceptual recreation plan for the LPP includes one bituminous multipurpose trail loop and two aggregate multipurpose trail loops with a combined length of approximately 44-miles.

The bituminous multi-purpose trails will be 10-foot wide asphalt, situated on the banks or spoils of the diversion channel, and designed to be a trail system that will provide varying distances and aesthetic experiences to the users. The bituminous trail crosses the diversion channel in two locations. The crossing at 36th Street SE will be a shared-use crossing and will have a trail head with parking while the 44th Street SE shared-use crossing will have a trail head with car/trailer parking. Additional parking will also be at 38th Street SE.

The aggregate multipurpose trails will be 10-foot wide compacted gravel. The north segment of aggregate trail will be an approximate 6-mile loop from 28th Street SE extending south to 31stth Street SE. The trail would then continue along the east side of the diversion for approximately 5 miles to 36th Street SE. This north segment will have a pedestrian crossing at the Maple River and a shared-use crossing at 28th Street SE and 31st Street SE. It will also have car/trailer parking at 28th Street SE, car parking at 31st SE and a wildlife observation structure at the Rush River. The south segment of the trail will start at 44th Street SE and will be a 4.5-mile loop extending south to 46th Street SE where there will be a shared-use crossing. The south segment will continue for approximately 8.5 miles on the east side of the diversion until the diversion joins the Red River. Along this segment there will be a pedestrian bridge crossing for the Sheyenne River and for the Wild Rice River. There will be fishing structures adjacent the Wild Rice River as well as the Red River. These fishing structures will be rustic in nature and built into the shore protection to allow anglers access to the river. Car parking will be located at 48th Street SE and a trail head with car/trailer parking will be located at County Road 81.

Along the entire trail, benches, trash receptacles and interpretive signage will be located approximately every mile to provide the trail users information about the wildlife, history, culture and ecology of the area as well as respite. Support facilities for the trails include 3 trailheads, where restrooms, potable water, picnic facilities, interpretive kiosks and parking are proposed. Landscaping of trees and shrubs at the trail heads are also proposed along with trees, native prairie grasses and forbs along the trail. All proposed recreation facilities will meet the guidelines for Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA) as well as the final draft of the ADA-ABA Accessibility Guidelines for Outdoor Developed Areas.

3.13.1.5 General Operation and Effects

The LPP would significantly reduce flood damages and flood risk in the Fargo-Moorhead metropolitan area, but it would not completely eliminate flood risk. The LPP will reduce flood stages on the Red River in the cities of Fargo and Moorhead and will also reduce stages on the Wild Rice, Sheyenne, Maple, Rush and Lower Rush Rivers between the Red River and the diversion channel. With the LPP in place, the stage from a 1-percent chance flood event on the Red River would be reduced from approximately 42.4 to 30.6 feet on the Fargo gage. At that level, only minimal emergency measures would be required to safely pass the 1-percent chance flood event with the LPP in place. However, floods larger than the 1-percent chance event will still require emergency flood fighting measures; with the LPP in operation, the stage for a 0.2-percent chance flood event would be approximately 40.0 feet, which is comparable to the 2009 flood event.

3.13.2 Design and Construction Considerations

Please refer to the individual engineering appendices for this discussion.

3.13.3 Real Estate Requirements

A preliminary Real Estate Plan was developed as part of this project and it can be found in Appendix G, Real Estate. The Real Estate Plan identifies the plans under consideration, the types of interest that may be needed for this project and a cost breakout for the LPP, FCP and ND35K alternatives.

3.13.4 Local Betterments

A betterment is defined as a difference in the construction of an element of the project that results from the application of standards that the Government determines exceed those that the Government would otherwise apply to the construction of that element. The term does not include any construction of features not included in the project as defined in the project authorization. The non-federal sponsors have not indicated that any additional betterments are desired at this time.

3.13.5 Operation, Maintenance, Repair, Rehabilitation and Replacement Considerations

The non-federal sponsors will be responsible for all operations, maintenance, repair, rehabilitation and replacement (OMRR&R) of project features. This will include annual maintenance of the diversion channel and associated structures including the Red River control structure, any additional structures required for the alternative, bridges and recreation facilities. See Appendix L, Costs for a detailed breakout of the estimated OMRR&R costs for each of the alternatives. Overall cost can be found in Table 11 and Table 12. See Section 5.5 of this report for information on monitoring plans.

3.13.6 Economic Summary

The estimated first costs and OMRR&R costs have been developed using the Corps micro-computer aided cost estimating system (MCACES). The costs are allocated between the project's purposes. These costs, along with total annual costs, annual benefits, net economic benefits and the benefits-to-cost ratios are shown on Table 23. These values are based on October 2011 price levels, an interest rate of 4.125 percent and a 50-year period of economic analysis.

Table 23 – Economic Analysis of the LPP

Estimate of Project First Costs LPP				
Account	**Item**	**Flood Risk Management**	**Recreation**	**Total**
01	Lands & Damages	273,172		273,172
02	Relocations	151,917		151,917
06	Fish and Wildlife Facilities	64,998		64,998
08	Roads, Railroads and Bridges	59,121		59,121
09	Channels & Canals	775,208		775,208
11	Levees and Floodwalls	141,376		141,376
14	Recreation Facilities		29,275	29,275
Subtotal		$ 1,465,792	$ 29,275	$1,495,067
30	Planning, Engineering and Design	182,753	4,486	187,239
31	Construction Management	85,289	2,094	87,383
Subtotal		$ 268,042	$ 6,580	$ 274,622
	Interest During Construction	295,008	740	295,749
	Total Investment Costs	**$ 2,028,843**	**$ 36,595**	**$2,065,438**
Estimate of Annual Costs				
	Annualized Project Costs	96,473	1,740	98,214
	Annual OMRR&R Cost	3,617	47	3,664
	Annual Induced Damages	-		-
	Total Annual Costs	**$ 100,090**	**$ 1,787**	**$ 101,878**
Average Annual Benefits				
	Flood Risk Management	162,800	0	162,800
	Flood Proofing Cost Savings	10,430	0	10,430
	Flood Insurance Administrative Costs	960	0	960
	Non Structural Flood Risk Benefit	627		627
	Recreation	-	5,130	5,130
	Total Annual Benefits	**$ 174,817**	**$ 5,130**	**$ 179,947**
	Net Annual Benefits	$ 74,727	$ 3,343	$ 78,069
	Benefit to Cost Ratio	1.75	2.87	1.77
All costs and benefits in thousands ($1,000)				

3.13.7 Environmental Commitments

Environmental commitments incorporated into the tentatively selected plan are as follows:

- The opportunity for inter-agency partnerships to develop areas for improved habitat would be explored with the non-federal sponsors, interested federal, state and local agencies, Indian Tribes and interest groups during preparation of plans and specifications. These measures could be incorporated into the project without additional authorization.
- Future coordination on constructing the Red River control structure and tributary structures. This would be coordinated with the Resource Agency Team identified in Section 6.2.
- Future coordination on ways to reduce the frequency of operation would be coordinated with the Resource Agency Team identified in Section 6.2.
- The mitigation plan includes geomorphic assessments, physical aquatic habitat assessments and fisheries surveys on the Red, Wild Rice, Sheyenne, Maple, Rush and Lower Rush rivers to verify that project assumptions have been met over time.

3.13.8 Relationship to environmental requirements

This Environmental Impact Statement was prepared in compliance with federal environmental laws, executive orders, and policies, and with State and local laws and policies as shown below including: the Clean Air Act, as amended; the Clean Water Act as amended; the Endangered Species Act of 1973, as amended; the National Historic Preservation Act of 1966, as amended; the Land and Water Conservation Fund Act of 1965, as amended; the National Environmental Policy Act of 1969, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; the Farmland Protection Policy Act; Executive Order 11990, Protection of Wetlands; Executive Order 11988, Floodplain Management; and Executive Order 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.

Table 24 summarizes the status of project actions proposed by the Corps of Engineers in relation to applicable environmental laws and regulations.

Table 24 - Status of Project Compliance with Applicable Laws and Statutes

STATUTES OR DIRECTIVES	STATUS
Federal Statutes	
Archeological and Historic Preservation Act	Partial
Clean Air Act as amended	Full
Clean Water Act as amended	Partial
Coastal Zone Management Act	N/A
Endangered Species Act of 1973, as amended	Full
Farmland Protection Policy Act of 1984	Full
Federal Water Project Recreation Act, as amended	Full
Fish and Wildlife Coordination Act, as amended	Partial
Estuary Protection Act	N/A
Land and Water Conservation Fund Act, as amended	Full

Marine Protection, Research and Sanctuaries Act, as amended	N/A
National Environmental Policy Act of 1969, as amended	Partial
National Historic Preservation Act of 1966, as amended	Partial
Resource Conservation and Recovery Act	N/A
Full Watershed Protection and Flood Prevention Act, as amended	Full
Wild and Scenic Rivers Act, as amended	N/A
Bald and Golden Eagle Protection Act	Full
Executive Orders, Memorandums, etc.	
Floodplain Management (E.O. 11988)	Full
Full Protection of Wetlands (E.O. 11990)	Full
Full Environmental Effects Abroad of Major Federal Actions (E.O. 12114)	N/A
Analysis of Impacts on Prime and Unique Farmlands (CEQ Memorandum, 8/11/80)	Full
Protection and Enhancement of Environmental Quality (E.O. 11514, as amended by E.O. 11991)	Full
Protection and Enhancement of the Cultural Environment (E.O. 11593)	Full
Environmental Justice (E.O. 12898)	Full

3.13.9 Environmental Operating Principles

The Corps' seven Environmental Operating Principles, listed in Appendix O, Section 8.2, were followed during the entire planning process as indicated in the paragraph below.

The tentatively selected plan **strives to achieve environmental sustainability** by incorporating features to facilitate fish passage, minimize impacts to geomorphology and minimize any other environmental impacts caused by the project. The feasibility study team coordinated extensively with the appropriate environmental agencies in order to **proactively consider environmental consequences** so that appropriate measures could be included in the project design and as mitigation where necessary. The project provides an appropriate **balance and synergy among human development activities and natural systems** by reducing the risk of flooding to the largest urban area in North Dakota and western Minnesota, thereby avoiding the significant environmental and economic damage that would be caused by repeated flood fighting actions and eventual catastrophic flooding of the Fargo-Moorhead metropolitan area. The plan is consistent with all applicable laws and policies, and the Corps and its non-federal sponsors **accept corporate responsibility and accountability** for the project in accordance with those laws and policies. The study team has used **appropriate ways and means to assess cumulative impacts to the environment** through the use of engineering models, environmental surveys and coordination with natural resource agencies. The project design has evolved to address as many concerns as possible, and **appropriate mitigation** will be included to address remaining impacts. Study activities including hydrologic, hydraulic, economic, geomorphic, geotechnical, cultural resource and HTRW surveys will **increase the integrated scientific knowledge base** for the Red River Basin. The feasibility study process included numerous public and agency meetings and a project website to interact with **individuals and groups interested in the study activities**. Through those meetings and written interactions, the study team **listened actively and respectfully** to project proponents and opponents alike in an effort to find innovative solutions to the flooding problems in the study area.

3.13.10 Campaign Plan
The four goals and underlying objectives of the Corps of Engineers campaign plan, listed in Appendix O, Section 8.3, were followed during the entire planning process as indicated in the paragraph below.

The development of the plan and the information contained in the report is an **integrated, sustainable, water resource solution** that was developed through the use of collaborative approaches to effectively address the problem of flood risk management in the Fargo-Moorhead Metropolitan area. The information was presented to the non-federal sponsors and the public through the use of clear and strategic communications with an emphasis on transparency. This resulted in a plan that would sustain the aquatic resources of the nation while providing a high flood risk management level to the citizens of the Fargo-Moorhead Metropolitan area.

3.14 IMPLEMENTATION REQUIREMENTS

3.14.1 Institutional Requirements
The schedule for project implementation assumes authorization in the proposed Water Resources Development Act (WRDA) of 2011, if enacted, or a future WRDA. After project authorization, the project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based upon national priorities, magnitude of the federal commitment, economic and environmental feasibility, level of local support, willingness of the non-federal sponsors to fund their share of the project cost, and the budget constraints that may exist at the time of funding. Once Congress appropriates federal construction funds, the Corps and the non-federal sponsors would enter into a project partnership agreement (PPA). This PPA would define the federal and non-federal responsibilities for implementing, operating and maintaining the project.

The Corps would officially request that the non-federal sponsors acquire the necessary real estate immediately after the signing of the PPA. The advertisement of the construction contracts would follow the certification of the real estate. The final acceptance and transfer of the project to the non-federal sponsors would follow the delivery of an operation and maintenance (O&M) manual and as-built drawings. The estimated schedule for project implementation is shown below:

Receive project Authorization	December 2011
Received construction funds	October 2012
Initiate construction	April 2013
Complete Construction	October 2021

A detailed project schedule was developed as part of this project and is included in Appendix L.

3.14.2 Cost Apportionment
Table 26 indicates the allocation of funds between the non-federal sponsors and the federal government for the Federally Comparable Plan (FCP). Table 27 indicates the allocation of funds between the non-federal sponsors and the federal government for the LPP. The project cost share is based on the FCP and the additional costs attributed to the LPP. The federal share of the

project will be limited to 65 percent of the FCP for the flood risk management features. This results in a federal cost of $767,178,000 which is 65 percent of the FCP first costs of $1,180,274,000. The non-federal sponsors are responsible for the costs of the lands, easements, relocations, rights-of-way and disposal areas (LERRDs), not to exceed 50 percent of the total project cost, and for a minimum cash contribution of five percent. The LERRDs are anticipated to cost $201,954,000, less than the project minimum 35 percent contribution that is required. The remaining non-federal share will be a cash contribution of $211,142,000; this exceeds the minimum cash contribution meaning no additional cash is needed.

The non-federal sponsors are required to pay the increment between the FCP costs ($1,180,274,000) and the LPP costs ($1,733,834,000), which is $553,560,000. The recreation features are cost shared 50/50, resulting in federal and non-federal costs of $17,927,000 each. Table 25 identifies the incremental cost difference by line item between the FCP and LPP plans. This incremental difference is 100 percent the responsibility of the non-federal sponsors.

Table 25 – Incremental cost table FCP versus LPP, without recreation.

Account	Item	LPP	FCP	(LPP-FCP)
01	Lands & Damages	273,172	69,655	-203,517
02	Relocations	151,917	108,020	-43,897
06	Fish and Wildlife Facilities	64,998	14,706	-50,292
08	Roads, Relocations and Bridges	59,121	161,853	102,732
09	Channels & Canals	775,208	597,296	-177,912
11	Levees and Floodwalls	141,376	24,927	-116,449
30	Planning, Engineering and Design	182,753	138,968	-43,785
31	Construction Management	85,289	64,849	-20,440
	Total First Costs	**$ 1,733,834**	**$ 1,180,274**	**$ (553,560)**
	All costs in thousands ($1,000)			

Table 26 – Allocation of funds table--FCP

FCP			
Item	Federal ($)	Non-Federal ($)	Total ($)
Flood Risk Management			
Lands and Damages		69,655	69,655
Relocations	161,853	108,020	269,873
Fish and Wildlife Facilities	14,706		14,706
Channels and Canals	597,296	0	597,296
Levees and Floodwalls	24,927	0	24,927
Planning, Engineering, & Design	122,414	16,554	138,968
Construction Management	57,124	7,725	64,849
Cash Contribution	-211,142	211,142	0
Total FRM	767,179	413,096	1,180,274
Recreation			
Lands and Damages	0	0	0
Relocations	0	0	0
Recreation Facilities	25,390	0	25,390
Planning, Engineering, & Design	3,891	0	3,891
Construction Management	1,816	0	1,816
Cash Contribution	-15,548	15,548	0
Total Recreation	15,548	15,548	31,097
Total Project	782,727	428,644	1,211,371
All costs in thousands ($1,000)			

Table 27 – Allocation of funds table--LPP.

LPP			
Item	Federal ($)	Non-Federal ($)	Total ($)
Flood Risk Management			
Lands and Damages		273,172	273,172
Relocations	59,121	151,917	211,038
Fish and Wildlife Facilities	64,998		64,998
Channels and Canals	775,208	0	775,208
Levees and Floodwalls	141,376	0	141,376
Planning, Engineering, & Design	159,474	23,279	182,753
Construction Management	74,425	10,864	85,289
Cash Contribution	-507,424	507,424	0
Total FRM	767,178	966,656	1,733,834
Recreation			
Lands and Damages	0	0	0
Relocations	0	0	0
Recreation Facilities	29,275	0	29,275
Planning, Engineering, & Design	4,486	0	4,486
Construction Management	2,094	0	2,094
Cash Contribution	-17,927	17,927	0
Total Recreation	17,927	17,927	35,855
Total Project	785,106	984,583	1,769,689
All costs in thousands ($1,000)			

3.14.3 Fully Funded Cost Estimate

The fully funded estimate for the tentatively selected plan includes price escalation using Office of Management and Budget inflation factors. Project inflation factors, midpoint of construction features and fully funded costs can be found in the total project cost summary in Table 28. Project funding requirements by fiscal year are summarized in Table 29, as fully funded estimates.

Table 28 – Total Project Cost Summary (LPP)

LPP TOTAL PROJECT COST SUMMARY								
	PROJECT: Fargo Moorhead Metro Feasiblity Study							
	LOCATION: Red River of the North Basin							
						FULLY FUNDED ESTIMATE		
ACCOUNT NUMBER	FEATURE DESCRIPTION	Estimated Cost ($K)	Contigency ($K)	Contigency (%)	Total First Cost($K)	Estimated Cost ($K)	Contigency ($K)	Fully Funded plus Contigency ($K)
01	Lands & Damages	218,537	54,634	25%	273,171	236,103	59,026	295,129
02	Relocations	121,533	30,383	25%	151,916	135,857	33,964	169,821
06	Fish and Wildlife Facilities	51,999	13,000	25%	64,999	57,420	14,355	71,775
08	Roads, Relocations and Bridges	47,297	11,824	25%	59,121	51,294	12,824	64,118
09	Channels & Canals	620,166	155,042	25%	775,208	692,283	173,071	865,354
11	Levees and Floodwalls	113,101	28,275	25%	141,376	130,867	32,717	163,584
14	Recreation Facilities	23,420	5,855	25%	29,275	26,090	6,523	32,613
30	Planning, Engineering and Design	149,791	37,448	25%	187,239	181,074	45,269	226,343
31	Construction Management	69,907	17,477	25%	87,384	88,295	22,074	110,369
	Total	1,415,751	353,938	25%	1,769,689	1,599,285	399,821	1,999,106
All costs in thousands ($1,000)								

Table 29 – Fully Funded estimate by fiscal year

LPP	Fully Funded Amount Plus Contingency	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	Total Project
Federal											
E&D	$ 198,230	$ 19,000	$ 45,000	$ 40,000	$ 35,000	$ 35,000	$ 15,000	$ 4,000	$3,000	$2,230	$198,230
S&A	$ 96,661		$2,634	$7,025	$10,977	$12,470	$15,807	$15,807	$15,807	$16,133	$96,661
Construction	$ 1,100,713		$ 30,000	$ 80,000	$ 125,000	$ 142,000	$ 180,000	$ 180,000	$ 180,000	$183,713	$1,100,713
Non-Federal Cash	$ (623,702)	$ (7,000)	$ (20,000)	$ (25,000)	$ (67,000)	$ (80,000)	$ (100,000)	$ (100,000)	$ (115,000)	$(109,702)	$ (623,702)
Federal LERRD	$ 64,118		$ 45,000	$ 10,000	$ 7,000	$ 2,118					$64,118
Recreation	$ 32,613						$ 7,000	$ 7,000	$7,000	$11,613	$32,613
											$0
Total Federal	$ 868,633	$12,000	$102,634	$112,025	$110,977	$111,588	$117,807	$106,807	$90,807	$103,987	$868,633
Non-Federal											
E&D	$ 28,113	$ 5,000	$ 5,000	$ 10,000	$7,000	$1,113					$28,113
S&A	$ 13,708		$3,229	$3,229	$3,229	$3,229	$793	$0	$0	$0	$13,708
Relocation	$ 169,821		$ 40,000	$ 40,000	$40,000	$40,000	$9,821				$169,821
Lands	$ 295,129		$ 50,000	$ 50,000	$ 50,000	$50,000	$35,000	$35,000	$25,129		$295,129
Non-Federal Cash	$ 623,702	$ 7,000	$ 20,000	$ 25,000	$ 67,000	$ 80,000	$ 100,000	$ 100,000	$ 115,000	$ 109,702	$623,702
											$0
Total Non-Federal	$ 1,130,473	$ 12,000	$ 118,229	$ 128,229	$167,229	$174,342	$145,614	$135,000	$140,129	$109,702	$1,130,473
Total Project	$ 1,999,106	$ 24,000	$ 220,863	$ 240,254	$278,206	$285,930	$263,421	$241,807	$230,936	$213,689	$1,999,106
All costs in thousands ($1,000)											

3.14.4 Permits

As part of implementing this project, the non-federal sponsors will be required to obtain a Minnesota Department of Natural Resources protected waters permit, a water quality permit from the North Dakota Department of Health and a Sovereign Lands Permit through the North Dakota State Water Commission. In order to obtain the necessary permits from the State of Minnesota, the non-federal sponsors must complete the scoping and review process required by the Minnesota Environmental Policy Act.

A Section 401 water quality certification will be obtained from the Minnesota Pollution Control Agency and the North Dakota Department of Health.

The construction contractors will be responsible for acquiring all local licenses/permits required to comply with state and municipal laws, codes and regulations (road, borrow, construction, etc,) and for acquiring the National Pollutant Discharge Elimination System (NPDES) permit from the Minnesota Pollution Control Agency and the North Dakota Department of Health.

3.14.5 Views of non-federal sponsors and any other agencies having implementation responsibilities.

The city of Fargo and city of Moorhead have expressed the desire to implement the project and sponsor project construction in accordance with the items of local cooperation that are set forth in Chapter 8. The non-federal sponsors will complete the necessary financial self-certifications to indicate that they are financially capable of implementing the tentatively selected plan.

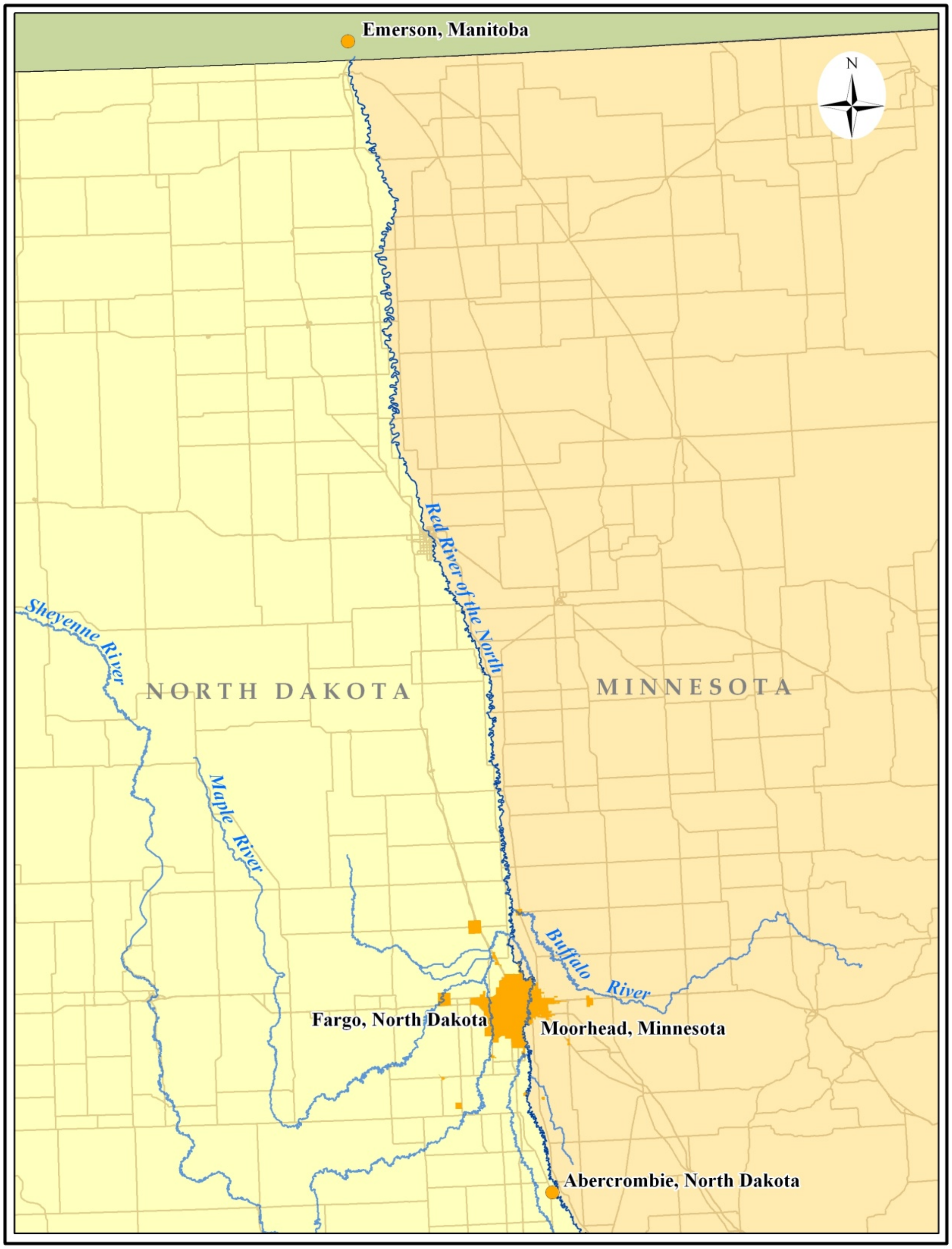
4.0 AFFECTED ENVIRONMENT

The affected environment is the area and resources that might be affected by the alternatives discussed in this report. This chapter also serves to describe the existing and future "without-project" conditions.

4.1 ENVIRONMENTAL SETTING OF THE STUDY AREA

The geographic scope of analysis for the environmental impacts of the proposed action and alternatives encompasses the Fargo-Moorhead Metropolitan region plus areas in the floodplain of the Red River from approximately 300 river miles north of Fargo near Emerson, Manitoba to approximately 30 miles south of Fargo near Abercrombie, ND. The Fargo-Moorhead Metropolitan region is located within the area from approximately 12 miles west to 5 miles east of the Red River and from 20 miles north to 20 miles south of Interstate Highway 94. This area includes the Red River and the downstream portions of the Buffalo River, Wild Rice River (North Dakota), Sheyenne River, Maple River, Rush River, Lower Rush River and other contributing streams that enter the Red River in the study area (Figure 40). In North Dakota the study area includes a portion of Cass County and the cities of Fargo, West Fargo, Hickson, Oxbow, Wild Rice, Frontier, Briarwood, Prairie Rose, Horace, Reiles Acres, and Harwood. In Minnesota the study area includes a portion of Clay County and the cities of Moorhead, Dilworth, Oakport, Rustad, Kragnes and Georgetown.

Figure 40 – Project Study Area



4.2 SIGNIFICANT RESOURCES

This section describes the existing and without project conditions for the study area. In cases where no without project condition is described it is assumed that the existing project condition will remain relatively unchanged.

Resources that could be affected by the Project's proposed alternatives occur throughout the geographic scope of the project as shown in Figure 40. Issues identified through the scoping process or resources that potentially could be affected by the Project are:

Natural Resources

- Climate
- Geomorphology
- Air Quality
- Water Quality
- Water Quantity
- Shallow Ground Water
- Aquifers
- Fisheries and Aquatic Habitat
- Riparian Habitat
- Wetlands
- Upland Habitat
- Terrestrial Wildlife
- Endangered Species
- Prime and Unique Farmland

Cultural Resources

- Historic Conditions
- Previous Cultural Resources Investigations
- Known Cultural Resources Sites

Socioeconomic Resources

4.2.1 Natural Resources

4.2.1.1 Climate

The study area is in a region classified as a subhumid to humid continental climate with cold winters and moderately warm summers. Rapid changes in daily weather patterns are common. Frequent passage of weather fronts and high and low pressure systems result in a wide variety of weather conditions. The average temperature between November and March is below 32^{o} F, resulting in an average of 185 days per year at or below 32^{o}F. The average temperature of the warmest month, July, is 71.1^{o}F. The annual average normal temperature of 41.2^{o}F reflects the northern location of the study area. On an annual basis, the prevailing wind at Fargo is from the north and northwest. The average annual precipitation in the Fargo area is about 19.5 inches. Nearly three-fourths of the annual precipitation occurs between April and September, with the remainder occurring during the winter. The average annual snowfall is about 50 inches.

The existing and future without project conditions are assumed to be the same, however an expert opinion elicitation (EOE) panel was used to determine the effects of climate change or variation. Information regarding this panel can be found in Appendix A, Hydrology.

4.2.1.2 Geomorphology

The following is summarized from a more detailed analysis of geomorphic conditions and sediment transport provided. Please reference Exhibit I of Appendix F of Attachment 5 (IF5) for a more complete description and analysis of existing geomorphic conditions.

4.2.1.2.1 Overview

The Red River of the North originates at the confluence of the Otter Tail and Bois de Sioux Rivers south of Fargo, ND. It flows northward into Canada and forms most of the boundary between Minnesota and North Dakota. The annual mean flow of the Red River at Fargo-Moorhead for the period of record (1901 to the present) averages approximately 677 cubic feet per second (cfs). Monthly median flows range from a low of about 250 cfs during the winter months, to a high of 1,300 to 1,400 cfs during April. The channel capacity of the Red River in the Fargo-Moorhead area is about 7,000 cfs.

The central feature of the Red River Basin is the Red River Valley, the flat plain that once was the bed of Glacial Lake Agassiz. The lake formed at the southern edge of the Laurentide Ice Sheet and remained in existence from approximately 11,500 to 7,500 years before present (Teller and Clayton, 1983). Within the study area and over much of the old lake bed, the lake left behind a 150 to 300 foot layer of primarily silts and clays (Klausing, 1968; Fenton et al., 1983; Tornes and Brigham, 1994) over a 50 to 60 mile wide area stretching from south of Breckenridge, MN to Winnipeg, Manitoba. This area is known as the "lake plain." Within the lake plain, topographic relief is minimal and the typical slope is less than 5 feet per mile (0.1%, IF5). The cities of Fargo and Moorhead sit at the center of the Red River Valley and the lake plain.

The lake plain is bordered by steeper beach ridges, which formed the shoreline of Glacial Lake Agassiz. Glacial rivers flowing into the lake deposited coarser sediment (sands and gravels) in these areas (Christensen, 2007), creating deltas that are mostly buried beneath later lake-deposited fine sediment. The surficial geology of the study area is shown in IF5. Regional soil survey information shows that the sandiest soils in the Red River Basin are concentrated along the shoreline areas, approximately 20 miles from the proposed LPP Diversion Channel.

4.2.1.2.2 General Stream Characteristics

Red River of the North

The Red River originates in the cities of Wahpeton and Breckenridge at the confluence of the Otter Tail and Bois de Sioux Rivers, approximately 187 miles upstream of Fargo and Moorhead. Through the study area, the gradient of the Red River is extremely flat at approximately 0.6 feet per mile (0.01%).

Brooks (2003a, 2005) indicates that the suspended sediment load of the Red River is composed primarily of silt with some clay. Paakh et al. (2006) state that the fine clay and silt sediments in the Red River Valley Lake Plain are easily suspended and tend to stay in suspension even during relatively low-flow conditions. Lauer et al. (2006) hypothesize that although some of the Red River sediment moves as bedload in the form of aggregated pellets of fine sand size, most of the bed sediment is transported in disaggregated form as silt and clay in suspension. Thus over engineering time scales, unless there is a significant change in the sediment supply from the watershed, potential changes of the Red River channel geometry would be associated with channel migration rather than with bed aggradation or degradation. However, Brooks (2003b) reports a very slow net expansion of Red River (meander) bends with channel migration rates in the order of 4 centimeters per year (1.6 inches per year) over the past 1,000 years. Therefore, the Red River can be considered a stable riverine system, an opinion that is shared by Professor Gary Parker (University of Illinois, personal communication), one of the world leading experts in river morphodynamics.

There are several existing low-head dams on the Red River in the study area. Three dams in the cities of Fargo and Moorhead have been retrofitted with rock spillways to increase public safety and to improve fish passage up the Red River during low flow conditions. Two dams at Christine and Hickson, ND (just upstream of Fargo, ND) are planned for retrofitting, though construction has not been initiated.

Tributaries

The Wild Rice River enters the lake plain near Wahpeton, ND and flows northward for more than 60 miles before joining the Red River approximately 10 miles south of the cities of Fargo and Moorhead. Like the Red River, the Wild Rice River is highly meandering and has a very low gradient of approximately 0.7 feet per mile (0.01%).

The Sheyenne River enters the lake plain near Kindred, ND and flows northward for approximately 75 miles before joining the Red River near Harwood. The Sheyenne River is highly meandering, with a gradient of approximately 0.8 to 1.1 feet per mile (0.01% to 0.02%) upstream of the confluence with the Maple River. The river gradient steepens somewhat near the confluence with the Maple (to about 2.8 feet per mile or 0.05%), then returns to its previous range for the rest of the distance to the Red River.

Within the study area, the Sheyenne River includes the Horace/West Fargo Diversion which is a significant diversion project. This diversion channel routes a portion of the Sheyenne River water around Horace and areas of West Fargo during high flow conditions. Farther downstream, the West Fargo/Riverside Diversion channel routes additional flow around West Fargo and Riverside. Under the highest flow conditions all of the flow in the Sheyenne River is transferred to this diversion channel and direct flow down the main stem of the Sheyenne River is stopped entirely. The combined diversion channel rejoins the main stem of the Sheyenne River near the confluence with the Maple River.

The Maple River enters the lake plain near Leonard, ND and flows northwest for approximately 68 miles before joining the Sheyenne River near Riverside, ND. Like the other rivers, the gradient of the Maple River in the study area is extremely flat at approximately 0.7 feet per mile (0.01%).

All three tributaries have existing low-head dams within the study area, with additional dams further upstream.

4.2.1.2.3 Sediment Transport Characteristics

Historical sediment data from the USGS was reviewed for the Red River and several of its tributaries. In addition, USACE contracted with the USGS to determine sediment concentrations, loads, and particle size distributions at six sites in the Red River and its tributaries during the spring high flow of 2010 (Blanchard et al. 2010). Sampling began on March 24, 2010 and the last measurement was taken on April 7, 2010.

Sediment transport in the Red River is dominated by the movement of suspended fine material. This suspended material is well-distributed throughout the vertical water column and is transported through the study area with minimal interaction with the stream bed. Data from 2010 also suggest the sediment load in the Red River through the cities of Fargo and Moorhead is neither increasing or decreasing. The Red River does not appear to be gaining sediment (via erosion) or losing sediment (via aggradation) over this reach. This corroborates the description of the Red River as a stable riverine system, with sediment loading from fine suspended material that is primarily washed through the system.

Similarly, observations from the Maple, Sheyenne and Wild Rice rivers suggest the sediment load carried by these tributaries in the study area is overwhelmingly fine suspended material, which is likely transported long distances from its origin in overland and bank erosion. Some of this material may settle to the bed of the river during periods of lower river velocity, but typical high flows are likely sufficient to re-suspend any settled material, leading to minimal net change in channel dimensions over time.

Specifically for the Horace/West Fargo Diversion on the Sheyenne River, data indicate that the sediment load carried by the Sheyenne River and the Horace/West Fargo Diversion is primarily fine material. The sediment load data for the diversion channel indicate that the suspended material is diverted from the main Sheyenne River in proportion to the flow diversion, and with similar timing. The diversion channel, however, carries relatively less bedload sediment, indicating that the coarser bedload material may be preferentially retained in the Sheyenne River and presumably transported into the protected areas of Horace and West Fargo.

4.2.1.2.4 Bank Stability

Bank stability and failure is a frequent issue on rivers and streams of the Red River valley. This is largely due to soil conditions that result in poor strength of the bank. The stability of the bank is largely dependent on the elevation of the Red River, with stability typically decreasing as river elevation decreases. Slides often occur during low water conditions, particularly during droughts.

The scarps from riverbank slides are typically located on the flat or gently sloped portions between the primary bank and the secondary bank. Often, the slides progress up slope, away from the river, thereby leading to a hummocky appearance between the tops of the primary and secondary banks. The slides may extend for several hundred feet along the river bank.

Slides in the Red River Valley are most typically found on the outside of river bends. These slides are likely initiated, in part, by the scouring action of the river on the toe of the primary or lower river bank. In addition to slides in the upper or secondary bank, smaller scale sloughing of the lower river bank is frequently observed.

4.2.1.3 Air Quality
The United States Environmental Protection Agency (USEPA) has established primary and secondary National Ambient Air Quality Standards (NAAQS) under the provisions of the Clean Air Act (CAA). The CAA not only established the NAAQS, but also set emission limits for certain air pollutants from specific sources, set new source performance standards based on best demonstrated technologies, and established national emissions standards for hazardous air pollutants.

The USEPA classifies the air quality within an air quality control region according to whether the region meets or exceeds Federal primary and secondary NAAQS. Primary standards define levels of air quality necessary to protect public health with an adequate margin of safety. Secondary standards define levels of air quality necessary to protect public welfare (i.e., soils, vegetation, and wildlife) from any known or anticipated adverse effects of a pollutant. Federal NAAQS are currently established for seven pollutants (known as “criteria pollutants”); including carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), particulate matter equal to or less than 10 micrometers in aerodynamic diameter (PM_{10}), and very fine particulate matter ($PM_{2.5}$).

The Fargo-Moorhead area is considered a NAAQS Attainment Area for all air quality parameters (USEPA 2009). This indicates existing concentrations of air pollutants are below the established standard(s) and limited increases in emissions are allowable. Therefore, the General Conformity Rule under the CAA does not apply.

The North Dakota air quality standards are the same as those established by the USEPA, except for a more restrictive sulfur dioxide level. North Dakota’s Air Quality Program includes a Fugitive Dust Control Regulation, Chapter 33-15-17 which is primarily complaint driven (North Dakota Department of Health 2009; Bachman 2009). Cass County, North Dakota’s Dust Control Guidelines pertain to dust control on county or local roads (Cass County Highway Department 2004). Fargo has a Nuisance Ordinance that includes the generation of fugitive dust. However, no particulate values are included in the ordinance. Implementation of the ordinance is complaint driven. If complaints are received, the City works with parties involved to resolve the issue. The ordinance is interpreted more loosely for construction related dust issues (Shocker 2009).

The Minnesota air quality standards are the same as those established by the CAA, except for more restrictive levels of Sulfur Dioxide, Small Particulates and Lead. Clay County, Minnesota does not have a specific air quality regulation or fugitive dust ordinance. Fugitive dust is regulated under permits issued when doing construction/development. Fugitive dust issues are also addressed on a complaint basis. If a fugitive dust problem is identified, the County would work with the contractor to remedy the situation (Magnusson 2009)

4.2.1.4 Water Quality

Water quality in the Red River of the North main stem is generally impaired from Breckenridge, MN down to the Marsh River confluence near Shelly, MN in Norman County, a distance of approximately 191 river miles. Point and non-point sources of pollution result in high pH, fecal coliform, nutrients, biochemical oxygen demand (BOD), suspended solids, turbidity and conductivity resulting in non-support of aquatic life and overall use, and partial support of swimming, agriculture, and wildlife uses. From the Marsh River confluence downstream, the general water quality improves to threatened, with the exception of two segments, just upstream from Grand Forks, ND-East Grand Forks, MN and near Pembina, ND-St. Vincent, MN, where water quality is impaired. Cropland use, feedlots, livestock holding facilities, agricultural chemicals, urban runoff, septic systems, channelization, dredging, streambank modification, landfills, and dams contribute to oxygen depletion, eutrophication, bacterial contamination, sedimentation, toxicity from pesticides, turbidity, and habitat alteration on the Red River.

4.2.1.4.1 Red River at Fargo

Many constituent concentrations downstream of Fargo have exceeded water quality guidelines, standards and criteria. The maximum sulfate concentration of 303 mg/L was greater than the 250 mg/L EPA (2005b) secondary drinking water standard. Other exceedances, including cadmium, copper, lead, and selenium concentrations, generally occurred during the 1970s or earlier. These exceedances could be attributed to natural occurrences, pollution or sample contamination. Tornes (2005) used available data from July, 1969 to September, 1994 to obtain median values for TDS, sulfate, chloride and sodium downstream of Fargo of 356, 69, 11 and 20 mg/L, respectively. Also, a pH median value of 8.1 was identified.

Section 1.3 of Appendix F, Environmental, contains a Water Quality Spreadsheet which summarizes data provided by the Minnesota Pollution Control Agency (MPCA) load monitoring site. This site is located near Clay County Highway 26 at the Red River; about 7 miles north of Moorhead and 2 miles east of Harwood, ND. The field data were collected with an YSI multi-parameter sonde. Other samples were collected via a mid-stream mid-depth single grab with a Van Dorn type sampler and analyzed using USEPA approved lab methods.

Minnesota Pollution Control Agency classifies the reach of the Red River through the study area as Class 1C for domestic consumption; 2Bd for aquatic life and recreation; and 3C for industrial use (State of Minnesota 2009). Class 1C waters are such that with treatment consisting of coagulation, sedimentation, filtration, storage and chlorination, or other equivalent treatment processes, the treated water will meet both the primary (maximum contaminant levels) and secondary drinking water standards issued by the USEPA. Class 2Bd waters are such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life and their habitats. These waters are suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface waters is also protected as a source of drinking water. Class 3C waters are such as to permit their use for industrial cooling and materials transport without a high degree of treatment being necessary to avoid severe fouling, corrosion, scaling or other unsatisfactory conditions.

Future water quality in the Red River would be expected to improve slightly due to more stringent environmental laws and several ongoing initiatives in the area. The Red River Basin Commission has been working with the local soil and water conservation districts, watershed districts and Pheasants Forever on the Red River Basin Buffer initiative. Goals of this are to demonstrate a process for restoring strategically targeted riparian buffers within a small watershed so the process can be duplicated throughout the Red River Basin. This project will also demonstrate the water quality benefits to these restorations. Measurable goals include establishing buffers, restoring prescribed wetlands within the watersheds, reducing sediment concentrations/loads at stream sites, reducing total phosphorus concentrations/loads at stream sites and educating the public about benefits of buffers to promote their implementation.

4.2.1.4.2 North Dakota Tributaries

Based on the North Dakota State stream classification system the Sheyenne River is a Class IA, the Maple River and Wild Rice River are Class II, and the Rush River (upper and lower) are Class III. Class I waters are such that the quality of the waters is suitable for the propagation or protection, or both, of resident fish species and other aquatic biota and for swimming, boating and other water recreation. The quality of the waters is suitable for irrigation, stock watering and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, chlorination, or equivalent treatment processes, the water quality would meet the bacteriological, physical and chemical requirements of the department for municipal or domestic use. Class IA are such that the quality of the waters is the same as the quality of Class I streams, except that treatment for municipal use may also require softening to meet the drinking water requirements of the North Dakota Department of Health. Class II waters are such that the quality of the waters is the same as the quality of Class I streams, except that additional treatment may be required to meet the drinking water requirements of the Department. Streams in this classification may be intermittent in nature, which would make these waters of limited value for beneficial uses such as municipal water, fish life, irrigation, bathing, or swimming. Class III waters are such that the quality of the waters is suitable for agricultural and industrial uses. Streams in this class generally have low average flows with prolonged periods of no flow. During periods of no flow, they are of limited value for recreation, and fish and aquatic biota. The quality of these waters must be maintained to protect secondary contact recreation uses (e.g., wading), fish and aquatic biota, and wildlife uses.

4.2.1.5 Water Quantity

Existing and future without project hydrologic and hydraulic conditions are discussed in Chapter 2.

The Red River is a meandering river that begins where the Otter Tail River and Bois de Sioux River join at Wahpeton, ND, and Breckenridge, MN. The Red River has 548 river miles of which 394 are in the United States. Parts of South Dakota, North Dakota, and Minnesota are drained by the Red River.

The Red River is unusual for the northern plains because it flows northward through the center of an ancient lakebed, glacial Lake Agassiz. The remnant lakebed has extremely flat topography, a feature that characterizes the Red River Valley. The valley covers a strip of land about 35 miles wide on either side of the Red River in North Dakota and Minnesota. The Red River Valley is part of the larger Red River Basin.

The Red River receives most of its flow from its eastern tributaries because of regional patterns in precipitation, evapotranspiration, soils and topography. The Red River Valley has a sub-humid to humid climate with an average annual precipitation of about 19.5 inches. Major tributaries entering the Red River in the United States include the Sheyenne River, Red Lake River and Otter Tail River.

Most of the annual precipitation and annual evaporation occurs from April through September. As a result, most of the time precipitation is absorbed in the soil and transpired or evaporated back to the atmosphere and very little results in runoff or groundwater recharge. Most runoff is in the early spring when snowmelt and precipitation generally exceed evapotranspiration (Sloan 1972). Thus, maximum flow occurs in the spring, decreases throughout the summer and fall, and is lowest during the winter months.

Currently, there are several lowhead dams along the Red River that pool water for Municipal, Rural & Industrial (MR&I) intakes during times of low flow. A lowhead dam is a dam of low height, usually less than 15 feet, that extends from bank to bank across a stream channel. Lowhead dams are located on the river at Wahpeton, Wolverton, Hickson, Fargo, Grand Forks-East Grand Forks and Drayton, ND. Some of the dams have been modified for safety reasons and to allow fish passage (MNDNR and North Dakota Game and Fish Department 1996).

The Red River is the primary source of water for municipal, industrial, and irrigation purposes in the Red River Valley. It is the principal water supply for cities such as Moorhead, MN, and Fargo, Grand Forks, Grafton, and Drayton, ND, among others.

The Sheyenne River is a major tributary to the Red River of the North. The river begins north of McClusky, ND and meanders eastward before turning south near McVille. The southerly flow continues through Griggs and Barnes counties before turning northeast near Lisbon. The river forms Lake Ashtabula behind the Baldhill Dam north of Valley City. From Lisbon, the river crosses the Sheyenne National Grassland before entering into Cass County near the city of Kindred. From Kindred, the river flows northeastward through the Red River Valley and into the Red River North at Fargo. The Sheyenne River flows are regulated by dams that form Lake Ashtabula and several smaller reservoirs. These dams provide flood control and can be used to supplement downstream discharge during low flow (USGS 2011).

The Wild Rice River is a tributary of the Red River; it is an approximately 240 mile long river starting as an intermittent stream near Brampton Township approximately 6 miles south of

Cogswell ND. It flows eastward to Great Bend, then turns north near Wahpeton where it parallels the Red River in a winding channel approximately 5-7 miles from the Red. It flows into the Red River approximately seven miles south of Fargo.

The Maple River is a tributary of the Sheyenne River; it is an approximately 100 mile long river beginning as an intermittent stream near the town of Finley, flowing southward to Enderlin where it turns to the northeast flowing past Mapleton, flowing into the Sheyenne River approximately 5 miles north of West Fargo not far from the confluence of the Sheyenne and Red River.

Figure 41 through Figure 44 illustrate flood inundation throughout the study area by event. Impacts to acres and existing structures are discussed in section 4.2.3 Socioeconomic Resources.

Figure 41 – 10-Percent Chance Flood – Existing Conditions

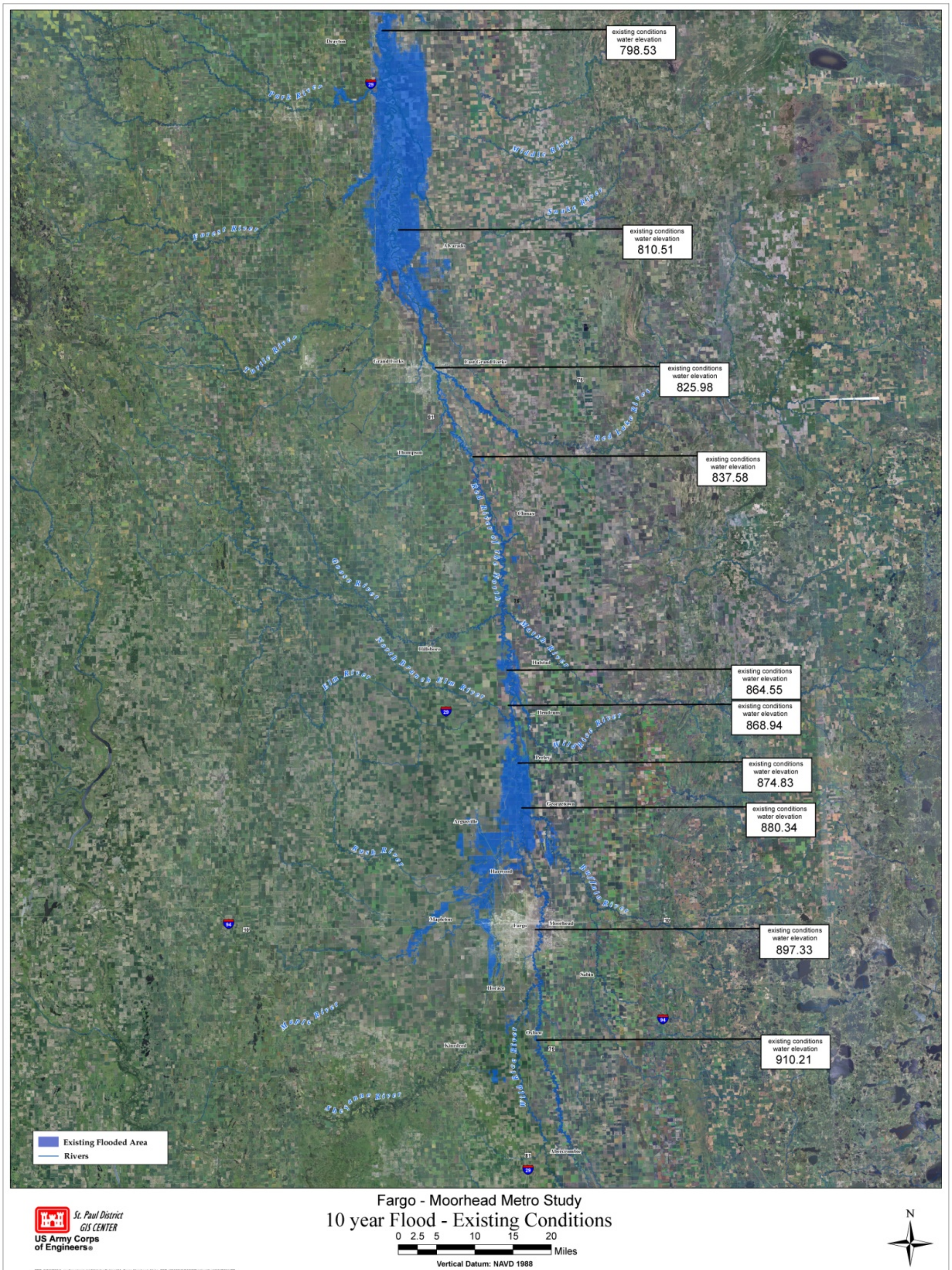


Figure 42 – 2-Percent Chance Flood – Existing Conditions

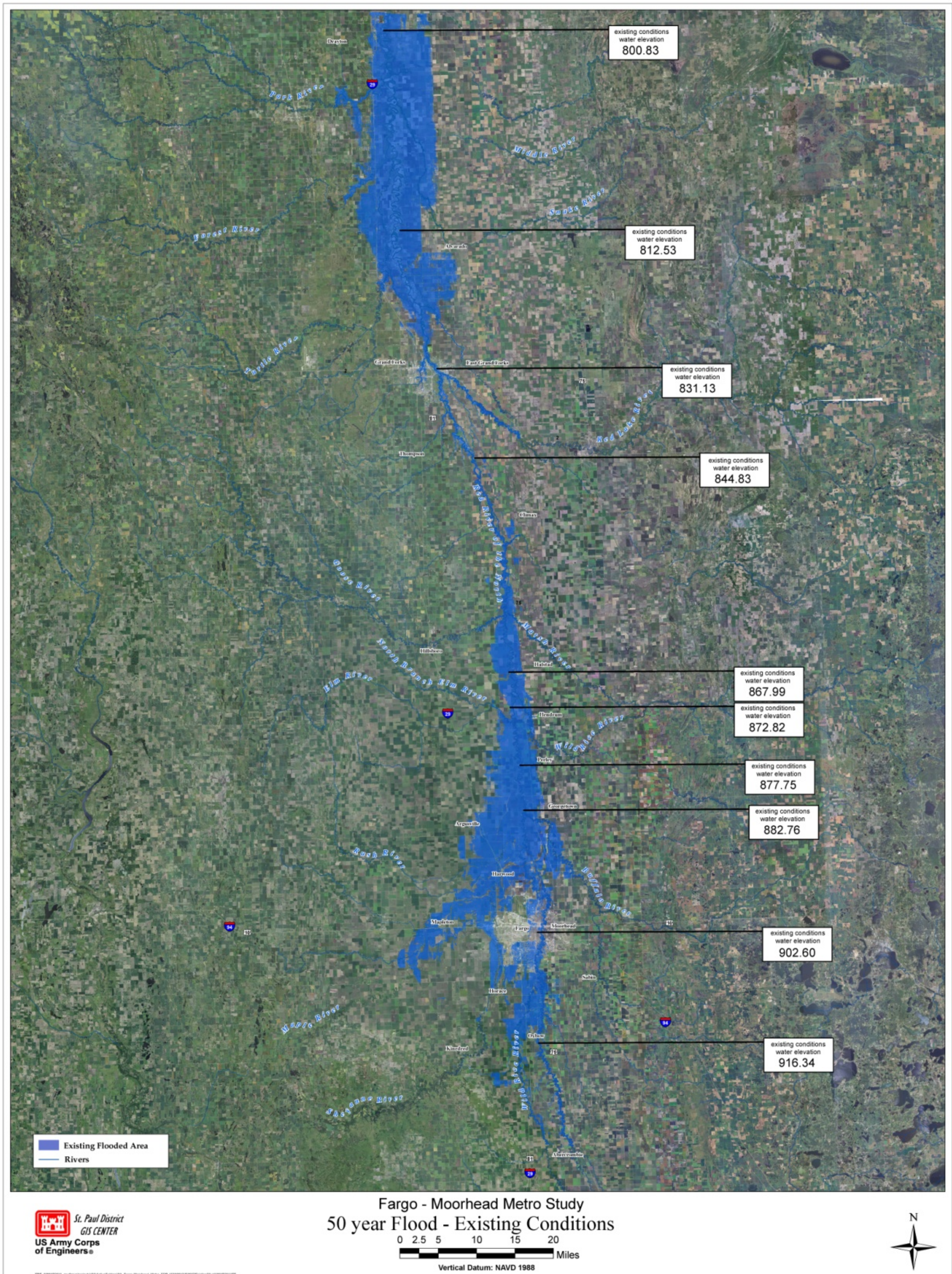


Figure 43 – 1-Percent Chance Flood – Existing Conditions

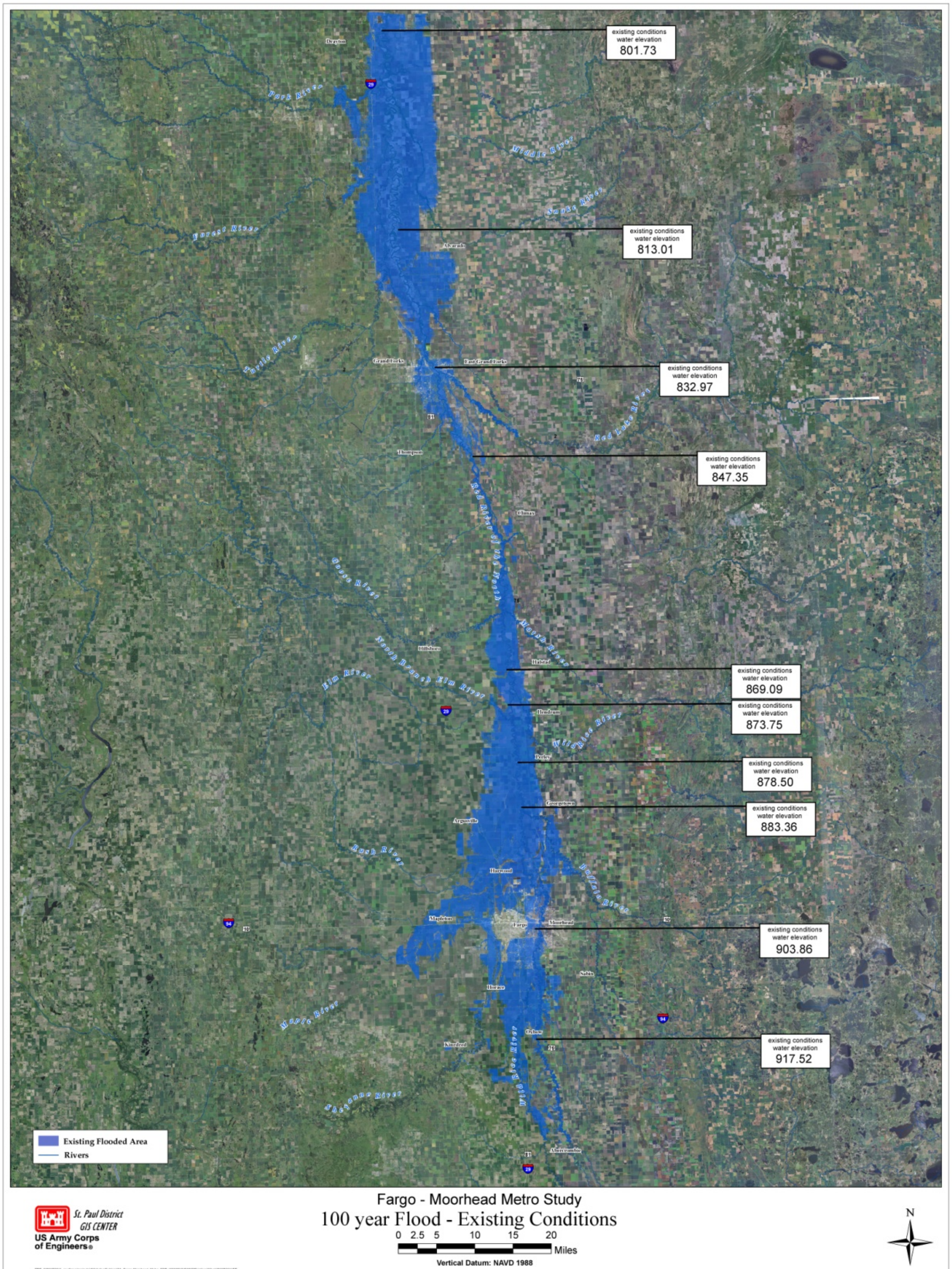
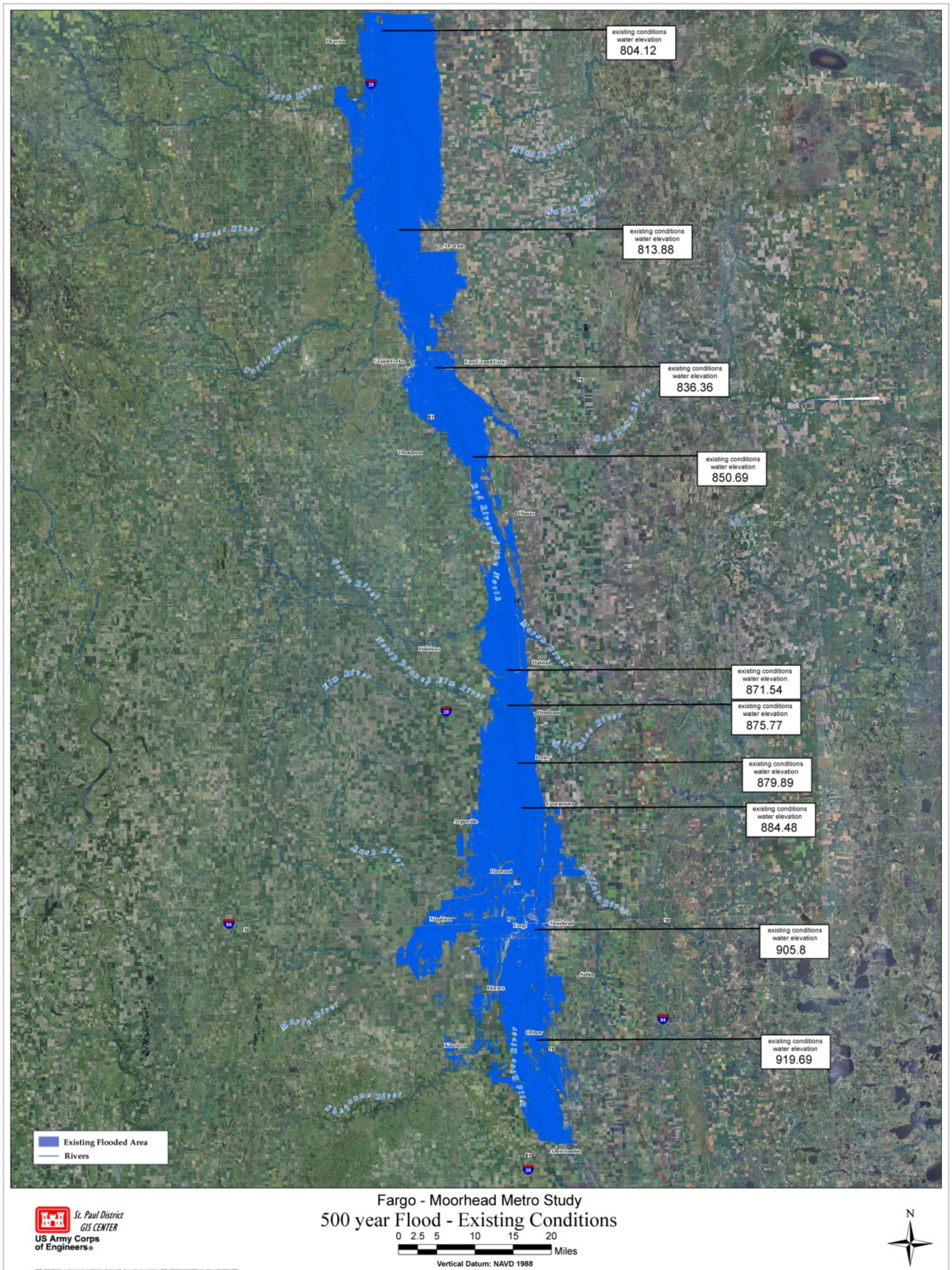


Figure 44 – 0.2-Percent Chance Flood – Existing Conditions



4.2.1.6 Shallow Ground Water

Borings have been conducted to delineate the stratigraphy, and for conducting laboratory testing of the soils necessary to define the physical parameters of the subsurface geology. Vibrating wire piezometers with automated data-loggers have been installed, straddling the proposed alignments east of Dilworth, MN (FCP) and west of Fargo, ND (ND35K and LPP). Piezometers are used to record subsurface groundwater levels, and this information is used to better understand the groundwater regime in the vicinity of the proposed diversion alignments. The piezometers are located in lower, middle and upper elevations and/or sandy layers encountered to further understand the ground water regime. Nested piezometers with data-loggers may also being placed at proposed structure locations. Once a more precise alignment is selected additional subsurface information will be needed for inclusion into the plans and specifications for project construction.

The Corps has obtained a 3-Dimensional geological model compiled by the Minnesota Geological Survey in 2005. The model used existing well and subsurface data to map the groundwater bearing deposits within the study area. The Corps is utilizing this geological data in an effort to locate potential shallow groundwater potential relative to the FCP, LPP, and ND35K diversion alignments. Additional subsurface investigations are also being used to help identify the presence, location, and limits of any smaller scale shallow ground water along the alignments.

4.2.1.7 Aquifers

For the FCP alignment the Buffalo Aquifer was identified as a planning constraint early in the feasibility study. Water usage from the aquifer has declined in recent years but is still tapped for individual, irrigation, and municipal water wells. The Buffalo Aquifer may be characterized as a north-south trending, complex, heterogeneous outwash deposit composed of primarily of sand and gravel placed during the last glacial epoch (Figure 45). Studies have shown that along its east-west boundaries the Buffalo aquifer becomes increasingly fine-grained and can include silt and clay beds. Located five to seven miles east of Moorhead, the deposit is interpreted to have been formed in a tunnel valley by glacial meltwater exiting the southern end, or snout, of a glacier. The exiting meltwater was under pressure and occurred in multiple events which are indicated by the vertical and horizontal meandering of the deposit. In Clay County the Buffalo Aquifer is 1 to 2 miles wide, and up to 250-feet thick. The top of the aquifer is at, or very near, ground surface adjacent to the Buffalo River but is buried in glacial lake clays along diversion alignments proposed to date.

The Buffalo River, located approximately 5-miles east of Moorhead, runs parallel to and along the east side of the aquifer and contributes significant recharge, especially in the northern reach of the aquifer near the city of Moorhead’s north well field. Regional aquifer flow in the clayey lake plain soils adjacent is generally westward or toward the Red River of the North; variations due to local hydrology, such as over-pumping, drought conditions, and adjacent wetlands can alter local groundwater flow directions.

In 1994 the city of Moorhead opened a new water treatment plant and began taking more water from the Red River of the North. Water levels in the aquifer have risen approximately 15-feet in the succeeding 10 years. Over the last 30 years, many studies have been conducted on the Buffalo Aquifer and additional groundwater management initiatives and studies are ongoing.

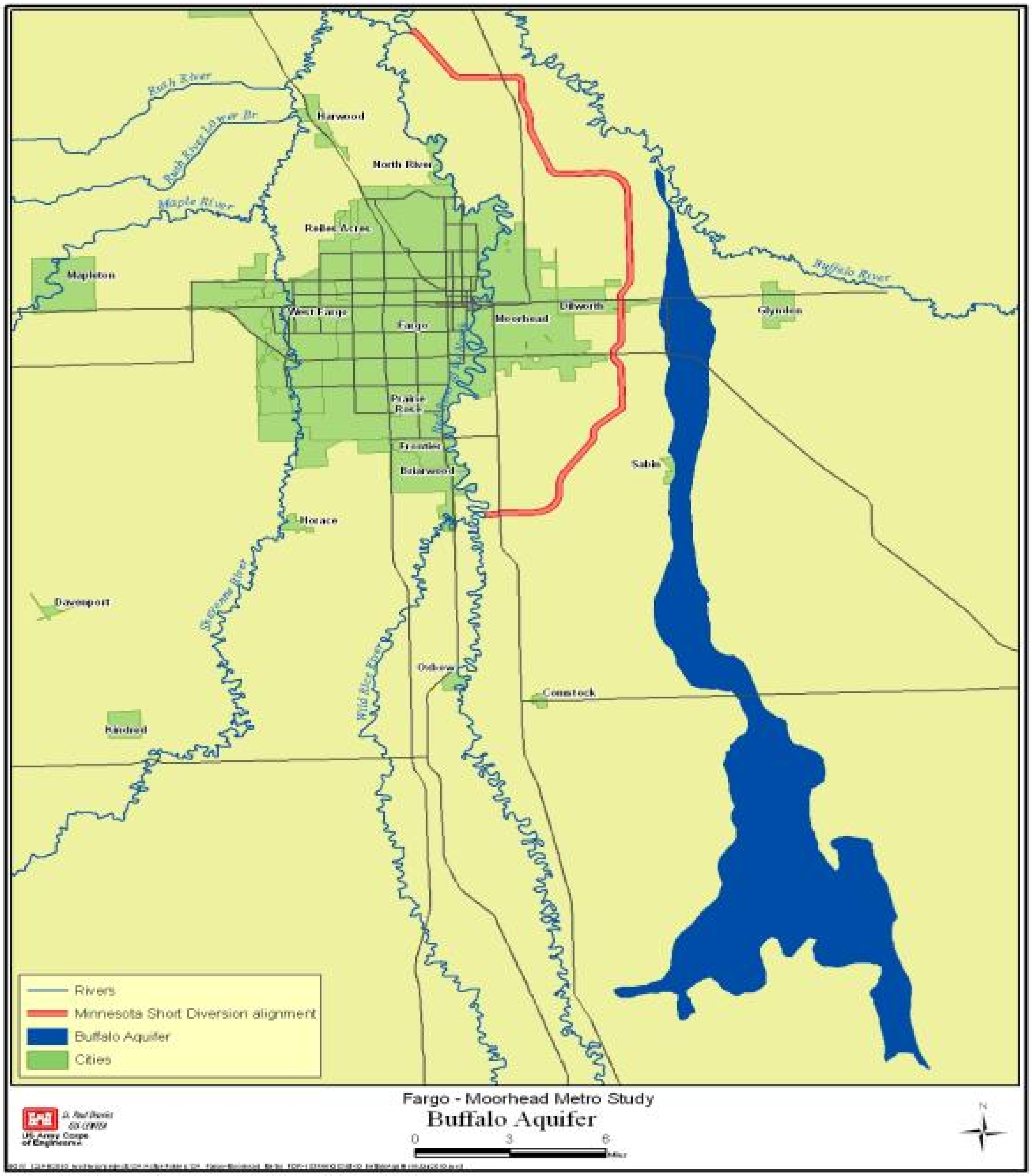
For the North Dakota alignment alternatives (LPP and ND35K) the West Fargo Aquifer is the primary water source of concern. It is possible to divide the West Fargo Aquifer into several separate sub-units but, for the purposes of this report, it shall be treated as one. Water from the aquifer is tapped for individual, irrigation, and municipal water wells. The West Fargo Aquifer is a buried glacio-fluvial deposit placed during the last glacial epoch that extends generally in a north-south direction for about 30 miles in Cass County. The modern day Sheyenne River traverses the same general trend of the West Fargo Aquifer from about 6 miles south of Horace, ND to about 2 miles south of Argusville, ND. The aquifer ranges in width from about 2 ½ to 8-miles and underlies an area of approximately 110 miles. Typically the aquifer is overlain by deposits of glacial till and glacio-lacustrine lake clay at depths of approximately 70 to 170 feet below ground surface. The aquifer is composed of material ranging in size from fine sand to boulders but is primarily fine to medium sand. In places these coarse grained deposits may be interbedded with silt or clay, especially near the top of the aquifer. The deposit is interpreted to have been formed in a tunnel valley by glacial meltwater exiting the southern end, or snout, of a glacier, in the same manner as the Buffalo aquifer.

Recharge to the West Fargo Aquifer probably occurs primarily through lateral movement of water through the till and associated deposits and by downward percolation of shallow groundwater through the glacio-lacustrine deposits. Due to the relatively tight nature of the surrounding soils it is likely that the recharge rate of the aquifer is not able to keep pace with the withdrawal rate and this is reflected in declining water levels. Regional aquifer flow appears to be influenced by areas of heavy pumping but generally the piezometric surface slopes from east to west. The average depth of the water level in the West Fargo Aquifer is not defined but it is known that the decline is such that unconfined (non-artesian) conditions now exist.

The city of West Fargo draws its municipal water supply entirely from 8 production wells located in the West Fargo Aquifer. Until alternate water sources are located it is reasonable to assume that water levels will continue to decline in the aquifer.

Other, unnamed aquifers occur at various depths within the tills and glacio-lacustrine clays adjacent to the diversion alignments. These buried aquifers may generally be characterized as elongate, discontinuous, lenses composed primarily of sand and gravel. Accurately locating and delineating these aquifers is difficult due to their scattered nature and relatively small aerial extent. On-going studies by the Corps of Engineers and others will aid in better defining these types of aquifers.

Figure 45 – Buffalo Aquifer



4.2.1.8 Fisheries and Aquatic Habitat

Areas potentially affected directly by the proposed action include the Red River of the North and adjacent tributaries around Fargo-Moorhead. These include the Wild Rice, Sheyenne, Maple, Rush and Lower Rush rivers in North Dakota. The Lower Rush is intermittent and typically does not have flow year-round, but for the purpose of this EIS will be considered one of five tributaries that could provide fisheries habitat. The project also could affect other small intermittent tributaries and drainage ditches in North Dakota. However, these likely provide limited, if any, aquatic habitat value. In Minnesota, the Buffalo River is a significant tributary located in the study area. However, the Buffalo River and other tributaries in Minnesota will not be directly impacted by the proposed action.

4.2.1.8.1 Fish Communities

The Red River is a warm water system that is dominated by turbid conditions during the open-water months. Its habitat consists largely of a main channel, with little to no side-channels, islands or backwaters. The vast majority of the habitat for the Red River would be considered "pool" or "run" habitat. Little submerged aquatic plant growth occurs due to the river's turbid conditions. Fallen trees, log jams and snags provide important physical habitat for Red River fishes.

Aadland et al (2005) performed an extensive review of literature and historical fisheries surveys for the Red River basin. Their observations provide a valuable reference for historical and existing conditions for fisheries resources in the Red River Basin. Aadland et al (2005) reported 57 fish species were identified in the Red River mainstem for surveys conducted from 1962 thru 2000 (Table 30). By comparison, the Sheyenne River had a similar number of fish species collected (56). However, the Wild Rice (23), Maple (30) and Rush (22) rivers had fewer species observed (Table 30).

The Red River is known as perhaps the best trophy catfish channel fishery in the world. Other important sportfish include walleye and sauger. Goldeye are abundant in the Red River and appear to be an important forage base for channel catfish and potentially other species. Common species to the Red River include members of the Cyprinid (minnow) and Catastomid (sucker) families.

Lake sturgeon is a species that was historically found in the Red River Basin, but until recently were extirpated from the watershed. Aadland et al. (2005) recounts the history of the lake sturgeon within the basin. Though the species was found periodically until the 1950s, it was likely extirpated from much of the basin by the early 1900s. Likely factors for extirpation include overharvest, habitat destruction and fragmentation. In 1997, the Minnesota DNR and White Earth Indian Nation began a 20-year program to reintroduce lake sturgeon to the basin. The program calls for the annual release of 34,000 fingerling and 600,000 lake sturgeon fry in key sub-basins of the Red River watershed. Habitat enhancement and improved habitat connectivity are likely key factors on the long-term success of this reintroduction program.

The river darter also seems to have been extirpated from the Red River mainstem. Several other species have been extirpated from various tributaries but still occur elsewhere in the watershed.

To date, there has been a relatively minimal influx of invasive aquatic species to the Red River Basin. The common carp is the most widely established invasive. Several species have been stocked outside their native range, including white bass and white crappie.

Table 30 includes information on the Fish Species Observed in the Red River Basin between 1962 and 2000. “X” indicates a species presence. “E” indicates species extirpated from the indicated waterbody. No mark represents a species within the Red River Basin, but not found in the indicated waterbody. Source: Aadland et al. 2005.

Table 30 – Fish Species Observed in the Red River Basin. Source: Aadland et al. 2005.

Taxon								
Petromyzontidae	**Scientific Name**	**Common name**	**N or I[1]**	**Red**	**Wild Rice**	**Sheyenne**	**Maple**	**Rush**
	Ichthyomyson castaneus	chestnut lamprey	N	X				
	Ichthyomyson unicuspis	silver lamprey	N	X				
Acipenseridae								
	Acipenser fulvescens[2]	lake sturgeon	N	E				
Lepisosteidae								
	Lepistoseus osseus[2]	longnose gar	N					
Amiidae								
	Amia calva	bowfin	N					
Hiodontidae								
	Hiodon alosoides	goldeneye	N	X		X		
	Hiodon tergisus	mooneye	N	X		X		
Salmonidae								
	Coregonus artedii	ciscoe	N					
	Coregonus clupeaformis	whitefish	N	X				
	Oncorhynchus mykiss	rainbow trout	I			X		
	Salmo trutta	brown trout	I					
	Salvelinus fontinalis	brook trout	I					
	Salvelinus namaycush	lake trout	I					
Catostomidae								
	Carpiodes cyprinus	quillback carpsucker	N	X		X	X	X
	Catostomus commersonii	white sucker	N	X	X	X	X	X
	Hypentelium nigricans	northern hog sucker	N					
	Ictiobus bubalus	smallmouth buffalo	N					
	Ictiobus cyprinellus	bigmouth buffalo	N	X	X	X	X	
	Moxostoma anisurum	silver redhorse	N	X	X	X		
	Moxostoma erythrurum	golden redhorse	N	X		X		
	Moxostoma macrolepidotum	shorthead redhorse	N	X	X	X	X	
	Moxostoma valenciennesi	greater redhorse	N	X		X	X	
Cyprinidae								
	Campostoma anomalum	central stoneroller	N					
	Campostoma oligolepis	largescale stoneroller	N					
	Carassius auratus	goldfish	I	X				
	Cyprinella spiloptera	spotfin shiner	N	X	X	X	X	X
	Cyprinus carpio	common carp	I	X	X	X	X	X
	Hybognathus hankinsoni	brassy minnow	N			X	X	
	Luxilus cornutus	common shiner	N	X		X	X	X
	Macrhybopsis storeriana	silver chub	N	X		X		

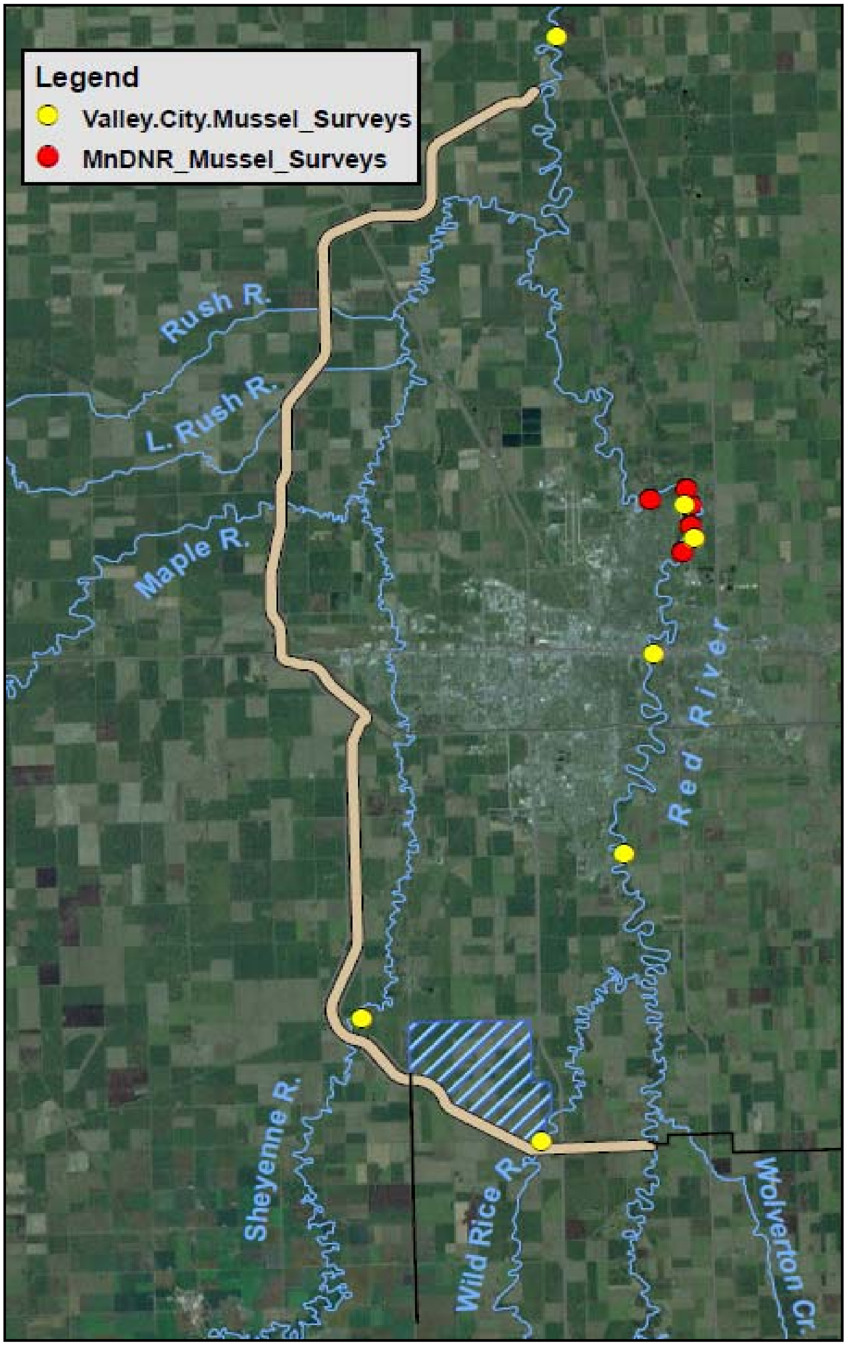
	Margariscus margarita	pearl dace	N					
	Nocomis biguttatus	hornyhead chub	N	X		E	E	
	Notemigonus chrysoleucas	golden shiner	N	X		X		
	Notropis anogenus	pugnose shiner	N			E		
	Notropis atherinoides	emerald shiner	N	X		X	X	X
	Notropis blennius	river shiner	N	X	X	X	X	X
	Notropis dorsalis	bigmouth shiner	N	X		X	X	X
	Notropis heterodon	blackchin shiner	N			X		
	Notropis heterolepis	blacknose shiner	N			X		
	Notropis hudsonius	spottail shiner	N	X		X		
	Notropis percobromus	carmine shiner	N			X		
	Notropis rubellus	rosyface shiner	N					
	Notropis stramineus	sand shiner	N	X		X	X	
	Notropis texanus	weed shiner	N					
	Notropis volucellus	mimic shiner	N					
	Phoxinus eos	northern redbelly dace	N			X		X
	Phoxinus neogaeus	finescale dace	N					
	Pimephales notatus	bluntnose minnow	N	X		X	X	X
	Pimephales promelas	fathead minnow	N	X	X	X	X	X
	Platygobio gracilis	flathead chub	I	X				
	Rhinichthys atratulus	blacknose dace	N					
	Rhinichthys cataractae	longnose dace	N	X		X		
	Rhinichthys obtusus	western blacknose dace	N			X	X	
	Semotilus atromaculatus	creek chub	N	X		X	X	X
Ictaluridae								
	Ameiurus melas	black bullhead	N	X	X	X	X	X
	Ameiurus natalis	yellow bullhead	N	X				
	Ameiurus nebulosus	brown bullhead	N	X		X		
	Ictalurus punctatus	channel catfish	N	X	X	X	X	X
	Noturus flavus	stonecat	N	X		X		
	Noturus gyrinus	tadpole madtom	N	X	X	X	X	
Umbridae								
	Umbra limi	central mudminnow	N	X				
Esocidae								
	Esox lucius	northern pike	N	X	X	X	X	X
	Esox masquinongy	muskellunge	I			X		
Osmeridae								
	Osmerus mordax	rainbow smelt	N	X				
Cyprinodontidae								
	Fundulus diaphanus	banded killfish	N	X		E		
Gadidae								
	Lota lota	burbot	N	X				
Percopsidae								
	Percopsis omiscomaycus	trout-perch	N	X	X	X	X	X
Moronidae								
	Morone chrysops	white bass	I	X		X		
Centrarchidae								

	Ambloplites rupestris	rock bass	N	X	X	X		
	Lepomis cyanellus	green sunfish	N	X		X	X	
	Lepomis gibbosus	pumpkinseed	N		X	X		
	Lepomis humilis	orangespotted sunfish	N	X		X		
	Lepomis macrochirus	bluegill	N	X		X		
	Micropterus dolomieu	smallmouth bass	N	X		X		
	Micropterus salmoides	largemouth bass	N			X		
	Pomoxis annularis	white crappie	N	X		X	X	
	Pomoxis nigromaculatus	black crappie	N	X	X	X	X	
Percidae									
	Etheostoma caeruleum	rainbow darter	N					
	Etheostoma exile	Iowa darter	N		X	X	X	X
	Etheostoma microperca	least darter	N					
	Etheostoma nigrum	johnny darter	N	X	X	X	X	
	Perca flavescens	yellow perch	N	X	X	X		
	Percina caprodes	logperch	N	X				
	Percina maculata	blackside darter	N	X	X	X	X	X
	Percina shumardi	river darter	N	E		E		
	Sander canadensis	sauger	N	X		X	X	X
	Sander vitreus	walleye	N	X	X	X		X
Scianidae									
	Aplodinotus grunniens	freshwater drum	N	X	X	X		X
Cottidae									
	Cottus bairdi	mottled sculpin	N					
	Cottus cognatus	slimy sculpin	N					
	Cottus ricei	spoonhead sculpin	N					
Gasterosteidae									
	Culaea inconstans	brook stickleback	N		X	X	X	X
	Pungitius pungitius	ninespine stickleback	N					
[1] Species that are native (N) or introduced (I) to the Red River Basin.									
[2] Species which are known only from historical records and most likely no longer exist in the Red River basin.									

4.2.1.8.2 Mussel Communities

The Red River and its tributaries also contain communities of freshwater mussels. Surveys performed recently in the study area provide insight into mussel resources (Figure 46). Mussel sampling from the Red River in the study area was dominated by threeridge, pocketbook and pink heelsplitter (MnDNR Data; Valley City State University Data). Relative abundance and diversity could be considered low to moderate. Surveys by MnDNR had a Catch-Per-Unit-Effort of 40 to 94 mussels per hour of qualitative dive surveys, with three to six species collected per site. Special status species observed included Wabash pigtoe (ND), black sandshell (ND and MN) and mapleleaf (ND).

Figure 46 – Location of Recent Mussel Surveys



Mussel sampling also was recently performed on the Wild Rice and Sheyenne rivers (Figure 46; Valley City State University Data). Observations on the Wild Rice found only 11 mussels in 120 minutes of qualitative wading surveys. This included five species, with black sandshell most abundant. Observations on the Sheyenne River near the proposed diversion alignment found 56 mussels (nine different species) with the same search effort. The two most dominant species included three ridge and black sandshell. Wabash pigtoe and mapleleaf also were collected from the Sheyenne River site.

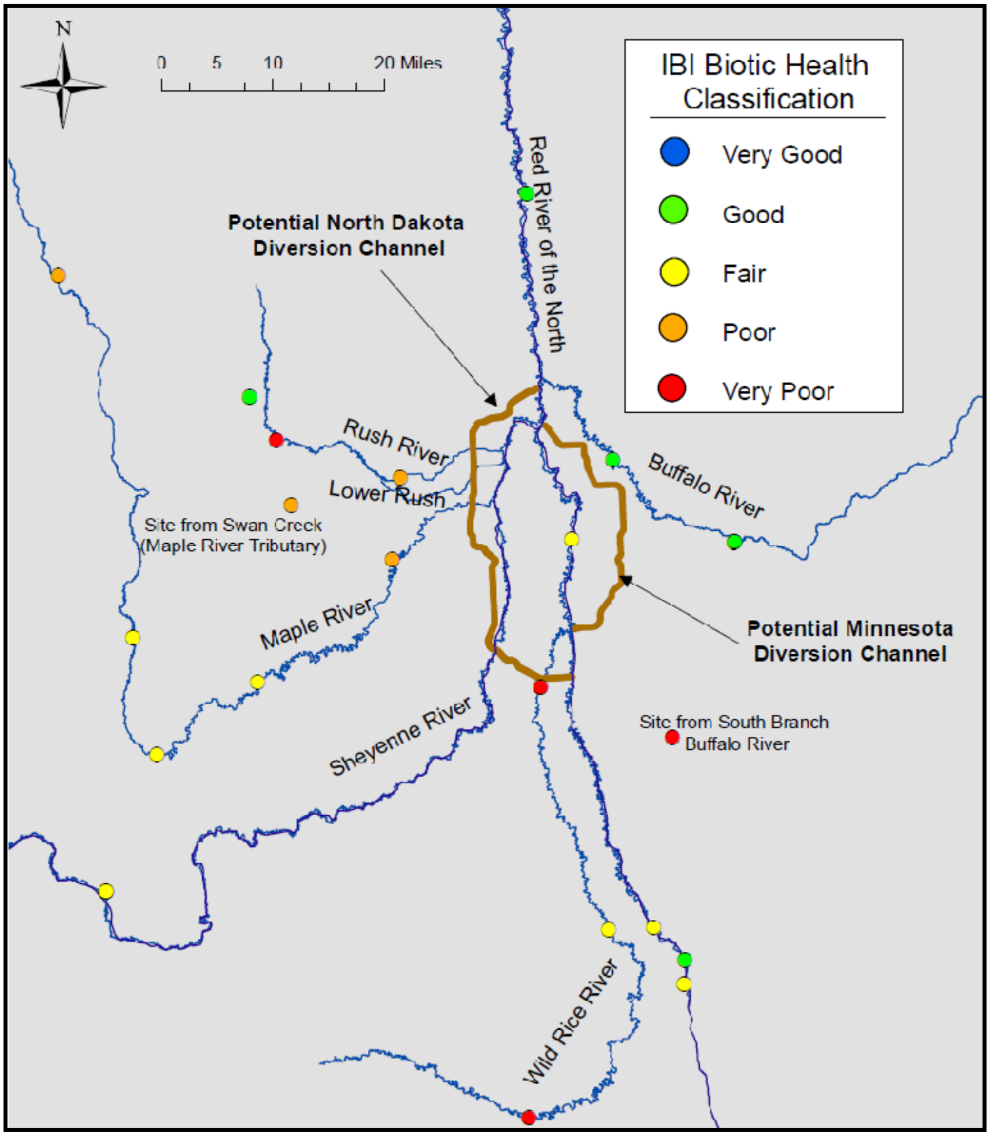
4.2.1.8.3 Habitat Quality and Biotic Integrity

Previous studies have characterized the biotic health of the Red River and select tributaries, including Index of Biotic Integrity (IBI) studies of fish and macroinvertebrates. USEPA (1998) evaluated fish communities in the Red River, and characterized river health as ranging between “poor” to “good” based on fish community composition. The survey reach observed at Fargo would be characterized as “fair” based on their IBI criteria (USEPA 1998, Figure 47).

USEPA (1998) observations classified biotic integrity as “very poor” or “poor” for sites on the Wild Rice, Maple and Rush rivers that were within or closest to the study area (Figure 47). The nearest survey reach on the Sheyenne was classified as “fair” but was considerably upstream of the study area. Biotic health for the Sheyenne in the study area is probably more degraded, similar to the other tributaries with information closer to the study area. Tributary habitat upstream of the study area appears to improve for some tributaries, with habitat classified as “fair” or “good” in some sections of the Rush, Maple and Sheyenne rivers.

Physical tributary habitat in the study area has been heavily modified, which is reflected in the IBI scores. The Rush and Lower Rush rivers have been channelized and straightened through the study area to its confluence with the Sheyenne River. The Sheyenne River has been heavily modified from several actions. The Horace/West Fargo Diversion includes multiple control structures and diversion channels that are operated with flows as low as a 50-percent chance event. During some flood events, flows are actually blocked at West Fargo, with the entire river routed through a flood diversion channel. Additional features along the lower Sheyenne River include a low-head dam and several bridge crossings that may constrict flow. Ultimately, these features cumulatively result in modified hydraulic and geomorphic conditions in the Sheyenne, which adversely affect its aquatic habitat.

Figure 47 - Index of Biotic Integrity classification for select sites on the Red River and adjacent tributaries (from EPA 1998).



Additional actions such as tiling, ditching and draining have been widely done across the study area, resulting in altered hydraulic and geomorphic conditions in tributaries. Several tributary reaches in the study area also have limited or no riparian habitat along their corridor. These altered conditions directly affect aquatic habitat quality, and may be most apparent with tributaries on the Red River valley floor, within or adjacent to the study area.

Although tributary habitat may be degraded around the study area, tributaries are important for many species within the Red River basin. Areas of greatest value are typically upstream of the valley floor in areas with more diverse habitat. Much of the Red River mainstem lacks rock/cobble habitat that would be utilized by fishes that spawn in riffle habitat. However, such habitat is found in adjacent tributaries, particularly within high-gradient areas upstream of the study area where streams descend through old beach ridges of glacial Lake Agassiz and glacial moraines (Aadland et al 2005).

4.2.1.8.4 Aquatic Habitat Connectivity

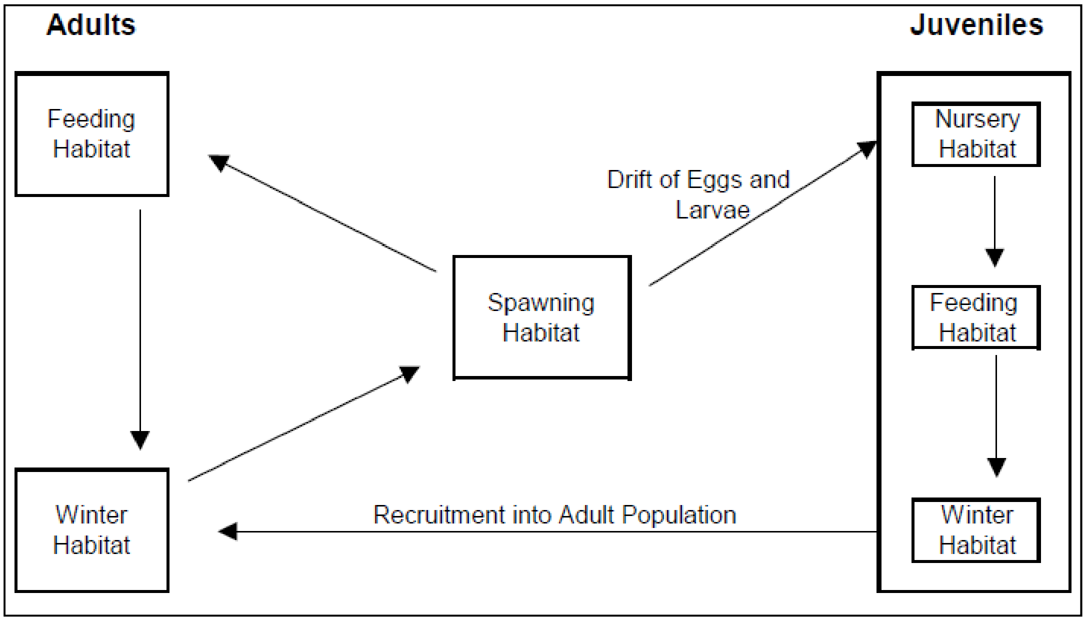
Connectivity is an important attribute of aquatic habitat for river fishes. Connectivity refers to the continuous nature of aquatic habitats in main channels, floodplain water bodies and tributaries. Natural rivers contain a heterogeneous mosaic of aquatic habitats that are very dynamic in both a spatial and temporal sense. River habitats can substantially vary over scales from short- (e.g., flood events) to medium- (e.g., seasonal) or long-term (annual, decadal, or longer). Fish in rivers have evolved migratory and life history strategies that take advantage of these complex, changing riverscapes.

Habitat connectivity is important in terms of fulfilling seasonal and life-stage specific habitat needs for river fishes. Fish undergo alimental (food procurement), climatic (seasonal habitat movements), and gametic (reproduction) migrations in rivers (McKeown 1984) (Figure 48). In addition to the conceptual model by McKeown, others (e.g., Fauch et al. 2002; Schlosser 1991) have identified refinements regarding migrations that are common features of fish life histories including migrations that occur between different feeding habitats, and migrations associated with refugia during catastrophic events such as floods, droughts, and extreme water quality conditions (i.e., high temperature, low dissolved oxygen).

Dams and similar structures reduce the connectivity of aquatic habitat by restricting movement of river fish. Impeded fish movements resulting from dams have been implicated in altering fish community structure and declining fish populations in rivers throughout the world (Northcote 1998; Pringle et al. 2000). Restrictions on movements of migratory fish in a river system can potentially limit the extent and quality of habitats that they can occupy. Effects of reduced access to habitats can be expressed at the individual, population, and community levels.

Information on the effects of dams and reduced connectivity of most inland fish populations is generally scarce. However, impeding migrations that freshwater fish use to optimize growth, reproduction and survival can ultimately affect fish production (Northcote 1978). Reduced access to prime foraging habitat can result in greater expenditure of energy for foraging and reduce growth of individual fish. Reduced access to suitable winter habitat can limit winter survival. Restrictions on movements of migratory fish can have significant adverse effects on pre-spawning movements, can limit access to suitable spawning habitats, and limit the size of spawning aggregations.

Figure 48 - Pattern of seasonal movements of many Red River of the North fishes (after McKeown 1984)



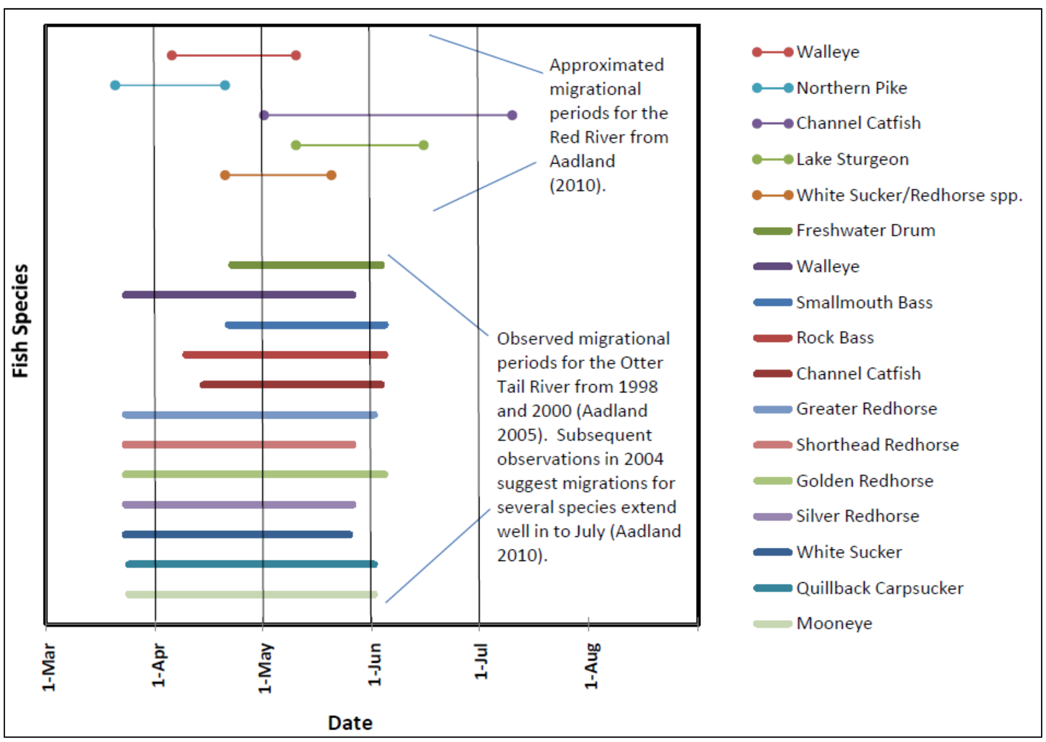
A wide range of fish species potentially migrate long distance to fulfill life-history requirements in the Red River basin. In many cases, it may be difficult to define whether or not a species is specifically "migratory." Species in the basin that likely perform regular migrations include, but are not limited to, lake sturgeon, channel catfish, walleye, sauger, goldeye, mooneye, northern pike and several Catastomid (sucker) species. In addition to the tributaries listed above in the study area, tributaries throughout the basin may have fish populations that migrate back and forth from the Red River.

Aadland et al. (2005) provided a summary of fish migration observations through a fish bypass channel on the Otter Tail River, a Minnesota tributary upstream of the study area (Table 31 and Figure 49). The sampling location was about eight miles upstream of the confluence of the Otter Tail and the Bois de Sioux River; the confluence of these rivers forms the Red River. Sampling was done during the spring of 1998 and 2000 over a period of a couple months. Though the study included typical limitations due to sampling gears and methodology, the observations provide insight into seasonal upstream fish migrations from the Red River into the Otter Tail River.

Table 31 – Upstream migrating fishes caught on Otter Tail River (Aadland et al 2005).

Species	Common Name	Total Catch	% of Total	Peak Catch	Earliest Catch	Latest Catch
Hiodon alosoides	goldeneye	2	<1	May 19	May 19	Jun 1
Hiodon tergisus	mooneye	204	5	May 18	Mar 24	Jun 1
Esox lucius	northern pike	6	<1	Apr 26	Mar 24	May 3
Cyprinus carpio	common carp	5	<1	May 11	Apr 14	May 26
Carpiodes cyprinus	quillback carpsucker	181	4	May 14	Mar 24	Jun 1
Ictiobus cyprinellus	bigmouth buffalo	2	<1	May 26	Mar 30	May 26
Catostomus commersonii	white sucker	75	2	Mar 30	Mar 23	May 25
Moxostoma anisurum	silver redhorse	369	9	May 3	Mar 23	May 26
Moxostoma erythrurum	golden redhorse	435	11	May 3	Mar 23	Jun 4
Moxostoma macrolepidotum	shorthead redhorse	1707	43	May 3	Mar 23	May 26
Moxostoma valenciennesi	greater redhorse	133	3	May 3	Mar 23	Jun 1
Ameiurus melas	black bullhead	4	<1	May 11	Apr 23	May 12
Ameiurus nebulosus	brown bullhead	1	<1	May 3	May 3	May 3
Ictalurus punctatus	channel catfish	679	17	Apr 29	Apr 14	Jun 3
Noturus flavus	stonecat	4	<1	Apr 15	Apr 14	Apr 15
Ambloplites rupestris	rock bass	27	1	May 11	Apr 9	Jun 4
Micropterus dolomieu	smallmouth bass	34	1	Apr 23	Apr 21	Jun 4
Pomoxis nigromaculatus	black crappie	4	<1	May 25	Apr 26	May 12
Sander canadensis	sauger	1	<1	Apr 21	Apr 21	Apr 21
Sander vitreus	walleye	65	2	Apr 22	Mar 23	May 26
Aplodinotus grunniens	freshwater drum	65	2	May 26	Apr 22	Jun 3

Figure 49 - Migrational periods for several fish of the Otter Tail and Red Rivers, MN.



Aadland et al (2005, Table 31) noted 21 species of fish captured at the upstream end of the fishway. The timing and duration of migration varied by species, but often occurred over a period of several weeks between late March and early June. The date of peak catch was also variable, but was often in late April or the first couple weeks of May. Table 31 lists the upstream migrating fishes caught in a trap net at the upstream end of the Breckenridge fishway on the Otter Tail River in 1998 and 2000. Catches represent 14 net-days from April 7 to June 4, 1998 and 22 net-days from March 23 to June 1, 2000 (Aadland et al. 2005). Additional observations from this location in 2004 suggested fish migrations of several species could extend well into July (Aadland 2010).

Aadland (2010) provided approximate migration periods for select Red River fishes (Figure 49). This includes an approximated migrational period for lake sturgeon which was not captured during observations on the Otter Tail River. For the fish identified, migrational periods on the Red River would be expected to occur over a period of a month or more. Key Red River species of concern include lake sturgeon and channel catfish. Lake sturgeon would be expected to migrate from early- to mid-May thru mid-June. Channel catfish would be expected to migrate over a period of a couple months, generally from May thru early July. Aadland (2010) noted channel catfish migrations on the Otter Tail in 2004 began in late-April. However, he observed that the largest individuals (600 mm and larger) were captured in July. Aadland (2010) noted these large fish were likely spawners and the late migration of large individuals could have significant ramifications for catfish populations. Thus, migration during these summer months could be particularly important for these species.

Connectivity in the Red River basin has been interrupted through the construction of numerous dams. This includes eight low-head dams constructed on the Red River mainstem within the United States (Table 32), as well as the Lockport dam in Manitoba, Canada. Aadland et al (2005) reported over 500 dams exist on Red River tributaries within the U.S. This has limited the ability for fish populations to move throughout the Red River basin, including movement between the Red River and upstream tributary habitats.

Table 32 – Distribution of low-head dams on the Red River of the North.

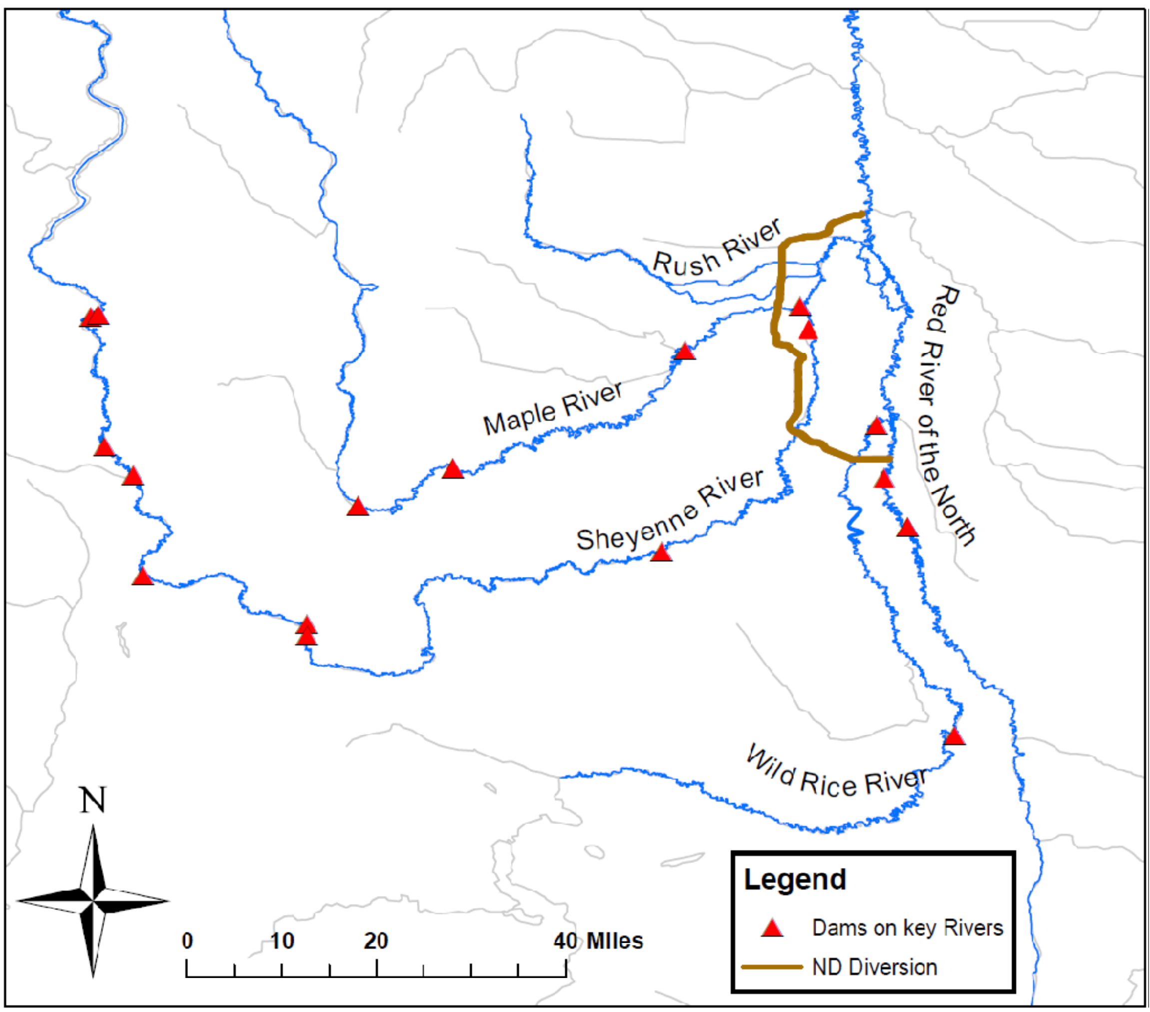
The Red River crosses the international border into Canada at River Mile 158.0.

River Mile	Location	Fish Passage Status
207.1	Drayton, North Dakota	Planning Study Underway
296.1	Grand Forks, North Dakota-East Grand Forks, Minnesota	Rock-Rapids Fishway Completed 2001
448.9	North Dam, Fargo-Moorhead (12th/15th Avenue)	Rock-Rapids Fishway Completed 2002
452.2	Midtown Dam, Fargo-Moorhead (4th Street)	Rock-Rapids Fishway Completed 1999
458.1	South Dam, Fargo-Moorhead (32nd Avenue)	Rock-Rapids Fishway Completed 2003
482.7	Hickson, North Dakota	Planning Study Underway
496.6	Christine Dam, North Dakota	Planning Study Underway
546.4	Wahpeton, North Dakota-Breckenridge, Minnesota	Rock-Rapids Fishway Completed 2000

Connectivity between the Red River and adjacent tributaries in the study area is also poor as a result of several existing dams (see Figure 50). The Maple, Sheyenne and Wild Rice rivers all have low-head dams between their confluence with the Red River and the proposed diversion alignment for the North Dakota alternatives (Figure 50). Figure 50 does not include dams that have been retrofitted for fish passage and additional dams are also found upstream on these tributaries, further limiting connectivity.

The Sheyenne River especially has limited connectivity between the Red River and habitat upstream of the study area. A low-head dam in West Fargo on the lower Sheyenne limits or eliminates connectivity during low-flow conditions. Conversely, connectivity during high flow conditions is also limited or non-existent due to the flood project at Horace and West Fargo. This includes multiple control structures that divert all river flow into a flood diversion channel when flows approach a 50-percent chance event. Any biotic connectivity would require fish to migrate upstream through this flood channel, then through a small denil-style fishway at the Horace control weir. The effectiveness of this fishway has not been evaluated. Ultimately, there is likely poor biotic connectivity between the lower Sheyenne and Red rivers under existing conditions.

Figure 50 – Existing dams on the Red River and Tributaries



The Rush River includes at least one rock and culvert structure that limits biotic connectivity. Fish migrations are possible when this structure is overtopped. However, under most conditions, fish would have to migrate through one of two culverts to pass this structure.

Picture 7 - Wild Rice Dam on the Wild Rice River, just downstream of the diversion channel alignment for the North Dakota alignment alternatives. Photo from June 23, 2010

Extensive work has been done to improve connectivity and fish passage on the Red River mainstem. Of the eight dams on the Red River mainstem, five have implemented rock-riffle structures to facilitate fish passage (Table 32). Resource agency biologists believe these projects provide the opportunity for free migration to all species of fish approaching 100-percent of the time. The remaining three dams currently have planning studies underway that are also looking to implement similar fish passage opportunities. If implemented, these projects would facilitate the reconnection of over 300 miles of Red River mainstem habitat. However, the likelihood of implementation of these three projects is unknown. The projects at Christine and Hickson dams are currently being planned by the city of Fargo, and will potentially see construction in 2011. The project at Drayton Dam appears much less certain given likely construction costs and uncertain funding sources.

Outside of the study area, Red River tributaries have received attention for improving fish passage opportunities. These include 30 projects to provide for improved fish movement; a majority of these have been done on Minnesota tributaries.

Picture 8 - Example of a rock-rapids fish passage structure at North Dam, Red River of the North, Fargo, ND. Project completed in 2002.

Picture 9 - Rock and culvert structure on the Rush River within the study area. Photo from April 22, 2010.

Picture 10 - Example of a fish bypass channel at a dam on the Otter Tail River near Fergus Falls, MN. Project completed in 2002. Photo and information source: Aadland 2010.

4.2.1.9 Riparian Habitat

A riparian zone is the area between a body of water and the adjacent upland, identified by soil characteristics and distinctive vegetation that requires an excess of water. It includes wetlands and those portions of the floodplain that support riparian vegetation. Generally it is comprised of trees and shrubs as well as understory vegetation, including a variety of grasses and forbs. Eastern North Dakota riparian zones are dominated by green ash and elm trees where cottonwoods are prevalent in western zones of the state. The riparian zones along the Wild Rice, Maple, Rush and Lower Rush Rivers consist of mostly open farm land. The riparian zones along the Sheyenne and Red River consist of small strips of bottomland hardwoods including, but not limited to, cottonwood, green ash, bur oak, basswood, American elm, silver maple, and hackberry. Although this habitat type makes up a small area it is an important home to numerous wildlife species and is vital to stream health.

The narrow riparian zone is in a relatively natural condition. The remaining wooded riparian areas are an important wildlife and aesthetic resource. The riparian woodlands are essentially the only wooded habitat remaining in this predominantly agricultural area. Tree species identified in these areas include bur oak, American linden, eastern cottonwood, American elm, boxelder, green ash, silver maple, buckthorn, and hackberry. Woodland was never very common in the prairie environment, but it is extremely important as nesting, breeding, and overwintering habitat for a number of birds, mammals, and reptiles

Picture 11 – Riparian area along Wild Rice River.

4.2.1.10 Wetland Habitat
Based on the National Wetland Inventory (NWI) database there are 4,626 acres of wetlands in the study area (Figure 51, Table 33). Wetlands outside of the area in Figure 51 were not calculated; the majority of these lands are adjacent to the rivers and streams in the area. This number represents less than 0.05-percent of the area within the study area. Table 33 lists the existing wetlands in the study area by type and size. Definitions of wetland types and a detailed photo log of wetlands can be found in Appendix F.

It is important to point out that a detailed wetland delineation of wetlands has been conducted on potentially impacted areas and there were many acres of farmed wetlands identified. These wetland types are not reported by the NWI database, meaning that the 4,626 acres understates what actually exists in the area today. Based on the delineation and the changes from a drier to wetter climate in recent years there are more wetlands within the study area than initially reported in the DEIS.

There are numerous wetland restoration programs within the Red River Basin, but implementation has often been hindered by cost and/or land availability. The objectives of the wetland restoration programs include providing flood storage, improving water quality, and increasing wildlife and recreation opportunities.

Due to increasing pressure to either urbanize or improve drainage on cropland, it is anticipated that wetland acreage will either remain the same or decrease within the study area under the without project condition.

Picture 12 – Floodplain Forest.

Picture 13 – Arrowhead plants near an oxbow.

Figure 51 – Existing Wetlands

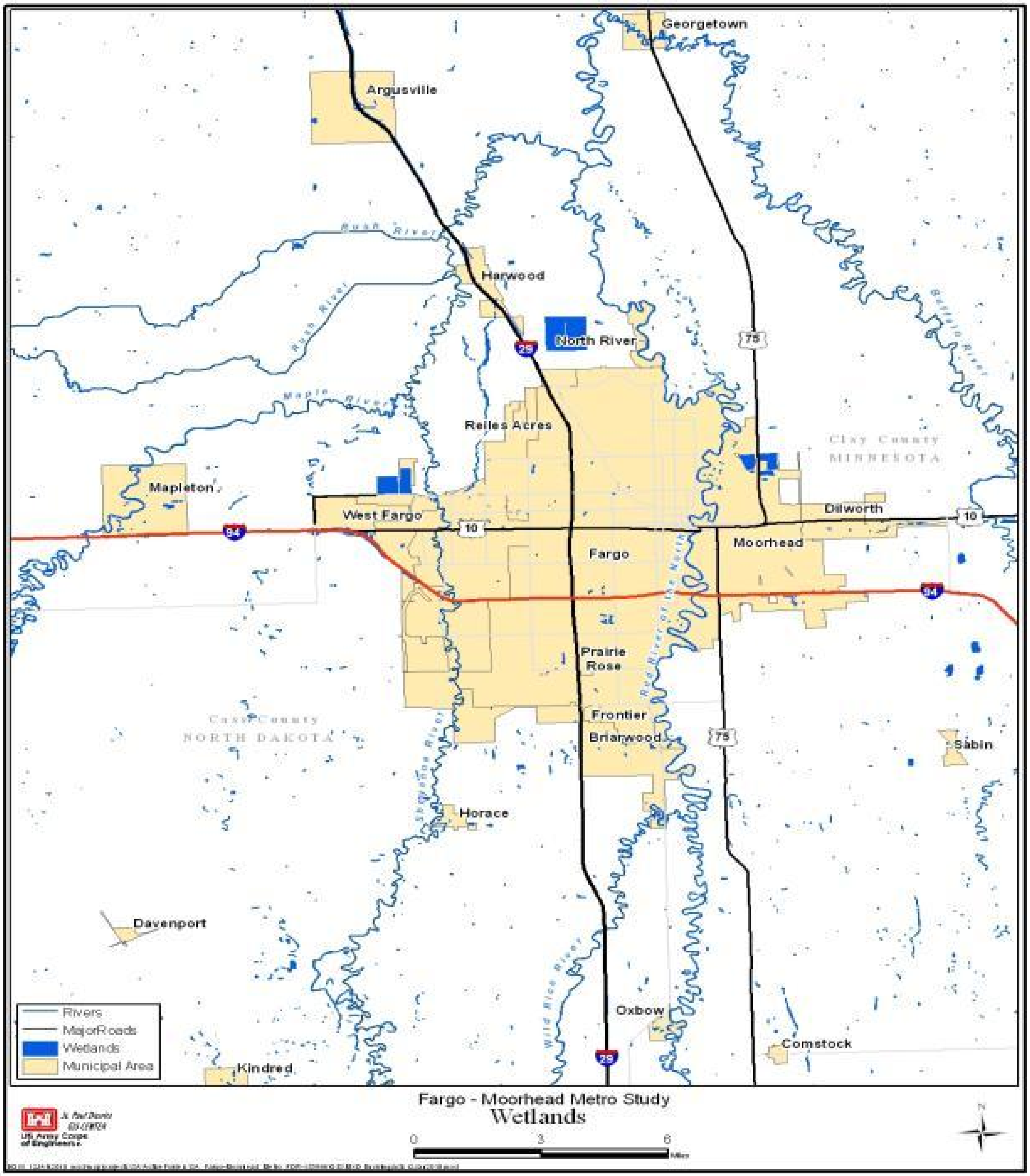


Table 33 – List of existing wetlands by type and number of acres from the NWI database.

Type	Wetland Code	Acres
Lacustrine, Littoral, Aquatic Bed, Intermittently Exposed, Excavated	L2ABGx	761.44
Lacustrine, Littoral, Unconsolidated bottom, Artificially Flooded, Intermittently Exposed, Excavated	L2UBKGx	91.01
Palustrine, Aquatic Bed, Semipermanently Flooded	PABF	77.25
Palustrine, Aquatic Bed, Semipermanently Flooded, Diked/Impounded	PABFh	1.04
Palustrine, Aquatic Bed, Semipermanently Flooded, Excavated	PABFx	26.61
Palustrine, Emergent, Aquatic Bed, Semipermanently Flooded	PEM/ABF	24.28
Palustrine, Emergent, Forested, Broad-Leaved Deciduous, Seasonally Flooded	PEM/FO1C	7.07
Palustrine, Emergent, Forested, Seasonally Flooded	PEM/FOC	28.64
Palustrine, Emergent/Scrub-Shrub, Broad-Leaved Deciduous, Seasonally Flooded	PEM/SS1C	26.34
Palustrine, Emergent/ Unconsolidated Bottom, Semipermanently Flooded	PEM/UBF	2.09
Palustrine, Emergent, Temporarily Flooded	PEMA	163.05
Palustrine, Emergent, Temporarily Flooded, Partially Drained/Ditched	PEMAd	181.92
Palustrine, Emergent, Temporarily Flooded. Excavated	PEMAx	24.83
Palustrine, Emergent, Seasonally Flooded	PEMC	174.59
Palustrine, Emergent, Seasonally Flooded, Partially Drained/Ditched	PEMCd	71.22
Palustrine, Emergent, Seasonally Flooded, Excavated	PEMCx	242.63
Palustrine, Emergent, Semipermanently Flooded	PEMF	69.33
Palustrine, Emergent, Semipermanently Flooded, Partially Drained/Ditched	PEMFd	7.13
Palustrine, Emergent, Semipermanently Flooded, Excavated	PEMFx	32.12
Palustrine, Forested/ Emergent, Seasonally Flooded	PFO/EMC	3.98
Palustrine, Forested, Broad-Leaved Deciduous/ Emergent, Seasonally Flooded	PFO1/EMC	0.55
Palustrine, Forested, Broad-Leaved Deciduous, Temporarily Flooded	PFO1A	7.58
Palustrine, Forested, Broad-Leaved Deciduous, Seasonally Flooded	PFO1C	5.21
Palustrine, Forested, Temporarily Flooded	PFOA	31.53
Palustrine, Forested, Temporarily Flooded, Drained/Ditched	PFOAd	3.20
Palustrine, Forested, Seasonally Flooded	PFOC	10.56
Palustrine, Scrub-Shrub, Emergent, Seasonally Flooded	PSS/EMC	7.17
Palustrine, Scrub-Shrub, Emergent, Seasonally Flooded, Excavated	PSS/EMCx	10.33
Palustrine, Scrub-Shrub, Forested, Seasonally Flooded	PSS/FOC	5.38
Palustrine, Scrub-Shrub, Broad-Leaved Deciduous, Emergent, Seasonally Flooded	PSS1/EMC	1.33
Palustrine, Scrub-Shrub, Broad-Leaved Deciduous, Seasonally Flooded	PSS1C	11.41
Palustrine, Scrub-Shrub, Broad-Leaved Deciduous, Seasonally Flooded, Partially Drained/Ditched	PSS1Cd	0.91
Palustrine, Scrub-Shrub, Temporarily Flooded	PSSA	13.25
Palustrine, Scrub-Shrub, Seasonally Flooded	PSSC	2.57
Palustrine, Unconsolidated Bottom, Semipermanently Flooded	PUBF	6.47
Palustrine, Unconsolidated Bottom, Semipermanently Flooded, Diked/Impounded	PUBFh	2.97
Palustrine, Unconsolidated Bottom, Semipermanently Flooded, Excavated	PUBFx	21.79
Palustrine, Unconsolidated Bottom, Intermittently Exposed	PUBG	0.31
Palustrine, Unconsolidated Bottom, Intermittently Exposed, Excavated	PUBGx	15.54
Palustrine, Unconsolidated Bottom, Artificially Flooded, Intermittently Exposed, Excavated	PUBKGx	74.71
Riverine, Lower Perennial, Unconsolidated Bottom, Intermittently Exposed	R2UBG	241.53
Riverine, Lower Perennial, Unconsolidated Bottom, Permanently Flooded	R2UBH	2114.90

Type	Wetland Code	Acres
Riverine, Lower Perennial, Unconsolidated Shore, Temporarily Flooded	R2USA	2.08
Riverine, Lower Perennial, Unconsolidated Shore, Seasonally Flooded	R2USC	2.10
Riverine, Intermittent, Streambed, Semipermanently Flooded	R4SBF	0.69
Riverine, Intermittent, Streambed, Semipermanently Flooded, Excavated	R4SBFx	15.33
Total Wetland Acres		4625.97

4.2.1.11 Upland Habitat

Upland habitat in the study area is mainly cropland, with a mixture of hayed pasture, hobby farms and suburban dwellings. Wooded areas include mostly a mixture of bottomland hardwood tree species and low vegetation. The small percentage of upland wooded areas are made up of shelter belts planted near farmsteads and homes or along field edges, these shelter belts include some coniferous trees but mostly small shrubs and fast growing tree species. Wildlife species present within the project vicinity include typical urban and farmland species such as rabbits, squirrels, raccoons, white-tailed deer, and various songbirds.

Picture 14 – Wheat field.

4.2.1.12 Terrestrial Wildlife

Birds and mammals that inhabit the rural portions of the study area include raptors, gray partridge, pheasant, mourning dove, waterfowl, fox squirrel, white-tailed deer, red fox, raccoon, mink, badger, striped skunk, white-tailed jackrabbit, beaver, muskrat, and numerous song birds.

The riparian vegetation (forested floodplain) associated with the Red, Wild Rice and Sheyenne rivers represents most of the terrestrial wildlife habitat that presently exists within the study area. Other than this limited riparian habitat, wildlife resources in the study area are limited to those species that can reside in drainage ways, shelterbelts, cultivated fields and road right-of-ways (ROWs).

Habitat within the urban areas is limited to manicured lawns and landscaped areas. These areas provide only limited habitat for wildlife species. Therefore wildlife resources are primarily limited to songbirds, reptiles, amphibians and small mammals.

4.2.1.13 Endangered Species

4.2.1.13.1 North Dakota Federal

According to United States Fish and Wildlife Service's (USFWS), there are two Federally listed threatened or endangered species listed for Cass County North Dakota: the whooping crane (*Grus americanus*) and the gray wolf (*Canis lupus)*, both of which are endangered.

4.2.1.13.1.1 Whooping Crane

The whooping crane was listed as endangered by the USFWS on June 2, 1970. The whooping crane is the tallest bird in North America. It is a white bird with black wingtips and red markings on the head. Young birds have a brown-mottled appearance until their second summer. Whooping cranes are 5 feet tall and have wingspans of 7 feet. They fly with a slow downward flap and a rapid upstroke, and often migrate with the smaller, gray, sandhill crane. Their trumpet-like call carries for miles (United States Geological Survey [USGS] 2009b).

Whooping cranes inhabit shallow wetlands that are characterized by cattails, bulrushes and sedges. They can also be found in upland areas, especially during migration. Whooping cranes feed on crabs, crayfish, frogs, and other small aquatic life as well as plants (USGS 2009b).

The historical breeding range of the whooping crane extended from Illinois, northwest through North Dakota, and up to the Northwest Territories. The last nesting record for North Dakota was in McHenry County in 1915. The birds historically wintered along the Gulf of Mexico (USGS 2009b). In the 1940s, there were an estimated 21 whooping cranes left in the world. Most were from a flock that wintered at the Aransas National Wildlife Refuge on the coast of Texas. These birds are known to breed in the Wood Buffalo National Park. Today, there are approximately 145 whooping cranes in the wild. About 132 birds are in the Aransas-Wood Buffalo flock. The Aransas-Wood Buffalo population migrates through North Dakota. The fall migration occurs from late September to mid-October and the spring migration occurs from late April to mid-June. Although the bird can show up in all parts of North Dakota, most sightings occur in the western 2/3 of the state (USGS 2009b). No sightings have been recorded in the study area.

Loss of habitat and poaching are the main reasons for the whooping cranes decline (USGS 2009b).

4.2.1.13.1.2 Gray Wolf

The gray wolf was listed as endangered by USFWS on March 11, 1967. It is the largest of the canines, weighing up to 80 lbs, and can reach a length of 6.5 feet. The gray wolf is also known as the "timber wolf," "arctic wolf" in the arctic, and "tundra wolf" in the tundra. It has a gray fur coat with long tawny colored legs, a narrow chest, and tawny-colored flanks; it can live up to 13 years.

The gray wolf can reach speeds up to 45 mph and has excellent sense of smell and hearing. They are excellent hunters, often hunting in packs where they seek large prey, such as moose, elk, or deer. When they hunt alone they focus on smaller prey such as beavers, rabbits, or hares. The gray wolf can travel up to 30 miles a day searching for prey.

There are an estimated 7,000 to 9,000 wolves in Alaska and more than 3,500 in the lower 48 states, although none are reported in the study area. The main threats to the survival of the gray wolf were hunting and trapping because it was thought of as a nuisance, and habitat loss due to human encroachment into wolf territories. The gray wolf population was nearly wiped out, but now the gray wolf is legally protected and is said to be thriving and may even be taken off the endangered species list.

4.2.1.13.2 North Dakota State

The North Dakota Natural Heritage Program within the North Dakota Parks and Recreation Department was contacted to obtain information on North Dakota's species of concern within Cass County (Dirk 2006a; 2006b). Based on the supplied information, it was determined that 52 plant and animal species of concern in North Dakota have the potential to occur in Cass County. These 52 species and the type of habitat utilized/required by each species are provided in Section 1.9.3 of Appendix F**.** Supplied maps were used to identify documented occurrence of each species in Cass County, which in turn was used to determine the potential for each of the species to be present in the study area. Seven of the 52 species that have the potential to occur in Cass County have documented occurrences in the study area. These seven species included one fish species (Northern redbelly dace), three mussels (Wabash pigtoe, Black Sandshell, and Mapleleaf) one plant (blue cohosh) and two bird species (whip-poor-will and northern cardinal).

4.2.1.13.3 Minnesota Federal

Clay County, Minnesota has one species listed on the Federal threatened species list, the Western prairie fringed orchid (*Platanthera praeclara*), and one species on the candidate species list, the Dakota skipper (*Hesperia dacotae*).

4.2.1.13.3.1 Western Prairie Fringed Orchid

The western prairie fringed orchid was listed as threatened by the USFWS on September 28, 1989. The orchid is perennial and distinguished by large, white flowers that come from a single stem. Up to 20 flowers may occur on a single plant and two to five narrow leaves hug the stem. The flower is fringed on the margins, giving it a feathery appearance. The orchid can grow up to three feet high (USGS 2009a).

The vegetative shoots of the western prairie fringed orchid emerge in late May. Flowers do not emerge until mid-June to late July. The entire plant can display flowers for about 21 days with individual flowers lasting up to 10 days. Flowers must be pollinated for seed production. Pollination appears to be accomplished only by hawkmoths with the microscopic seed being dispersed by the wind in early fall (USGS 2009a).

The western prairie fringed orchid occurs most often in remnant native prairies and meadows, but has also been observed at disturbed sites. In the southern parts of its range it is more likely to be found in mesic upland prairies and in the north more frequently in wet prairies and sedge meadow. It is also found in prairies swales and sand dune complexes that are fed by shallow groundwater (Sather 1991). Also, the orchid is well adapted to survive fires (USGS 2009a).

The western prairie fringed orchid was historically found throughout the tall grass regions of North America. This included the Dakotas, Nebraska, Kansas, Oklahoma, Missouri, Iowa, Minnesota and Manitoba. The Mississippi River was the eastern limit of its range (USGS2009a). The Red River Valley of Manitoba, Minnesota and North Dakota represented the heart of the orchid's range (Sather 1991). Presently, there are at least 37 separate populations remaining in seven states. In North Dakota, there is a large scattered population in the Sheyenne National grasslands in the southeastern part of the state (USGS 2009a). In Minnesota, there are two populations known: one in Pipestone National Monument and one in Pembina Trail Preserve Scientific and Natural Area (Minnesota Seasons 2009). It is unlikely any western prairie fringed orchids are in the study area.

The main reason for the decline of the western prairie fringe orchid is the conversion of native prairie lands to cropland (USGS 2009a).

4.2.1.13.3.1 Dakota Skipper

The Dakota skipper is a candidate for listing under the Endangered Species Act. It is a small to medium-sized butterfly with a 1-inch wingspan. The butterfly inhabits wet lowland prairie dominated by bluestem grasses, and dry upland prairie dominated by mixed bluestem grasses and needle stem grasses. The Dakota Skipper was once widely distributed throughout the northern tallgrass, Dakota mixed grass and a portion of the central tallgrass prairie ecoregions. Its distribution once included tallgrass and mixed grass prairies of Illinois, Iowa, Minnesota, South Dakota, North Dakota, Manitoba and Saskatchewan. The distribution is now largely centered in western Minnesota, northeastern South Dakota and the eastern half of North Dakota; it is unlikely any are in the study area.

4.2.1.13.4 Minnesota State

Based on information available from the Minnesota Department of Natural Resources' Natural Heritage program, 15 Minnesota-listed threatened and endangered species have the potential to occur in Clay County (Appendix F) (MnDNR 2009). These identified state-listed species include eight bird species (six endangered and two threatened species), four invertebrate species (two endangered and two threatened) and three plant species (all threatened). As shown in section 1.9.2 of Appendix F, six of the bird species and all four of the invertebrate species are found in areas with native upland prairies, while the remaining two bird species and the three plant species are found in wetlands, wet meadows, lake shores, and other wet/moist area including peatlands. With their mobility, it can also be assumed that the listed bird and invertebrates may on occasion be sighted in areas adjacent to their preferred habitat.

Minnesota's special concern species that have the potential to occur in Clay County are shown in section of 1.9.1 of Appendix F. As shown, 34 special concern species have the potential to occur in Clay County including two mammal species, five bird species, one reptile species, one fish species, two mussel species, five insect species, and 18 plant species. With the exception of the bald eagle, lake sturgeon and two mussel species, identified species are found in native upland grasslands, savanna and prairies or in wetland areas including wet meadows, fens, swamps, and other wet/moist areas. A recovery program has been initiated to restore lake sturgeon to the Red River drainage, and the two mussel species are found in rivers and streams. Bald eagles frequent riparian areas associated with lakes and large rivers, especially riparian forests that contain large trees that can be used as nest sites, roosts and perches. As discussed above, the mobile species (mammals, birds and insects) can be expected to infrequently occur in areas adjacent to areas that contain habitat preferred by a species.

4.2.1.13.5 Bald Eagles

Bald eagles and their nests are protected from take and disturbance, respectively, per the Bald and Golden Eagle Protection Act. The Fish and Wildlife Service verified the location of two bald eagle nests within the study area. One of the nests is located along the Sheyenne River on the northwest edge of the city of Fargo. This nest was verified to be a successful active nest during the 2009 nesting period. The other nest is located near the confluence of the Sheyenne River and Red River. It is unknown whether this nest was active during the 2009 nesting period.

4.2.1.14 Prime and Unique Farmland

The Federal Farmland Protection Policy Act (FPPA) was enacted in 1981 (Public Law [PL] 98-98) to minimize the unnecessary conversion of farmland to nonagricultural uses as a result of federal actions. In addition, FPPA seeks to assure federal programs are administered in a manner compatible with state and local policies and programs that have been developed to protect farmland.

The policy of the Natural Resources Conservation Service (NRCS) is to protect significant agricultural lands from conversions that are irreversible and result in the loss of an essential food and environmental resource. Prime farmland has been identified by NRCS as a significant agricultural resource that warrants protection. The FPPA defines prime farmland as land that has the physical and chemical characteristics for producing food, feed, fiber, forage and oilseed crops, and is available for these uses. Prime farmland has the soil quality, growing season and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods.

Three of the Cass County, North Dakota soils are considered prime farmland by the NRCS. Eight other soils are considered prime farmland if they are drained. For the North Dakota alternatives (LPP and ND35K) over 90 percent of the land in the footprint area is considered to be prime and unique farmland; this equates to up to approximately 5,889 acres for the ND35K and 6,878 acres for the LPP.

For the Clay County, Minnesota study area, four soils are considered prime farmland by the NRCS and five are considered prime farmland if they are drained. One soil type is prime farmland if protected from flooding or not frequently flooded during the growing season. One soil type is considered farmland of state importance. For the FCP footprint area over 95 percent of the land is considered to be prime and unique farmland; this equates to approximately 6,540 acres.

4.2.2 Cultural Resources

4.2.2.1 Historic Conditions

Paleoindian tradition cultures based on the hunting of large Late Pleistocene/early Holocene game animals dating to 11,500 B.P. (years before present) are the earliest documented cultures in North America. No early Paleoindian sites are expected in the study area due to the presence of glacial Lake Agassiz in what is now the Red River valley and northwestern Minnesota. The Sheyenne River valley to the west was a glacial meltwater channel which emptied into the lake until ca. 10,900 B.P. By 10,000 B.P., however, areas of boreal forest surrounding Lake Agassiz and the lake's beaches would have become increasingly available for use by Paleoindian peoples. Small seasonal camps, kill sites and isolated projectile points from Late Paleoindian times have been found on the Lake Agassiz beach ridges and buried in the river terraces in the Red River Basin (USACE 1998).

Glacial Lake Agassiz had receded well north into Canada by 8,000 B.P. and the large Pleistocene mammals (mammoth, camel, horse, bison) hunted by the earlier Paleoindians had become extinct. The boreal forest of the Red River valley was replaced by prairie grassland to the west of the Red River and first by pine and then by mixed deciduous forests to the east of the Red. By 7,000 B.P., the climate had entered a long, dry period during which prairie grasslands spread eastward as far as northeastern Minnesota. The prairie/forest border shifted several times through the subsequent years, but the Red River valley remained prairie grasslands. The expansion of the prairie grassland eastward resulted in a change to more regionally oriented cultures that are part of the Archaic tradition (8,000-3,000 B.P.), based on gathering wild plants and hunting bison and smaller animals. Prairie Archaic cultures were adapted to the tall grass prairie of western Minnesota, while Plains Archaic cultures were adapted to the mixed grass prairie of eastern North Dakota. Archaic sites have been found along small streams, at pothole lakes, on the beach ridges of glacial Lake Agassiz, and buried on the terraces and floodplain of the Red River and its tributaries (USACE 1998).

The following Woodland tradition (3,000-900 B.P.) is characterized by the initial appearance and manufacture of grit-tempered pottery vessels and the use of earthen mounds for burial purposes. Bison hunting and plant gathering formed the basic Woodland economy. The bow and arrow with its small triangular points were introduced at this time. Woodland sites have been found near lakes and rivers and on the uplands overlooking river valleys. Late Prehistoric Period Woodland hunting and gathering cultures continued from 1,100 B.P. (A.D. 900) up to the time of contact (A.D. 1660 in Minnesota; A.D. 1738 in North Dakota) in all but the southernmost Red

River valley. Village sites of the Northeastern Plains Village complex occur on river terraces along the Sheyenne River, while Cambria complex village sites occur on river terraces in southwestern Minnesota. Both complexes are based on a dual corn horticulture and bison hunting, wild-plant gathering economy (USACE 1998).

Native American groups known to have lived in the Red River valley include the Hidatsa, Arapaho/Atsina, Plains Ojibwe (Chippewa), Assiniboin, and Yanktonai Dakota. The Arapaho/Atsina are believed to have occupied the Red River valley prior to and during the early 1600s though no archeological sites found to date have been attributed to them. The village-dwelling Hidatsa originated in southwestern Minnesota and migrated northward down the west side of the Red River. Their home territory prior to A.D. 1650 centered on Devils Lake, but extended from the Red River west to the Souris River. They left the Red River-Devils Lake area for the Missouri River valley when the gun-equipped, bison-hunting Plains Ojibwe moved into northeastern North Dakota from northern Minnesota and southern Manitoba in the 1700s. The Plains Ojibwe occupied tipi camps from the Red River west to the Turtle Mountains and hunted bison out on the Plains even prior to their acquisition of the horse (USACE 1998).

The Yankton and Yanktonai Dakota lived in central Minnesota in the mid-1600s where they practiced a hunting-gathering-gardening lifestyle. The Assiniboin, having gradually split off from the Dakota, occupied northwestern Minnesota and the Red River valley in Canada at that time. The prehistoric and protohistoric Blackduck culture in northern Minnesota is considered ancestral to the Assiniboin. The encroachment of the Ojibwe from the north and east between A.D 1679 and 1750 forced both the Dakota and Assiniboin westward. After 1750 the Yanktonai Dakota occupied the southeastern quarter of North Dakota east of the Missouri River. The Assiniboin moved to northwestern North Dakota and adjacent Canada west of the Souris River loop (USACE 1998).

The fur trade flourished in the Red River valley from 1738 to around 1860. French fur trade activities lasted from their initial contact with the Dakota in Minnesota in A.D. 1660 to their 1763 loss of the French and Indian War, and thereby Canada, to the British. From A.D. 1763 to 1803, the British controlled the fur trade in the Red River Basin. Posts were established at Pembina in 1797 by Chaboillez and by David Thompson and Alexander Henry for trade with the Plains Ojibwe in the Red River valley. Independent British trader Robert Dickson established a post at Lake Traverse in the 1790s. Furthermore, a North West Company fur trading post was established at Grand Forks/East Grand Forks in the early 1800s. In 1811, the Scottish Earl of Selkirk, with a land grant from the Hudson’s Bay Company, started an agricultural colony at the confluence of the Red and Assiniboine rivers in Manitoba. In 1816 the colony was attacked by the large Metis population of the area. Subsequent to this, Lord Selkirk purchased from the Ojibwe and Cree a strip of land extending from the mouth of the Red River upstream to where Grand Forks is now located, with the main settlement at the 49th parallel in the Pembina area (USACE 1998).

The development of the Red River oxcart trails was a direct result of the fur trade and the need for transporting goods between settlers in the Red River region and St. Paul, Minnesota. These cart trails were used from the 1830s to 1871 when the railroads replaced them. The Red River

Trail followed the east side of the river from Lake Traverse to Pembina. The North Dakota Trail ran north-south to the west of, and roughly paralleling the Red River (USACE 1998). A branch of the Red River Trail crossed the
Red River between these two trails at Georgetown, roughly 12 miles north of Moorhead (Gilman et al. 1979).

A land cession treaty between the United States government and the Ojibwe in 1863 resulted in the Ojibwe giving up most of their land and mineral rights in northern Minnesota and the Red River valley in North Dakota. The Dakota ceded most of their lands in southwestern Minnesota and the Red River Basin in North Dakota in 1872 (USACE 1998).

Minnesota was organized as a territory in 1849 and the Dakota Territory was organized in 1861. Minnesota statehood came in 1858. North and South Dakota became states in 1889 (USACE 1998). Clay County, Minnesota was established in 1862 and Cass County, North Dakota in 1872. Both, Fargo's and Moorhead's origins date to 1871 with the Northern Pacific Railway's arrival at and first crossing of the Red River into North Dakota (Upham 1969:117; Williams 1966:63). Fargo acquired a post office that same year and soon became the hub for a large agricultural area. Fargo was incorporated in 1875 (Williams 1966:63-64) and Moorhead in 1881 (Upham 1969:117). The Northern Pacific Railway built a siding spur, water station and stockyards on the west side of Fargo in the 1870s. In 1882, the spur was extended five miles west and the stockyards and water station were moved to the east bank of the Sheyenne River. The rail station, originally named Haggert, was renamed West Fargo in 1925 when a company town grew up around the newly established Armour meat packing plant. West Fargo was incorporated in 1931 and is now a suburb of Fargo (Williams 1966:72-73).

Settlement of western Minnesota and the Dakotas was directly tied to the arrival of the Northern Pacific Railroad in Moorhead in 1871 and the St. Paul, Minneapolis and Manitoba (Great Northern) Railroad in Grand Forks in 1880. The 1878-1887 influx of settlers from Germany, Scandinavia, Great Britain, Ireland and the Great Lakes region into the Red River valley was the direct result of the chance for free land under the Homestead Act of 1862 and the active promotions of the railroads. A second influx of settlers occurred from the late 1890s to 1920 and involved eastern, central and southern Europeans. Improvements to highways and country roads occurred after 1910 with the increasingly common use of the automobile. The drought and depression of the late 1920s and 1930s resulted in the loss of many farms in the Red River valley due to an inability to pay mortgages and/or taxes because of successive crop failures (USACE 1998).

4.2.2.2 Previous Cultural Resources Investigations
Due to the large study area the information gathered from previous cultural resources investigations was limited for each of the diversion channel alternatives as described below.

The diversion channel alignments for the North Dakota alternatives (LPP and ND35K) substantially overlap. Information gathered was limited to a one-mile corridor centered on the overlapping alignments. The previous investigations include a 1978 survey of parts of the lower Sheyenne River Basin (Vehik 1978); a 1986 survey of the West Fargo Flood Control Project

(Floodman 1988); a 1986 archeological survey and test excavations in Cass County (Michlovic 1986); a 1990 Cenex pipeline survey (Schweigert 1990); and the 2009 survey of the Fargo Southside Study Area (URS Group 2009). Generally less than ten percent of the North Dakota diversion channel alignment has been covered by these prior cultural resources surveys, the exception is where it intersects the existing West Fargo diversion channel area, which has been completely investigated. Until 2010, there have been no previous cultural resource surveys along a one-eighth-mile wide corridor centered on the LPP and ND35K plan tie-back levee alignments, which are located in Minnesota.

Previous Phase I cultural resources investigations within the one-mile-wide corridor centered on the FCP diversion channel alignment includes a 1978 archeological survey along the Red River in Clay County, Minnesota (Michlovic 1978, 1979). A historic standing structures inventory of the city of Moorhead took place in 1979 (Moorhead Community Development Department 1979). Less than five percent of the alignment has been previously checked for cultural resources. Until 2010, there have been no previous cultural resources surveys within the one-half mile wide corridor centered on the FCP Red River Breakout Channel and Wild Rice River Breakout Channel alignments, located in Minnesota and North Dakota, respectively. The 2009 Phase I cultural resources survey of the Fargo Southside Study Area (URS Group 2009) includes small areas of the one-eighth-mile wide corridor centered on the FCP's tie-back levee alignment, which is located primarily in North Dakota.

A Phase I cultural resources survey of the ND35K alignment and the FCP alignment (including its tie-back levee and breakout channel alignments) was begun in 2010. This survey includes portions of the LPP diversion channel and tie-back levee alignments as it overlaps substantially with the same features of the ND35K alternative.

4.2.2.3 Known Cultural Resources Sites

Cultural resources include any prehistoric or historic archeological site, building, standing structure or object at least 50 years old relating to the history, architecture, archeology or culture of an area. A historic property is a site, structure, building, object or district which has been listed on or has been determined eligible for inclusion on the National Register of Historic Places. An unverified site lead refers to a potential prehistoric or historic archeological site based on verbal or written information which has not been field verified by a professionally qualified archeologist or historian.

Known cultural resources within the one-mile corridor centered on the ND35K diversion channel alignment include four prehistoric archeological sites (32CS42, 32CS43, 32CS44, 32CS201), six historic archeological sites (FM1-2, FM2-2, FM2-5, FM2-6, FM2-7, FM4-7), one prehistoric isolated find (FM2-8), three bridges (32CS4461, 32CS4462, ND-15), 11 farmsteads (ND-1 to ND-7, ND-10 to ND-14), three houses (32CS5090, 32CS5091, ND-9), one railroad crossing (ND-8), a collapsed granary (ND-16), and a collapsed house (ND-17). In addition, there is an unverified lead to one historic archeological site (32CSX238b-Red River Trail segment). As of March 8, 2011, there are no historic properties along the ND35K diversion channel alignment listed in the National Register of Historic Places. The only property determined eligible for the National Register is the Sheyenne River Bridge in Warren Township (32CS4462). One historic archeological site (FM2-2) and two farmsteads (ND-5, ND-14) are recommended as eligible to the National Register. Phase II testing to evaluate the National Register of Historic Places eligibility of archeological sites 32CS42 and 32CS44 for the West Fargo Flood Control Project resulted in non-eligibility determinations (Persinger 1988).

An unverified lead to one historic archeological site (21CYr), the Red River Trail, three historic isolated finds (FM3-3, FM3-4, FM3-6), one historic archeological site (FM3-2), and a segment of railroad (FM3-5) are the only known cultural resources within the one-eighth-mile wide corridor centered on the ND35K tie-back levee centerline. The tie-back levee centerline crosses the historic oxcart trail in one location in Clay County, Minnesota. The railroad segment has been recommended as eligible to the National Register. No National Register listed historic properties were present along this alignment as of March 8, 2011.

Known cultural resources within the one-mile-wide corridor centered on the FCP diversion channel alignment include three prehistoric archeological sites (21CY3, 21CY19, 21CY55), three isolated prehistoric artifacts (FM2-3, FM2-12, FM4-6), five historic archeological sites (FM1-1, FM2-1, FM2-4, FM2-9, FM2-11), 11 farmsteads (MN-2 to MN-6, MN-13 to MN-17), six historic houses (CY-KRG-001-John Olness House at Kragnes, MN-7, MN-9 to MN-12) and four other historic standing structures (CY-DWG-003 and MN-8 -Northern Pacific shop buildings at Dilworth, CY-KRG-004-Kragnes Bar, CY-KRG-005-warehouse at Kragnes). The FCP diversion channel alignment crosses the unverified location of three historic archeological sites: the ghost towns of Ruthruff (21CYk) and Lafayette (21CYl[el]), and the Red River Trail (21CYr). The latter historic oxcart trail is crossed three times by this diversion's centerline. The FCP diversion channel alignment also crosses the unverified historic archeological ghost town site of Burlington (21CYo). The John Olness House (CY-KRG-001) at Kragnes is the only National Register listed property found along the FCP diversion channel alignment as of March 8, 2011. Historic archeological site FM2-4 and farmstead MN-14 are recommended as eligible to the National Register.

There are unverified leads to two historic archeological sites within the one-half-mile wide corridor centered on the FCP Red River Breakout Channel alignment: the ghost town of Burlington (21CYo) and the Red River Trail (21CYr). The breakout channel centerline follows the historic oxcart trail for three-quarters of a mile. One historic archeological site (FM4-4) and two farmsteads (MN-18, MN-19) are also located along this alignment. Farmstead MN-19 is recommended as eligible to the National Register. No National Register listed historic properties are present along this alignment as of March 8, 2011.

There is an unverified lead to one historic archeological site within the one-eighth-mile wide corridor centered on the FCP tie-back levee alignment: the Holy Cross Mission (32CSX1). One prehistoric and historic archeological site (FM4-3), the Meridian Highway (322CS2657), and one farmstead (ND-11) are also located along this alignment. The archeological site is recommended as eligible to the National Register. No National Register listed historic properties are located along this alignment as of March 8, 2011.

There is one historic archeological site (FM-A) within the one-half-mile wide Wild Rice River breakout channel alignment, which is part of the FCP. This site is been recommended as eligible to the National Register. No National Register listed historic properties are located along this alignment as of March 8, 2011.

Known cultural resources sites within the one-mile-wide corridor centered on the LPP diversion channel alignment include five prehistoric archeological sites (32CS42, 32CS43, 32CS44, 32CS4563), one prehistoric isolated find (FM2-8), eight historic archeological sites (32CS5078, FM1-2, FM2-2, FM2-5, FM2-6, FM2-7, FM4-1, FM4-7), three historic archeological site leads (32CSX33, 32CSX131, 32CSX238b), one church (32CS114), two bridges (32CS4462, ND-15), 13 farmsteads (ND-1 to ND-7, ND-10 to ND-14), one railroad segment (ND-8), one historic house (ND-9), one collapsed granary (ND-16), and one collapsed house (ND-17). No National Register of Historic Places listed historic properties are present along this alignment as of March 8, 2011. Bridge site 32CS4462 has been determined eligible to the National Register and historic archeological site FM2-2 and farmsteads ND-5 and ND-14 are recommended as eligible to the National Register. Archeological sites 32CS42 and 32CS44 were determined not eligible to the National Register in 1988 in connection with the Horace-West Fargo Flood Control Project.

One historic archeological site (FM3-2), three historic isolated finds (FM3-3, FM3-4, FM3-6), and a segment of railroad (FM3-6) are located along the LPP's one-eight-mile wide diversion tie-back levee alignment in Minnesota. The railroad segment is recommended as eligible to the National Register. There are no National Register listed historic properties along this alignment as of March 8, 2011.

There is one farmstead (ND-11) located in Staging Area #1 for the LPP and within one-eighth-mile of its exterior boundary. There are no National Register listed or eligible historic properties at the staging area as of March 8, 2011.

There are no recorded cultural resources sites at the staging area tie-back levee alignment associated with the LPP alternative. There are no National Register listed or eligible historic properties along this alignment as of March 8, 2011.

4.2.3 Socioeconomic Resources

This section presents an overview of major socioeconomic characteristics and trends, including demographics and economics in order to provide a context from which to assess impacts of the proposed project and alternatives. The affected environment extends along the Red River, between Abercrombie, ND, and the Canadian border. It includes portions of 12 counties in North Dakota and Minnesota and the Fargo-Moorhead Metropolitan Statistical Area (MSA). The MSA covers portions of Cass County, ND, and Clay County, MN. Quantitative data reported by the U.S. Census Bureau were utilized to analyze the socio-demographic characteristics of the MSA. The dataset used for the analysis includes the 3-year estimates (2006, 2007 and 2008; pooled data) from the Population and Housing Narrative Profile of the American Community Survey (ACS). These ACS data provide the highest-quality, most general current data on the Fargo-Moorhead area. Data to report population growth is from annual population estimates produced by the Census Bureau.

4.2.3.1 Existing and Future Without Project Flood Damage Risk

Hydrologic and hydraulic (H&H) modeling was performed throughout the affected area for the Red River of the North and tributaries at three points in time: existing conditions, 25 years out and 50 years out. Economic conditions were inventoried for existing conditions and forecasted for the future analysis years. Flood damage categories include damage to infrastructure, and emergency flood fighting costs. Consideration was given to existing levees and other flood risk management projects, and sewer backup flooding. The H&H and economic inventories formed the basis for evaluating flood damage risk in the study area. Table 34 displays existing conditions expected annual damages and equivalent expected annual damage. Table 35 displays the impacts of flooding on infrastructure and acreage under existing conditions for the areas upstream and downstream of the Fargo-Moorhead Metro.

Table 34 - Existing and Future without Project Conditions Damages

Existing Conditions Expected Annual Damage			
	Infrastructure	Emergency Costs	Total
Fargo-Moorhead Metro	$190,800	$7,700	$198,500
Upstream of Fargo-Moorhead to Abercrombie	$690	-	$690
Downstream of Fargo-Moorhead to Thompson	$760	-	$760
Equivalent Expected Annual Damage (Including Future without Project Conditions)			
	Infrastructure	Emergency Costs	
Fargo-Moorhead Metro	$187,700	$7,100.00	$194,800
Upstream of Fargo-Moorhead to Abercrombie	$690	-	$690
Downstream of Fargo-Moorhead to Thompson	$760	-	$760

*Figures in $1,000's

Table 35 - Structures and Acres Inundated - Existing Conditions

Downstream of Metro to Thompson

Flood	Homes	Non-Residential	Acres
10%	190	880	224,000
2%	600	2,000	347,000
1%	950	2,400	391,000
0.2%	1,900	3,400	522,000

Upstream of Metro to Abercrombie

Flood	Homes	Non-Residential	Acres
10%	6	13	7,859
2%	96	159	20,364
1%	177	294	31,546
0.2%	464	685	66,567

4.2.3.2 Regional Economy

The Fargo-Moorhead Metropolitan Statistical Area (MSA) straddles the North Dakota and Minnesota border on either side of the Red River. Fargo-Moorhead's business environment continues to grow and is ranked as follows, according to the Greater Fargo-Moorhead Economic Development Corporation (GFMEDC) Web site (2009):

- #5 in Forbes ranking of the Top College Towns for Jobs in May 2009.
- #7 in Forbes Best Places for Business and Careers in March 2009. This is the sixth consecutive year that Fargo has made the top ten for small metropolitan areas. The index ranks cities according to cost of doing business, educational attainment of the population, income growth, projected job growth and net migration.
- #1 city in North Dakota for entrepreneurial start ups, according to Business Week.
- #8 in MSN and CareerBuilder.com's October 2008 list of the 25 Best Markets to Find a Job.

With one of the lowest unemployment rates in the nation, Fargo-Moorhead has experienced gains in income and employment for the last 5 years that exceed the national average. Also, according to Moody's Economy.com, the Fargo-Moorhead economy continues to rank among the highest in vitality for U.S. metropolitan areas (GFMEDC 2009).

The Fargo-Moorhead MSA unemployment rate in October 2009 was 3.5 percent, which had increased from 1.6 percent in October 2000 despite seasonal fluctuations (Job Service North Dakota 2010). However, the unemployment rate in March 2009 hit a 10-year high at 5.1 percent.

Historically, the economy in Fargo-Moorhead has been dependent upon agriculture; however, that has changed substantially in recent decades. Now, the economy is based on retail trade, healthcare, technology, higher education and manufacturing. Major employers in the Fargo-Moorhead MSA are in the healthcare and education industries. Among the companies with the largest number of full-time employees (FTEs), the top five are in one of these two industries. MeritCare Health Systems is the largest employer with 3,691 FTEs (GFMEDC 2010). North Dakota State University is the second-largest with 2,401 FTEs. Notable mentions in other industries, such as back office operations, are the US Bank Service Center with 952 FTEs, and in the technology industry, Microsoft with 948 FTEs.

4.2.3.3 Population size and composition

According to the 2009 ACS, the population of the Fargo-Moorhead metropolitan area is estimated to be 194,839 persons. Based on the 2010 census, the total population in the 12-county study area is estimated to be 377,631 persons (U.S. Census Bureau, 2010 Census). As reported by the 2009 ACS estimates, the gender ratio within the metro area is nearly 1:1 (50 percent male and 50 percent female) and the median age is 30.2 years. Nationally, the population is 51 percent female and the median age is 36.7 years. Persons under 18 years old represent 23 percent of the population, which is lower than the national percentage of 25 percent. The percentage of residents over the age of 65 years (10.2 percent) is also lower in the metro area than the national percentage of 13 percent (U.S. Census Bureau, 2009 ACS). The communities downstream of the metro area have lower percentages of persons under 5 years old, but higher concentrations of persons over 65 years old. It can generally be said of the downstream communities that, on average, they have a slightly higher percentage of older persons than is found in the metro area.

With the exception of Clay County, MN and Polk County, MN, and Grand Forks and Cass Counties, ND, all the other counties in the study area experienced a decline in population between 2000 and 2010. The decreases ranged from 4.4 percent to as much as 16.1 percent. Over the past 50 years, the communities downstream of the Fargo-Moorhead metro area have seen population losses of between 10 and 35 percent. The population of nearly every city and township between Fargo-Moorhead and Thompson, ND has decreased, with the exception of Oakport and Kragnes Townships, which are located immediately downstream of the metro area (U.S Census Bureau, 2000).

4.2.3.4 Household structure

The ACS estimates from 2009 indicate that the average size of the 84,330 households in the metro area is 2.3 persons, compared to an average size of 2.6 persons nationally. In 2000, there were nearly 70,000 households in the metro area and a total 128,262 households in the 12-county study area (U.S. Census Bureau, 2000 Census). In the metro area, more than half (58 percent) of these households consisted of families (46 percent married couples and 12 percent other). The majority of nonfamily households consisted of persons living alone, which represented 32 percent of all households. The percentage of married-couple families closely mirrored ACS estimates for the United States as a whole (50 percent); the percentage of households of persons living alone was higher than the estimate for the United States (27 percent); and the percentage of other nonfamily households in the United States was correspondingly lower (6 percent nationally).

4.2.3.5 Race and ethnic diversity

While ethnic diversity in the metro area stands markedly lower than that in the United States as a whole, there seems to be an upward trend in the ratio of non-White residents to White residents. Between 2000 and 2010, nearly all the counties in the study area reported an increase in their share of minority persons. While an estimated 13 percent of U.S. residents were foreign-born in 2006 through 2008, only 4 percent of persons living in the metro area during that period were foreign-born (U.S. Census Bureau, 2009 ACS) . Between 2000 and 2005, immigrants accounted for 54 percent of the Fargo-Moorhead metro area's growth. The universities in the Fargo-Moorhead metro area also attract a foreign student population, adding to its diversity.

Table 36 and Table 37 show the racial and ethnic characteristics of the North Dakota and Minnesota counties, from upstream to downstream based on the latest 2010 Census.

Table 36 - Population Characteristics of Study Areas–North Dakota

Race	North Dakota											
	Richland County		Cass County		Traill County		Grand Forks County		Walsh County		Pembina County	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
White	15,507	95.0%	137,308	91.7%	7,809	96.2%	60,358	90.3%	10,391	93.5%	7,077	95.5%
Non-Hispanic White	15,351	94.1%	135,530	90.5%	7,693	94.7%	59,271	88.6%	9,834	88.4%	6,947	93.7%
Hispanic White	156	1.0%	1,778	1.2%	116	1.4%	1,087	1.6%	557	5.0%	130	1.8%
Non-White	814	5.0%	12,470	8.3%	312	3.8%	6,503	9.7%	728	6.5%	336	4.5%
Black or African American alone	110	0.7%	3,428	2.3%	42	0.5%	1,361	2.0%	25	0.2%	21	0.3%
American Indian and Alaska Native alone	330	2.0%	1,827	1.2%	64	0.8%	1,657	2.5%	168	1.5%	144	1.9%
Asian alone	88	0.5%	3,532	2.4%	21	0.3%	1,292	1.9%	36	0.3%	11	0.1%
Native Hawaiian and Other Pacific Islander alone	9	0.1%	52	0.0%	1	0.0%	40	0.1%	4	0.0%	2	0.0%
Some other race alone	67	0.4%	798	0.5%	89	1.1%	553	0.8%	345	3.1%	58	0.8%
Two or more races	210	1.3%	2,833	1.9%	95	1.2%	1,600	2.4%	150	1.3%	100	1.3%
Total	16,321	100.0%	149,778	100.0%	8,121	100.0%	66,861	100.0%	11,119	100.0%	7,413	100.0%
Minority Population	970	5.9%	14,248	9.5%	428	5.3%	7,590	11.4%	1,285	11.6%	466	6.3%

Source: U.S. Department of Commerce, U.S. Census Bureau, 2010. SF1 and SF3 Tables.

Table 37 - Population Characteristics of Study Areas–Minnesota

Race	Minnesota											
	Wilkin County		Clay County		Norman County		Polk County		Marshall County		Kittson County	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
White	6,381	97.0%	54,684	92.7%	6,455	94.2%	29,495	93.3%	9,119	96.6%	4,484	98.5%
Non-Hispanic White	6,294	95.7%	53,434	90.6%	6,293	91.8%	28,497	90.2%	8,952	94.8%	4,434	97.4%
Hispanic White	87	1.3%	1,250	2.1%	162	2.4%	998	3.2%	167	1.8%	50	1.1%
Non-White	195	3.0%	4,315	7.3%	397	5.8%	2,105	6.7%	320	3.4%	68	1.5%
Black or African American alone	15	0.2%	842	1.4%	13	0.2%	270	0.9%	26	0.3%	11	0.2%
American Indian and Alaska Native alone	64	1.0%	803	1.4%	109	1.6%	453	1.4%	43	0.5%	4	0.1%
Asian alone	18	0.3%	846	1.4%	25	0.4%	218	0.7%	19	0.2%	16	0.4%
Native Hawaiian and Other Pacific Islander alone	0	0.0%	21	0.0%	0	0.0%	2	0.0%	3	0.0%	0	0.0%
Some other race alone	27	0.4%	528	0.9%	92	1.3%	497	1.6%	148	1.6%	12	0.3%
Two or more races	71	1.1%	1,275	2.2%	158	2.3%	665	2.1%	81	0.9%	25	0.5%
Total	6,576	100.0%	58,999	100.0%	6,852	100.0%	31,600	100.0%	9,439	100.0%	4,552	100.0%
Minority Population	282	4.3%	5,565	9.4%	559	8.2%	3,103	9.8%	487	5.2%	118	2.6%

Source: U.S. Department of Commerce, U.S. Census Bureau, 2010. SF1 and SF3 Tables.

Based on 2010 U.S. Census data, downstream communities in both North Dakota and Minnesota had smaller minority populations than Cass County, ND and Clay County, MN with the exceptions being Grand Forks County, ND and Polk County, MN (U.S. Census Bureau, 2010 Census). As reported by the 2010 U.S. Census, the Hispanic/Latino population downstream of Fargo represents 2.4 percent of the entire population. Within Moorhead, Hispanic persons account for 4.5 percent of the total population. As reported by the 2000 U.S. Census, comparing the populations that "speak English less than ‘very well, ’” finds larger non-English proficient populations in Fargo and Moorhead than in their respective downstream communities (U.S. Census Bureau, 2000). In North Dakota, the non-English proficient population downstream is 4.5 percent smaller, on average, than in Fargo. In Minnesota, the difference between the downstream communities and Moorhead is 6.4 percent (U.S. Census Bureau, 2000).

The percentage of residents who speak a language other than English at home was markedly lower in the Fargo-Moorhead metro area than in the United States as a whole (20 percent of persons more than 5 years old nationally vs. 6 percent in the metro area). Approximately one-third of these persons speak Spanish (U.S. Census Bureau, 2009 ACS).

4.2.3.6 Education

According to the 2000 census, 39 percent of the population in the Fargo-Moorhead metro area had an associate degree or higher (compared to 27 percent nationally). In 2009, the percentage of residents in the metro area with an associate degree or higher increased to 45 percent of the population (U.S. Census Bureau, 2009 ACS). During the same time period, persons with a high school diploma accounted for nearly 26 percent of the population in the metro area compared to 29 percent nationally.

As more recent data on the educational attainment of the population is not available for the all 12 study area counties, data from the 2000 U.S. Census was utilized to better understand the levels of educational attainment. All the downstream study area counties in ND had higher percentage of persons with a high school diploma compared to levels exhibited in Fargo. Similarly, the downstream counties in Minnesota had persons with higher levels of persons with a high school diploma than was found in Moorhead. However, persons with College and Bachelor’s degrees were higher in Fargo and Moorhead compared to the downstream counties in their respective states. Table 38 and Table 39 show the levels of educational attainment in the study area counties in North Dakota and Minnesota.

Table 38 - Educational Attainment in Study Areas–North Dakota

Geographic Area	High School Graduates (age 25+)	College Graduates (age 25+)
North Dakota	27.9%	24.5%
Cass County	22.9%	26.9%
Pembina County	31.9%	24.0%
Walsh County	32.1%	24.2%
Grand Forks County	24.4%	27.7%
Traill County	25.9%	27.4%
Richland County	27.4%	25.0%

Source: U.S. Department of Commerce, U.S. Census Bureau, 2000.

Table 39 - Educational Attainment in Study Areas–Minnesota

Geographic Area	High School Graduates (age 25+)	College Graduates (age 25+)
Minnesota	28.8%	24.0%
Clay County	28.2%	25.4%
Kittson County	34.5%	22.9%
Marshall County	37.0%	21.5%
Polk County	31.7%	23.9%
Norman County	34.9%	24.9%
Wilkin County	32.5%	23.5%

Source: U.S. Department of Commerce, U.S. Census Bureau, 2000.

4.2.3.7 Housing

In 2009 (U.S. Census Bureau, 2009 ACS) there were 87,115 occupied housing units in the metro area, compared to 73,356 in 2000 (U.S. Census Bureau, 2000 Census). Nearly six percent of the housing units stood vacant (much lower than the national average of 12 percent), 58 percent were single-unit structures, 39 percent were multi-unit structures, and 3 percent were mobile homes. The median value of owner-occupied housing units was $142, 800. Table 40 shows the housing data for the study area (U.S. Census Bureau, 2009 ACS).

Table 40 - Housing Data in the Study Area

Geographic Area	Housing Units	Percent of Occupied Housing Units
North Dakota	309,043	88.3%
Cass County	64,139	95.2%
Pembina County	4,067	83.3%
Walsh County	5,739	85.1%
Grand Forks County	29,304	91.5%
Traill County	3,760	89.5%
Richland County	7,695	86.8%
Minnesota	2,301,307	89.6%
Clay County	22,976	92.7%
Kittson County	2,738	75.5%
Marshall County	4,885	85.4%
Polk County	14,677	85.2%
Norman County	3,499	84.0%
Wilkin County	3,106	87.0%

Source: U.S. Department of Commerce, U.S. Census Bureau, 2005-2009 American Community Survey 5-Year Estimates.

Based on 2009 estimates (U.S. Census Bureau, 2009 ACS), the median monthly housing cost for mortgaged owners was lower than the comparable national statistic ($1,316 in the metro area and $1,486 nationally). For non-mortgaged owners the cost was $446, which is comparable to the national statistic of $419 and for renters the cost was $597, which is markedly lower than the $817 national statistic. Nearly 14 percent of non-mortgaged owners spent at least 30 percent of their household income on housing, compared to 16 percent nationally; 46 percent of renters (50 percent nationally) fell into this category. More than three-quarters (77.7 percent) of residents lived in the same house they had lived in 1 year before.

4.2.3.8 Journey to work

For commutes to work in Fargo-Moorhead metropolitan area, the proportion of workers who drove alone was somewhat higher than in the United States as a whole (82 percent versus 76 percent nationally), and the proportion who carpooled (9 percent) or used public transportation (1 percent) were somewhat lower. Notably, an estimated 7.1 percent of occupied households had no vehicle available (ACS pooled data from 2006–2008).

The mean travel time to work in all 12 counties in the study area was less than 25 minutes and, with the exception of Marshall and Norman Counties, MN, commute times were less than 20 minutes (U.S. Census Bureau, 2000).

4.2.3.9 City Government

The Fargo City Commission consists of four commissioners and the mayor, who acts as the commission president. Commissioners are elected to four-year terms from the city at large, not from specific precincts. Two commission seats are elected biennially. Each commissioner is responsible for specific portfolios of city departments and projects. Commissioners and mayors are limited to three consecutive four-year terms. The city has 84 full-time fire department personnel, and 83 full-time city police officers.

The city of Moorhead operates under the "city manager" form of government, with an elected City Council serving as decision makers for the community. Their policies focus on long-range goals such as community growth, land use development, capital improvement plans, capital financing and strategic development. The City Manager, who reports directly to the Mayor and the City Council, is responsible for carrying out the established policies and oversees the daily operation of the city of Moorhead.

In Moorhead, the City Manager supervises four departments, each with its own divisions and directors: Community Services, Operations, Fire and Police. The city has 37 full-time fire department personnel, and 55 full-time and 6 part-time city police officers.

4.2.3.10 Recreational Opportunities

The metro area has a number of recreational activities, including ice-skating, figure skating, youth and adult hockey, volleyball, basketball, track, soccer, walking, cross-country skiing, ballroom dancing, table tennis, and broom ball. There are also 39 casinos in public establishments, with profits used for public causes. The area features neighborhood and regional public parks covering over 3,000 acres, 7 public golf courses within Fargo-Moorhead, and soccer and softball/baseball complexes. Biking and walking trails run for more than 99 miles throughout Fargo, Moorhead and West Fargo. There are a number of annual celebrations, including the Fargo Film Festival, Downtown Street Fair, Pioneer Days, Fargo Blues Festival, and Christmas on the Prairie.

Residents of the study area tend to be active in recreational activities. This is evidenced by the numbers that participate in sporting events throughout the year. Many residents are engaged in hunting or fishing. Fargo-Moorhead is a regional hub for the arts, with many local painters, musicians, street fairs, and music venues.

The planning commissions in Fargo and Moorhead aim to increase the "walkability" of their cities and neighborhoods. Participants in Moorhead planning workshops suggested that a park should be within walking distance of all homes and that they would like to see an increase in the connectivity of neighborhoods. The city of Fargo also aims to use smart growth principles to keep the city as compact as possible to limit expensive infrastructure and keep down the cost of energy.

Outside the metro area, numerous parks line the river. Boaters have access to the water from boat ramps on both sides of the river. There are also several shore-fishing facilities. In the unincorporated areas of Clay County, parks and recreation is the second largest land-use category, accounting for 3 percent of the land area. There are five area state parks that provide year-round outdoor recreation activities within a short driving distance of Fargo-Moorhead. Most state parks provide camping, swimming, boating/canoeing, fishing and hiking/biking/snowmobile trails. The cities of Grand Forks and East Grand Forks are about 90 miles from Fargo-Moorhead and offer additional recreation opportunities.

Appendix M, Recreation has additional information on the existing recreational opportunities in the region.

4.2.3.11 Cultural Opportunities

Fargo-Moorhead is home to several art museums, a growing zoo, an active community theater organization, a symphony orchestra and an opera company. The three universities in town host a wide variety of activities ranging from prominent visiting lecturers to internationally-known performing artists. The Fargodome is a 28,000-seat arena adjacent to the North Dakota State University (NDSU) campus and hosts activities ranging from concerts and ice shows to rodeos and monster truck races. Bonanzaville, located in West Fargo, celebrates the region's history through displays and events. The 1926 restored Fargo Theatre is a vintage movie palace with a vaudeville stage. The theatre serves as a multi-purpose facility with capacity for film showings, live productions and meetings, and is a registered historic landmark. It also houses a restored theatre pipe organ, the "Mighty Wurlitzer." The home stadium for the area minor league baseball team, the Fargo Moorhead Redhawks, is located on the NDSU campus. The cities host collegiate athletic events ranging from Division I football to women's basketball. The Fargo Force major junior hockey team plays in the newly constructed Urban Plans Center, which hosted the U-18 World Junior Hockey Championship in April, 2009.

4.2.3.12 Transportation

Transportation planning is done in conjunction with the Fargo-Moorhead Council of Government (Metro COG). Metro COG is the primary transportation planning agency for the metropolitan area. Metro COG coordinates the development of a comprehensive and coordinated transportation system for the area. In addition to roadway networks, Metro COG also works on transit and bicycle routes.

Moorhead has 175 miles in its local street system, of which 156.5 miles, almost 90 percent, are under the City's jurisdiction. Twelve of the remaining miles are under state jurisdiction, of which 6.5 miles are under Clay County's jurisdiction.

Fargo has approximately 552 miles of roadway divided into the following functional classifications: 338 miles of local or residential; 53 miles of local collectors; 77 miles of minor arterial; and 84 miles of principal arterial roadways.

4.2.3.12.1 Major Highways
Fargo Moorhead is connected with northern markets across the United States and Canada via Interstate-94. The I-94/I-90 corridor reaches from Boston and Quebec on the east coast to Seattle on the west coast linking major metropolitan areas, such as Buffalo, N.Y., Cleveland, Detroit, Chicago, Milwaukee, Minneapolis, Montreal and Toronto.

The community is also connected with central markets through the United States via I-29. I-29 reaches from Winnipeg to Kansas City, Missouri, where I-35 continues to the border of Mexico. I-29 also provides direct links to major east-west connections such as I-40, I-70, I-80 and I-90.

4.2.3.12.2 Air Service
Hector International Airport in Fargo is serviced by Delta Airlines, United Airlines, Allegiant Air and American Eagle Airlines with daily jet service to/from Chicago, Salt Lake City, Minneapolis and Denver. Frequent seasonal charter flights are available to points in Nevada and Mexico. Hector also features multiple cargo/freight carriers; six on-site car rental companies; 24-hour full service aviation line services including fueling, aircraft maintenance and avionics repair station; aircraft charter service; flight school; aircraft rental; heated hanger space; and a U.S. Port of Entry with on-site customs services.

4.2.3.12.3 Railroads
Burlington Northern Santa Fe (BNSF) has its Dakota division headquartered in Fargo and serves North Dakota, Northwest South Dakota, Eastern Montana, Western Minnesota and the Canadian province of Manitoba with 60 trains per day. **An Intermodal Port** operated by Burlington Northern Santa Fe, located 3 miles east of downtown Fargo-Moorhead in Dilworth, MN handles flatcar shipments of trailers, containers, and other freight.

Railroad service is offered to multiple industrial park sites within the Fargo-Moorhead area, providing convenience and efficiency to the businesses using the services. Otter Tail Valley Railroad is a short-line railroad serving industrial parks and rural communities throughout Clay County, MN. The Otter Tail Valley Railroad interchanges with the Burlington Northern Santa Fe Railroad and Dilworth yard in Fargo-Moorhead.

Red River Valley & Western Railroad is a short-line regional railroad serving industrial parks and properties in rural communities throughout Cass County, ND. The Red River Valley & Western interchanges with the Burlington Northern Santa Fe Railroad in Casselton, ND and with the Canadian Pacific Railroad just west of Cass County.

Amtrak provides service to the Fargo-Moorhead area with its Chicago - St. Paul - Portland/Seattle route. Two trains arrive and depart daily, one east bound and one west bound.

4.2.3.12.4 Bus

Metro Area Transit, or MAT, Fargo-Moorhead's public bus system, operates 6 days per week on 18 different routes though Fargo, Moorhead and West Fargo; accumulating over 1 million miles each year. Bus travel begins at 6 am (Monday- Friday) and ends as late as 10:15 pm (Monday-Friday). Saturday operations are from 7 am until 7 pm. Services provided by MAT include: Para-transit, wheelchair accessibility, bike racks, fare-free rides for college students and park-and-ride.

Fargo-Moorhead has a Greyhound bus station in the central station of the MAT, located in downtown Fargo. Fargo-Moorhead's Greyhound routes run east to Minneapolis/St. Paul, MN; west through Bismarck, ND to Billings, MT; south to Sioux Falls, SD; and north to Grand Forks, ND.

5.0 ENVIRONMENTAL CONSEQUENCES*

5.1 ENVIRONMENTAL EVALUATION METHODOLOGY

An environmental analysis was conducted for the proposed project and its alternatives, and a discussion of those impacts is presented below. In accordance with the Clean Water Act, a Section 404(b)(1) evaluation has been prepared and can be found in Attachment 1. The no action alternative assumes no federal action but does assume full implementation of emergency protection actions so that some level of flood risk management will continue for the community.

This chapter describes the predicted impacts of the alternatives, including the consequences of the no action alternative, on the relevant environmental resources described in Chapter 4. It evaluates direct, indirect, and cumulative effects, and quantifies these effects whenever possible. Measures and commitments intended to mitigate adverse environmental impacts are described in Attachment 6.

5.2 EFFECTS ON SIGNIFICANT RESOURCES

The analyses recognize that there are links between resources. For example, if an alternative affects streamflows, it may also in turn affect aquatic communities and riparian areas. Changes in these resources could, over time, impact wildlife and cultural resources. Throughout these impact assessments, linkages are discussed where appropriate and are quantified when possible. The significant resources were identified during the scoping process and outlined in the Scoping Document in Appendix F. The effects on these resources are identified in this chapter. Not all resources are highlighted from the scoping document since they will not be affected by the evaluated alternatives.

The "diversion channel alternatives" includes a Minnesota diversion channel sized to carry 35,000 cfs of flow (FCP), a North Dakota diversion channel sized to carry a 35,000 cfs flow (ND35K), and a North Dakota diversion channel sized to carry approximately 20,000 cfs of flow (LPP). The FCP and ND35K alternatives would be operated in a manner that would cause downstream impacts; while the LPP will have features incorporated to minimize downstream impacts, but will have impacts upstream. The features for the three alternatives are described in detail in Chapter 3. Impacts for the no action alternative are only discussed for the resources where there is expected to be an impact; these include water quality, wetlands and floodplain.

Natural Resources

- Geomorphology
- Air Quality
- Water Quality
- Water Quantity
- Wetlands
- Shallow Groundwater
    - Aquifers
- Fisheries and Aquatic Habitat
    - Fish Passage

- Upland Habitat/Riparian Habitat
- Terrestrial Wildlife
- Endangered Species
- Prime and Unique Farmland
- Hazardous, Toxic and Radioactive Waste (HTRW)

Cultural Resources

Socioeconomic Resources
- Social Effects
- Economic Issues
- Environmental Justice

5.2.1 Natural Resources

5.2.1.1 Geomorphology

With the diversion channel alternatives, a proportion of water from the Red River, and select tributaries with the North Dakota diversion alignment, will be diverted around the study area. The proportion and timing of flow diverted will depend on many factors, including the alternative, flood magnitude, and location within the study area relative to project features. Project features will effectively reduce the flood flows into the protected area for events greater than the 50-percent chance event to the 10-percent chance event. This could potentially impact downstream sediment transport and geomorphology of the streams in the study area. For the FCP, this could influence approximately 42 miles or more of Red River habitat. For the LPP and ND35K, this could influence approximately 60 miles of Red River habitat downstream of the control structure, as well as 12 to 13 miles of the Wild Rice River, 43 miles of the Sheyenne River and 3.5 miles of the Maple River downstream of their respective structures. The project also could influence approximately 1.8 miles of Wolverton Creek through operation of a gate located at the tie-back levee under the LPP. In addition to downstream effects, the LPP includes the upstream staging of water on the Red and Wild Rice rivers, as well as Wolverton Creek, which could also affect upstream geomorphic conditions. Finally, construction of most project features will be done outside of existing channels, with rivers permanently re-routed through these features. This could change channel length and slopes and cause channel instability.

5.2.1.1.1 Effect of altered hydraulics and sediment transport on downstream geomorphology

With all of the diversion channel alternatives the flow regime in the Red River within the study area could change the capacity of the river to transport sediment. The LPP and ND35K alternatives also could affect the Maple, Sheyenne and Wild Rice rivers, as well as Wolverton Creek, downstream of their respective structures. However, because all of the affected rivers appear dominated by the transport of fine suspended material (see Exhibit I of Appendix F of Attachment 5 (IF5)), the diversion of a fraction of the river flow is expected to divert a proportional fraction of the total sediment load transported as suspended sediment. This suspended sediment, being fine-grained with very slow settling velocities, can be expected to move through these diversion systems and return to the Red River downstream of Fargo and Moorhead. The changes to river flows within the protected area are not expected to be sufficient for the remaining fraction of the suspended sediment to settle. Therefore, the total sediment budget of the system will be essentially unchanged for all diversion channel alternatives.

The Horace/West Fargo Diversion of the Sheyenne River provides an example of the potential maximum impacts that can be expected from the diversion channel alternatives. As discussed in IF5, the Sheyenne River system has coarser bed material and more coarse suspended sediment than the other affected rivers, meaning that the impacts of diversion on sediment transport would be expected to be the most significant. However, even the somewhat coarser suspended sediment in the Sheyenne River is passed to the diversion channel in proportion to the flow, validating the description of expected future conditions proposed above. Although the bed material of the Sheyenne River (and most of the other rivers in this study) appears to consist of fine or medium sand, this more coarse material is not transported in significant quantities through the system. What little bedload sediment is in the Sheyenne River appears to move primarily past the diversion structure and into the protected area. The presence of the diversion channel and diversion control structures does not appear to have altered the geomorphic behavior of the Sheyenne River within the study area. Recent modeling (West 2001) has shown that monitored locations on the lower Sheyenne River experienced only slight adjustments to channel shape over more than 50 years, including periods after the construction of the two Sheyenne River diversion projects, which have been in place for nearly 20 years. The slight widening of the river in these areas was expected based on the hydrology of the larger Sheyenne River, and was not interpreted as a response to local changes in the flow regime caused by the diversion.

With all of the diversion channel alternatives, it is expected that the diversion of additional flood water will have a similarly small impact on the downstream geomorphology of the rivers under concern. This initial conclusion will be examined more thoroughly during the ongoing geomorphic study of the area rivers being performed for this study. The potential project impacts to the downstream geomorphology of the Red River and its tributaries from the discussed changes in sediment transport are expected to be negligible (see IF5). The Red River is a stable riverine system, neither aggrading nor degrading, with sediment transport primarily in suspension. These characteristics are not expected to change significantly following construction of any of the diversion channel alternatives.

5.2.1.1.2 Effect of altered channel length on channel stability

Construction of the Red River control structure could alter stream length adjacent to the feature under any of the diversion channel alternatives. Under the LPP and ND35K, additional structures could similarly impact channel slope on the Wild Rice, Sheyenne and Maple rivers. Changes in channel length for Wolverton Creek would be fairly small and localized, relative to these other tributaries. Changes in stream length would cause a proportional increase in local slope and could trigger channel instability.

Existing slopes in the area of flow control structures include:

Red River: 0.006%
Wild Rice River: 0.004%
Sheyenne River: 0.017%

Maple River: 0.024%

Based on aerial measurements for the LPP and ND35K, realignment of the channel on these rivers would result in the following approximate changes in stream length. Conditions around the Red River control structure under the FCP would be similar.

Red River: new channel 78% of existing channel
Wild Rice River: new channel 56% of existing channel
Sheyenne River: new channel 88% of existing channel
Maple River: new channel 77% of existing channel

Although all new channels would result in a decrease in channel length, these changes will not necessarily cause increased velocity or trigger instability in the realigned channel. The realigned channel will not necessarily have the same cross-sectional area as the abandoned channel. Careful design would be able to maintain approximately the same channel velocities during lower-flow conditions by altering the cross-sectional area of the realigned channel (i.e. provide a slightly wider channel to compensate for the slightly higher slope). Given the very low slopes typical of these rivers, the locally increased slopes will likely not be out of the range of slopes observed in short reaches of the existing rivers. Under high-flow conditions, flow through the realigned channels will typically be controlled by downstream tailwaters and the velocities will not be sensitive to the small local changes in channel slope proposed here. With careful design and planning under any of the diversion channel alternatives, the shortening of river channels would not cause substantial changes to channel stability or geomorphic condition at the placement of structures.

5.2.1.1.3 Effect of upstream staging on upstream geomorphology

The LPP includes the upstream staging of water on the Red and Wild Rice rivers, as well as Wolverton Creek, which could affect upstream geomorphic conditions. The degree of upstream staging is discussed in Section 3.7 and Section 5.2.1.4. This condition is not a part of any other diversion channel alternative.

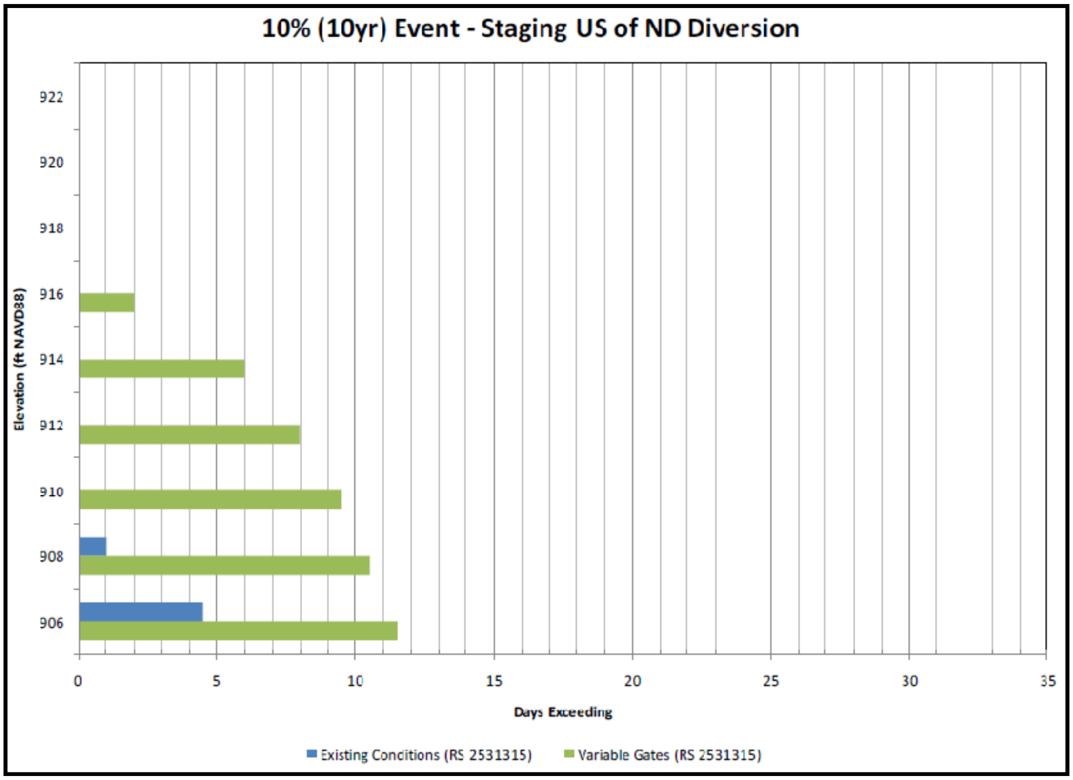
Given the flat slope of the Red River and its valley floor, upstream staging can influence water elevations for several miles upstream. In addition to water elevation, staging can influence water distribution, flow patterns, velocity, and potentially sedimentation and sediment transport. It could also influence bank stability and the potential for bank failure.

Upstream staging under the LPP will not substantially change flow velocities near the Red River channel banks during conditions when water is staged. The stability of banks is likely more controlled by bankfull events, which would not be significantly affected by the LPP. The frequency of project operations is tied to a flow threshold (e.g., 9,600 cfs in the Red River at Fargo) that is equal to or larger than the bankfull discharge. The LPP will not be increasing the frequency that upstream elevations rise above bankfull.

The duration of bankfull conditions could be longer under the LPP, increasing the potential for soil saturation and possibly reducing soil strength in bankline areas. For example, under the

LPP, modeled water elevations for a 10-percent chance event would exceed 906 ft (an elevation a few feet above bankfull) approximately seven days longer than existing conditions (Figure 52). However, the durations under consideration here would not be expected to substantially change soil strength conditions. Also, the LPP should not lead to a meaningful change or increase in key de-stabilizing forces around bankline areas. These include flow velocities, or boundary shear stress applied on the channel banks. Ultimately, the LPP would not be anticipated to result in a substantial increase in bank failure conditions upstream of the project.

Figure 52 Comparison of Increased Water Surface Elevations, between with-project and existing conditions, Upstream of the Red River Control Structure for the simulated 10-percent chance event.



While some sedimentation may occur across inundated upstream areas, it is not expected that a substantial amount of material will settle from the water, relative to the total amount being transported by the river during flooding. The amount of settlement would not be expected to substantially reduce the amount of sediment transported during floods, and thus trigger additional geomorphic concerns upstream or downstream of the control structures. Also, any settlement that would occur would cause negligible increases in floodplain elevations behind the control structures. Based on sediment transport observations from the 2010 flood, even if all river sediment settled during such a flood during project operations, the average level of elevation increase across the inundated area would be less than 0.02 inches under those conditions. This would not significantly influence floodwater storage, or reduce the ability to stage water upstream.

5.2.1.2 Air Quality

The Fargo-Moorhead area is considered a National Ambient Air Quality Standards (NAAQS) Attainment Area for all air quality parameters (USEPA 2009). The air quality effects of the diversion channel alternatives would be the same or similar. Heavy equipment would produce small amounts of hydrocarbons in exhaust emissions compared to total hydrocarbon emission in the area. The construction contractor would be required to maintain the vehicles on the sites in good working order to minimize exhaust emissions. Fugitive dust could also result from construction activities so the contractor would be required to conduct dust suppression activities. Adverse impacts to air quality resulting from the activities would be minor and short term in nature regardless of the alternative that is implemented.

5.2.1.3 Water Quality

5.2.1.3.1 No Action Alternative

There are many initiatives and programs in place in the study area that have and will continue to improve water quality. The Red River Basin Commission has been working with the local soil and water conservation districts, watershed districts and Pheasants Forever on the Red River Basin Buffer initiative. The goals of this initiative are to demonstrate a process for restoring strategically targeted riparian buffers within a small watershed so the process can be duplicated throughout the Red River Basin. This initiative will also demonstrate the water quality benefits of these restorations. Measurable goals include establishing buffers, restoring prescribed wetlands within the watersheds, reducing sediment concentrations/loads at stream sites, reducing total phosphorus concentrations/loads at stream sites, and educating the public about benefits of buffers to promote their implementation. Water quality is expected to improve under the no action alternative.

5.2.1.3.2 All diversion channel alternatives

All of the diversion channel alternatives would likely have temporary minor adverse impacts on surface water quality. The removal of the river substrate and the placement of rock would result in moderate increases in suspended solids in the river water during the construction period. Once the construction has been completed, water quality would return to pre-project conditions. Erosion from storm water runoff from the terrestrial construction areas also could have the potential to negatively impact surface water quality during construction and until the area has developed a protective ground cover. In order to minimize any erosion and sedimentation that could occur, a Storm Water Pollution Prevention Plan (SWPPP) would be prepared for the site, and the measures indicated in the plan would be implemented for any alternative that is constructed. The SWPPP would contain specific construction measures (e.g., silt curtains, silt fences, drainage swales, hay bales, etc.) to reduce or eliminate runoff impacts during construction activities and reduce the potential for soil erosion after construction. Best management practices (BMPs) as provided by the Environmental Protection Agency (EPA), Storm Water Pollution Prevention Plan Guidance from the North Dakota Department of Health NDPDES program, or in the Minnesota Pollution Control Agency’s “Protecting Water Quality in Urban Areas: A Manual” would be used. The construction contractor would also be required to implement protective measures to prevent spillage of chemicals, fuels, oils, greases, bituminous materials, waste washings, herbicides, insecticides, or any other materials associated with construction activities, and keep these materials from entering drainages. With implementation of measures identified in the SWPPP and the incorporation of BMPs to reduce spillage, all of the diversion channel alternatives would be anticipated to have only temporary, minor adverse impacts on surface waters.

5.2.1.4 Water Quantity

All of the diversion channel alternatives will change the timing and flows of water, significantly reducing the quantity of water flowing through the communities of Fargo and Moorhead. As a result of the modifications to the timing of the flows, downstream and/or upstream impacts are anticipated. These impacts are identified in Table 41-Table 44.

These tables show the increase in inches of water depths downstream at nineteen locations and upstream at three locations with the project in place versus existing conditions with no emergency measures in place.

5.2.1.4.1 FCP

Analysis for the FCP alternative for downstream impacts compares stages for existing conditions versus 10-, 2-, 1-, and 0.2-percent chance events. Table 41-Table 44 and Figure 53 - Figure 56 indicate the difference in water quantities for these events compared to existing conditions with no emergency protection in place.

The affected area for the FCP was based on the diversion outlet entering the Red River at RM427. The analysis extends downstream 272 river miles to Emerson at RM155. This defines the area analyzed for the FCP. The number of acres currently affected, with no emergency protection in place, for the 10-percent chance event within the area analyzed is 224,205 acres. The area affected during a 10-percent chance event with the FCP in place would be 231,553 acres, for an increase of 7,348 acres. The depth of increase will vary throughout the area with increases from 0.1 inch to 2.9 inches expected. The number of acres currently affected for the 2-percent chance event is 347,214 acres. The area affected during a 2-percent chance event with the FCP in place would be 357,200 acres, for an increase of 9,986 acres. The depth of increase will vary throughout the area with increases from 0.1 inch to 9.7 inches. The number of acres currently affected for the 1-percent chance event is 390,942 acres. The area affected during a 1-percent chance event with the FCP in place would be 409,163 acres, for an increase of 18,221 acres. The depth of increase will vary throughout the area with increases from 0.7 inch to 12.5 inches. The number of acres currently affected for the 0.2-percent chance event is 522,229 acres. The area affected during a 0.2-percent chance event with the FCP in place would be 531,975 acres, for an increase of 9,566 acres. The depth of increase will vary throughout the area with increases from 0.8 inch to 5.6 inches (Table 41 - Table 44, Figure 53 – Figure 56). The figures only show impacts to Drayton, which is 50 miles upstream of Emerson.

Increases in the level and duration of downstream flooding would have no appreciable effects on natural resources, but may result in significant adverse effects on social resources.

Table 41 – Downstream and upstream water quantity, LPP, FCP, and ND35K – 10%

10% Chance (10-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	0.1	--
Pembina Gage	--	0.1	--
Drayton Gage	0.1	0.1	--
ND SH#17/MN SH317	0.2	0.1	--
Co. Hwy 15	0.1	0.1	--
Oslo Gage	0.5	0.1	--
DS Grand Forks Levees	1.0	0.2	--
Grand Forks Gage	1.3	0.2	--
LPP Maximum DS Impact Location	1.4	--	--
32nd Ave, Grand Forks	1.3	0.4	--
Thompson Gage	0.5	1.2	12.2
Hwy 25/Co.Rd 221	0.5	1.4	13.3
ND35K Maximum Impact Location	--	--	13.9
DS Sandhill River/Climax	0.4	1.6	13.6
Nielsville	0.4	1.6	12.6
DS Marsh River	0.5	1.6	11.9
US Goose River/Shelly	0.4	1.8	12.0
Halstad Gage	-1.4	1.8	7.6
Hendrum	-3.0	1.9	8.0
Perley	-6.5	2.4	11.4
Georgetown	-5.2	1.8	10.6
FCP (MN35K) Maximum Impact Location	--	2.9	--
Upstream Locations			
US FCP Diversion	--	1.6	--
US ND Wild Rice River	-61.8	-1.8	-65.2
US LPP Diversion	98.8	--	-0.6
Hickson Gage	79.0	0.5	0.6
Abercrombie	1.3	0.0	--

Table 42 – Downstream and upstream water quantity, LPP, FCP, and ND35K – 2%

2% Chance (50-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	0.7	--
Pembina Gage	--	1.3	--
Drayton Gage	1.0	1.2	--
ND SH#17/MN SH317	0.8	1.2	--
Co. Hwy 15	0.6	1.1	--
Oslo Gage	0.5	0.4	--
DS Grand Forks Levees	1.3	0.8	--
Grand Forks Gage	2.2	1.2	--
32nd Ave, Grand Forks	3.4	2.8	--
LPP Maximum DS Impact Location	4.6	--	--
Thompson Gage	2.9	6.7	20.9
Hwy 25/Co.Rd 221	2.5	8.8	26.9
ND35K Maximum Impact Location	--	--	29.4
DS Sandhill River/Climax	2.5	9.2	29.3
Nielsville	2.2	9.6	25.3
FCP (MN35K) Maximum Impact Location	--	9.7	--
DS Marsh River	1.9	8.5	22.2
US Goose River/Shelly	1.4	8.0	17.3
Halstad Gage	0.0	4.8	10.3
Hendrum	-1.4	4.9	15.1
Perley	-3.8	4.0	9.4
Georgetown	-2.8	3.6	8.0
Upstream Locations			
US FCP Diversion	--	-1.8	--
US ND Wild Rice River	-112.9	0.6	-112.2
US LPP Diversion	85.2	--	0.0
Hickson Gage	55.0	0.4	0.2
Abercrombie	1.7	0.1	--

Table 43 - Downstream and upstream water quantity, LPP, FCP and ND35K – 1%

1% Chance (100-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	0.7	--
Pembina Gage	--	2.0	--
Drayton Gage	1.0	1.7	--
ND SH#17/MN SH317	0.8	1.6	--
Co. Hwy 15	0.6	1.8	--
Oslo Gage	0.7	1.1	--
DS Grand Forks Levees	1.8	2.5	--
Grand Forks Gage	2.9	4.1	--
LPP Maximum DS Impact Location	3.5	--	--
32nd Ave, Grand Forks	3.4	5.8	--
Thompson Gage	0.5	7.0	15.8
Hwy 25/Co.Rd 221	-0.2	10.7	23.6
ND35K Maximum Impact Location	--	--	25.4
DS Sandhill River/Climax	-0.5	11.8	25.3
FCP (MN35K) Maximum Impact Location	--	12.5	--
Nielsville	-0.5	12.4	22.8
DS Marsh River	-0.4	10.7	19.4
US Goose River/Shelly	-0.5	9.2	15.1
Halstad Gage	-0.7	6.2	10.4
Hendrum	-0.7	6.6	11.3
Perley	-3.4	6.6	7.6
Georgetown	-3.0	5.8	8.4
Upstream Locations			
US FCP Diversion	--	6.8	--
US ND Wild Rice River	-107.9	5.3	-105.1
US LPP Diversion	98.8	--	0.2
Hickson Gage	64.6	-0.1	0.1
Abercrombie	1.3	0.0	--

Table 44 - Downstream and upstream water quantity, LPP, FCP and ND35K – 0.2%

0.2% Chance (500-Year) Event			
Location	Stage Increase (Inches)		
	LPP	**FCP**	**ND35K**
Downstream Locations			
Emerson Gage	--	1.0	--
Pembina Gage	--	2.2	--
Drayton Gage	1.3	1.0	--
ND SH#17/MN SH317	0.8	1.0	--
Co. Hwy 15	1.1	1.2	--
Oslo Gage	0.6	0.8	--
DS Grand Forks Levees	1.4	1.9	--
Grand Forks Gage	2.6	4.6	--
LPP Maximum DS Impact Location	3.2	--	--
FCP (MN35K) Maximum Impact Location	--	5.6	--
32nd Ave, Grand Forks	2.8	5.6	--
Thompson Gage	-0.6	2.4	7.2
Hwy 25/Co.Rd 221	-1.4	3.4	6.6
DS Sandhill River/Climax	-1.8	3.8	7.9
ND35K Maximum Impact Location	--	--	8.4
Nielsville	-1.9	4.4	7.7
DS Marsh River	-1.7	4.1	7.3
US Goose River/Shelly	-1.6	3.7	6.5
Halstad Gage	-2.6	1.7	3.7
Hendrum	-3.6	0.8	1.4
Perley	-4.3	-0.4	0.6
Georgetown	-4.0	-0.5	0.2
Upstream Locations			
US FCP Diversion	--	-2.3	--
US ND Wild Rice River	-15.7	2.9	-9.0
US LPP Diversion	78.0	--	1.7
Hickson Gage	34.2	-0.1	-0.4
Abercrombie	0.1	0.0	--

Figure 53 - 10-percent chance event (10-year) downstream extent to Drayton—existing vs. FCP

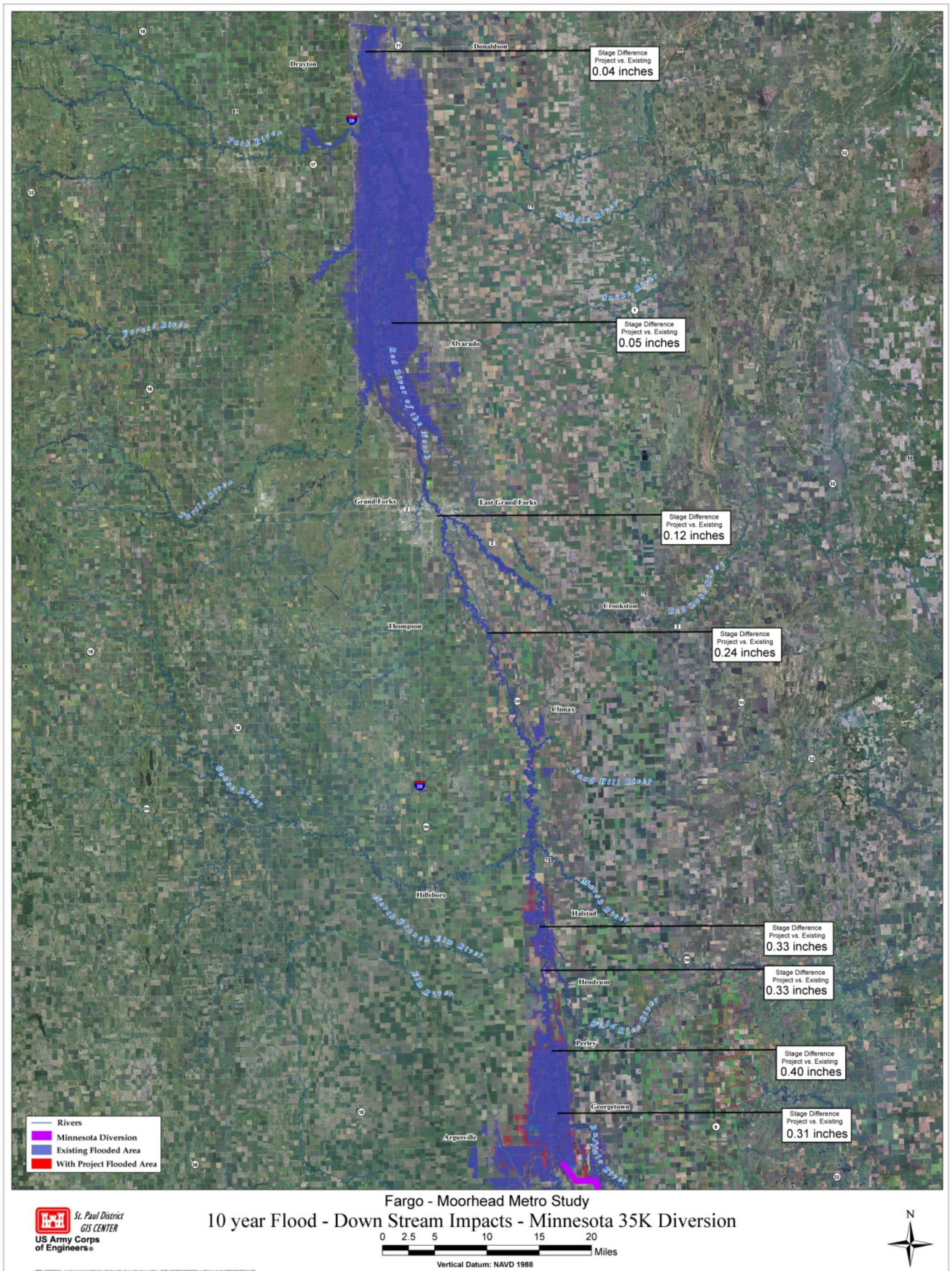


Figure 54 - 2 percent chance event (50-year) downstream extent to Drayton—existing vs. FCP

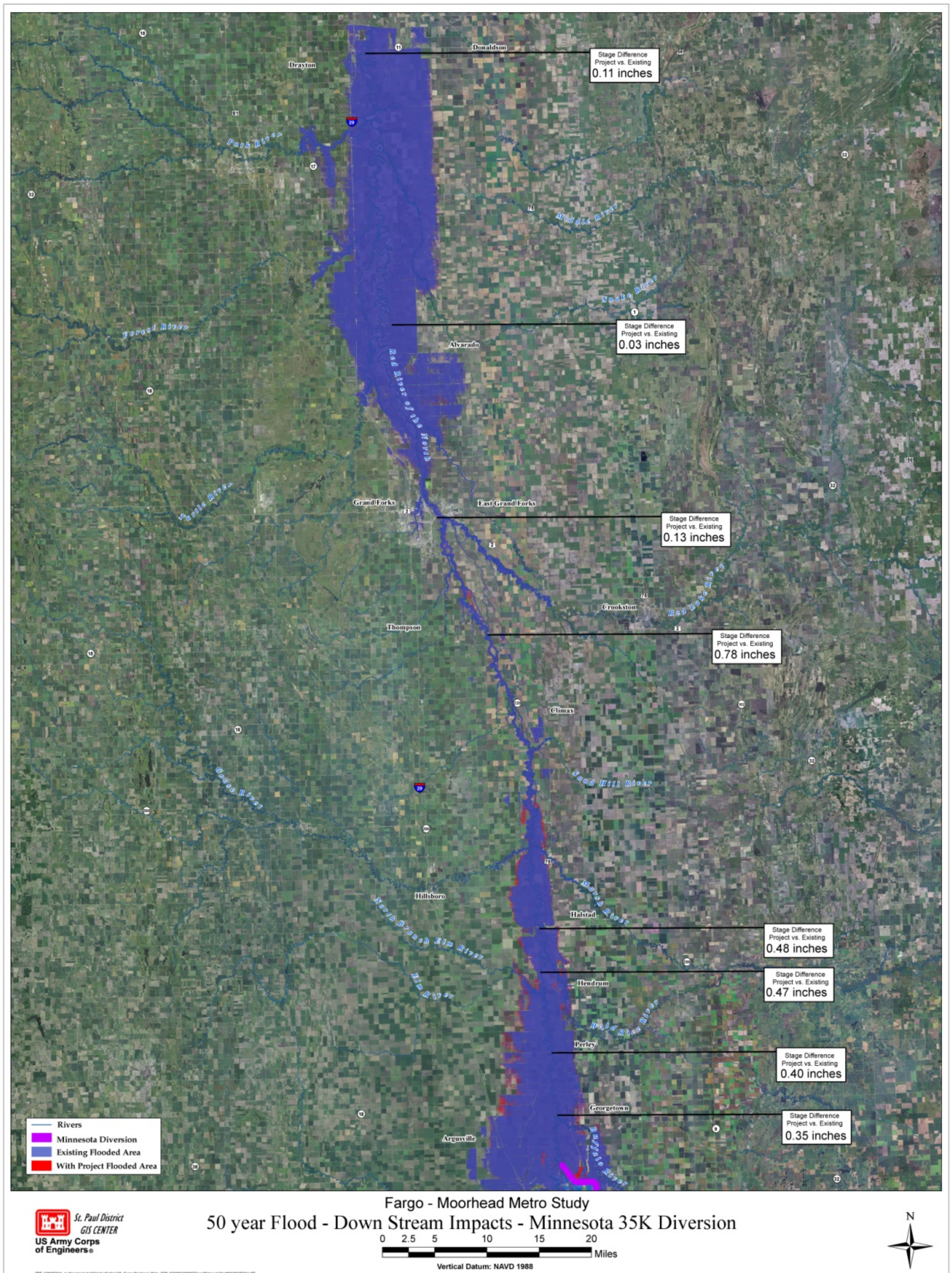


Figure 55 – 1-percent chance event (100-year) downstream extent to Drayton—existing vs. FCP

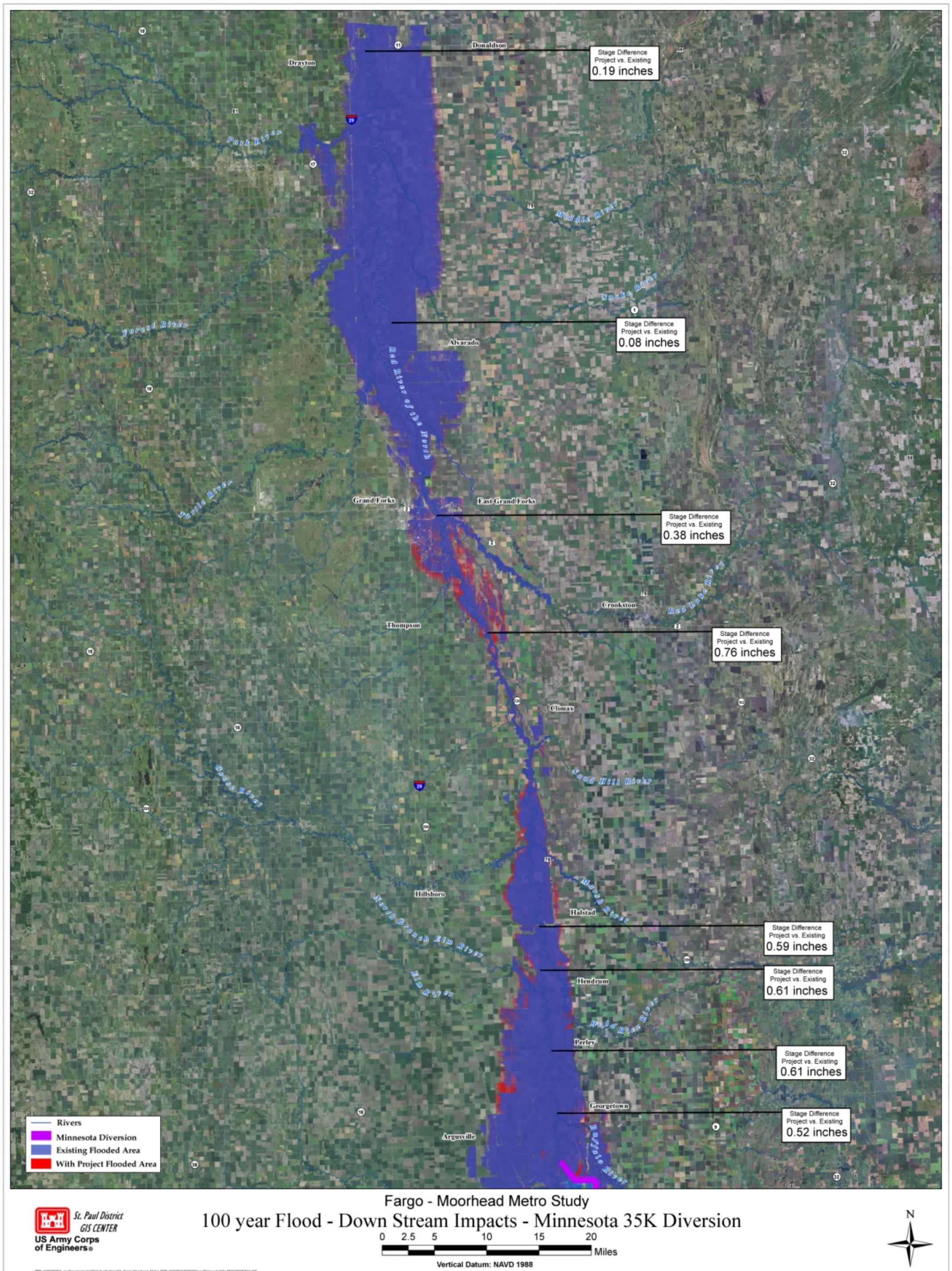
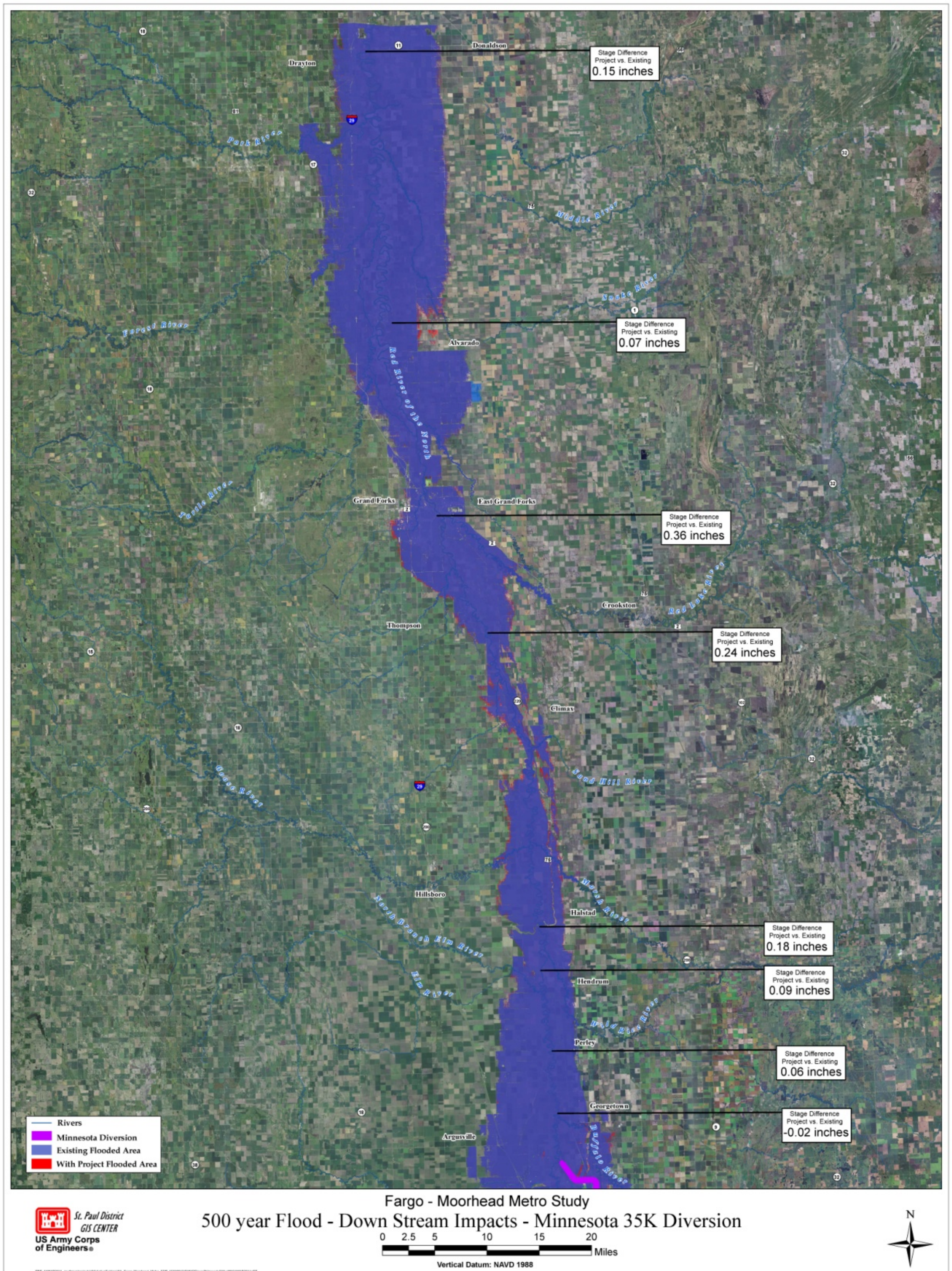


Figure 56 - 0.2-percent chance event (500-year) downstream extent to Drayton—existing vs. FCP



5.2.1.4.2 ND35K

The ND35K alternative was analyzed for downstream impacts. Table 41 - Table 44 and Figure 57 - Figure 64 indicate the difference in water quantity for the 10, 2, 1, and 0.2-percent chance flood events between the conditions with the ND35K plan in place and the existing conditions with no emergency protection in place.

The affected area for the ND35K was based on the diversion outlet entering the Red River at RM 418.5. The analysis extends downstream 102 river miles to Thompson, ND at RM 316. This defines the area analyzed for the ND35K plan. The number of acres currently affected, with no emergency protection in place, for the 10-percent chance event within the area analyzed is 45,676 acres. The area affected during a 10-percent chance event with the ND35K plan in place would be 56,821 acres, for an increase of 11,145 acres. The depth of increase will vary throughout the area with increases from 0.6 inch to 13.9 inches. The number of acres currently impacted for the 2-percent chance event is 112,936 acres. The area affected during a 2-percent chance event with the ND35K plan in place would be 126,705 acres, for an increase of 13,769 acres. The depth of increase will vary throughout the area with increases from 0.2 inch to 29.4 inches. The number of acres currently affected for the 1-percent chance event is 129,424 acres. The area affected during a 1-percent chance event with the ND35K plan in place would be 142,299 acres, for an increase of 12,875 acres. The depth of increase will vary throughout the area with increases from 0.1 inch to 25.4 inches. The number of acres currently affected for the 0.2-percent chance event is 183,296 acres. The area affected during a 0.2-percent chance event with the ND35K plan in place would be 192,602 acres, for an increase of 9,306 acres. The depth of increase will vary throughout the area with increases from 0.2 inch to 8.4 inches. The ND35K plan was not modeled any further than Thompson, ND because the impacts were far greater than those for the FCP. It was assumed that the impacts would continue to be greater than the FCP all the way to Emerson.

Increases in the level and duration of downstream flooding would have no appreciable effects on natural resources, but may result in significant adverse effects on social resources.

Figure 57 – 10-percent chance event (10-year) downstream to Halstad—existing vs. ND35K

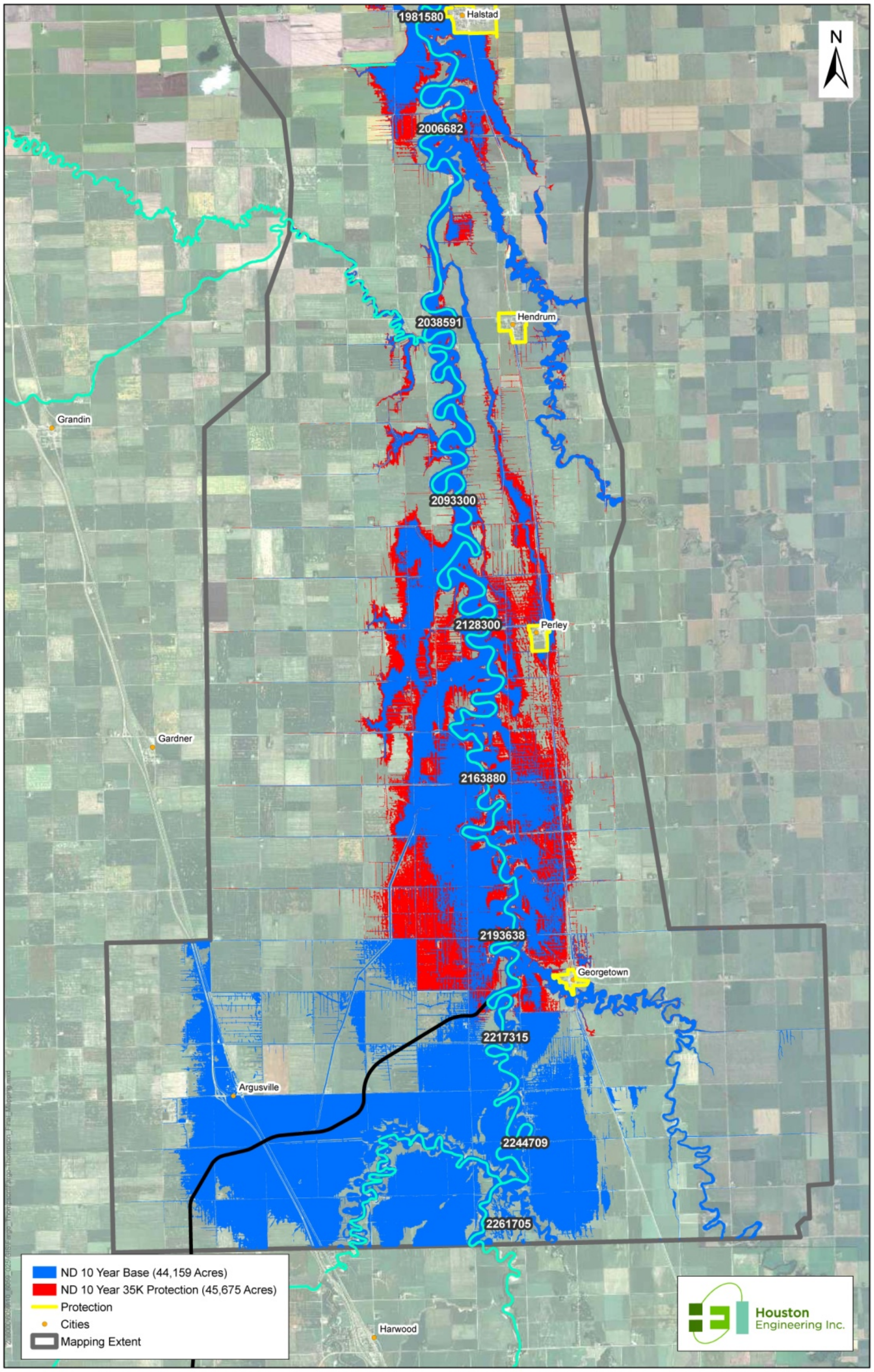


Figure 58 – 10-percent chance event (10-year) from Halstad to Thompson—existing vs. ND35K

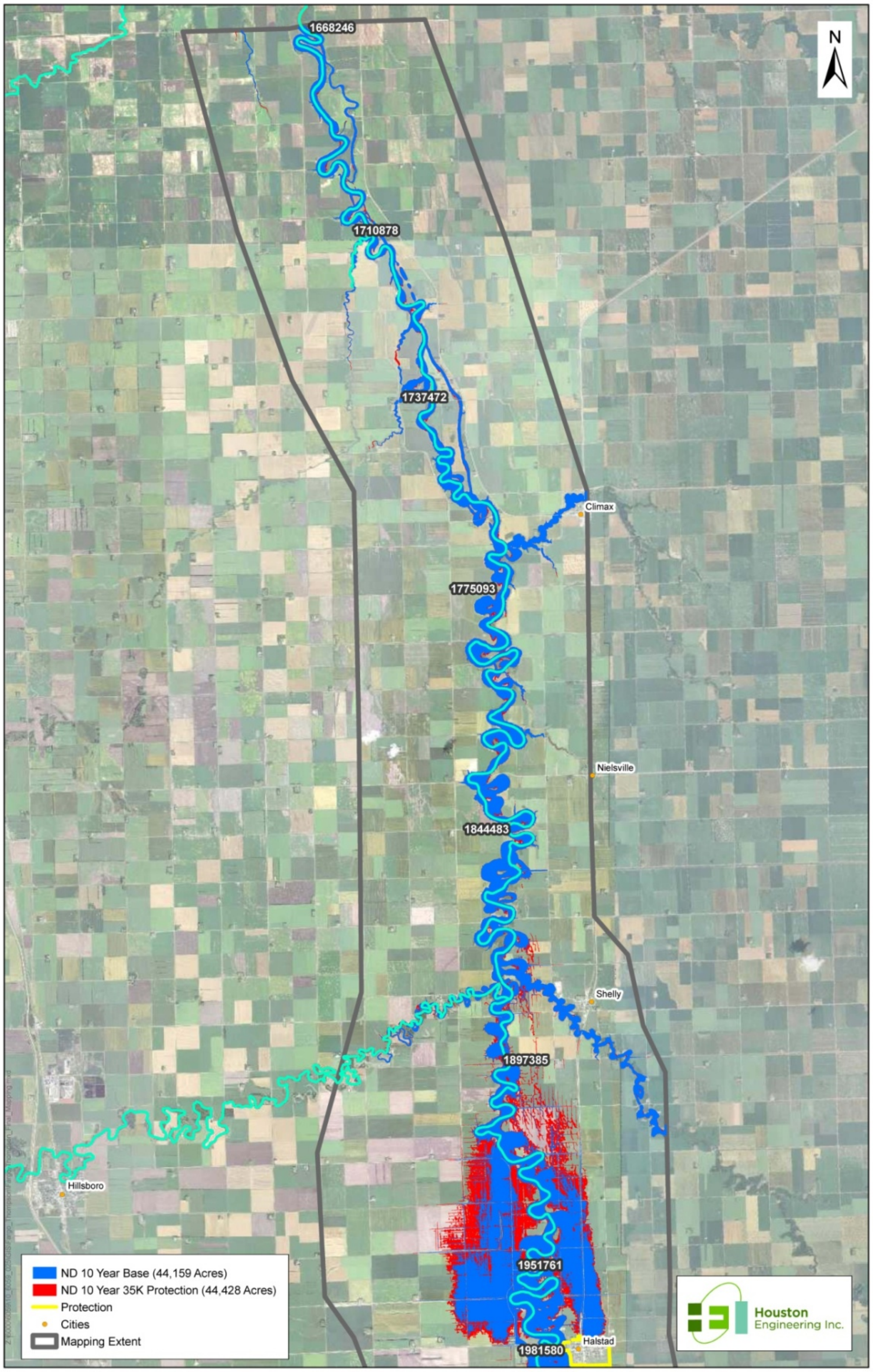


Figure 59 – 2-percent chance event (50-year) downstream to Halstad-existing vs. ND35K

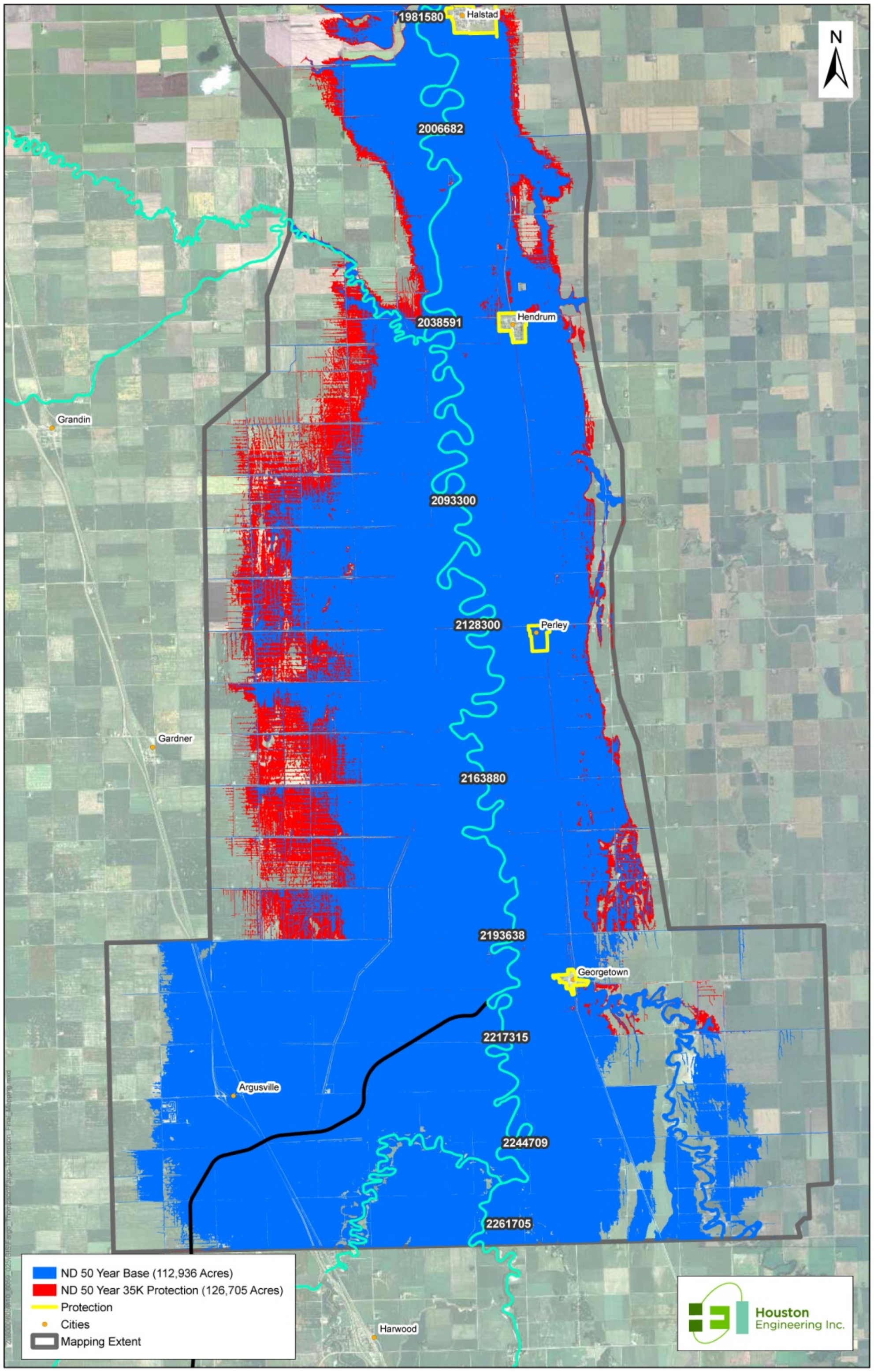


Figure 60 – 2-percent chance event (50-year) from Halstad to Thompson—existing vs. ND35K

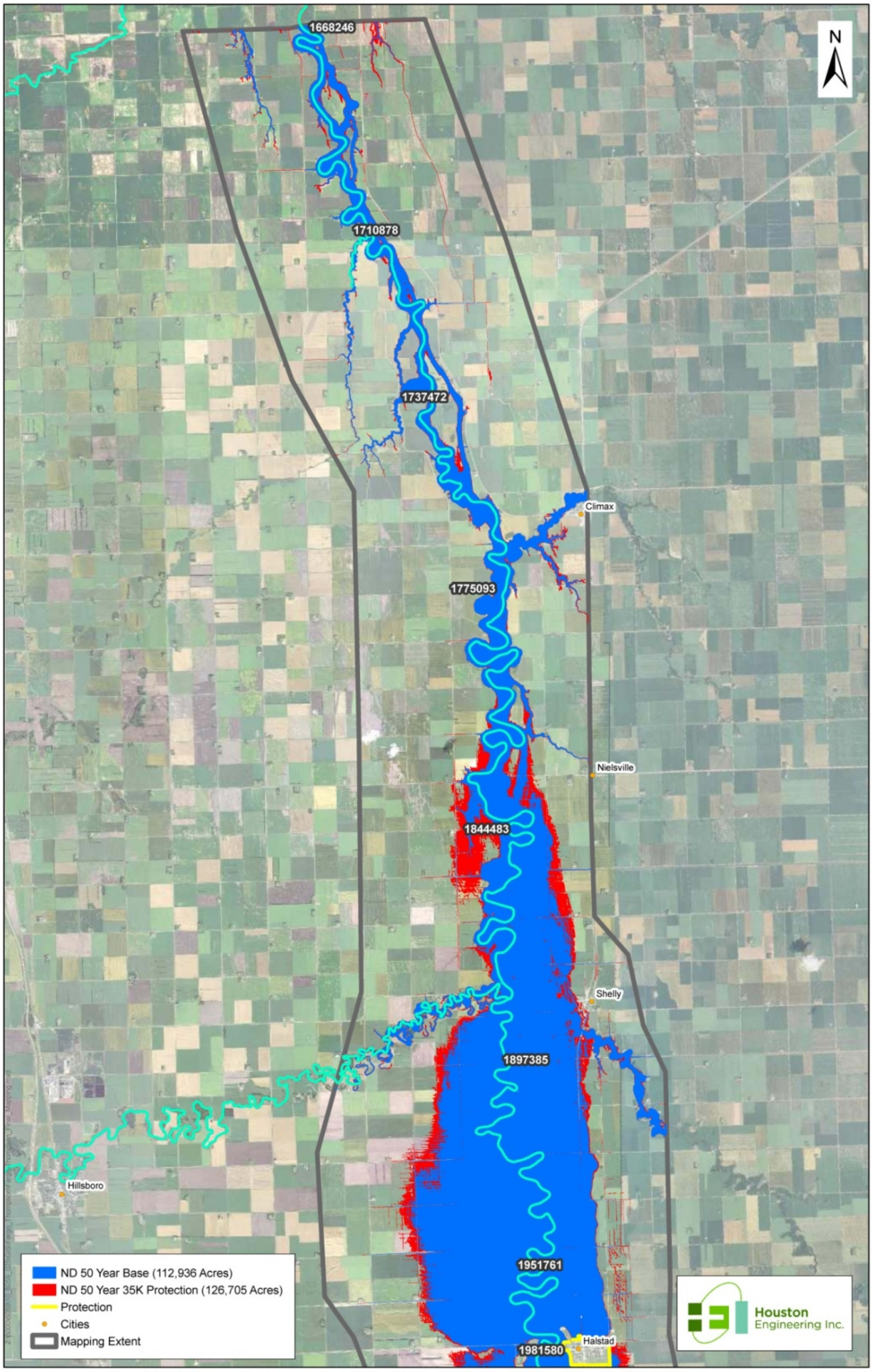


Figure 61 – 1-percent chance event (100-year) downstream to Halstad—existing vs. ND35K

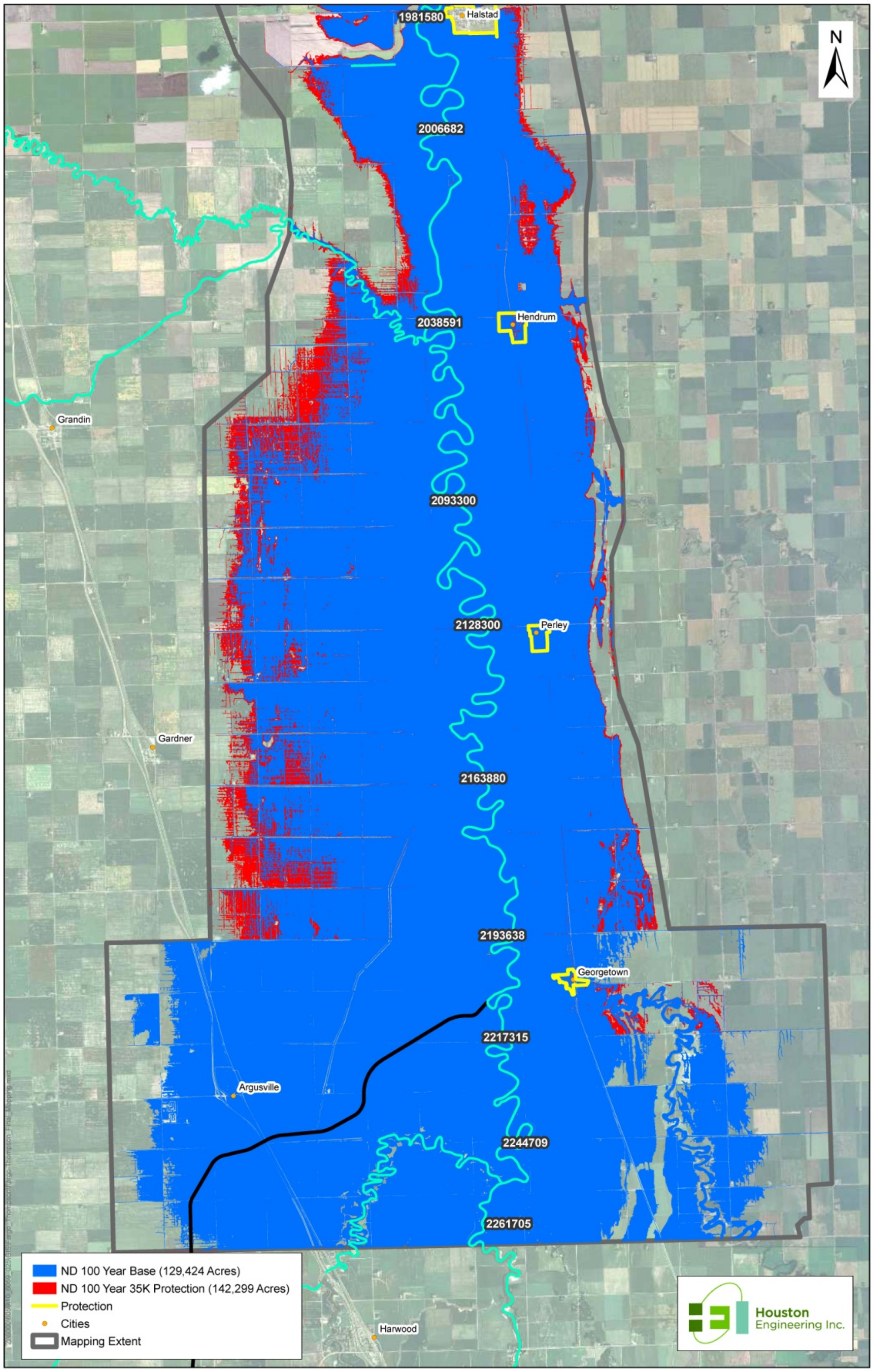


Figure 62 – 1-percent chance event (100-year) from Halstad to Thompson—existing vs. ND35K

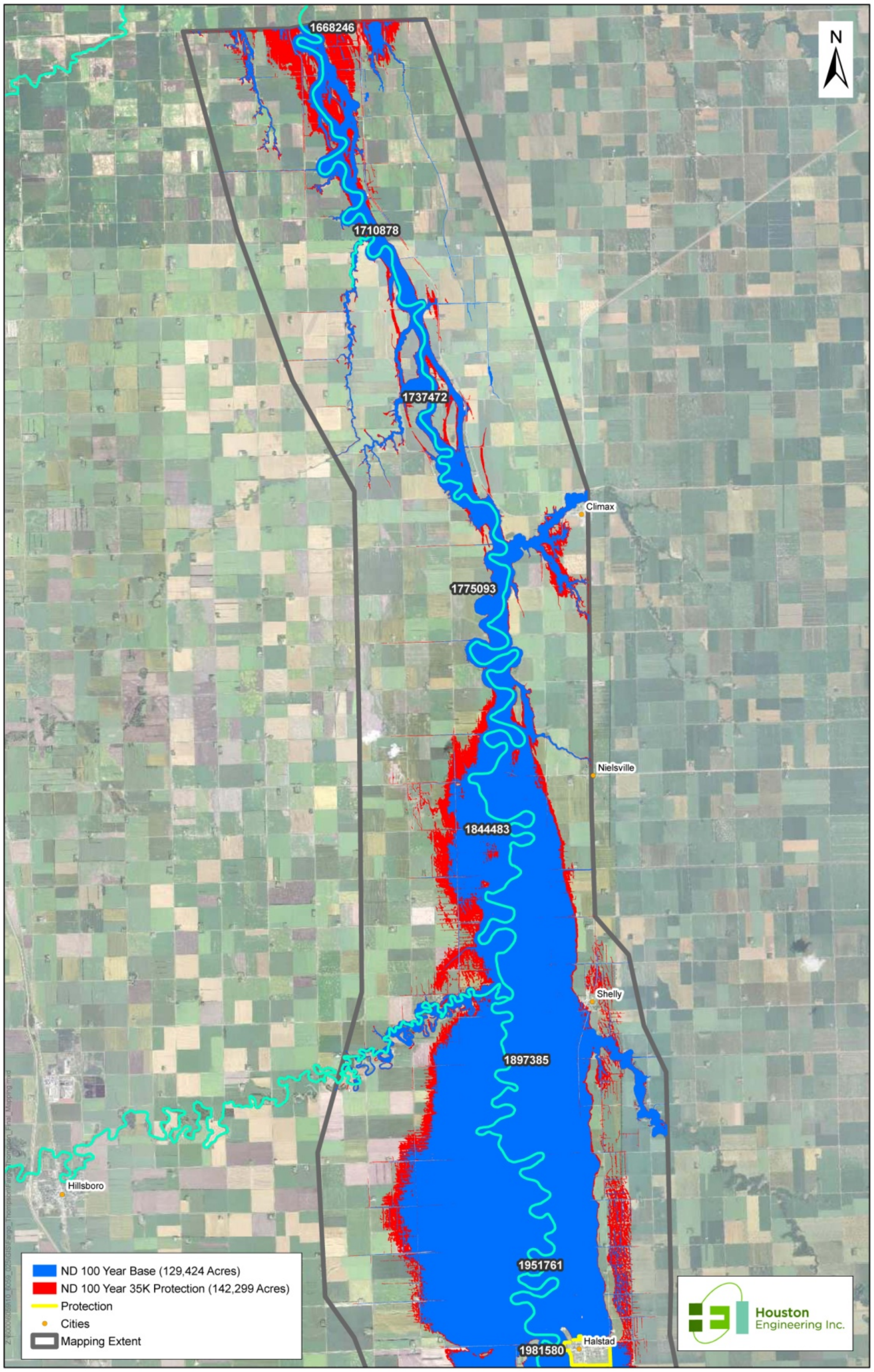


Figure 63 - 0.2-percent chance event (500-year) downstream to Halstad—existing vs. ND35K

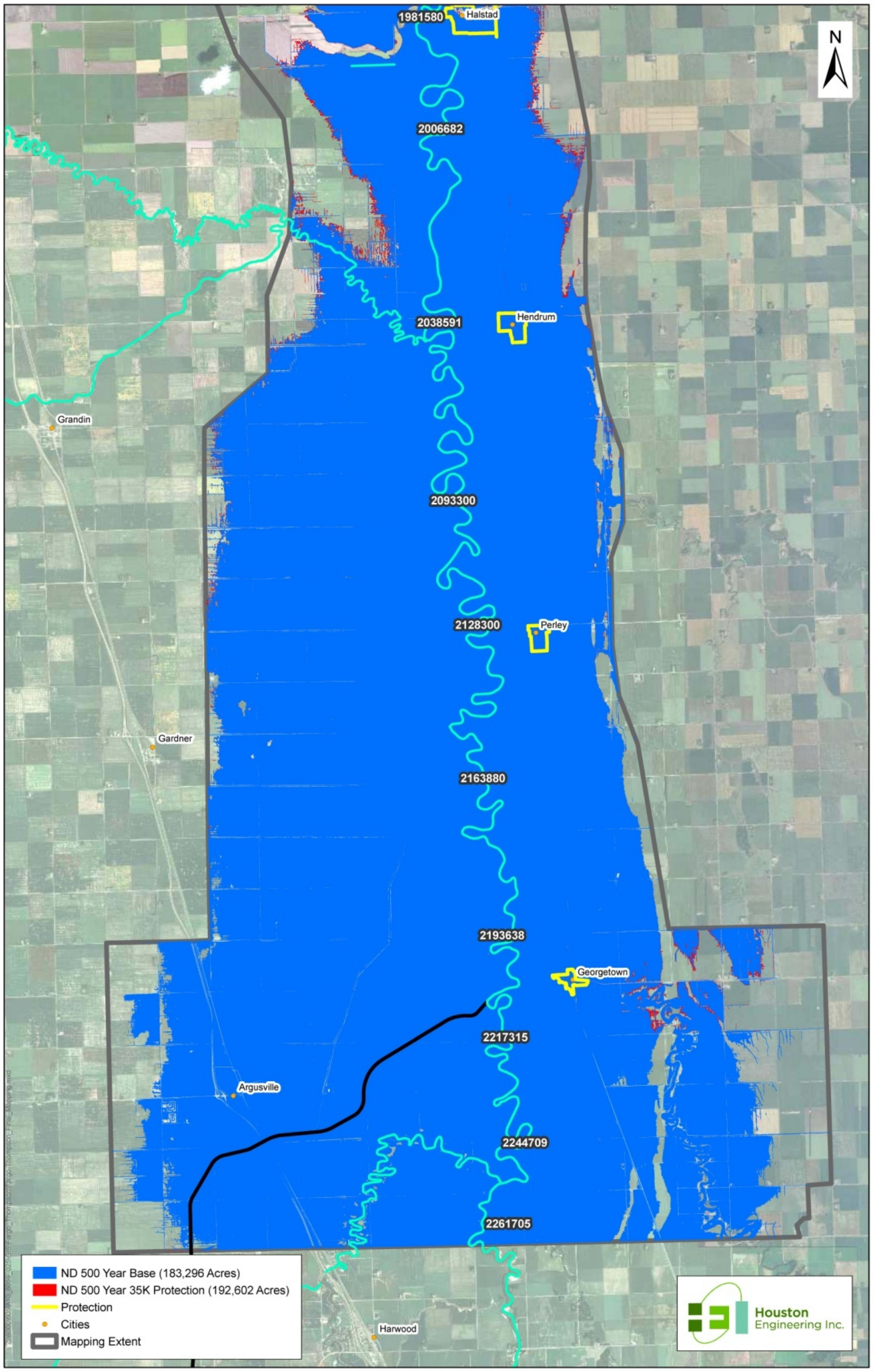
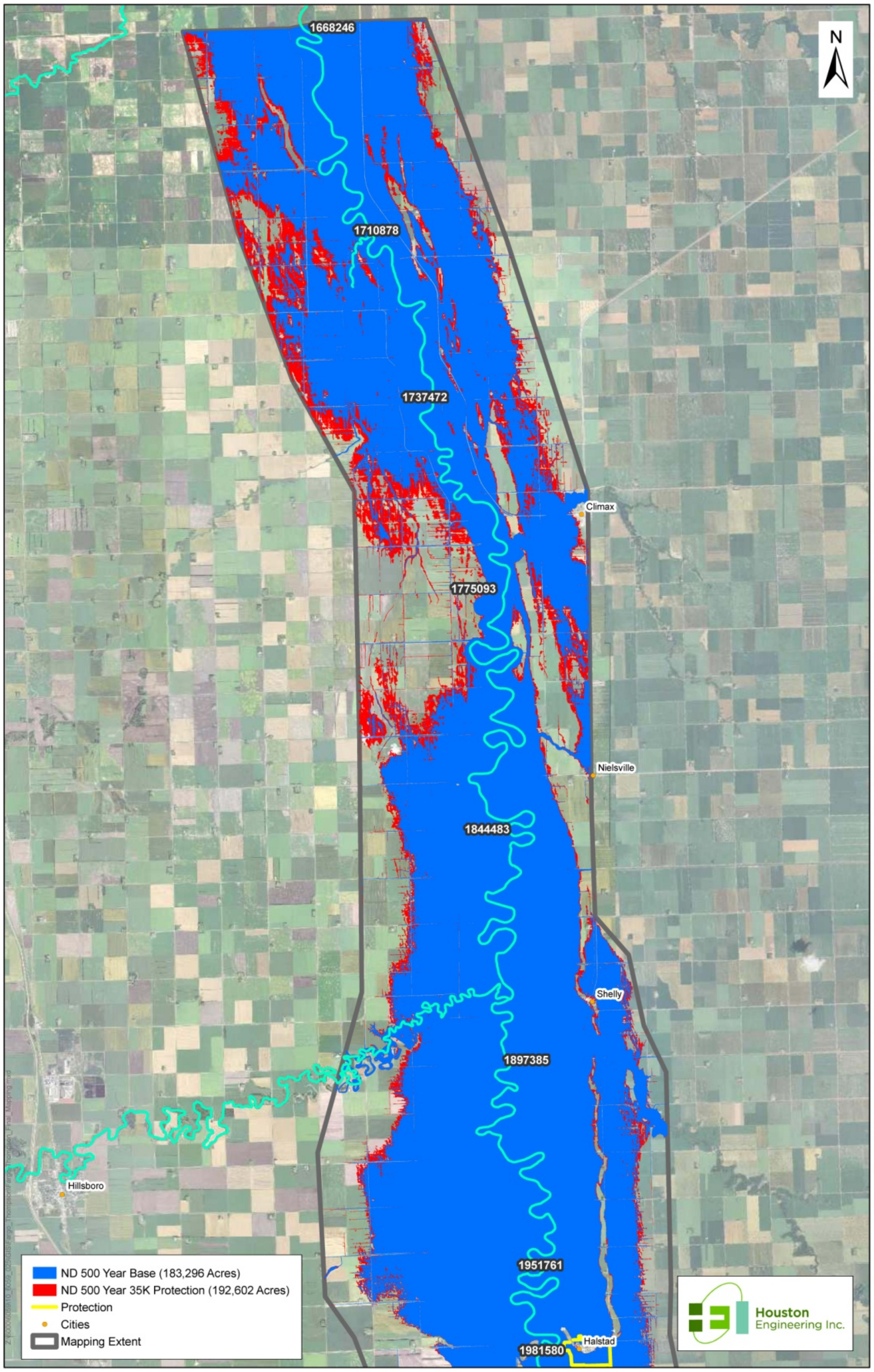


Figure 64 - 0.2 percent chance event (500-year) from Halstad to Thompson—existing vs. ND35K



5.2.1.4.3 LPP

The LPP alternative was analyzed for downstream and upstream impacts. Table 41 - Table 44 and Figure 65 - Figure 72 indicate the difference in water quantity for the 10, 2, 1, and 0.2-percent chance flood events between the conditions with the LPP in place and the existing conditions with no emergency protection in place.

The downstream affected area for the LPP was based on the diversion outlet entering the Red River at RM 418.5. The analysis extends downstream 210 river miles to Drayton, ND at RM 208. This defines the extent of the downstream area analyzed for the LPP. The number of acres currently affected downstream, with no emergency protection in place, for the 10-percent chance event within the area analyzed is 224,166 acres. The area affected during a 10-percent chance event with the LPP in place would be 221,176 acres, for a decrease of 2,990 acres. The number of acres currently affected upstream for the 10-percent chance event with no emergency protection in place is 7,858 acres, while the area affected for a 10-percent chance event with the LPP in place is 20,841 acres. This would be an increase of 12,983 acres at varying levels of depth. The depth of increase will vary throughout the area with increases from 0.1 inch to 98.8 inches expected. The number of acres currently affected downstream for the 2-percent chance event is 347,158 acres. The area affected during a 2-percent chance event with the LPP in place would be 346,696 acres, for a decrease of 462 acres. The number of acres currently affected upstream for the 2-percent chance event is 20,363 acres, while the area affected for a 2-percent chance event with the LPP in place is 38,000 acres. This would be an increase of 17,637 acres at varying levels of depth. The depth of increase will vary throughout the area with increases from 0.5 inch to 85.2 inches expected. The number of acres currently affected downstream for the 1-percent chance event is 390,866 acres. The area affected during a 1-percent chance event with the LPP in place would be 390,557 acres, for a decrease of 309 acres. The number of acres currently affected upstream for the 1-percent chance event is 31,546 acres, while the area affected for a 1-percent chance event with the LPP in place is 54,721 acres. This would be an increase of 23,175 acres at varying levels of depth. The depth of increase will vary throughout the area with increases from 0.5 inch to 98.8 inches expected. The number of acres currently affected downstream for the 0.2-percent chance event is 521,944 acres. The area affected during a 0.2-percent chance event with the LPP in place would be 521,738 acres, for a decrease of 206 acres. The number of acres currently affected upstream for the 0.2-percent chance event is 66,566 acres, while the area affected for a 0.2-percent chance event with the LPP in place is 78,876 acres. This would be an increase of 12,310 acres at varying levels of depth. The depth of increase will vary throughout the area with increases from 0.1 inch to 78.0 inches expected. (Table 41 - Table 45 and Figure 65 - Figure 72.)

Figure 65 - 10-percent chance event (10-year) upstream extent—existing vs. LPP

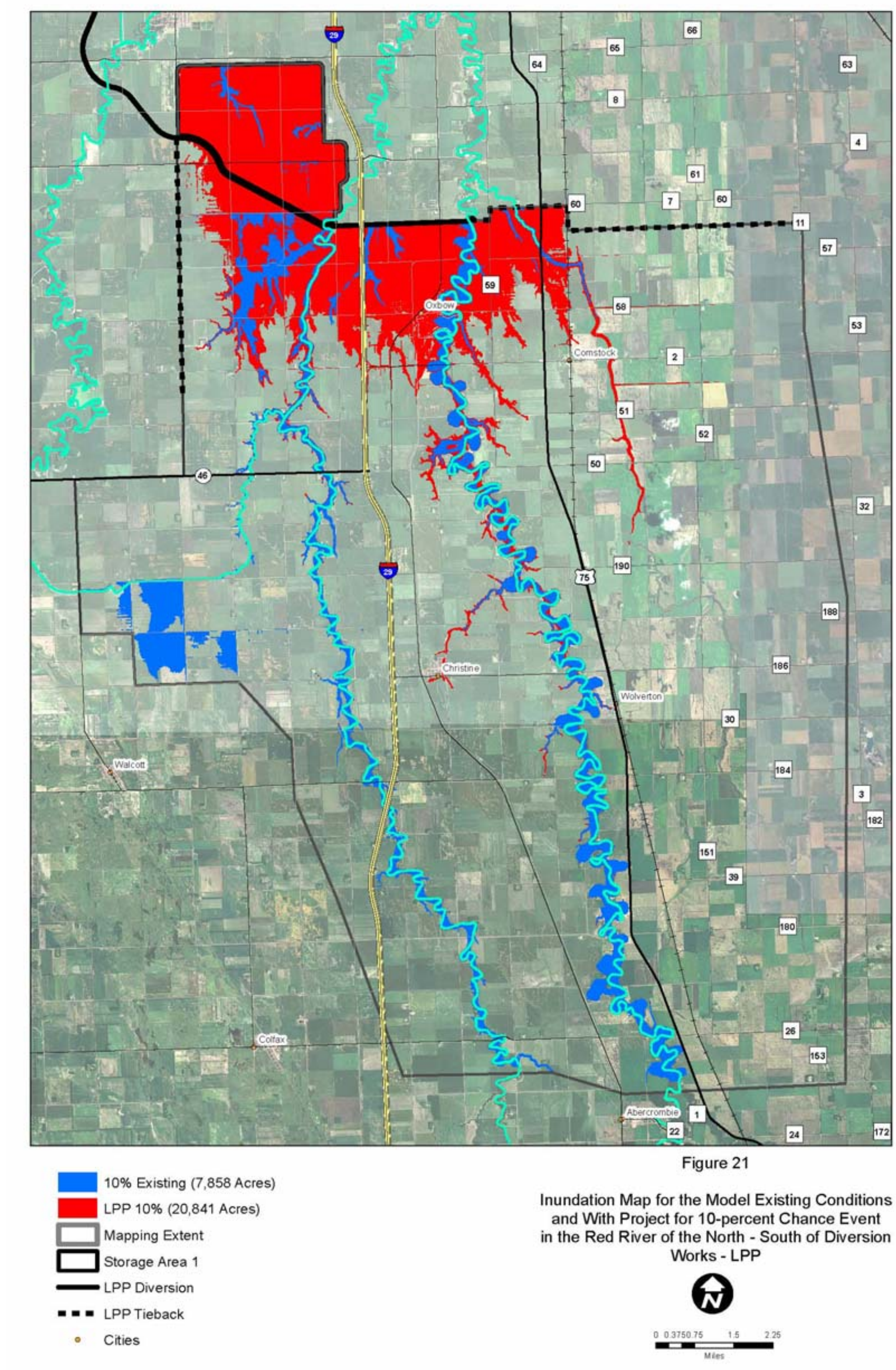


Figure 66 – 10-percent chance event (10-year) downstream extent to Drayton—existing vs. LPP

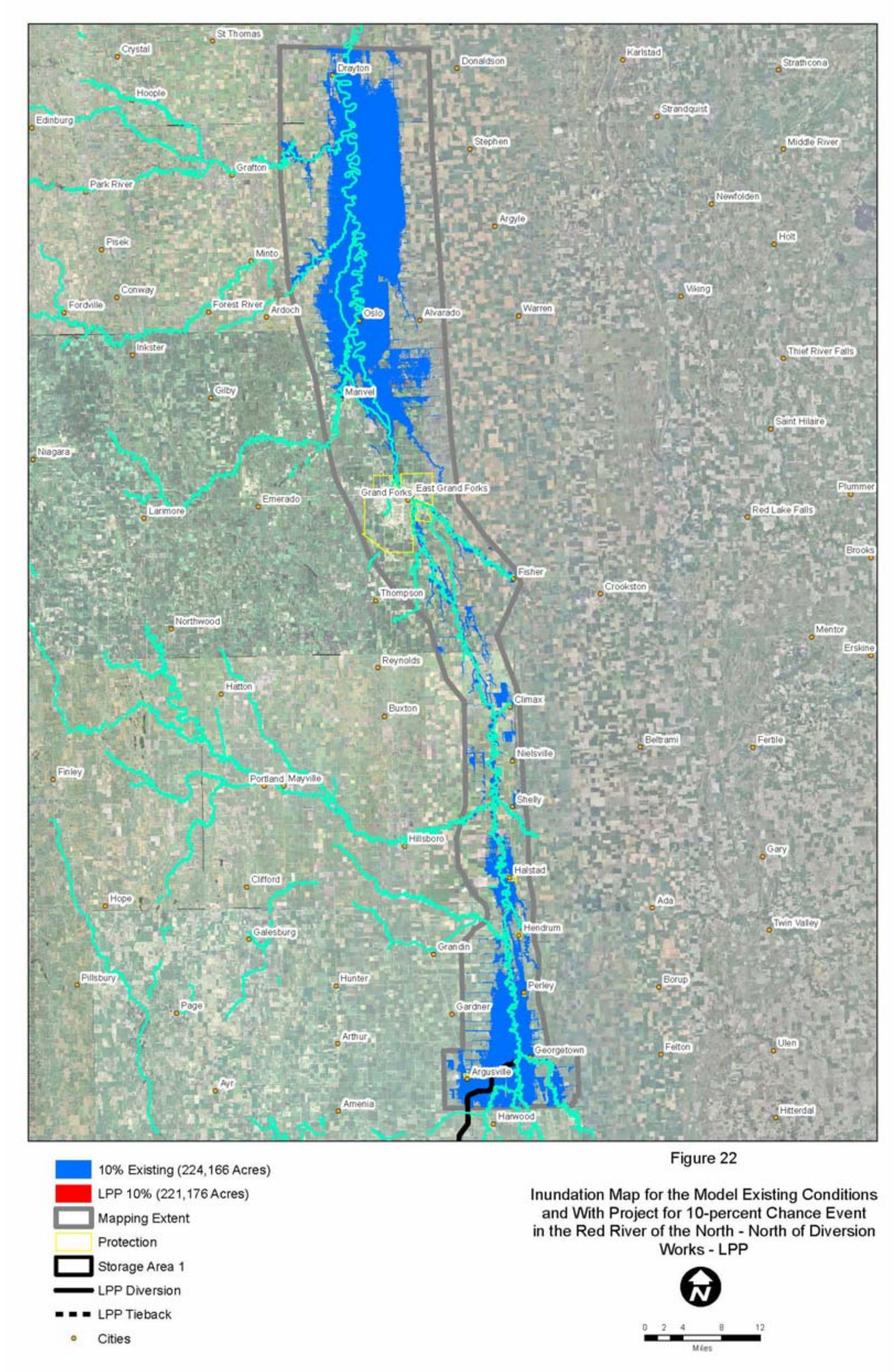


Figure 67 – 2-percent chance event (50-year) upstream extent—existing vs. LPP

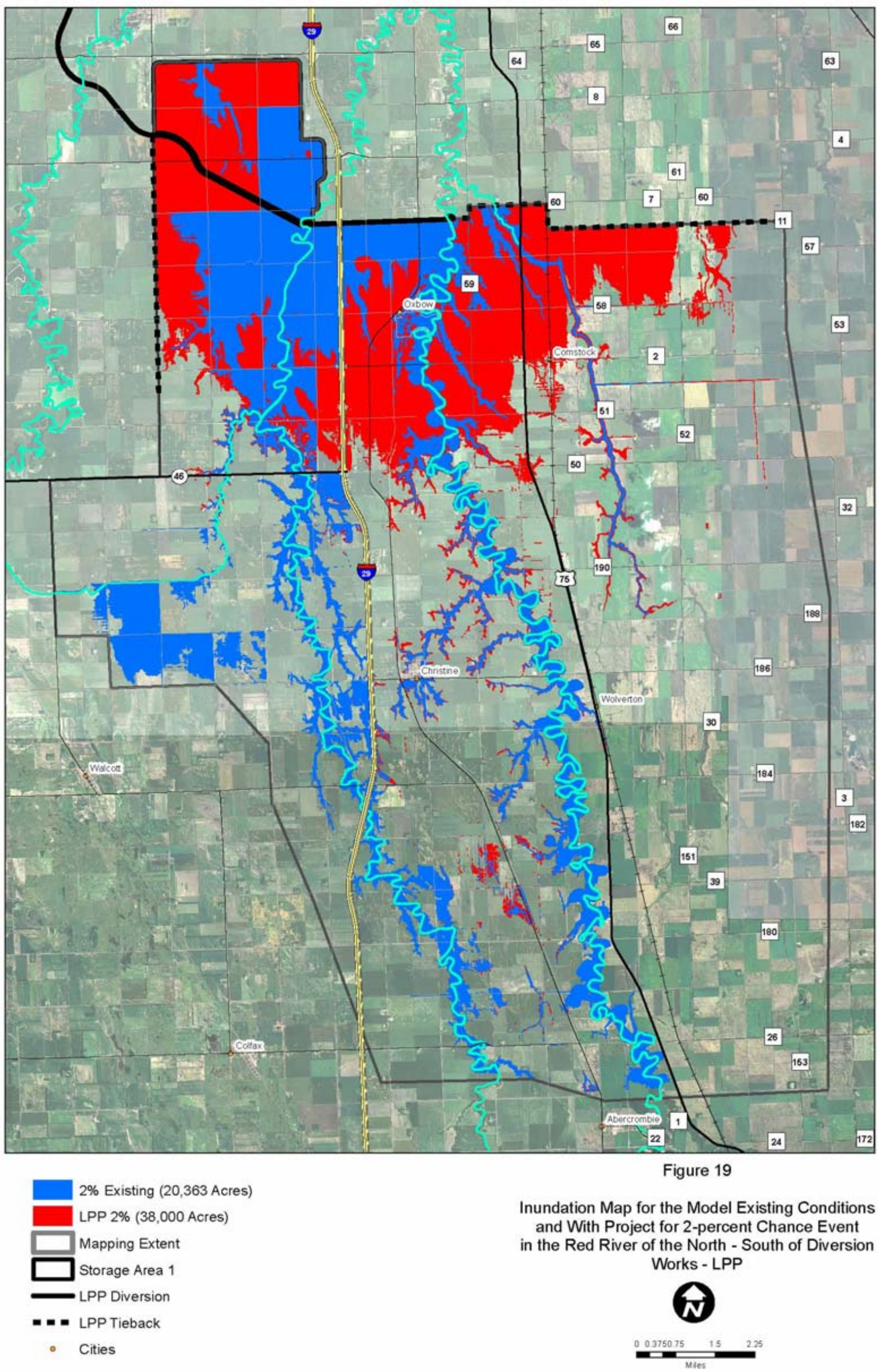


Figure 68 – 2-percent chance event (50-year) downstream extent to Drayton—existing vs. LPP

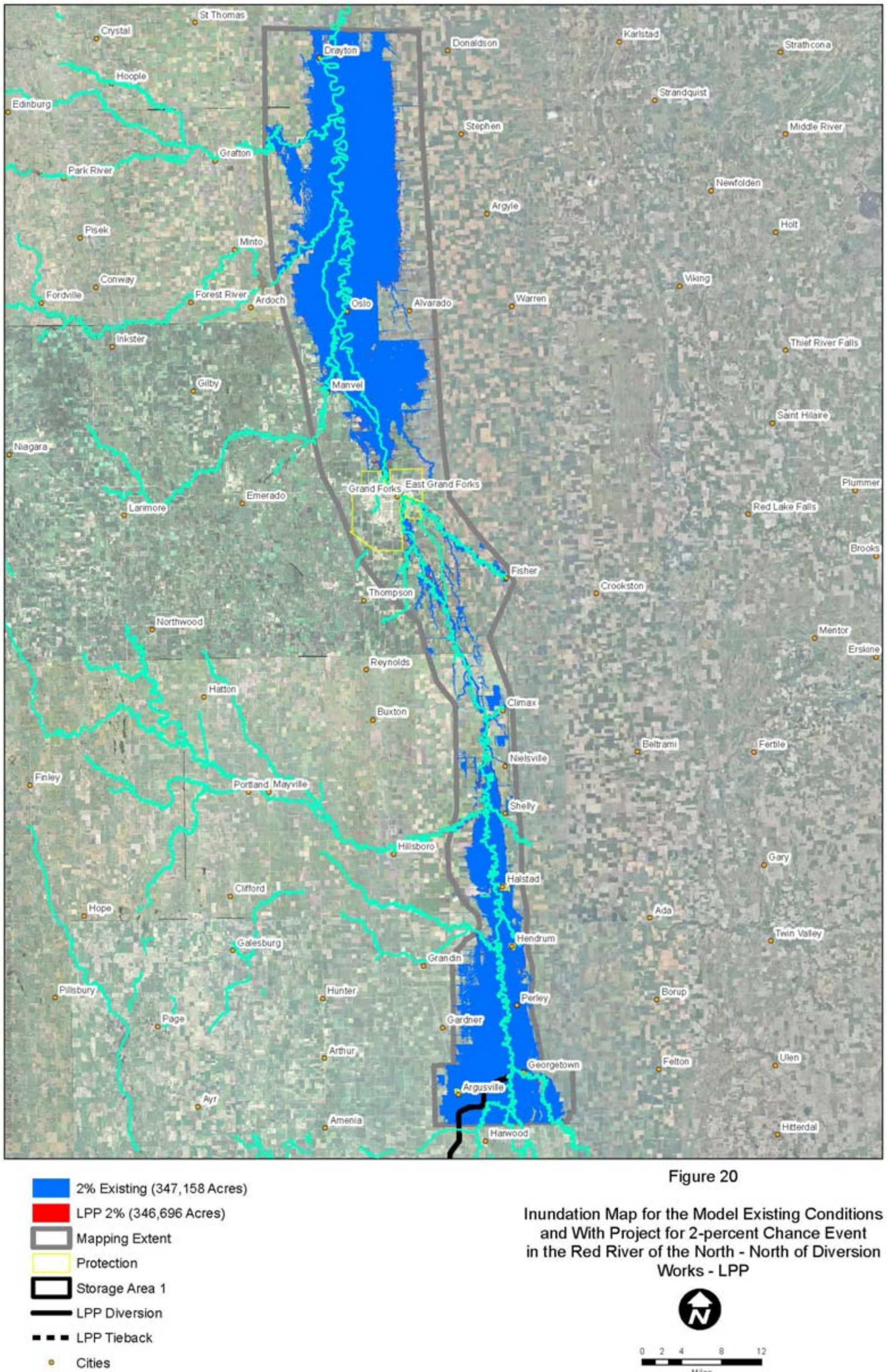


Figure 69 – 1-percent chance event (100-year) upstream extent—existing vs. LPP

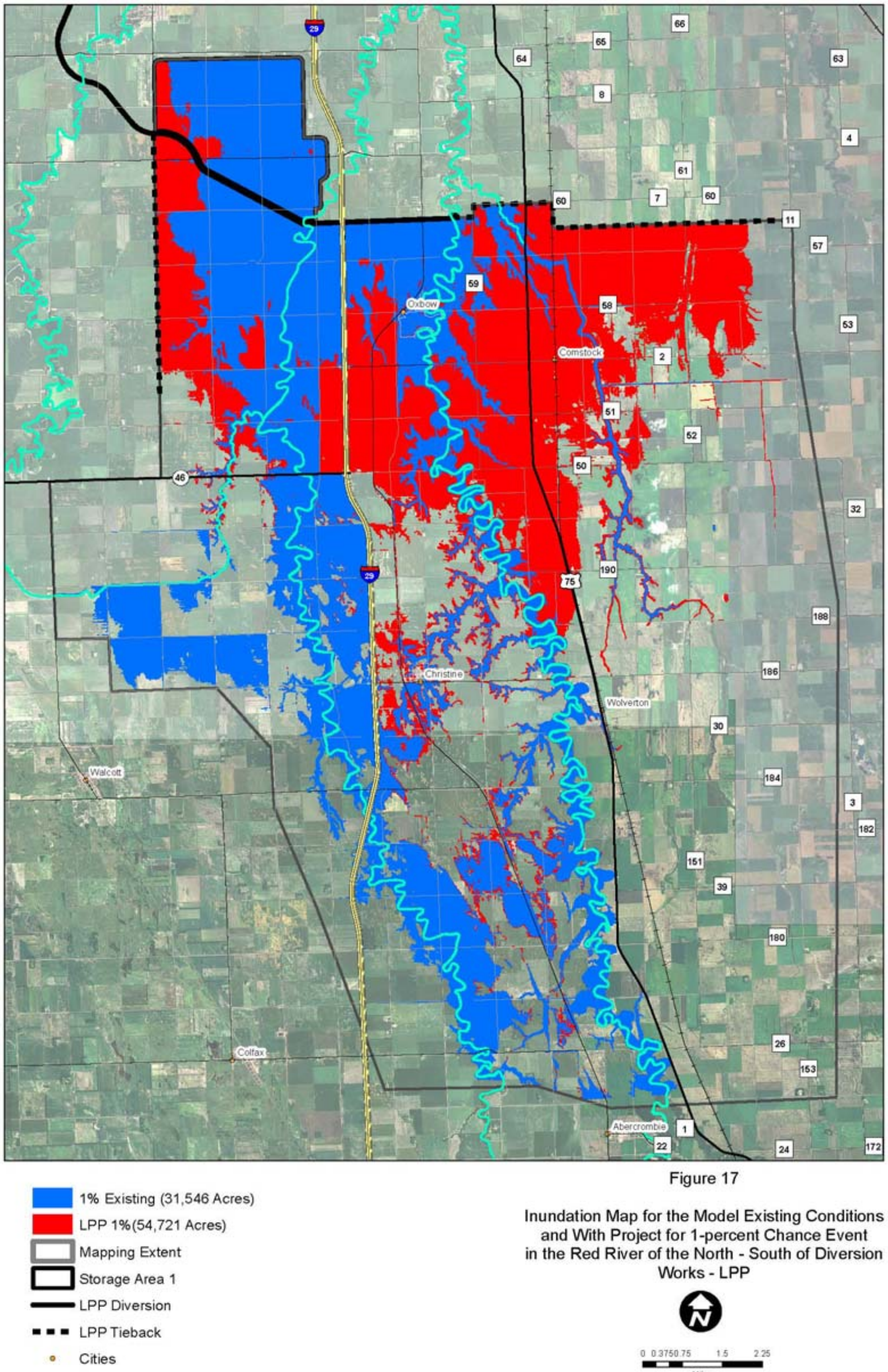


Figure 70 – 1-percent chance event (100-year) downstream extent to Drayton—existing vs. LPP

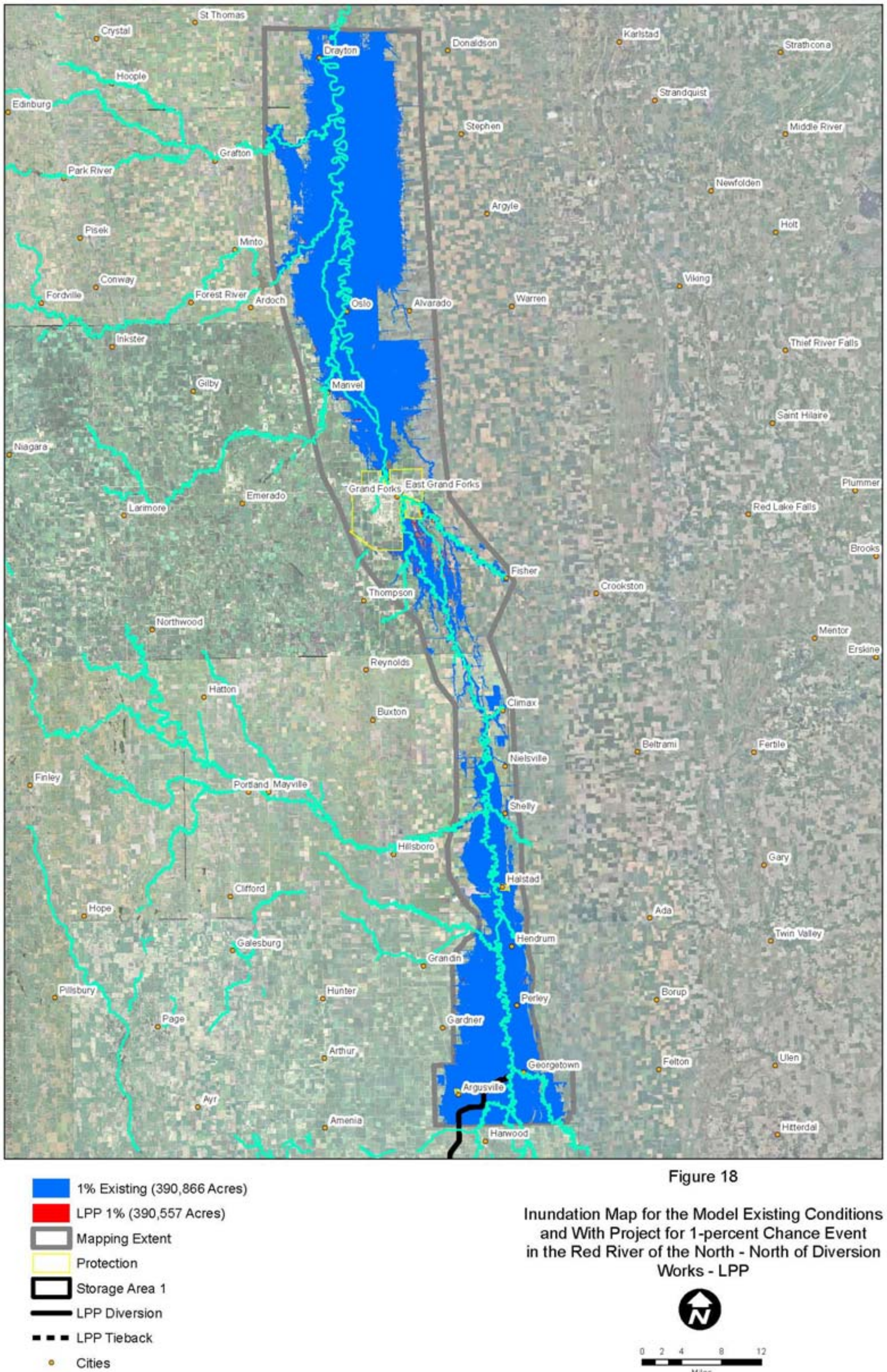


Figure 71 - 0.2-percent chance event (500-year) upstream extent—existing vs. LPP

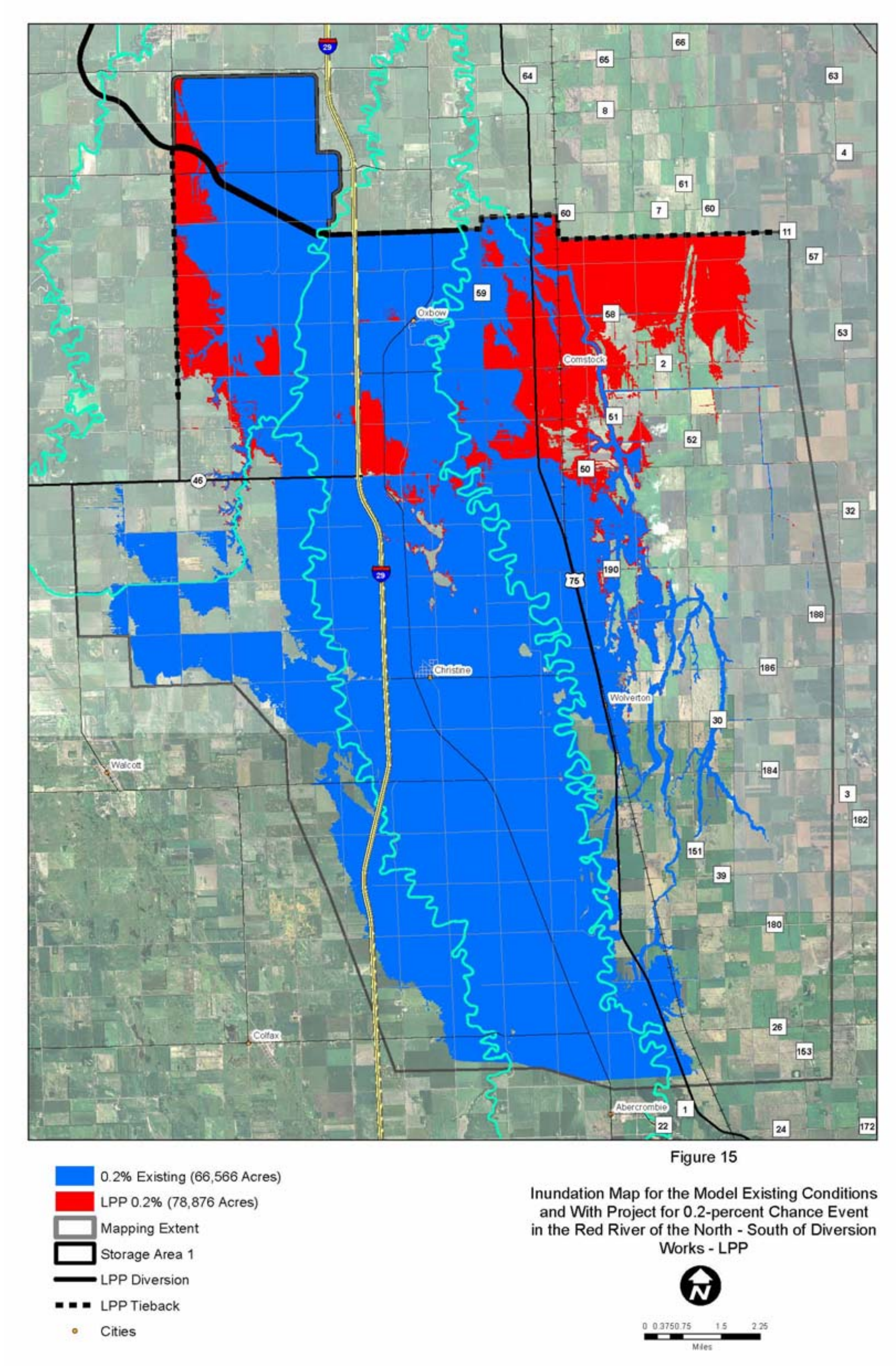
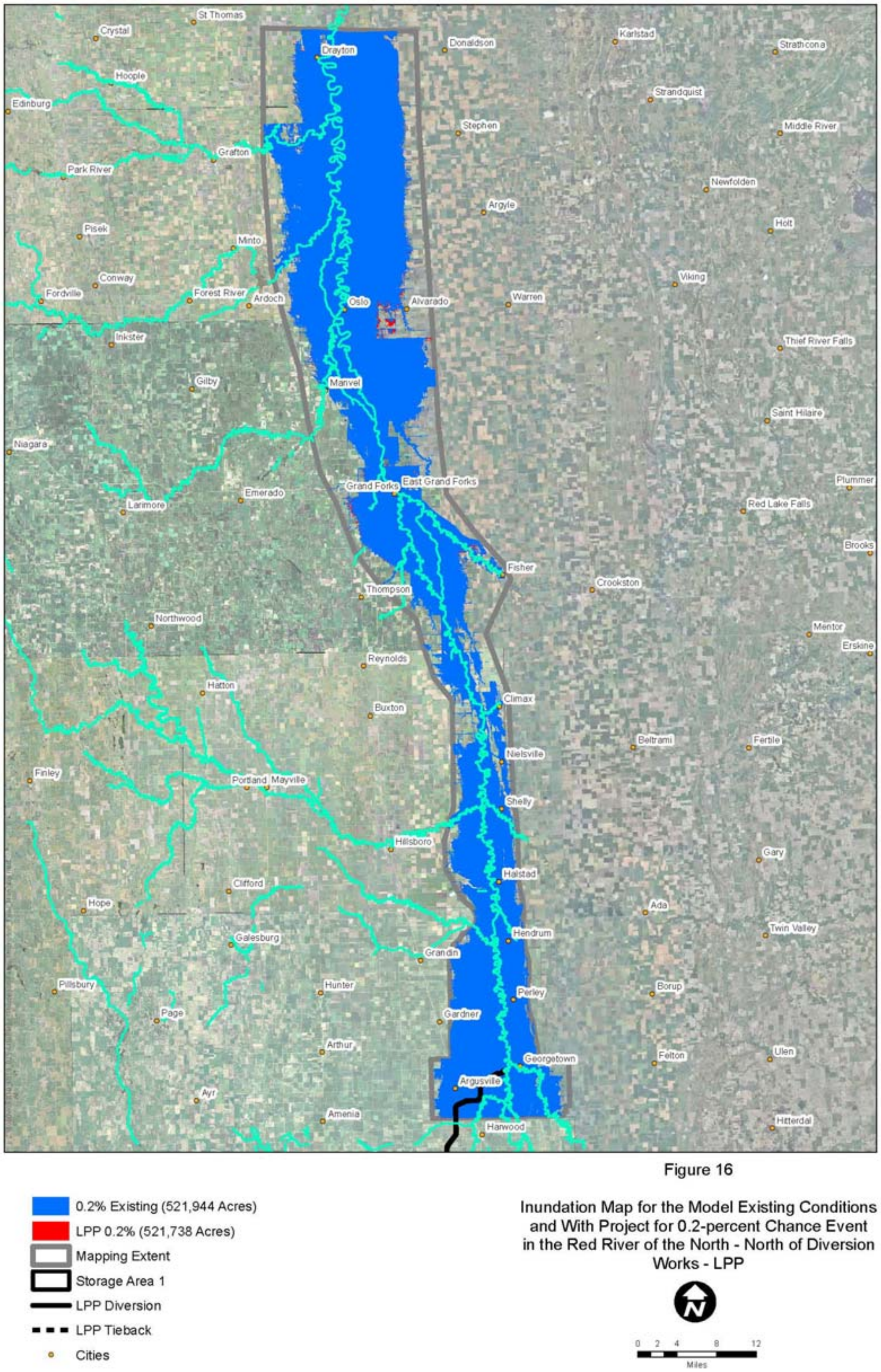


Figure 72 - 0.2-percent chance event (500-year) downstream extent to Drayton—existing vs. LPP



5.2.1.5 Wetlands

For the Supplemental Draft EIS, a team of Corps wetland scientists assessed wetlands using off-site review methodology, followed by field review to ground-truth the off-site review and to perform representative wetland delineations and functional assessments. Wetland areas were identified using all available sources of information, including National Wetlands Inventory (NWI) mapping, soil survey mapping, USGS topographic maps, LiDAR imagery and multiple years of aerial photography. Antecedent precipitation was analyzed prior to each field review, as well as in relation to dates of aerial photography.

On July 1-2, 2010, the team reviewed both diversion corridor alignments to ground-truth the images and signatures identified on aerial photography as wetland areas. Antecedent precipitation for this field review was normal. Following this ground-truthing field review, the team completed the off-site mapping of all the wetlands within the study area. On July 27-30, the team returned to the study area to complete representative delineations and functional assessments, using the Corps of Engineers Wetland Delineation Manual (Manual), the Regional Supplement to the Corps Delineation Manual: Great Plains Region (Version 2.0), March 2010 (Supplement) and Minnesota Routine Assessment Methodology for Evaluating Wetland Functions (MnRAM), Version 3.3, refining the extent of wetlands within all off-site mapped areas. Antecedent precipitation prior to the final field review at the end of July 2010 was wet. The field work is documented in the "Fargo-Moorhead Metropolitan Area Feasibility Study Wetland Delineation Report" that is in appendix F.

The types of wetlands found within the corridors for the diversion channel alternatives, in accordance with Eggers & Reed (corresponding Cowardin Classification), are farmed seasonally flooded basin (PEMAf), fresh wet meadow (PEMB), shallow marsh (PEMC), floodplain forest (PFO1A) and shallow open water (PUBH). Floodplain forest wetlands were assessed for the Upland Habitat/Riparian Habitat section of this Supplemental Draft EIS and were not analyzed further for this section of the document, except for a brief description of functions. Table 45 - Wetlands directly impacted by construction below provides a breakdown, by type, of the total acreage of non-forested wetlands found for the FCP, LPP and ND35K. Figure 73 - Figure 83, show the locations of wetlands found for the FCP, LPP and ND35K.

Farmed, seasonally flooded basins in the study area are lower lying areas within agricultural fields from which shallow surface drains have not effectively removed surface water or saturation, therefore wetland hydrology remains long enough during the growing season. Many of these lower lying areas are themselves shaped into shallow field ditches channeling water from the remainder of the fields. Prior to European settlement of the study area, this lake plain (see soils discussion below) was dominated by wetland communities. These seasonally flooded basins are generally the remnants of the historic wetland areas.

Wet meadows may have surface water only early in the growing season and are typically saturated into the latter part of the summer. Wet meadows in the study area are dominated by reed canarygrass (*Phalaris arundinacea*), sedges, other grasses and forbs.

Shallow marshes typically have at least 6 inches of surface water throughout the growing season, and in the study area are dominated by cattail species (*Typha sp*.). Many field-side and roadside ditches traverse the area (see discussion of lateral effect below), and, where these areas also exhibit the characteristics of wetlands, they were classified as wet meadows or shallow marshes, depending upon the predominant vegetation and depth of water present.

In the ND35K and LPP alignment corridor, there are a few shallow open water basins, where standing water from 3 to 6 feet is normally present throughout the growing season. Most of these areas appear to be excavated ponds, some of which are used as stormwater retention basins. There were no shallow open water areas identified in the FCP alignment corridor.

Soils of the study area are primarily associated with lake plains and floodplains and formed in calcareous clayey lacustrine sediments. They are very deep, poorly and very poorly drained and slowly permeable. Slope gradients are commonly less than 1 percent but range from 0 to 6 percent, with steeper slopes associated with side slopes of streams. Runoff is negligible depending on slope. Saturated hydraulic conductivity is slow. A system of surface drains associated with road ditches, section lines and agricultural fields remove surface water from most soils. A seasonal high water table is at the surface to about 3.0 feet below the surface at some time during the period of March through July. The water table is 1.0 foot above the surface to 2.0 feet below the surface at some time during the period of February through August in lower lying depressional areas. (Source: Official Soil Series Descriptions. USDA, NRCS. 2010).

As mentioned in the preceding paragraph, a system of surface drains is present. Subsurface drainage such as tiling is not a common practice in the areas near the LPP and ND35K alignment, but is more common in the areas near the FCP alignment. Except for lower lying depressions, the drains remove surface water from most soils. Given the slow permeability of the soil, the drains have a reduced effect on lowering the water table. Nonetheless, the lateral drainage effect of surface drains on the water table was estimated using the van Schilfgaarde equation (Hydrology Tools for Wetland Determination. Engineering Field Handbook, Chapter 19. USDA, NRCS. August, 1997 and Hydrology Tools for Wetland Determination, Minnesota Supplement 19-57 to the Engineering Field Handbook. USDA, NRCS. April, 2005). To calculate lateral effect, variables such as ditch depth were estimated during field visits and soil parameters were estimated from the WEB Soil Survey. The “T” factor, or the duration of time for the drain to lower the water table one foot below the soil surface, was set at 14 days. Fourteen days is the required duration for determining wetland hydrology on hydrologically altered sites (Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region version 2.0). Lateral effect information was used in determining the extent of wetlands remaining on the landscape.

The surface drainage was initiated during European settlement of this area in order to make production of agricultural crops possible, and much of the land within the proposed diversion alignments is currently used for agricultural purposes. Although the surface drainage systems (ditches) make agricultural production possible in many areas in most years, the ditches have not effectively removed all of the hydrology from the surface, and many wetlands remain. These wetlands are farmed through in most years, and crops are often lost in lower lying depressions.

Wetlands in this area have been significantly impacted by the agricultural practices, including the drainage of the natural hydrology, plowing of the soils and loss of the natural vegetation. The wet meadow, shallow marsh and floodplain forest areas, although usually left untouched by direct planting, have been affected by the agricultural runoff containing eroded soils and agricultural chemicals.

Functional Assessment Analysis

As stated above, part of the assessment of impacts to aquatic resources as a result of the proposed Red River diversion channels included completion of MnRAM analyses on representative sites within the diversion channel corridors. Due to time constraints and similarity of the majority of wetlands within the study area, Corps staff chose not to assess functionality on every area determined to be wetland. Instead, at least one randomly-chosen area representative of each type of wetland found within the diversion channel corridors was assessed for typical functionality. (Note: Although forested wetlands were assessed in the Riparian Habitat section below, a short statement about forested wetlands is included below.)

As expected, wetlands found within those active agricultural lands provide limited levels of functionality within this environment due to the extensive drainage and overall alteration that has taken place in the region. The majority of wetlands within the review area are depressional field ditches and depressional isolated wetlands of the farmed, seasonally flooded basin type (see field photos in Appendix F). Due to the extensive drainage systems, these seasonally flooded wetlands generally provide "Low" function for *Maintenance of Hydrologic Regime* and *Maintenance of Wetland Water Quality*. When drainage moves water off the landscape more quickly than in a natural setting, wetlands do not have the opportunity to continually feed the downstream system with a supply of water, and the agricultural impacts directly affect the wetland's ability to maintain water quality within the basin. Because the wetlands are found within agricultural fields, they also function at a low level in *Maintenance of Character of Wildlife Habitat,* and A*esthetics/Recreation/Education/Cultural benefit*. Without natural vegetation, there is no opportunity to provide wildlife habitat and the wetlands do not provide any aesthetic or recreational 'value' to the human landscape.

The depressional wetland areas within agricultural fields do, however, generally provide "Moderate" to "High" functionality for *Flood/Storm-water Attenuation* and also for *Downstream Water Quality*. Those wetlands that have been shaped into shallow field ditches provide a moderate level of flood/stormwater attenuation because they are able to hold some of the water on the landscape for at least a short period of time. Shallow isolated depressional wetlands provide a high level of functionality for flood/stormwater attenuation, as they are able to hold the water on the landscape until it can infiltrate, rather than run off to nearby over-stressed water courses. All field wetlands provide a moderate level of functionality for protection of downstream water quality because they are able to filter at least some of the nutrients from the agricultural runoff before the water enters nearby waterways. The depressional wetlands generally do not provide any level of function for amphibian or fish habitat or shoreline protection, therefore functional analysis was not applicable in these areas.

Fresh wet meadows and shallow marsh wetlands that are not actively farmed within the diversion channel corridors provide similar levels of functionality as described above, with a few noted differences. For *Maintenance of Wetland Water Quality*, wet meadows and shallow marshes provide a moderate level of functionality. With natural vegetation present, such as cattails (*Typha sp*.), the water quality within the wetland is treated through the plants' uptake of nutrients. These wetlands also provide a moderate level of wildlife habitat because of the natural vegetation.

In the ND35K and LPP diversion channel corridor, there are two areas classified as shallow open water. One is a constructed storm water retention pond at west edge of Prairie Rose, and the other is located adjacent to the Wild Rice River surrounded by a forested floodplain on private property. The constructed water resource functions as it should at a high level for flood/stormwater attenuation as well as protection of downstream water quality, and it functions at a low to moderate level for most other functions, such as amphibian and wildlife habitat and maintenance of hydrologic regime. The shallow open water basin adjacent to the Wild Rice River performs at a low to moderate level for all measured functions. While it can provide a moderate level of flood/stormwater attenuation and water quality protection, its outlet to the Wild Rice River is too low and not constricted, minimizing its ability to retain water. This basin provides a moderate level of wildlife and fish habitat, providing protection for water fowl and spawning habitat for fish.

Floodplain forest wetlands provide a moderate level of functionality for maintenance of the hydrologic regime, as they are able to gradually feed the river system with water stored in the soils following flood events. The forested floodplains also provide a moderate level of shoreline protection and floodwater resistance by increasing the surface roughness resulting in an increased detention of high flows and reduced erosion, and ultimately reducing peak flows downstream. In addition, the forest canopy provides the wetland with the opportunity to provide a moderate level of function for wildlife habitat.

5.2.1.5.1 No Action Alternative

There are numerous wetland restoration programs in place within the study area but many of which are slowed by cost and/or land availability. The objectives of the wetland restoration programs include flood risk management, improving water quality, and wildlife and recreation opportunities. Due to increasing pressure to either urbanize or improve drainage on cropland, it is anticipated that wetland acreage will either remain the same or decrease within the study area.

5.2.1.5.2 FCP

The construction of the FCP will cause a direct loss of wetlands due to either excavation of the wetlands within the diversion channel or placement of spoil in the wetlands adjacent to the diversion channel. The FCP alignment could directly or indirectly impact approximately 906 acres of wetlands (Table 45), these acres do not include floodplain forest acreage or abandon channel acreage; these acreages are being accounted for in other sections of the SDEIS. Impacts were calculated by using the footprint of the FCP diversion channel. This area included the footprint of the 25 mile long diversion channel and spoil piles for this plan. This analysis also included the tieback levees and extension channels that would be constructed for this plan.

Wetlands could also be lost indirectly through the construction of the diversion channel. The natural drainage patterns could be changed due to the placement of the spoil adjacent to the diversion channel. These changes could either be: 1) the drainage pattern to the wetlands is cutoff, eliminating the recharge of the wetland, or 2) a drainage pattern is created to the diversion, allowing the wetland to drain. In addition, the diversion channel creates a lower hydraulic potential area toward which water will try to seep. The seepage into the diversion channel could cause the wetlands adjacent to the diversion channel to dry up. These acreages would be minor due to the permeability of the soils in the study area and are included in the total impacts delineated.

The risk associated with the indirect loss of wetlands is low for two reasons. First, the spoil could possibly be placed such that it would not affect the natural drainage pattern, either away from or into the wetlands. Second, the flow of water from the wetlands into the diversion channel through the subsurface will be minimal due to the impervious nature of the surrounding soils. It is likely that seasonal fluctuation and precipitation patterns will have a greater effect on the wetlands than the subsurface drainage. The indirect loss of any wetlands is expected to be minimal and would be offset by the creation of wetlands within the diversion channel bottom. The impacts to wetlands are not considered significant.

Examination of aerial photography shows that the area had considerably more wetlands prior to conversion to agriculture. The direct loss of the wetlands is certain and unavoidable within the footprint of the channel and spoil piles. Wetland acres that will be adversely affected by diversion channel construction will be offset by the creation of wetlands within the diversion channel bottom. Features that will be used to facilitate the creation of wetlands will include meandering the low flow channel; constructing rock riffles in locations to create ponding; and other features developed during the design of the project. Vegetative species would be planted that are appropriate to temporarily flooded wetlands. A low flow channel is a channel that is typically in the center of a larger channel which is sized to handle small flows from drains, ditches or groundwater. The low flow channel would be approximately a 10 foot wide by 3 foot deep channel located in the middle of the larger diversion channel, and could meander back and forth within the 400 foot wide diversion channel bottom. The area used for the mitigation will include the entire 400 foot bottom width of the diversion channel as well as a several hundred foot prairie swale buffer up the side slope of the channel. The opportunity for inter-agency partnerships to develop areas for improved habitat would be explored with the non-federal sponsors, interested federal, state and local agencies and interest groups during preparation of plans and specifications for the project.

Table 45 - Wetlands directly impacted by construction

Wetland Type	Acreage in North Dakota/LPP Corridor	Acreage in North Dakota/ND35K Corridor	Acreage in FCP Diversion Corridor
Farmed, seasonally flooded basin	794.37	720.85	798.52
Wet meadow	141.62	121.16	54.93
Shallow marsh	51.36	41.91	46.28
Shallow open water	11.49	11.49	6.14
Total	998.84	895.41	905.87

For Wetland Type definitions see Appendix F

Figure 73 – Wetlands along FCP diversion channel.

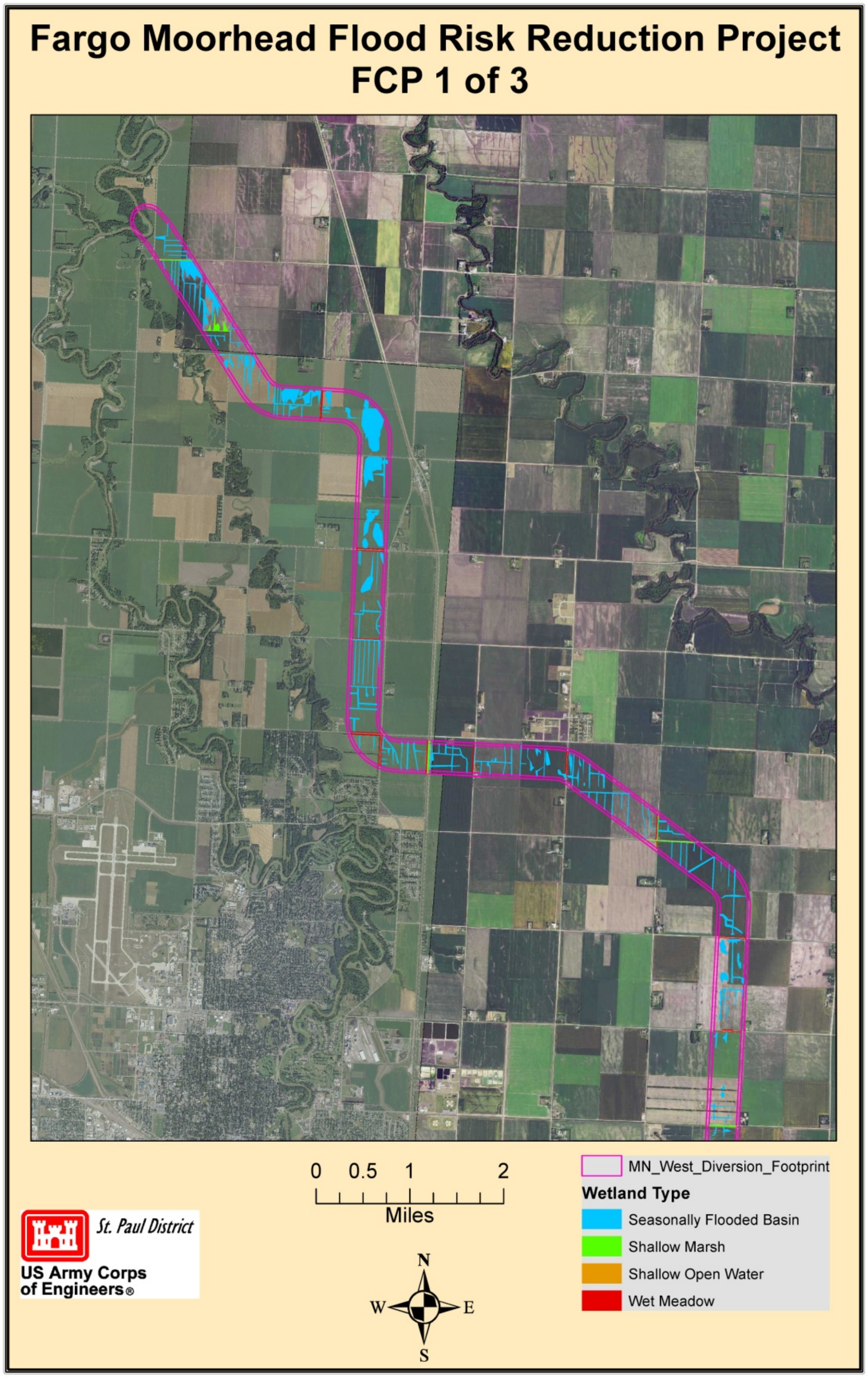


Figure 74 - Wetlands along FCP diversion channel.

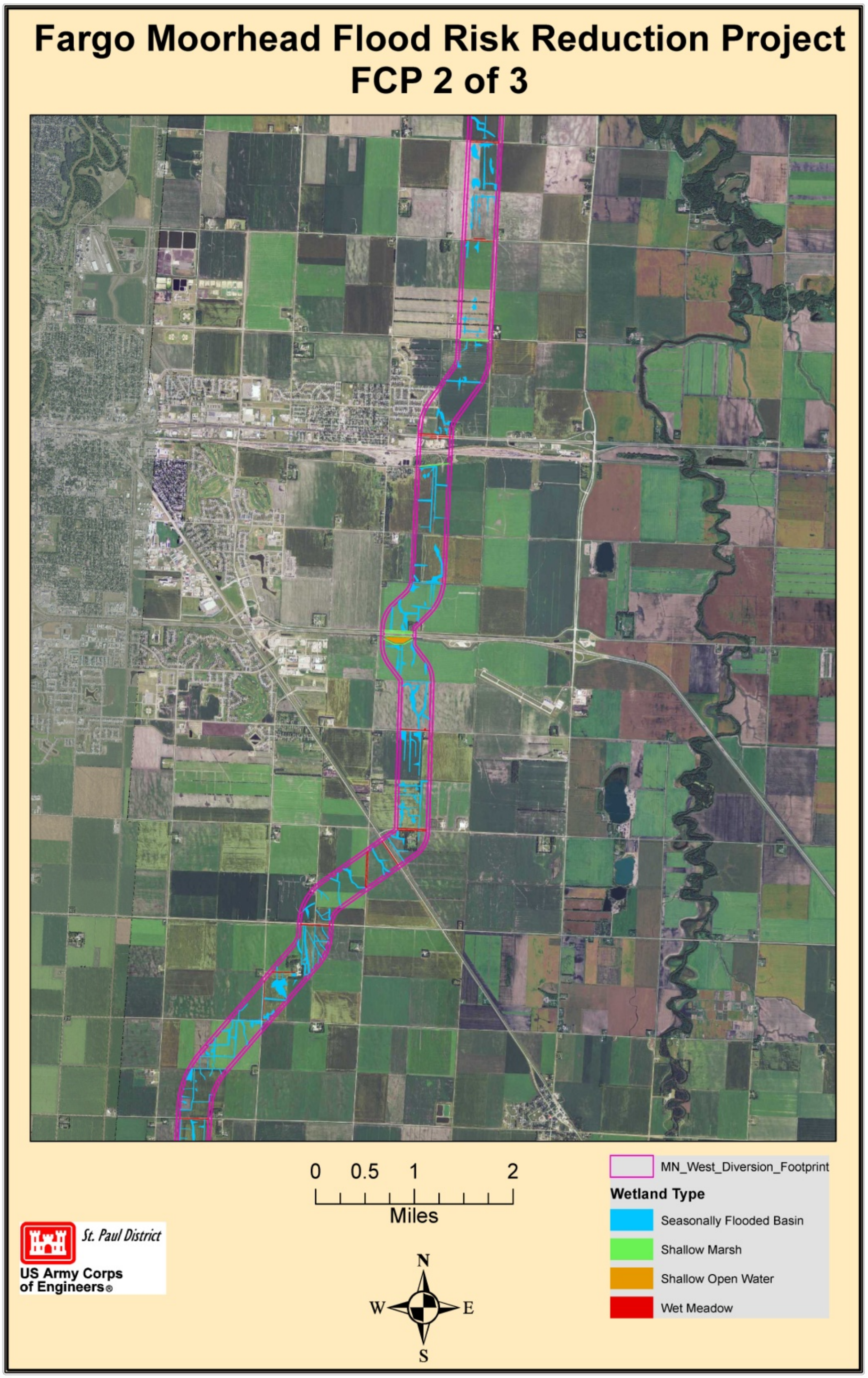
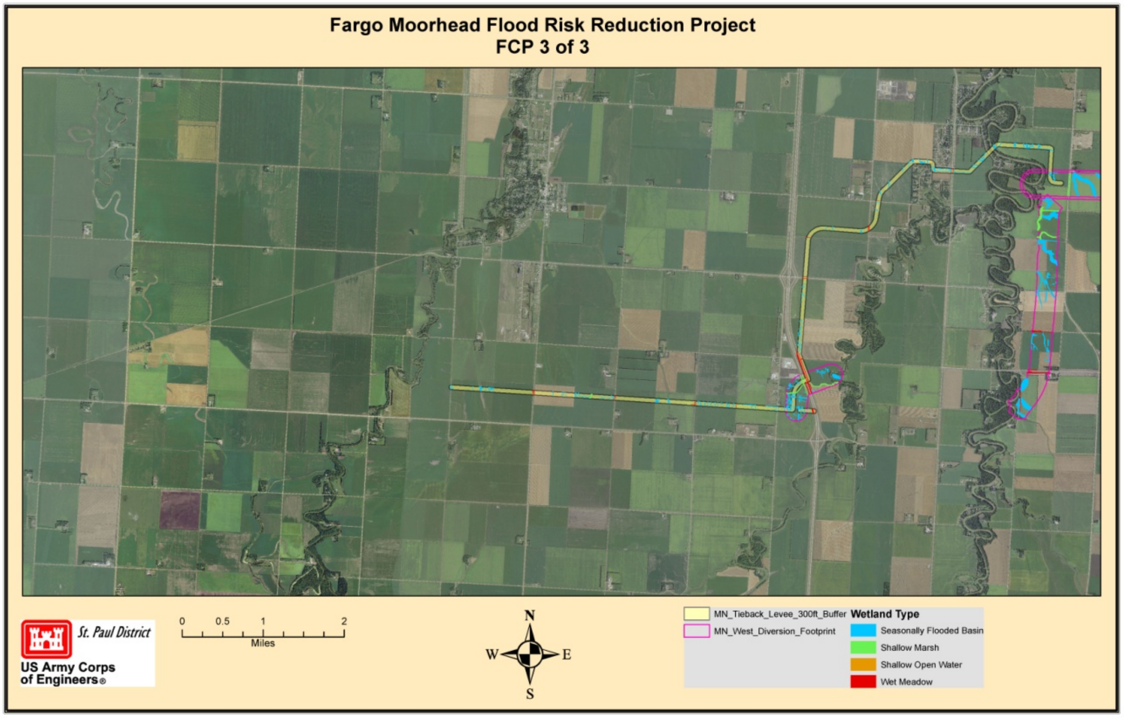


Figure 75 - Wetlands along FCP diversion channel and tie-back levees.



5.2.1.5.3 LPP and ND35K

The construction of the LPP or ND35K plan will cause a direct loss of wetlands due to either excavation of the wetlands within the diversion channel or placement of spoil in the wetlands adjacent to the diversion channel. The ND35K alignment could directly impact approximately 895 acres of wetlands, while the LPP could impact approximately 998 acres of wetlands (Table 45). An additional 117 acres of floodplain forest and 46 acres of stream or riverine channel will be impacted for both alternatives, but these acreages are covered under different sections within this SDEIS. Impacts were calculated by using the footprint of the North Dakota alignment diversion channel. This area is the 36 mile long diversion channel and spoil pile for both plans. This analysis also includes the tie-back levees for both plans and the levee around the storage area for the LPP (Figure 80 - Figure 83). The tie-back levee that extends into Minnesota will be slightly longer for the LPP (Figure 82), which will impact more wetland acres. There is also an additional tie-back levee along County Rd 17 that is included for the LPP and not necessary for the ND35K (Figure 82).

Wetlands could also be lost indirectly through the construction of the diversion channel. The natural drainage patterns could be changed due to the placement of the spoil adjacent to the diversion channel. These changes could either be: 1) the drainage pattern to the wetlands is cutoff, eliminating the recharge of the wetland, or 2) a drainage pattern is created to the diversion, allowing the wetland to drain. In addition, the diversion channel creates a lower hydraulic potential area toward which water will try to seep. The seepage into the diversion channel could cause the wetlands adjacent to the diversion channel to dry up. These acreages would be minor due to the permeability of the soils in the study area and are included in the total impacts delineated.

The risk associated with the indirect loss of wetlands is low for two reasons. First, the spoil could possibly be placed such that it would not affect the natural drainage pattern, either away from or into the wetlands. Secondly, the flow of water from the wetlands into the diversion channel through the subsurface will be minimal due to the impervious nature of the surrounding soils. It is likely that seasonal fluctuation and precipitation patterns will have a greater effect on the wetlands than the subsurface drainage. The indirect loss of any wetlands is expected to be minimal and would be offset by the creation of wetlands within the diversion channel bottom.

Similar to the FCP, an examination of aerial photography shows that the area had considerably more wetlands prior to conversion to agriculture. The direct loss of the wetlands is certain and unavoidable within the footprint of the channel and spoil piles. Wetland acres that will be adversely affected by diversion channel construction will be offset by the creation of wetlands within the diversion channel bottom. Features that will be used to facilitate the creation of wetlands will include meandering the low flow channel; constructing rock riffles in locations to create ponding, and other features developed during the design of the project. Vegetative species would be planted that are appropriate to temporarily flooded wetlands. A low flow channel is a channel that is typically in the center of a larger channel which is sized to handle small flows from drains, ditches or groundwater. The low flow channel would be approximately a 10 foot wide, 3 foot deep channel, with 4:1 foot slopes for a top width of 34 feet. This channel would be located in the middle of the larger diversion channel, and could meander back and forth within the maximum of 250 foot wide diversion channel bottom. Additionally, for the LPP the footprint of the 4,450 acre storage area will have some wetland function after project construction. This area will be inundated with water at approximately the 28-percent chance event; this inundation as well as inundation from rainfall will increase wetland function over these acres. The opportunity for inter-agency partnerships to develop areas for improved habitat would be explored with the non-federal sponsors, interested federal, state and local agencies and interest groups during preparation of plans and specifications.

Additional wetland impacts from the LPP and ND35K are possible because the existing channels downstream of the diversion for the Lower Rush River and the Rush River will be abandoned. This will not cause a loss of wetlands but a change in function, because the channels will still have some overland flow enter into the channels. These areas will remain wetland. Acreages associated with the change of wetland function for the Lower Rush River and Rush River will be offset by the channel design within the diversion channel.

Figure 76 - Wetlands along ND35K diversion channel alignment

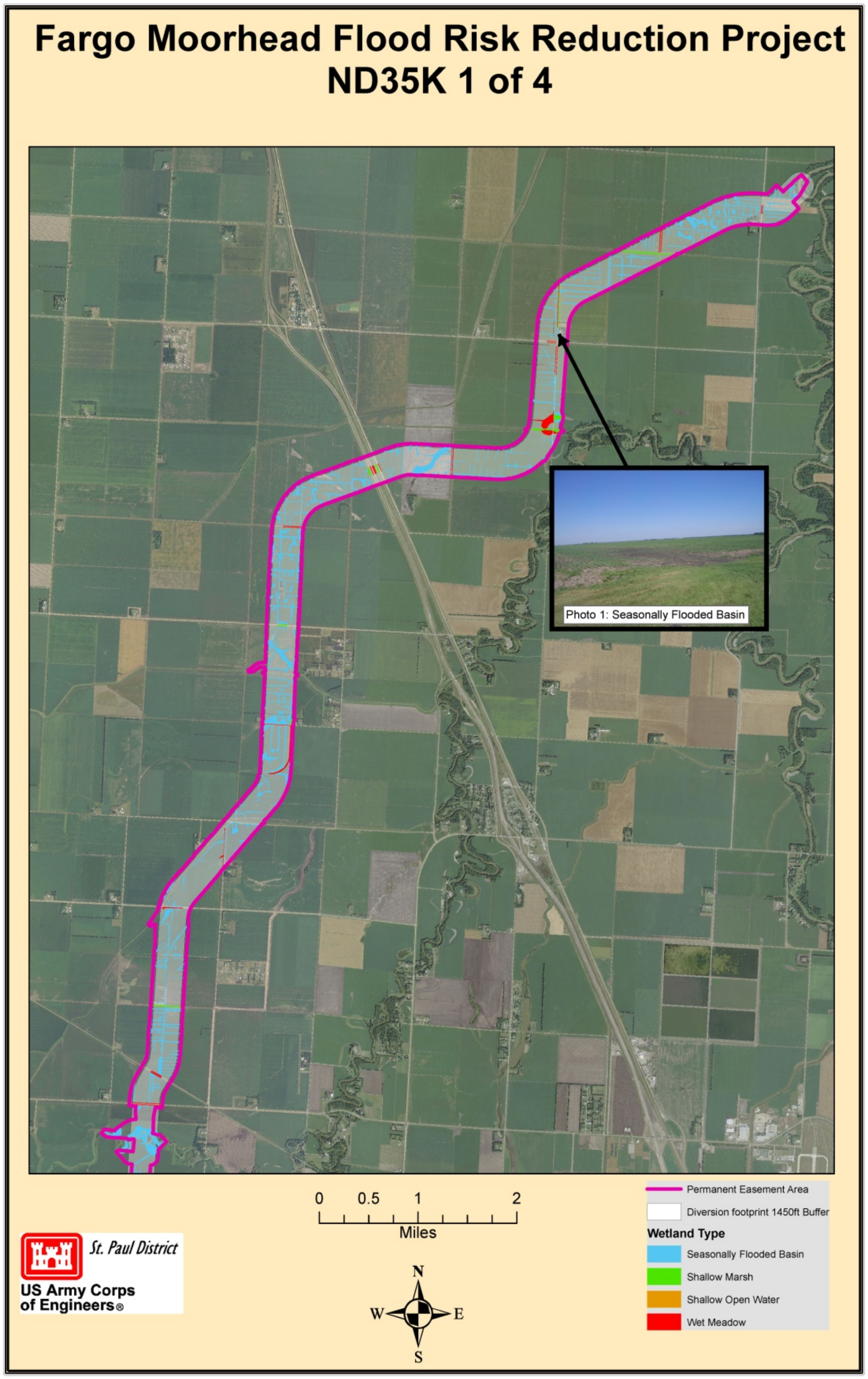


Figure 77 - Wetlands along ND35K diversion channel alignment

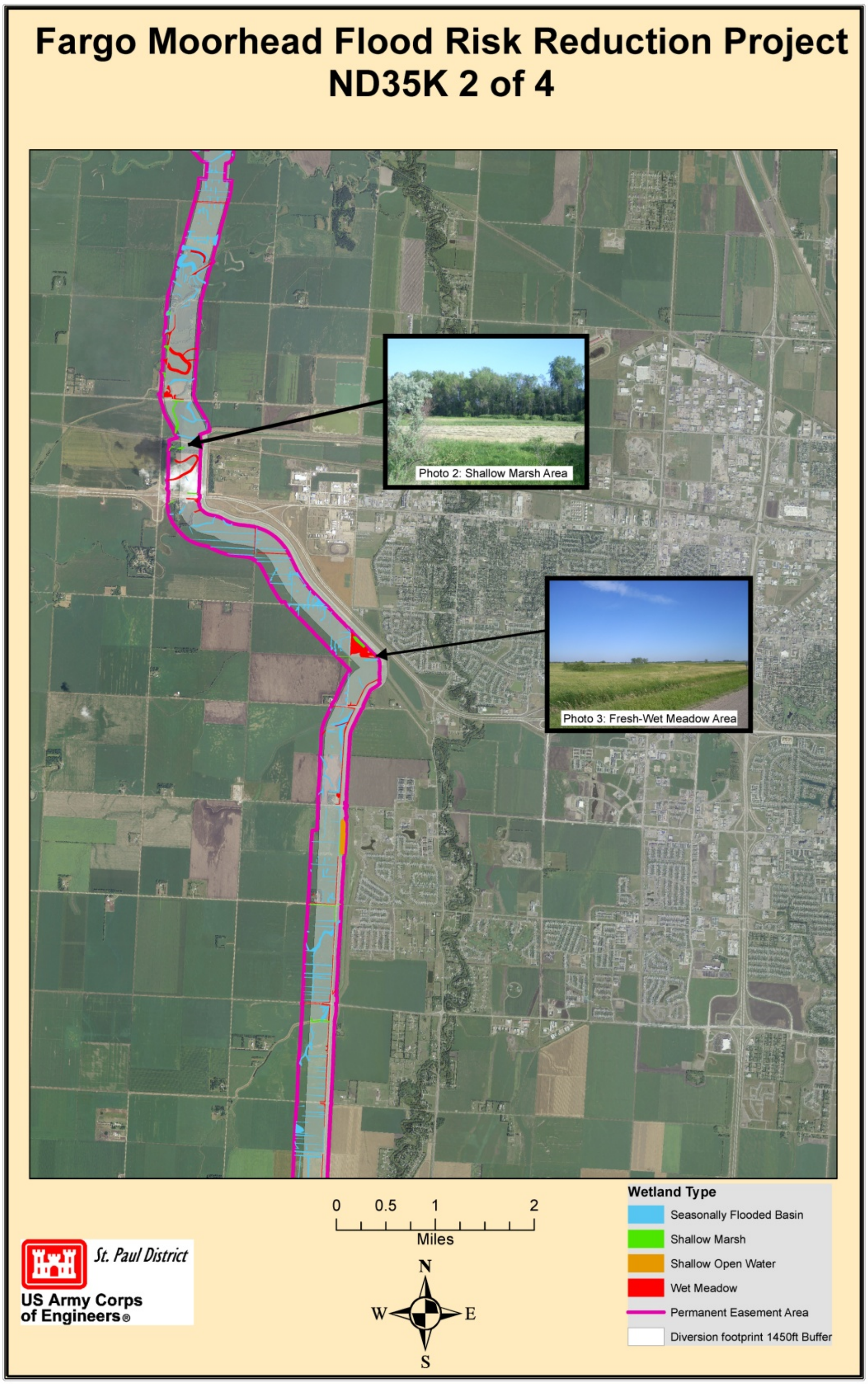


Figure 78 - Wetlands along ND35K diversion channel alignment

Figure 79 - Wetlands along ND35K diversion channel alignment

Figure 80 - Wetlands along LPP diversion channel alignment

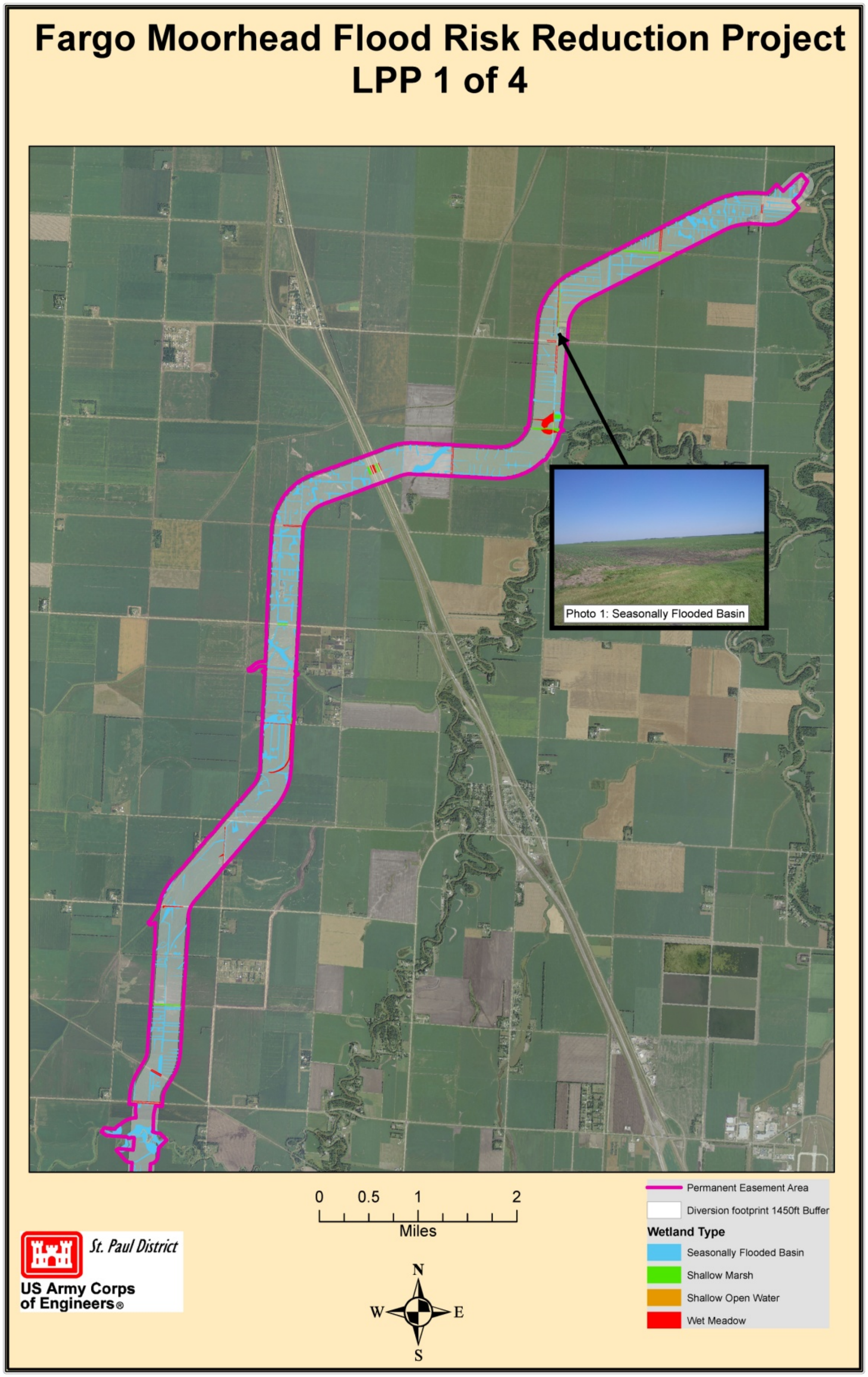


Figure 81 - Wetlands along LPP diversion alignment channel

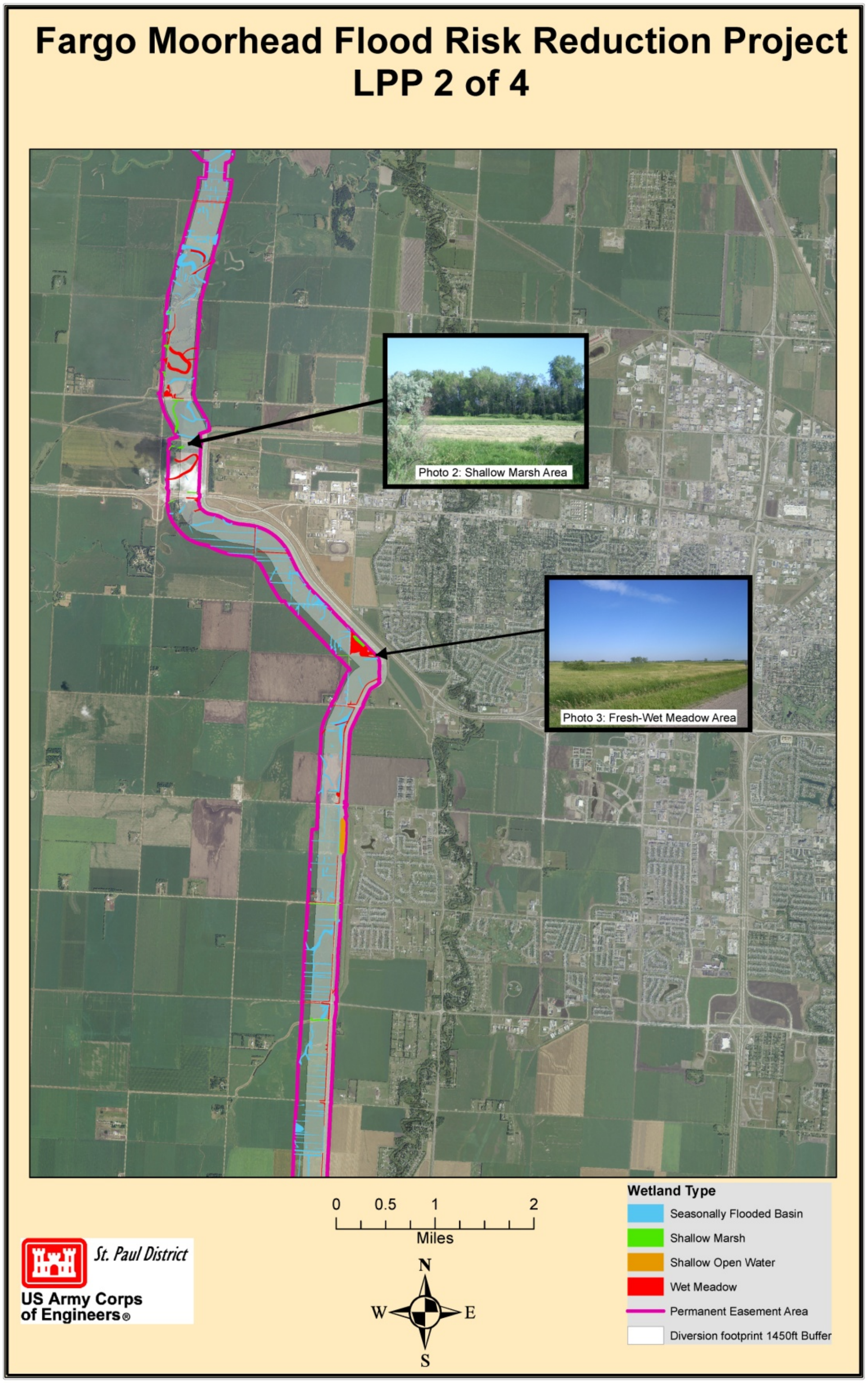


Figure 82 - Wetlands along LPP diversion channel alignment

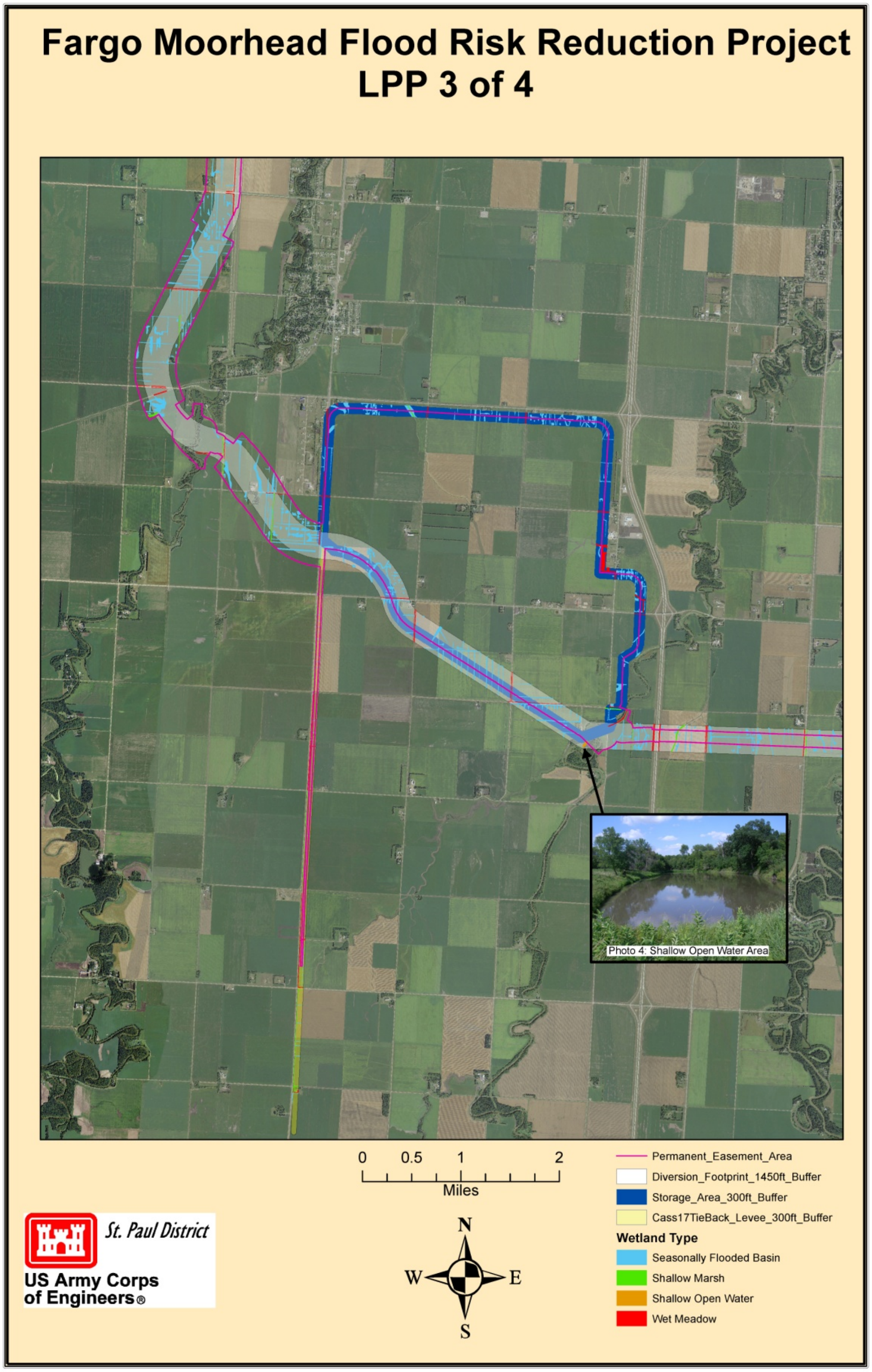


Figure 83 - Wetlands along ND35Kdiversion alignment channel

5.2.1.6 Shallow Groundwater

All of the diversion channel alternatives would have a similar effect on shallow groundwater. The shallow groundwater table is defined as the locally observed groundwater table near the ground surface, typically located within the first 15 feet below the ground surface. The groundwater table fluctuates seasonally, depending on the soil type, precipitation and climatic conditions experienced throughout the year or years. Periodic fluctuation of the groundwater table is assumed to occur even without the construction of a diversion channel. Groundwater is not considered a significant source for water in the area due to the relatively low permeability of soils and the low volume of water expected to flow through these soils.

Under the conditions reasonably anticipated, the flow of the shallow groundwater should be "downhill" or toward the area of lower hydraulic potential. After the excavation of a diversion channel is completed, the "downhill" or lowest potential area should be the bottom of the diversion channel. This may lower the groundwater table near the diversion channel but, at most, only to the depth of the excavated diversion channel. The lateral extent of the lowered groundwater table would likely be confined to areas immediately adjacent to the diversion channel including the spoil banks. Areas outside the extent of this would likely see very little to no change. The natural groundwater flow quantities through tight clayey soils would reasonably be expected to be relatively small.

A lowered shallow groundwater table could potentially reduce the capacity of shallow local wells that are recharged by the groundwater table. The risk to the shallow groundwater table as related to the proposed diversion is low because the anticipated area affected would be concentrated adjacent to the diversion channel. The lowering of the shallow groundwater table may cause consolidation of the surrounding soils and settlement of structures within the area affected. Only structures immediately adjacent to the proposed diversion channel would have the potential to settle. Since the area affected is not expected to extend beyond the channel and spoil piles it is unlikely that any structures remaining after construction would be impacted. If local shallow wells experience reduction in capacity, the depth of the well could be increased or an additional well be installed to mitigate for the reduced capacity. Wells and structures that are within the proposed footprint of the diversion channel would be removed or abandoned, while those immediately adjacent would be identified and monitored to quantify any impacts. Any impacts identified as the result of the construction and/or operation of the proposed diversion can be mitigated for.

5.2.1.6.1 Aquifers

All of the diversion channel alternatives would have a similar effect on aquifers. For the purposes of this report, aquifers in the study area are defined as pervious, water-bearing geological formations that are located at depth and covered by relatively impermeable formations. Aquifers may provide a major source of water and are assumed to have some amount of artesian pressures. The major aquifers in the study area are the Buffalo Aquifer in Minnesota and the West Fargo Aquifer in North Dakota. The most current subsurface geological model known is a 3-D model (Minnesota Geological Survey, 2005) that shows the majority of the Buffalo aquifer is over 1000 feet from the FCP channel. Measureable impacts to the aquifer with this separation are considered unlikely. Sandy beds within the lake clays may also be present along the alignment; verifying if and how they are hydraulically connected to the Buffalo Aquifer is on-going. Additional subsurface exploration in the spring and summer of 2010 along with an on-going review of existing data was used in an attempt to identify any sandy seams that may exist within the proposed diversion foot-print. To date no significant sandy seams have been identified and work remains on-going. The West Fargo Aquifer is somewhat more limited in aerial extent with conditions similar to these surrounding the Buffalo Aquifer. For these reasons measurable impacts are considered unlikely.

The first potential effect that construction of a diversion channel could have is the lowering of the artesian pressures in the aquifer. With the construction of the diversion channel, the seepage path length from the aquifer to the ground surface could be reduced approximately by the depth of the channel excavation. This reduced seepage path length and creation of a lower potential area may increase the flow of the water out of the aquifer. If the quantity of flow out of the Buffalo Aquifer (or any aquifer) is greater than the quantity of flow recharging the system, the artesian pressures can be reduced. The total volume of water available at a given time in the aquifer may be negatively impacted as well. The result of the lowered artesian pressures would be that more pumping would be necessary for private and municipal use.

The second potential effect of a diversion channel is that contamination of the aquifer could occur. The diversion channel excavation would reduce the length that contaminants would have to travel from the ground surface to the aquifer. However an aquifer under artesian pressure will have a positive pressure “outward” toward the diversion channel making it very difficult for potential contaminants to “migrate” against this pressure (away from the diversion) and towards the main portion of the aquifer. In the unlikely event of contamination the use of the aquifer as a source of water for domestic use could be restricted.

Due to the relatively impervious nature of the subsurface materials likely to be encountered along the route of any proposed diversion alternative, the flow of water from the aquifer due to artesian pressures and the migration of contaminates into the aquifer are minimized.

There are two mitigation/adaptive management measures that could be taken to reduce the risk of long term changes to the aquifer as a result of the proposed diversion. The first adaptive management measure would be to monitor the aquifer and the areas surrounding the diversion channel to see if the artesian pressures are being lowered after excavation of the diversion channel and what direction the water is flowing. If an impact to the aquifer was detected the second mitigation measure would be to place a more impervious buffer between the aquifer and the channel excavation to minimize the flow of water into the diversion channel or contaminants into the aquifer. If a pervious material was encountered during channel excavation, over-excavation of this material could be required and impervious fill placed to provide this buffer.

Additional data analyses and design refinements are recommended to verify alignment choices considering the local variations in the sub-surface geology. Based on the literature and initial exploration conducted for this study, there are some smaller scale sand and gravel beds that could be considered localized aquifers (groundwater instead of buried aquifers) if the beds are extensive enough to provide potable water for a residence or farmstead. The existence of these smaller localized aquifers needs to be matched with existing water wells to prevent or compensate for the loss of individual water wells along the alignment.

5.2.1.7 Fisheries and Aquatic Habitat

The discussion below addresses potential impacts of the various alternatives to fisheries resources and aquatic habitats. Because of similarities among alternatives, the discussion below will generally discuss effects common to all of the diversion channel alternatives, unless specifically noted. From a broad perspective, the FCP would have less substantial impacts to fisheries resources and aquatic habitat than the LPP or ND35K. Impacts to fisheries and aquatic habitat would be more substantial with the LPP or ND35K due to the project affecting an additional five tributaries. The LPP has additional impacts, relative to the ND35K, due to upstream staging of water to alleviate downstream water level impacts.

5.2.1.7.1 Direct Footprint Impacts

5.2.1.7.1.1 Red River Footprint Impacts

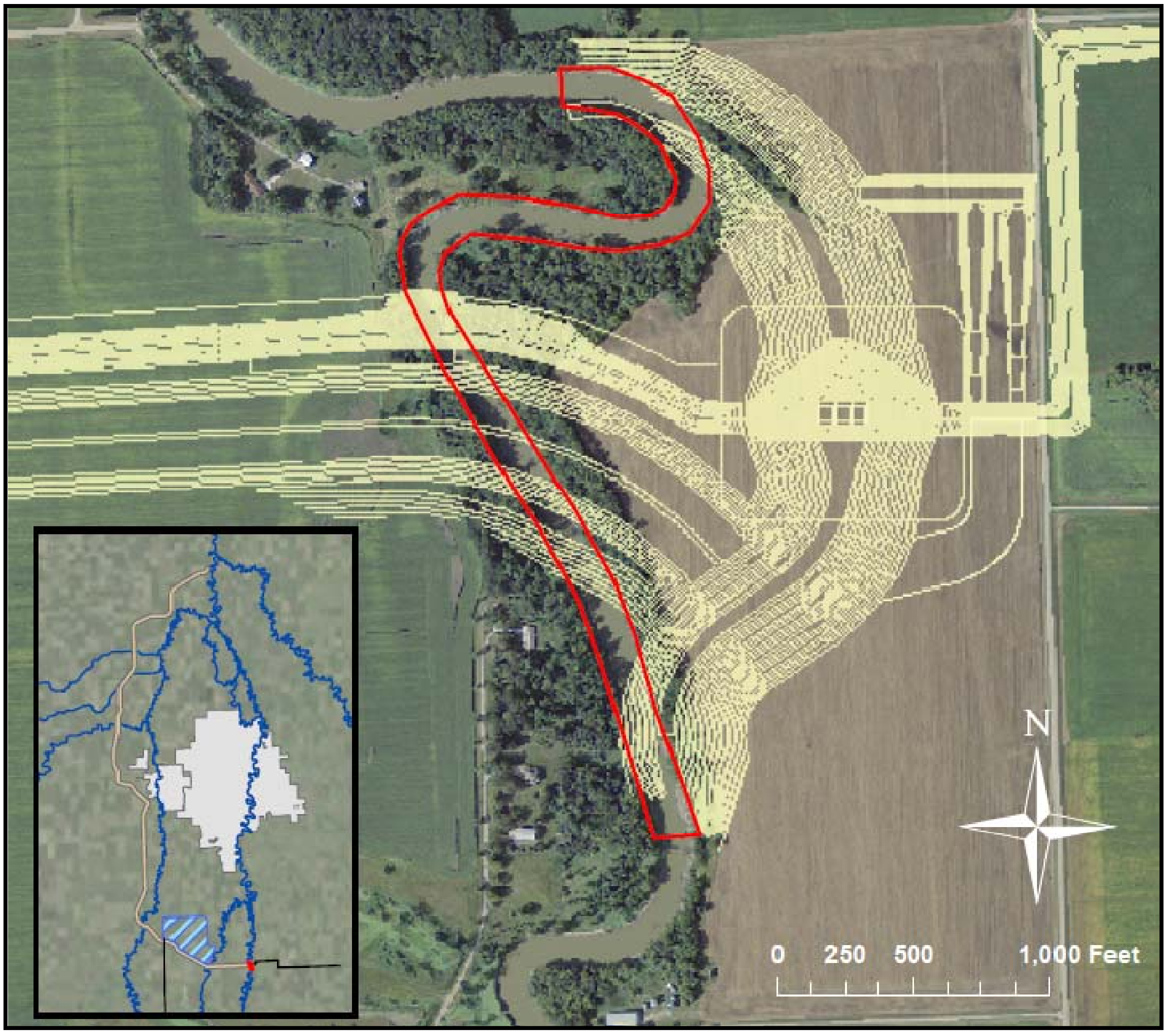
A concrete Red River control structure would be constructed for each of the three diversion channel alternatives. The exact location of the structure is not yet known but would be different between the North Dakota alignment and the Minnesota alignment. However, all alternatives would generally have similar footprint impacts. The control structure, including its operation, is described in Section 3.7.

Because of logistical challenges and construction risks, the likely construction method is to build the control structure "in the dry" adjacent to the Red River. Following completion, a new channel would be excavated and flow permanently routed through the new control structure.

To assess footprint impacts, aerial photos were reviewed within GIS to estimate the amount of riverine habitat directly affected. The upstream and downstream extent of the footprint were first identified based on likely feature boundaries. The channel area was then identified laterally up the bank to approximately a bankfull elevation, typically identified by the presence of trees. A polygon was then established to quantify the amount of riverine habitat impacted.

For the LPP and ND35K, the Red River control structure would result in the permanent abandonment of approximately 0.8 miles of Red River channel habitat. This would equate to approximately 14 acres of river habitat lost (Figure 84). The exact location and footprint impact could be further refined in future NEPA documentation. The North Dakota alignment is shown in Figure 84 - Potential footprint impact area on the Red River for a diversion control structure for a North Dakota diversion alignment. Areas with channel abandonment or extensive modification area outlined in red..; By comparison, the FCP would result in abandonment of approximately 1.2 miles of channel, which would equate to 27 to 28 acres of river habitat. Riverine habitat would be created within the newly constructed channel through the control structure. However, it is not fully known to what extent the habitat created might replace that which is lost. As such, mitigation would be implemented to offset this impact. Potential mitigation measures are discussed in Section 5.5 and Attachment 6, Mitigation and Adaptive Management.

Figure 84 - Potential footprint impact area on the Red River for a diversion control structure for a North Dakota diversion alignment. Areas with channel abandonment or extensive modification area outlined in red.



For the downstream weir at the confluence of the Red River and the diversion channel, all three diversion channel alternatives would influence approximately 0.1 to 0.2 miles of Red River channel. This would equate to just under 3 acres of river habitat (Figure 85), With similar impacts amongst alternatives. The downstream weir will include adjacent riprap placement along both shorelines. Riparian habitat would be altered, and in-channel habitat could change with the presence of riprap. However, aquatic habitat would not be directly abandoned or lost. Benthic invertebrates would be buried where riprap is placed. However, such areas would be expected to recolonize. Although habitat could change, overall aquatic habitat quality adjacent to the downstream weir would not be expected to be substantially reduced with any of the diversion channel alternatives. Impacts to riparian habitat are discussed separately below.

Construction activities for any structures outlined here would result in temporary avoidance of the study area by fish during periods when in-water construction causes disturbance. However, this should be temporary, and would not be expected to have any meaningful long-term effect on Red River fisheries. Immobile biota (e.g., mussels and macroinvertebrates) would be lost during channel abandonment or placement of rock or other materials. However, mussels and invertebrates would likely recolonize new habitats.

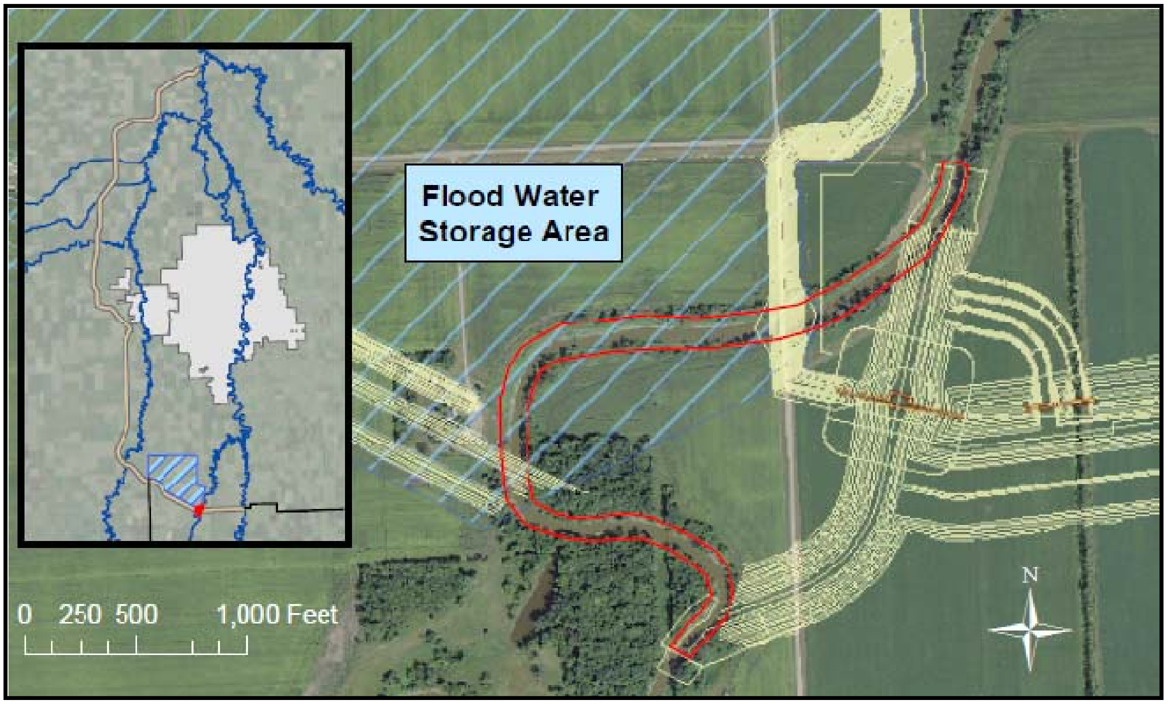
Figure 85 - Potential footprint impact area on the Red River for the downstream weir at the confluence with the flood diversion, North Dakota diversion alignment. The Minnesota diversion alignment would join the Red River at a different location, but would have similar characteristics.

5.2.1.7.1.2 Wild Rice River Control Structures Footprint Impact

For the Minnesota alignment, the diversion channel will not cross any tributaries or other surface waters with notable fisheries resources. Thus, the FCP would not result in any direct significant impacts to tributary fisheries resources or habitat.

Both of the North Dakota diversion alternatives would have three different structures constructed at the confluence of the diversion channel and the Wild Rice River. This includes a control structure on the Wild Rice River just downstream of the confluence with the diversion channel; and two control weirs constructed on opposite banks of the Wild Rice River just upstream of the Wild Rice River control structure. These control structures, including their operation, are described in Section 3.7.

Figure 86 - Potential footprint impact area on the Wild Rice River. Areas with channel abandonment or extensive modification area outlined in red.



Similar to other structures, this structure also would be built "in the dry" adjacent to the existing Wild Rice River. Following completion, a new channel would be excavated and flow permanently routed through the new control structure.

The Wild Rice River control structure would result in the permanent abandonment of approximately 0.8 to 0.9 miles of riverine habitat. This would equate to approximately 12 acres of river habitat lost (Figure 86). The exact location and footprint impact could be further refined in future NEPA documentation. This impact would only occur with the two North Dakota diversion alternatives. Riverine habitat would be created within the newly constructed channel through the control structure. However, it is not fully known to what extent the habitat created might replace that which is lost. As such, mitigation would be implemented to offset this impact. Potential mitigation measures are discussed in Section 5.5 Mitigation and Adaptive Management and Attachment 6.

Construction activities for any structures would result in temporary avoidance of the study area by fish during periods when in-water construction causes disturbance. However, this should be temporary, and would not be expected to have any meaningful long-term effect on Wild Rice River fisheries. Immobile biota (e.g., invertebrates) would be lost during channel abandonment or placement of rock or other materials. However, invertebrates would likely recolonize new habitats.

5.2.1.7.1.3 Sheyenne and Maple River Tributary Aqueduct Footprint Impact

For both of the North Dakota alternatives, the diversion channel must cross the Sheyenne and Maple rivers. To accomplish this task, the Corps proposes to construct an aqueduct on each tributary that facilitates flow over the diversion channel. These structures are described in Section 3.7. The exact location, design and footprint, and corresponding impacts, could be further refined in future NEPA documentation. Both aqueducts would be designed for a channel width and depth similar to existing conditions at the chosen sites. Both structures would be a concrete channel, with a preliminary planned length of about 650 feet from the upstream to downstream edge of the concrete footprint.

Given the logistical challenges of constructing these aqueducts concurrently with the diversion channel, the Corps proposes to build these features adjacent to the tributaries. Similar to other features, these two tributaries would then be permanently diverted through the aqueducts.

Although the exact design has yet to be finalized, these tributary structures would impact several acres of aquatic habitat within both the Sheyenne and Maple rivers (Figure 87 - Figure 88). The Sheyenne River could see channel abandonment, or substantial alteration, to 0.8 to 0.9 miles of channel, which would amount to 8 to 9 acres of river habitat. The Maple River could see channel abandonment, or substantial alteration, to approximately 1.1 miles of channel, which would amount to 10 to 11 acres of river habitat.

The concrete portion of these new channels would have little aquatic habitat value. Riverine habitat would be created within the newly constructed channel leading into and out of the aqueducts. However, it is not fully known to what extent the habitat created might replace that which is lost. As such, mitigation would be implemented to offset this impact. Potential mitigation measures are discussed in Section 5.5 Mitigation and Adaptive Management and Attachment 6.

Figure 87 - Potential footprint impact area on the Sheyenne River. Areas with channel abandonment or extensive modification area outlined in red.

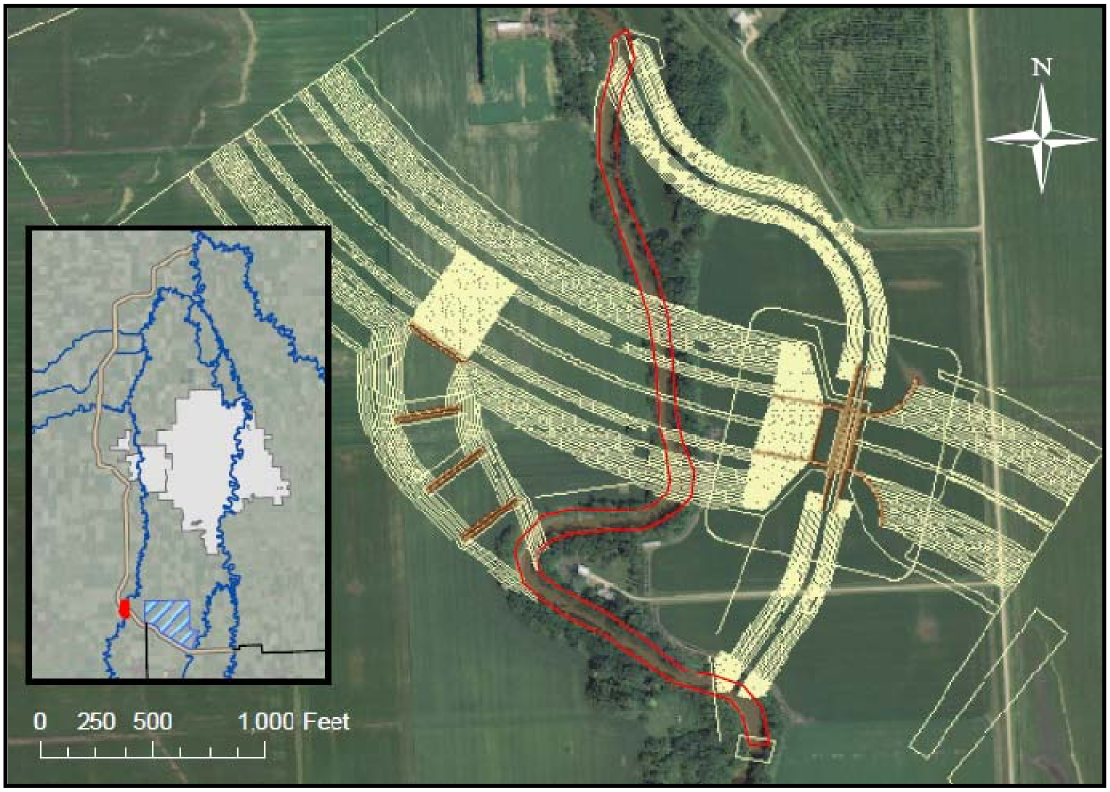
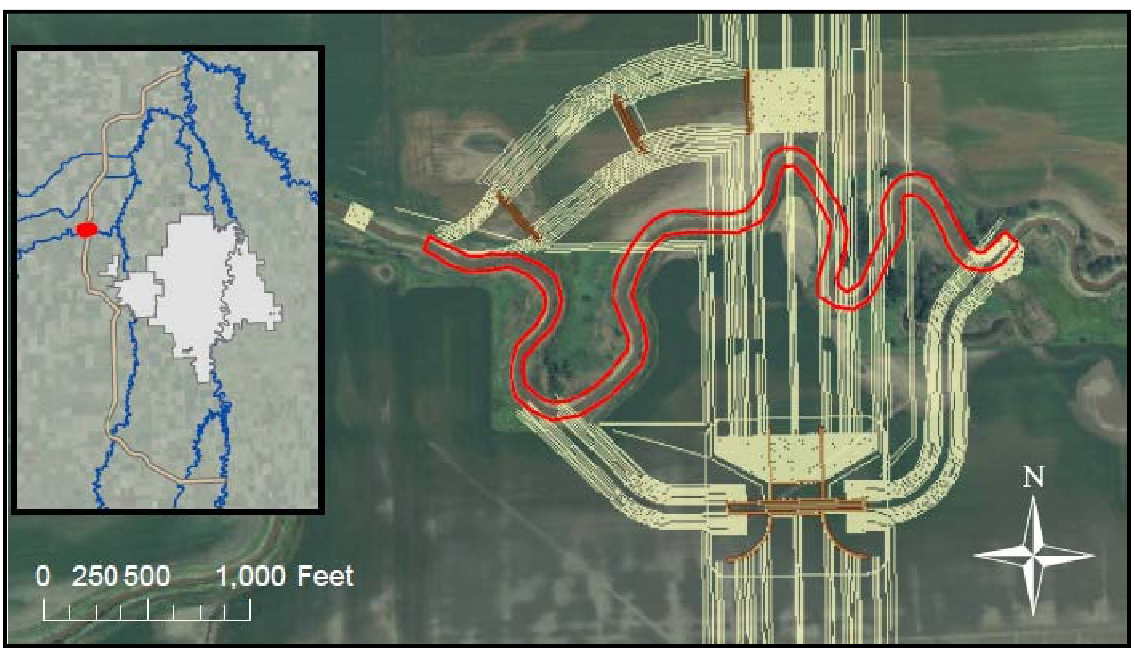


Figure 88 – Potential footprint area on the Maple River. Areas with channel abandonment or extensive modification area outlined in red



In addition to the footprint impact identified above for lost channel habitat, it is possible additional rock could be placed in and along the channel upstream or downstream for erosion protection or grade control. However, additional aquatic habitat would not be directly abandoned or lost.

Construction activities for any structures would result in temporary avoidance of the study area by fish during periods when in-water construction causes disturbance. However, this should be temporary, and would not be expected to have any meaningful long-term effect on Sheyenne and Maple river fisheries. Immobile biota (e.g., invertebrates) would be lost during channel abandonment or placement of rock or other materials. However, invertebrates would likely recolonize new habitats.

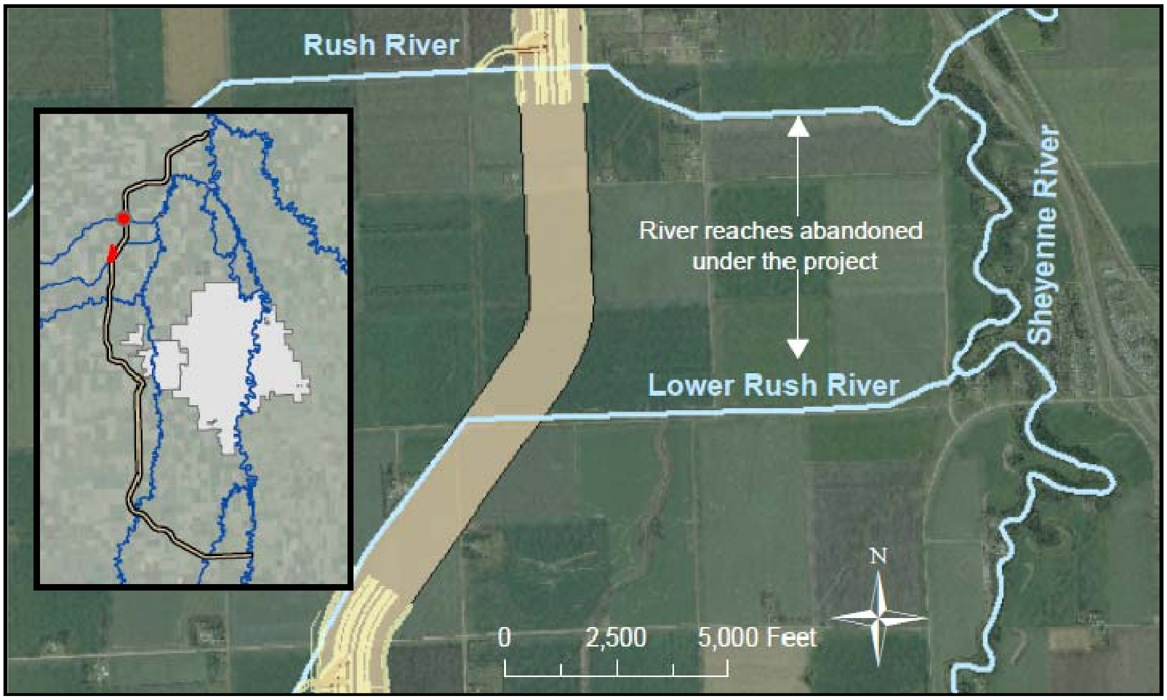
5.2.1.7.1.4 Rush and Lower Rush Control Structures Footprint Impact

For both of the North Dakota alternatives, the diversion channel must also cross the Rush and Lower Rush rivers. Within the study area, these two rivers are channelized and appear to have limited habitat value. The Lower Rush River is intermittent, and at best will only be used seasonally as a fisheries resource. Given this, the Corps proposes to direct both of these tributaries into the diversion channel, as opposed to constructing aquaducts to convey flow over top of the diversion. In short, both tributaries would include a series of weirs to provide grade control to drop the tributaries from their current elevation down to the diversion channel. The base of the diversion channel, starting at the Lower Rush River, would include a meandering channel design along the remaining length of the diversion down to its confluence of the Red River. This channel would convey flows from these two tributaries, and provide river habitat in the bottom of the diversion channel.

The plan for the North Dakota alternatives would result in abandoning approximately 2.1 miles of the Rush River, and 3.4 miles of the Lower Rush River, between the diversion channel and their respective confluences with the Sheyenne River. Figure 89 shows the potential impact areas for the Rush and Lower Rush rivers for the North Dakota diversion alignment. This river habitat would be directly lost as a result of the project. However, these sections of both tributaries are channelized and likely of limited habitat value. Conversely, the North Dakota alternatives would create several miles of flowing habitat in the base of the diversion channel. This habitat would be more abundant, and potentially of better quality, than the habitat lost from abandonment. For these reasons, no mitigation is currently planned for this impact. However, as identified in Section 5.5 Mitigation and Adaptive Management, habitat quality will be further evaluated both pre-project and post-project within these areas. This will help verify, in the future, if effects on the Rush River and Lower Rush River were minimal.

The abandoned channels would likely be identified as areas not to be developed in the future. These areas would thus remain as green space, and likely as functional wetland habitat. The area would probably remain wet in the future due to tiling, drainage and stormflow runoff.

Figure 89 – Potential impact areas for the Rush and Lower Rush rivers

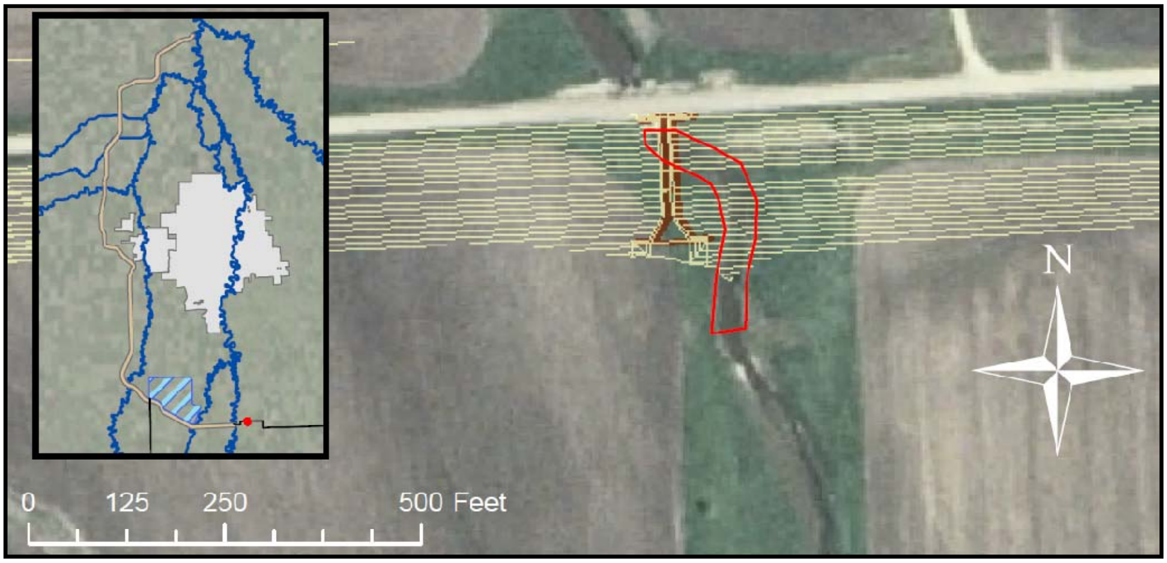


5.2.1.7.1.5 Wolverton Creek Footprint Impact

For both of the North Dakota alternatives, a tie back levee is needed in Minnesota that would cross Wolverton Creek. To accomplish this, a box culvert would be constructed through the proposed levee (Figure 90). The culvert would be located at the same location as an existing box culvert. At a minimum, the proposed culvert would be designed to provide similar hydraulic conditions as the existing culvert. The new culvert and any channel realignment would affect approximately 100 yards of Wolverton Creek. This would impact approximately 0.3 acres of aquatic habitat. Mitigation would be implemented to offset this impact.

Construction activities would result in temporary avoidance of the study area by fish. However, this should be temporary, and would not be expected to have any meaningful long-term effect on Wolverton Creek fisheries. Immobile biota (e.g., invertebrates) would be lost during channel abandonment or placement of rock or other materials.

Figure 90 - Potential footprint area on Wolverton Creek. Channel area impacted outlined in red



5.2.1.7.2 Effects on Red River Floodplain Access Within the Study Area

Many fish species use floodplain areas during flood events. These uses can include spawning, feeding, shelter from high velocities and other functions. All alternatives would reduce flood elevations within the protected area for events that are above 9,600 cfs. This would be observed on the Red River from the control structure, downstream to the confluence of the Red River with the diversion channel.

Flood elevations, and the quantity of area inundated by the river during floods will change under all alternatives. This would reduce the availability of floodplain habitat for fish use within the study area. The loss in floodplain availability would be relatively small for more frequent events above the 9,600 cfs. Losses would differ between alternatives. For example, with the FCP, there could be a loss of about 10-15 percent of the inundated floodplain for frequent flood events (e.g., 5-10 year floods), relative to existing conditions. Conversely, for the LPP and ND35K plan, there could be a loss of about 50-percent of the inundated floodplain for similar events, relative to existing conditions.

Under existing conditions, access to the floodplain in the study area, and its overall value, may be somewhat limited during floods. The area is urban nature, and the cities of Fargo and Moorhead implement emergency flood protection. With one of the diversion channel alternatives in place, floodplain access for events up to 9,600 cfs event would still occur with the same frequency and flood elevation. Only more extreme and less frequent events would affect floodplain access. During larger floods, biota within the protected area would be subjected to conditions similar to a 9,600 cfs event, and would still have access to floodplain areas inundated at that event.

Under the FCP and ND35K alternatives, floodplain access would remain unchanged upstream and downstream of the protected area, providing large areas of habitat during flooding. Under the LPP, floodplain access would actually increase substantially upstream of the protected area. Also, no scientific evidence has been found that suggests floodplain access is a limiting factor for fish populations or communities in the Red River basin. Any localized effect to the fish community due to reduced floodplain access in the study area would most likely be undetectable in terms of a population or community response. Thus, the changes in floodplain habitat access would be expected to have a less-than-significant impact to the fish community of the Red River and adjacent tributaries.

5.2.1.7.3 Fish Stranding within the Diversion Channel

All alternatives include a diversion channel that will convey significant flow during flood events above 9,600 cfs at Fargo. For the FCP, the diversion channel would be approximately 25 miles long, compared to approximately 36 miles long for the LPP and ND35K.

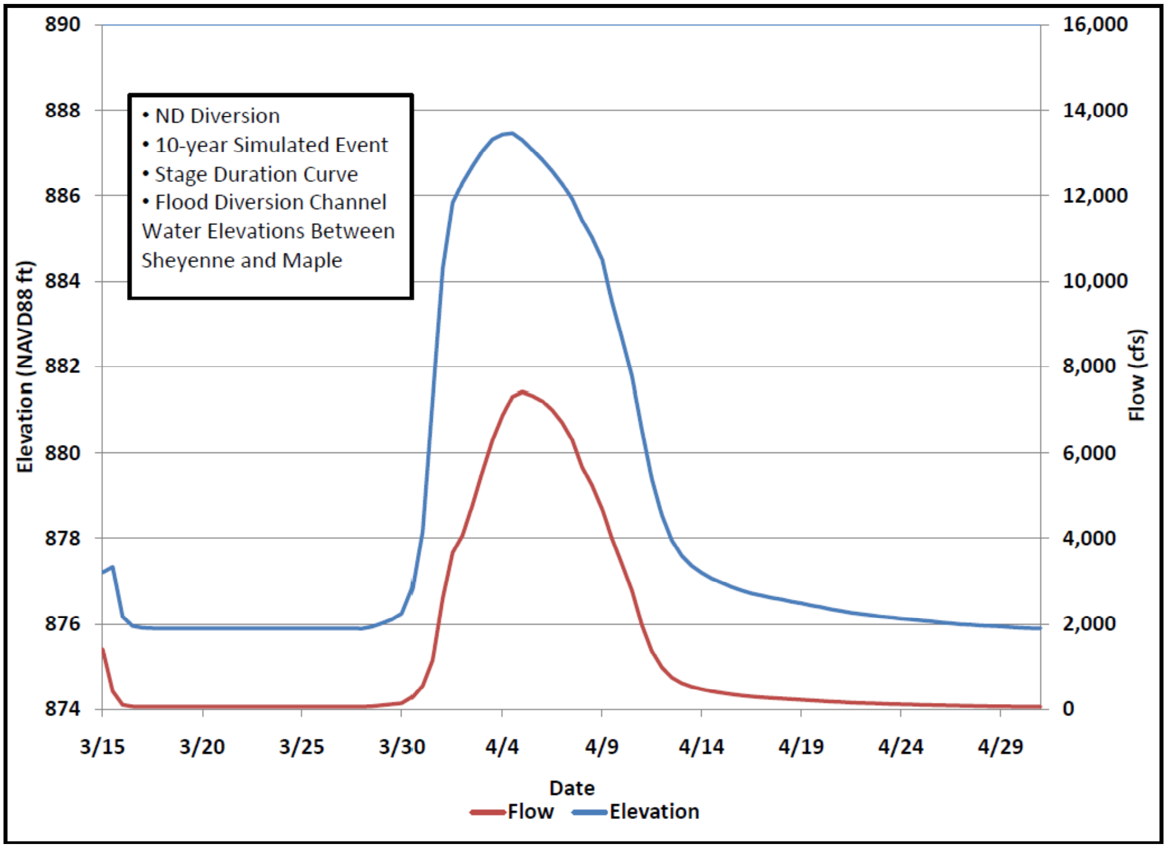
With any alternative, the diversion channel could be used by fish during flood periods when fish may be drawn into the channel. Fish use of the channel would not be considered a benefit. During periods when the diversion channel is not in operation, there may be a small amount of water present at the bottom of the diversion due to ditches and drainage tiles discharging to the upper end of the diversion channel. However, this is not expected to provide any meaningful fisheries habitat. For the North Dakota alternatives, the downstream end of diversion channel could be used continuously by fish as this area will include a low-flow channel. This low-flow channel will be built to permanently convey flow from the Rush and Lower Rush Rivers and will have year-round flow.

Concern has been expressed that fish stranding could be an issue under any alternative. As waters recede toward the end of a flood, fish in the diversion channel could become trapped if water levels fall too quickly. This could result in fish mortality from isolation and stranding, poor water quality and predation.

To aid in assessing the potential for fish stranding, the Corps performed modeling of stage hydrographs at locations within the diversion channel for the LPP. The location represented in Figure 91 is situated between the Sheyenne River and Maple River crossings. The modeling process including the development of the 10-percent chance event hydrograph are described in Appendix B. The 10-percent chance event was selected as it would be most representative of more frequent flood events where the project would operate. Modeled results and the impact conclusions for fish stranding would generally be the same amongst the LPP, FCP and ND35K alternatives.

Review of modeling output for the simulated 10-percent chance event suggests that water elevations within the diversion channel would decline at different rates along the descending hydrograph (Figure 91). The decline in water surface elevations could be up to about 2.5 ft per day. This rate of decline would decrease toward the end of the flood. As water depths become shallower in the diversion, water elevations would decrease at rates up to about a foot per day or less.

Figure 91 - Water surface elevations within the LPP diversion channel for a simulated 10-percent chance event hydrograph.



As water levels decrease, fish would be expected to respond by migrating downstream out of the diversion channel. The flow control structures for the diversion channel would be designed to have a low-flow notch to avoid an instant cut-off of flow once river elevations drop to the elevation of the control weir. In addition to the meandering channel in the downstream end of the diversion channel for the North Dakota alternatives, a low-flow channel would be created at the base of the diversion channel under any diversion channel alternative. This low-flow channel would run the entire length of the diversion channel, and is necessary to account for the water that is expected to flow through the diversion channel under most conditions. This water would originate from field and tile drains and flow into the diversion channel. The low flow channel would be three feet deep, with a bottom width of 10 feet and a top width of 34 feet. This low flow channel and additional discharge would help remaining fish exit the diversion channel. While it is possible that a few larger fish could be lost in isolated pools within the diversion channel, it is believed that this would not be a significant issue during project operations. No significant impacts to long-term fish populations trends would be anticipated from fish stranding within the diversion channel under any diversion channel alternative.

5.2.1.7.4 Effects of Fish Stranding in the Floodplain

Fish naturally use river floodplain areas during periods of high water. Under natural conditions some fish become trapped and are lost when water elevations drop. Under the LPP, water will be staged upstream to minimize downstream impacts to flood elevations. This staging will flood large areas of floodplain that will be accessible to fish. If water elevations subsequently drop too quickly on the descending limb of the hydrograph, fish could be trapped or stranded resulting in mortality. Although such conditions occur naturally, concern exists that the hydraulic conditions created under the LPP could be so extreme that fish mortality due to stranding could become too frequent or drastic to where fish populations could be effected. This condition would not occur under the FCP or ND35K. Impacts discussed below are specific to the LPP.

Conditions that could most likely affect long-term fish population trends under the LPP are flood events that occur frequently. Under the LPP the project could be operated with staging for flood events with a discharge as low as 9,600 cfs. Such flood events have occurred 22 times since 1943, and 14 times in the last 21 years.

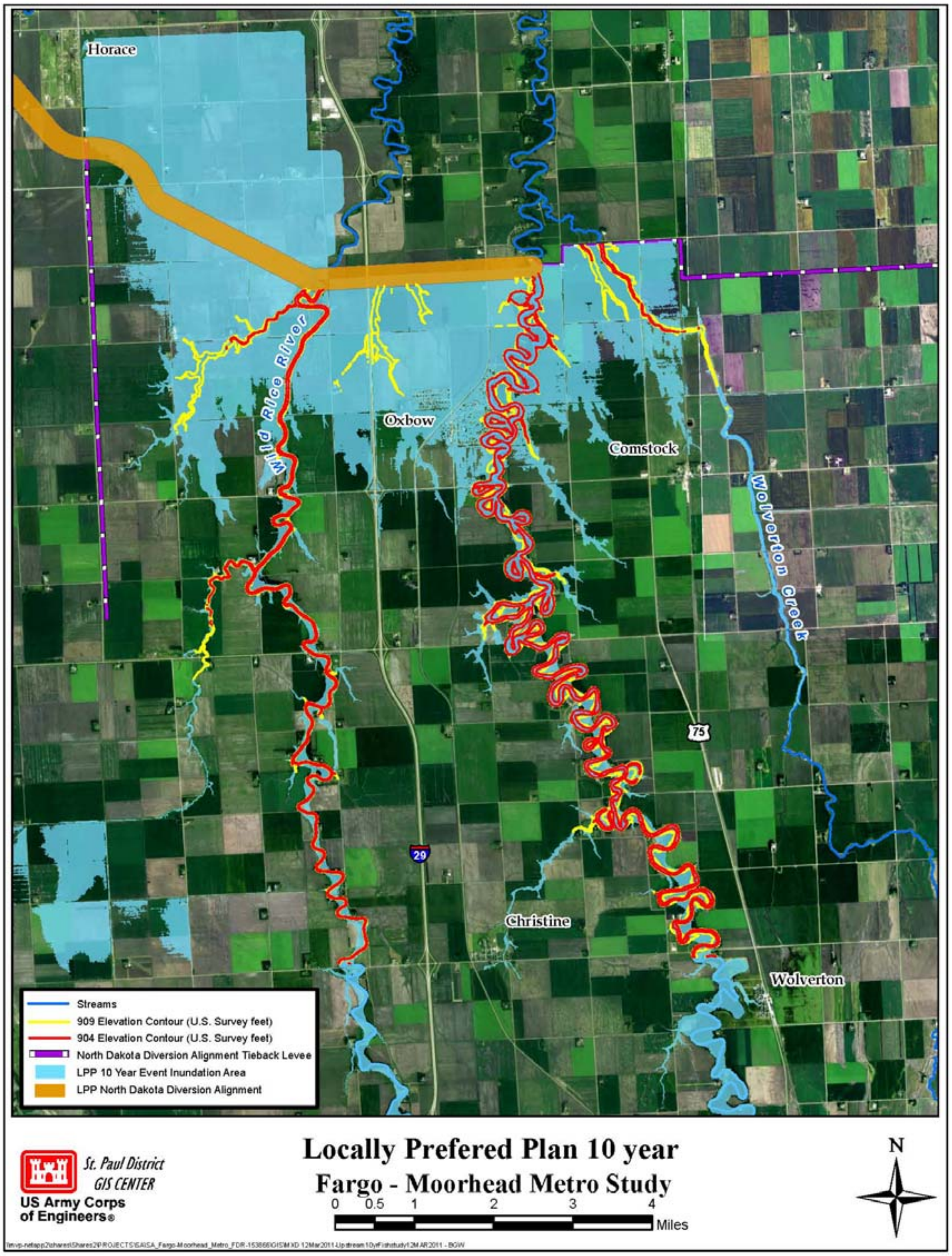
To assess potential impacts, the hydraulic modeling output was analyzed for the simulated 10-percent chance event (17,000 cfs at Fargo). This was the most frequent flood modeled and can provide insight into stranding potential. Under the LPP, approximately 20,841 acres of land would be inundated, compared to 7,858 acres under existing conditions (Figure 93). This includes large areas of land that is a considerable distance from the Red and Wild Rice rivers. During recent floods, river stage as measured at the USGS gage in Fargo has shown drops in water levels between 1.0 and 1.5 feet per day under existing conditions. By comparison, review of the modeling output for a 10-percent chance event for the Red River immediately upstream of the proposed control structure showed a range in water elevation declines. Drops in water elevations initially range from 0.2 to 0.6 feet per day, increase to a maximum rate of 3.6 feet per day, before decreasing to 0.3 to 0.5 feet per day.

Drops as rapid as 3.6 feet per day are considerably faster than natural conditions and could be especially problematic for fish on a floodplain as flat as the Red River. However, a more detailed review of the modeling output provides additional context on the significance. The initial drops in water elevation were associated with water that was spread out across the floodplain. By the time water elevations began dropping by 2.0 feet per day or more, upstream water elevations had dropped to an elevation of 909. The area inundated at this point was fairly confined to the Red and Wild Rice rivers (Figure 92). Water elevations that were dropping at the maximum rate (3.6 feet per day) occurred when water elevations were at approximately 904. This elevation is associated with river levels that appear within existing channels (Figure 93).

The precise operations of the project under the LPP will require extensive analysis prior to implementation, and almost certain refinement over time. It is unknown how closely the current modeling for the 10-percent chance event represents future project operations. It also should be recognized that river discharge could be quite different than what is portrayed in the model. That said, review of the model data suggests that water elevations will drop more gradually (e.g., 0.2 to 0.6 feet per day) when fish may be most susceptible to stranding. This could suggest the stranding potential is lower, which could translate to conditions that might not substantially impact fish populations. However, the true impact is very hard to predict, especially given exact operations have yet to be determined, and the project could stage water for even very frequent flood events (e.g, flows of 9,600 cfs at Fargo). At this time, the likely impact to long-term fish population trends remains largely unknown. It should be realized that even with optimal operations, some individual fish may become stranded following project operations that involve substantial staging of water.

The risk to fish stranding will require additional consideration during development of the project operating plan, to include observation during the first few flood events to determine resulting stranding. If substantial stranding is identified, the best mitigation likely is to modify project operations, if possible, to reduce stranding potential. Other options would also be considered collectively amongst the non-federal sponsors and natural resource agencies. No specific mitigation is planned at this time for this impact.

Figure 92 - Area of upstream staging for the LPP during the modeled 10-percent chance event. Map indicates floodplain elevation 909 and 904 ft msl relative to flooded area.



5.2.1.7.5 Effects on Fish Passage and Biotic Connectivity for Red River

Under any diversion channel alternative, fish passage on the Red River could be impacted by the Red River control structure and diversion channel. Flow velocities and patterns would be modified with the Red River control structure, which could in turn influence the ability for fish to migrate. The diversion channel could affect how fish migrate upstream through the Red River during flood events given the diversion will convey a large percentage of total-river flow. In addition to fish, the diversion channel alternatives could also affect organisms such as freshwater mussels that rely on fish as a host species during portions of their lifecycle. Impacts are discussed below for both the control structure and the diversion channel. Impacts for the Red River and diversion channel would generally be similar amongst alternatives.

5.2.1.7.5.1 Red River Control Structure Effects on Connectivity

Flow velocities through the control structure must remain low enough that fish can successfully migrate upstream. This is especially important during months when fish tend to migrate, though the ability for free fish movement can be important during all months of the year. It is also important to provide a variety of flow velocities and patterns, as opposed to providing uniform flow. Under natural conditions, rivers typically have a range of flow velocities within the channel, providing lower-velocity zones fish can use to successfully migrate upstream.

A complete description of the proposed Red River control structure is provided in Section 3.7 (also see Figure 93 and Figure 94). A complete discussion of hydraulic modeling and analyses for the diversion channel alternatives is included in Appendix B, Hydraulics. The location of the control structure will vary between the North Dakota and Minnesota alignments, namely its location above or below the Wild Rice River. This could result in slightly different designs and hydraulic conditions between the North Dakota and Minnesota alternatives. However, for this analysis, it is assumed the Red River control structure would be designed to provide similar hydraulics regardless of diversion alignment. The designs used here for the different alignments generally result in similar flow velocities and patterns through the structure.

Under most conditions, the proposed control structure on the Red River will essentially function as a bridge with flows passing below without constriction. The structure under any diversion channel alternative includes three gates that are 50 ft wide. Each gate bay sill will be approximately 90 ft long, meaning fish would have a 90-ft span to migrate through the structure. A combination of rocks, and possibly concrete baffle blocks, placed in the concrete bottom sill of the control structure will provide roughness and flow complexity along the bottom of the channel. This will provide fish a variety of velocities and flow patterns with which they can migrate upstream, provided velocities remain suitable. Water depth through the structure would not be a concern, as even under low summer flows water depths through the structure would be on the order of several feet.

Figure 93 - Schematic of proposed Red River Control Structure without flow.

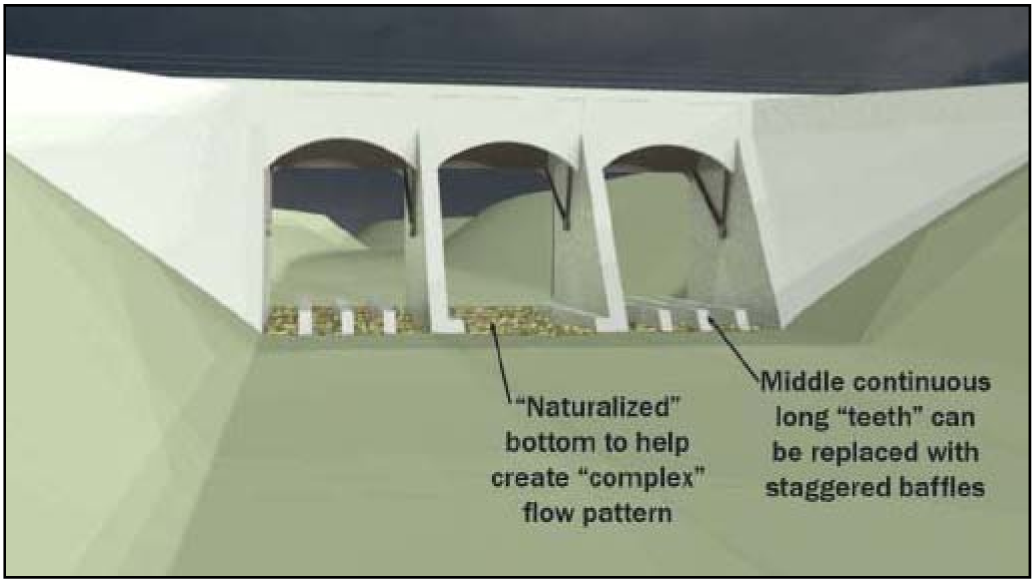
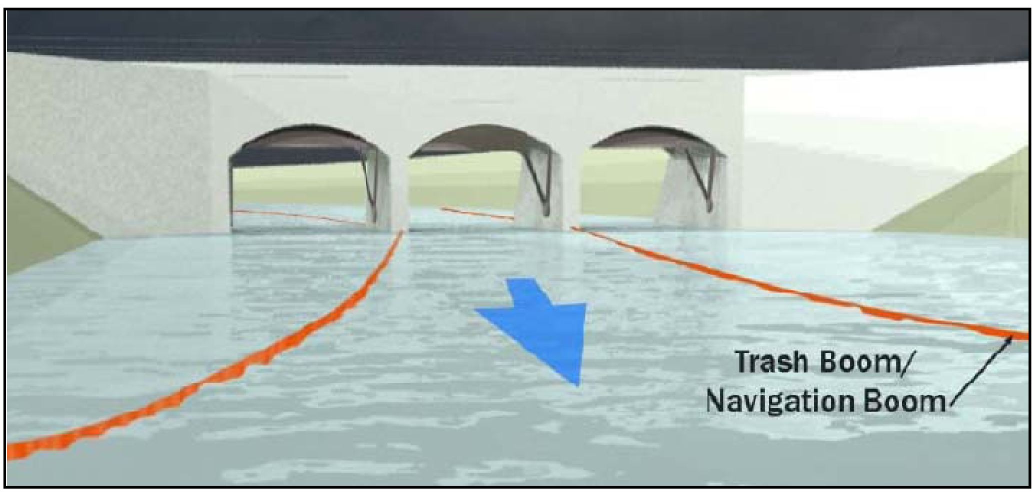


Figure 94 - Schematic of proposed Red River Control Structure with flow. Gates are out of the water, and the project is not in operation.



Under existing conditions, average flow velocities at Fargo are well under 1 foot per second (ft/s) for the annual median flow of 360 cfs, and usually average 1-2 ft/s for flows around 3,500 cfs. Velocities increase to an average of 1.5 to 4 ft/s for flows around 9,600 cfs (discharge at Fargo where the project would begin operating), and can increase more for larger events (Figure 95 and Figure 96). Velocities observed across a transect at Fargo, ND during flood events include areas of higher velocity mid-channel (e.g., flows greater than 3 ft/s). However, lower velocity areas (e.g., 1-2 ft/s) also occur near the channel perimeter, and up onto the floodplain (Figure 95 and Figure 96).

Figure 95 - Observed average channel velocities for the Red River at Fargo, North Dakota, USGS gauge 05054000, for various river discharges. Source: USGS.

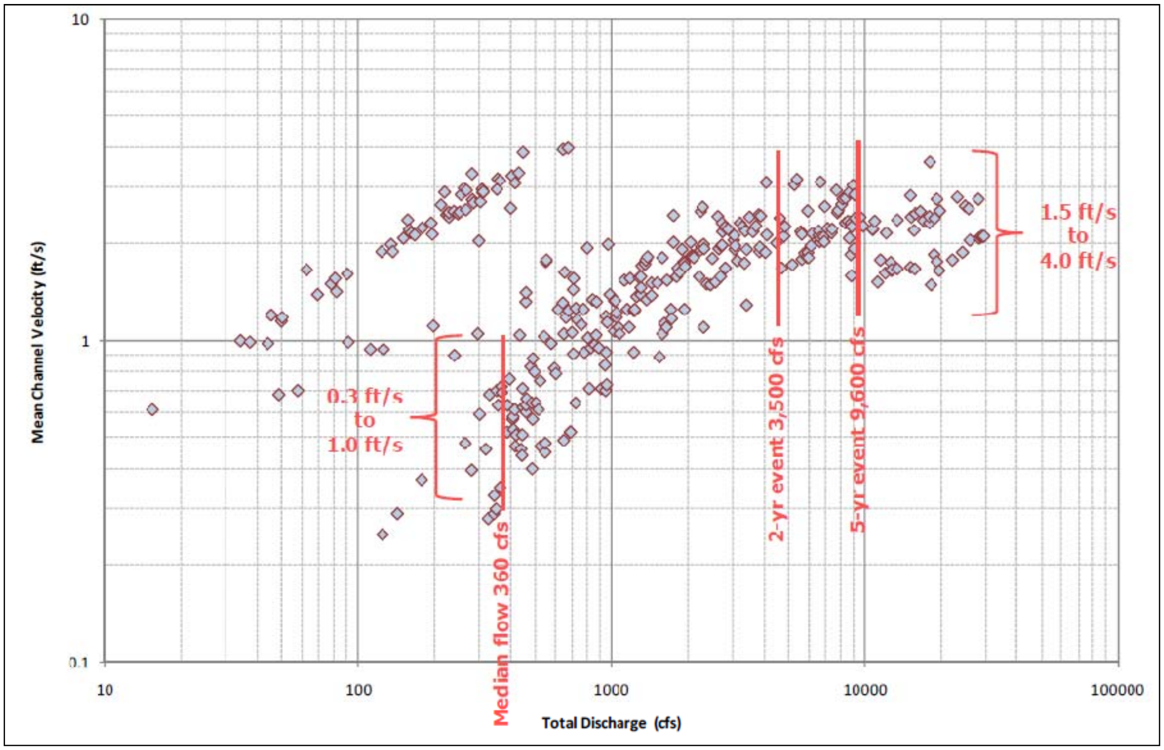
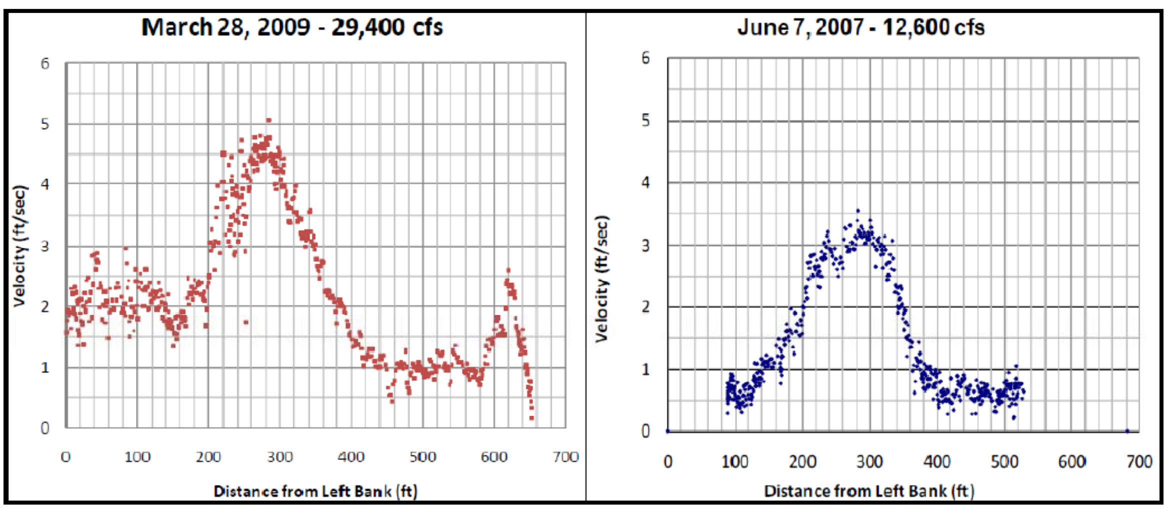


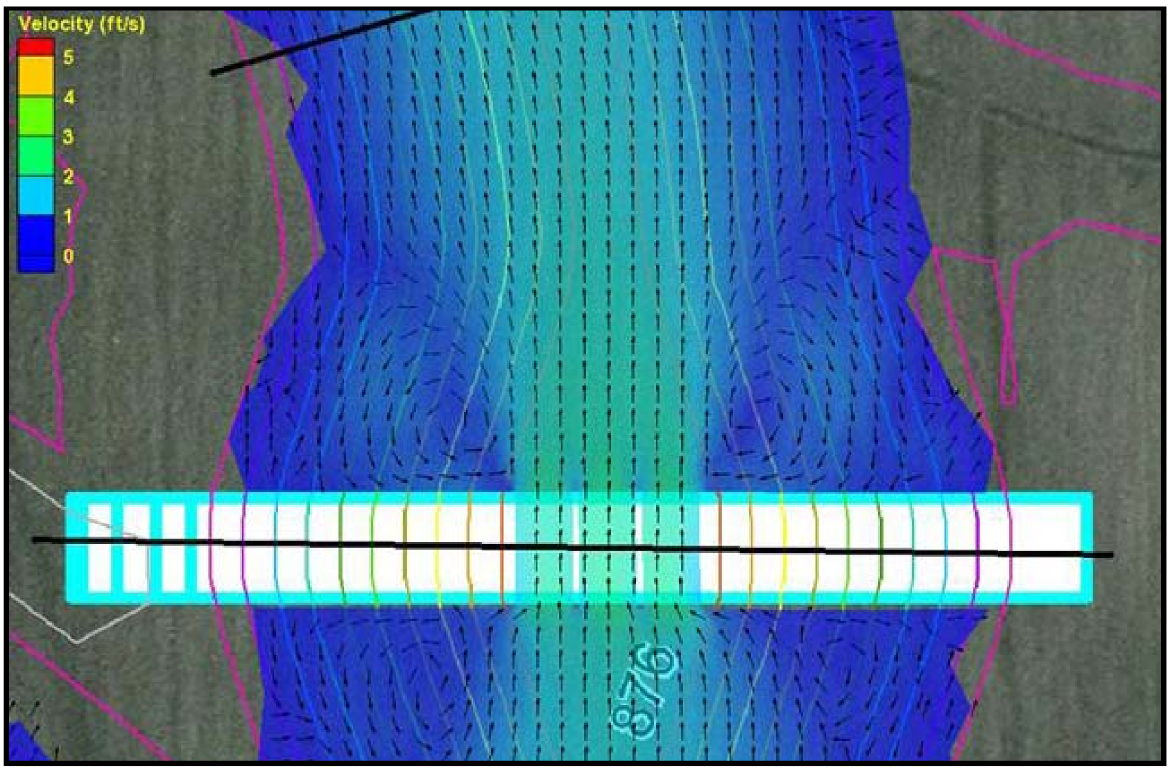
Figure 96 - Observed average channel velocities across a channel transect for the Red River at Fargo, North Dakota, USGS gauge 05054000, for a river discharges of 12,600 and 29,400 cfs. Source: USGS.



Modeling for the LPP was done at discharge levels similar to those immediately prior to the control structure going into operation. At those discharge levels, all flow is directed through the control structure and represents a "worst case" scenario in terms of velocities when the project is not in operation. Modeled velocities at this discharge suggest an average approximate flow velocity of 1.5 ft/s through the control structure. This approximate velocity would occur for the LPP and ND35K. Modeling of the FCP under similar flow conditions observed velocities of approximately 2.0 ft/s through the control structure. Modeling for lower discharges would see lower corresponding velocities.

The average velocities noted in the preceding paragraph, in combination with rock and concrete placed in the bottom of the channel to increase flow diversity, should ensure the proposed structure under any alternative is functional for fish passage, similar to existing conditions, for river discharges up to the event where the project would go in to operation (e.g., approximately 9,600 cfs at Fargo), Figure 97.

Figure 97 - Depth-averaged velocity for Red River Control Structure under the LPP for the discharge just before which the project would go into operation (i.e., generally equivalent to 9,600 cfs at Fargo, ND). Modeling assumes increased roughness along river bottom via baffle blocks or rock boulders. Velocity profiles would be similar for ND35K.



When the proposed Red River control structure is placed into operation, the gates would be lowered to begin controlling flow. This would result in constricted flows through the structure, with a substantial increase in current velocities. Although this exact situation has not been modeled, it is likely that velocities through the gate bays would be 8 to 10 ft/second, if not substantially more, for all of the diversion channel alternatives. The velocities would be well above existing conditions, and above what can be reasonably assumed to be passable for all fish species on the Red River. As such, it can be assumed that fish would not be able to pass through the proposed Red River control structure when it is in operation.

To minimize impacts to fish migration during periods when the project is in operation, fish passage channels would be incorporated into the control structure. The tentative, preliminary plans of the fish passage channels are described below. These are basic designs made for the purpose of cost-estimation, and more refined designs will be needed in the next phase of planning. This will include collaboration with State and local biologists, and other fish passage experts as necessary, to design an effective structure. The fish passage channels will be designed to maximize the opportunity for fish passage, to the extent practical, during high-flow events. The channels would provide an avenue for fish passage beginning at approximately the time the project goes into operation. The channels would operate until water elevations approach levels approximately corresponding to 20,000 cfs under the LPP; and between 29,000 and 30,000 cfs under the FCP and ND35K. At this point, no fish passage would be possible as the fish passage gates would be closed to protect the control structure from extreme hydraulic conditions. It should be noted that the limit of operation of the fish passage gates is dictated by upstream water elevations, and these elevations could vary under the LPP for a discharge of 20,000 cfs depending on how water must be staged to account for the peak flow discharge and timing.

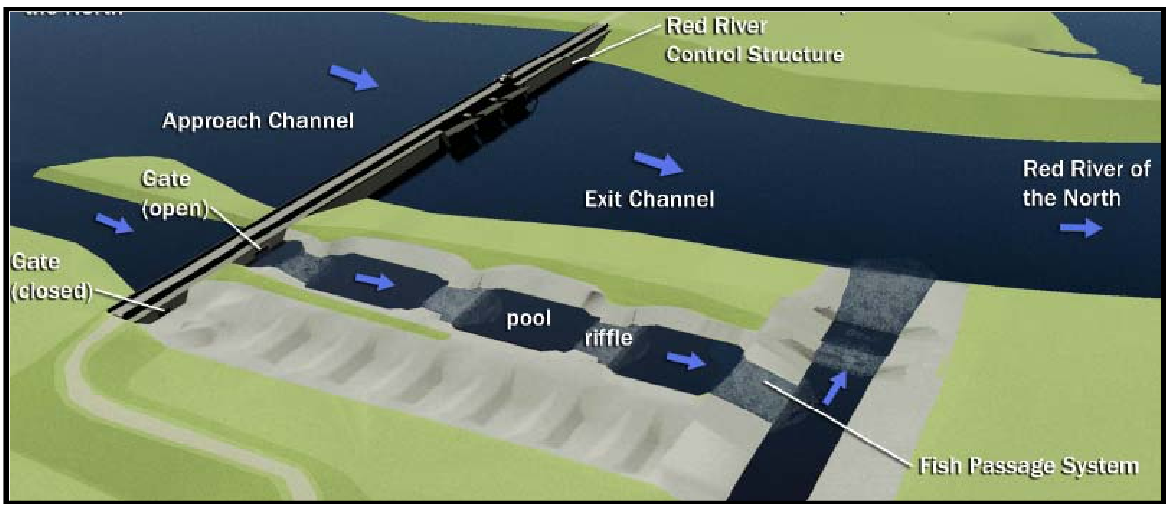
The current, preliminary fish passage system includes two channels with gates to facilitate flow through the Red River control structure (Figure 98). Each channel would be operated individually (i.e., channels would not operate simultaneously). The preliminary plans include channels with a general grade of about 2.2-percent and average velocities between 2 to 6 ft/sec through the control gate. The fish passage channels are tentatively planned to include pools that are 40 ft wide, with a total channel length up to 900 ft. However, the length may change as channel design is optimized for effectiveness and cost. Depending on design and any upstream staging, total discharge conveyed through any fish passage channel would be between approximately 50 and 600 cfs. This would be up to approximately 6 percent of the total flow through the Red River control structure. The fish passage channels will include a downstream entrance as close as possible to the Red River control structure to maximize the potential for fish to find and use the fish passage channel. The upstream exit of the channels would be placed off to the side of the Red River control structure to ensure that fish do not get drawn back into the control structure at high velocities.

Current project designs for all diversion channel alternatives include two fish passage channels to facilitate fish passage during periods when the project is in operation. Two channels would work for a wide range of flows under the FCP and ND35K alternatives. However, two channels would provide limited connectivity during floods with the LPP in place. Under the LPP, water must be staged upstream to account for downstream water level increases. As such, upstream water elevations fluctuate much more substantially under the LPP. Gates through the structure that allow for fish passage are designed for a height of 5 ft, and can only operate with water depths through the gate between 1 ft and 4.5 ft. However, upstream water level elevations could fluctuate approximately 18 feet for a flood peak of 17,000 cfs at Fargo. If only two gates were utilized it would result in narrow periods during the hydrograph where fish passage could be provided. Three additional channels would potentially be necessary (five channels total) to provide fish passage across a range of flows, up to an approximate discharge of 20,000 cfs.

To further improve the potential success of the fish passage channels under the LPP, several alternatives will be considered. This could include installation of additional gates to provide additional fish passage channels that would function across more of the hydrograph. It also could include methods to reduce the amount of staging needed, or the duration of time staging is needed, for the LPP.

It is recognized that a fish passage channel is not as effective for fish passage as an open, un-constricted channel with natural flows. However, with careful design, the fish passage channels should provide another route for fish to migrate upstream past the control structure. As discussed in Section 5.5 Mitigation and Adaptive Management, fish passage through the control structure (including the fish passage channel) will be further evaluated to verify effectiveness. This would include post-project monitoring to gauge the effectiveness of these structures in facilitating fish migration.

Figure 98 - Tentative design of the fish passage channel for the Red River control structure. Channel would function between a 9,600 cfs and 20,000 cfs under the LPP; between 9,600 cfs and approximately 29,000 and 30,000 cfs under the FCP and ND35K.

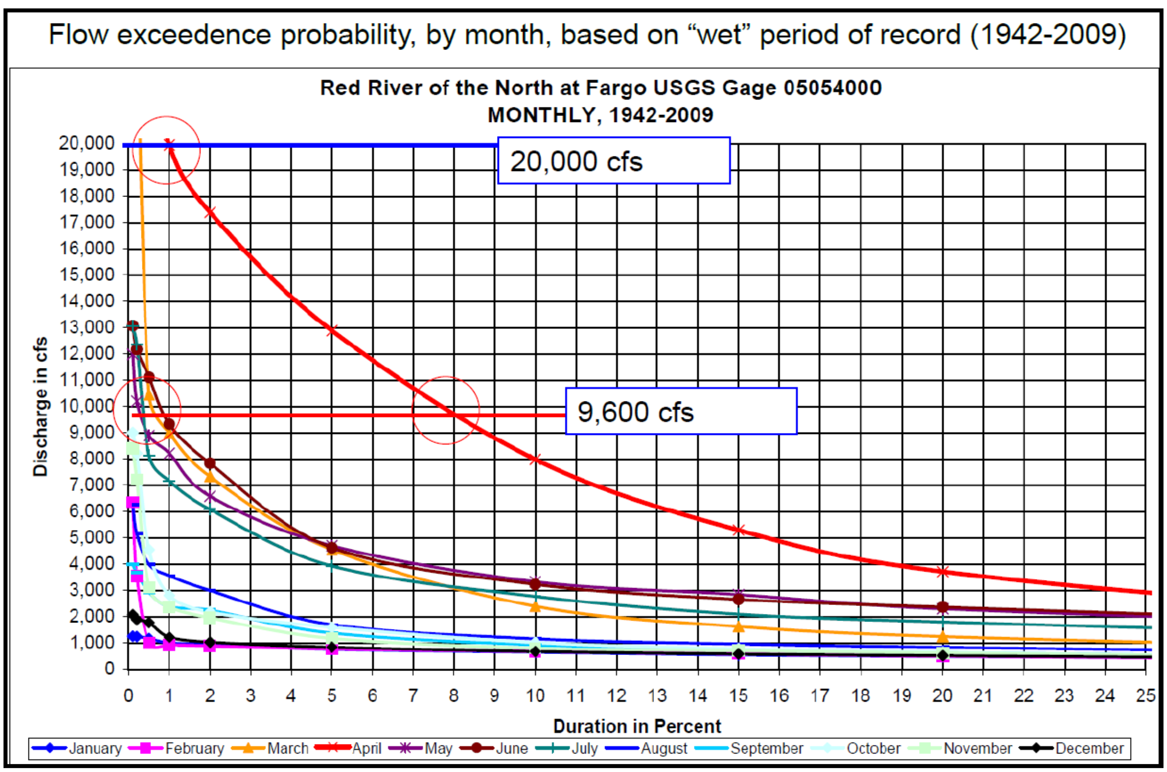


Overall, Red River fish passage most likely would not be impacted under most flow conditions. However, some limitations would exist. Under the FCP and ND35K, a fish's ability for migration could be reduced, relative to existing conditions, for river flows between 9,600 cfs and approximately 29,000 cfs at Fargo (period when fish passage channels would operate). Fish passage would be halted completely for flows above approximately 29,000 to 30,000 cfs. The impacts to connectivity would be greater under the LPP, which, even with incorporation of five fish passage channels, would provide fish passage up to an elevation that would equate to a peak flow of approximately 20,000 cfs. The impact magnitude for the LPP would vary depending on the peak and duration of the flood event. To better understand the context of these impacts requires understanding the timing and frequency of when these limitations would occur.

Discharge frequency was analyzed for available USGS gage data collected at Fargo, North Dakota. Historical daily flow data exists for this gage site dating back to 1901 (108-year period of record). However, hydrologic conditions in the early 20th century are very different from conditions in the later part of this period. Thus, the entire period of record may not be a good indicator of flow frequencies. A statistical analysis was performed to assess a period of record that may better approximate more recent flow regimes (see Appendix A). From this effort, the period 1942 through 2009 was identified as the period of record (Appendix A). This period better represents more recent conditions (e.g., more "wet" conditions), thus providing a more realistic representation of given flow frequencies.

When considering the period 1942 through 2009, Red River flows at Fargo, ND are at or below 9,600 cfs at Fargo, ND over 99-percent of the time annually. When considering flow data on a monthly basis for the wet period (1942-2009), flows exceed 9,600 cfs 1-percent or less of the time during all months except April (Figure 99). During the month of April, flows exceed 9,600 cfs about 8-percent of the time (an average of about two to three days), and exceed 20,000 cfs at Fargo, ND 1-percent or less of the time during all months (Figure 99).

Figure 99 - Percent of the time various flows are exceeded, by month, for the USGS flow gauge at Fargo, ND (USGS Gage 05054000) for the period 1942 through 2009. Comparison is made among the percent of the time flows exceed 9,600 cfs and 20,000 cfs at Fargo, ND.



Daily discharge data, for the period 1901 through December 2010 (this includes data from 2010), was further reviewed for the Red River USGS gauge at Fargo to understand potential impacts.

Under the FCP and ND35K, upstream fish migration would not occur above approximately 30,000 cfs. However, such conditions have never occurred since 1901. The fish passage channels will be designed to operate up to levels observed during the 2009 flood in Fargo. While a flood will occur at some point in the future greater than 30,000 cfs, it is reasonable to conclude that such conditions would happen extremely infrequently.

Connectivity would be slightly more restricted under the LPP. Even with five fish passage channels, connectivity may be lost when water elevations above the Red River control structure exceed an elevation typical of a peak flow of approximately 20,000 cfs. A flow of 20,000 cfs has been exceeded 6 times at Fargo (including 2011); with five events since 1997.

Under the FCP and ND35K, upstream fish migration could be more limited between approximately a 9,600 cfs and 30,000 cfs. Since 1942 there have been 23 events where discharge exceeded 9,600 cfs at Fargo, ND (including 2011). These events averaged about 10 days where flows were above 9,600 cfs (average does not include 2011). Four events (1997, 2001, 2009 and 2010) had conditions where flows were above 9,600 cfs for at least two weeks.

Impacts to connectivity under the LPP would be more pronounced. Because this alternative stages water, there is a protracted period when the project would operate. For a 10-percent chance event (17,000 cfs at Fargo), modeling suggests the project would potentially operate for a period of 19 days. Similar flood events at Fargo where floods peaked around 17,000 cfs (e.g., 1978, 1979 and 1989) might have resulted in the project operating for 7 to 10 days under the FCP or ND35K alternatives. This may suggest that under the LPP the project might operate about twice as long as it would under the FCP or ND35K for a 10-percent chance event. These impacts will be further refined as the projects operating plan is developed in greater detail.

The timing of seasonal fish migrations is outlined in Section 4, including observations for specific species. Fish migrating upstream during the month of April would have the greatest likelihood of being restricted by the diversion channel alternatives. The majority of flood events where the project would have operated historically occurred in April, though similar floods have occurred in the months of March through July. April is important for connectivity, particularly later in the month, as supported by observations of fish migration in the basin. A wide range of species could potentially experience limited capability for migration during certain conditions under any of the diversion channel alternatives. Two species of specific concern on the Red River, lake sturgeon and channel catfish, generally migrate later in the spring (e.g., May through July). While migrations of these species could be affected, they typically appear to migrate later in the spring when the project is less likely to operate. Project operations could occur more frequently in May under the LPP, compared to the FCP and ND35K, due to the need to stage water upstream.

As outlined above, the frequency and duration for limiting fish movement would be small for the FCP and ND35K. Under these two alternatives, the only conditions where fish movement would be completely impeded is during flood events in excess of the 2009 peak flood flow (e.g., flows above approximately 29,000 to 30,000 cfs). As noted above, the 2009 flood is the flood of record, and flows higher than this have never been observed over the last 110 years. For the

LPP, fish passage could be halted above flows of approximately 20,000 cfs, even with the incorporation of 5 fish passage channels. This complete disconnect (e.g., flows above 20,000 cfs) would happen more frequently than with the FCP or ND35K, although it would still be a fairly infrequent event.

Although connectivity could be reduced, fish passage would still be possible under most conditions via the fish passage channel. Under the FCP and ND35K, the amount of time the project would operate is low. Under the FCP and ND35K, the project would historically have operated only 8 percent of the time in April (an average of two to three days), and less than 1 percent of the time in all other months. Effects would be more pronounced under the LPP, where the project could operate twice as long for more frequent flood events. Though variable by species and yearly conditions, fish migrations and spawning activities often occur over a period of a few weeks or more. Thus, under the FCP and ND35K, fish passage would be affected for a short duration, and not substantially affect an entire migrational period for a given population. Fish passage could be affected under the LPP for comparatively longer, and could occur over a broader period that might encompass the bulk of a spring migratory movement for some species.

In conclusion, the FCP and ND35K would largely avoid and minimize significant adverse impacts to fish migration. As outlined above, the FCP and ND35K would have a small adverse effect on biotic connectivity. However, although connectivity would be slightly affected, it appears unlikely this effect would result in a detectable response as might be observed by a change in long-term fish population trends. Thus, the FCP and ND35K would likely have a less-than-significant impact to fish population levels in the Red River basin as a result of slightly reduced connectivity.

The LPP, with its longer operational period, could have a more significant impact to Red River connectivity. Still, it would appear unlikely that the LPP would restrict connectivity to an extent that fish populations might have a measurable impact. However, given the potential risk, and given the concern expressed by natural resource agencies during the collaboration for this project, it is concluded that the LPP could have a potentially significant impact to fish populations within the basin. As such, additional mitigation would be implemented under the LPP to address this potential impact (see Section 5.5 and Attachment 6).

5.2.1.7.5.2 Wild Rice River Connectivity

Fish passage on the Wild Rice River would be impacted by the Wild Rice control structure and proposed diversion channel under the LPP and ND35K. Flow velocities and patterns would be modified with implementation of the flow control structure, which could in turn influence the ability for fish to migrate upstream and downstream. No such effects would occur under the FCP.

A complete description of the Wild Rice River control structure, including operation, is provided in section 3.7. Impacts to connectivity on the Wild Rice would be very similar to those discussed for the Red River control structure. Under most conditions, the control structure on the Wild Rice River would essentially function as a bridge with flows passing below without constriction.

The structure, as designed for this study, includes two gates that are 30 ft wide. A combination of rocks, and possibly concrete baffle blocks, placed in the river bottom at the control structure will provide flow complexity along the bottom of the channel. This will provide fish a variety of velocities and flow patterns with which they can migrate upstream, provided velocities remain suitable. Water depth through the structure generally would not be a concern, as even under low summer flows, water depths through the structure would be about 2 feet deep. This is similar to existing channel cross sections.

A complete discussion of hydraulic modeling and analyses for the project is provided at Appendix B. Hydraulic modeling of the North Dakota alternatives predicted average flow velocities of 2.5-2.7 ft/s through the control structure under conditions just prior to the project going into operation. These average velocities, in combination with rock and concrete placed in the bottom of the channel to increase flow complexity, should ensure the proposed structure is functional for fish passage, similar to existing conditions, for river discharges when the project is out of operation.

The Wild Rice River control structure would be placed into operation in concert with the Red River control structure, meaning the gates would be operated with the same frequency as those on the Red. When the gates are in the water, the constricted flows would result in substantial current velocities that would preclude fish movement. Since the two structures would be operated in concert, the frequency and duration of operations discussed for the Red River control structure also apply to the Wild Rice structure. The limitations for connectivity on the Wild Rice are thus highly similar to those described for the Red River under the LPP and ND35K.

To minimize impacts to fish migration when the project is operating, two fish passage channels would be constructed at the Wild Rice control structure. The preliminary plans of the fish passage channels are similar to those described for the Red River, with the preliminary designs included at Attachment 5. In addition the operational capabilities for these fish passage channels are highly similar to those outlined for the Red River structure. With careful design, this fish passage channels should provide another route for fish to migrate upstream past the Wild Rice River control structure.

It is likely that the ND35K alternative would largely avoid and minimize significant adverse impacts to fish migration on the Wild Rice River. Any remaining adverse effects to fish connectivity would likely be very small and undetectable in terms of measurable population changes or response by fish populations.

However, effects on connectivity would be more pronounced under the LPP, where the project could operate twice as long for more frequent flood events. In addition, the current design for fish passage at the Wild Rice structure only includes two channels. While this would facilitate fish passage for most river conditions under the ND35K, it would leave gaps in the hydrograph under the LPP when fish passage would not be possible. Though variable by species and yearly conditions, fish migrations and spawning activities often occur over a period of a few weeks or more. Conditions under the LPP would be comparatively longer, and could occur over a broader period that might encompass the bulk of a spring migratory movement for some species. Given this, the LPP could have a potentially significant impact to connectivity on the Wild Rice, particularly without additional gates to facilitate fish passage. To address this issue, mitigation is recommended in Section 5.5 to offset connectivity impacts on the Wild Rice.

5.2.1.7.5.3 Maple and Sheyenne River Connectivity

Fish passage and aquatic habitat connectivity on the Maple and Sheyenne rivers could be impacted by the LPP and ND35K, due to the aqueducts that pass stream flows over the diversion channel. The structures would be concrete channels with similar widths to the natural channel. The concrete structures would be about 650 ft long from upstream to downstream. Water depths through the structure would remain similar to existing conditions. Likewise, water velocities passing through the aqueducts would remain within the general range of what occurs under existing conditions. Water velocities would generally be less than 2 ft/s for discharges up to a 50-percent chance event flow, with lower velocities for lower discharges (Figure 100 and Figure 101). Both aqueducts would include boulders or other hard-points strategically placed to provide flow complexity to aid in fish migration. Both aqueducts also will include a low-flow channel at its base, ensuring water depths to help migration even under low flows.

The tributary flow structures would reduce flood flows on the Sheyenne and Maple rivers. Flood flows up to at least a 50-percent chance event would pass through these structures. Above that, additional flows would be diverted into the diversion channel. As such, flows through the structures would not exceed those levels identified for a 50-percent chance event. Given this, and the potential velocities through the structure, it appears fish migration through the structure generally would not be substantially affected.

The diversion channel could affect how fish migrate upstream through the Red River during flood events given the channel will convey a large percentage of total-river flow. It could also affect the number of fish that migrate up tributary streams. The proposed structures on the Sheyenne and Maple rivers would have overflow channels that divert excess tributary flows into the diversion channel. These overflow channels will include rock as grade control. Further design will be conducted to make these structures passable to fish, which would allow fish to migrate from the diversion channel into the Maple and Sheyenne rivers. However, if a cost-effective design cannot be developed, then fish that pass upstream into the diversion channel would not have access to the Maple and Sheyenne rivers. Although the proposed system would result in altered hydraulics and an unnatural condition, both the Sheyenne River and Maple River would remain biologically connected at all times. Existing conditions include limited connectivity as a result of several dams on both the Maple and Sheyenne, including one each downstream of their proposed aqueducts. Ultimately, the North Dakota alternatives would likely not have a significant impact to Sheyenne and Maple river fish communities due to altered connectivity.

Figure 100 - Average velocities for the Sheyenne Aqueduct under the LPP for a discharge equal to a 2-year event.

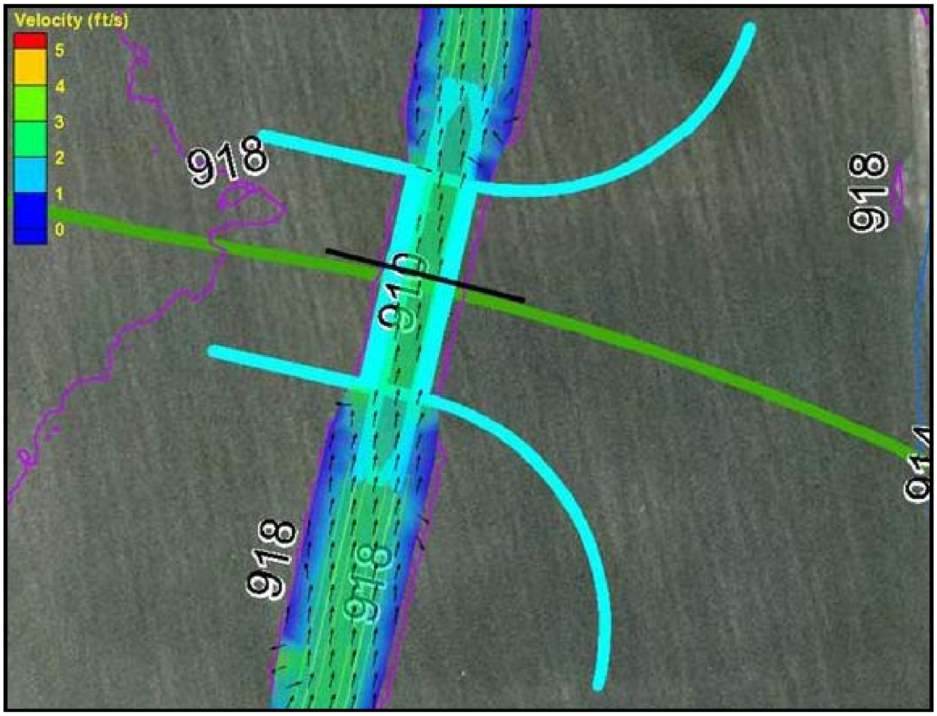
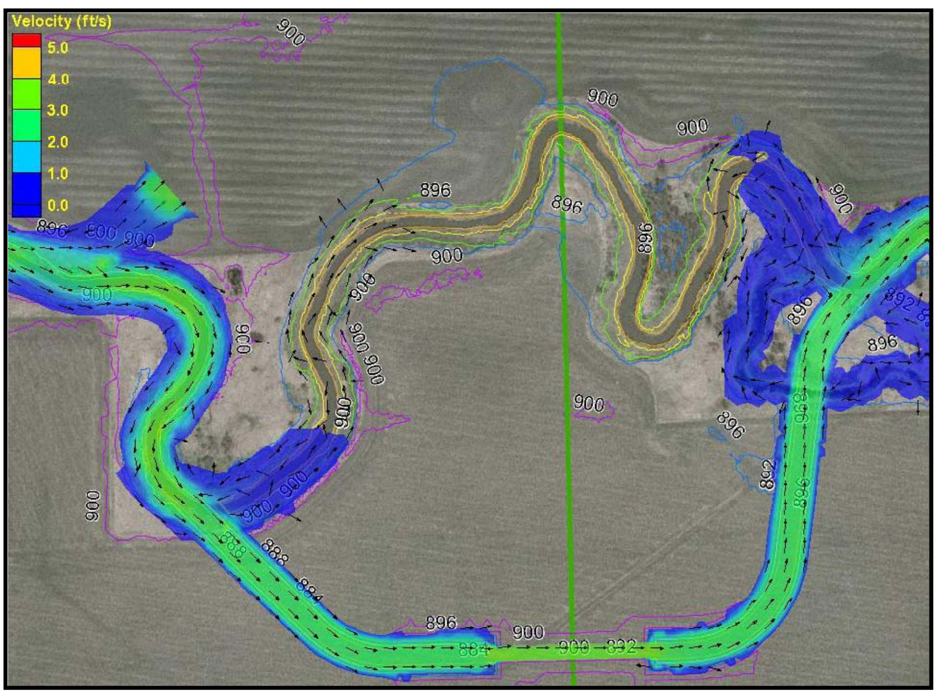


Figure 101 - Average velocities for the Maple Aqueduct under the LPP for a discharge equal to a 2-year event.



5.2.1.7.5.4 Rush and Lower Rush River Connectivity

Fish passage and aquatic habitat connectivity on the Rush and Lower Rush rivers could be impacted by the LPP and ND35K. Weirs would be constructed to step flows from the existing channels, down to the base of the diversion channel. Given the slope and need to convey a range of flow volumes it could be difficult to make these weirs directly passable for fish. Current plans include constructing a fish passage channel for both the Rush and Lower Rush Rivers to facilitate migration. These designs are included in attachment 6. These features should be passable to fish across the majority of flow conditions, with the possible exception of substantial flood events.

The need for fish passage for these two rivers will be studied further in subsequent NEPA documentation as appropriate. Given the apparent upstream habitat available on the Rush River, the need for fish passage appears greater. Conversely, the Lower Rush River is an intermittent river, and may be dry during periods of the year. The concept of fish passage will be evaluated further to determine whether the Lower Rush provides any habitat values for migratory fish. This consideration is important given that accommodating fish passage into each river could cost several million dollars.

5.2.1.7.5.5 Wolverton Creek Connectivity

Fish passage and aquatic habitat connectivity on Wolverton Creek could be reduced under the LPP and ND35K. Under these alternatives, a tie-back levee is needed to extend from the Red River control structure back across the floodplain. This will cross Wolverton Creek and require a box culvert to convey creek flows. The levee and culvert would be built adjacent to an existing road and boxculvert. For this study, the new box culvert was assumed to match the existing culvert.

Under the ND35K, the new culvert for Wolverton Creek should allow fish to pass in a similar manner as with the existing culvert. Additional design work could be done to make this a "fish friendly" culvert, to help facilitate fish movement. Such actions can be done with relatively low cost.

Fish passage through the new Wolverton Creek culvert will be more affected under the LPP. For this alternative, fish would be able to migrate through the culvert when the project is not operating. During operation of the LPP, water will be staged upstream, which could create a substantial head difference on both sides of the culvert. This will require the use of a gate to stop flow through the culvert during project operations of the LPP. This would halt fish movement. The timing and periodicity would be similar to that outlined above for project effects to the Red and Wild Rice rivers. Ultimately, the LPP could restrict upstream fish movement in Wolverton Creek during periods when the project is operating. Unlimited fish movement would be able to occur when the project is not operating. The LPP could potentially affect fish populations and communities within Wolverton Creek. Measures will be studied during more detailed project planning to minimize this impact to the extent practicable.

5.2.1.7.5.6 Red River Diversion Channel Effects on Connectivity

During operation fish could potentially migrate upstream through the diversion channel. The diversion channel would convey several thousand cfs during major discharge events . The project would not divert water until river discharge is 9,600 cfs at Fargo for the FCP and ND35K. Under the LPP flows could be diverted at flows below 9,600 cfs, though the amount and duration would vary based on the flood risk. The percent of flow diverted under all alternatives could range from roughly 30-percent to over 65-percent. An example of the potential flow distribution is provided at
Table 46. Under the LPP, the distribution of flows between the diversion channel and the protected area varies greatly depending on many factors. But the range of water diverted would generally be similar that for the FCP and ND35K.

Table 46 – Potential Flow distribution (in cfs) between diversion channel and Red River below the proposed control structure for the FCP alternative.

Flow conditions differ somewhat under the LPP and ND35K (See Appendix B).

Event	Flow in Diversion Channel	Flow Through Control Structure	Total Red River Discharge	% Flow diverted to bypass
20%	11	9,589	9,600	0%
10%	4,164	10,377	14,500	29%
5%	9,192	9,808	19,000	48%
2%	15,888	9,612	25,500	62%
1%	20,114	9,886	30,000	67%
0.2%	35,049	17,951	53,000	66%

Hydraulic modeling suggests that velocities within the diversion channel could vary based on diversion alignment and alternative (Figure 102 and Figure 103). At a 10-percent chance event, velocities under the FCP would generally be between 1 to 2.0 ft/s (Figure 102). At a 5-percent chance event, the diversion channel would have average velocities between 2 to 2.5 ft/s . The range of diversion channel velocities for the LPP alternative would generally be similar to the FCP, and would range from 1 to 3.5 ft/s (Figure 103) for flood events up to a 2-percent chance event.

Figure 102 - Average velocities for Red River Diversion channel, FCP alternative, during various discharge events. Velocity estimates begin at the confluence of the diversion channel and the Red River, and extend upstream to the diversion weir. Spikes in velocity plots are due to constrictions at bridge crossings.

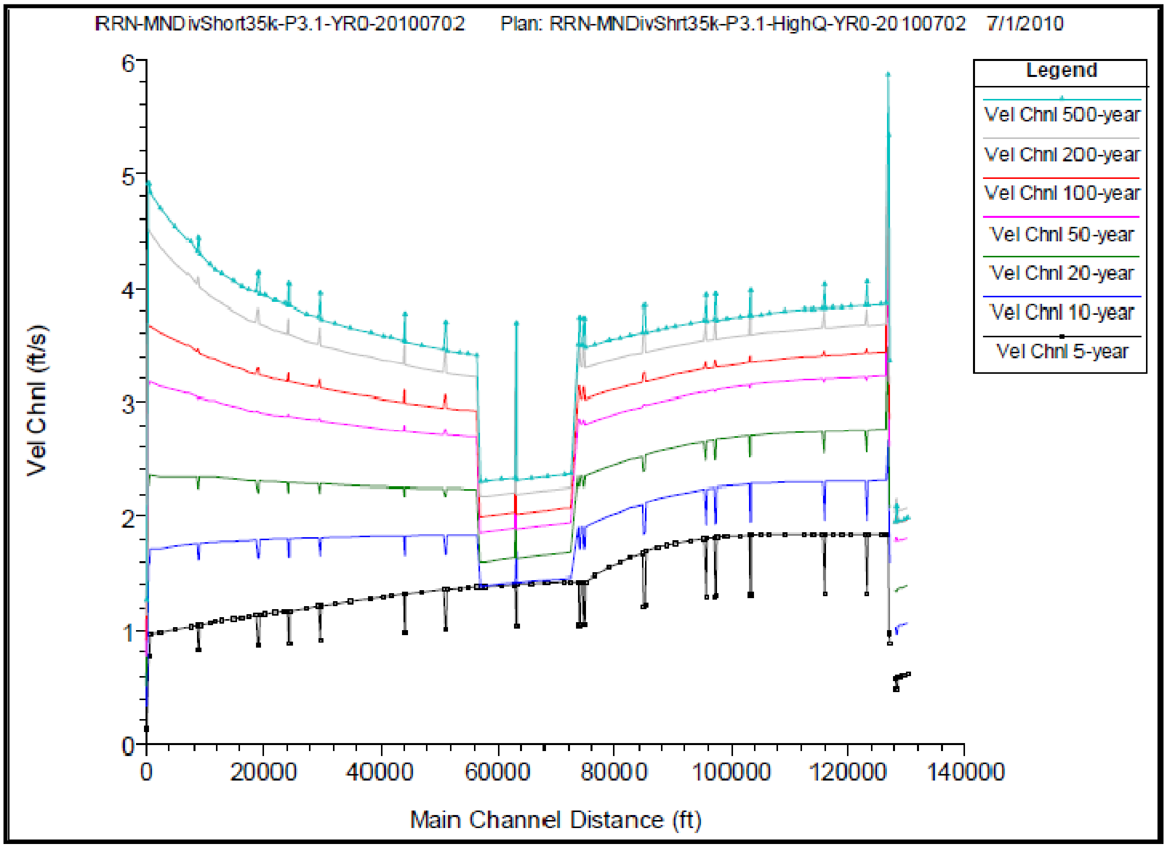
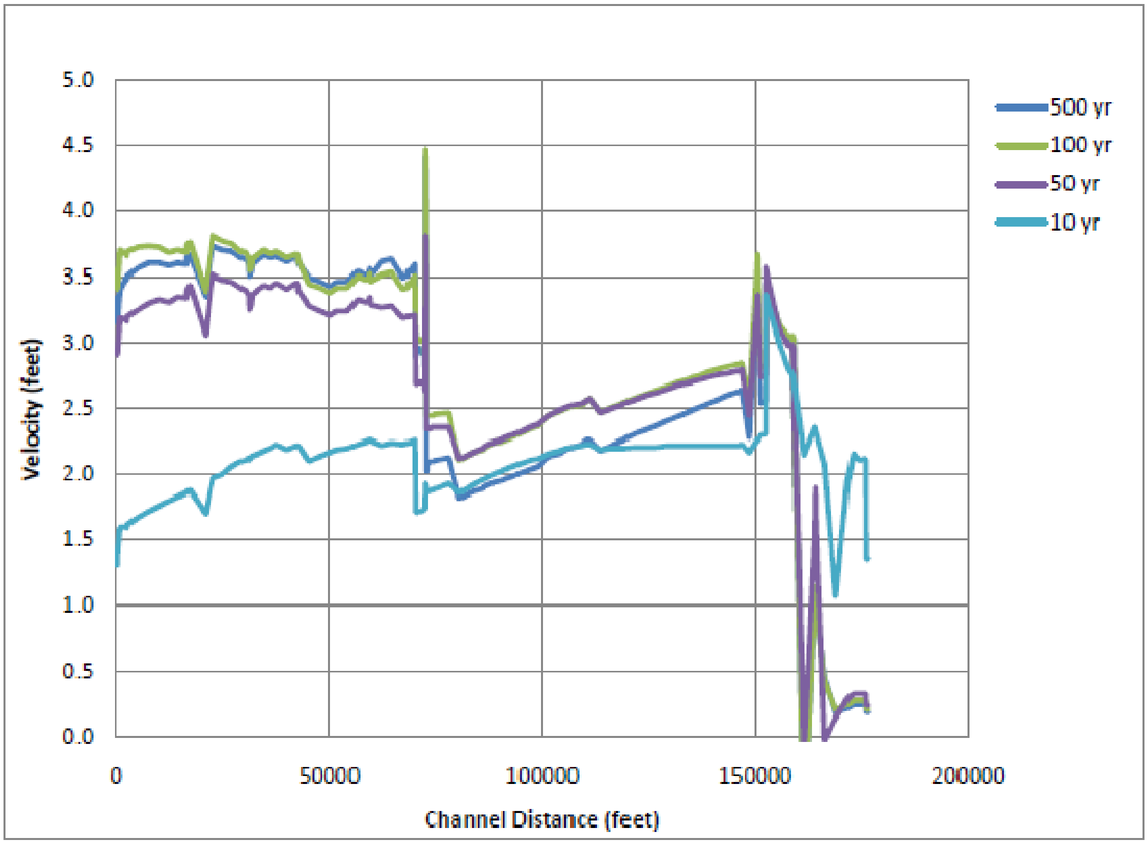


Figure 103 - Average velocities for Red River diversion channel, LPP, during various discharge events. Velocity estimates begin at the confluence of the diversion channel and the Red River, and extend upstream to the Wild Rice River diversion weir control structure. Spikes in velocity plots are due to constrictions at bridge and stream crossings.



The diversion channel would be 25 miles long for the FCP, and 36 miles for the LPP and ND35K. It is unknown how successfully fish would migrate upstream through a long straight channel with the indicated average velocities. However, under any alternative, it is possible the diversion channel would be passable to fish up to about a 5-percent chance event, and possibly even up to a 2-percent chance event.

For the FCP, once at the upstream end of the diversion channel, fish would need to pass over a weir to access back into the Red River. This weir would be designed to accommodate fish passage by building a series of rock rapids at the weir, similar to what has been done at other Red River dams.

For the LPP and ND35K, fish passage at the upstream control weir does not seem feasible. Current designs include a substantial vertical drop from the top of the control weir to the bottom of the diversion channel. Under the LPP, the bypass would be especially problematic due to staging additional water upstream of the control structure. Professional judgment suggests that attempting to include a fish passage for the diversion channel under the LPP could cost an additional $20 to $30 million. Costs for the ND35K could be less, but still substantial.

Without connectivity on the upper end of the diversion channel for the LPP and ND35K, fish would be required to swim back down the diversion channel to access the Red River. While not ideal, the low-flow channel at the bottom of the diversion should ensure that fish have a route to access back to the Red River when diversion channel flows drop.

Fish migrations could be influenced when the diversion channel is in operation, The frequency and duration of project operations has been outlined above for other impacts. Fish migrating upstream during the month of April would have the greatest likelihood of being influenced by the diversion channel. April is typically a period when fish migrations become more pronounced, with the end of April and early May being especially important for some species.

The tendency that fish would migrate up the diversion channel is unknown. It is possible fish could migrate the entire length of the diversion channel, even during brief periods of operation (e.g., a few days). Fish that do access the diversion channel would have the opportunity to migrate back out. The key question is how affected might fish migrations be if they are drawn into the flood diversion, then have to emigrate back out to continue to their movements back in the Red River. The effect on migrations, and the subsequent impact to long-term population's trends is impossible to predict. The impact to fish migrations likely can only be evaluated through monitoring once the project has been constructed. If migrational movements are substantially affected, potential mitigation measures might include deterrent systems to keep fish out of the flood diversion. These could be implemented at the downstream diversion confluence, or potentially one of the bridges that would serve as a constriction point.

Since fish would have a path to exit the diversion channel, the risk to direct mortality would be very low. Given this, no mitigation is recommended at this time. However, the potential impact to fish migrations will be evaluated further following project construction. Potential impacts will be verified, and need for any mitigation measures confirmed at that time.

5.2.1.8 Upland/Riparian Habitat

The surface areas that would have direct impacts for the project features are as follows: FCP, approximately 6,415 acres; ND35K plan, approximately 6,560 acres; and LPP approximately 8,054 acres. Of these areas, disturbance caused by project-related construction would be limited to the diversion channel, spoil disposal area, tie-back levee footprints, storage area levee construction, and construction areas of the river crossing structures. The acreage for the LPP also includes areas used for storage and staging, which would not be disturbed by construction.

There would be some areas where upland forest and riparian forested areas would be cleared or otherwise impacted. For the FCP the Red River control structure would impact approximately 22 acres of riparian forest; the diversion channel would impact approximately 49 acres of a mix of upland forest and riparian forest; and the Red River outlet structure would impact approximately 18 acres of riparian forest. For the ND35K the Red River control structure would impact approximately 20 acres of riparian forest; the diversion channel and tie-back levees would impact 95.5 acres of a mixture of upland forest and riparian forest; the Wild Rice River control structure would impact approximately 20 acres of riparian forest; the Sheyenne River aquaduct would impact approximately 10 acres of riparian forest; and the Maple River aquaduct would impact approximately 3 acres of riparian forest; and the Red River outlet structure would impact 9 acres of riparian forest. There would be no impacts to forests at the Lower Rush and Rush rivers. For the LPP the Red River control structure would impact approximately 20 acres of riparian forest; the diversion channel and tie-back levees would impact 96 acres of a mixture of upland forest and riparian forest; the Wild Rice River control structure would impact approximately 20 acres of riparian forest; the Sheyenne River aquaduct would impact approximately 10 acres of riparian forest; the Maple River aquaduct would impact approximately 3 acres of riparian forest; the storage area would impact 40 acres upland forest; and the Red River outlet structure would impact 9 acres of riparian forest. There would be no impacts to forests at the Lower Rush and Rush rivers.

Table 47 - Impacts to Forested Land with FCP

Forest Impacted FCP			
Riparian Forest Impacted	Acres	Upland Forest/Shelter Belts	Acres
Red River Control Structure Impacts MN	22	Red River Control Structure Impacts MN	0
Red River Outlet Structure Impacts MN	18	Red River Outlet Structure Impacts MN	0
Diversion Channel MN	2	Diversion Channel MN	47
Total	42	Total	47

Table 48 - Impacts to Forested Land with ND35K

Forest Impacted ND35K			
Riparian Forest Impacted	Acres	Upland Forest/Shelter Belts	Acres
Red River Control Structure Impacts ND	20.4	Red River Control Structure Impacts ND	0
Red River Outlet Structure Impacts ND	9	Red River Outlet Structure Impacts ND	0
Wild Rice River Control Structure Impacts ND	20	Wild Rice River Control Structure Impacts ND	1
Sheyenne River Aquaduct Impacts ND	9.8	Sheyenne River Aquaduct Impacts ND	0
Maple River Aquaduct Impacts ND	3.1	Maple River Aquaduct Impacts ND	0
Diversion Channel ND	55	Diversion Channel ND	40.5
Total	117.3	Total	41.5

Table 49 - Impacts to Forested Land with LPP

Forest Impacted LPP			
Riparian Forest Impacted	Acres	Upland Forest/Shelter Belts	Acres
Red River Control Structure Impacts ND	20.4	Red River Control Structure Impacts ND	0
Red River Outlet Structure Impacts ND	9	Red River Outlet Structure Impacts ND	0
Wild Rice River Control Structure Impacts ND	20	Wild Rice River Control Structure Impacts ND	1
Sheyenne River Aquaduct Impacts ND	9.8	Sheyenne River Aquaduct Impacts ND	0
Maple River Aquaduct Impacts ND	3.1	Maple River Aquaduct Impacts ND	0
Diversion Channel ND	55	Diversion Channel ND	41
		Storage Area	40
Total	117.3	Total	82

The loss of these wooded areas would be permanent but would be mitigated for by converting farmed wetland along the Red River into floodplain forest at a 2:1 ratio. There will also be tree plantings along the recreational corridor. A discussion of the mitigation proposals and methods for calculating acres is in Attachment 6. The other upland areas to be disturbed are currently farmed and have reduced natural resource value. Portions of the spoil areas would be available for farming after completion. All other disturbed areas would be replanted with native species, primarily grasses that would have positive impacts on the area's overall habitat value. Overall, the construction activities would have temporary adverse impact on the terrestrial habitat but the eventual changes in vegetative cover would have long term beneficial impacts on the avian and small mammal groups which are found in areas on the periphery of residential development and agricultural plots.

5.2.1.9 Endangered Species

5.2.1.9.1 Federal Species

Two federally-listed threatened or endangered species are listed for Cass County: the whooping crane (*Grus americanus*) and the Gray Wolf (*Canis lupus*), both of which are endangered. One federally-listed threatened or endangered species is listed for Clay County: the Western prairie fringed orchid (*Platanthera praeclara*), which is threatened. One species is on the candidate species list for Clay County, the Dakota skipper (*Hesperia dacotae*). The Fish and Wildlife Service's records do not indicate any individuals of any of these species within the study area for any of the diversion channel alternatives (FWS letter in Appendix Q).

Bald eagles and their nests are protected from take and disturbance, respectively, per the Bald and Golden Eagle Protection Act. The Fish and Wildlife Service verified the location of two bald eagle nests within the study area inside of the protected area of the ND35K and LPP, but several miles from any proposed construction, and a third nest has been identified approximately 5 miles upstream of the Red River control structure that may be impacted by the LPP due to staged water.

The three nests will not be impacted by the project construction due to location, but the three nests will be monitored during the spring of 2011. In addition, the study area will continue to be monitored during the upcoming years to ensure that no new nests will be impacted by project construction. The nest located upstream of the control structure may be impacted by staged water weakening the root system of the tree. This is highly unlikely due to the frequency of events that require staging, however if there is an extreme event year after year there could be an impact. There will be raptor nest surveys completed in the spring of the year preceding construction within or near any affected wooded areas.

5.2.1.9.2 State Listed Species

5.2.1.9.2.1 Minnesota Special Concern Species and Threatened and Endangered Species with Potential to Occur in Clay County

There are several species on either the Special Status species list or the Threatened and Endangered Species list with potential to occur in Clay County, Minnesota (see Section 1.9 Appendix F). Of these species listed there are is one bird species (bald eagle), one fish species (lake sturgeon), and one mussel species (black sandshell) with moderate potential to occur within our study area. The other species listed either have no potential or low potential of occurring within in the study area.

Impacts to the bald eagle are addressed in section 5.2.1.10.1. Direct impacts to the lake sturgeon would likely be minimal as the lake sturgeon would avoid construction activity. The ability for lake sturgeon to migrate could be occasionally affected during operation of the structure. These impacts are outlined above for each diversion channel alternative. Impacts to lake sturgeon would likely be less than significant for each alternative, following construction of all project features (e.g., fish passage channels) and mitigation features outlined for each alternative.

In-water construction activities under any diversion channel alternative could result in mortality of black sandshell mussels. Previous mussel surveys have collected black sandshell from the Red River in the study area. Additional mussel surveys are being considered for project footprint areas to verify whether impacts to mussel resources would be substantial.

5.2.1.9.2.2 North Dakota Special Status Species with Potential to Occur in Cass County
There are several Special Status Species with potential to occur in Cass County, North Dakota (see section 1.9 Appendix F). Of these listed species, five have a moderate potential of occurring within the study area. The other species listed either have no potential or low potential of occurring within in the study area.

The five species that have a moderate chance of occurring in the study area include two bird species (whip-poor-will and a cardinal), and three Mussel species (Wabash pigote, black sandshell, and the mapleleaf).

Habitat used for nesting by either the cardinal or the whip-poor-will may be disturbed or removed during project construction. To the extent practicable, vegetation clearing activities would be done so as to avoid affecting nesting individuals. Nonetheless, some limited take of individuals may occur incidental to construction activities. It is expected that any limited take would have no long lasting effect on the affected migratory bird species.

Forested land that will be impacted as part of the project will be impacted during the winter months in order to not impact the bird species during their nesting and rearing periods. This action will minimize the risk of any impacts to either listed bird species.

In-water construction activities under any diversion channel alternative could result in mortality of black sandshell, mapleleaf and Wabash pigtoe mussels. Previous mussel surveys have collected these species from the Red River in the study area. All three have been collected from the Sheyenne River in the vicinity of the proposed aqueduct. Black sandshell have been collected from the Wild Rice River in the area of the control structure for the ND35K and the LPP. Additional mussel surveys are being considered for project footprint areas to verify whether impacts to mussel resources would be substantial.

5.2.1.10 Prime and Unique Farmland

Maps of the FCP, ND35K and LPP were sent to the Natural Resources Conservation Services (NRCS) in both North Dakota and Minnesota. NRCS evaluated these footprints for the Farmland Conversion Act and made determinations for each of these alternatives. For the FCP approximately 5,889 acres would be impacted, for the ND35K up to 6,540 acres of prime and unique farmland would be impacted, and for the LPP approximately 6,878 acres of prime and unique farmland would be impacted. (Appendix F sections 1.4 and 1.5)

For all of the diversion channel alternatives there will be a great deal of prime and unique farmland impacted, as the majority of the land impacted is farmland, and of that farmland over 95-percent of it is considered prime and unique for the FCP and over 90-percent is considered to be prime and unique for the LPP and ND35K. This impact is considered to be less than significant based on the large quantity of farmland in the study area and the fact that over 90-percent of all farmland is considered prime and unique in this region.

5.2.1.11 Hazardous, Toxic and Radioactive Waste (HTRW)

A Phase I Environmental Site Assessment (ESA) was completed for both the Minnesota and North Dakota diversion channel alternatives in December 2010. It conformed to ASTM Standard Practice E1527-00. The ESA recommended a limited Phase II Environmental Site Assessment depending upon the ultimate selected diversion alternative. Detailed information will be made available upon request.

5.2.2 Cultural Resources

Most lands in Cass County, North Dakota, and Clay County, Minnesota, have not been surveyed for cultural resources. Previous cultural resources surveys conducted in these two counties have usually been related to specific projects or studies, e.g., Red River bank stabilization in Fargo and Moorhead; Cenex pipeline construction; Fargo Southside Study Area; and West Fargo Flood Control Project. Inventories of potentially historic standing structures were undertaken in Cass County in 1979 and the City of Fargo in 1985 under the sponsorship of the Historic Preservation Division of the State Historical Society of North Dakota (Fiege 1986; Granger 1986; Ramsey 1979), and in the City of Moorhead in 1979 and other Clay County communities in the 1980s under the sponsorship of the State Historic Preservation Office of the Minnesota Historical Society (Moorhead Community Development Department 1979). Few of those structures have been evaluated for eligibility to the National Register of Historic Places (National Register). Since the 1980s additional structures have reached 50 years old and need to be recorded and evaluated as well. Specific effects on cultural resources for each of the diversion channel alternatives are given below. Appendix E, Cultural Resources, contains more detailed information on known cultural resources sites, reported but unverified site leads, and previous cultural resources investigations for each diversion channel alternative.

The area of potential effect for each alternative includes one-half mile on either side of the diversion channel centerline, one-quarter mile on either side of a breakout channel centerline, and one-sixteenth mile on either side of a tie-back levee centerline. A Programmatic Agreement for the project will be negotiated between the St. Paul District, U.S. Army Corps of Engineers, the Minnesota State Historic Preservation Officer, and the North Dakota State Historic

Preservation Officer, with the City of Fargo and the City of Moorhead, being the non-federal sponsors, as concurring parties. Certain Indian Tribes may also elect to be concurring parties. The Programmatic Agreement will cover the Section 106 of the National Historic Preservation Act responsibilities of the Corps for this project. A draft of the Programmatic Agreement is included as Attachment 3.

5.2.2.1 ND35K Plan

As of March 8, 2011, there are no National Register listed historic properties in the ND35K alignment. The Sheyenne River Bridge (32CS4462) in Warren Township has been determined eligible to the National Register. Prehistoric archeological sites 32CS42 and 32CS44 have been determined not eligible to the National Register. Prehistoric archeological sites 32CS43 and 32CS201 and historic standing structures 32CS4461 (Maple River bridge in Raymond Township), 32CS5090 (rural residence), and 32CS5091 (rural residence) have not had their National Register eligibility evaluated. A lead to one historic archeological site—32CSX238b-Red River Trail segment in North Dakota—needs to be field verified. None of these known sites or structures is crossed by the diversion channel. The tie-back levee alignment crosses where the historic oxcart trail (21CYr-Red River Trail) ran north-south along the Minnesota side of the Red River. The continued existence of the Red River Trail in this area needs to be field verified. Of the known sites and structures in the ND35K diversion channel alignment, only site 32CS42 is crossed by the diversion channel. Site 32CS42 has been determined not eligible for the National Register. This diversion channel alignment needs a Phase I cultural resources survey, except for where it intersects the existing West Fargo diversion channel. The Phase 1 survey has been partially completed; the results can be made available upon request. The entire tie-back levee footprint needs to be surveyed. A partial survey of the diversion channel and tie-back levee alignments in 2010 recorded seven historic archeological sites, one isolated prehistoric projectile point, three isolated historic artifacts, 11 farmsteads, two railroad segments, and four other structures. Of these, two farmsteads (ND-5 and ND14), one railroad segment (FM3-5), and one historic archeological site (FM2-2) are recommended eligible to the National Register; six farmsteads (ND-3, ND-4, ND-7, ND-10, ND-12 and ND-13) have undetermined National Register eligibility. The remaining eight structures, six sites, and four isolated finds are recommended as not eligible to the National Register.

5.2.2.2 FCP

As of March 8, 2011, the John Olness House (CY-KRG-001) on U.S. Highway 75 at Kragnes is the only National Register listed historic property in the FCP alignment. Prehistoric archeological sites 21CY3, 21CY19 and 21CY55 and three historic standing structures (CY-DWC-003-Northern Pacific shop buildings; CY-KRG-004-Kragnes Bar; CY-KRG-005-warehouse in Kragnes) have not had their eligibility to the National Register evaluated. Leads to three historic ghost towns (21CYk-Ruthruff, 21CYl[el]-Lafayette, and 21CYo-Burlington) and to 21CYr, the Red River Trail, an historic oxcart running along the east side of the Red River, need to be field verified. This diversion alignment crosses the locations of the historic ghost towns of Ruthruff and Lafayette as well as crossing the Red River Trail three times. The breakout channel alignment crosses the location of the historic ghost town of Burlington (21CYo) and follows the Red River Trail (21CYr) for roughly one mile and crosses it once further south as well. The location of an unverified lead to one historic archeological site

(32CSX1-Holy Cross Mission) is crossed by the FCP tie-back levee alignment, which is in North Dakota. The diversion alignment, the breakout channel alignment, and the tie-back levee alignment all need a Phase I cultural resources survey. The Phase 1 survey has been partially completed; the results can be made available upon request. The existence of the various ghost towns, the mission site, and the Red River Trail in this area needs to be field verified if this alternative is selected. A partial survey of this diversion channel alignment and its associated Red River and Wild Rice River breakout channel alignments and tie-back levee alignment in 2010 recorded seven historic archeological sites, one prehistoric and historic archeological site, three isolated prehistoric artifacts, 14 farmsteads, five houses, and two other structures. Of these, two farmsteads (MN-14 and MN-19), two historic archeological sites (FM2-4), and the prehistoric and historic archeological site (FM4-3) are recommended as eligible to the National Register; one farmstead (MN-6) and a railroad segment (MN-8) are of undetermined eligibility to the National Register. The remaining five archeological sites, 17 structures and three isolated finds are recommended as not eligible to the National Register.

5.2.2.3 LPP

There are five prehistoric archeological sites, one prehistoric isolated find, nine historic archeological sites, three historic isolated finds, four historic archeological site leads, 13 farmsteads, and six other structures within one half mile either side of the LPP diversion channel centerline, within 100 meters/330 feet of either side of its two tie-back levee centerlines, in Storage Area 1, or within 100 meters/330 feet of the exterior boundary of Storage Area 1. As of March 8, 2011, there are no National Register of Historic Places listed historic properties present in the LPP alignment. Bridge site 32CS4462 has been determined eligible to the National Register and historic archeological site FM2-2 and two farmsteads (ND-5 and ND-14) and a segment of railroad (FM3-5) have been recommended as eligible to the National Register. Prehistoric archeological sites 32CS43, 32CS201 and 32CS4563, church site 32CS114, farmsteads ND-3, ND-4, ND-7, ND-10, ND-12 and ND-13, and unverified historic site leads 32CSX33, 32CSX131, 32CSX238b, and 21CYr have not had their National Register eligibility evaluated. Prehistoric archeological sites 32CS42 and 32CS44 have been determined not eligible to the National Register in 1988 in conjunction with the Horace-West Fargo Flood Control Project. The remaining eight archeological sites, four isolated finds, and 10 structures are recommended as not eligible to the National Register.

5.2.3 Socioeconomic Resources

<u>5.2.3.1 Social Effects</u>

5.2.3.1.1 Noise

During project construction temporary increases in noise are expected from the operation of construction equipment. No increases in noise are expected during project operation.

5.2.3.1.2 Aesthetics

Any of the diversion channel alternatives would result in changes to the landscape near Fargo or Moorhead. The diversion channel would be vegetated with native species but would still be visible as man-made structures.

5.2.3.1.3 Recreational Opportunities

Recreational opportunities will not be adversely impacted by any of the diversion channel alternatives. Recreation plans have been developed for both Minnesota and North Dakota diversion alignments and are described in Appendix M. Recreation plan features contain multipurpose trails, interpretive signage, benches, trash receptacles, two pedestrian bridges, three trailheads with parking facilities and two car/trailer parking facilities. The trailheads would also include potable water, picnicking, restrooms, interpretive kiosks and landscaping. The recreation plan could result in a healthier, more vibrant community accenting the current growth trends of the region. The plantings associated with the recreation will make the recreational opportunities more visually pleasing and will help to enhance the overall experience.

5.2.3.1.4 Transportation

A number of rural section line roads will be impacted with the construction any diversion channel alternatives. Some roads will be cut off at the diversion channel. The Minnesota diversion alignment intersects approximately 30 roads, as does the North Dakota alignment. New bridges across either diversion channel alignment are planned a minimum of every three miles. For the FCP, there would be 20 bridges across the channel. For the LPP and ND35K there would be 19 bridges across the channel. The LPP requires a raise of Interstate 29 through the staging area.

Table 50 and Table 51 detail the locations and sizes of the bridges for the FCP and the LPP respectively. Chapter 3 displays maps of each alternative with the locations of the bridges. Either diversion alignment would result in the modification of traffic patterns for local residences and farmsteads that are close to the alignment. There would be little disruption to through traffic. In some locations, farm fields will be bisected by the diversion channel, which will result in additional transportation time for farm equipment. It is anticipated that over time farmers will exchange land so that the time they spend in transit across the diversion alignment is minimized.

For the LPP, a large amount of land upstream of the diversion inlet will be used for staging water during high flows. As a result a number of residences and farmsteads will be bought out. Traffic patterns in the staging area will change permanently. Much of this area, currently used for access to local residences, will be used as a throughway for those commuting to and from the Metro on Interstate 29, or to and from locations to the East or West. During high flows, water in the staging area will prevent commuting along East –West routes. Interstate 29 and Minnesota Highway 75 will be elevated so that traffic can continue during high flows. The railroad bridge would also be raised.

For the FCP and ND35K the maximum stage increases downstream at the 1-percent chance event are 12.5 inches and 25.4 inches, respectively. The increase in duration would be negligible. Stage increases would restrict access to roads and buildings downstream more so than under existing conditions.

With any of the diversion channel alternatives in place, the need to close highway and railroad bridges and the airport during high water events would be significantly diminished when compared to the without project condition.

Project construction could have some short-term minor negative impacts on normal community traffic patterns due to the construction activity and truck hauling. These effects would be attenuated through the appropriate placement of construction and safety signage and use of road detours. These effects would be temporary and would terminate when project construction is complete.

Table 50 - Minnesota Diversion (FCP) Alignment - Bridge Locations and Sizes

Bridge Location FCP	Estimated Bridge Length (ft)	Bridge Deck Width (ft)
Interstate 29 South Bound	300.6	44.5
Interstate 29 North Bound	300.6	44.5
110th Ave S.	415.6	34.5
US Highway 75	690.9	50.5
80th Ave S	803.2	34.5
60th Ave S	800.8	34.5
County-State Highway 52	817.6	34.5
50th Ave S	827.4	34.5
Interstate 94 East Bound	867.4	44.5
Interstate 94 West Bound	867.4	44.5
US Highway 10 East Bound	911.6	44.5
US Highway 10 West Bound	911.6	44.5
28th Ave N	889.0	34.5
57th Ave N	706.7	34.5
40th St N	697.2	34.5
90th Ave N	684.7	34.5
100th Ave N	681.0	34.5
US Highway 75	677.3	50.5
110th Ave NW	666.7	34.5
15th St NW	640.2	34.5

Table 51 North Dakota Diversion (ND35K & LPP) Alignment – Bridge Locations and Sizes

Bridge Location LPP & ND35K	Estimated Bridge Length (ft)	Bridge Deck Width (ft)
County Road 81	605	38.5
Interstate 29 North Bound	583	42.5
Interstate 29 South Bound	582	42.5
48th St SE	431	32.5
170th Ave SE	641	30.5
46th St SE	752	32.5
44th St SE	702	30.5
41st St SE	640	38.5
Interstate 94 East Bound	689	42.5
Interstate 94 West Bound	689	42.5
36th St SE	659	38.5
33rd St SE	632	38.5
31st St SE	613	30.5
28th St SE	615	30.5
Interstate 29 South Bound	586	42.5
Interstate 29 North Bound	586	42.5
County Road 81	587	38.5
25th St SE	588	32.5
173rd Ave SE	593	30.5

5.2.3.1.5 Public Health and Safety

For the metro area, all of the diversion channel alternatives would have significant beneficial effects on public health and safety by significantly reducing the risks of loss of life and property damage attributable to the effects of flooding. Flood risk management would minimize the adverse effects that have occurred to communities in the Red River Valley during recent flood events including: large-scale community evacuation, potential contamination of the drinking water supply, spoilage of food through loss of refrigeration or floodwater contamination, lack of access to health care, evacuation of hospitals and nursing homes, and stress and trauma. Flooding of buildings introduces multiple contaminants into the water including sewage, fuel oil, pesticides, and solvents. The cleanup of flooded structures exposes individuals to potential adverse health effects from exposure to contaminants, bacteria, and molds. All of the diversion channel alternatives would reduce the likelihood of these adverse effects of flooding.

The structure on the Red River will be treated as if it were a bridge for the majority of the time and recreational boats will be able to pass underneath it as they please. While the project is in operation recreational boaters will not be allowed to pass underneath the structure or to go within a to-be-determined distance of the structure for safety reasons. Appropriate signage and educational information regarding the Red River and its tributaries will be available to the public as the project moves forward.

For the areas downstream, the FCP and ND35K have adverse impacts on public health and safety due to stage increases. Impacts on public health and safety are expected to be minor. An analysis of additional flood risk will be made to determine the magnitude of impacts.

For the communities upstream the LPP will require a number of fee acquisitions in the staging area. Health and safety in this area will be benefited due to the removal of some homes and businesses from the flood prone areas. Homes and businesses that are not bought out may have other mitigation features (such as ring-levees). Buildings with no mitigation would experience increases in risk of flooding. For major flood events, there will be a large staging area for a number of days or weeks that will pose a safety concern. Appropriate safety measures will be implemented to minimize risks from the staging area. Design criteria will need to be appropriate to minimize the possibility of failure for the control structures and the tie-back levees.

5.2.3.1.6 Community Cohesion (Sense of Unity)

All of the diversion channel alternatives, by providing increased protection from future floods, would enhance community stability in the metro area. With increased security, residents would be less likely to relocate. Similarly, they would be able to devote greater attention to other community issues and needs. The Fargo-Moorhead Metropolitan Area as a whole should become more cohesive after project construction, but some areas would lose the cohesion that they have had. In particular, the areas bisected by the diversion channel will have loss of cohesion. These include rural areas with farmsteads and farm fields.

For the FCP and ND35K, downstream areas may experience loss of cohesion due to stage increases. Additionally, downstream impacts will be seen as a gain for the metro area at the expense of the communities downstream. This may have a divisive effect between citizens in the downstream communities and the metro.

For the LPP many residents in the staging area will need to be relocated. The relocation of many residents will have adverse impacts to community cohesion, and will impact school districts and local government entities.

5.2.3.1.7 Community Growth and Development

All of the diversion channel alternatives are expected to have a beneficial effect on the growth and development of the Fargo-Moorhead Metropolitan Area. Provision of this level of flood risk management will likely foster investment in homes, businesses, and community infrastructure. This would be greater for the North Dakota alignments as they remove a larger area from the existing floodplain.

The FCP would have an adverse impact on the future development area for the city of Dilworth, where the diversion channel footprint divides the city's future development area in half.

For the FCP and ND35K, the communities downstream would experience stage increases. This would be associated with additional flood risk and would have a minor impact on property values and future demand for development.

For the LPP some homes and businesses upstream in the staging area would require fee acquisitions, and some buildings would have other mitigation features. Several hundred or thousands of residents would need to be relocated and the area would not be able to be used for development.

There would be temporary impacts to civic planning due to fee acquisitions and loss of tax base for the LPP. At least one school district's plans for a new school in Kindred would be impacted in the short term due to a potential loss of tax base and diminished student body.

5.2.3.1.8 Business and Home Relocations

The LPP will require a substantial number of relocations for communities in the staging area.

All diversion alternatives will require a small number of relocations for those structures that the channel right-of-way intersects.

Because the affected owners will be covered by P.L. 91-646 (Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970), they should not experience direct financial loss from the relocations.

For residents and business owners, relocation can be stressful. Many individuals have lived in the area for a long time and may be attached to their homes or businesses.

5.2.3.1.9 Existing and Potential Land Use

Along with the aforementioned relocations, land use changes could occur along and near the proposed diversion alignments with the purchase of project right-of-way, although farming will be allowed on the landward side slopes of the diversion channel spoil banks.

For the LPP some of the staging area will not be able to be used for residential or retail zoning. There are opportunities to convert this area to wetlands, grasslands, wooded areas or other uses (a significant part of the staging area is currently farmland).

Land in the channel right-of-way would be impacted. An estimated 5,889 acres of prime farmland would be directly or indirectly impacted with the construction of the FCP, while the ND35K would impact 6,540 acres and the LPP would affect 6,878 acres. This includes less than ½-percent of the total cropland in Cass and Clay counties. Owners of agricultural lands that are purchased for the project would be compensated at fair market value.

The both alignments are expected to split or divide farms into separate parcels. In some cases, farmers would have to detour around the diversion channel using established roadways or specially constructed access roads to access their property and conduct farming operations. The number of farms under active use that would be divided by the proposed right-of-way is unknown at this stage. Mitigation measures would be incorporated into the final design to minimize impacts to farmland.

5.2.3.2 Economic Effects

5.2.3.2.1 Property Values

For the metro area all of the diversion channel alternatives are expected to have a beneficial effect on currently developed community property values because of the decreased risk of flood damage, along with the lessening of restrictions on improvements that can be made to existing developments in the floodplain. Developable lands within the protected area would retain or increase in property value through removal of the risk of flood damage. There would no longer be a need to raise or flood-proof new construction. New development or intensification of existing development should be pursued only in a manner that retains awareness and sensitivity to the residual flood threat. These beneficial effects will be greater for the ND35K and LPP as they provide flood risk management for a larger area.

For the FCP and ND35K, property values will be adversely impacted in the downstream area. The magnitude of impacts to property values is expected to be small. For landowners outside the benefited area that experience increased flood stages when compared to the current without project condition, further analysis will be undertaken to determine if there has been a taking. For any properties that are deemed to have incurred a taking, compensation would be provided as required by the Fifth Amendment of the U.S. Constitution.

For the LPP there may be impacts to property values due to fee acquisitions in the staging area, however a number of factors make the reaction in market values unpredictable. These factors include the expectation of locals regarding the timing and implementation of the LPP.

5.2.3.2.2 Tax Revenues

All of the diversion channel alternatives are expected to have a minor beneficial effect on tax revenues in the metro area. The project would preserve property values in benefited developed and developable areas, allow for the redevelopment of marginal properties and attract additional businesses and industry. These beneficial effects will be greater for the ND35K and LPP as they provide flood risk management for a larger area. New development or intensification of existing development should be pursued only in a manner that retains awareness and sensitivity to the residual flood threat. Future tax revenues would be lost from the properties that would be acquired for project construction.

The LPP requires a large amount of land to be purchased for the staging area. This will impact the tax base of local governments and have a short term impact on current planning efforts.

For the FCP and ND35K the downstream areas will experience a small decrease in property values. Tax revenues will be affected proportionately.

5.2.3.2.3 Public Facilities and Services
All of the diversion channel alternatives could have a substantial beneficial impact on public facilities and services because the potential for damage to public facilities would be reduced, the potential for disruption in the delivery of public services would be reduced, and the public works response to future flood threats would not be as great.

5.2.3.2.4 Regional Growth
All of the diversion channel alternatives would enhance the capacity of Fargo-Moorhead to function as a trade, medical, financial, and cultural center of the region. These will be greater for the ND35K and LPP as they provide flood risk management for a larger area. Growth would continue as projected as indicated in section 4.2.3.

5.2.3.2.5 Employment
For all of the diversion channel alternatives there will be an increase in construction employment during project construction. In addition, the protection provided by the project should contribute to community growth and along with it the associated increases in employment opportunities.

5.2.3.2.6 Business Activity
For all of the diversion channel alternatives, project construction could stimulate local business activity and the protection provided by the project upon completion could provide a climate for business expansion and attraction.

5.2.3.2.7 Farmland/Food Supply
An estimated 5,900 areas of prime farmland would be directly or indirectly impacted by the FCP, while 6,500 to 6,900 acres of prime farmland would be impacted by the ND35K or LPP. Additional farmland in the staging area of the LPP may be converted from farmland. None of the diversion channel alternatives would have an appreciable effect on food supply. A diversion channel would require the purchase of approximately 5,500 to 10,000 acres of agricultural land and disrupt the farming operation of approximately 10 to 15 landowners for the footprint of the channel.

Additional impacts will occur for the LPP, as the staging area may require the acquisition of property interests in as much as 20,000 acres of farmland. Most of the 20,000 acres will likely remain in production long term, but some crop production losses may occur for the years the staging area is operated. Crop losses could occur for up to 20,000 acres if a summer flood event occurs and the staging area is operated. Sedimentation due to staging (spring or summer events) would leave on average less than 0.02 inches of silty clay material across the staging area, with a maximum of 2 inches in localized spots. The deposit of some flood debris could occur in localized spots as well. The effect of small amount of sediment on cropland in the area of the staging area is fairly minor. The material (silty clay) brought in by flood water would be similar to the existing soil in physical and chemical characteristics. This was confirmed by recent research after the flood of 2009. Impacts can range from minor adverse, if weed infestation is a problem requiring added herbicide, to minor beneficial if added fertilizer is brought in with the flood water. Note that sediment from glacial Lake Agassiz is the source of the existing soil, and is credited with the high level of crop fertility in the region. A larger impact due to the staging of water would be the delay in planting of crops due to a prolonged dry-out period, which could occur in years when the staging area operates. A solution for this would be installation of drain tiles (drain tiles are not part of the project features).

Most of the agricultural land is considered to be prime farmland with soybeans and corn as the major crops. Owners of agricultural lands that are purchased for the project would be compensated at fair market value. For situations where the diversion channel would split individual's farmland, the non-federal sponsors may try to facilitate trades so that individuals can keep their property on the same side of the diversion.

5.2.3.2.8 Flooding Effects

All of the diversion channel alternatives would have a significant beneficial impact on flooding effects in the metro area. The project is intended to provide flood risk management from floods, such as the one experienced in 2009, by reducing flood stages within the protected area when compared to the without project condition.

The FCP and ND35K alternatives will increase stages downstream as much as 12.5 and 25 inches, respectively, for the 1-percent chance event. The LPP will have large stage increases in the staging area of as much as 98.8 inches.
Table 52 – Structure Impacts shows the impacts of each plan on homes and other structures upstream and downstream of the metro area.

Table 52 – Structure Impacts

Downstream Structures Impacted				
Flood Event	Without	ND35K	LPP	FCP
50%	0	0	0	0
20%	14	14	14	14
10%	90	111	63	111
5%	251	315	189	315
2%	641	711	579	711
1%	878	1051	790	1051
0.5%	1119	1238	982	1238
0.2%	1498	1549	1347	1549
Upstream Structures Impacted				
Flood Event	Without	ND35K	LPP*	FCP
50%	0	0	0	0
20%	0	0	0	0
10%	15	28	4	28
5%	64	75	13	75
2%	197	225	76	225
1%	438	465	208	465
0.5%	767	767	362	767
0.2%	1107	1095	534	1095
*These estimates do not include 926 structure buyouts for				
the staging area				

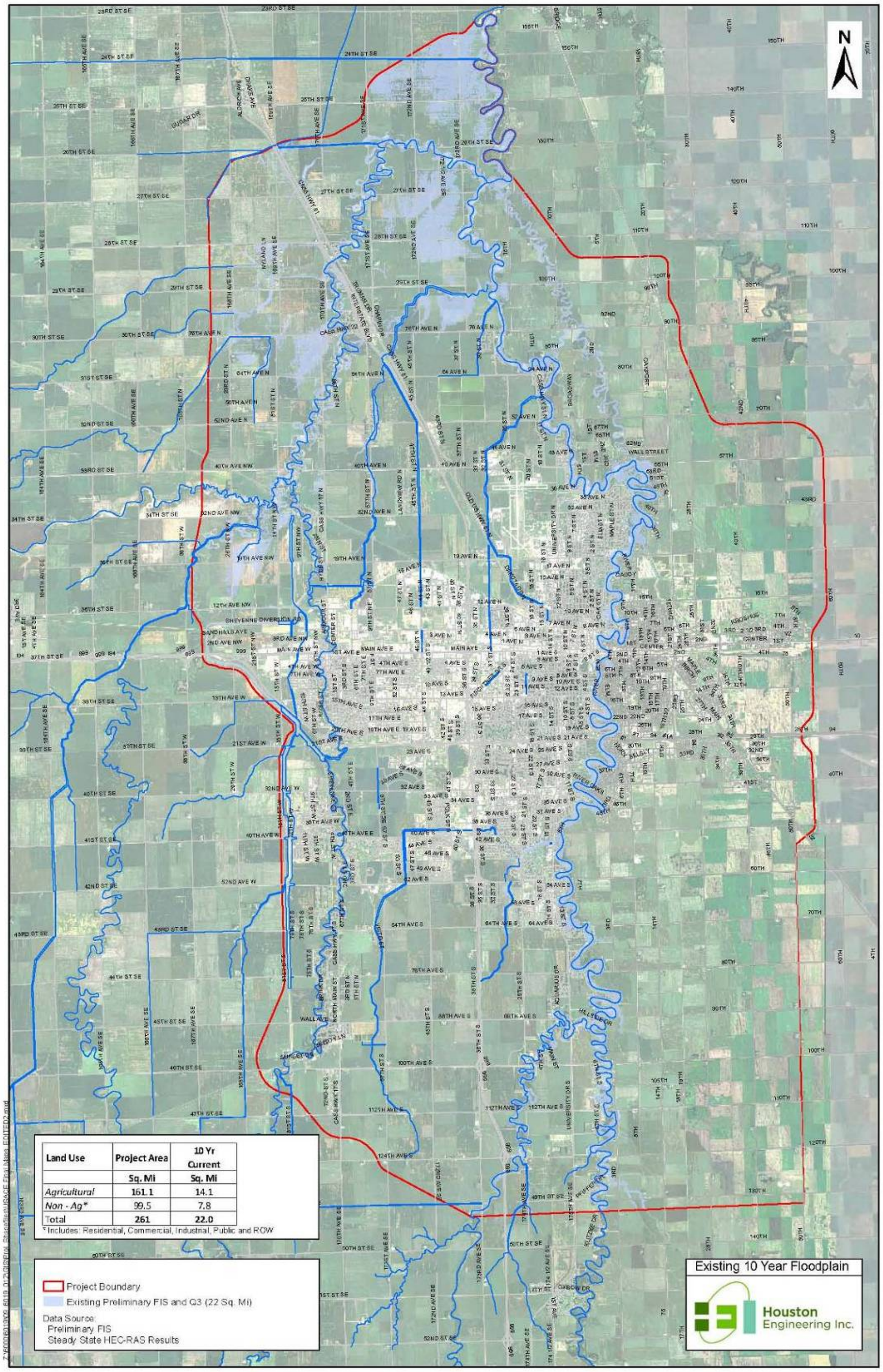
5.2.3.2.9 Energy Needs and Resources
All of the diversion channel alternatives would have no appreciable effect on energy needs and resources.

5.2.3.2.10 Floodplain (Executive Order 11988)
Executive order (EO) 11988 was issued by President Jimmy Carter on May 24, 1977 and is entitled "Floodplain Management". The Corps of Engineers and other federal agencies must comply with EO 11988 when designing or permitting projects. One goal of EO 11988 is to "avoid direct or indirect support of floodplain development wherever there is a practicable alternative." If avoiding the floodplain altogether is not practicable, EO 11988 requires federal agencies to "minimize potential harm to or within the floodplain."

5.2.3.2.10.1 No Action Alternative
The study area used for the floodplain analysis is 261 square miles: 161 square miles of agriculture land and 99.5 acres of non-agriculture land which includes residential, commercial, industrial, and public right-of-way lands. With no project or emergency levees in place the

current 10-percent chance event will impact 22 square miles of total land within the study area; of that land, 14.1 square miles is agriculture land. For the 2-percent chance event the number increases to 83.3 square miles of total land and 65.8 square miles of agriculture land. For the 1-percent chance event the number increases to 112.2 square miles of total land impacted, of which 82.4 square miles are agricultural lands. For the 0.2-percent chance event the number of acres impacted increases to 204.4 square miles out of a possible 261 square miles, of which 122.6 square miles is agricultural land (Figure 104, Figure 105, Figure 106, and Figure 107).

Figure 104 – Existing 10-percent chance event (10-year) Floodplain.



Land Use	Project Area	10 Yr Current
	Sq. Mi	Sq. Mi
Agricultural	161.1	14.1
*Non - Ag**	99.5	7.8
Total	**261**	**22.0**

* Includes: Residential, Commercial, Industrial, Public and ROW

Figure 105– Existing 2-percent chance event (50-year) floodplain.

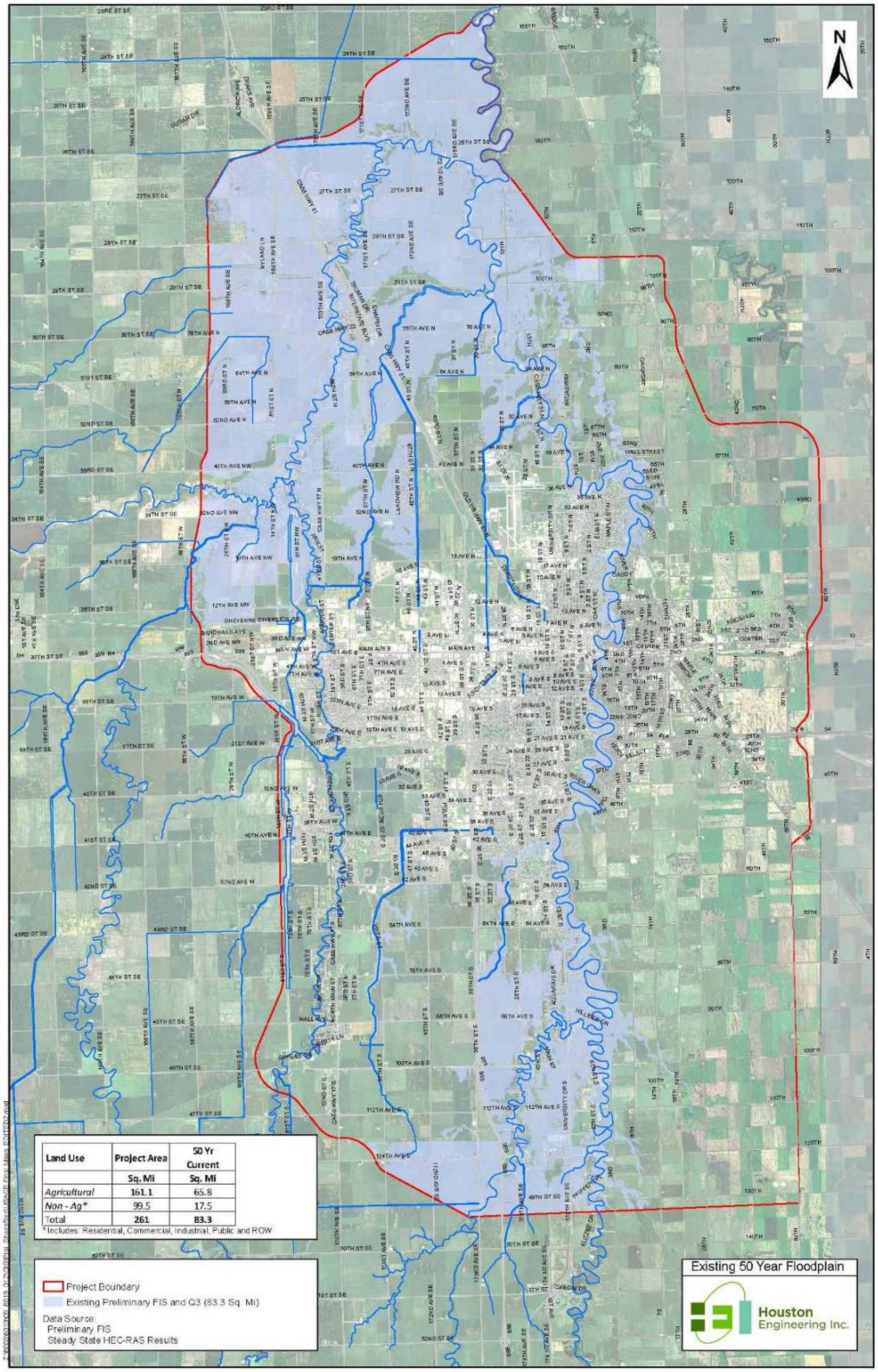


Figure 106 – Existing 1-percent chance event (100-year) floodplain

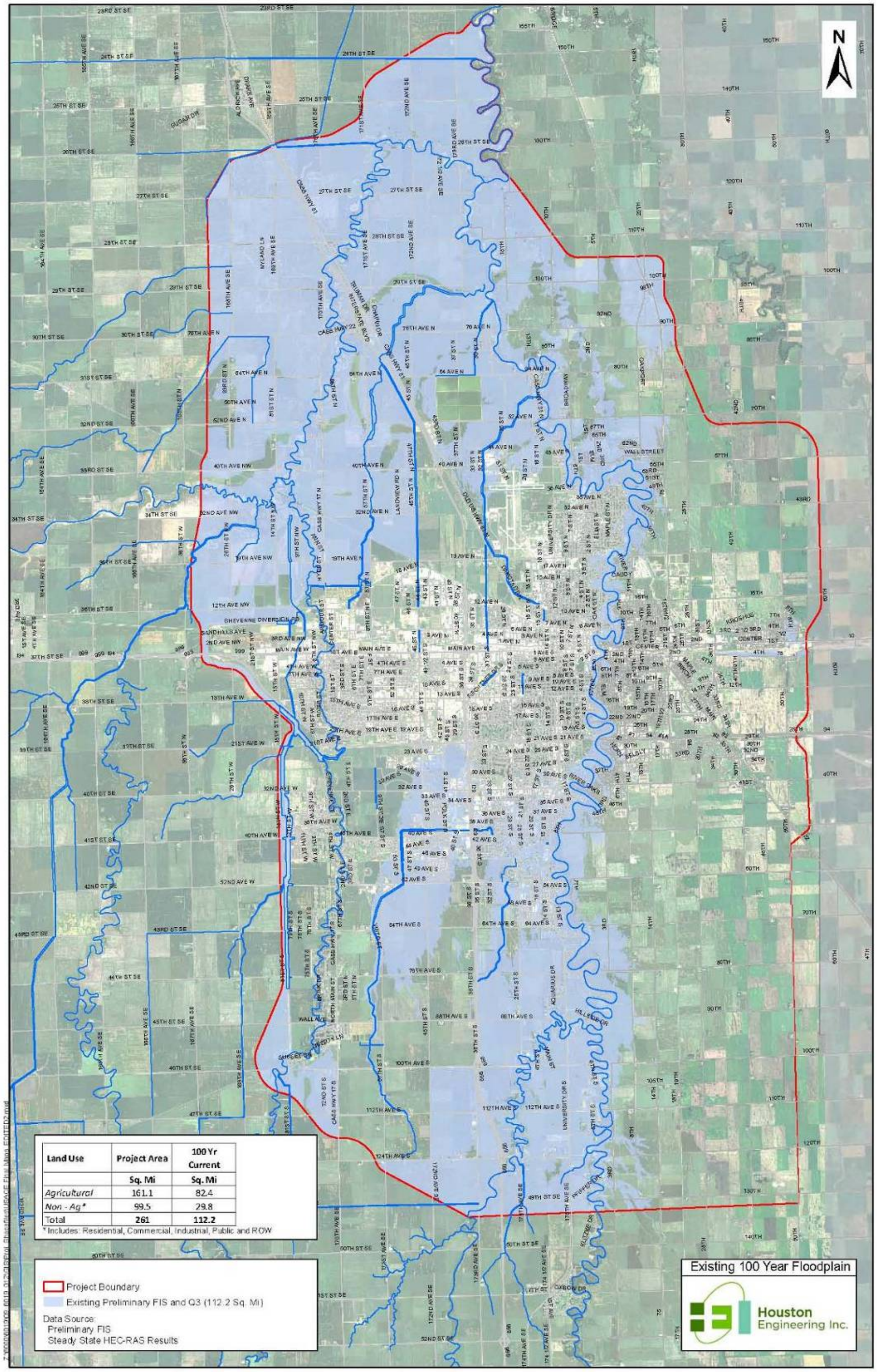
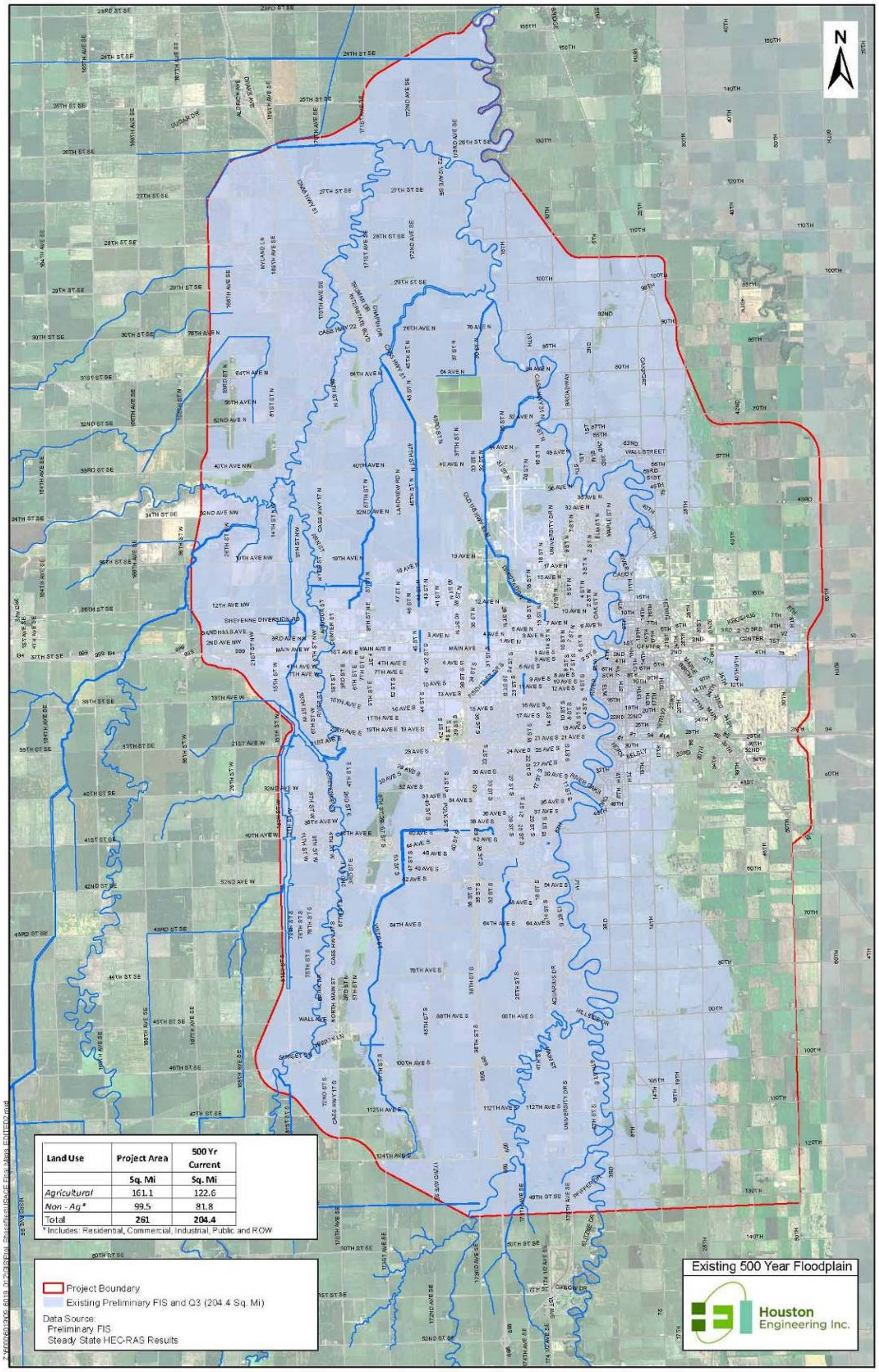


Figure 107 – Existing 0.2-percent chance event (500-year) floodplain.



Land Use	Project Area	500 Yr Current
	Sq. Mi	Sq. Mi
Agricultural	161.1	122.6
*Non - Ag**	99.5	81.8
Total	**261**	**204.4**

* Includes: Residential, Commercial, Industrial, Public and ROW

A Steady State HEC-RAS hydraulic model was used to determine the impact of different size flood events within the study area. All of the diversion channel alignments will take several square miles out of the floodplain; the number of square miles will vary depending on which alternative is selected, as further discussed below.

5.2.3.2.10.2 FCP

For the FCP the model was run for the 10-percent chance event, 2-percent chance event, 1-percent chance event and 0.2-percent chance event (see Table 53). The results for the 10-percent chance event show 2.3 square miles would be taken out of the floodplain, of which 1.5 square miles are agricultural lands. The results for the 2-percent chance event show 16.5 square miles will be taken out of the floodplain, with 12.3 square miles of this being agriculture lands. The results for the 1-percent chance event show 31.3 square miles will be taken out of the floodplain, with 18.6 square miles of this being agriculture lands. The results for the 0.2-percent chance event show 80.5 square miles will be taken out of the floodplain, with 33.1 square miles of this being agriculture lands (Figure 108, Figure 109, Figure 110, and Figure 111). For the figures, the blue shading indicates inundation for existing conditions, and the pink shading indicates inundation with the project in place.

Table 53 – Floodplain impacts with project

	Total Area Removed from Floodplain (in square miles)			
Diversion Alternatives	10% Event	2% Event	1% Event	0.20% Event
LPP	1.1	45.4	69.8	87.4
FCP	2.3	16.5	31.3	80.5
ND35K	10.8	60.0	81.5	146.0

Figure 108 - FCP alignment 10-percent chance event (10-year) floodplain

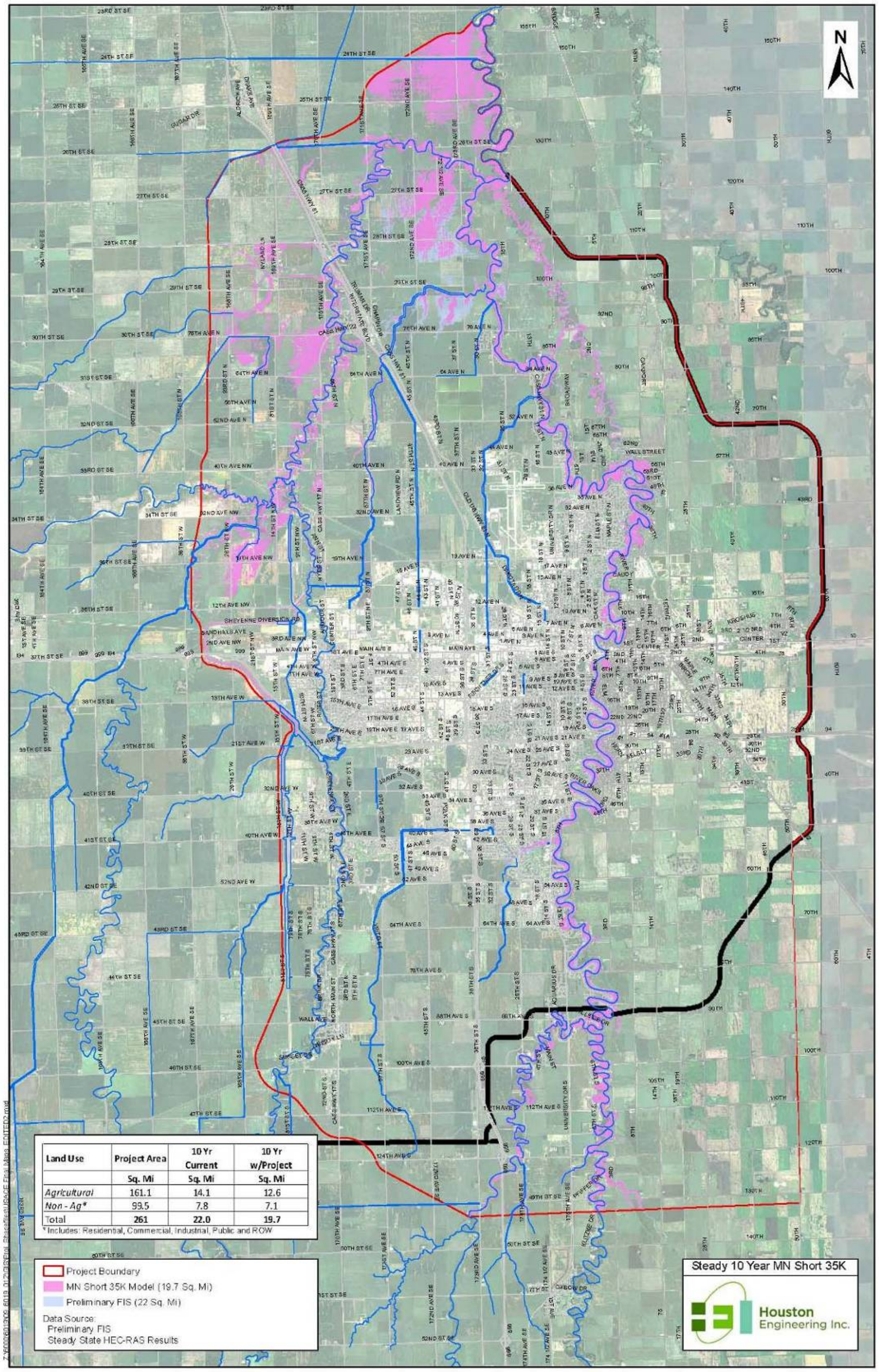


Figure 109 - FCP alignment 2-percent chance event (50-year) floodplain

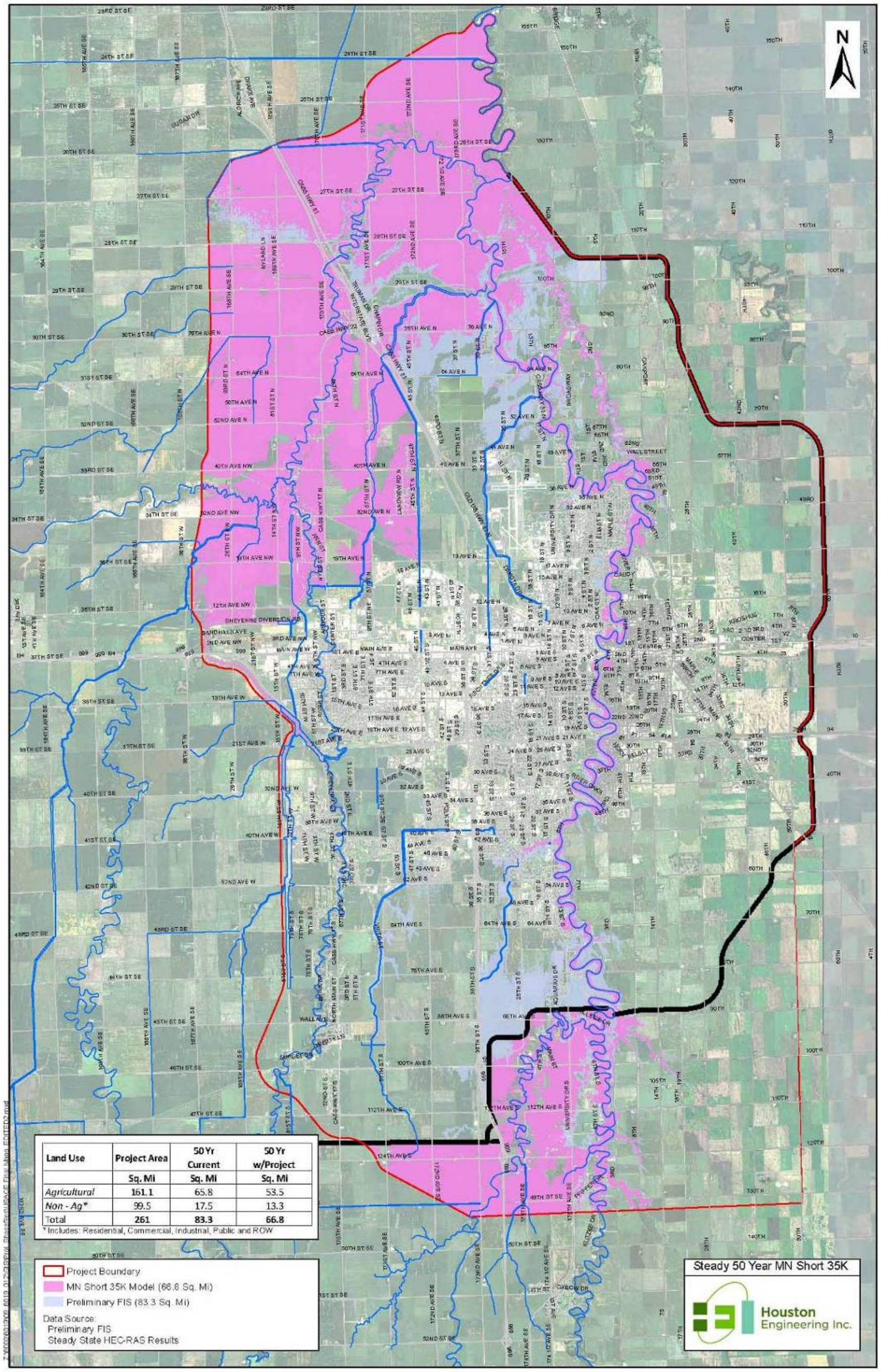


Figure 110 - FCP alignment 1-percent chance event (100-year) floodplain

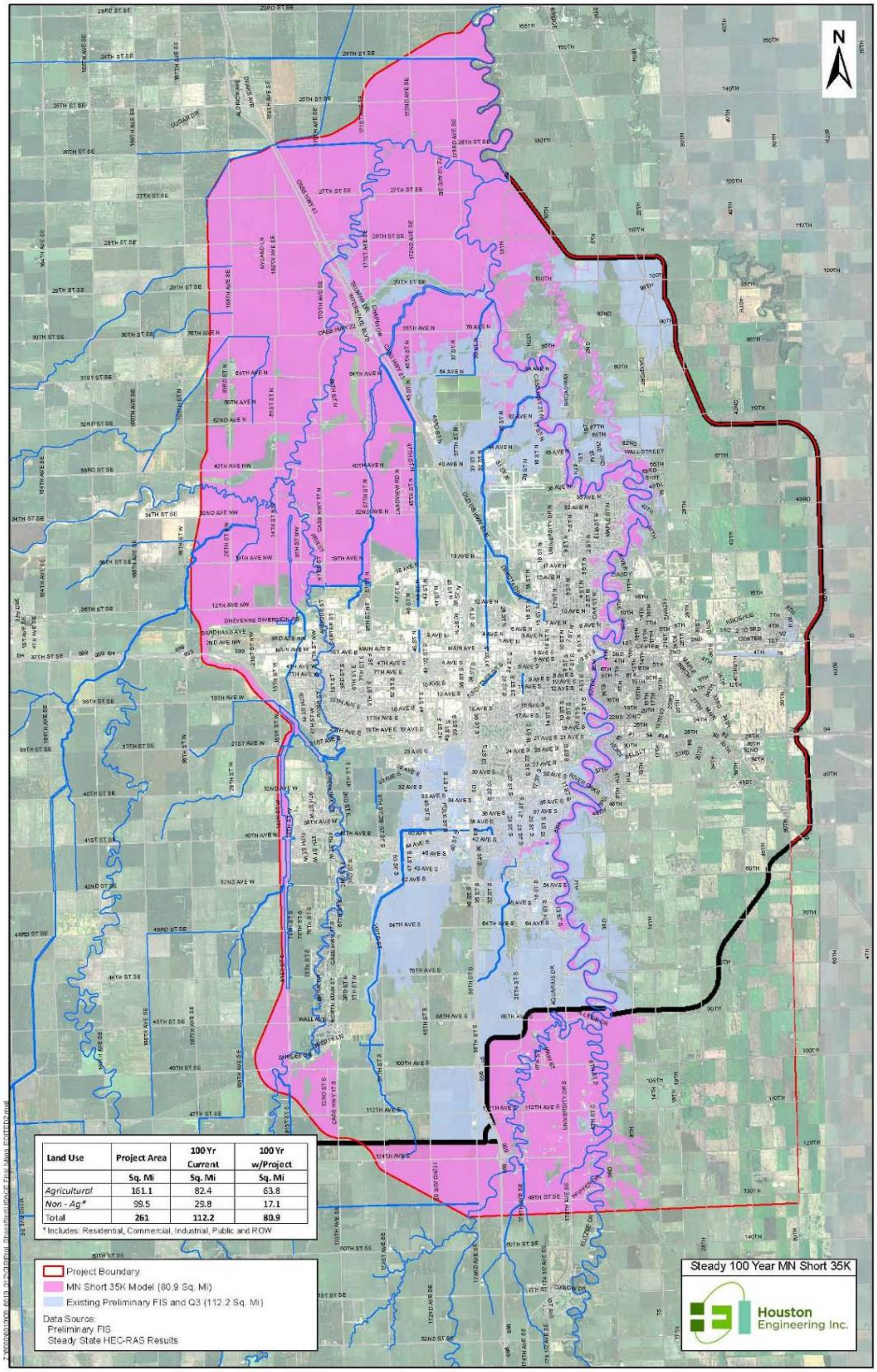
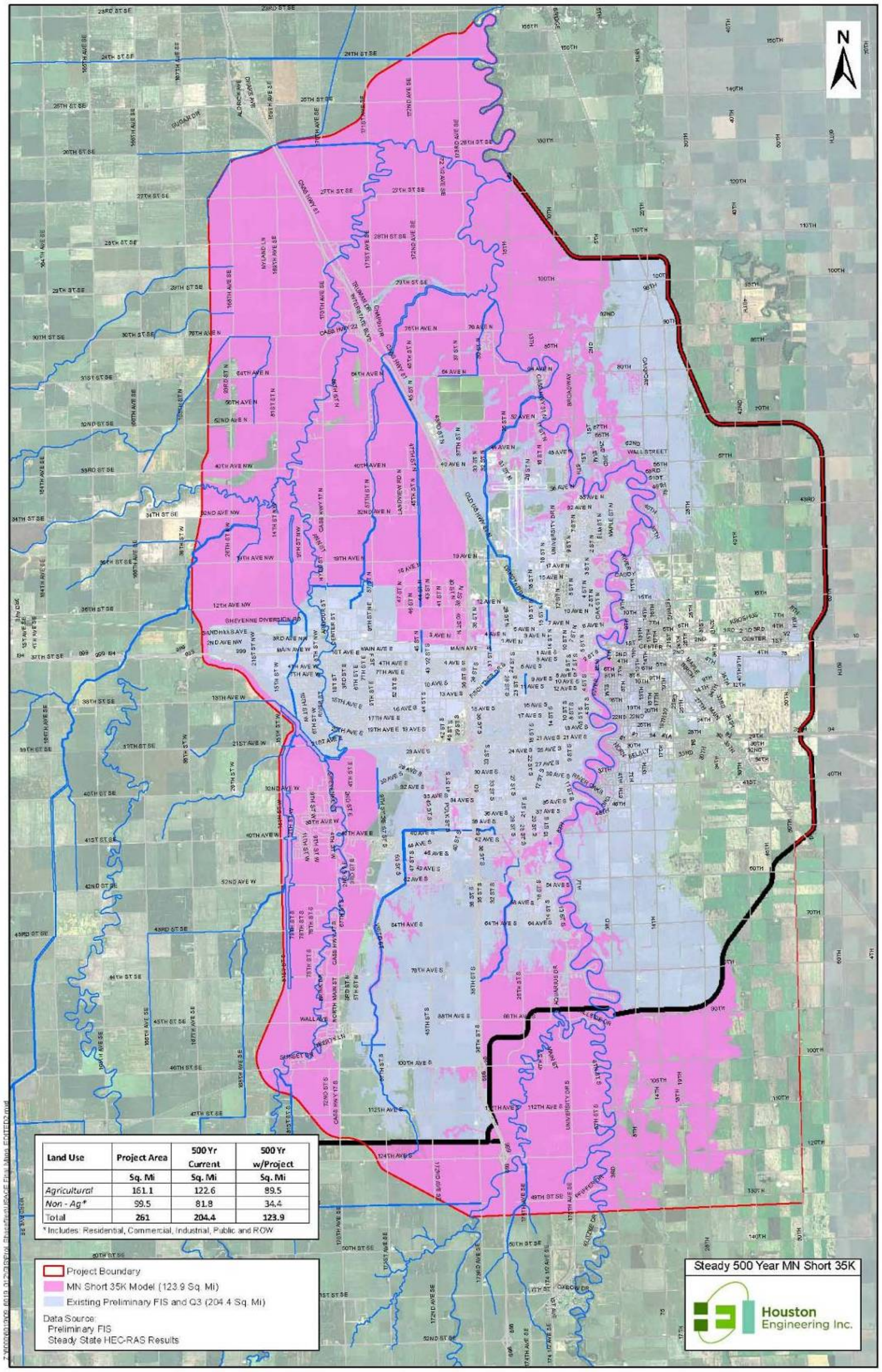


Figure 111 - FCP alignment 0.2-percent chance event (500-year) floodplain



5.2.3.2.10.3 North Dakota Alternatives
The ND35K and the LPP looked at in detail for this analysis.

5.2.3.2.10.3.1 ND35K plan
For ND35K the model was run for the 10-percent chance event, 2-percent chance event, 1-percent chance event and 0.2-percent chance event (see Table 53). The results for the 10-percent chance event show 10.8 square miles would be taken out of the floodplain, of which 8.4 square miles are agricultural lands. The results for the 2-percent chance event show 60.0 square miles will be taken out of the floodplain, with 49 square miles of this being agriculture lands. The results for the 1-percent chance event show 81.5 square miles will be taken out of the floodplain, with 59.6 square miles of this being agriculture lands. The results for the 0.2-percent chance event show 146.0 square miles will be taken out of the floodplain, with 77.3 square miles of this being agriculture lands (Figure 112, Figure 113, Figure 114, and Figure 115). For the figures, the blue shading indicates inundation for existing conditions, and the yellow shading indicates inundation with the project in place.

Figure 112 – ND35K 10-percent chance event (10-year) floodplain

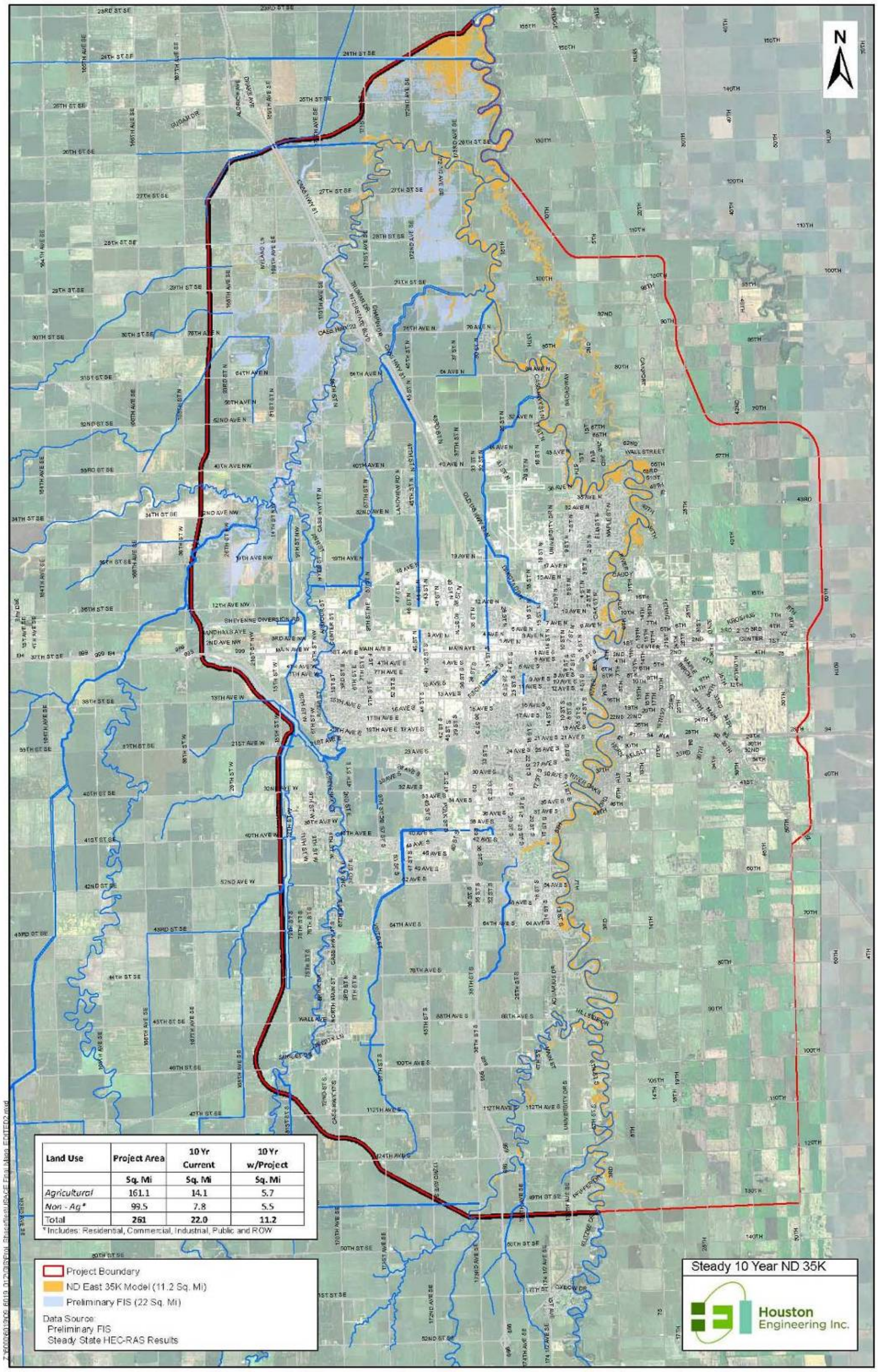


Figure 113 - ND35K 2-percent chance event (50-year) floodplain

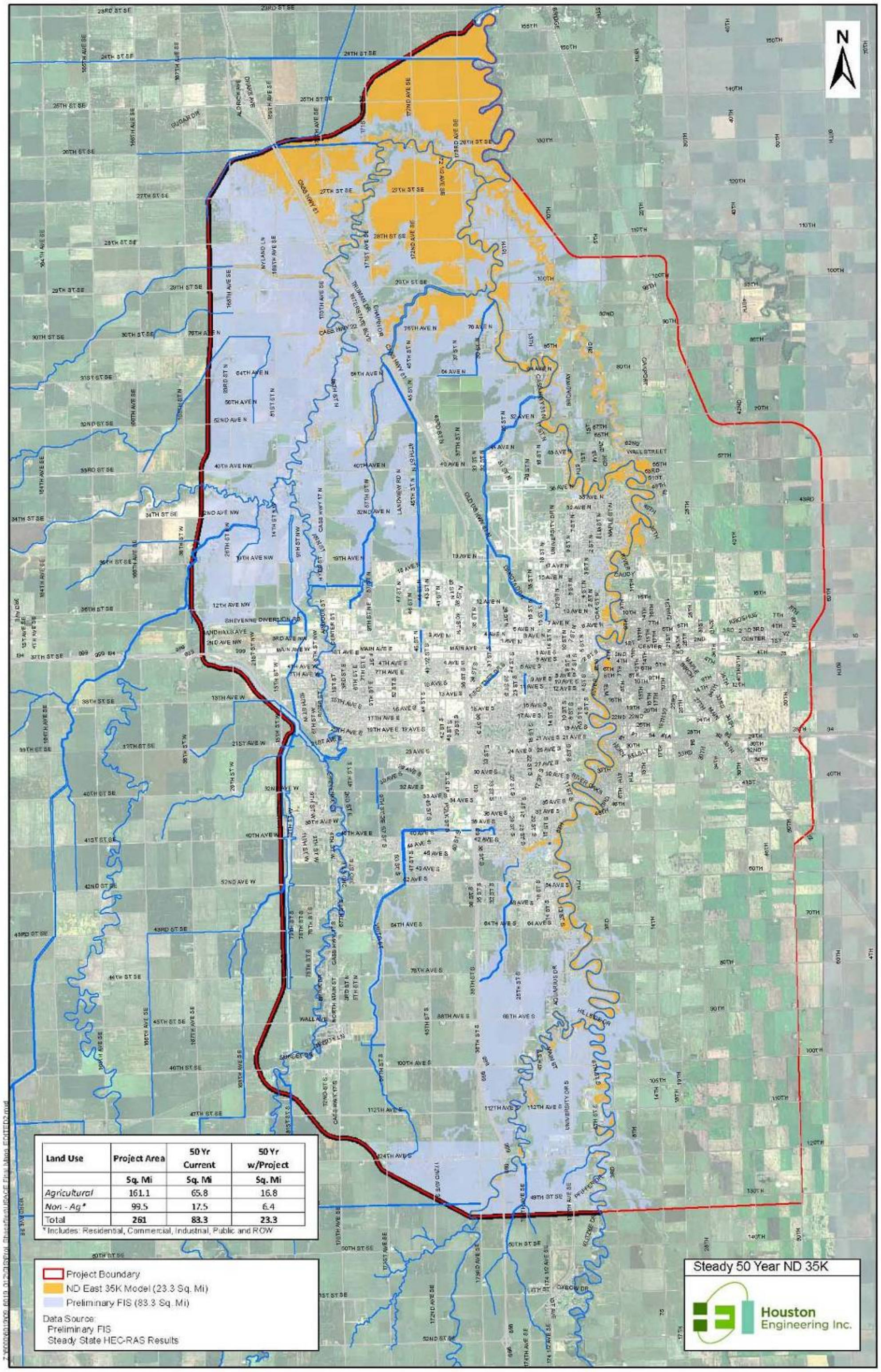


Figure 114- ND35K 1-percent chance event (100-year) floodplain

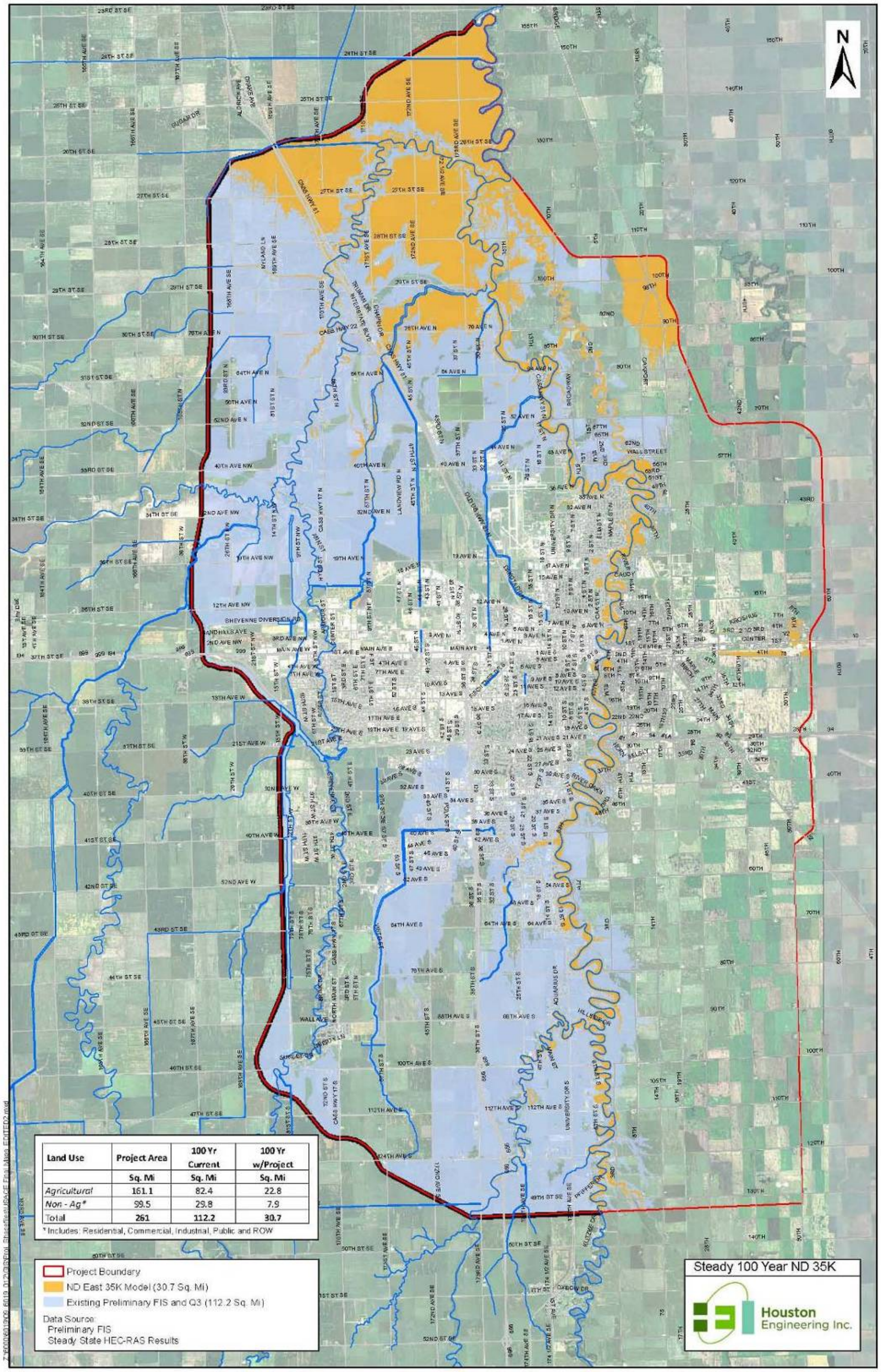
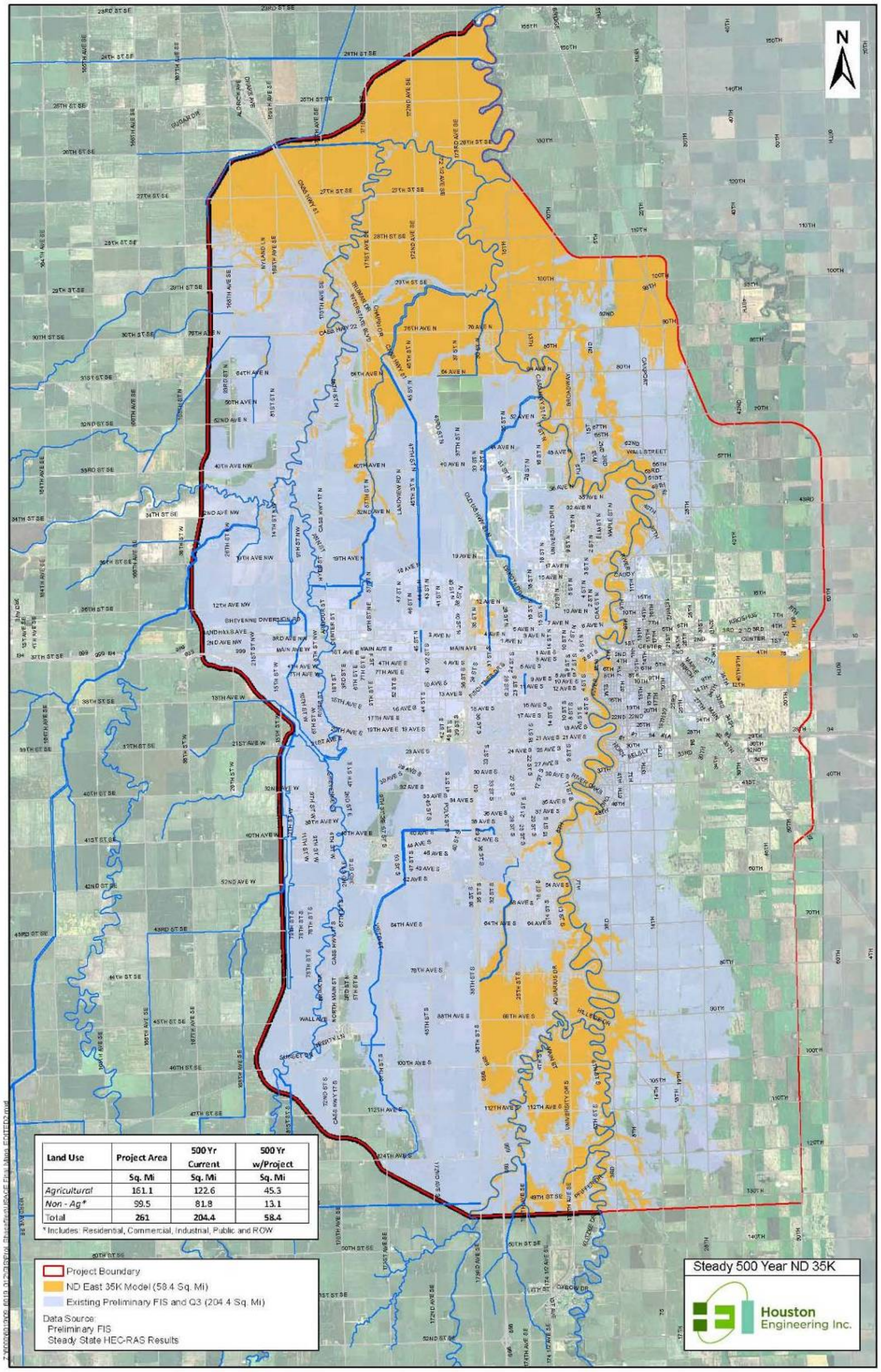


Figure 115 - ND35K 0.2-percent chance event (500-year) floodplain



5.2.3.2.10.3.2 LPP

For the LPP the model was run for the 10-percent chance event, 2-percent chance event, 1-percent chance event and 0.2-percent chance event (see Table 53). The results for the 10-percent chance event show 1.1 square miles would be taken out of the floodplain. The results for the 2-percent chance event show 45.4 square miles will be taken out of the floodplain, with 37.9 square miles of this being agriculture lands. The results for the 1-percent chance event show 69.8 square miles will be taken out of the floodplain, with 50 square miles of this being agriculture lands. The results for the 0.2-percent chance event show 87.4 square miles will be taken out of the floodplain, with 44 square miles of this being agriculture lands (Figure 116, Figure 117, Figure 118, and Figure 119). For the figures, the blue shading indicates inundation for existing conditions, and the yellow shading indicates inundation with the project in place.

Figure 116 – LPP 10-percent chance event (10-year) floodplain

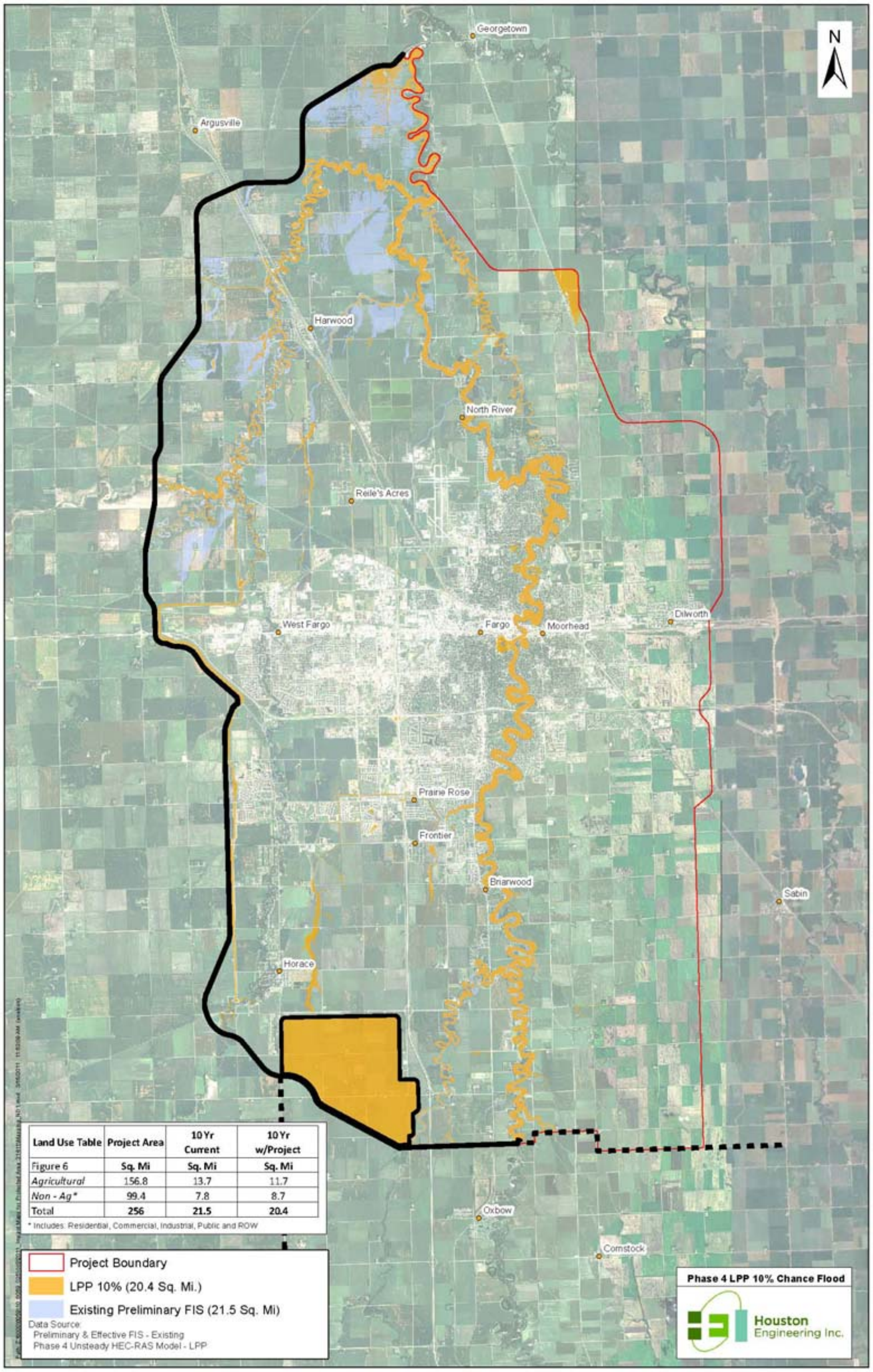
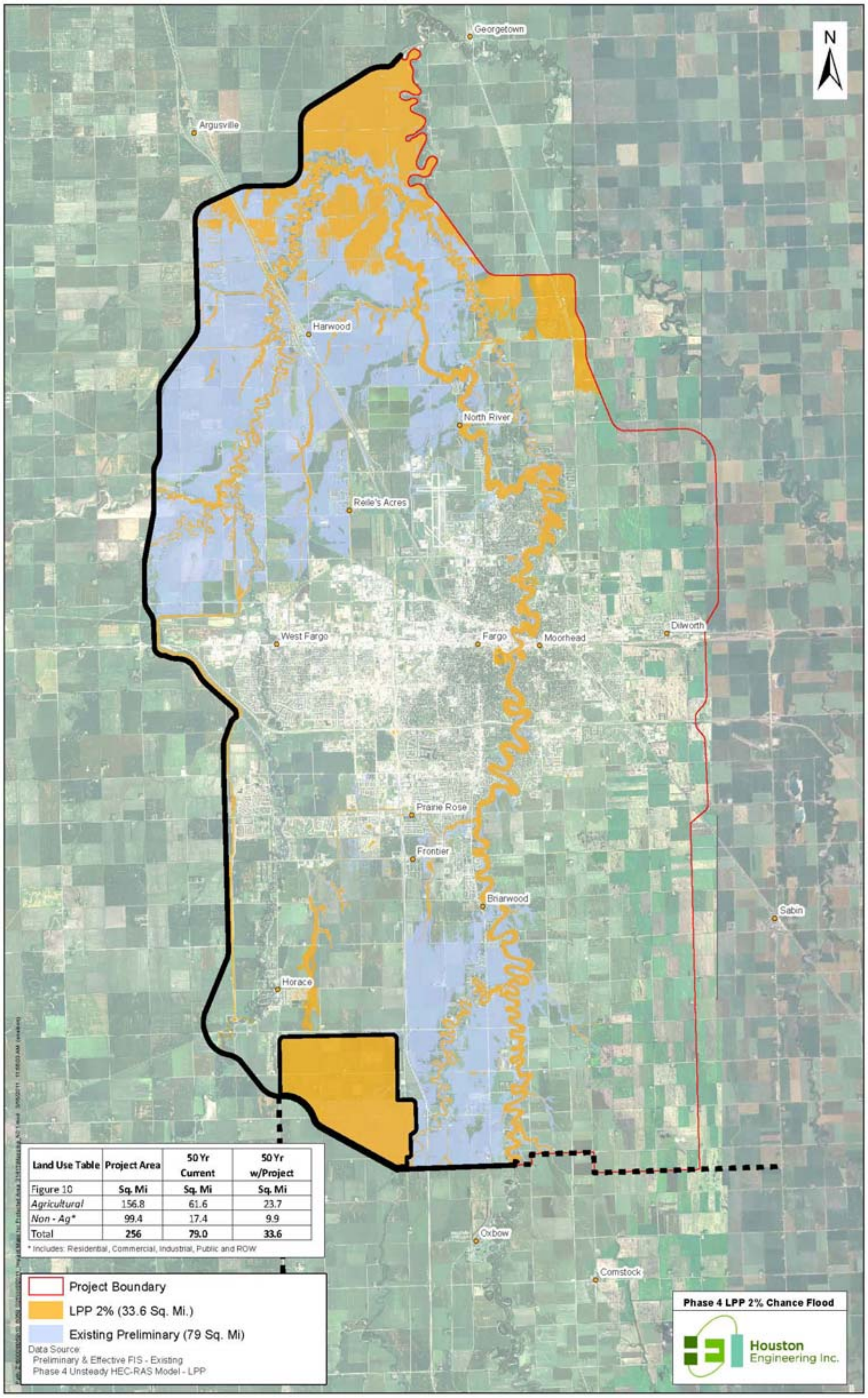


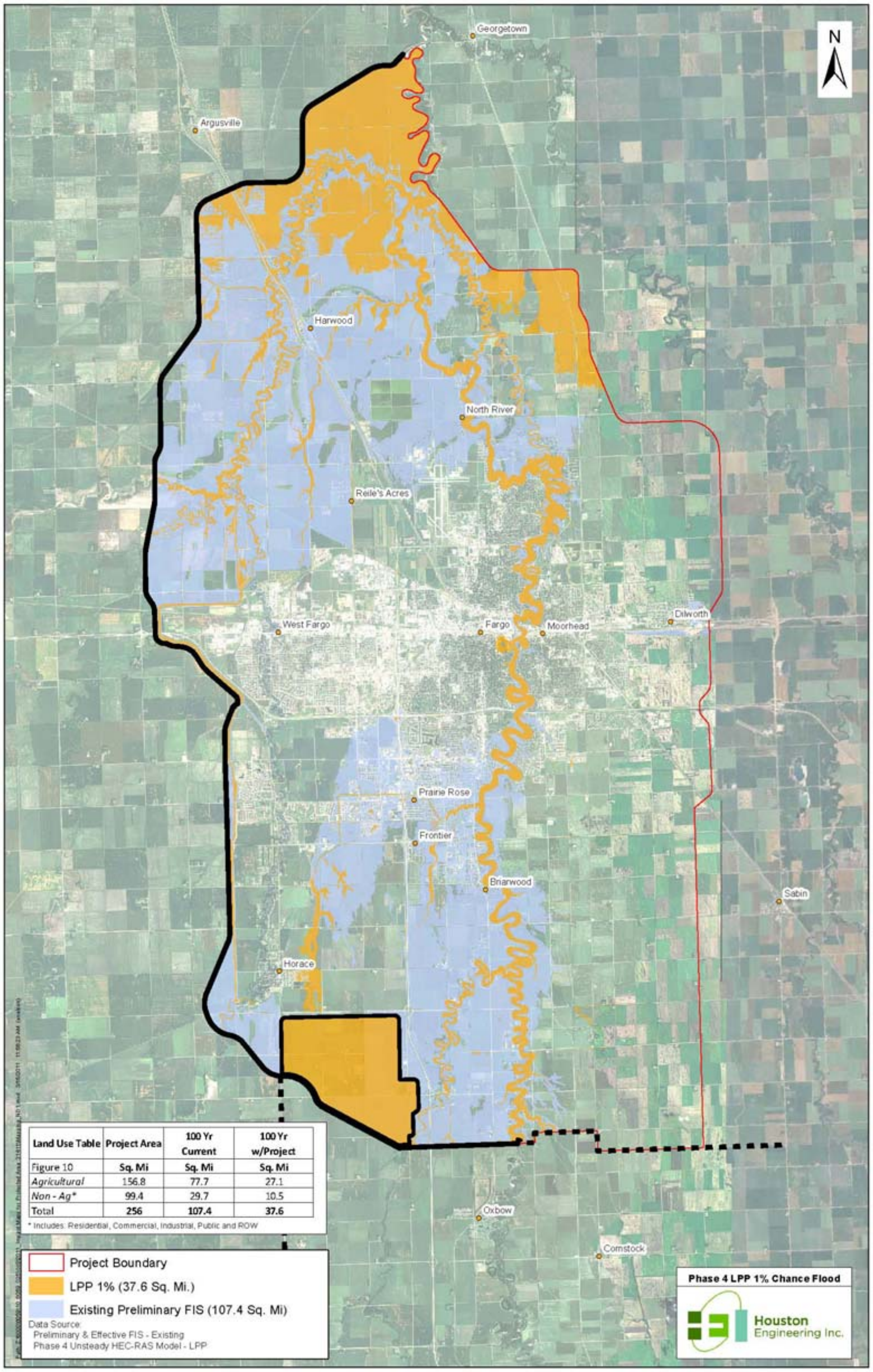
Figure 117 – LPP 2-percent chance event (50-year) floodplain



Land Use Table	Project Area	50 Yr Current	50 Yr w/Project
Figure 10	Sq. Mi	Sq. Mi	Sq. Mi
Agricultural	156.8	61.6	23.7
*Non - Ag**	99.4	17.4	9.9
Total	**256**	**79.0**	**33.6**

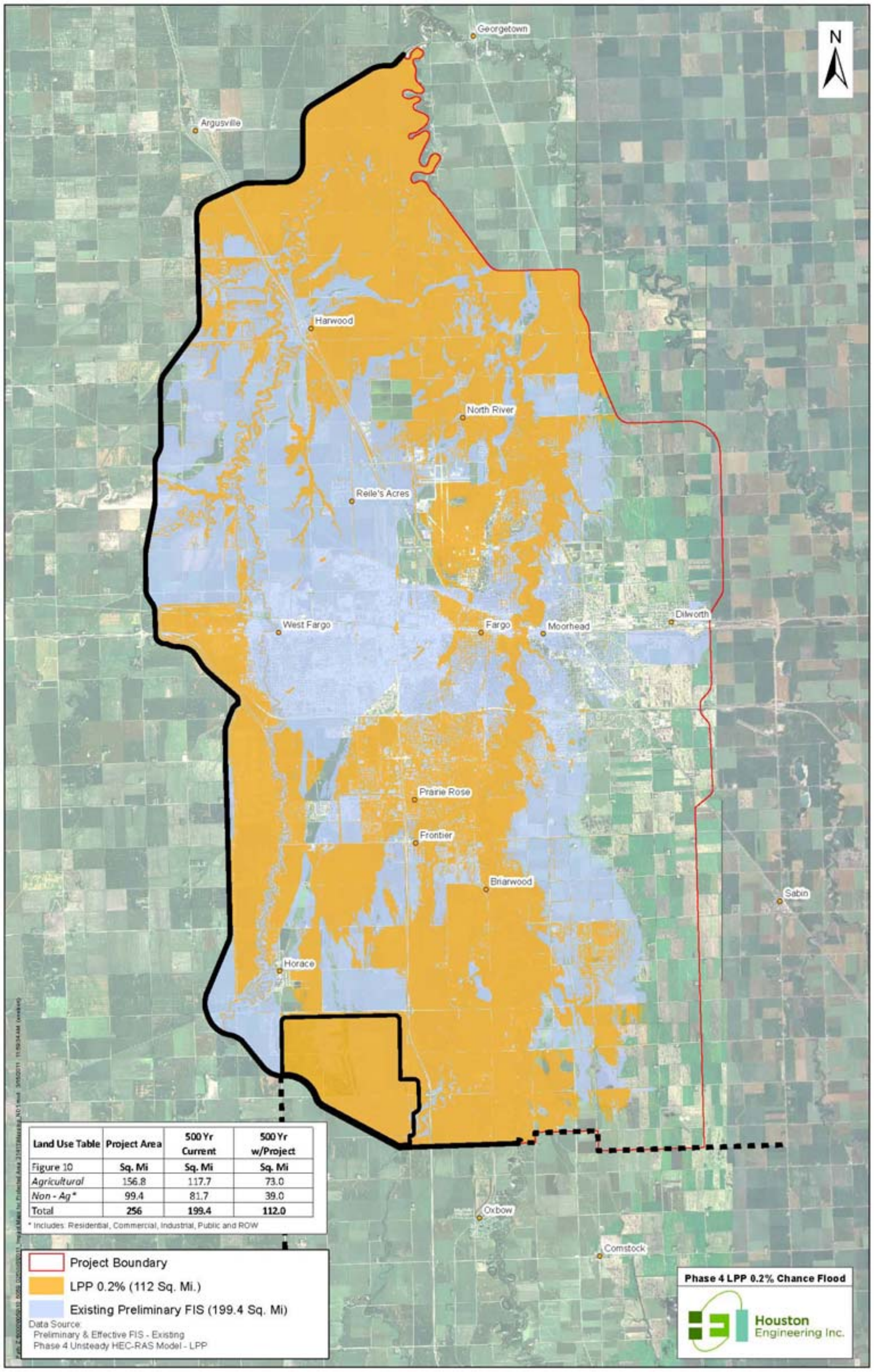
* Includes: Residential, Commercial, Industrial, Public and ROW

Figure 118 – LPP 1-percent chance event (100-year) floodplain



Land Use Table	Project Area	100 Yr Current	100 Yr w/Project
Figure 10	**Sq. Mi**	**Sq. Mi**	**Sq. Mi**
Agricultural	156.8	77.7	27.1
*Non - Ag**	99.4	29.7	10.5
Total	**256**	**107.4**	**37.6**

Figure 119 – LPP 0.2-percent chance event (500-year) floodplain



Land Use Table	Project Area	500 Yr Current	500 Yr w/Project
Figure 10	Sq. Mi	Sq. Mi	Sq. Mi
Agricultural	156.8	117.7	73.0
*Non - Ag**	99.4	81.7	39.0
Total	**256**	**199.4**	**112.0**

5.2.3.3 Environmental Justice

5.2.3.3.1 Introduction

The purpose of this environmental justice (EJ) review is to determine if a disproportionate number of low-income and minority persons would be adversely affected by the diversion channel alternatives.

5.2.3.3.2 Applicable Rules/Guidelines

Because the Corps is a part of the federal government, it must comply with Title VI of the Civil Rights Act, 42 U.S.C., Sec. 2000 et seq. This law states that "No person in the United States shall, on the ground of race, color or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." The importance of considering EJ issues in federal actions was elevated with the February 11, 1994, signing of Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." EO 12898 requires that "…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations…." [Subsection 1-101].

The EO also requires that each federal agency:

Conducts its programs, policies and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies and activities do not have the effect of excluding persons and populations from participation in, denying persons and populations the benefits of, or subjecting persons or populations to discrimination under such programs, policies and activities because of their race, color or national origin [Subsection 2-2].

and

Works to ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public [Subsection 5-5(c)].

5.2.3.3.3 Identification of Minority and Low-Income Populations

This section presents an evaluation of the demographic composition of the population in the study area. The study area extends from the Canadian border along the Red River to Abercrombie, ND, and includes portions of six counties in North Dakota and six in Minnesota. The North Dakota counties, from north to south, are Pembina, Walsh, Grand Forks, Traill, Cass, and Richland Counties. The Minnesota counties, from north to south, are Kittson, Marshall, Polk, Norman, Clay, and Wilkin Counties. The demographic composition of these 12 counties is compiled as part of the analysis. As race and income related data at the census block and census block group level is not yet available from the 2010 U.S Census for these geographies, data from the 2000 U.S Census has been utilized. Race characteristics at the census block level and income characteristics at the block group level from the 2000 U.S. Census of Population and Housing were analyzed to identify populations of concern with respect to potential EJ issues. Detailed information at the block and block group levels are computed based on the decennial census, which are determined between census periods. The following information was collected for specific blocks and block groups and aggregated to represent the study area:

- Racial and Ethnic Characteristics – race and ethnic populations in each census block of the study area were characterized using the following racial categories: Hispanic White (for which demographic data is reported as one category by the U.S. Census), Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Persons of Hispanic Origin, and Other. These categories are consistent with the affected populations requiring study under EO 12898.
- Percentage of Minority Population – As defined by the U.S. Census Bureau, the minority population includes all non-Whites and White-Hispanic persons. According to Council of Environmental Quality guidelines, "Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis."
- Low-Income Population – The percentage of persons living below the poverty level, as defined in the 2000 U.S. Census, was one of the indicators used to determine the low-income population in a given census block or tract. The median household income and per capita income were also used to characterize income levels.

Population characteristics of the 12 counties are used to define the reference population for comparative purposes throughout this analysis. Table 54 and Table 55 show minority and low-income population characteristics in the North Dakota and Minnesota counties.

Table 54 - Population and Economic Characteristics of Study Areas – North Dakota

Race	**North Dakota**											
	Pembina County		**Walsh County**		**Grand Forks County**		**Traill County**		**Cass County**		**Richland County**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
White	8,198	95.5%	11,752	94.9%	61,479	93.0%	8,249	97.3%	117,106	95.1%	17,428	96.8%
Non-Hispanic White	8,058	93.9%	11,436	92.3%	60,801	92.0%	8,170	96.4%	116,263	94.4%	17,337	96.3%
Hispanic White	140	1.6%	316	2.6%	678	1.0%	79	0.9%	843	0.7%	91	0.5%
Non-White	387	4.5%	637	5.1%	4,630	7.0%	228	2.7%	6,032	4.9%	570	3.2%
Black or African American alone	13	0.2%	41	0.3%	904	1.4%	9	0.1%	996	0.8%	62	0.3%
American Indian and Alaska Native alone	123	1.4%	126	1.0%	1,525	2.3%	80	0.9%	1,325	1.1%	299	1.7%
Asian alone	18	0.2%	24	0.2%	646	1.0%	13	0.2%	1,551	1.3%	44	0.2%
Native Hawaiian and Other Pacific Islander alone	-	0.0%	2	0.0%	44	0.1%	1	0.0%	43	0.0%	6	0.0%
Some other race alone	109	1.3%	311	2.5%	475	0.7%	81	1.0%	530	0.4%	25	0.1%
Two or more races	124	1.4%	133	1.1%	1,036	1.6%	44	0.5%	1,587	1.3%	134	0.7%
Total	8,585	100.0%	12,389	100.0%	66,109	100.0%	8,477	100.0%	123,138	100.0%	17,998	100.0%
Minority Population	527	6.1%	953	7.7%	5,308	8.0%	307	3.6%	6,875	5.6%	661	3.7%
Persons Below Poverty		9.2%		10.9%		12.3%		9.2%		10.1%		10.4%
Per-Capita Income	$18,692		$16,496		$17,868		$18,014		$20,889		$16,339	
Median Household Income	$36,430		$33,845		$35,785		$37,445		$38,147		$36,098	

Source: U.S. Department of Commerce, U.S. Census Bureau, 2000. SF1 and SF3 Tables

Table 55 - Population and Economic Characteristics of Study Areas–Minnesota

Race	Minnesota											
	Kittson County		Marshall County		Polk County		Norman County		Clay County		Wilkin County	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
White	5,184	98.1%	9,873	97.2%	29,543	94.2%	7,092	95.3%	48,149	94.0%	6,979	97.8%
Non-Hispanic White	5,142	97.3%	9,750	96.0%	28,994	92.4%	6,957	93.5%	47,330	92.4%	6,912	96.8%
Hispanic White	42	0.8%	123	1.2%	549	1.8%	135	1.8%	819	1.6%	67	0.9%
Non-White	101	1.9%	282	2.8%	1,826	5.8%	350	4.7%	3,080	6.0%	159	2.2%
Black or African American alone	8	0.2%	10	0.1%	104	0.3%	8	0.1%	268	0.5%	11	0.2%
American Indian and Alaska Native alone	14	0.3%	29	0.3%	408	1.3%	129	1.7%	740	1.4%	30	0.4%
Asian alone	13	0.2%	17	0.2%	95	0.3%	23	0.3%	449	0.9%	11	0.2%
Native Hawaiian and Other Pacific Islander alone	-	0.0%	-	0.0%	5	0.0%	-	0.0%	14	0.0%	1	0.0%
Some other race alone	20	0.4%	165	1.6%	806	2.6%	84	1.1%	857	1.7%	35	0.5%
Two or more races	46	0.9%	61	0.6%	408	1.3%	106	1.4%	752	1.5%	71	1.0%
Total	5,285	100.0%	10,155	100.0%	31,369	100.0%	7,442	100.0%	51,229	100.0%	7,138	100.0%
Minority Population	143	2.7%	405	4.0%	2,375	7.6%	485	6.5%	3,899	7.6%	226	3.2%
Persons Below Poverty		10.2%		9.8%		10.9%		10.3%		13.2%		8.1%
Per-Capita Income	$16,525		$16,317		$17,279		$15,895		$17,557		$16,873	
Median Household Income	$32,515		$34,804		$35,015		$32,535		$37,889		$38,093	

Source: U.S. Department of Commerce, U.S. Census Bureau, 2000. SF1 and SF3 Tables.

For comparative purposes at the county level, with the exception of Clay County, MN and Polk County, MN, and Grand Forks and Cass Counties, ND, all the other counties in the study area experienced a decline in population between 2000 and 2010. The decreases ranged from 4.4 percent to as much as 16.1 percent.

5.2.3.3.4 Minority Analyses

To better understand the location of minority persons in the counties in the study area, percentages of minority persons by census block were calculated and mapped. As shown in Figure 120, Figure 122, Figure 124, Figure 126, Figure 128, and Figure 130 there are very few census blocks with minority persons along the Red River in both states that exceed the state threshold of minority persons.

As shown in Table 54, the percentage of minority persons in the North Dakota counties is highest in Grand Forks County (8.0 percent). Traill County reported the lowest percentage of minority persons, with 3.6 percent. In the Minnesota counties, Polk and Clay Counties reported the highest percentage of minority persons, with 7.6 percent each. Kittson County reported the lowest percentage of minority persons (2.7 percent).

The proposed diversion channels run through portions of Cass County, ND, and Clay County, MN. In Cass County, minority persons account for 5.6 percent of the total population (U.S. Census Bureau, 2000). Greater concentrations of minority persons were identified south of I-94 and in areas near the intersection of I-94 and I-29. As shown in Figure 128, the North Dakota diversion alignment does not appear to intersect any census blocks that have higher concentrations of minority persons than the Cass County threshold of 5.6 percent. As shown in Table 55, minority persons in Clay County, MN, account for 7.6 percent of the total population. Small pockets of minority persons are spread throughout the city of Moorhead and in the eastern portion of the city of Dilworth. Pockets of minority persons are also located toward the northern and southern portions of the County. Just four census blocks along the FCP alignment were identified with higher concentrations of minority persons than the Clay County threshold of 7.6 percent. The minority population in these blocks ranges from one to four persons.

5.2.3.3.5 Poverty and Income Analyses

In the North Dakota counties, Grand Forks County reported the highest percentage of persons living below the poverty level, with 12.3 percent and is the only North Dakota county that reported levels of poverty exceeding the State threshold of 11.9 percent. Compared to the State's median household income of $34,604, five of the six North Dakota counties have higher median household incomes. Four of the counties have higher per capita incomes than the State average of $17,769. Overall, residents of the study area in North Dakota counties are better off as measured by income and poverty.

All of the six Minnesota counties have higher levels of poverty than the State threshold of 7.9 percent. None of the Minnesota counties have higher per capita incomes than the State average of $23,198 or higher median household incomes than the State median of $47,111 (U.S Census Bureau, 2000)

In Clay County, MN, and Cass County, ND, through which the diversion channels run, the percentage of persons living below the poverty level is 13.2 percent and 10.1 percent of the total population, respectively. Figure 131 shows the locations of block groups with a higher percentage of persons living below the poverty level than the county thresholds. In both counties, higher percentages of persons living below the poverty level appear to be present in urban areas that are not immediately adjacent to the diversion channel locations. The alignments do not intersect any census block groups with higher percentages of persons living below the poverty level than the county thresholds.

5.2.3.3.6 Determination of Disproportionately High and Adverse Effects on Populations of Concern

The determination of whether the populations of concern would be subject to disproportionately high and adverse environmental impacts involves two principal considerations: evidence of previous disproportionate environmental degradation caused by past major projects or pre-existing sources of environmental contamination, and a disproportionate distribution of impacts caused by the alternatives. The first consideration involves projects or impacts that occurred in the past and may still be affecting these populations of concern. One of the purposes of EO 12898 is to ensure that areas of high minority and low-income concentrations have not previously been "dumping grounds" for land uses that cause substantial adverse environmental impacts. The second consideration involves determining whether plans for the alternatives have been directed toward areas of high minority and low-income concentrations due to factors such as lower property values or expectations of less effective citizen opposition.

The following types of impacts were evaluated for this analysis:

- Previous Environmental Degradation—Previous degradation to the physical or social environment in a minority or low-income community can arise from past projects that had major impacts or an accumulation of land uses that have a negative impact on the environment. Additional impacts related to the alternatives, however small, can have a greater cumulative effect in areas where previous levels of degradation are high.
- Impacts Related to the Diversion Channel Alternatives—Impacts identified in this and other technical studies have been evaluated to determine whether their effect is borne disproportionately by populations of concern. Issues considered include:

- Induced flooding affecting low-income and minority persons
- Residential and business displacement due to right-of-way (ROW) acquisition
- Changes in accessibility and mobility caused by the diversion channel alternatives
- Noise

The U.S. Environmental Protection Agency (EPA) maintains a detailed database of point sources of environmental contaminants.[1] This database is a good indicator of the degree of pre-existing environmental degradation throughout the country. EPA-regulated site data is provided by zip code area and street address. Emphasis was placed on identifying projects that required environmental reviews under the National Environmental Policy Act, and major local or State construction projects (e.g., solid waste disposal facilities, incinerators, trash disposal or transfer facilities, major transportation projects). Major private projects were not considered unless they involved significant environmental effects, in which case they probably would have required environmental reviews. The analysis found that, other than establishments that handle hazardous wastes, no environmentally sensitive establishments, such as active or archived Superfund sites, are located in the study area[2].

5.2.3.3.7 Environmental Justice Conclusions

Currently, three diversion channel alternatives are being analyzed as part of the Feasibility Study. Long-term impacts from the diversion channels would include induced flooding and loss of farmland due to land acquisition. Based on hydrology and hydraulics studies, there would be some areas that could experience induced flooding for all of the diversion channel alternatives. Areas where the induced flooding at the 1-percent chance event would exceed 1 foot were mapped by alternative. The locations of minority and low-income concentrations were then overlain on the areas with the potential increased flooding to illustrate the location of impacts in relation to the populations of concern.

For the FCP, areas in Clay, Norman, and Polk Counties, MN, would experience some induced flooding in excess of 1 foot (see Figure 120-Figure 125). However, areas of flooding do not appear to be concentrated in the minority and low-income areas in these counties.

For the ND35K, there would be some induced downstream flooding at the 1-percent chance event in excess of 1 foot in Traill and Cass Counties, ND (see Figure 126-Figure 131). However, the increased flooding does not appear to be concentrated in the minority and low-income areas in these counties.

The LPP includes staging areas upstream of the diversion inlet with stage increases of up to 8 feet at the 1-percent chance event. A large part of the staging area would be purchased in fee, or have mitigation of impacts with flowage easements or ring-levees. Impacts will be evaluated on a case by

1 www.epa.gov/enviro/html/cerclis/cerclis_query.html

2 A Superfund site is an uncontrolled or abandoned place where hazardous waste is located, possibly affecting local ecosystems or people. Sites are listed on the National Priorities List (NPL), which guides the Environmental Protection Agency (EPA) in making a determination on sites that require further investigation. They are listed upon completion of a Hazard Ranking System screening, public solicitation of comments about the proposed site, and after all comments have been addressed. (Source: www.epa.gov/superfund/sites/index.htm).

case basis to determine if there will be a taking. The extent of induced flooding does not appear to be concentrated in the minority and low-income areas in these counties. Land that would need to be acquired for staging areas would only be finalized after making a detailed assessment whether minority or low-income persons would need to be relocated.

One of the concerns regarding the FCP and ND35K is the increased potential for induced flooding downstream. Based on U.S Census 2010 data at the County level, the racial composition of the downstream communities closely mirrors that of the metro area; however, there is slightly less diversity downstream. . The percentage of minority persons in both the upstream counties such as Richland County, ND and Wilkin County, MN are low and there does not appear to a concentration of minority or low-income persons along the river. Comparing the populations that are fluent in English with those that are not finds a higher share of non-English speaking persons in most of the North Dakota downstream counties compared to the city of Fargo. However, on the Minnesota side the share of non-English speakers in the downstream counties was lower than those reported in Moorhead (U.S. Census Bureau, 2010). Richland County, ND had a slightly higher proportion of Spanish speaking persons than the city of Fargo.

Education level was also considered as part of this review. Both upstream and downstream study area counties in North Dakota had higher percentage of persons with a high school diploma compared to levels exhibited in Fargo. Similarly, both the upstream and downstream counties in Minnesota had higher levels of persons with a high school diploma than was found in Moorhead. However, the percentage of persons with college and Bachelor's degrees was higher in Fargo and Moorhead compared to upstream and downstream counties in their respective states and this is primarily due to the large number of educational facilities in these two cities compared to the other jurisdictions.

There is a lower percentage of children below the age of 5 years in the population of the downstream communities, but a higher percentage of individuals 65 years old or older. Based on these findings, it can be generalized that, on average, the downstream communities have a slightly higher percentage of older individuals than is found in the metro area.

The EPA's "Toolkit for Assessing Potential Allegations of Environmental Injustice" offers a definition for disproportionately high and adverse effects or impacts as those "(1)...predominately borne by any segment of the population, including, for example, a minority population and/or a low-income population; or (2) will be suffered by a minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect or impact that will be suffered by a non-minority population and/or non-low-income population."

Any downstream impacts created by the FCP or ND35K, regardless of location or extent, would not adversely affect minority or low-income populations more severely or in greater numbers than it would the wealthier, White populations. Upstream impacts due to the staging areas or flooding do not appear to disproportionately impact minority or low-income populations. In the event of downstream impacts, those with higher median household incomes or higher levels of education would be affected to the same extent as those who are not proficient in English or who are over 65 years old. This non-discriminatory nature of any upstream or downstream effects minimizes any EJ impacts; therefore, it cannot be said that these groups would bear a disproportionately high and adverse share of the effects of the FCP, ND35K, or LPP.

In addition to the acquisition of land for the project, a diversion channel would cause changes in accessibility and mobility across farms and have air quality- and noise-related impacts during construction. The diversion channel alternatives would divide farms into separate parcels. In some cases, farmers would have to detour around the diversion channel using established roadways or specially constructed access roads to access their property and conduct farming operations. The number of farms in active use that would be divided by each of the alternatives is unknown at this preliminary stage. Mitigation measures would be incorporated into the final project design to minimize impacts on farmland and commuting. Currently each diversion channel alignment has bridges approximately every 3 miles as discussed in Chapter 3.

Figure 120 - Traill County, ND and Norman County, MN: Census Blocks Showing Minority Persons and Areas of Induced Flooding

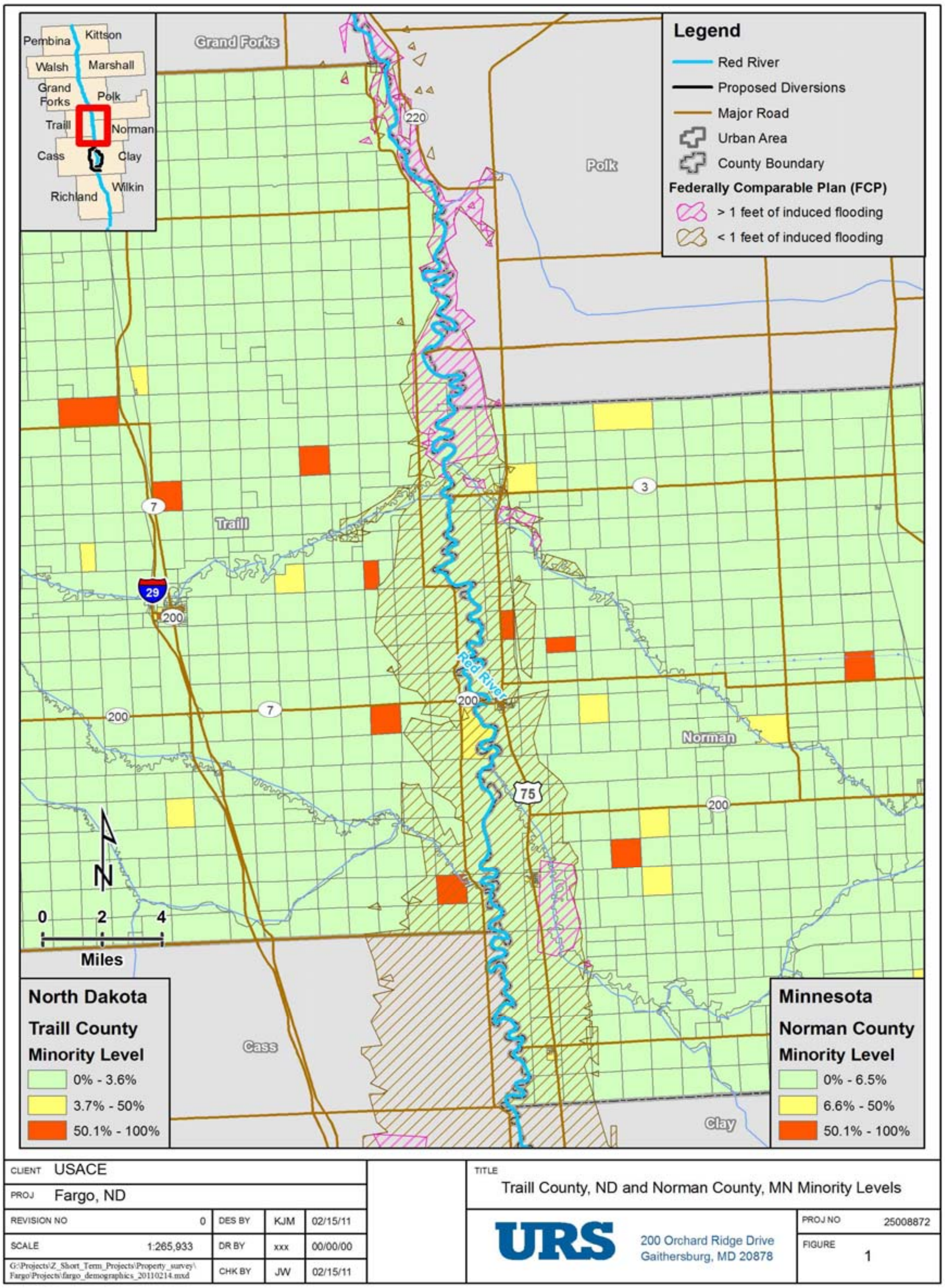


Figure 121 - Trail County, ND and Norman County, MN: Census Block Groups Showing Persons Below Poverty and Areas of Induced Flooding

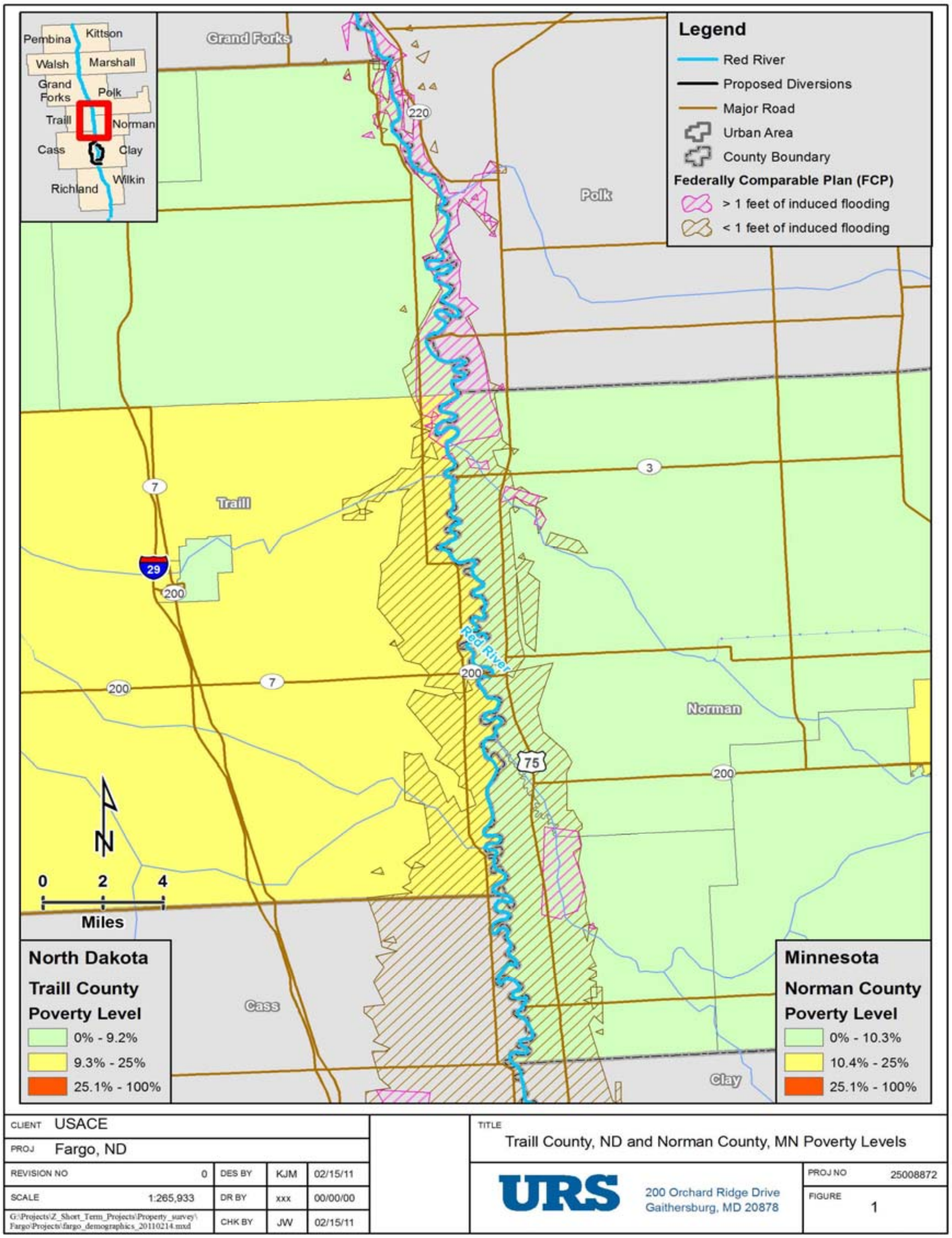


Figure 122 - Grand Forks County, ND and Polk County, MN: Census Blocks Showing Minority Persons and Areas of Induced Flooding

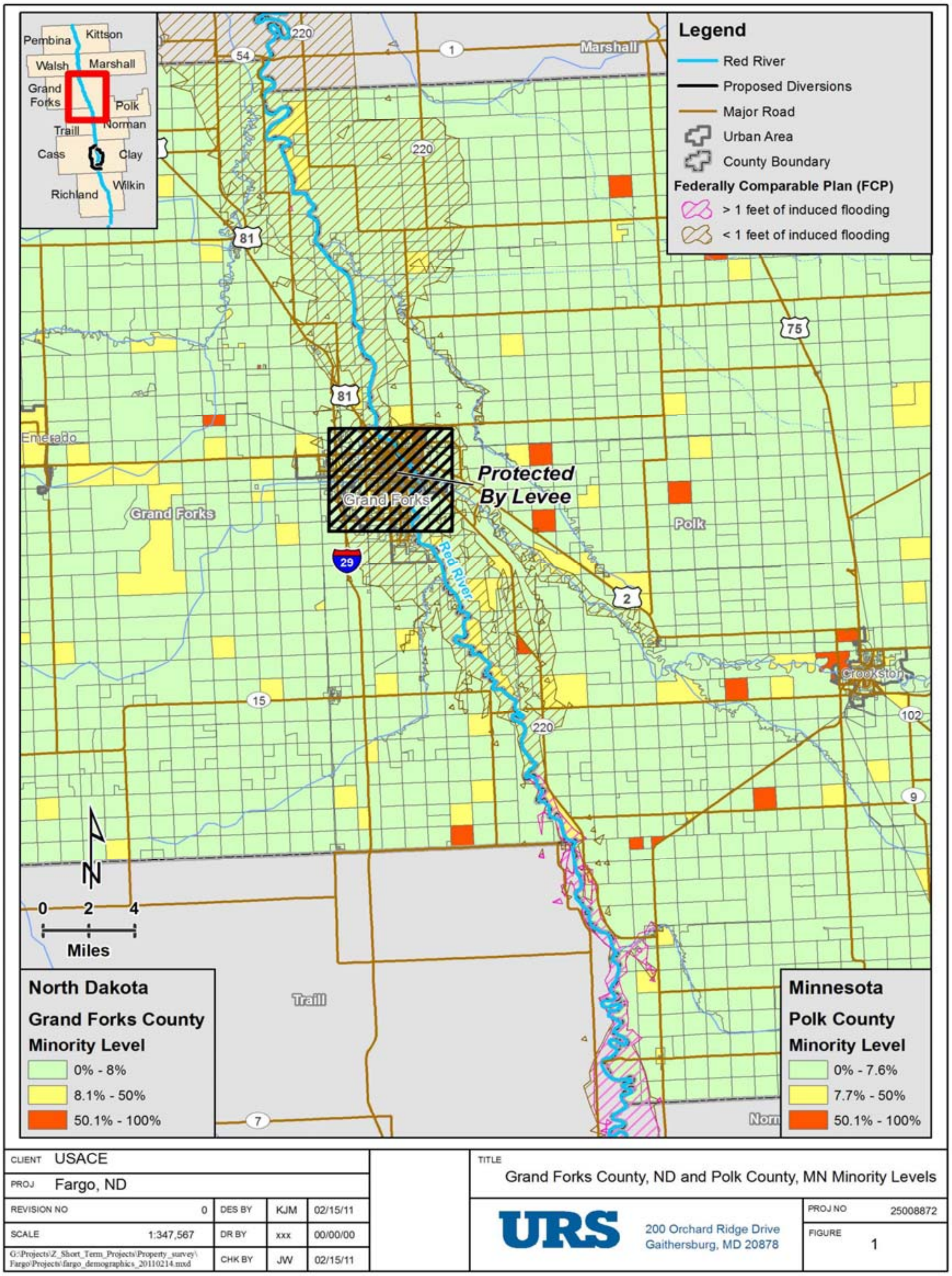


Figure 123 - Grand Forks County, ND and Polk County, MN: Census Block Groups Showing Persons Below Poverty and Areas of Induced Flooding

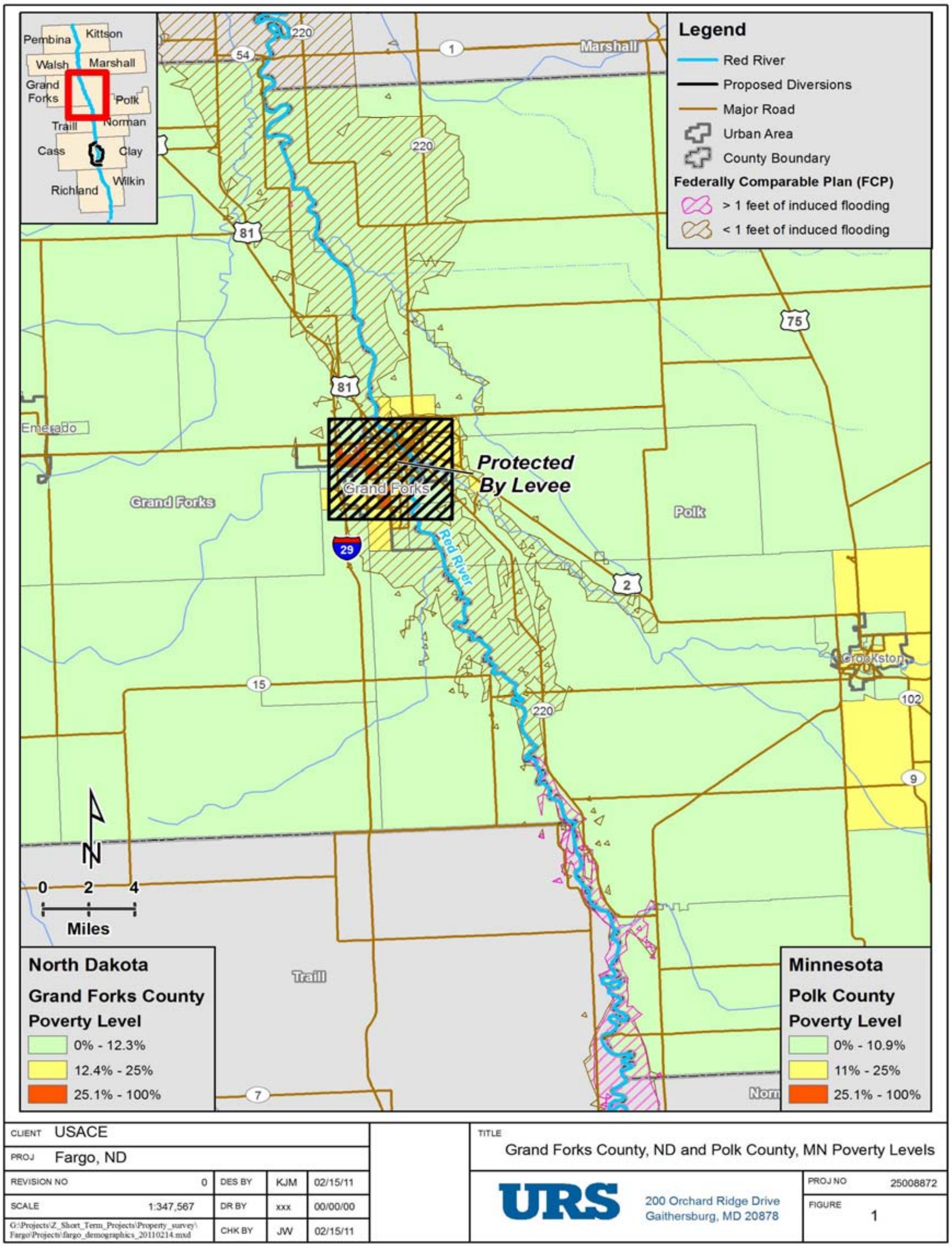


Figure 124 - Cass County, ND and Clay County, MN: Census Blocks Showing Minority Persons and Areas of Induced Flooding

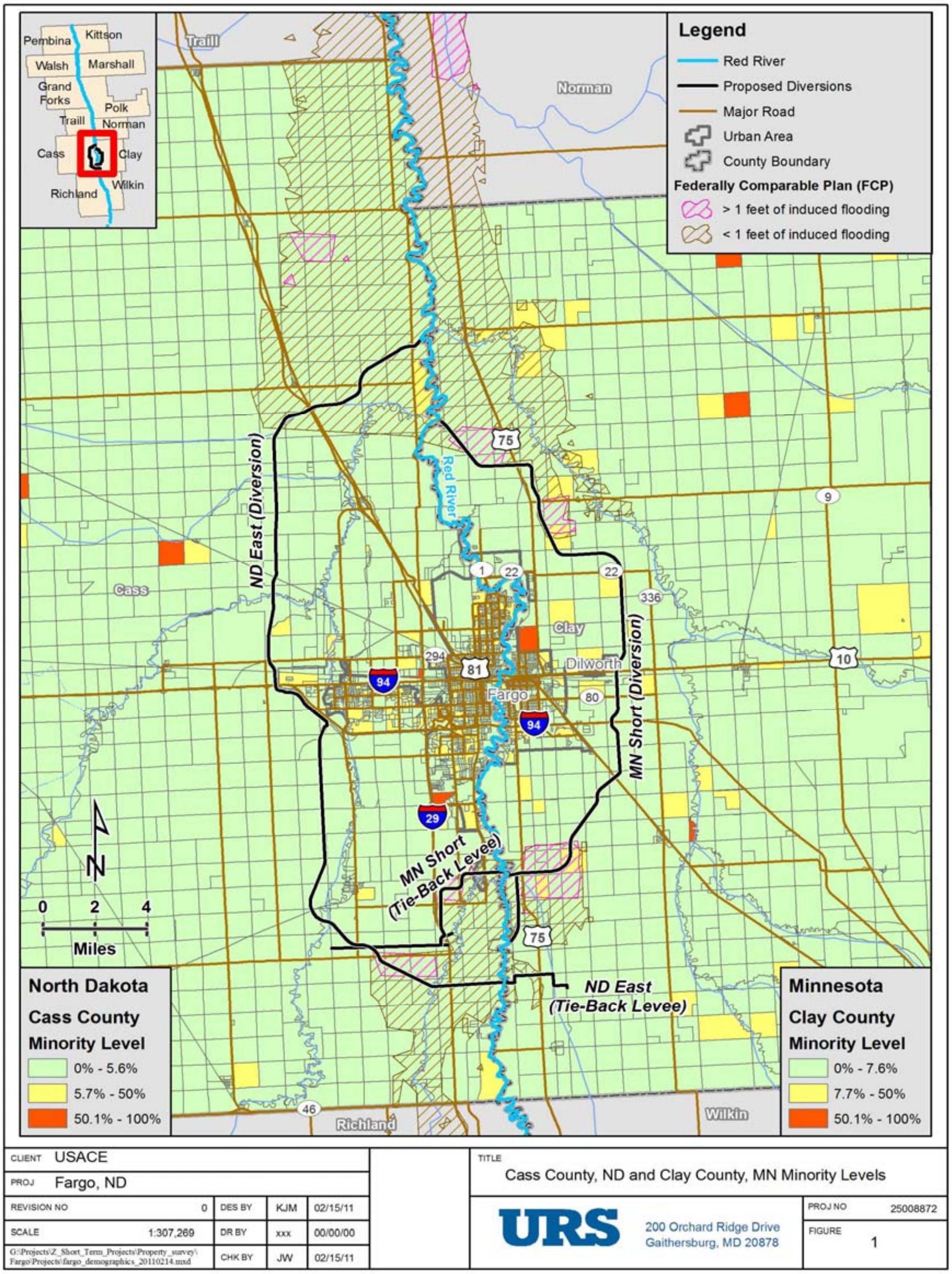


Figure 125 - Cass County, ND and Clay County, MN: Census Block Groups Showing Persons Below Poverty and Areas of Induced Flooding

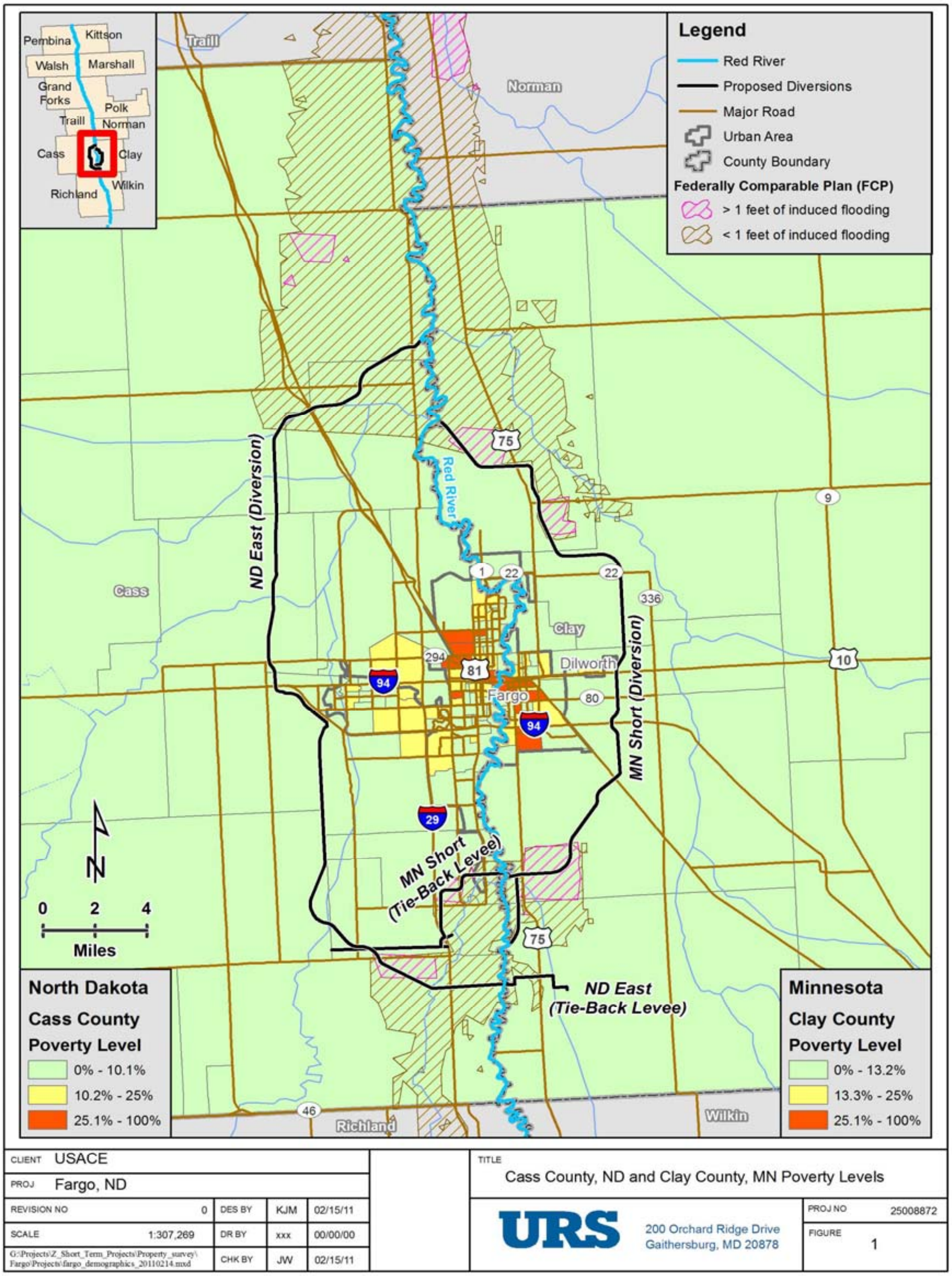


Figure 126 - Traill County, ND and Norman County, MN: Census Block Groups Showing Persons Below Poverty and Areas of Induced Flooding

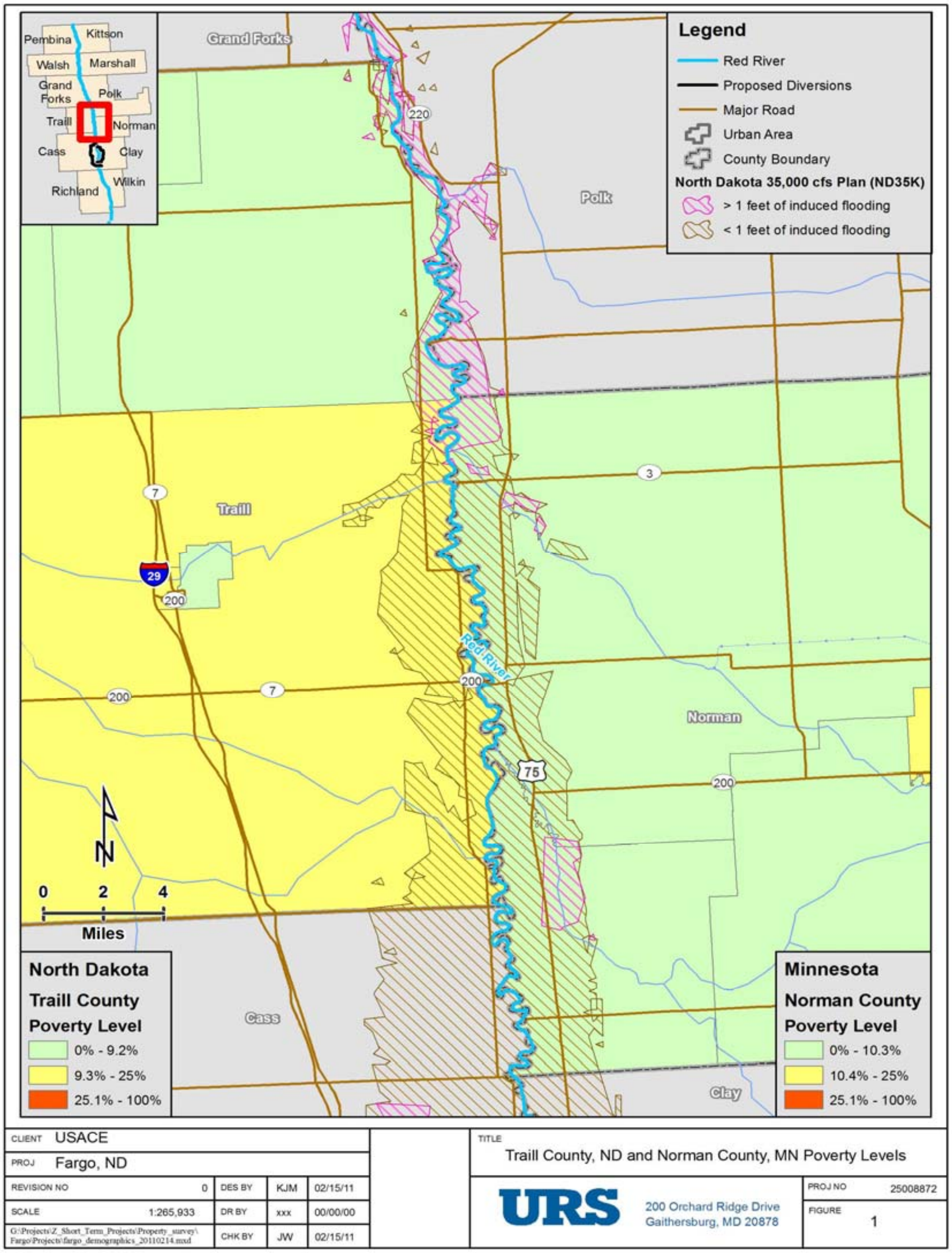


Figure 127 - Traill County, ND and Norman County, MN: Census Blocks Showing Minority Persons and Areas of Induced Flooding

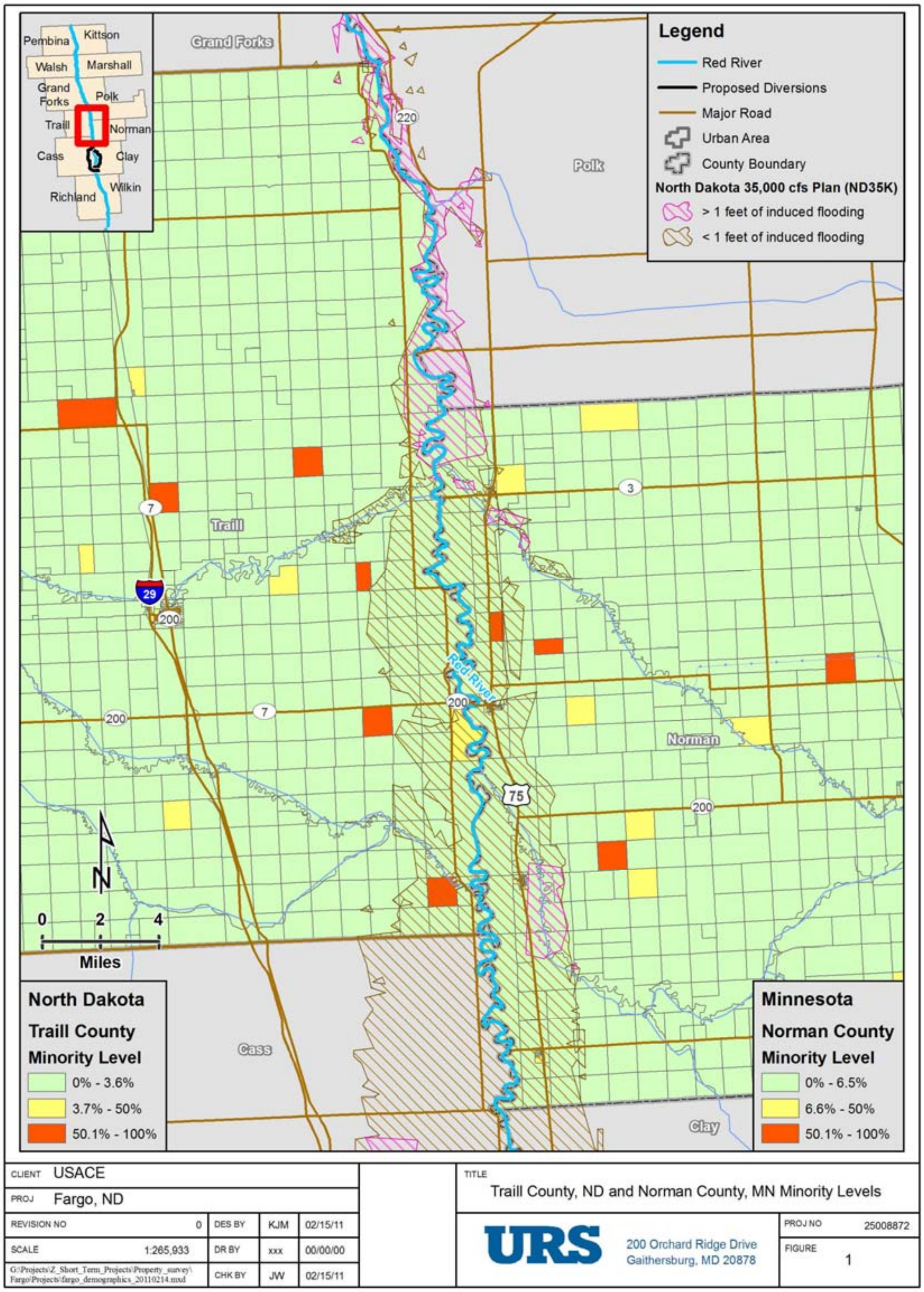


Figure 128 - Grand Forks County, ND and Polk County, MN: Census Block Groups Showing Persons Below Poverty and Areas of Induced Flooding

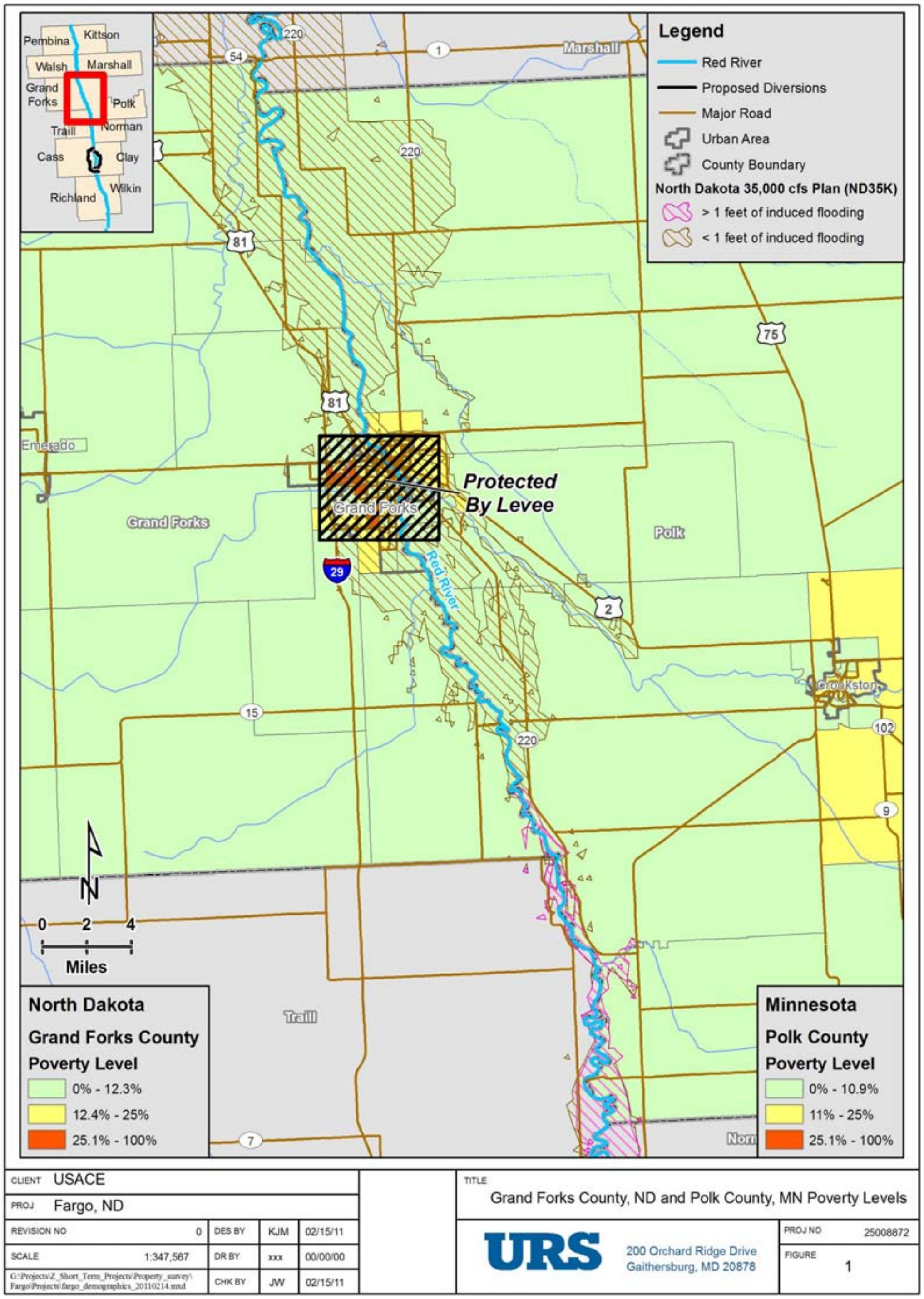


Figure 129 - Grand Forks County, ND and Polk County, MN: Census Blocks Showing Minority Persons and Areas of Induced Flooding

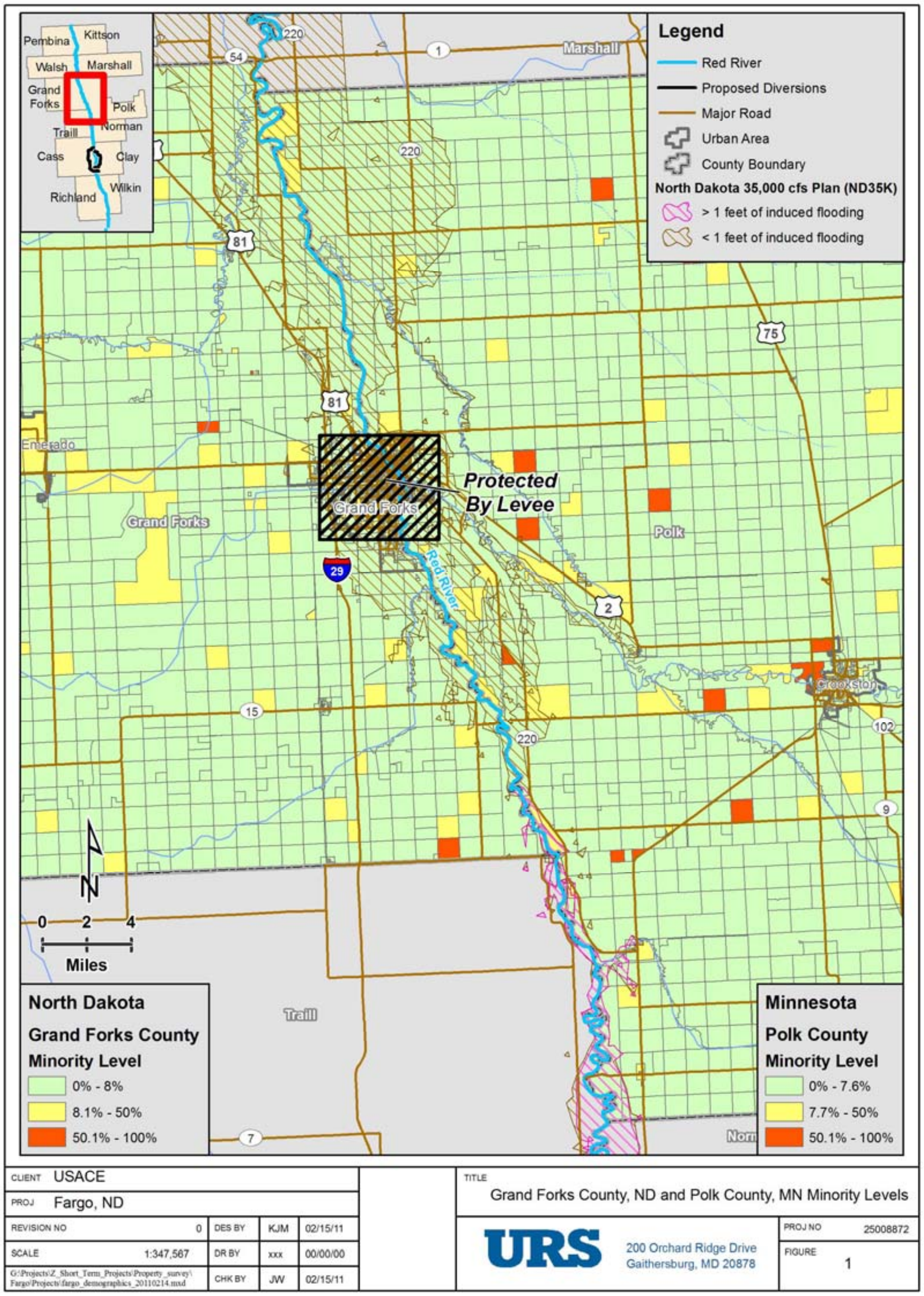


Figure 130 - Cass County, ND and Clay County, MN: Census Blocks Showing Minority Persons and Areas of Induced Flooding

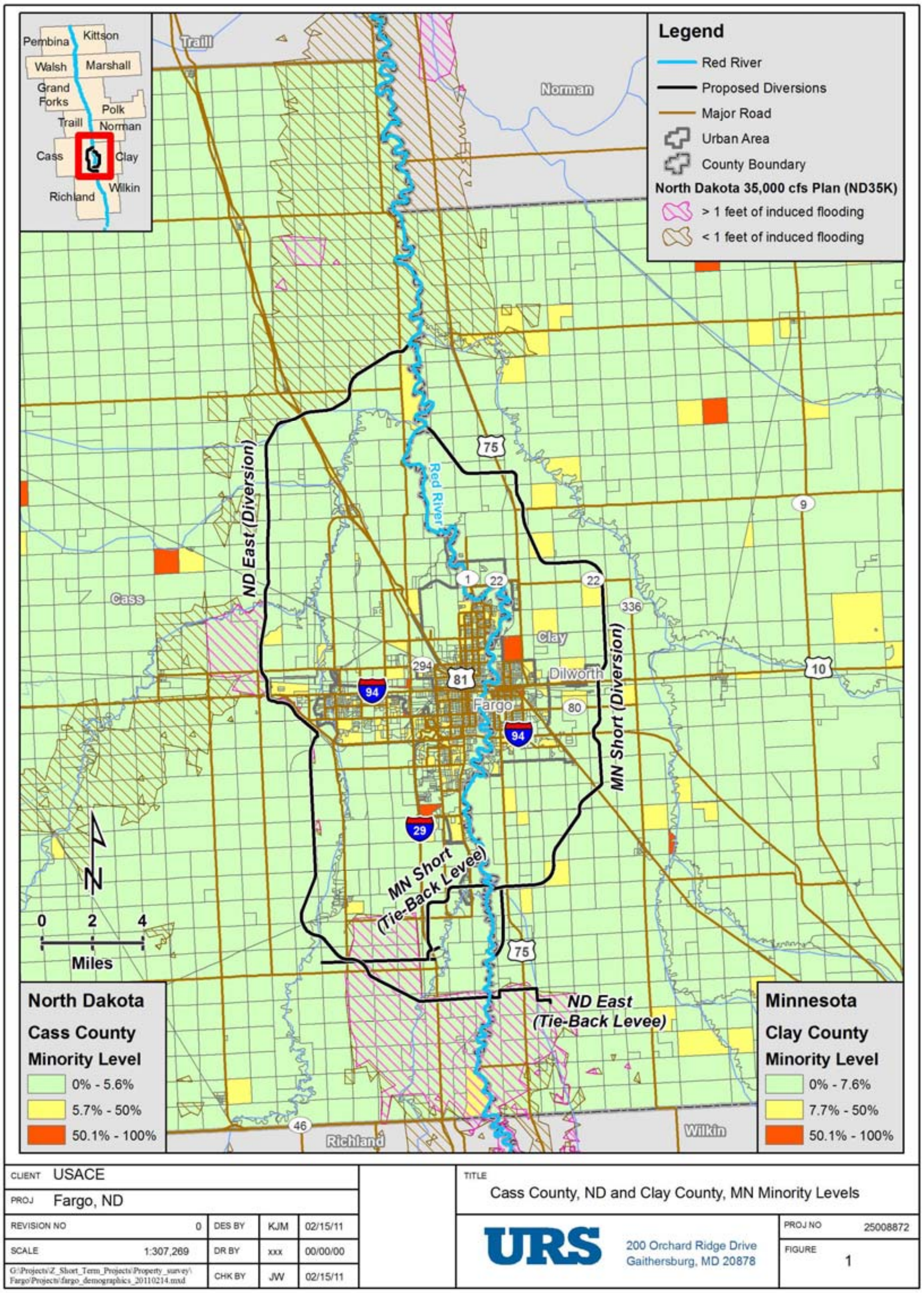
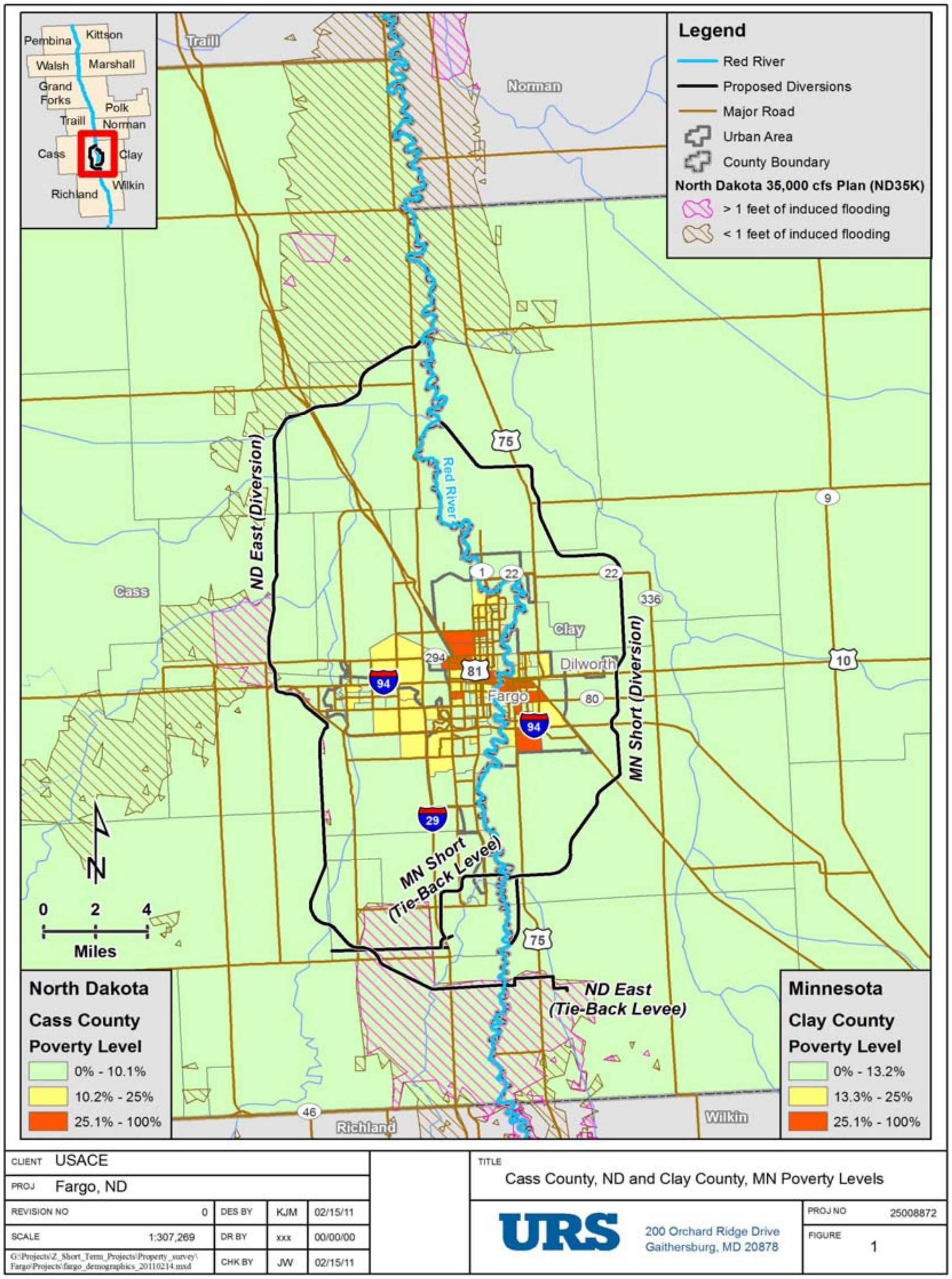


Figure 131 - Cass County, ND and Clay County, MN: Census Block Groups Showing Persons Below Poverty and Areas of Induced Flooding



5.3 CONTROVERSY

Most of the controversial aspects of the project are related to the selection of the tentatively selected plan and the location of the diversion alignments. Individual areas of controversy are discussed in various sections of the EIS and those pertaining to the socioeconomic resources are summarized here.

Some landowners near the alignments are uncomfortable with the project in their backyard, but most landowners believe that a flood risk management project is important to the area's survival. Owners of agricultural lands that are purchased for the project would be compensated at fair market value.

Landowners outside the study area are concerned about induced flooding damages to their property, but all of the diversion channel alternatives have been designed to minimize increased stages in areas outside the project limits where possible. Steps will be taken to avoid, minimize, or mitigate any negative impacts to these landowners. As described above, there will be some downstream and/or upstream impacts with all of the diversion channel alternatives. A preliminary takings analysis has been completed and there appear to be takings for all diversion channel alternatives.

Some concern has been expressed at public meetings that the level of protection provided by the project should be equal to that provided by the existing diversion channel in Winnipeg, Manitoba, which is a 700-year level. Other concerns regarding flood water storage have been raised by the public; this is primarily in response to the induced flooding that will occur downstream of the study area for the ND35K and FCP. There is also equal concern for the induced flooding upstream associated with the LPP.

Concerns from the city of Dilworth, Minnesota have been raised that the FCP would have serious adverse impacts to the future growth of the town. Concerns from the city of Oxbow, and all impacted cities upstream of the LPP diversion channel have been raised concerning the impacts that would be caused by the LPP, and what it will mean to their tax base, their schools, future, growth etc. Similar concerns have been raised by downstream communities in regard to the FCP and the ND35K.

The city of West Fargo and other entities have raised concern over the diversion channel alignment from Horace to West Fargo. They have requested that the alignment be moved west approximately 1.5 miles to protect infrastructure and provide additional land for their development. This is discussed further in Chapter 3 Alternatives.

5.4 CUMULATIVE EFFECTS

The Council on Environmental Quality (CEQ) regulations (40 CFR §§ 1500-1508) implementing the procedural provisions of the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. § 4321 et seq.) define cumulative impact as:

> "…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions

regardless of what agency (federal or non federal) or person undertakes such other actions" (40 CFR § 1508.7).

Cumulative effects analysis recognizes that the most serious environmental impacts may result from the combination of individually minor effects of multiple actions over time, rather than the direct or indirect effects of a particular action (CEQ 1997). The challenges in assessing cumulative impacts derive in part from (1) incomplete identification of the ecological stressors or actions that alter ecological processes (2) limited data and information of suitable quality that describe the individual stressors; (3) imperfect and uncertain understanding of the potential interactions among stressors in determining cumulative ecological impacts; (4) spatial and temporal scales relevant to the overall assessment; and (5) limited understanding of the resilience of potentially affected resources to past, present, and future stress (USEPA 1997).

The CEQ has suggested frameworks for incorporating cumulative effects analyses (CEA) into the environmental impact assessment process, and steps for conducting the CEA (CEQ 1997). These frameworks are shown in Table 56 and Table 57. These frameworks indicate that the CEA should begin with the NEPA scoping process, and continue throughout the descriptions of the affected environment and the environmental effects of the action. Individual steps in conducting a CEA are also tied to these three major components of the NEPA process. Three fundamental elements typically characterize CEA (Spaling and Smit 1993 in Canter 1999): 1) a cause or source of change (perturbations); 2) the process of change as reflected via the pertinent system structure or processes; and 3) the result of the change (effect).

Table 56 – CEQ framework for conducting cumulative impact assessments.

1. Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions. The effects of a proposed action on a given resource, ecosystem, and human community include the present and future effects added to the effects that have taken place in the past. Such cumulative effects must also be added to effects (past, present, and future) caused by all other actions that affect the same resource.
2. Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter who (Federal, non-Federal, or private) has taken the actions. Individual effects from disparate activities may add up or interact to cause additional effects not apparent when looking at the individual effects one at a time. The additional effects contributed by actions unrelated to the proposed action must be included in the analysis of cumulative effects.
3. Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, and human community being affected. Environmental effects are often evaluated from the perspective of the proposed action. Analyzing cumulative effects requires focusing on the resource, ecosystem, and human community that may be affected and developing an adequate understanding of how the resources are susceptible to effects.

4. It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful. For cumulative effects analysis to help the decision-maker and inform interested parties, it must be limited through scoping to effects that can be evaluated meaningfully. The boundaries for evaluating cumulative effects should be expanded to the point at which the resource is no longer affected significantly or the effects are no longer of interest to affected parties.
5. Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries. Resources typically are demarcated according to agency responsibilities, county lines, grazing allotments, or other administrative boundaries. Because natural and sociocultural resources are not usually so aligned, each political entity actually manages only a piece of the affected resource or ecosystem. Cumulative effects analysis on natural systems must use natural ecological boundaries and analysis of human communities must use actual sociocultural boundaries to ensure including all effects.
6. Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects. Repeated actions may cause effects to build up through simple addition (more and more of the same type of effect), and the same or different actions may produce effects that interact to produce cumulative effects greater than the sum of the effects.
7. Cumulative effects may last for many years beyond the life of the action that caused the effects. Some actions cause damage lasting far longer than the life of the action itself (e.g., acid mine drainage, radioactive waste contamination, species extinctions). Cumulative effects analysis needs to apply the best science and forecasting techniques to assess potential catastrophic consequences in the future.
8. Each affected resource, ecosystem, and human community must be analyzed in terms of its capacity to accommodate additional effects, based on its own time and space parameters. Analysts tend to think in terms of how the resource, ecosystem, and human community will be modified given the action's development needs. The most effective cumulative effects analysis focuses on what is needed to ensure long-term productivity or sustainability of the resource.

[1]From: CEQ. 1997. Considering cumulative effects under the National Environmental Policy Act. Council on Environmental Quality, Executive Office of the President, Washington, D.C. 64 pages + appendices.

Table 57 – Steps in cumulative effects analysis to be addressed in each component of environmental impact assessment.

EIA Components	CEA Steps
Scoping	1. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals. 2. Establish the geographic scope for the analysis. 3. Establish the time frame for the analysis. 4. Identify other actions affecting the resources, ecosystems, and human communities of concern.
Describing the Affected Environment	5. Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses. 6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds. 7. Define a baseline condition for the resources, ecosystems, and human communities.
Determining the Environmental Consequences	8. Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities. 9. Determine the magnitude and significance of cumulative effects. 10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects. 11. Monitor the cumulative effects of the selected alternative and adapt management.

[1]From: CEQ. 1997. Considering cumulative effects under the National Environmental Policy Act. Council on Environmental Quality, Executive Office of the President, Washington, D.C. 64 pages + appendices.

The geographical extent is broadly defined by the Red River of the North Drainage Basin. The pertinent time scale for assessing cumulative impacts spans approximately 160 years, and dates from 1901, the beginning of the existing discharge records for the USGS gauge at Fargo, through 2060, the end of the project planning horizon.

This section will briefly review the affected environment, which was described in detail earlier in Chapter 4, describe the stressors that have shaped and will continue to shape the natural and human environments of the Red River Basin, and then consider the cumulative effects of the impacts presented earlier in this chapter.

5.4.1 Cumulative Impacts with Diversion Channel Alternatives

The CEA will focus on the same resource categories described in Chapter 4, Affected Environment, and further evaluated for likelihood of direct and/or indirect impacts in this chapter. These include the following:

Natural Resources
Geomorphology
Air Quality
Water Quality
Water Quantity
Shallow Groundwater

Aquatic Habitat
Fish Passage
Wetlands
Upland Habitat/Riparian Habitat
Endangered Species
Prime and Unique Farmland

Cultural Resources
Cultural Resources

Socioeconomic Resources
Social Effects
Economic Issues
Environmental Justice

5.4.1.1 Geomorphology
The Red River basin has stream hydraulics that have been modified by tiling and draining activities. Many dams also have been constructed throughout the basin, including several on rivers immediately within the study area. A flood diversion project also exists within the study area for the Sheyenne River. This diversion project serves as a proxy for many potential geomorphic impacts under the diversion channel alternatives. Observations on the Sheyenne River adjacent to the diversion project suggest minimal changes to sediment transport and stream cross sections, even after the project has been in place for 20 years. This suggests fairly minimal effects to Sheyenne River geomorphology as a result of the project.

Sediment transport in the Red River and its tributaries is dominated by fine-grained sediments that easily remain suspended in the water column. All of the diversion channel alternatives could alter hydraulic conditions for the Red River. The ND35K and LPP would also affect five tributaries and Wolverton Creek. However, none of the diversion channel alternatives would substantially alter sediment transport or other key geomorphic properties. Ultimately, it is not anticipated that any of the alternatives would substantially contribute to any adverse geomorphic conditions either downstream or upstream of the study area. And while channel slope could be increased for short areas adjacent to several project structures, careful project design should minimize any potential for destabilization of the stream bed or stream banks.

5.4.1.2 Air Quality
The Fargo-Moorhead area is considered a NAAQS Attainment Area for all air quality parameters (USEPA 2009). Heavy equipment would produce small amounts of hydrocarbons in exhaust emissions. The construction contractor would be required to maintain the vehicles on the sites in good working order to minimize exhaust emissions. Fugitive dust could also result from proposed construction activities so the contractor would be required to conduct dust suppression activities. Adverse impacts to air quality resulting from the diversion channel alternatives would be minor and short term in nature regardless of the alternative that is implemented.

5.4.1.3 Water Quality

As outlined above, water quality in the Red River of the North main stem is generally impaired for much of its length in the continental U.S. Point and non-point sources of pollution result in high concentrations of several pollutants. This results in non-support of aquatic life and overall use; and partial support of swimming, agriculture, and wildlife uses. These impairments are largely due to various agricultural activities, urban runoff, septic systems, channelization, dredging, streambank modifications, dams and other stressors. Water quality within tributaries of the study area face similar water quality limitations discussed above.

The diversion channel alternatives considered here could slightly affect water quality that has already been greatly reduced. Construction of any of the alternatives could result in minor reductions in water quality, although the effects would be temporary. Potential geomorphic effects could result in slight increases in turbidity. However, the likelihood of geomorphic effects appears small, and for areas where such effects are more likely, mitigation would be applied to reduce those effects. None of the diversion channel alternatives would further contribute to other pollutants affecting water quality, such as nutrients, pH, fecal coliform or Biological Oxygen Demand. Thus, the diversion channel alternatives should not significantly contribute to further cumulative degradation of water quality in the basin.

5.4.1.4 Water Quantity

The quantity of water flowing through the Red River system has changed over time. As outlined above, review of annual peak discharge data suggests that flooding at Fargo, ND has increased over time. This includes a general increase in the frequency and magnitude of flood events. Causes of this are a likely combination of increased precipitation over time, as well as increased tiling and draining of the watershed. This has resulted in more water flowing through the system more quickly.

All of the diversion channel alternatives will change the timing and flows of water, significantly reducing the quantity of water flowing through the communities of Fargo and Moorhead. However, all diversion channel alternatives also include an increase in water quantity for areas downstream and/or upstream of Fargo-Moorhead. These impacts are outlined above, and include anticipated impacts for the 10, 2, 1 and 0.2-percent chance events. Impacts would extend approximately 220 miles downstream for the FCP and even further downstream for the ND35K, and as far as 15 miles upstream for the LPP. Ultimately, all diversion channel alternatives would result in varying improvements in the cumulative condition of water quantity and flood elevations for the Fargo-Moorhead Metropolitan area. Conversely, all alternatives will increase flood elevations and alter the timing of flooding for areas downstream and/or upstream of the Fargo-Moorhead Metropolitan Area.

5.4.1.5 Shallow Groundwater

Shallow groundwater in the study area includes the Buffalo Aquifer to the east, and the West Fargo Aquifer to the west. The Buffalo Aquifer is located five to seven miles east of Moorhead, trending north-south. The aquifer is about 25-30 miles long, 1 to 2 miles wide and as deep as 250-feet. The top of the aquifer is at ground surface in some areas and buried in glacial lake clays in others. The West Fargo aquifer occurs around West Fargo. However, this aquifer is at least 70 feet deep.

Based on the available data, the FCP is approximately one thousand feet west of the Buffalo Aquifer, which provides a reasonable buffer between the aquifer and an excavated diversion channel. Measureable impacts to the aquifer with this separation are very unlikely. The West Fargo aquifer appears to be deep enough to avoid impacts that could occur from project structures or excavation associated with either of the North Dakota alternatives.

Additional data analyses and design refinements are recommended to verify alignment choices versus the local variations in the hydrogeology. However, none of the diversion channel alternatives should have adverse impacts to the cumulative condition of aquifers in the region.

5.4.1.6 Aquatic Habitat

Aquatic habitat includes the Red River mainstem and tributaries. This riverine habitat is occupied by many species of fish and invertebrates. This habitat also has been affected by many human influences. Activities such as stream channelization, damming and other alternations over the last 100 years have influenced hydrology, geomorphic processes and physical aquatic habitat. Additionally, alterations to the watershed, including changing to agricultural landcover, artificial drainage and tiling, have further influenced these processes. Today, habitat quality on the Red River and adjacent tributaries appears greatly reduced over that of pre-European settlement. Tributaries such as the Rush River, Lower Rush River and Wild Rice River appear greatly affected. The Sheyenne River, Maple River and Red River mainstem may be in slightly better condition, though habitat here is also degraded relative to pre-settlement conditions.

All of the diversion channel alternatives could further degrade aquatic habitat quality that has already been greatly reduced. Impacts would be greater for the LPP and ND35K, and lesser for the FCP. As outlined above, significant impacts from the project footprint for any diversion channel alternative would be mitigated through improvement of similar habitat within the basin. Geomorphic impacts generally appear small, thus the forces that form and shape river habitat would not be substantially affected. All alternatives include measures to avoid and minimize impacts. They also include mitigation to further reduce any remaining significant impacts. Ultimately, with proposed mitigation, the LPP, FCP and ND35K would not be expected to significantly contribute to further cumulative degradation to aquatic habitat in the basin.

5.4.1.7 Fish Passage and Biological Connectivity

Biological connectivity has changed greatly over time in the Red River Basin. Prior to European settlement, fish had full access to move throughout the Red River mainstem, and between its tributaries. Following settlement, many dams were constructed to facilitate water supply, floodwater storage and other goals. This included eight dams on the Red River, and hundreds of dams on tributaries throughout the basin. Dam construction began in the late 1800s, and continued through 1970.

Over approximately the last 15 to 20 years, biological connectivity has begun to improve in the basin. Fish passage projects have improved biological connectivity on five dams of the Red

River Basin, with the three remaining dams currently under consideration for potential future fish passage improvements. An additional 30 projects have been implemented to improve fish movement on Red River tributaries. Although many impediments still remain, the level of biological connectivity has slowly improved in the basin.

The LPP could have a potentially significant impact to aquatic habitat connectivity on the Red and Wild Rice rivers. As such, the LPP includes several minimization and mitigation measures to reduce the level of this impact. Interrupted connectivity would be mitigated under the LPP to minimize the contribution toward this cumulative condition.

The FCP and ND35K could slightly reduce the level of biological connectivity relative to existing conditions. However, any effects would be small. The FCP and ND35K include extensive measures to minimize impacts to connectivity to levels that would be less than significant in terms of effects to long-term Red River fish populations and community trends. The FCP will have the least effect to connectivity, as impacts are limited to the Red River mainstem. The ND35K would be slightly worse as connectivity could affect the Red and Wild Rice rivers. However, under these two alternatives, significant efforts were made to minimize impacts to connectivity. Any reductions to biological connectivity would be small and not anticipated to noticeably affect fish populations or communities of the Red River or associated tributaries.

Ultimately, the LPP, FCP and ND35K could slightly reduce levels of biological connectivity to varying degrees. However, with proposed minimization and mitigation measures for each alternative, these reductions would be negated, and not significantly affect fish populations or communities, relative to existing conditions.

5.4.1.8 Wetlands

Anderson and Craig (1984, as reported in Aadland et al 2005) estimated over 95% of the wetlands in the Agassiz Lake Plain ecoregion have been drained. This number may have increased since that evaluation in 1984. Clearly, wetlands are a natural resource that has been severely impacted through human development. Due to increasing pressure to either urbanize or improve drainage on cropland, it is anticipated that wetland acreage will either remain the same or decrease within the study area in the future even without implementation of any of the diversion channel alternatives.

Wetland areas would be impacted under any of the diversion channel alternatives. These impacts are outlined above. Impacts would occur either directly through impacts from the project footprint, or indirectly through reduced hydraulic connectivity of wetlands to the river because of reduced river flood discharge. However, as outlined above, these impacts should be offset. Wetlands that will be adversely affected by the footprint of the diversion channel would be more than offset by creation of wetlands within the diversion channel bottom. Wetlands potentially impacted because of altered connectivity will be mitigated through wetland creation.

Ultimately, all the diversion channel alternatives would include appropriate measures to minimize and mitigate potential losses to wetland areas. Any of the alternatives considered here would not contribute to further cumulative degradation of wetland habitats in the basin.

5.4.1.9 Upland Habitat

European settlement resulted in the conversion of landcover type over the vast majority of the basin. Previous upland habitats have almost entirely been converted to cropland, with a mixture of hayed pasture, hobby farms and some urban development around larger cities. The remaining wooded areas, which are primarily riparian corridors, are an important wildlife and aesthetic resource.

For all the diversion channel alternatives, there would be some areas where forested habitat would be cleared. The loss of these wooded areas would be permanent but would be offset, at no less than a 1:1 ratio, by tree plantings that would be done along land that will be acquired along one of the tributaries as part of the mitigation. The other areas to be disturbed are currently farmed and have reduced natural resource value. Portions of the spoil areas adjacent to the diversion channel would be available for farming after completion. All other disturbed areas would be replanted with native species, primarily grasses that would have positive impacts on the area's overall habitat value. Overall, the construction activities would have temporary adverse impact on the terrestrial habitat but the eventual changes in vegetative cover would have long term beneficial impacts on the avian and small mammal groups which are found in areas on the periphery of residential development and agricultural plots. All diversion channel alternatives would have a small, beneficial effect to the existing condition of upland habitat.

5.4.1.10 Endangered Species

Degradation of habitat in the basin has contributed to reduced abundance and federal listing of select species. This has included the whooping crane (*Grus americanus*; endangered), the gray wolf (*Canis lupus;* endangered*)* the Western prairie fringed orchid (*Platanthera praeclara*; threatened), and the Dakota skipper (*Hesperia dacotae*; candidate). None of the diversion channel alternatives would contribute to cumulative impacts on these species.

5.4.1.11 Prime and Unique Farmland

Prime farmland is a valuable resource for the region. This farmland has developed through the conversion of previous natural landcovers, and through improvements such as tiling and draining. A large percentage of the study area includes prime and unique farmland.

Long-term impacts from the FCP, ND35K, or LPP would include loss of farmland and business income. The three diversion channel alternatives would result in the loss of 5,800 to 6,900 acres of prime and unique farmland (Appendix F). All of the diversion channel alternatives would contribute to the cumulative loss of this resource.

5.4.1.12 Cultural Resources

5.4.2.12.1 Cumulative Effects on Historic Properties

For any of the diversion channel alternatives, project features (diversion channel with associated spoil piles, the associated tie-back levees, and, for the FCP, the breakout channels with associated spoil piles) may have indirect visual impacts on any National Register eligible or listed historic properties located within one-half mile of the features. Conversely, once constructed, project features would have a beneficial effect for historic properties in the cities of Fargo and Moorhead and some smaller communities in Cass and Clay counties as they would protect the historic properties from future flood related damages.

Based on cultural resources investigations along other stretches of the Red, Sheyenne, and Maple rivers, prehistoric archeological sites tend to occur on the edge of uplands overlooking the river valley and within one-quarter mile of riverbanks, with older, buried sites likely on river terraces. Any archeological sites lost as a result of project construction will be in addition to those lost to past urban and/or agricultural development in the Fargo-Moorhead portion of the Red River Basin.

5.4.1.13 Socioeconomic Resources

5.4.1.13.1 Economic Issues

With any of the diversion channel alternatives in place, development could increase slightly, with the added protection provided by the project features. This increase in development would also come at a cheaper cost because the requirements for developing will change because of the provided protection.

5.4.1.13.2 Recreational Opportunities

Recreational opportunities will not be adversely impacted by any of the diversion channel alternatives, but will be increased under all of them. Recreational amenities will be part of the project design and will be incorporated into whichever alternative is selected.

5.5 MITIGATION AND ADAPTIVE MANAGEMENT

This section describes the potential to avoid, minimize and mitigate adverse impacts; and provides mitigation cost estimates (in year 2011 dollar values) for implementation of any of the diversion plans considered. It also discusses the adaptive management approach to evaluating impacts over time, and assessing the effectiveness of mitigation measures. Mitigation strategies were developed for each diversion channel alternative to support the National Economic Development (NED) analysis. Mitigation strategies were not developed for the no-action alternative because this alternative would have no construction or site-specific impacts.

The Council on Environmental Quality (CEQ) has identified five components to mitigation. These include: 1) avoiding the impact altogether by not taking a certain action or parts of an action; 2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; 3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; 4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and 5) compensating for the impact by replacing or providing substitute resources or environment.

Measures to avoid or minimize adverse impacts were considered as part of this analysis through modification of project designs. Ideally, project designs would be tailored to avoid all impacts. However, that is not practicable. The FCP has fewer ecological impacts than the ND35K and

LPP. Ecological impacts would likely be the greatest under the LPP. However, several factors are involved with selection of a preferred plan, including ecological, economic and social impacts; public input; sponsor preferences; and other related factors. In cases where significant impacts could not be avoided or minimized to levels that were less than significant, mitigation actions are proposed to compensate for the loss of habitat or ecological function.

The analysis below and in Attachment 6 provides a habitat-based assessment of impacts and mitigation measures for aquatic habitat, connectivity, floodplain forest and wetland resources. It assesses losses of habitat over time, describes various alternatives for mitigating habitat losses, and compares the costs and benefits of these alternatives to provide a basis for mitigation planning. For this analysis, benefits of mitigation measures are based on potential habitat conditions likely to result from a potential action. As required by Corps policy, a Cost Effectiveness and Incremental Cost Analysis (CE/ICA) was performed with these various alternatives to identify which provided the best option for mitigation for the given restoration action.

There are many restoration measures that could be used to compensate for unavoidable impacts of project alternatives. These mitigation measures are described briefly in this mitigation plan, with a more detailed discussion in Attachment 6. Preliminary candidate sites have been identified, and will continue to be pursued in the following months. However, specific mitigation plans, including the exact mitigation sites, have not been finalized because additional planning and evaluation are still underway. The plans through this feasibility phase provide assurance on the types of mitigation that would be implemented, that the mitigation would offset project impacts, and provide an estimate of costs required for mitigation and adaptive management actions for the study. Further refinement of the combinations, timing, and placement of mitigation actions will occur during detailed planning for individual mitigation projects. Any future mitigation planning would go through additional agency coordination, including possible future supplemental NEPA documentation, as appropriate.

This plan identifies the path for mitigating any remaining impacts, adaptively evaluating impacts in the future, and providing a cost basis to include as a part of overall project costs. The cost estimates below are estimates, and will be refined over time. The mitigation and monitoring plans will continue to be developed through 2011, with an increased level of detail to be provided in the Final EIS and Feasibility Report.

The Corps is committed to performing appropriate mitigation for lost ecosystem functions and values resulting from the project and implementing an adaptive management approach to evaluating impacts over time. As a part of an adaptive approach to mitigation, detailed pre-construction and/or post-construction surveys will be performed to better assess impacts and effectiveness of mitigation. Additional future actions could be performed, if needed, to modify, improve or optimize mitigation actions.

Coordination for this plan with the natural resource agencies is on-going, and largely began during from the fall of 2009. The Corps is committed to collaboratively working in the future with our federal and State agency partners and non-federal sponsors to implement project mitigation and adaptive management. Partners involved with planning for mitigation and adaptive management include the non-federal sponsors, U.S. Fish and Wildlife Service (USFWS), North Dakota Game and Fish (NDGF), North Dakota State Water Commission (NDSWC), North Dakota Department of Health, Minnesota Department of Natural Resources (MDNR), Natural Resource Conservation Service (NRCS), and Minnesota Pollution Control Agency (MPCA). Additional partners may be involved as needed.

The discussion below is broken into three sections. First, impacts requiring mitigation are expressed in terms of lost habitat quality and quantity. Second, the recommended mitigation measures are discussed for each resource category. Third, adaptive management is discussed to further evaluate potential impacts over time, and mitigation effectiveness. It also discusses possible actions that can be taken if mitigation does not prove effective, or if unforeseen impacts arise from the project. Detailed discussions on habitat quantification, mitigation alternatives analysis and selection are provided at Attachment 6.

5.5.1 Quantification of Lost Habitat

The amount of habitat lost by the diversion channel alternatives was first identified by reviewing project features and quantifying the area of aquatic habitat impacted. A quality factor was then applied for identified habitat quality. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated by multiplying habitat quantity by habitat quality. To identify general habitat changes over time, Habitat Units are averaged over the life of the project (50 years) to determine what is known as the Average Annual Habitat Units (AAHUs). A complete description of this analysis is provided at Attachment 6.

For the ND35K and LPP alignments, approximately 17 AAHUs of aquatic habitat could be lost through footprint impacts. For the ND35K, approximately 82 AAHUs of floodplain forest could be lost, along with 895 acres of wetland habitat. For the LPP, approximately 103 AAHUs of floodplain forest could be lost, along with approximately 998 acres of wetland habitat (Attachment 6).

For the FCP alignment, approximately 15 AAHUs of aquatic habitat could be lost through footprint impacts. Approximately 46 AAHUs of floodplain forest could be lost, and approximately 906 acres of wetland habitat could be lost (Attachment 6).

Connectivity impacts would be greatest under the LPP, with the project reducing access to over 2,000 AAHU of upstream Red River and tributary habitat. The LPP also would partially reduce access to upstream habitat on the Wild Rice River, though impacts would be less at approximately 350 AAHUs. Impacts would be less under the ND35K and FCP, with mitigation not proposed beyond the minimization measures already included in alternative plan design (e.g., fish passage channels).

5.5.2 Mitigation Measures

Several features have been included within project designs to minimize potential ecological effects. These include wider gates on the Red and Wild Rice River control structures; including two fish passage channels at each control structure; incorporating boulders or baffle blocks into the gate bay designs for the control structures; and other features. However, impacts remain to several resource categories even after these minimization techniques are included in the alternative designs.

The discussion below includes actions to further minimize and mitigate remaining significant impacts. Mitigation costs for alternatives under the two diversion alignments are provided in Table 58-Table 60.

Table 58 - Overview of mitigation actions for the ND35K.

Resource	Lost AAHUs	Mitigation Action	Cost
Aquatic Habitat	17	Stream Restoration and Fish Passage	$11.1M
Floodplain Forest	82	Convert floodplain agriculture land to floodplain forest	$1.59 M
Wetland	895 acres	Wetland creation in the bottom of diversion channel and other wetland mitigation	$17.9 M
Total:			$30,590,000

Table 59 - Overview of mitigation actions for the LPP.

Resource	Lost AAHUs	Mitigation Action	Cost
Biotic Connectivity	Partially reduced access to over 2,000 AAHUs (Red River)	Construct three additional fish passage channels; Construct Drayton fish passage	$16.5M
Biotic Connectivity	Partially reduced access to approximately 350 AAHUs (Wild Rice)	Construct fish passage at Wild Rice and Hanson Dams	$8.8M
Aquatic Habitat	17	Stream Restoration and Fish Passage	$11.1M
Floodplain Forest	103	Convert floodplain agriculture land to floodplain forest	1.99 M
Wetland	998 acres	Wetland creation in the bottom of diversion channel and other wetland mitigation	$19.96 M
Total:			$58,350,000

Table 60 - Overview of mitigation actions for the FCP.

Resource	Lost AAHUs	Mitigation Action	Cost
Aquatic Habitat	15	Stream Restoration and Fish Passage	$9.7M
Floodplain Forest	46	Convert floodplain agriculture land to forest	$890,000
Wetland	906 acres	Wetland creation in the bottom of diversion channel and other wetland mitigation	18.1M
Total:			$28,690,000

5.5.2.1 Fish passage mitigation for LPP.
For the LPP, three additional fish passage channels would be added to the design to accommodate fish passage across most flow conditions at the Red River control structure. This will help to further minimize impacts to connectivity. For remaining potential impacts, Drayton Dam fish passage would be constructed to further offset any impacts to Red River connectivity due to the protracted operation period of the control structure. The selection of Drayton Dam is further discussed in Attachment 6.

To address remaining impacts to connectivity on the Wild Rice River, fish passage will be constructed at the Wild Rice Dam and the Hanson Dam; both are on the Wild Rice River. Reduced connectivity at this control structure will be mitigated by improving connectivity at these two dams which are located above and below the proposed features under the LPP. The selection of these two dams is further discussed in Attachment 6.

5.5.2.2 Aquatic Habitat Footprint Impacts
To offset footprints impacts outlined above, the Corps proposes full stream restoration as the preferred mitigation technique. However, if adequate mitigation areas cannot be developed, the Corps also will consider stream restoration via riparian buffers, as well as fish passage, to mitigate for remaining impacts. Any of these three mitigation alternatives could provide valuable habitat benefits and offset adverse effects to lost habitat. Attachment 6 provides a detailed discussion of the mitigation analysis, including consideration of specific alternatives, costs, and CE/ICA analyses to compare various restoration alternatives. It also discusses coordination with the natural resource agencies, and their preference for mitigation methods.

The specific areas for stream restoration have not been finalized, but would be in the Red River basin, preferably near the study area. There are multiple other efforts that are considering stream meandering as a possible project. These include projects on the Mustinka, Buffalo and Wild Rice rivers, all in Minnesota. Coordination with the NRCS suggests that additional sites may be available on the Maple, Sheyenne and Wild Rice rivers in North Dakota. Preference would be given to sites first on the Red River, then on nearby tributaries (e.g., Sheyenne, Maple or Wild Rice rivers), and as a last resort, other tributaries elsewhere in the watershed. While there appears to be many opportunities for stream restoration, the willingness of landowner participation appears to be a significant obstacle to overcome with this restoration technique.

If mitigation cannot be achieved through stream restoration, then fish passage will be pursued to offset remaining impacts. This technique is different in that it provides more systemic benefits, rather than improvements at a specific site. Stream restoration is easier to assess in terms of its effectiveness in offsetting impacts. Assessment of mitigation effectiveness is more challenging with implementing fish passage. However, the benefits also could be more substantial, and benefit a broader group of organisms.

Fish passage could be constructed at one or more dams in the Red River basins. Potential sites for fish passage, include the costs and benefits of implementation, are discussed in Attachment 6 for several dams in the Red River basin. It’s estimated that $11.1M would be needed to provide mitigation entirely through stream restoration for the LPP and ND35K; and $9.7M for the FCP.

After site-specific habitat restoration is accounted for, remaining funds and mitigation needs will be directed towards one or more fish passage projects. Given the high value that fish passage appears to have, implementation of fish passage should provide as many overall benefits, and be as effective, as site-specific restoration.

5.5.2.3 Wetland Mitigation

For all of the diversion channel alternatives, wetland acres that will be adversely affected by diversion channel construction will be offset by the creation of wetlands within the diversion channel bottom. Features that will be used to facilitate the creation of wetlands will include meandering the low flow channel; constructing rock riffles in locations to create ponding; and other features developed during the design of the project. Vegetative species would be planted that are appropriate to temporarily flooded wetlands. A low flow channel is a channel that is typically in the center of a larger channel which is sized to handle small flows from drains, ditches or groundwater. The low flow channel would be approximately a 10 foot wide; 3 foot deep channel located in the middle of the larger diversion channel, and could meander back and forth within the 250 - 400 foot wide diversion channel bottom. The opportunity for inter-agency partnerships to develop areas for improved habitat would be explored with the non-federal sponsors, interested federal, state and local agencies and interest groups during preparation of plans and specifications. The area available on the bottom of the diversion channel for all alternatives far exceeds the amount of wetland acres that would be impacted. This large corridor of wetland habitat will be a continuous habitat corridor that rarely exists in this region, which will make it very desirable to a wide array of existing wildlife species. In accordance with Corps policy, the Corps also considered the use of mitigation banks to mitigate for wetland impacts, but the number of available credits in the watershed does not come close to the mitigation credits needed.

5.5.2.4 Riparian Forest Mitigation

There would be unavoidable impacts to riparian forest habitat for all diversion alternatives. Impacts for the FCP include approximately 42 acres for the Red River control structure and outlet structure and approximately 47 acres for diversion channel, for a total of 89 acres. Impacts for the ND35K include approximately 29 acres for the Red River control structure and outlet structure, 96 acres for the diversion channel, 20 acres for the Wild Rice River control structure, 10 acres for the Sheyenne River aquaduct and 3 acres for the Maple River aquaduct, for a total of approximately 157 acres.

Impacts for the LPP include approximately 29 acres for the Red River control structure and outlet structure, 96 acres for the diversion channel, 20 acres for the Wild Rice River control structure, 10 acres for the Sheyenne River aquaduct, 3 acres for the Maple River aquaduct and 40 acres for the storage area, for a total of approximately 199 acres.

The compensatory mitigation for these impacts would involve the restoration of existing floodplain agricultural land to floodplain forest. This land would be floodplain agricultural land that has been cleared of trees and is adjacent to and hydraulically connected by seasonal surface flow to a river within or near the study area, with a target hydrologic regime for a flood recurrence interval from 2-5 years.

The objective would be to restore riparian forest vegetation on the mitigation land similar to the vegetation types that have been lost. Targets would be to mitigate at a 2:1 ratio and to restore stand density with an average of 300 trees per acres over 80 percent of the mitigation site(s) with diameter at breast height (DBH) of 2 inches within 10 years.

5.5.3 Adaptive Management

The discussion below addresses adaptive management and project monitoring for all of the diversion channel alternatives, including an overview of activities to be done both prior to and following construction. An overview of costs associated with monitoring and adaptive management are summarized in Table 61 and Table 62.

5.5.3.1 Red River:

As discussed above, footprint impacts were identified that would result in direct loss of aquatic habitat. Beyond that, it is believed that the potential for any future impacts to geomorphology, physical habitat, biotic use or biotic connectivity is low for all of the diversion channel alternatives. However, these conditions would be further verified before and after construction to ensure that these impacts have been adequately addressed.

For the Red River, the following survey assessments would be performed both pre- and post-construction:

- Geomorphic Assessment, including description of physical habitat
- Biotic Assessment to include fish and macroinvertebrate surveys
- Freshwater mussel surveys

The area assessed would generally be identified as the Red River between the upstream and downstream junctions of the diversion channel. Additional areas above and below the diversion confluences could be assessed primarily for potential geomorphic effects. The exact number and location of survey sites for both geomorphic and biotic assessments is still under discussion, but would likely include several sites along approximately 60 miles of Red River that could be influenced by the project. The protocols for these assessments also are still under development. The biotic assessment would likely follow the assessment protocol developed by the Minnesota Pollution Control Agency (MPCA) for fish and invertebrate surveys. The protocol for mussel surveys will require its own specific protocol.

Geomorphic surveys would be performed once prior to construction, and at least once following construction. The timing of post-construction monitoring is still being considered, but would potentially be five to ten years following project completion. Additional geomorphic surveys could be warranted further into the future, the need for which would be decided by the non-federal sponsors and agency partners.

Biotic surveys would be performed at least once prior to construction, with additional surveys under consideration. Given the variability in species distribution and abundance, and with sampling effectiveness, multiple biotic surveys are desirable. The exact number of pre-construction surveys is still under discussion, and could be influenced by results of the initial survey, how quickly construction begins, field conditions and funding. The timing of post-construction monitoring also is under discussion, but could include multiple surveys performed over the first 20 years following project completion.

Monitoring also would be performed post-construction to assess fish migration through the Red River control structure, and associated fish passage channel. The exact methodology for assessing this issue is under discussion, but could include activities such as netting and/or radio telemetry. Netting could be done immediately above the control structure or fish passage channel, and would provide insight into which species are able to migrate through these features. Netting is a fairly easy and inexpensive method to use to evaluate whether fish are able to pass through project structures. However, it is not as complete as radio telemetry work. Conversely, radio telemetry could be used to assess how many fish approach the identified structures, and what portions of those fish are able to migrate through these features. This information would be extremely beneficial for not only assessing fish movement through project structures, but could provide general knowledge on effectiveness of features like fish passage channels and nature-like fishways that have not been evaluated in great detail. The drawback is that radio telemetry studies can be considerably more expensive, particularly for the equipment that is involved. It also requires the collection of fish and attachment or surgical implantation, which is labor intensive. It is biased toward larger bodied fish that can better handle the radio transmitter. There are also limitations in how long radio transmitters may last, which is problematic given the unknown of which years would have flooding events significant enough to activate the flood risk management project.

For cost estimation purposes, it was assumed the Red River would have completed a geomorphic assessment, three fish and macroinvertebrate surveys, and one mussel survey. These actions would be done prior to construction to characterize existing conditions. Similar monitoring would be completed post construction. For cost estimation purposes, it was assumed this would include at least two geomorphic surveys and three surveys for fish and macroinvertebrates. The non-federal sponsors and agency team would determine how long after construction the surveys would be performed. A study of post-project connectivity impacts also would be performed. A preliminary cost estimate for all surveys is provided for the diversion channel alternatives in Table 61 and Table 62. Updated cost estimates may be developed for the Final EIS and Feasibility Report.

5.5.3.2 Rush and Lower Rush Rivers:

For the ND35K and LPP the Rush River and Lower Rush River would be redirected to flow into the diversion channel, abandoning almost six miles of tributary habitat. Given their channelized nature, habitat value may be limited. The Lower Rush habitat may be especially limited given it is intermittent. It is believed that impacts from this action would be offset because both tributaries would flow through a new meandering channel at the bottom of the diversion channel. The habitat value and biotic use, following construction, would need to be further verified to assure that these impacts have been adequately offset.

Monitoring for biotic use would be performed prior to construction within sections of the Rush and Lower Rush rivers proposed for abandonment. The exact study plan is under development, but would likely involve sampling for fish and macroinvertebrates following the MPCA protocol. For these two tributaries, pre-project sampling is currently proposed for a single event. Additional discussion may be warranted for pre-project surveys of the Lower Rush. If this tributary is in fact intermittent, surveys following the MPCA protocol, which includes sampling during summer and late summer, may not be appropriate. The type of surveys, or the need to do fish or macroinvertebrate surveys, may need to be reevaluated. This decision would be coordinated with the agency partners.

Following construction of the project, additional surveys for biotic use would be performed within the new channel at the base of the diversion channel. Costs for pre- and post-construction surveys on the Rush and Lower Rush rivers are included in Tables 21 and 22.

5.5.3.3 Maple River, Sheyenne River and Wild Rice River:
For the ND35K and LPP, the Maple, Sheyenne, and Wild Rice rivers would include various hydraulic structures that modify tributary flood discharges between the diversion channel and the Red River. The level of hydraulic change is discussed in the aquatic habitat section above in Section 5.2.1.7, including the potential for adverse effects. However, the geomorphic condition and biotic use would need to be further verified before and after construction to ensure that these impacts have been adequately offset.

For these tributary rivers, the following survey assessment would be performed both pre- and post-construction:

- Geomorphic Assessment, including description of physical habitat
- Biotic Assessment to include fish and macroinvertebrate surveys
- Freshwater mussel surveys

The exact number and location of survey sites for both geomorphic and biotic assessments is still under discussion, but would likely include multiple sites along each tributary. This would likely include one site within the potential footprint area, and one or more downstream reaches. It is also possible that an upstream site could be included for biotic surveys to better assess whether the project has influenced biotic connectivity and upstream diversity. The protocols for these assessments also are still under development. The biotic assessment would likely follow the assessment protocol developed by the Minnesota Pollution Control Agency (MPCA) for fish and invertebrate surveys. The protocol for mussel surveys will require its own specific protocol.

Geomorphic surveys would be performed in all three tributaries once prior to construction, and at least once following construction. The timing of post-construction monitoring is still being considered, but would potentially be five to ten years following project completion. Additional geomorphic surveys could be warranted further in the future, the need for which would be decided by the non-federal sponsors and agency partners.

Biotic surveys would be performed at least once prior to construction, with additional surveys under consideration. Given the variability in species distribution and abundance, and with sampling effectiveness, multiple biotic surveys are desirable. The exact number of pre-construction surveys is still under discussion, and could be influenced by results of the initial survey, how quickly construction begins, field conditions and possibly funding. The timing of post-construction monitoring also is under discussion, but could include multiple surveys performed over the first 20 years following project completion.

For cost estimation purposes, it was assumed pre-construction monitoring would include one geomorphic assessment, and three biotic surveys. These actions would be done in all three tributaries to characterize conditions pre- and post-project. For post construction, it was assumed that monitoring would include two geomorphic assessments, and three biotic surveys. A study of post-project connectivity impacts also would be performed. Costs for pre- and post-construction surveys on the Maple, Sheyenne and Wild Rice rivers are included in Tables 21 and 22.

5.5.3.4 Monitoring at Mitigation Sites:
Implementation of any diversion channel alternative would require implementation of mitigation. As outlined above, the type and location of mitigation is still being determined. Stream restoration will be the primary mitigation method, with fish passage also providing additional mitigation for site-specific impacts. It is recognized that whatever type of mitigation is selected, monitoring will be needed to verify effectiveness.

The type of monitoring would likely be along the lines of what has been discussed here. For stream restoration efforts, monitoring would likely include pre-project assessment for geomorphic and biotic conditions similar to what has been proposed for the Red River and North Dakota tributaries. Conversely, if fish passage is implemented, a monitoring approach similar to that outlined above for the Red River control structure could be implemented. To the extent possible, monitoring for stream restoration would be performed both pre-construction and post-construction.

The cost for pre- and post-project monitoring of mitigation sites is also included in Table 61 and Table 62 for the diversion channel alternatives. Given that specific mitigation sites are still being planned, the monitoring costs for mitigation (and thus the totals in Table 61 and Table 62) will continue to be refined, and could increase or decrease depending on the number and location of mitigation sites ultimately implemented.

Table 61 - Overview of studies for adaptive management, including post-construction evaluation of impacts and mitigation effectiveness for the FCP.

Studies	Cost
Study Area Geomorphic Assessment: Pre-construction (1 event)*	$1,000,000
Study Area Geomorphic Assessment: Post-construction (2 events)	$1,000,000
Connectivity/Fish Passage Assessment: Post Construction	$5,000,000
Biotic Use: Pre-construction (3 events)	$2,250,000
Biotic Use: Post-construction (3 events)	$2,250,000
Diversion Channel Wetlands Monitoring Post Construction	$100,000
Total Pre-Project Monitoring	$3,250,000
Total Post-Project Monitoring	$8,350,000

*Costs for pre-project geomorphic surveys are based on work already underway. Pre-project surveys will be more extensive than needed for the FCP as survey work is being completed to cover all three diversion channel alternatives.

Table 62 - Overview of studies for adaptive management, including post-construction evaluation of impacts and mitigation effectiveness for the ND35K and LPP.

Studies	Cost
Study Area Geomorphic Assessment: Pre-construction (1 event)	$1,000,000
Study Area Geomorphic Assessment: Post-construction (2 events)	$2,000,000
Connectivity/Fish Passage Assessment: Post Construction	$5,000,000
Biotic Use: Pre-construction (3 events)	$3,500,000
Biotic Use: Post-construction (3 events)	$3,500,000
Diversion Channel Wetlands Monitoring Post Construction	$100,000
Total Pre-Project Monitoring	$4,500,000
Total Post-Project Monitoring	$10,600,000

5.5.3.5 Wetlands

For the Draft EIS/Feasibility Study, wetland areas were identified using only the National Wetlands Inventory (NWI) mapping for the region. While the NWI is an excellent tool that is used on a regular basis for initial identification of potential wetland areas, there are limitations with this mapping in agricultural regions. As noted in an interagency agreement developed in the 1970s between the U.S. Fish and Wildlife Service and the USDA Natural Resources Conservation Service, “NWI maps, by design, do not show many farmed wetlands in most of the country [leading] to a significant underestimate of the amount of wetland in agricultural regions” (National Wetlands Newsletter, Vol. 19, No. 2, 1997). Therefore, the Draft EIS/Feasibility

Study identified a significantly lower estimate of wetlands than was found by the field investigation for the Supplemental Draft EIS.

The design of the diversion channel, to include a sinuous low-flow channel, provides a number of self-mitigating factors to offset the proposed loss of wetlands on the landscape due to the project itself. The diversion channel alternatives have the opportunity to return many of these functions back to the landscape in the area. Creating and restoring wetlands within the diversion footprint will increase the retention and treatment of flood/stormwater on the landscape, rather than moving it off the landscape as quickly as possible. Wetlands within the diversion channel, no longer subject to regular farming, will reestablish natural vegetation that will treat the water quality within the wetland, resulting in improved downstream water quality. This natural vegetation will also improve wildlife habitat in the area, providing refuge for wildlife and increasing diversity of species seen in the area.

For the FCP, ND35K, and the LPP the diversion channel itself is expected to provide a functional offset for the proposed impacts; approximately 1,515 acres (FCP), 1,527 acres (ND35K) and 1,450 acres (LPP) of wetlands, resulting in a 1.67:1 ratio (FCP), 1.7:1 ratio (ND35K), and a 1.45:1 ratio (LPP) are expected to establish within the diversion channel, including areas of seasonally flooded basin, wet meadow and shallow marsh. This return of functionality to the landscape within the diversion channel serves as self-mitigation to compensate for the impacts to wetland resources due to the project. (Note: Floodplain forest wetlands were assessed under a separate portion of this document, where mitigation for all forested resources will be provided at a ratio of 2:1. Forested communities take longer to become established than non-forested communities, resulting in a period of time between the loss of the existing forested resource and the return of a forested community. This is referred to as temporal loss of function from the forested resource. The mitigation ratio for forested communities partly accounts for this temporal loss.)

5.5.4 Future Project Modification

Future monitoring will verify the impact conclusions reached during this feasibility study, and evaluate the effectiveness of mitigation. Monitoring activities, including review of results, will be performed collaboratively between the non-federal sponsors and the agency partners. If future impacts are identified that were not mitigated for, or if mitigation has proven ineffective, then the non-federal sponsors will work with the Corps and the partner agencies to identify what can be done to rectify any remaining issues.

If significant project modifications are needed, or if further construction actions are needed, the non-federal sponsors will work with the Corps and agency partners to identify the correct funding source. The non-federal sponsors could choose to take action and modify the project, or implement further mitigation on their own. They also could work with the Corps to secure potential funds under the Corps' Continuing Authorities Program (CAP) to modify an existing project. It also could include seeking congressional action to secure additional federal funds.

6.0 PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION*

6.1 PUBLIC INVOLVEMENT PROGRAM

This chapter describes public involvement activities, agency consultation and coordination, and acknowledges the agencies that have been involved with this NEPA process.

6.1.1 Scoping Notice

A scoping notice was prepared to provide the public with information on the project and an opportunity for people to express their thoughts and comments. The notice announced the intent to prepare an Environmental Impact Statement and was published in the May 5, 2009, *Federal Register* Volume 74, Number 85. Maps showing locations of the project area and alternative features were made available for inspection. Dates and locations of public scoping meetings were identified in the notice. A scoping notice for the Supplemental Environmental Impact Statement was published in the December 27, 2010, *Federal Register* Volume 75, Number 247. Comments received during the scoping phase can be found in Appendix Q.

6.1.2 Public and Agency Scoping Meetings

The intent of the scoping meetings was to inform people about the project and to collectively identify key issues. The *Federal Register* notice and news releases to local media announced a series of public meetings. The locations and dates for these meetings were:

Table 63 – Public and Agency Scoping Meetings

Location	Date	Time	Attendees	Meeting Location
Moorhead , MN (Public)	November 17, 2008	7:00 p.m.	50	City Council Chambers
Fargo, ND (Public)	November 18, 2008	7:00 p.m.	40	Prairie Rose Inn
Fargo, ND (Public)	May 19, 2009	5:30 p.m.	115	The Centennial Hall, Fargo N.D.
Fargo, ND (Agency)	May 20, 2009	10:00 a.m.	44	The Centennial Hall, Fargo N.D
Moorhead, MN (Public)	May 20, 2009	5:30 p.m.	140	Hanson Theatre, University of Minnesota Moorhead Campus, MN

Several written comments were received in response to the public scoping effort. Several additional comments were received in response to the agency scoping effort. All comments have been reviewed and compiled in a scoping document which is included in Appendix F. The scoping document summarizes, consolidates, and organizes the public and agency comments.

6.1.3 Public Meetings

In addition to the public scoping meetings, public meetings were held to keep the public informed on the project and the path forward. These meetings were used to present the public with information and to gather feedback. The dates and locations of the public meetings are presented in **Table 64** . Presentations, handouts, and other general information from the meetings can be found in Appendix Q, Public Involvement and Coordination. The non-federal sponsors developed the Metro Flood Management Committee (MFMC) which consisted of all members from the Fargo City Council, Moorhead City Council, Clay County Board, and Cass County Board. As a subset to the MFMC a working group was developed consisting of members from the MFMC. The working group had a number of meetings that were open to the public and the Corps provided information and presentations at each of these meetings. The working group meetings were held on: August 26, 2009; November 5, 2009; November 12, 2009; December 17, 2009; January 15, 2010; February 4, 2010; February 11, 2010; February 18, 2010; February 25, 2010; March 4, 2010; March 11, 2010; March 18, 2010; April 22, 2010; April 25, 2010; May 13, 2010; May 26, 2010; August 5, 2010; August 25, 2010; November 18, 2010; December 9, 2010; January 13, 2011; January 19, 2011; February 24, 2011, and April 1, 2011.

Table 64 – Public Meetings

Location	Date	Time	Attendees*	Meeting Location
Moorhead, MN (MFMC)	October 19, 2009	8:00 a.m.	100	Marriott Hotel, Moorhead MN
Fargo, ND (Public)	October 20, 2009	6:00 p.m.	400	Howard Johnson Inn, Fargo ND
Moorhead, MN (Public)	October 21, 2009	6:00 p.m.	400	Hagan Hall, University of Minnesota Moorhead Campus, MN
Fargo, ND (MFMC)	November 24, 2009	7:30 a.m.	100	Ramada Plaza Suites, Fargo ND
Fargo, ND (MFMC)	February 1, 2010	11:00 a.m.	200	The Centennial Hall, Fargo ND
Fargo, ND (Public)	February 2, 2010	6:00 p.m.	400	The Centennial Hall, Fargo ND
Moorhead, MN (Public)	February 3, 2010	6:00 p.m.	200	Hanson Theatre, University of Minnesota Moorhead Campus, MN
Moorhead, MN (Public)	June 9, 2010	6:00 p.m.	60	Minnesota Moorhead Campus, Student Ballroom, MN
Fargo, ND (Public)	June 10, 2010	6:00 p.m.	50	The Centennial Hall, Fargo ND
Fargo, ND (Landowner)	June 14, 2010	6:00 p.m.	80	The Centennial Hall, Fargo ND
Moorhead, MN (Landowner)	June 15, 2010	6:00 p.m.	50	The Hjemkomst Center, Moorhead MN
Hendrum, MN (Downstream stakeholder)	June 16, 2010	6:00 p.m.	200	Hendrum Civic Center, Hendrum MN

Kindred, ND (Upstream stakeholder)	March 30, 2011	6:00 p.m.	400	Kindred High School, Kindred ND
West Fargo, ND (Public)	March 31, 2011	6:30 p.m.	200	West Fargo High School, West Fargo ND
Moorhead, MN (Public)	May 2011	TBD		TBD
Fargo, ND (Landowner)	May 2011	TBD		TBD
Fargo, ND (Public)	May 2011	TBD		TBD
Moorhead, MN (Public)	May 2011	TBD		TBD

*Approximate

6.1.4 Website

A website (http://www.internationalwaterinstitute.org/feasibility/index.htm) was established as the project's primary website. The purpose of the site was to deliver information to the public that was made available at public meetings and for distribution of information as part of the NEPA process. The website also provides the interested public opportunities to ask questions, submit comments through e-mail, or be added to an email mailing list. The Corps standard webpage is a secondary site which is used to distribute information. This site is located at: http://www.mvp.usace.army.mil/fl_damage_reduct/default.asp?pageid=907. In addition to the two project websites, the City of Moorhead provided live video of the February 3, 2010 meetings on its webpage.

6.2 RESOURCE AGENCY TEAM

The Corps established a resource agency team to facilitate transfer of information among agencies and between the agencies and the Corps through meetings and frequent communications at key steps of the process. The resource agencies provided information on their special expertise or jurisdiction related to the project, assisted with analyses, and reviewed draft report chapters and analyses. The following organizations participated during the process:

- Minnesota Department of Natural Resources (MDNR)
- Minnesota Pollution Control Agency (MPCA)
- U.S. Fish and Wildlife Service (USFWS)
- Environmental Protection Agency (EPA)
- North Dakota Game, Fish and Parks (NDGFP)
- Fargo-Moorhead Metropolitan Council of Governments (FM COG)
- North Dakota State Water Commission (ND SWC)
- North Dakota Department of Health
- Federal Emergency Management Agency (FEMA)
- North Dakota Wildlife Federation

- Buffalo Red River Watershed District (BRRWD)
- Cass County, North Dakota
- Clay County, Minnesota
- Southeast Cass Water Resources District (SE Cass WRD)
- Federal Aviation Administration (FAA)
- Minnesota Natural Resource Conservation Service (MN NRCS)
- North Dakota Natural Resource Conservation Service (ND NRCS)
- National Wildlife Federation (NWF)
- Minnesota Board of Water and Soil Resources (BWSR)
- Minnesota Department of Transportation (MNDOT)
- North Dakota Natural Resources Trust

Resource Agency Team meetings were held on the following dates and at the following locations:

- May 20, 2009 Fargo, North Dakota (scoping document)
- September 2, 2009 Fargo, North Dakota
- October 29, 2009 Fargo, North Dakota
- November 10, 2009 Fargo, North Dakota
- December 10, 2009 Fergus Falls, Minnesota
- December 22, 2009 St. Paul, Minnesota (conference call)
- February 3, 2010 Fargo, North Dakota
- February 19, 2010 Fargo, North Dakota
- April 22, 2010 Fargo, North Dakota
- May 12, 2010 St. Paul, Minnesota (conference call)
- June 10, 2010 Fargo, North Dakota
- June 28, 2010 Washington, D.C.
- July 12, 2010 St. Paul, Minnesota
- July 28, 2010 St. Paul, Minnesota (conference call)
- November 18, 2010 Fargo, North Dakota
- January 13, 2011 Fargo, North Dakota
- January 26, 2011 St. Paul, Minnesota (conference call)
- March 3, 2011 St. Paul, Minnesota (conference call)
- March 10, 2011 Fargo, North Dakota

Meeting notes can be found in Appendix F.

6.3 INSTITUTIONAL INVOLVEMENT

The non-federal sponsors for this study are the City of Fargo, North Dakota and the City of Moorhead, Minnesota. The cities have been supported and have received input during the study from the Southeast Cass Water Resource District, Cass County, the Buffalo-Red Watershed District, and Clay County. The sponsors have worked closely with the other local entities to develop a consensus on the path forward including the optimal levels of protection afforded by the project, the desire for a locally preferred plan, identifying which entities will be responsible for signing the Project Partnership Agreement with the Corps, and discussions on setting up a special joint powers agreement to ensure that the long-term operations and maintenance of the project is continued in perpetuity. Recommendations on these topics were made by the Metro Flood Management Committee, and forwarded to each of the individual entities for formal adoption and approval.

6.4 ADDITIONAL REQUIRED COORDINATION

6.4.1 Coordination with Minnesota and North Dakota State Historic Preservation Office, the Advisory Council, and Other Interested Parties

A Programmatic Agreement will be negotiated between the St. Paul District, U.S. Army Corps of Engineers, the Minnesota State Historic Preservation Officer, and the North Dakota State Historic Preservation Officer. The City of Fargo and the City of Moorhead, the non-federal sponsors of the project, will be concurring parties to the Programmatic Agreement and will be consulted during its development. The Fargo Historic Preservation Commission will also be invited to sign the Programmatic Agreement as a concurring party if the alternative selected includes City of Fargo lands. The Programmatic Agreement will cover the Corps' responsibilities to ensure compliance with Section 106 of the National Historic Preservation Act (NHPA), as amended, and its implementing regulations, 36 CFR Part 800, Protection of Historic Properties. Stipulations in the Programmatic Agreement will provide for the continued consultation with these parties during historic preservation activities covered by the agreement. The Advisory Council on Historic Preservation was contacted by letter dated May 29, 2009, requesting their participation in the Programmatic Agreement for this Project. In an email response dated June 17, 2009, the Advisory Council declined to become involved in this project.

6.4.2 Coordination with Indian Tribes

Indian tribes with historic connections to the project area include the Sisseton Wahpeton Oyate of the Lake Traverse Reservation, the White Earth Band of Minnesota Chippewa, the Leech Lake Band of Ojibwe, the Turtle Mountain Band of Chippewa, the Upper Sioux Community of Minnesota, the Lower Sioux Indian Community, the Spirit Lake Tribe of North Dakota, and the Red Lake Band of Chippewa Indians. Additional tribes contacted included the Bois Forte Band of Chippewa Indians, the Three Affiliated Tribes (Mandan, Hidatsa and Arikara Nation), the Northern Cheyenne Tribe, the Standing Rock Sioux Tribe, the Yankton Sioux Tribe, and the Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation. Highlights of consultation with tribes are given below.

April 8, 2009 – An initial contact letter was sent from the St. Paul District's District Engineer to tribal chairpersons of Sisseton Wahpeton, White Earth, Leech Lake, Turtle Mountain, Upper Sioux, Lower Sioux, Spirit Lake, and Red Lake tribes to determine if they wished to consult under Section 106 of the National Historic Preservation Act, as amended, regarding effects of the project on properties of traditional cultural or religious importance to them. A copy of the signed letter to the tribal chairperson was also furnished to each tribe's Tribal Historic Preservation Officer (THPO) or designated cultural resources point of contact (POC). Any consulting tribe may also be a concurring party to the Project's NHPA Programmatic Agreement.

May 1, 2009 – The THPO for the Leech Lake Band of Ojibwe responded that the Leech Lake Band did not have any concerns regarding cultural or religious sites in the project area.

June 2010 – The DEIS was sent to White Earth, Turtle Mountain, Upper Sioux, Lower Sioux, Spirit Lake and Red Lake tribes. Comments were due August 9, 2010.

August 9, 2010 – The Corps had a phone conversation with the Section 106 Coordinator at Sisseton Wahpeton THPO's office to set up a meeting to initiate consultation on the Project.

August 31, 2010 – Meeting at Sisseton Wahpeton THPO office in Sisseton, South Dakota. The Corps project manager, tribal facilitator and archeologist and Sisseton-Wahpeton THPO, Section 106 Coordinator and tribal archeologist met in person. The White Earth THPO, Bois Forte THPO, Yankton Sioux THPO, Leech Lake Heritage Sites, and City of Fargo participated in the meeting by phone. During the meeting, participants discussed a group tribal meeting, tribal input into Programmatic Agreement, tribal participation in surveys, and paying tribes travel per diem. Participants set a tentative meeting date for October 19, 2010.

October 7, 2010 – Letters were sent by certified mail from the Corps' District Engineer to tribal chairpersons with copies furnished with attachments to the THPOs and Cultural Resources POCs summarizing the August 31st meeting. The letters offered face-to-face group meeting or individual meetings, but noted that the District will not pay per diem for travel. Attachments included the revised Programmatic Agreement and North Dakota diversion and Minnesota diversion maps. Letters were sent to Sisseton Wahpeton, White Earth, Leech Lake, Yankton Sioux, Bois Forte, Turtle Mountain, Upper Sioux, Lower Sioux, Spirit Lake, Red Lake, Fort Peck, Three Affiliated Tribes, Northern Cheyenne, and Standing Rock.

December 3 to 16, 2010 – The Corps followed up the October 7 letters with telephone calls to THPOs and Cultural Resources POCs. The Red Lake Band stated that no further contact was needed. The Turtle Mountain, Leech Lake, and Lower Sioux stated that they did not want to meet but would like to be kept informed. The White Earth, Bois Forte, Standing Rock, Sisseton Wahpeton, Spirit Lake, and Fort Peck stated that they wished to meet face-to-face. The Three Affiliated Tribes, Northern Cheyenne, Upper Sioux, and Yankton Sioux did not respond.

December 21, 2010 – The Corps sent an email to THPOs and Cultural Resources POCs of the White Earth, Bois Forte, Standing Rock, Sisseton Wahpeton, Fort Peck, Spirit Lake, Northern Cheyenne, Yankton Sioux and Lower Sioux. The email stated that a face to face meeting would be held at Fargo on January 11, 2011 but that the District will not pay travel per diem.

January 7, 2011 – The Corps emailed the meeting agenda and telephone call-in number for the January 11, 2011 meeting.

January 11, 2011 – A face to face meeting with teleconference call-in was held at Fargo. The Standing Rock tribal historian and Fort Peck cultural resources director attended in person, along with the Corps project manager, tribal facilitator and archeologist and Fargo staff from the engineering department... The White Earth THPO and Bois Forte THPO participated by phone.

The following handouts were provided: an agenda, power point presentation on Fargo Moorhead Metro Flood Risk Management Project, draft Programmatic Agreement (January 2011 version), air photos and topographic maps of North Dakota and Minnesota diversion alignments, URS cultural resources survey field reports #1 and #2, and photographs of river crossings.

January 28, 2011 – Paper copies of the DEIS were mailed to the Sisseton Wahpeton THPO, Fort Peck Cultural Resources Director, and Standing Rock THPO.

February 1, 2011 – The Corps emailed the January 11th meeting notes to the tribes. Paper copies of revised North Dakota diversion alignment air photos and topographic maps were mailed to the same tribes.

6.4.3 Future Coordination with Agencies

The Corps and the non-federal sponsors will work with the following agencies to pursue authorities and funding to assist in the implementation of the proposed project:

- Federal Emergency Management Agency (FEMA)
- Minnesota Department of Transportation (MNDOT)
- National Resources Conservation Service (NRCS)
- North Dakota Department of Transportation (NDDOT)
- Federal Highway Administration (FHA)

6.5 REPORT RECIEPIENTS

The following Federal, State, County, local and regional agencies, environmental organizations, and interested groups will receive notice of availability of this document:

- Red River Basin Commission (RRBC)
- International Red River Board (IRRB)
- Red River Watershed Management Board (RRWMB)
- North Dakota Red River Joint Water Resource District (NDJWRD)
- Minnesota Department of Natural Resources (MDNR)
- Minnesota Pollution Control Agency (MPCA)
- U.S. Fish and Wildlife Service (USFWS)
- Environmental Protection Agency (EPA)
- North Dakota Game, Fish and Parks (NDGFP)
- Fargo-Moorhead Metropolitan Council of Governments (FM COG)
- North Dakota State Water Commission (ND SWC)
- North Dakota Department of Health
- Federal Emergency Management Agency (FEMA)
- North Dakota Wildlife Federation
- Buffalo Red River Watershed District (BRRWD)
- Cass County, North Dakota
- Clay County, Minnesota
- Southeast Cass Water Resources District (SE Cass WRD)

- Federal Aviation Administration (FAA)
- Minnesota Natural Resource Conservation Service (MN NRCS)
- North Dakota Natural Resource Conservation Service (ND NRCS)
- National Wildlife Federation (NWF)
- Minnesota Board of Water and Soil Resources (BWSR)
- Indian Tribes with Historic Connections to project area

6.6 PUBLIC VIEWS AND RESPONSES

A complete list of public comments and responses regarding the scoping process is contained in Section 1.11 of Appendix F, Environmental. A complete list of public and private comments regarding the Draft Environmental Impact Statement is contained in Appendix R, Draft Environmental Impact Statement Public and Private Comments Received. Responses to the comments received are contained in Appendix S, Draft Environmental Impact Statements Public and Private Summarized Comments and Corps Responses.

6.7 AGENCY CORRESPONDENCE

Agency correspondence and communications are included in Appendix Q, Public Involvement and Coordination. The correspondence included in Appendix Q only includes the correspondence that occurred after the Scoping Document was completed; the earlier correspondence can be found in section 1.11 of Appendix F.

6.7.1 Status of Environmental Coordination Activities

The Corps has had a number of meetings with the resource agencies as described in section 6.2. The coordination is an ongoing activity that will continue throughout the feasibility study, design and implementation of the proposed project.

6.7.2 Resource Agency Views

The views of the resource agencies can be found in Appendix R, Draft Environmental Impact Statement Public and Private Comments Received.

6.8 Recommendations from April 2011 Fish and Wildlife Coordination Act Report

1. Determine wetland acreage to be impacted directly or indirectly by the proposed project, and assess the functions and values of individual wetlands with an established method of assessment, such as the Minnesota Rapid Assessment Method (MnRAM).

   Response: For the Supplemental Draft EIS, a team of Corps wetland scientists assessed wetlands using off-site review methodology, followed by field review to ground-truth the off-site review and to perform representative wetland delineations and functional assessments. Wetland areas were identified using all available sources of information, including National Wetlands Inventory (NWI) mapping, soil survey mapping, USGS topographic maps, LiDAR imagery and multiple years of aerial photography. Antecedent precipitation was analyzed prior to each field review, as well as in relation to dates of aerial photography.

On July 1-2, 2010, the team reviewed both diversion corridor alignments to ground-truth the images and signatures identified on aerial photography as wetland areas. Antecedent precipitation for this field review was normal. Following this ground-truthing field review, the team completed the off-site mapping of all the wetlands within the study area. On July 27-30, 2010, the team returned to the study area to complete representative delineations and functional assessments, using the Corps of Engineers Wetland Delineation Manual (Manual), the Regional Supplement to the Corps Delineation Manual: Great Plains Region (Version 2.0), March 2010 (Supplement) and Minnesota Routine Assessment Methodology for Evaluating Wetland Functions (MnRAM), Version 3.3, refining the extent of wetlands within all off-site mapped areas. Antecedent precipitation prior to the final field review at the end of July 2010 was wet. The field work is documented in the "Fargo-Moorhead Metropolitan Area Feasibility Study Wetland Delineation Report" that is in appendix F.

2. Provide compensatory mitigation for all wetland impacts in accordance with the standards specified for a Section 404 Permit under the Clean Water Act. A final wetland mitigation plan should be coordinated with the Service and Corps Regulatory Project Manager.

   Response: Design of the diversion channel alternatives, to include a sinuous low-flow channel, provides a number of self-mitigating factors to offset the loss of wetlands on the landscape due to the project itself. The diversion channel alternatives have the opportunity to return many of these functions back to the landscape in the area. Creating and restoring wetlands within the diversion footprint will increase the retention and treatment of flood/stormwater on the landscape, rather than moving it off the landscape as quickly as possible. Wetlands within the diversion, no longer subject to regular farming, will reestablish natural vegetation that will treat the water quality within the wetland, resulting in improved downstream water quality. This natural vegetation will also improve wildlife habitat in the area, providing refuge for wildlife and increasing diversity of species seen in the area.

   For the FCP, ND35K, and the LPP the diversion channel itself is expected to provide a functional offset for the project impacts; approximately 1,515 acres (FCP), 1,527 acres (ND35K) and 1,450 acres (LPP) of wetlands, resulting in a 1.67:1 ratio (FCP), 1.7:1 ratio (ND35K), and a 1.45:1 ratio (LPP), are expected to be established within the diversion corridor, including areas of seasonally flooded basin, wet meadow and shallow marsh. This return of functionality to the landscape within the diversion corridor serves as self-mitigation to compensate for the impacts to wetland resources due to the project. (Note: Floodplain forest wetlands were assessed under a separate portion of this document, where mitigation for all forested resources will be provided at a ratio of 2:1. Forested communities take longer to become established than non-forested communities, resulting in a period of time between the loss of the existing forested resource and the return of a forested community. This is referred to as temporal loss of function from the forested resource. The mitigation ratio for forested communities partly accounts for this temporal loss.)

3. Wetlands within the currently active floodplains of the Red, Wild Rice (ND), Sheyenne, Lower Rush, and Rush Rivers, downstream of the proposed structures and the diversion channel crossings or channel abandonments should be monitored for a 10 year period following the beginning of project flood reduction operations. This monitoring should focus on hydrologic impacts to the wetlands, wetland type conversions, and loss of wetlands. (All Alternatives as appropriate)

   Response: The existing wetlands will not be adversely impacted by the project features because the more frequent event flows will be passing through the project the same as for existing conditions. For the Red River and the Wild Rice River the project will not start holding water back until the velocities reach 9,600 cfs, which is equivalent to a 28-percent chance event meaning all lesser flows will pass as normal. These more frequent flows, along with precipitation, are what sustain the wetlands.

4. Utilize the data provided by the proposed geomorphic and biotic surveys within the potentially affected reaches of Red, Wild Rice (ND), Sheyenne, Maple, Lower Rush, and Rush Rivers to assess the quality of existing habitats and quantify impacts to the fish and wildlife resources.

   Response: Concur. This data will not be available in time for the Final EIS later this summer. That EIS will base impacts quantification on best data currently available. However, as a part of adaptive management, this new data collected will be used as the pre-project baseline to verify resulting impacts following project construction. These impacts will then be compared to mitigation effectiveness to verify that impacts have been negated.

5. Utilize native plant species in all aspects of mitigation, reconstruction, and replanting involved with the project.

   Response: Native plant species will be used for project mitigation as well as for reseeding excavated areas that result from project construction.

6. Avoid impacts to migratory bird nesting habitats (woodlands, grasslands, and wetlands) during the primary nesting season, April 1st to August 31st, to the greatest extent that is feasible.

   Response: Typical migratory bird species that are present in the project area include two special status species for North Dakota, the Northern Cardinal and the Whip-poor-wil, as well as many other breeding populations of bird species (Table 5 in Attachment 2 provides a complete list of Breeding Birds of Clay County, MN).

   Habitat used for nesting by migratory bird species may be disturbed or removed during project construction. To the extent practicable, vegetation clearing activities would be done so as to avoid affecting nesting individuals. Nonetheless, some limited take of individuals may occur incidental to construction activities. It is expected that any limited take would have no long lasting effect on the affected migratory bird species.

7. Provide equal mitigation (1:1) for lands currently enrolled in state or federally funded restoration or conservation programs that will be impacted by the proposed project.

   Response: Impacts to lands enrolled in state or federally funded restoration or conservation programs adversely will mitigated. Currently none of these land types have been identified as being impacted by project construction or operation.

8. Raptor nest surveys should be conducted every spring to determine the presence of existing or new nests that may be affected by the project construction and excavation activities. Surveys should be completed annually prior to “leaf out” until the project construction is complete.

   Response: Concur. Raptor nest surveys will be conducted in early spring each year during construction in the areas where construction is ongoing, until construction is complete.

9. Follow the Service’s National Bald Eagle Management Guidelines to minimize the likelihood that the proposed project will affect any bald eagles nesting in the Fargo/Moorhead Project Area.

   Response: Concur. The National Bald Eagle Management Guidelines will be followed to minimize the likelihood of project impacts to bald eagles nesting in the project study area.

10. Allocate funding toward and coordinate with the Service to develop large scale wetland restoration areas within the upstream reaches of the Red River basin, which could help attenuate flood waters in the smaller more frequent storm events.

    Response: The Fargo-Moorhead diversion is being designed to address extremely large flood events in which wetland restoration would provide little additional benefit. Flood storage upstream could help reduce flows from smaller more frequent flood events and might reduce the diversion's frequency of operation, but it would not affect the design of the diversion project features. The Corps of Engineers has two ongoing studies that could complete additional investigations of the benefits and costs of implementing large-scale wetland restoration in the upper watershed. Those studies are the Fargo-Moorhead Upstream Study and the Red River Basin Wide Feasibility Study. These studies have already started development of HEC-HMS and HEC-RAS models that could be used to determine some benefits of these possible restoration efforts, including the potential for upstream flood storage to reduce the frequency of operation of the Fargo-Moorhead diversion. Specific investigations related to restoration would need to be coordinated and supported by the non-federal sponsors for each of the projects.

11. A survey for blooming western prairie fringed orchids will be coordinated with the Service, and will be completed at the identified location within the upstream staging area in Richland County, ND.

Response: Concur.

7.0 LIST OF PREPARERS*

Name	Discipline	Experience	Role in Preparing Report
Jonathan Sobiech	Environmental/Forester	9 years	EIS Preparation, Impact Assessment and Mitigation Planning
Elliott Stefanik	Environmental/Fisheries	13 years	Fisheries-related Impact assessment and Mitigation Planning
Craig Evans	Planner/Project Management	11 years discipline/24 years Corps	Main Report and Planning Appendix
Aaron Snyder	Planner/Project Management	8 years	Main Report and Planning Appendix
Byron Williams	Spatial Analysis and Map Preparation	11.5 years	Preparing Maps and Figures
Renee McGarvey	Landscape Architect	11 years	Recreational Plan
Mike Lesher	Hydraulic Engineer	32 years in discipline/33 years Corps	Hydraulic and Hydrology Appendix
Aaron Buesing	Hydraulic Engineer	20 years discipline/18 years Corps	Hydraulic and Hydrology Appendix
Corby Lewis	Hydraulic Engineer	8 years	Hydraulic and Hydrology Appendix
Eric Wittine	Structures Engineer	12 years	Structures
Tony Fares	Structures Engineer	21 years	Structures
Jeff Hansen	Cost Engineer	11 years discipline/29 years Corps	Cost Estimator
John Albrecht	Real Estate	31 years	Real Estate
Rodney Peterson	Real Estate	20 years discipline/2 years Corps	Real Estate Attorney
Virginia Gnabasik	Archeologist	27.5 years	Cultural/Historical Section
Rick Carlson	Economist	21 years	Economics/Social
Lance Awsumb	Economist	2 years	Economics
Jeff McGrath	Economist	31 years	Economics Appendix and Social - Economic input for EIS
Kevin Bluhm	Economist	25 years	Economics
Kurt Heckendorf	Geotechnical Engineering	8 years	Geotech
Terry Jorgenson	Engineering Geologist	27 years	Ground Water/Buffalo Aquifer Geotech Appendix
Edith Pang	Civil Engineer/Civil Layout	25 years	General Engineering
Grant Riddick	Geologist	25 years	Geologist
Miguel Wong	Geomorphology/Water Resources Engineer	17 years	Geomorphology/Sedimentation
Dan Reinartz	Hydrology	31 years discipline/38 years engineering	Hydrology
Chanel Kass	Hydrology	2 years	Hydrology

8.0 RECOMMENDATIONS

As District Engineer, I have considered the environmental, social, and economic effects, the engineering feasibility, and comments received from the other resource agencies, the non-federal sponsors, and the public, and have determined that the tentatively selected plan presented in this report is in the overall public interest and is technically sound, environmentally acceptable, and economically feasible. I recommend that the tentatively selected plan and associated features described in this report be authorized for implementation as a federal project.

The tentatively selected plan is the Locally Preferred Plan, which is the North Dakota Diversion with storage and staging. The plan includes flood risk management features consisting of a 36-mile diversion channel, 10.1 miles of tie-back levees, a control structure on the Red River of the North, a control structure on the Wild Rice River, two aqueduct tributary structures—one on the Sheyenne River and one on the Maple River, two tributary drop structures, a diversion inlet structures at each river, 19 highway bridges, four cost shared railroad bridges, a storage area, upstream staging and other appurtenant facilities and primary recreation features consisting of multipurpose trails, restrooms, potable water, picnic facilities, parking areas, and landscaping and tree plantings. The total estimated first cost of the tentatively selected plan based on October 2011 price levels is $1,769,689,000, with the federal and non-federal shares of total first cost estimated at $785,106,000 and $984,583,000, respectively. The flood risk management features have an estimated total first cost of $1,733,834,000, with the federal and non-federal shares estimated at $767,178,000 and $966,656,000, respectively. The recreation features have an estimated total first cost of $35,855,000, with the federal and non-federal shares estimated at $17,927,000 and $17,927,000 respectively. The annual operation and maintenance costs are $3,664,000. The tentatively selected plan has an overall benefit-cost ratio of 1.77 and would provide in excess of 1-percent chance level of risk reduction for the Fargo-Moorhead Metro Area.

The project will modify two existing federal projects: the Rush River Channel Improvement project authorized by the Flood Control Acts of 1948 and 1950; and the Lower Rush River Channel Improvement project authorized under provisions of Section 205 of the 1948 Flood Control Act, as amended. The modifications to these projects will not impact their authorized purposes, however portions of these projects will be abandoned.

These recommendations are made with the provision that, prior to implementation, the non-federal sponsors will agree to comply with the following requirements:

Federal implementation of the recommended project would be subject to the non-federal sponsors agreeing to comply with applicable federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total FCP flood risk management costs as further specified below:

    1. Provide 25 percent of design costs allocated by the Government to flood risk management in accordance with the terms of a design agreement entered into

prior to commencement of design work for the flood risk management features;
2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the Government to flood risk management;
3. Provide, during construction, a contribution of funds equal to 5 percent of total FCP flood risk management costs;
4. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the flood risk management features;
5. Provide, during construction, any additional funds necessary to make its total contribution for flood risk management equal to at least 35 percent of total FCP flood risk management costs;
6. Provide 100 percent of all incremental costs of the Locally Preferred Plan.

b. Provide 50 percent of total recreation costs as further specified below:

1. Provide 25 percent of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;
2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the Government to recreation;
3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;
4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;
5. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the Federal share of total FCP flood risk management costs;

c. Shall not use funds from other federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-federal obligations for the project unless the federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

d. Not less than once each year, inform affected interests of the extent of protection afforded by the flood risk management features;

e. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

f. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the flood risk management features;

g. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

h. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the flood risk management features afford, hinder operation and maintenance of the project, or interfere with the project's proper function;

i. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

j. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

k. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

l. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

m. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

n. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

o. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

p. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-federal sponsors with prior specific written direction, in which case the non-federal sponsors shall perform such investigations in accordance with such written direction;

q. Assume, as between the Federal Government and the non-federal sponsors, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

r. Agree, as between the Federal Government and the non-federal sponsors, that the non-federal sponsors shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

s. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

This plan is being recommended with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the non-federal sponsors, the State of Minnesota, the State of North Dakota, interested Federal agencies, and other parties will be advised of any modifications and will be afforded the opportunity to comment further.

MICHAEL J. PRICE
St. Paul District
District Engineer

Attachment 1

Fargo-Moorhead Metro

Supplemental Draft Feasibility Report and Environmental Impact Statement

April 2011

Section 404(b)(1) Evaluation

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Attachment 1

Section 404(b)(1) Evaluation

Preliminary

SECTION 404(B)(1) EVALUATION
FARGO MOORHEAD METROPOLITAN
FLOOD RISK MANAGEMENT STUDY
CASS COUNTY, NORTH DAKOTA AND CLAY COUNTY, MINNESOTA

I PROJECT DESCRIPTION

A. Background – The U.S. Army Corps of Engineers (Corps) has prepared an integrated Feasibility Report and Environmental Impact Statement (Feasibility/EIS document) to present the results of its studies to address flooding problems in the Fargo Moorhead Metropolitan Area and describe possible consequences of implementing various alternatives. The geographic scope of analysis for the environmental impacts of the proposed action and alternatives encompasses the Fargo-Moorhead Metropolitan region plus areas in the floodplain of the Red River from approximately 300 river miles north of Fargo near Emerson, Manitoba to approximately 30 miles south of Fargo near Abercrombie, ND. The Fargo-Moorhead Metropolitan region is located within the area from approximately 12 miles west to 5 miles east of the Red River and from 20 miles north to 20 miles south of Interstate Highway 94. Fargo and Moorhead are on the west and east banks, respectively, of the Red River of the North which flows north approximately 453 river miles to the mouth of the river at Lake Winnipeg in Manitoba, Canada. The Fargo-Moorhead metropolitan area has a relatively high risk of flooding. Flooding in Fargo-Moorhead typically occurs in late March and early April as a result of spring snowmelt. Average annual flood damages in the Fargo-Moorhead metropolitan area are estimated to be over $194.8 million. The Red River of the North has exceeded the National Weather Service flood stage of 18 feet in 48 of the past 109 years, and every year from 1993 through 2011. In addition to the Red River, the Wild Rice River (North Dakota), Sheyenne River, Maple River, Lower Rush River and the Rush River contribute to the flooding issues in the study area.

The study analyzed a number of possible alternatives that could potentially achieve the original purpose and need identified for the feasibility study: reducing flood risk, flood damages and flood protection costs related to the flooding in the Fargo-Moorhead Metropolitan Area. These measures included: no action - continue emergency measures; nonstructural measures; flood barriers; increased conveyance; and flood storage. These alternatives are described in detail in sections 3.2 through 3.5 of the Feasibility/EIS document.

The alternatives went through an initial screening that used the following criteria: effectiveness, environmental effects, social effects, acceptability, implementability, cost, risk, separable mitigation, and cost-effectiveness. Initial screening results were presented in the Alternatives Screening Document dated December 2009 which is attached to Appendix O of the feasibility report. The rationale used in the screening process is also summarized in section 3.4 and 3.5 of the Feasibility/EIS document. The analysis resulted in two diversion concepts being carried forward: a diversion in Minnesota and a diversion in North Dakota. The diversion concepts significantly outperformed any other conceptual alternative with respect to achieving the stated purpose and need in a cost effective manner using existing technology.

Diversion capacities ranging from 10,000 cubic feet per second (cfs) to 45,000 cfs were analyzed for the Minnesota diversion alignment; capacities ranging from 20,000 through 35,000 cfs were analyzed for the North Dakota alignment. In addition, various features were looked at for the North Dakota alignment to minimize downstream impacts. The design, alignments, and features were refined, baseline cost estimates for each plan were completed, and an economic analysis was performed. The study identified a 40,000 cfs diversion along the Minnesota Short alignment as the national economic development (NED) plan, which maximizes national net average annual economic benefits. A Federally Comparable Plan (FCP) of a 35,000 cfs Minnesota diversion channel was designed to provide a comparison for cost-sharing purposes; benefits and impacts of the FCP are slightly smaller than those of the NED plan. While the Minnesota alignment was most cost effective from the Federal economic perspective, it did not reduce flood risk for the portion of the study area affected mainly by the Sheyenne River and its tributaries, the Maple, Rush and Lower Rush rivers.

The Federal objective in water resources planning is to contribute to NED. Corps of Engineers planning studies must comply with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G). The P&G requires that the feasibility study must identify the plan that reasonably maximizes NED benefits consistent with protecting the environment (the NED plan). The NED plan must be recommended for implementation unless there are overriding reasons for recommending another plan, based on other Federal, state, local and international concerns. Corps of Engineers planning regulations recognize that it is appropriate to consider factors other than NED in selecting a plan for implementation, but the Corps relies on the NED analysis to determine the appropriate level of federal investment in the resulting project. The NED plan often fails to fully address the overall planning objectives, since it is defined and constrained primarily by cost effectiveness. Corps of Engineers regulations allow non-federal partners to identify a locally preferred plan and contribute additional funding to achieve objectives not met with the NED plan.

During the course of the planning process, it became evident that local stakeholders strongly desired measures to reduce flood risk for the entire Metropolitan area, including flooding from the Red River of the North, as well as the Sheyenne, Wild Rice (ND), Maple, Rush, and Lower Rush rivers. A locally preferred plan is the plan that, in the opinion of the non-federal sponsors, best meets the needs of the local community. Corps regulations allow recommendation of a LPP if the plan has a benefit to cost ratio greater than 1.0 and if a waiver to allow recommendation of the LPP is approved by the Assistant Secretary of the Army for Civil Works. A 35,000 cfs diversion along the North Dakota East alignment was identified as the locally preferred plan in the Draft Feasibility/EIS document. Upon further study of the North Dakota 35,000 cfs channel alternative

(ND35K) using current modeling, the Corps determined that it would have widespread impacts to infrastructure downstream. Given the unacceptability of logistical problems with trying to mitigate for widespread downstream impacts, the ND35K is not a practicable alternative based on current modeling.

Following further study of possible alternatives, the non-federal sponsors identified a 20,000 cfs diversion along the North Dakota East alignment, along with upstream storage and staging, as a locally preferred plan (LPP) that would reduce flood risk for both the Red River and the five tributaries. The cities of Fargo and Moorhead, Cass County, North Dakota, Cass County Joint Water Resource District, North Dakota, Clay County, Minnesota, and the Buffalo-Red River Watershed District, Minnesota jointly requested that the revised North Dakota plan be pursued as the LPP on April 6, 2011. The original request to designate the ND35K as an LPP for the Draft Feasibility/EIS document was approved by the Assistant Secretary of the Army for Civil Works (ASA(CW)) on April 28, 2010; the updated request for the revised LPP has been forwarded to the ASA(CW). The LPP provides flood stage reductions to a greater geographic area and for approximately 6,250 additional citizens than does the NED plan or FCP. It achieves this result by reducing flood risk from the Sheyenne River and its tributaries in addition to the Wild Rice (ND) and Red rivers. This added level of risk reduction is not available from the NED plan or FCP.

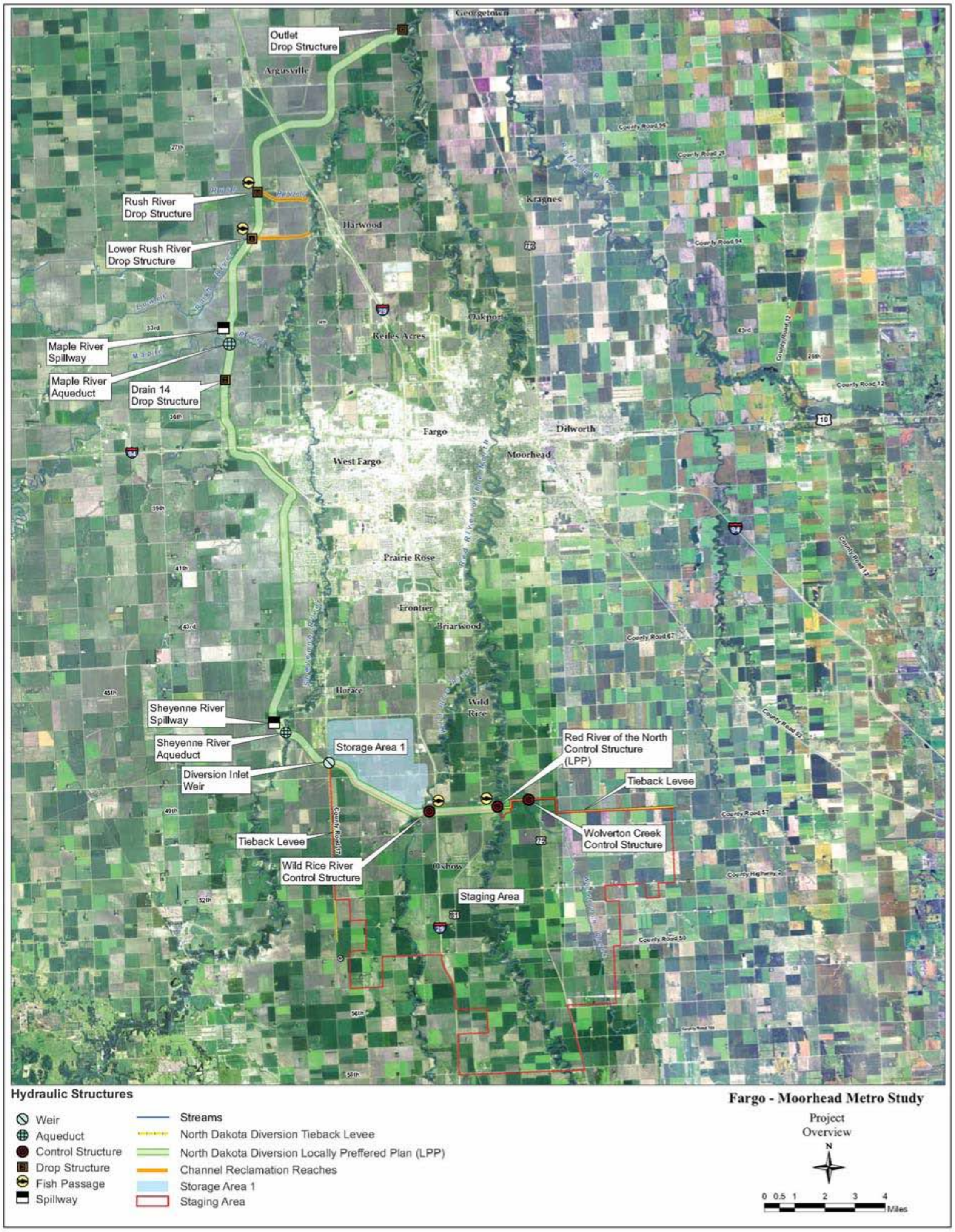
This Section 404(b)(1) evaluation pertains to the LPP fully described in section 3.13 of the Feasibility/EIS document. The proposed project is the least environmentally damaging practicable alternative that would achieve the overall project purpose of reducing flood risk from both the Red River and the five North Dakota tributaries.

B. Location – The project area affected by the diversion construction is located in Cass County, North Dakota and Clay County, Minnesota. The proposed fill activities will take place in the Red River of the North, Wild Rice River, Sheyenne River, Maple River, Lower Rush River and the Rush River. Fill activities on the Red River are at three locations; at river mile 479 where the diversion channel is diverted away from the Red River, a little upstream of river mile 478 where the control structure is constructed, and at river mile 419 where the diversion channel would re-enter the main channel of the Red River (Figure 1). Fill activities would also occur in wetlands along the diversion alignment, the tie-back levees, and the storage area levee and at the general location of the hydraulic structures in the Wild Rice, Sheyenne, Maple, Rush and Lower Rush Rivers; these locations are shown on Figure 1.

C. General Description – This evaluation addresses the effects that would result from the placement of fill in waters of the United States in conjunction with the construction of a North Dakota diversion channel and the construction of hydraulic structures necessary for the operation of the diversion channel. The effects associated with the operation of the diversion channel and hydraulic structures are discussed in detail in chapter 5 of the Feasibility /EIS document. The diversion plan includes a 36 mile long diversion channel with a varying bottom width of 100 – 250 feet; the diversion channel would divert a portion of the Red River flow upstream of the metro area, pick up flow at the Wild Rice, Sheyenne, Maple, Lower Rush and Rush rivers, and return it to the Red River downstream of the Fargo Moorhead metro area. A control structure (Figure 16 of the Feasibility/EIS document) would be constructed adjacent to the Red River immediately downstream of the diversion inlet; once the control structure was built, the Red River would be re-routed through the control structure and back into the natural Red River channel. This structure would limit flows downstream in the natural channel and increase the efficiency of the diversion channel. The outlet structure located where the diversion returns to the Red River of the North would be an Ogee-type concrete spillway with a width of 250 feet. In addition, there would be hydraulic structures located at each tributary crossing. At the Wild Rice River crossing there would be two weirs and a control structure similar to the Red River control structure, also built in the dry. At the Maple River and Sheyenne River crossings there would be an open aqueduct that crosses over the top of the diversion channel and a weir spillway that would direct flows into the diversion channel (Figures 18-24 of the Feasibility/EIS document); these structures would also be built in the dry. At the Lower Rush River and Rush River, a stepped concrete spillway will be used to divert the entire flow into the diversion channel while abandoning the remaining channel between the diversion channel and the Sheyenne River. A 4,400 acre flood water storage area surrounded by 12 miles of levee (Storage Area 1) would be constructed inside of the protected area northwest of the Wild Rice River control structure. Approximately 10 miles of tie-back levees would be constructed to connect the Red River control structure and the diversion inlet weir to high ground and prevent water from circumventing the project. A gated culvert structure would be constructed where Wolverton Creek crosses the tie-back levee east of the Red River. The project would go into effect when combined flows from the Wild Rice and Red River equal 9,600 cfs; at that time water would start pooling upstream of the Wild Rice and Red River control structures. Also at that time water would begin to enter into Storage Area 1. Depending on the size of the event, water could be staged as far as 10-15 miles up-stream with increase of depths varying from zero to 9 feet (Figure 1).

The proposed fill activities associated with the construction of the hydraulic structures, Storage Area 1, tie-back levees, and the excavation of the diversion channel will include: partially filling the abandoned channels; excavation for the diversion channel and sidecasting material into wetlands approximately 600 feet on either side of the diversion channel; placing fill into wetlands along the levee routes; placing riprap in the Red River where the diversion channel would re-enter the Red; and fill associated with diverting the flow through the constructed hydraulic structures.

Figure 1. LPP



D. Authority and Purpose – This study is authorized by a September 30, 1974, Resolution of the Senate Committee on Public Works. A Reconnaissance Report for the Fargo-Moorhead Metropolitan Area was approved by the Corps' Mississippi

Valley Division on April 8, 2008. Based on the recommendations contained in the Reconnaissance Report, the city of Fargo, North Dakota; the city of Moorhead, Minnesota, and the Federal Government entered into a Feasibility Cost Share Agreement on September 22, 2008. The feasibility study is cost shared 50/50 between the two non-federal sponsors and the Federal Government. As explained above, the refined overall project purpose is to reduce flood risk, flood damages and flood protection costs related to the flooding in the Fargo-Moorhead Metropolitan Area caused by the Red River of the North, as well as the Sheyenne, Wild Rice (ND), Maple, Rush, and Lower Rush rivers.

E. General Description of Dredged or Fill Material

1. General Characteristics of Material – Final determinations for the source of material have not been made. Rock for the project would be obtained from existing sources. Stone for riprap would be durable material free from cracks, blast fractures, bedding, seams and other defects that would tend to increase deterioration from natural causes. Bedding used for the base layer would be clean rock 8-inches in diameter, or smaller, produced from an existing facility. Levee fill would be obtained from project excavations.

2. Quantity of Material – For the purpose of this analysis quantities were calculated based on the ordinary high water mark (OHWM) being at the level of the 50-percent chance event. There would be approximately 715,600 cubic yards of earth fill placed below the OHWM, approximately 75,000 cubic yards of rip rap and aggregate filter fill placed below the OHWM, and 22,800 sf of sheet pile installed below the OHWM; Table 1 describes quantities for each area of impact. Geotextile fabric would be placed on river banks prior to stabilization with riprap for all hydraulic structure features. These quantities are based on the Phase 4 design as of February 28, 2011, and will need to be revisited and modified during detailed design. These numbers are also overstated slightly due to the fact that that the level of the 50-percent chance event is actually above the OHWM in many locations, but for consistency this parameter was used to calculate these quantities.

Table 1. Impacts

Impact Location: LPP	Estimated Impact Type	Estimated Impact Magnitude	Units
Red River Control Structure	Fill Within OHWM	20.5	acre
Red River Control Structure	Fill Volume Below OHWM	405,000	cy
Red River Control Structure	Excavation Within OHWM	2.2	acre
Red River Control Structure	Riprap and Aggregate Filter Fill Within OHWM	13,000	cy
Red River Control Structure	Sheet Pile Installed Within OHWM at Toe of Tie-back Levee Crossing	9,000	sf
Hydraulic Structure at Wild Rice River	Fill Within OHWM	10.1	acre
Hydraulic Structure at Wild Rice River	Fill Volume Below OHWM	113,000	cy
Hydraulic Structure at Wild Rice River	Excavation Within OHWM	0.9	acre
Hydraulic Structure at Wild Rice River	Wild Rice River Rock Boulder Grade Control with Aggregate Bedding Within OHWM	1.0	acre
Hydraulic Structure at Wild Rice River	Riprap and Aggregate Filter Fill Within OHWM	12,000	cy
Hydraulic Structure at Wild Rice River	Sheet Pile Installed Within OHWM at Toe of Fill	4,200	sf
Hydraulic Structure at Sheyenne River	Fill Within OHWM	4.4	acre
Hydraulic Structure at Sheyenne River	Fill Volume Below OHWM	66,000	cy
Hydraulic Structure at Sheyenne River	Excavation Within OHWM	1.9	acre
Hydraulic Structure at Sheyenne River	Sheyenne River Rock Boulder Grade Control with Aggregate Bedding Within OHWM	1.0	acre
Hydraulic Structure at Sheyenne River	Riprap and Aggregate Filter Fill Within OHWM	5,000	cy
Hydraulic Structure at Sheyenne River	Sheet Pile Installed Within OHWM at Toe of Fill	4,800	sf
Hydraulic Structure at Maple River	Fill Within OHWM	7.5	acre

Hydraulic Structure at Maple River	Fill Volume Below OHWM	70,000	cy
Hydraulic Structure at Maple River	Excavation Within OHWM	2.3	acre
Hydraulic Structure at Maple River	Maple River Rock Boulder Grade Control with Aggregate Bedding Within OHWM	1.0	acre
Hydraulic Structure at Maple River	Riprap and Aggregate Filter Fill Within OHWM	5,000	cy
Hydraulic Structure at Maple River	Sheet Pile Installed Within OHWM at Toe of Fill	4,800	sf
Hydraulic Structure at Lower Rush River	Fill Within OHWM	4.1	acre
Hydraulic Structure at Lower Rush River	Fill Volume Below OHWM	20,000	cy
Hydraulic Structure at Lower Rush River	Excavation Within OHWM	0.2	acre
Hydraulic Structure at Lower Rush River	Riprap and Aggregate Filter Fill Within OHWM	7,000	cy
Hydraulic Structure at Rush River	Fill Within OHWM	5.0	acre
Hydraulic Structure at Rush River	Fill Volume Below OHWM	40,000	cy
Hydraulic Structure at Rush River	Excavation Within OHWM	1.0	acre
Hydraulic Structure at Rush River	Riprap and Aggregate Filter Fill Within OHWM	7,000	cy
Diversion Outlet to Red River	Fill Within OHWM	12.0	acre
Diversion Outlet to Red River	Riprap and Aggregate Filter Fill Within OHWM	25,000	cy
Hydraulic Structure at Wolverton Creek	Fill Within OHWM	0.2	acre
Hydraulic Structure at Wolverton Creek	Fill Volume Below OHWM	1,600	cy
Hydraulic Structure at Wolverton Creek	Excavation Within OHWM	0.8	acre
Hydraulic Structure at Wolverton Creek	Excavate and Install Riprap Within OHWM	1,000	cy

Earthwork Estimates

Diversion Channel	Channel Stripping	3,197,320	cy
	Berm Stripping	5,942,000	cy
	Type 1 Excavation*	11,467,403	cy

	Type 2 Excavation**	13,011,929	cy
	Type 3 Excavation***	17,622,600	cy
	Type 4 Excavation****	3,660,415	cy
	Low Flow Channel Excavation	387,780	cy
	TOTAL EARTHWORK	55,289,447	cy
	Channel Topsoil (From Stockpile)	1,065,773	cy
	Berm Topsoil (From Stockpile)	7,944,499	cy
Storage Area 1 Levee Embankment			
	Topsoil Stripping	1,000,300	cy
	Excavation and Fill	3,200,000	cy
	Seeding	620	acre
Tie-back Levee - TBL East 2B	Topsoil Stripping	110,024	cy
	Excavation and Fill	835,320	cy
	Seeding	113	acre
Tie-back Levee - TBL Cass 17	Topsoil Stripping	68,739	cy
	Excavation and Fill	292,080	cy
	Seeding	74	acre

* Non-Saturated Non-Brenna Soil
** Saturated Non-Brenna Soil
*** Oxidized Brenna Soil
**** Brenna Soil

3. Source of Material - All stone would be clean and reasonably free from soil, quarry fines, and would contain no refuse. Materials would be obtained from approved pits/quarries in the project vicinity and would be free of chemical contaminants.

F. Description of the Proposed Discharge Sites

1. Location – For Red River control structure construction, material would be placed just upstream of river mile 478, but off to the side of the channel and would only have fill impacts when the channel gets diverted toward the structure; at these locations the channel would have to be filled to help divert the flow toward the structure. For the diversion outlet construction material would be placed between river miles 418 and 419 on the Red River across the 200 foot width of the river and approximately 500 feet length. For the diversion channel control structure, construction material would be placed into the Red River for approximately 200 feet just downstream of river mile 479 and also at the crossings of the Wild Rice, Sheyenne, Maple, Lower Rush and Rush rivers (Figure 1). Approximately 1,161 acres of wetlands would be filled or excavated along the diversion channel alignment, the route of the storage area levees, or the route of the tie-back levees.

2. Size - Approximately 14 acres of riverine habitat would be affected by the abandonment of river channel for the construction of the Red River control structure. Approximately two acres of riverine habitat on the Red River would be affected by fill activities for the construction of the diversion channel where it exits and re-enters the Red River. Approximately 1,161 acres of wetlands would be affected by either fill activities or excavation along the diversion channel route. Approximately 12 riverine acres at the Wild Rice River crossing, eight riverine acres at the Sheyenne River crossing, 10 riverine acres at the Maple River crossing, three riverine acres at the Lower Rush River crossing and three riverine acres at the Rush River crossing would be affected by the proposed fill activities. A total area of approximately 50 riverine acres and approximately 1,111 other wetland acres would be affected. A detailed description of these acreages with figures can be found in chapter 5 of the Feasibility/EIS document.

3. Type of Site/Type of Habitat – Habitat affected by the proposed fill activities is a mix of wet meadow, shallow marsh, shallow open water, floodplain forest, riverine habitat, and farmed seasonally flooded wetland. Farmed seasonally flooded wetlands constitute the vast majority of the affected acreage (795 acres). The aquatic habitats located within the project area are typical of the Red, Wild Rice, Sheyenne, Rush, Lower Rush and Maple rivers. Depths on the Red River and the tributaries generally vary from 1 to 2 feet near shoreline areas to about 5-20 feet at mid-channel locations, depending on the tributary. Substrates present include a mixture of silt, sand, and clay (see Geomorphology in Chapter 4 of the Feasibility/EIS document). The channel is approximately 200 feet wide in the vicinity of the Red River control structure and 20-80 feet wide at the other tributary crossings.

4. Timing and Duration - Subject to approvals and appropriation of funds, construction could potentially begin in the year 2013. Construction is expected to last approximately eight and a half years, if sufficient funding is appropriated.

G. Description of Disposal Method – Material would be moved and placed mechanically. Cranes, backhoes, scrapers, dump trucks and other heavy machinery suited to working with rock would be used to deliver and place rock materials and other levee fill during construction. Riprap would generally be placed in a systematic manner to ensure a continuous uniform layer of well-graded stone. Stone placed underwater would not be cast across the surface of the water.

II. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope - Substrate would be excavated before placement of riprap and aggregate filter layer(s) to ensure that the existing substrate grade is maintained. Riprap placed on slopes for erosion protection would follow the existing contour. An exception to this armoring technique would be at areas of significant water depth in existing channels, where armoring would be placed directly over existing grade

to avoid dredging below the water surface elevation. The areas where different armoring placement strategies are utilized will be determined during final design. At locations where channels are directed through newly constructed hydraulic structures, the substrate will consist of concrete at the locations of the hydraulic structures.

2. Sediment Type - Substrates in the Red River basin are composed primarily of clay rich, unconsolidated glacial sediments. Placement of riprap for erosion protection would replace existing substrates with multiple layers of rock with varying gradations.

3. Dredged/Fill Material Movement – Fill material will be placed directly into abandoned reaches of the river channels. The fill material will be sufficiently large or protected with riprap, sheetpile coffering, plant community restoration or other stabilization measures so as to preclude downstream movement of the placed material. The method of stabilization applied to specific areas will be determined during final design.

4. Actions Taken to Minimize Impacts - Standard construction procedures in compliance with Federal and State requirements and best management practices would be used during construction to minimize impacts. Work on the rivers would be done during low flow periods so as to limit downstream sedimentation. Construction sequencing will be used to minimize impacts. Construction of large hydraulic structures (at the Red, Wild Rice, Sheyenne and Maple Rivers) will take place off channel “in the dry” to avoid exposure of unprotected soils within the existing river channels during the construction of the structure. Following the structure’s construction, these sites will be connected to the existing river channels with excavated channels. At this time, stabilization measures will be promptly applied to reduce the amount of downstream sedimentation. Temporary erosion prevention and sedimentation control measures will be used project-wide and shall be operated and maintained in accordance with necessary permit(s).

B. Water Circulation, Fluctuation, and Salinity Determinations

1. General Water Chemistry - The use of clean fill material would preclude any significant impacts on water chemistry during project construction. Some minor, short-term decreases in water clarity are expected from the proposed fill activities. No significant impacts on water color, odor, taste, dissolved oxygen levels, temperature or nutrient levels are anticipated.

2. Water Circulation, Fluctuation, and Salinity Determination

a. Current Patterns and Flow – The hydraulic structures on the Red River and Wild Rice River in combination with the diversion inlet structure will be operated in a manner that increases upstream water surface elevations (staging) during flood events. Water will be conveyed into the diversion channel for flood events where the peak flow forecasted for the Red River at the USGS gage in Fargo exceeds 9,600 cubic feet per second (cfs), which has a frequency of approximately 2 days per year on average (note: it does not happen every year for 2 days). Otherwise, these structures resemble bridges (with fully open gates). Above a flow of 9,600 cfs, the control structure gates will be partially closed as necessary to limit the flow continuing in the Red River through Fargo and Moorhead, to direct water to upstream staging areas and to divert flow into the diversion channel. There would be no significant change to current patterns and circulation for flows less than 9,600 cfs. The Sheyenne River and Maple River hydraulic structures will not increase upstream water surface elevations on the tributaries and will allow a minimum of the 50-percent chance event flow to pass through into the protected area. The pass through flow into the protected area will increase for larger events, but will always be less than the 10-percent chance event tributary flow. All excess flows will be directed into the diversion channel. Flow would be cut-off at the hydraulic structures on the Lower Rush and Rush Rivers and would be directed into the diversion. In general, local drainageways that are on the unprotected side and are interrupted by the diversion channel will be directed into the diversion channel, by way of new drop structures, for conveyance to the Red River. Furthermore, local drainageways that are interrupted by levees in the main line of flood protection at the south end of the project will be directed to one of the main rivers.

b. Velocity - The proposed diversion would result in some changes on the flow velocities upstream and downstream of the control structures on the Red River and Wild Rice River. These changes would occur when the gates at the control structures are partially closed (only when the peak flow forecasted for the Red River at the USGS gage in Fargo exceeds 9,600 cubic feet per second (cfs)) to limit the discharge passing into the protected area, and when upstream staging is induced to make use of available flood storage in the floodplain in order to eliminate impacts on flood levels downstream of the diversion works. As a result, flow velocities upstream of the control structure will be reduced in comparison to existing conditions, but both the with-project as well as the existing conditions velocities are relatively low across the very wide active floodplain. With-project flow velocities downstream of the Red River and Wild Rice River control structures will also be reduced in comparison to existing conditions, but this happens because the with-project discharge passing into the protected area will be smaller than the existing conditions to accomplish the project goal of providing flood damage reduction. In the case of the Sheyenne River and Maple River, the aqueduct crossing of the diversion channel has been designed to match the 50-percent chance event flow velocity under existing conditions. For the four design floods (10-percent, 2-percent, 1-percent, and 0.2 percent chance events) analyzed with the HEC-RAS unsteady flow model in the feasibility study, the difference between with-project and existing conditions is less than 1 foot per second (fps), and this is in great part due to the fact that the with-project discharge passing into the protected area is smaller than the existing conditions discharge. For more details, see Exhibit D and Exhibit G of Appendix F of Attachment 5.

c. Sedimentation Patterns- The preliminary assessment of potential project impacts on the sediment transport and geomorphologic characteristics of the affected rivers is presented in the SDEIS and Exhibit I of Appendix F of Attachment 5. There are four main conclusions and recommendations of this assessment (please reference the SDEIS and Exhibit I for full support).

1. The dominant form of sediment transport is in suspension, and the suspended sediments are primarily clays and silts that interact very little with the river bed, hence changes on flow velocity patterns should not have a significant effect on channel morphology (shape and longitudinal slope). When this is combined with the general assessment that the Red River is a very meandering but also a very morphodynamically stable riverine system (channel migration rates are relatively low), it is reasonable to conclude that the proposed configuration and operation of the diversion project is adequate and fits well the general setting of the project area.

2. The existing Horace to West Fargo diversion has been in place for nearly 20 years, and the impacts on the sediment transport and geomorphology of the Sheyenne River have not been significant. This existing diversion serves as a proxy of potential impacts of the proposed diversion.

3. Working with the sediment transport measurements by the USGS during the spring flood of 2010 and making conservative assumptions about sedimentation in the upstream staging area allows estimation of this sedimentation at less than 1 inch over the pass of a large flood hydrograph. Some of the conservative assumptions referred to above include, that all sediment mobilized over the pass of the flood hydrograph will settle upstream of the control structures, and that the relationship between discharge and sediment transport rates is non linear –with a exponent greater than one (even though the system is mobilizing primarily silts and clays as wash load). Sedimentation of less than 1 inch over the pass of the hydrograph is well within the range of sedimentation under existing conditions, as a result of sediment exchange between the channel and the floodplain, hence the project potential impact is not significant.

4. The alteration of river length at the location of the hydraulic structures is not large enough that it could result in sediment transport or geomorphologic impacts over the whole riverine system. However, the final design will provide a more detailed evaluation to ensure that project induced erosion or sedimentation is minimized. The assessment presented at this feasibility level will be validated through a pre-construction and post-construction monitoring plan created in cooperation with interested parties and agencies, and also through additional measurements during the most recent spring flood of 2011 and a parallel evaluation currently underway.

3. Actions Taken to Minimize Impact - Standard construction procedures in compliance with Federal and State requirements would be used. Design features for the hydraulic structures have been modified to minimize impacts, for example the control gates on the Red River structure have been widened to 50 feet from 40 feet.

C. Suspended Particulate/Turbidity Determination

1. Suspended Particulates and Turbidity - Turbidity and the concentration of suspended solids would be expected to increase temporarily during construction of project features. However, increases would be relatively minor and restricted to a relatively localized area. No long-term adverse impacts on water quality are expected.

2. Effects on Chemical and Physical Properties of the Water Column - Some minor short-term impacts on light penetration and aquatic organisms would occur during riprap placement. However, these effects would be rapidly dissipated upon project completion. No effects are expected on toxic metal concentrations, pathogens, or the aesthetics of the water column.

3. Actions Taken to Minimize Impacts – Impacts would be minimized by requiring that best management practices to limit the extent of turbidity plumes, such as silt curtains, would be followed during construction.

D. Contaminant Determinations - The use of clean, quarry-run rock riprap for construction would not introduce contaminants into the aquatic system. Neither the materials used nor the placement method would cause relocation or increases of contaminants in the aquatic system.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on Plankton - During construction, increases in turbidity and suspended solids near the proposed fill activities might have a short-term localized effect on phytoplankton productivity. The plankton populations should recover quickly once the fill and other construction activities have ceased. In the long-term, overall aquatic habitat quality would improve, with resulting positive effects on plankton.

2. Effects on Benthos - Placement of rock during construction would cover and smother benthic communities located within the footprint of these structures. In-water excavation activities also would result in mortality of macroinvertebrates within these areas. However, rapid colonization of newly placed rock substrates would be anticipated with resulting minimal long-term effects. Benthic invertebrates also may re-colonize newly excavated channels leading in to and out of project structures.

3. Effects on Fish - Increases in turbidity and suspended solids during construction, as well as general noise and disturbance, would temporarily displace fish occupying the construction areas. Fish are more mobile than benthic invertebrates and

would likely avoid construction areas during construction. Upon completion, fish migration would be partially impeded during larger events. Fish migrations would be completed impeded only during the peak flow of the largest flood events. Impacts to migration would be minimized and mitigated by adding fish passage around the hydraulic structures. Under the LPP, fish passage also would be constructed at Drayton Dam as additional mitigation for impacts that are greater than those under the FCP and ND35K. During the largest flood events (e.g., flood events greater than approximately a 20-50 year flood event) fish passage would be completely blocked. However events of this magnitude occur very infrequently and fish passage channels could be active before and following the peak of such floods. For a more detailed discussion on effects on fish see section 5.2.1.7 of the Feasibility/EIS document.

4. Effects on Aquatic Food Web - The proposed fill activities are not expected to affect the total productivity of the Red River although there would be a temporary disruption to the aquatic biota present during project construction.

5. Effects on Special Aquatic Sites - There would be 1,161 acres of wetlands impacted by the diversion channel and features associated with construction of the LPP. These impacts would be either by the filling of wetlands or the excavation of wetlands.

6. Threatened and Endangered Species - No known Federally-listed threatened or endangered species would be affected by the project. The project has been coordinated with the U.S. Fish and Wildlife Service and it concurs with this determination.

7. Other Wildlife - The proposed fill activities would result in the loss of aquatic and terrestrial habitat, as outlined in Section 5.2.1.7 of the Feasibility EIS/Document. However, significant habitat losses as a result of the proposed fill activities will be mitigated for as outlined in Attachment 6 of the Feasibility/EIS document (Mitigation and Adaptive Management). The general diversity and productivity of the affected areas would be maintained.

8. Actions Taken to Minimize Impacts – The diversion alignment was selected to avoid, to the extent practicable, existing wetlands. Wetlands will be established along the bottom of the diversion channel during construction. During the design phase there will be features added to create wetlands; features used to facilitate the creation of wetlands will include meandering the low flow channel, constructing rock riffles in locations to create ponding, and other features developed during the design phase. A mitigation plan (Attachment 6 of the Feasibility/EIS document) is also in place to mitigate for impacts caused by the construction of the hydraulic structures. Fish passages would be constructed around the hydraulic structures. A floodplain forest mitigation plan is also included in Attachment 6.

F. Proposed Disposal Site Determinations

1. Mixing Zone Determination - The proposed fill activities would have minimal mixing zones. The fill material used for the project would be large and relatively clean so that very little exposed material could be suspended in the water column.

2. Determination of Compliance with Applicable Water Quality Standards The fill materials used for this project would be obtained from approved quarries in the project area or excavated on-site. The area does not have a history of contamination, which should insure that State water quality standards would not be violated because of project-related activities. Water quality certification from Minnesota and North Dakota would be obtained prior to project construction.

3. Potential Effects on Human Use Characteristics - The proposed project would provide community flood protection without adversely affecting the river. The land acquired for the project would provide locations for the installation of recreational features. Water related recreational use of the project area would not be adversely affected by the project at normal flows. During high flows when the control structures are under operation, recreational use (boaters, jet skis, canoes, kayaks, etc.) will not be allowed to pass through the structure on the Red River or the Wild Rice Rivers due to safety concerns.

G. Determination of Cumulative Effects on the Aquatic Ecosystem - See section 5.4 Cumulative Effects in the Feasibility/EIS document.

H. Determination of Secondary Effects on the Aquatic Ecosystem – There could be some indirect impacts to wetlands adjacent to the 36 mile diversion channel. This is unlikely because the soil types are not very permeable, which limits the potential for percolation, and any wetlands within 600 feet of the excavated channel will have already been accounted for as filled by the side cast of material from the diversion excavation. The Lower Rush River and Rush River will have 5.7 miles of abandoned channel which will be maintained as wetland habitat. Disturbed aquatic habitat would be expected to quickly recover after construction.

III. FINDING OF COMPLIANCE WITH RESTRICTIONS ON DISCHARGE

The proposed fill activities would comply with Section 404(b)(1) guidelines of the Clean Water Act, as amended. No significant adaptations of the guidelines were made for this evaluation. Other alternatives considered to reduce the flood risk to the Fargo Moorhead Metropolitan area included no action - continue emergency measures; nonstructural measures; flood barriers; increased conveyance; flood storage; and other diversion channel alignments. Other alternatives were not selected because they were prohibitively more costly, were significantly less effective in reducing flood risk, had extensive downstream impacts that would have been logistically very difficult to mitigate for, or did not meet the overall project purpose of reducing flood risk from both the Red River and the five North Dakota tributaries. A discussion of the effects associated with the operation of the project and project features is presented in the Feasibility/EIS document. The placement of dredged and fill material for the proposed project is required to achieve the project purpose. The proposed project is the least environmentally damaging practicable alternative that would achieve the overall project purpose of reducing flood risk from both the Red River and the five North Dakota tributaries. The NED plan and FCP described above would reduce flood risk from the Red River and the Wild Rice River, but not the other four North Dakota tributaries, and the ND35K plan is not practicable due to its extensive downstream impacts.

The proposed fill activities would comply with all State water quality standards, Section 307 of the Clean Water Act, and the Endangered Species Act of 1973, as amended. The proposed fill activities would not have significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife would not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity, and stability and on recreational, aesthetic, and economic values would not occur.

To minimize the potential for adverse impacts, the fill would be placed during periods of normal to low water levels. Since the proposed action would result in few adverse effects, no additional measures to minimize impacts would be required.

On the basis of this evaluation, I have determined that the proposed action complies with the requirements of the 404(b)(1) guidelines for the discharge of fill material.

____
Date

Michael J. Price
Colonel, Corps of Engineers
District Engineer

Attachment 2

Fargo-Moorhead Metro

Supplemental Draft Feasibility Report and Environmental Impact Statement

April 2011

U.S. Fish and Wildlife Coordination Act Report

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DRAFT REPORT

Fish and Wildlife Coordination Act Report
Fargo-Moorhead Metropolitan Area
Flood Risk Management Project

April 13, 2011

INTRODUCTION

The Red River of the North and its associated watershed has experienced several large-scale flood events in the past decade. Significant financial damage resulting from these events has led to several coordinated local, state, and federal agency attempts to address flood-related impacts within the Red River Basin. In September 2008, officials from the City of Fargo, North Dakota and City of Moorhead, Minnesota along with the U.S Army Corps of Engineers (Corps) entered into a Feasibility Cost Share Agreement. The Corps then issued a Notice of Intent to complete an Environmental Impact Statement (EIS) in the May 5, 2009 Federal Register. Due to unanticipated potential downstream impacts of the proposed project alternative operational measures have been developed, and a Supplemental Draft EIS is being completed by the Corps. Accordingly, the Fargo – Moorhead Metropolitan Area Flood Risk Management Feasibility Study focused on alternatives that would alter and/or protect the Cities of Fargo and Moorhead against elevated flood levels from the Red River.

In 2010, the Corps completed Phase 3 of project analysis and determined that the North Dakota 35,000 cfs (ND 35K) alternative would require modification due to unexpected downstream impacts, which would result from Red River stage increases caused by the diversion channel operation. To reduce downstream impacts the Corps modified the LPP, which includes a 20,000 cfs diversion channel, along the original ND 35K alignment, construction of a temporary storage area, and staging flood waters upstream of the proposed control structure. The storage area would be constructed within the protected area adjacent to the southern end of the diversion channel. Upstream staging of flood waters would be accomplished through the operation of the control structure located within the main stems of the Red River and Wild Rice River. Control structures will be operational when forecasted peak flows are anticipated to exceed 9,600 cfs at the Fargo USGS gage station.

Phase 3 project analysis identified the Minnesota 35,000 cfs alternative as the Federally Comparable Plan (FCP), which will be used to compare to the LPP for cost-share, annual benefit, and residual damage purposes. An FCP is necessary as the LPP provides fewer average annual benefits then the National Economic Development (NED) plan, which was determined to be the Minnesota 40,000 cfs alternative.

The ND 35K alternative is carried forward in the SDEIS, so this report addresses the ND 35K alternative and possible impacts resulting from this alternative.

Under the FCP, the majority of the impacted lands along a diversion channel alignment in Minnesota would consist of agricultural lands. The LPP and ND 35K will impact five tributaries to the Red River; the Wild Rice River (North Dakota), Sheyenne River, Maple River, Lower Rush River, and the Rush River. Common resource concerns between the Minnesota and North Dakota Alternatives include the Red River channel impacts, construction of a control structure within the Red River, loss of fish passage within the main stem of the Red River, sedimentation issues in the Red River, loss of riparian habitat, wetland impacts, and the fate of fish entering the diversion channel during flood events.

The LPP will stage floodwaters upstream (south) of the proposed control structure on lands adjacent to the Red River and the Wild Rice River. Staging will be controlled by operation of the control structures, and will only occur during events where the forecasted peak flows are anticipated to exceed 9,600 cfs at the Fargo USGS gage. Staging will cause the control structure gates to be in operation longer while water is held back, which will result in reduced fish passage through the control structures. Fish passageway structures are proposed at the Red River and Wild Rice River control structures, which will allow some fish passage when the control structures in operation. The majority of the lands to be inundated by upstream staging are primarily agricultural lands, so impacts to wildlife habitat areas should be minimal. Negative hydrologic impacts to wetlands within the staging area are not anticipated to occur, due to the infrequency of storm events that will require staging and the time of staging, prior to the active growing season.

The U.S. Fish and Wildlife Service (Service) is authorized under the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) to provide reports on federally funded water development projects. The Fish and Wildlife Coordination Act (FWCA) states that fish and wildlife resources shall receive equal consideration with other project purposes in federal water resource development program activities.

In accordance with the October 2009 Scope of Work (SOW) for the proposed project review and Draft EIS, the Service issued a project review letter on February 1, 2010 and a Draft FWCA Report on May 27, 2010 to the Corps. A Revised SOW was generated and finalized on February 14, 2011 to involve the Service in the review and assistance with the revised project and the associated Supplemental Draft and Final EIS documents. This report constitutes the report of the Secretary of the Interior as required by Section 2(b) of the FWCA and, when finalized, will fulfill the Service's commitment as outlined in the Revised SOW.

The Minnesota Department of Natural Resources (MNDNR) and North Dakota Game and Fish Department provided valuable information regarding resources in the Red River and the Red River Valley and the project area for incorporation into this report. The MNDNR and the North Dakota Game and Fish Department participated in several joint agency discussions on project alternatives.

STUDY AREA

The rich soils and extremely flat terrain of ancient glacial Lake Agassiz located in and around Fargo and Moorhead supports a largely rural and agricultural community with the majority of development occurring in the metropolitan area. Human activities have induced significant environmental changes within the watershed, engineered by numerous drainage ditches, stream channelization, and subsurface tile drainage. The average annual precipitation for Fargo, North Dakota is 21.29 inches.

The proposed project could influence the following major watersheds in North Dakota; Western Wild Rice River, Lower Sheyenne River, and the Maple River. The Marsh River and Red River major watersheds are in North Dakota and Minnesota, and could be influenced by the proposed project. The Buffalo River major watershed in Minnesota could also be influenced by the proposed project.

Large wetland complexes are rare within the proposed project area, and the affected portions of the surrounding watersheds. Smaller wetlands are scattered throughout the interior of the watershed and have been heavily impacted by human activities.

The main collection point for surface runoff and drainage in the project area is the Red River, which is also influenced by the in flows of the Wild Rice (ND), Sheyenne (ND), Maple (ND), Lower Rush (ND), Rush (ND), and the Buffalo (MN) Rivers (Figure 1). The Red River originates at Lake Traverse to the south, and flows north where it enters Lake Winnipeg. The Red River and the associated Valley are generally flat with a south to north, channel gradient slope that averages a one-half foot fall per mile.

Stream flow measurements taken at a USGS gauge station in the Red River at Fargo, North Dakota show mean monthly flows in winter months (2009-2010) of 1,000 cubic feet per second (cfs). However, stream flow data collected in mid March of 2010 showed flows exceeding 20,000 cfs in the Fargo, ND area. Portions of the Red River and its tributaries, affected by this project, have been channelized or impacted by flood reduction and drainage improvement projects in the past which include bank armoring, floodplain levees, ditching, and tiling.

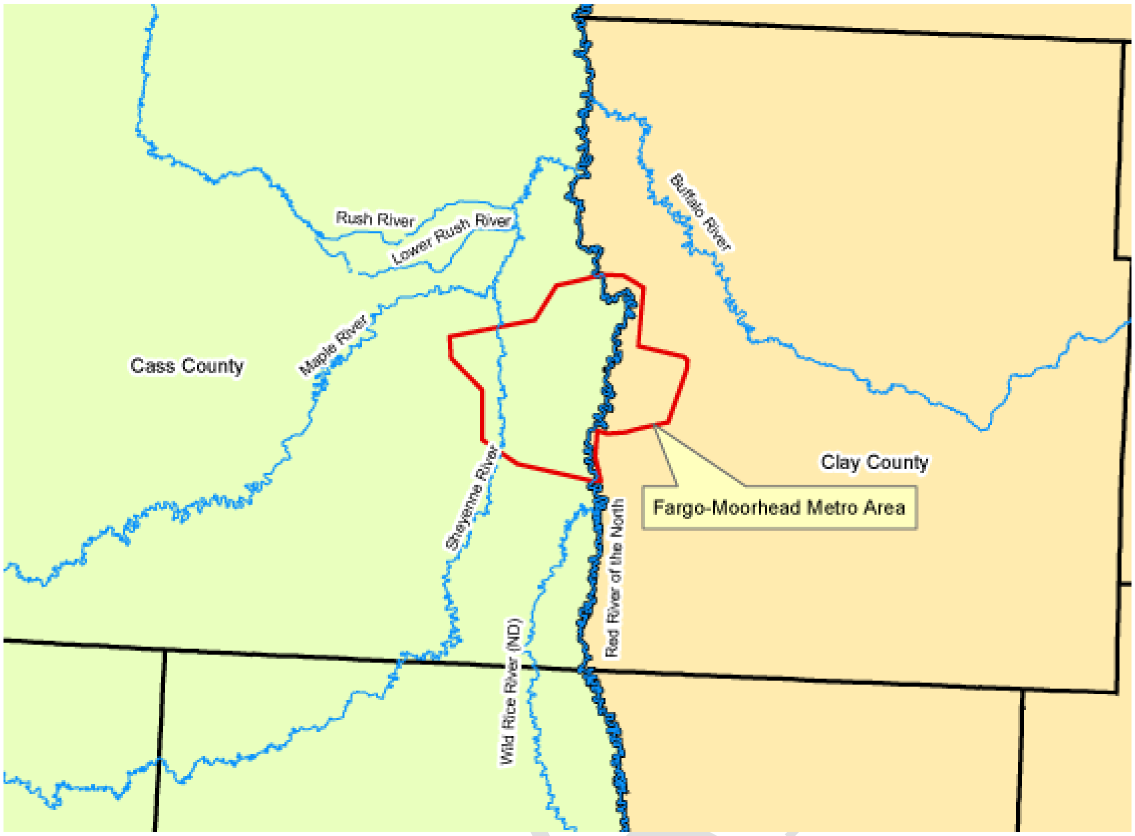

Figure 1. Rivers in close proximity to or within the Fargo-Moorhead Metropolitan Area.

FISH AND WILDLIFE RESOURCES

This section describes existing conditions for fish, wildlife, and habitat resources within the project area that may be either directly or indirectly impacted by the alternatives considered. This area includes the various diversion channel alternatives around Fargo/Moorhead (Figure 2) as well as the riparian corridors along the Red, Wild Rice (North Dakota), Sheyenne, Maple, Lower Rush, and the Rush River.

Riparian vegetation along the Red River and tributaries is heavily influenced by the extensive amount of agriculture in the area and the frequent flood events. Tree canopy and understory species typical of disturbed habitats are the primary dominates in the vegetated riparian zone. The riparian corridor provided by the Red River is the most protected method of travel for wildlife species in the project area. Wildlife capable of adapting to a variety of changing habitats, such as raccoon, skunk, and deer, are common closer to the metropolitan area. A list of wildlife species found through the project site is in Appendix 1.

The landscape surrounding Fargo/Moorhead, outside the Red River riparian zone, provides only small pockets of wildlife habitat in the form of woods, wetlands, and grasslands. There are many agricultural fields that harbor important short-term open water habitat for migratory birds in the spring. Although the extent of these ephemeral, open water areas has not been mapped, aerial photography suggests they are prevalent throughout the area. These areas provide critical feeding and resting areas for migratory birds, especially if precipitation or snowmelt has inundated other shallow water habitats in their migratory path.

The Red, Wild Rice (North Dakota), Sheyenne, Maple, Lower Rush, and Rush Rivers, support both game and non-game fish (Appendix 1). Diversity, abundance, and distribution of fish are largely dependent upon existing barriers, water quality issues and winterkill due to low flow events. The Fargo/Moorhead area is known for its sport fishing opportunities, including channel catfish, walleyes, and northern pike. The sport fishery has benefited greatly from MNDNR efforts in removal of low head dams and stocking efforts. Lake sturgeon reintroduction efforts within the Red River and its tributaries have been successful in re-establishing this species within the river system including the Fargo-Moorhead metro area.

Several mussel species have also been documented within the Red River and tributaries. Some survey work was completed in 2008, in the Fargo/Moorhead area, by the MNDNR, but minimal data currently exists for mussel species present within the Red, Wild Rice (ND), Sheyenne, Maple, Lower Rush, and Rush Rivers.

Biotic surveys within the Red, Wild Rice (ND), Sheyenne, Maple, Lower Rush, and Rush Rivers are scheduled to occur in the Spring/Summer of 2011 and 2012. Results of these surveys, as made available to the Service, will be incorporated into the Final FWCA Report for the Fargo/Moorhead Project.

<u>Wetlands</u>

The majority of the wetlands within the proposed project area are palustrine emergent, palustrine forested, and riverine wetlands. The majority of the wetlands within the project area are located along the river corridors. Many of the small isolated wetlands outside the riparian zone are influenced by agriculture activities (drainage, tillage, grazing, etc.). Temporarily flooded basins, including actively farmed basins, have the potential to provide excellent "stop-over" habitat for spring migrating birds.

<u>Federal Candidate, Threatened, and Endangered Species</u>

Five listed or candidate species under the Endangered Species Act of 1973 (ESA), as amended, occur within Clay and Wilkins Counties, Minnesota and Cass and Richland Counties, North Dakota.

Clay County, Minnesota

- Dakota skipper (Candidate)
- Sprague's pipit (Candidate)
- western prairie fringed orchid (threatened)

Wilkins County, Minnesota – No Listed Species

Cass County, North Dakota –
- whooping crane (Endangered)
- gray wolf (Endangered)

Richland County, North Dakota –
- Dakota skipper (Candidate)
- western prairie fringed orchid (threatened)
- whooping crane (Endangered)
- gray wolf (Endangered)

According to data available at the time of drafting this report there is record of western prairie fringed orchid in Richland County, ND, which is could potentially be affected by the upstream staging of flood water. Records indicate the last observation of orchids in this location occurred in 1984. Additional field surveys in coordination with the Service will be necessary to determine the presence of western prairie fringed orchid at previously identified locations.

Current data does not indicate records of whooping crane, gray wolf, or Dakota skipper within the proposed project area. If at any point during project planning, construction, or operation should additional information on listed species become available, or should a new species be listed, the Corps will reinitiate consultation with the Twin Cities Field Office of the Service.

Bald Eagle Nests

Bald eagles and their nests are protected from take and disturbance, respectively, per the Bald and Golden Eagle Protection Act. The Service verified the location of two bald eagle nests within the proposed project area. One nest is located on the northwest edge of the City of Fargo along the Sheyenne River in close proximity to a housing development. It was also verified with local private residents in the area that the nest was active and successful in 2009. The other nest is located north of the Cities of Fargo and Moorhead, close to the confluence of the Sheyenne River and the Red River.

A third bald eagle nest has been identified during desktop and map analysis of the proposed flood staging area upstream of the proposed Red River control structure. The identified nest is approximately 5.5 miles south of proposed control structure and diversion channel construction activities. Under existing conditions, 5, 10, 50, 100, and 500 year storm events place flood waters around the third nest tree. Proposed project operation will result in longer durations of staging flood waters around the nest tree. Increased inundation is not anticipated to have a direct negative impact on adult or juvenile bald eagles utilizing the nest, but increased inundation could potentially affect the structural integrity of the nest tree. The Service will attempt to verify 2011 activity of all nests, and include nest activity information in the Final FWCA Report.

During the planning, construction, and operational phases of the Fargo-Moorhead project the Service's National Bald Eagle Management Guidelines (May 2007), http://www.fws.gov/midwest/MidwestBird/EaglePermits/index.html, should be utilized to reduce impacts to any and all bald eagles nesting within the proposed project area. Because of the long timeline associated with this project (eight plus years) the Service recommends that raptor nest surveys be completed in all wooded areas potentially affected by this project. The raptor nest surveys should be completed at a minimum in the spring of the year proceeding construction within or near any affected wooded areas. If negative structural impacts to the third eagle nest, are anticipated due to the increased duration of inundation, a Non-intentional Nest Take Permit (50 CFR 22.26) may be necessary. These permits are valid for five year periods, the local project sponsors should consider applying for these permits in years when large flood events are anticipated and the resulting flood water staging could affect the eagle nest tree. The permitting process can take two to three months to complete depending on complexity, and all permits require minimization, mitigation, and monitoring measures.

<u>Migratory Birds</u>

Due to the varied habitat and cover types throughout the project site, there is the potential to impact wetlands, grasslands, and woodlands during the construction or excavation phases necessary to complete this type of project. The aforementioned habitat types can provide nesting habitat for a variety of migratory bird species. Upon final selection of a path for the diversion channel and levee alignments, mapping of significant migratory bird nesting areas should be coordinated with the Service.

Development of a construction timeline to minimize impacts to these areas during prime nesting times should be considered. The Service recommends that proposed construction and excavation within potential bird nesting habitat be completed outside of the primary nesting period (April 1st to August 31st) when possible and feasible. Attempts to minimize impacts to potential migratory bird nesting habitats should be made at all times during construction and excavation.

Executive Order 13186 (EO 13186), specifically addresses the responsibilities of federal agencies to protect migratory birds. EO 13186 includes a directive to federal agencies to restore and enhance the habitat of migratory birds as practicable, which provides a basis and a rationale for mitigating for the loss of migratory bird habitat that result from developing the proposed project.

ALTERNATIVES

During the original screening process of the proposed project, 11 alternatives were evaluated to determine which would be most the implementable, and which alternatives would move forward for further analysis. The Corps Alternative Screening Document, December 2009, provides explanation of the screening process, and provided the recommendation that the No Action and Diversion Channel alternatives should be carried forward for further evaluation as stand-alone alternatives.

No Action

This alternative represents future conditions without the project. Major flood events, such as 100-year events and higher, would continue to occur on a periodic basis. Land use in and surrounding the Cities of Fargo and Moorhead would remain the same. The alternative also anticipated that both Cities would continue to expand as population growth and economy allowed. The Cities would continue to rely on emergency flood protection measures; existing levee protection, temporary levees and floodwalls, and sand bagging activities that are completed as needed in response to flooding.

Flood Barriers

This alternative includes the use of permanent flood barrier measures such as levees, floodwalls, invisible floodwalls, gate closures, and pump stations. For analysis purposes the flood barriers alternative would have resulted in levees on both the Fargo and Moorhead sides of the Red River. Two levee top profiles were considered by the Corps, which could reliably contain the 2% chance and the 1% chance of flooding. This alternative was not pursued further as a stand-alone alternative by the Corps for the purposes of this project.

Diversion Channel

A diversion channel would direct flood waters from the Red River into a constructed channel around the Cities of Fargo and Moorhead, and eventually the diverted waters would enter back into the Red River downstream of Fargo/Moorhead. During early planning stages of the project the Corps developed multiple diversion channel alignments on both the Minnesota and North Dakota side of the Red River.

The local sponsors of the Fargo/Moorhead project requested that the Corps move forward with the North Dakota 35,000 cfs making it the Locally Preferred Plan (LPP). Both the MN 35K and the ND 35K would provide diversion of flood waters, around the metropolitan area, starting at 9,600 cfs flow event. However, the local sponsors felt that the ND 35K Alternative provided more local flood reduction benefits then the Minnesota alternatives. The LPP and ND 35K will assist in reducing potential flooding impacts caused by the Wild Rice and Sheyenne Rivers. Due to downstream impacts of Red River stage increases, the ND 35K alternative was modified and the current LPP was developed. The LPP consists of a 20,000 cfs diversion channel constructed along the same alignment as the ND 35k, and the construction of control structures on the Red River and Wild Rice River which will be operated when the forecasted peak flow is anticipated to exceed 9,600 cfs at the Fargo USGS gage. The LPP involves upstream staging of Red River and Wild Rice River flood waters, and the storage of waters directed through the diversion channel into holding basins proposed to be constructed adjacent to the south end of the diversion channel. The MN 35K alternative has been identified as the Federally Comparable Plan (FCP), which can be compared to the LPP for federal cost share purposes.

Under the FCP, the majority of the impacted lands along a diversion channel alignment in Minnesota would consist of agricultural lands. The LPP and ND 35Kwill impact five tributaries to the Red River; the Wild Rice River (North Dakota), Sheyenne River, Maple River, Lower Rush River, and the Rush River. Common resource concerns between the Minnesota and North Dakota Alternatives include the Red River channel impacts, construction of a control structure within the Red River, loss of fish passage within the main stem of the Red River, sedimentation issues in the Red River, loss of riparian habitat, wetland impacts, and the fate of fish entering the diversion channel during flood events.

Non-structural Measures

This alternative encompasses various flood-proofing measures such as relocating businesses and residential structures to an area outside the floodplain, elevation of structures, land acquisition and buyouts, basement removals, dry and wet flood proofing, and additional flood preparedness plans and warnings. Due to highly negative social impacts and the extremely high costs associated with this alternative, non-structural measures were not further considered as a stand-alone alternative by the Corps for the purposes of this project. The Corps did make the recommendation that the non-structural alternative should be considered for possible inclusion as a feature of the overall plan where it could be incrementally justified.

Flood Storage

The storage alternative involves preservation of natural floodplain, restoration of wetlands, and the construction of dams and other water retention facilities throughout the watershed. Utilization of agricultural fields for flood water retention would need to be a major component of this alternative. Through modeling the Corps determined that the storage alternative would have low effectiveness in larger flood events, but may be helpful in small flood events. Due to the low level of effectiveness during large flood events and the high costs associated with this alternative, flood storage was not further considered as a stand-alone alternative by the Corps for the purposes of this project. The Corps did make the recommendation that the flood storage alternative should be considered for possible inclusion as a feature of the overall plan where it could be incrementally justified, and it should be considered by the local communities within the basin.

Tunneling

This alternative would entail the construction of a series of tunnels under the Cities of Fargo and Moorhead to convey floodwaters, and reduce the water levels in the Red River. This alternative would provide similar benefits to the diversion channel alternatives, but with a much greater cost. There would also be significant negative impacts to aquatic habitats and fish passage associated with the tunneling alternative. Due to the high costs and uncertainties of long term maintenance associated with this alternative, tunneling was not further considered as a stand-alone alternative by the Corps for the purposes of this project.

Bridge Replacement or Modification

Bridge replacement or modification was considered because in some cases this can increase water conveyance and reduce flood stages within the river. However, in the case of Fargo/Moorhead and the Red River, the Corps determined that complete removal of the bridges had only a minor affect on flood levels. Due to the low level of effectiveness and the high costs associated with this alternative, bridge replacement or modification was not further considered as a stand-alone alternative by the Corps for the purposes of this project. The Corps did make the recommendation that the bridge replacement or modification alternative should be considered for possible inclusion as a feature of the overall plan where it could be incrementally justified.

Interstate 29 Viaduct

This alternative would involve reconstruction of the existing Interstate 29 corridor to function as an open viaduct during flood events. During non-flood times the corridor would then function as an interstate highway. This alternative would have significant negative impacts for fish passage and sedimentation, and there would be minimal environmental benefit as the interstate corridor would function as a highway during non-flood periods. Due to the low level of cost effectiveness and unacceptable transportation impacts associated with this alternative, the Interstate 29 viaduct was not further considered as a stand-alone alternative by the Corps for the purposes of this project.

Dredging and Widening the River

An alternative to deepen and widen the Red River to accommodate great flow conveyance through the Fargo/Moorhead area was considered. This alternative would result in substantial environmental impacts including; increased sedimentation, loss of suitable fish and mussel habitats, riparian habitat loss, wildlife mortality during excavation activities, and a high likelihood of riverbank instability issues. There would also be social impacts as homes and property would need to be acquired to insure the Red River could be widened to accommodate the new river depths. This alternative would also violate a number of local and national policies. Due to associated policy violations and the high costs associated with long term maintenance of this alternative, dredging and widening of the Red River was not further considered as a stand-alone alternative by the Corps for the purposes of this project.

Wetland and Grassland Restoration

Wetland and grassland restoration areas could be established to provide flood storage and also reduce peak runoff. Costs of this alternative were anticipated to be high due to large land acquisition needs to implement restoration activities. The Corps staff determined that the benefits of wetland restoration would be localized, and the flood storage needs of the Fargo/Moorhead area would not be met. Due to the low level of effectiveness to offset flood damages, high costs, and the large land acquisitions associated with this alternative, wetland and grassland restoration was not further considered as a stand-alone alternative by the Corps for the purposes of this project. The Corps did make the recommendation that the wetland and grassland restoration alternative should be considered for possible inclusion as a feature of the overall plan where it could be incrementally justified.

Throughout the project and comment process the Service has recommended that the Corps consider the utilization of wetland restoration within the watershed of the project to increase flood water storage and attenuation.

Cut-off Channels

Cut-off channels would be excavated across meanders within the Red River channel in the Cities of Fargo and Moorhead. Straightening the channel would allow greater conveyance of water through the Cities, and potentially reduce peak flood stages. This alternative would impact riparian habitat, wetlands, and potentially fisheries resources that are adjacent to or utilize these meanders. According to Corps staff this alternative would not provide substantial flood risk reduction. There would also be the potential for this alternative to violate state and federal policies. Due to the low reduction of flood risk and the environmental impacts associated with this alternative, cut-off channels was not further considered as a stand-alone alternative by the Corps for the purposes of this project. The Corps recommended that the cut-off channels alternative be considered for possible inclusion as a feature of the overall plan where it could be incrementally justified.

Locally Preferred Plan (LPP)

This alternative is located west of the Cities of Fargo and Moorhead, with an inlet planned to be constructed south of the Fargo/Moorhead metropolitan area on the Red River approximately 4 miles south of the confluence of the Red River and the Wild Rice River (North Dakota), see Figure 2. The outlet of the diversion channel into the Red River is planned to be constructed north of the Fargo/Moorhead metropolitan area on the Red River approximately 3.5 miles north of the confluence of the Red River and the Sheyenne River.

The connecting channel bottom width between the Red River and the diversion channel inlet weir is 100 feet, and the diversion channel downstream of the inlet weir will have an average bottom width of 250 feet, and internal 1(vertical):7(horizontal) side slopes. The peak of the spoil piles adjacent to the diversion channel will not exceed 15 feet above existing grade. Spoil slopes will be 1:7 internally and 1:10 externally. Total width of the diversion channel construction including; bottom width, internal slopes, and external side slopes will be approximately 2,200 feet. With a total length of approximately 36 miles, the total affected footprint of the diversion channel is approximately 9,600 acres.

The inlet of the diversion channel located east of the Sheyenne River will consist of a passive weir structure with a concrete spillway. A large control structure is proposed to be placed in the Red River channel, downstream of the connection channel inlet. The concrete structure will have three gates, 50 ft wide x 50 ft high. A natural variable bed roughness through the control structure is proposed to provide variable flow velocities. During normal flows the control structure would be completely open, and during flow events exceeding the 3.5 year storm event (9,600 cfs) the gates would partially close and the structure would act as a barrier that would back water into the diversion channel. Two or more gated fish bypass channels are proposed on the east side of the Red River structure. Proposed bypass channels will function to the extent practicable up to a 50 year storm event, and upstream headwater variation will affect the placement, number, and function of the proposed fish bypass channels.

A second weir structure will be constructed within the connection channel on the east bank of the Wild Rice River (ND). This second weir structure will be over topped by diverted flows from the Red River once a 9,600 flow event is exceeded. A gated control structure will be constructed in the Wild Rice River (ND), with two tainter gates (30 feet wide and 30 feet high). A natural variable bed roughness through the control structure is proposed to provide variable flow velocities. The gates will generally be fully open, but during large flow events the gates will be lowered to restrict the flow into the Fargo-Moorhead Metro. Flows above the 3.5 year event would overtop the inlet weir, located east of the Sheyenne River, into the diversion channel. Two or more gated fish bypass channels are proposed to be constructed adjacent to the Wild Rice River control structure. Proposed bypass channels will function to the extent practicable up to a 50 year storm event, and upstream headwater variation will affect the placement, number, and function of the proposed fish bypass channels.

Diverted flood waters will flow west and north around the Fargo/Moorhead metropolitan area. The diversion channel will affect four additional tributaries; the Sheyenne River, the Maple River, the Lower Rush River, and the Rush River.

Concrete bypass structures (aqueducts) will be built to convey waters within the tributaries over the diversion channel. The structures will allow the Sheyenne and Maple Rivers to flow through under normal conditions. However, flows exceeding the 2 year storm event within the Sheyenne and Maple will overtop small weir structures and flow through constructed channels into the main diversion channel. The Lower Rush and Rush Rivers will be routed, via drop structures, directly into the diversion channel. Fishways consisting of 40 foot wide riffle-pool sequences will be constructed to extended from the Lower Rush and Rush Rivers down to the low flow channel within the diversion channel. The channels of the Lower Rush and Rush Rivers between the diversion channel and downstream to their confluences with the Sheyenne River will be abandoned, and allowed to function as temporary flooded open ditches and as wetland habitat during the drier periods of the growing season. During flood events up to the 2 year event the Maple River aqueduct will convey cut off flows from the Rush and Lower Rush Rivers into the protected area.

The diversion channel will outlet into the Red River 1.5 miles south of the Red River/Buffalo River confluence through a 250 foot wide concrete spill way.

A three mile tie back levee will need to be constructed to connect the Red River control structure to high ground. The tie back levee contains a small control structure (two 10 foot by 10 foot gated box culverts), which would be placed within Wolverton Creek. The Wolverton Creek structure will be closed during flood events. The levee will prevent flood waters from flowing over land to north and east into the Fargo/Moorhead metropolitan area. An additional 6.8 mile tie back levee will be need to be constructed along Cass County Road 17 to keep staged flood waters from flowing overland to the Sheyenne River.

A significant structural and operational component to the LPP to eliminate downstream impacts of the proposed project is to provide upstream staging of flood waters and provide floodwater storage. Staging of approximately 200,000 acre feet of water is necessary upstream of the diversion channel inlet. A 4,360 acre storage area (Storage Area 1) will be constructed on the north side of the connection channel between the Wild Rice and Sheyenne Rivers. Storage Area 1 will be connected to the connection channel, and water levels within the storage area will rise and recede in correspondence to connection channel water levels. Flood water staging will be controlled by operation of the control structures, and will only occur when the forecasted peak flows are anticipated to exceed 9,600 cfs at the Fargo USGS gage. Longer staging will cause the control structure gates to be in operation longer while water is held back, which will result in reduced fish passage through the structures. The majority of the lands to be inundated by upstream staging are primarily agricultural lands, so impacts to wildlife habitat areas should be minimal. Hydrologic effects to wetlands are not anticipated to occur due to the infrequency of events that will require additional staging, and the majority of staging events will occur during spring snowmelt and early spring precipitation events which tend to occur prior to the beginning of the active growing season.

During operation the LPP alternative is anticipated to produce the following downstream impacts:

- 10 year event maximum impact location downstream stage increase 1.4 inches
- 50 year event maximum impact location downstream stage increase 4.6 inches
- 100 year event maximum impact location downstream stage increase 3.5 inches
- 500 year event maximum impact location downstream stage increase 3.2 inches

During operation the LPP alternative is anticipated to produce the following upstream impacts:

- 10 year event Hickson gage location upstream stage increase 79.0 inches
- 50 year event Hickson gage location upstream stage increase 55.0 inches
- 100 year event Hickson gage location upstream stage increase 64.6 inches
- 500 year event Hickson gage location upstream stage increase 34.2 inches

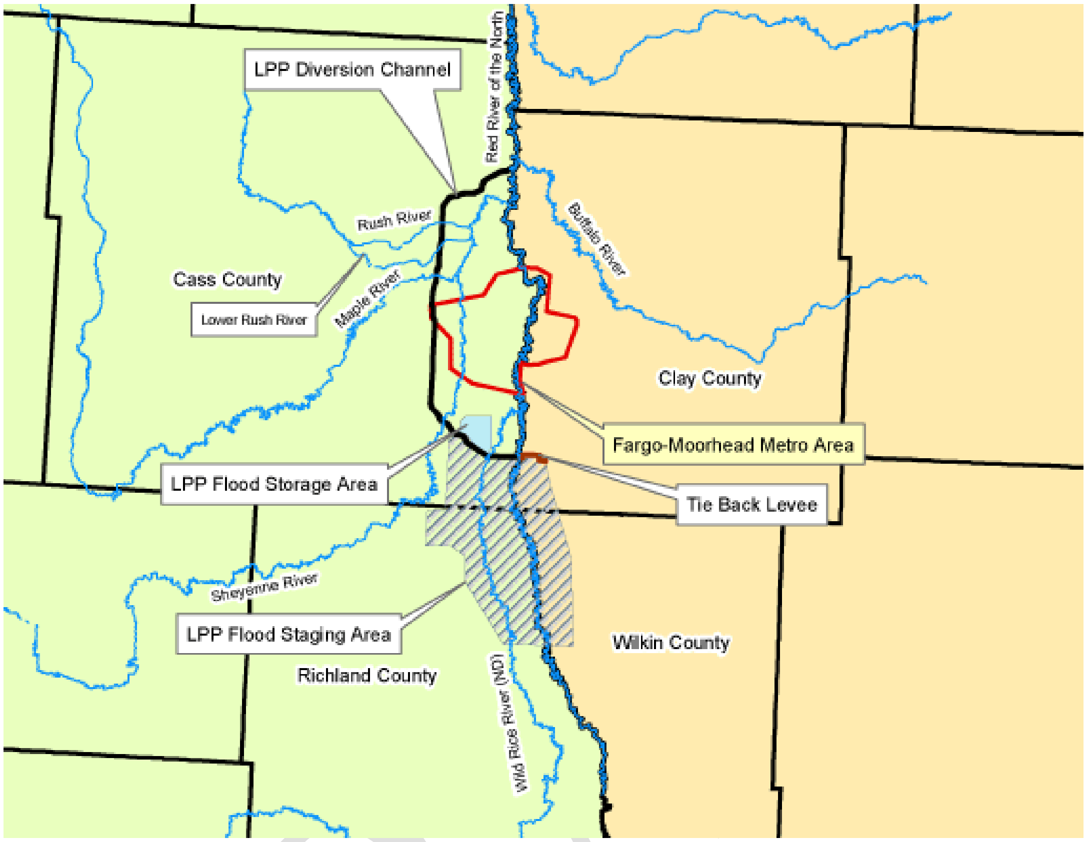

Figure 2. Proposed LPP Diversion Channel Alternative

MN 35K Diversion Channel (FCP)

This alternative is located east of the Cities of Fargo and Moorhead, with an inlet planned to be constructed south of the Fargo/Moorhead metropolitan area on the Red River north of the confluence of the Red River and the Wild Rice River (North Dakota), see Figure 3. The outlet of the diversion channel into the Red River is planned to be constructed north of the Fargo/Moorhead metropolitan area on the Red River, north of the confluence of the Red River and the Sheyenne River.

The diversion channel will have an average bottom width of 400 feet, and internal 1(vertical):7(horizontal) side slopes. The internal side slopes will be increased to 1:5 at highway and railroad intersections. The peak of the spoil piles adjacent to the diversion channel will not exceed 15 feet above existing grade, and external side slopes of the diversion channel will range from 1:7 to 1:10. Total width of the diversion channel construction including; bottom width, internal slopes, and external side slopes will be approximately 2,150 feet. With a total length of approximately 25 miles, the total affected footprint of the diversion channel is approximately 6,415 acres.

The inlet of the diversion channel on the east bank of the Red River will consist of a metal sheet pile and rock weir structure. Water from the Red River will begin to flow over the weir structure after a 9,600 cfs event is exceeded. Once the water has overtopped the weir structure the diversion channel will go east and north around the Fargo/Moorhead metropolitan area. The diversion channel will primarily bisect land currently used for agricultural production. The diversion channel will outlet into the Red River over a rip rap structure.

The diversion channel will function as a temporary flooded open ditch during the conveyance of flood waters, and as mix of channel habitat and wetland habitat during low flow periods.

A large control structure is proposed to be placed in the Red River channel, approximately 1,600 feet downstream of the diversion channel inlet. The concrete structure will have three gates, each 40 feet wide by 40 feet tall. During normal flows the control structure would be completely open, and during flow events exceeding 9,600 cfs the gates would partially close and the structure would act as a barrier that would back water into the diversion channel. A concrete fish ramp is proposed for construction to allow fish passage up to the 50 year storm event.

A 9.9 mile tie back levee will need to be constructed to connect the Red River control structure to high ground. The levee will prevent flood waters from flowing over land to north and west into the Fargo/Moorhead metropolitan area.

In addition to the main diversion channel this alternative would include to smaller channels upstream of the Red River structure. A three mile long supplementary channel will run south parallel to the Red River to allow for additional capacity, see Figure 3. A second supplementary channel, less then one mile long, is located near the intersection of I-29 and Cass County Highway 16, not shown in any Figures. These supplementary channels would have bottom widths of 50 feet.

During operation the FCP alternative is anticipated to produce the following downstream impacts:

- 10 year event maximum impact location downstream stage increase 2.9 inches
- 50 year event maximum impact location downstream stage increase 9.7 inches
- 100 year event maximum impact location downstream stage increase 12.5 inches
- 500 year event maximum impact location downstream stage increase 5.6 inches

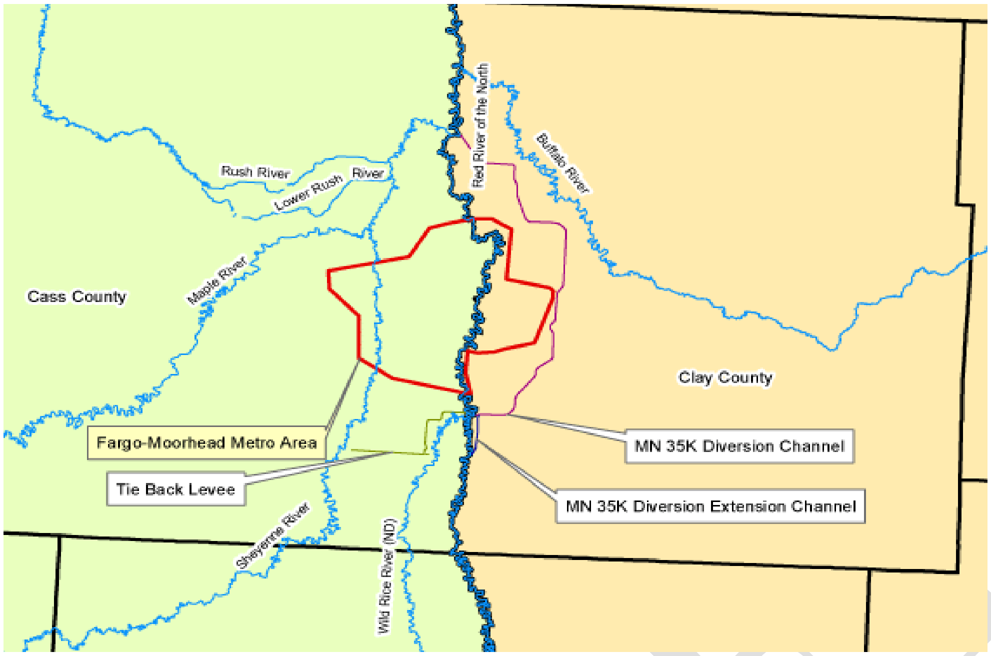

Figure 3. Proposed MN 35K Diversion Channel Alternative

<u>ND 35K Diversion Channel (ND 35K)</u>

This alternative is located west of the Cities of Fargo and Moorhead, with an inlet planned to be constructed south of the Fargo/Moorhead metropolitan area on the Red River approximately 4 miles south of the confluence of the Red River and the Wild Rice River (North Dakota), see Figure 2. The outlet of the diversion channel into the Red River is planned to be constructed north of the Fargo/Moorhead metropolitan area on the Red River approximately 3.5 miles north of the confluence of the Red River and the Sheyenne River.

The diversion channel will have an average bottom width of 300 feet, and internal 1(vertical):7(horizontal) side slopes. The internal side slopes will be increased to 1:5 at highway and railroad intersections. The peak of the spoil piles adjacent to the diversion channel will not exceed 15 feet above existing grade, and external side slopes of the diversion channel will range from 1:7 to 1:10. Total width of the diversion channel construction including; bottom width, internal slopes, and external side slopes will be approximately 2,450 feet. With a total length of approximately 36 miles, the total affected footprint of the diversion channel is approximately 6,560 acres.

A large control structure is proposed to be placed in the Red River channel, approximately 1,600 feet downstream of the diversion channel inlet. The concrete structure will have three gates, each 50 feet wide by 40 feet tall. During normal flows the control structure would be completely open, and during flow events exceeding 9,600 cfs the gates would partially close and the structure would act as a barrier that would back water into the diversion channel. A concrete fish ramp is proposed for construction to allow fish passage up to the 50 year storm event.

The inlet of the connection channel on the west bank of the Red River will consist of a metal sheet pile and rock weir structure. The inlet of the weir structure is set at an elevation which corresponds to the 9,600 cfs flow event at the Fargo USGS gage. A second weir structure will be constructed within the diversion channel on the east bank of the Wild Rice River (ND). This second weir structure will be set at an elevation one foot above the elevation of the first weir.

A gated control structure will be constructed in the Wild Rice River (ND), with two tainter gates (30 feet wide and 25 feet high). The gates will generally be fully open, but during large flow events the gates will be lowered to restrict the flow into the Fargo-Moorhead Metro. Flows would overtop the inlet weir into the diversion channel, on the west bank of the Wild Rice River (ND). Diverted flood waters will flow west and north around the Fargo/Moorhead metropolitan area.

Aqueducts will be built to convey waters in the Sheyenne and Maple Rivers over the diversion channel. The structures will allow the Sheyenne and Maple Rivers to flow through under normal conditions. However, flows exceeding the 2 year storm event within the Sheyenne and Maple will overtop small weir structures and flow through constructed channels into the main diversion channel. The Lower Rush and Rush Rivers will be routed, via drop structures, directly into the diversion channel. The channels of the Lower Rush and Rush Rivers between the diversion channel and downstream to their confluences with the Sheyenne River will be abandoned, and allowed to function as temporary flooded open ditches and as wetland habitat during the drier periods of the growing season. The diversion channel will outlet into the Red River over a weir and rip rap structure.

A three mile tie back levee will need to be constructed to connect the Red River control structure to high ground. The levee will prevent flood waters from flowing over land to north and east into the Fargo/Moorhead metropolitan area.

During operation the ND 35K alternative is anticipated to produce the following downstream impacts:

- 10 year event maximum impact location downstream stage increase 13.9 inches
- 50 year event maximum impact location downstream stage increase 29.4 inches
- 100 year event maximum impact location downstream stage increase 25.4 inches
- 500 year event maximum impact location downstream stage increase 8.4 inches
- Measureable downstream impacts would extend to Thompson, ND and likely into Canada

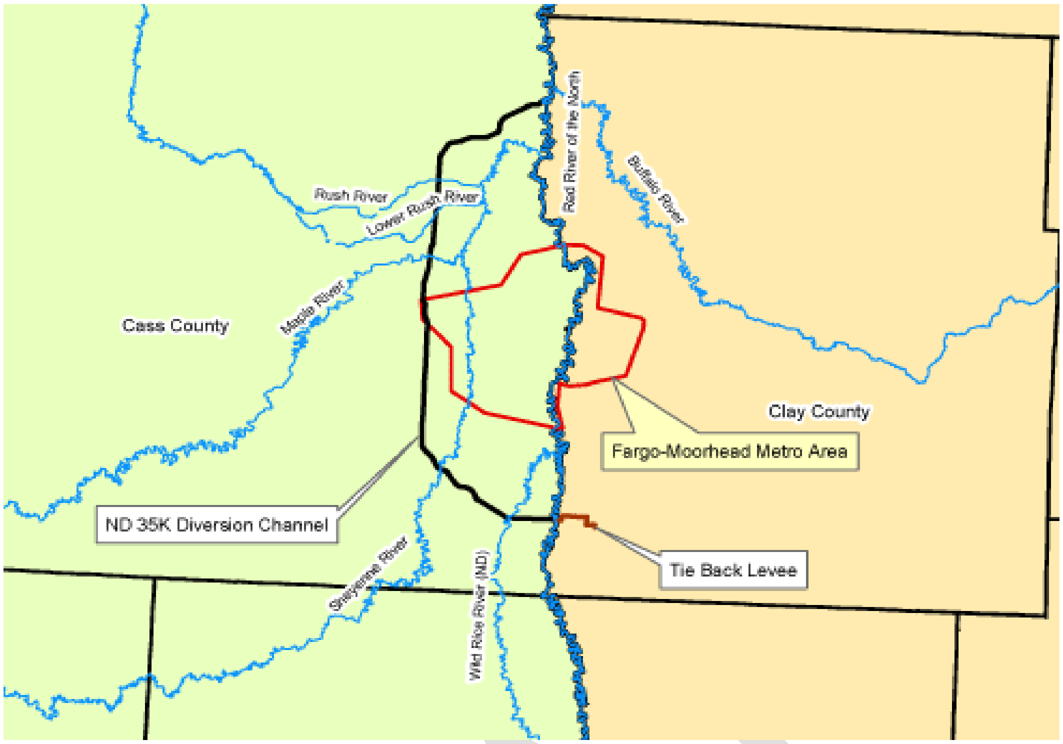

Figure 4. Proposed ND 35K Diversion Channel Alternative

	LLP	FCP	ND 35K Diversion
Length of Channel	36 miles	25 miles	36 miles
Total Width of Channel w/ side slopes	2,200 feet	2,800 feet	2,450 feet
Impact of Primary Diversion Channel	8,054 acres	6,415 acres	6,560 acres
Additional Features Causing Impacts	Upstream staging and storage area	2 secondary diversion channels	Significant rise in downstream Red River stage
Length of Tie Back Levees	10.1	9.9 miles	3.3 miles

Table 1. Comparison of Alternative specifics.

IMPACT ANALYSIS

This Report focuses on potential impacts that would result from the activities involved with the construction, excavation, and operation of the LPP, FCP and ND 35K. Environmental impacts from the LPP, FCP and ND 35K can be separated into two categories: direct impacts, those caused by project construction, and indirect impacts, those associated with project operation.

Direct Impacts of the Locally Preferred Plan

Habitat Loss

Construction and excavation associated with the proposed project will result in the removal or degradation of riparian forest, wetlands (various types), grasslands, and riverine aquatic habitat. The current plan for structure placement and diversion channel route will result in the following impacts; 199.3 acres of forested habitat, 866 acres of wetlands (direct and indirect), and 46 acres of riverine aquatic habitat. Activities resulting in direct impacts include; diversion channel excavation, Red River and Wild Rice River control structure construction, weir construction, levee constructions, Wolverton Creek gated culvert placement, Sheyenne and Maple River crossings construction (aqueducts), and tributary flow diversion and abandonment (Lower Rush and Rush Rivers).

The exact acreage of the various habitats impacted by the project should be calculated once the extent and location of the alternatives are determined.

Fisheries

Construction and excavation within the riverine aquatic habitats could kill adult or juvenile fish. Sediment discharges caused by the aforementioned work could result in adult and juvenile individuals being killed if their gills become filled with sediment, spawn bed abandonment by adult fish, and also the covering of spawning beds with silts and fines resulting in the loss of eggs within the bed. Large sediment loads could also lead to disruptions in foraging success for fish directly downstream of excavation and construction areas within the rivers or areas of bank construction or excavation. Disruption of foraging success could result in the death of juvenile individuals, or prohibit adult fish from spawning due to malnutrition.

Wildlife

Excavation and construction within forested areas, wetlands, and grasslands may be expected to potentially kill or displace nesting adult birds if construction activities occur during the primary nest seasoning (April 1st – August 31st). Abandonment of nests and crushing of eggs within construction and excavation areas is also considered a direct wildlife impact.

Mammal species within the excavation and construction areas will be displaced or killed during project activities. The majority of adult individuals should be mobile enough to move out of the construction/excavation areas prior to being injured or killed by equipment. The exception may be borrowing species that may be injured or killed during excavation activities. Juvenile individuals may not be able to avoid construction and excavation activities resulting in injury or death of certain individuals.

Mussel species within the riverine aquatic habitats may be killed by direct construction or excavation activities within mussel beds. Feeding activities and gill function may be interrupted by large sediment loads during construction and excavation activities. This could result in the death of individuals, or a reduction in or lack of reproduction by adult individuals.

<u>Indirect Impacts of the Locally Preferred Plan</u>

Habitat Loss and Conversation

With additional sediment load and deposition occurring the Red, Wild Rice (ND), Sheyenne, and Maple Rivers will experience some alteration of their bed composition. Also, because of structure placement and reductions in the current regular flood flows through these Rivers, sediments could accumulate and alter the aquatic habitat. This could also result in the need for regular mechanical clean out, which would disturb riparian habitat, aquatic habitat, and fish and wildlife species in the area of the clean out.

Wetlands within the floodplains of the Red, Wild Rice (ND), Sheyenne, and Maple Rivers, and downstream of the proposed structures and diversion channel, may be converted to non-wetland or a drier hydrologic regime if they are heavily influenced hydrologically by regular flood events that currently occur. Wetlands found at the confluences of the Lower Rush and Rush Rivers with the Sheyenne River would likely be converted to non-wetland or a drier hydrologic regime once the Lower Rush and Rush River channels are abandoned.

Fisheries

Movement of fish species within the Red, Sheyenne, and Maple Rivers will be impeded during flood events by structures constructed within the river channels as part of this project. These fish passage impacts will be most noticeable during flood flow events when the gates on the Red River and Wild Rice River control structures are closed and upstream staging of floodwater occurs. Fish passage around the control structures will be restricted through the proposed bypass channels up to the 50 year event. Events in excess of a 50 year event will completely stop fish passage through the control structures and proposed bypass channels. Due to long term upstream staging during large flood events the operation of the control structures could result in an almost complete loss of spring fish migration. The operation of the gated culvert on Wolverton Creek will limit fish passage during large flood events. This culvert will be sized according to the currently existing structure, and flows through the existing culvert during flood events may currently limit fish passage due to flow velocities. Flow velocities through the aqueduct structures on the Sheyenne and Maple Rivers become high enough to impede fish passage, primarily for smaller species.

Aquatic organisms displaced by flood events would also be affected by operation of a diversion channel. Fish carried into the diversion may be vulnerable to stranding during lower but more frequent flood events (e.g. 5 or 10 year event) if 1) they are unable to find their way back to the river as water levels recede or 2) the flow dissipates before reconnecting to the Red River. The proposed low flow channel within the diversion channel and fish connectivity step down structures from the Rush and Lower Rush Rivers into the diversion channel will provide possible routes for stranded fish species. Flood-formed scour pools may provide refugia for these fish but they would not survive the winter in such habitat.

Given the scenario above, it appears that a certain degree of fish mortality is unavoidable. The level of mortality is dependant upon the number of fish entering the diversion channel, abundance of water in the channel, and the life stage (juvenile or adult) of the affected individuals.

Wildlife

The upstream staging of flood waters, under 100 year and 500 year events, could prolong the inundation of the lands around the identified bald eagle nest tree approximately 4 miles south of the proposed LPP Red River control structure. It is anticipated that this additional inundation period would not have an effect on adult or fledged juvenile bald eagles. However, the structure stability and longevity of the nest tree could be negatively affected by additional inundation, which could result in the nest tree falling. Bald eagle eggs or unfledged young could be taken should the nest tree fall when either the eggs or the juvenile birds are present. The Service will complete a field survey of all three known bald eagle nests within the project area in the spring 2011. If field conditions and private land access allow, a more detailed analysis of the southernmost bald eagle nest tree will be completed.

Once the project is in the operational phase mussels could be affected by additional direct impacts of operation. In large flood flows the gates on the Red River control structure will partially close, resulting in some deposition of sediment on the upstream side of the structure. A large sediment load could bury and kill individuals. Sediment deposition will also occur on the Wild Rice River (ND) at the location of the proposed control structure. The structures on the Sheyenne and Maple Rivers will restrict flows during flood events, and a portion of the water will be directed into the diversion channel. Water that remains within the river channels will continue to carry a portion of the sediment load, however the quantity and flow of water will be diminished. This will result in additional sediment deposition downstream of the proposed structures. These areas of additional sediment deposition could bury and kill mussels if significant mussel beds are present.

Mussel species dispersal may be restricted during the operational phases of this project. Mussels infest host fish with glychodia, larval stage of mussel, which results in the host fish potentially transporting the glychodia to new suitable aquatic habitat. If fish passage is restricted during flood events potentially infested fish will not be able to disperse the glychodia. Infested fish may also move up the diversion channel and become stranded, or the glychodia could drop off in the diversion channel in unsuitable permanent habitat.

Infested fish moving in the diversion channel could result in the loss of larval stage mussels, and reduce the reproductive success and dispersion of various mussel species.

Direct Impacts of the Federally Comparable Plan

Habitat Loss

Construction and excavation associated with the proposed project will result in the removal or degradation of riparian forest, wetlands (various types), grasslands, and riverine aquatic habitat. The current plan for structure placement and diversion channel route will result in the following impacts; 89 acres of forested habitat, 360 acres of wetlands (direct and indirect), and 10 acres of riverine aquatic habitat. Activities resulting in direct impacts include; diversion channel excavation, Red River control structure construction, weir construction, and levee constructions.

The exact acreage of the various habitats impacted by the project should be calculated once the extent and location of the alternatives are determined.

Fisheries

Construction and excavation within the Red River could kill adult or juvenile fish. Sediment discharges caused by the aforementioned work could result in adult and juvenile individuals being killed if their gills become filled with sediment, spawn bed abandonment by adult fish, and also the covering of spawning beds with silts and fines resulting in the loss of eggs within the bed. Large sediment loads could also lead to disruptions in foraging success for fish directly downstream of excavation and construction areas within the rivers or areas of bank construction or excavation. Disruption of foraging success could result in the death of juvenile individuals, or prohibit adult fish from spawning due to malnutrition.

Wildlife

Excavation and construction within forested areas, wetlands, and grasslands may be expected to potentially kill or displace nesting adult birds if construction activities occur during the primary nest seasoning (April 1st – August 31st). Abandonment of nests and crushing of eggs within construction and excavation areas is also considered a direct wildlife impact.

Mammal species within the excavation and construction areas will be displaced or killed during project activities. The majority of adult individuals should be mobile enough to move out of the construction/excavation areas prior to being injured or killed by equipment. The exception may be borrowing species that may be injured or killed during excavation activities. Juvenile individuals may not be able to avoid construction and excavation activities resulting in injury or death of certain individuals.

Mussel species within the Red River may be killed by direct construction or excavation activities within mussel beds. Feeding activities and gill function may be interrupted by large sediment loads during construction and excavation activities. This could result in the death of individuals, or a reduction in or lack of reproduction by adult individuals.

Indirect Impacts of the Federally Comparable Plan

Habitat Loss and Conversation

With additional sediment load and deposition occurring within the Red River will experience some alteration of bed composition. Also, because of structure placement and reductions in the current regular flood flows through the Red River, sediments could accumulate and alter the aquatic habitat. This could also result in the need for regular mechanical clean out, which would disturb riparian habitat, aquatic habitat, and fish and wildlife species in the area of the clean out.

Wetlands within the floodplain of the Red River, and downstream of the proposed structures and diversion channel, may be converted to non-wetland or a drier hydrologic regime if they are heavily influenced hydrologically by regular flood events that currently occur.

Fisheries

Movement of fish species within the Red River will be impeded by the construction of the control structure within the river channel as part of this project. Fish passage impacts will be noticeable during flood flow events between 9,600 cfs and 25,000 cfs. Fish passage will stop during flows exceeding 25,000 cfs.

Aquatic organisms displaced by flood events would also be affected by operation of a diversion channel. Fish carried into the diversion may be vulnerable to stranding during lower but more frequent flood events (e.g. 5 or 10 year event) if 1) they are unable to find their way back to the river as water levels recede or 2) the flow dissipates before reconnecting to the Red River. Flood-formed scour pools may provide refugia for these fish but they would not survive the winter in such habitat. During planning it has been mentioned that a base flow will be maintained throughout the entire diversion channel. A base flow would be beneficial, but larger species may not be able to effectively move even with a base flow channel.

Given the scenario above, it appears that a certain degree of fish mortality is unavoidable. The level of mortality is dependant upon the number of fish entering the diversion channel, abundance of water in the channel, and the life stage (juvenile or adult) of the affected individuals.

Wildlife

Once the project is in the operational phase mussels could be affected by additional impacts of operation. During flood events the gates on the Red River control structure will close, resulting in deposition of some additional sediment on the upstream side of the structure. A large sediment load could bury and kill individuals. Sediment deposition may also occur downstream of the Red River control structure. Water that remains within the river channel will continue to carry a portion of the sediment load, however the quantity and flow of water will be diminished. These areas of additional sediment deposition could bury and kill mussels if significant mussel beds are present.

Mussel species dispersal may be restricted during the operational phases of this project. Mussels infest host fish with glychodia, larval stage of mussel, which results in the host fish potentially transporting the glychodia to new suitable aquatic habitat. If fish passage is restricted during large flood events potentially infested fish will not be able to disperse the glychodia. Infested fish may also move up the diversion channel and become stranded, or the glychodia could drop off in the diversion channel in unsuitable permanent habitat. Infested fish moving in the diversion channel could result in the loss of larval stage mussels, and reduce the reproductive success and dispersion of various mussel species.

<u>Direct Impacts of the ND 35K Diversion Channel Alternative</u>

Habitat Loss

Construction and excavation associated with the proposed project will result in the removal or degradation of riparian forests, wetlands (various types), grasslands, and riverine aquatic habitat. The current plan for structure placement and diversion channel route will result in the following impacts; 157 acres of forested habitat, 767 acres of wetlands (direct and indirect), and 37 acres of riverine aquatic habitat. Activities resulting in direct impacts include; diversion channel excavation, Red River and Wild Rice River control structure construction, weir construction, levee constructions, Wolverton Creek gated culvert placement, Sheyenne and Maple River crossings construction (aqueducts), and tributary flow diversion and abandonment (Lower Rush and Rush Rivers).

The exact acreage of the various habitats impacted by the project should be calculated once the extent and location of the alternatives are determined.

Fisheries

Construction and excavation within the riverine aquatic habitats could kill adult or juvenile fish. Sediment discharges caused by the aforementioned work could result in adult and juvenile individuals being killed if their gills become filled with sediment, spawn bed abandonment by adult fish, and also the covering of spawning beds with silts and fines resulting in the loss of eggs within the bed. Large sediment loads could also lead to disruptions in foraging success for fish directly downstream of excavation and construction areas within the rivers or areas of bank construction or excavation. Disruption of foraging success could result in the death of juvenile individuals, or prohibit adult fish from spawning due to malnutrition.

Wildlife

Excavation and construction within forested areas, wetlands, and grasslands may be expected to potentially kill or displace nesting adult birds if construction activities occur during the primary nest seasoning (April 1st – August 31st). Abandonment of nests and crushing of eggs within construction and excavation areas is also considered a direct wildlife impact.

Mammal species within the excavation and construction areas will be displaced or killed during project activities. The majority of adult individuals should be mobile enough to move out of the construction/excavation areas prior to being injured or killed by equipment. The exception may be borrowing species that may be injured or killed during excavation activities. Juvenile individuals may not be able to avoid construction and excavation activities resulting in injury or death of certain individuals.

Mussel species within the riverine aquatic habitats may be killed by direct construction or excavation activities within mussel beds. Feeding activities and gill function may be interrupted by large sediment loads during construction and excavation activities. This could result in the death of individuals, or a reduction in or lack of reproduction by adult individuals.

<u>Indirect Impacts of the ND 35K Diversion Channel Alternative</u>

Habitat Loss and Conversation

With additional sediment load and deposition occurring the Red, Wild Rice (ND), Sheyenne, and Maple Rivers will experience some alteration of their bed composition. Also, because of structure placement and reductions in the current regular flood flows through these Rivers, sediments could accumulate and alter the aquatic habitat. This could also result in the need for regular mechanical clean out, which would disturb riparian habitat, aquatic habitat, and fish and wildlife species in the area of the clean out.

Wetlands within the floodplains of the Red, Wild Rice (ND), Sheyenne, and Maple Rivers, and downstream of the proposed structures and diversion channel, may be converted to non-wetland or a drier hydrologic regime if they are heavily influenced hydrologically by regular flood events that currently occur. Wetlands found at the confluences of the Lower Rush and Rush Rivers with the Sheyenne River would likely be converted to non-wetland or a drier hydrologic regime once the Lower Rush and Rush River channels are abandoned.

Fisheries

Movement of fish species within the Red, Wild Rice, Sheyenne, and Maple Rivers will be impeded by structures constructed within the river channels as part of this project. These fish passage impacts will be noticeable during larger flood flow events when the gates on the Red River and Wild Rice control structures are closed, and when flow velocities through the structures on the Sheyenne and Maple Rivers become high enough to impede fish passage, primarily for smaller species.

Aquatic organisms displaced by flood events would also be affected by operation of a diversion channel. Fish carried into the diversion may be vulnerable to stranding during lower but more frequent flood events (e.g. 5 or 10 year event) if 1) they are unable to find their way back to the river as water levels recede or 2) the flow dissipates before reconnecting to the Red River. Flood-formed scour pools may provide refugia for these fish but they would not survive the winter in such habitat. During planning it has been mentioned that a base flow will be maintained throughout the entire diversion channel. A base flow would be beneficial, but larger species may not be able to effectively move even with a base flow channel.

Given the scenario above, it appears that a certain degree of fish mortality is unavoidable. The level of mortality is dependant upon the number of fish entering the diversion channel, abundance of water in the channel, and the life stage (juvenile or adult) of the affected individuals.

Wildlife

Once the project is in the operational phase mussels could be affected by additional direct impacts of operation. In large flood flows the gates on the Red River control structure will close, resulting in deposition of sediment on the upstream side of the structure. A large sediment load could bury and kill individuals. Sediment deposition will also occur on the Wild Rice River (ND) at the point of confluence with the proposed diversion channel and downstream of this point. The structures on the Sheyenne and Maple Rivers will restrict flows during flood events, and a portion of the water will be directed into the diversion channel. Water that remains within the river channels will continue to carry a portion of the sediment load, however the quantity and flow of water will be diminished. This will result in additional sediment deposition downstream of the proposed structures. These areas of additional sediment deposition could bury and kill mussels if significant mussel beds are present.

Mussel species dispersal may be restricted during the operational phases of this project. Mussels infest host fish with glochidia, larval stage of mussel, which results in the host fish potentially transporting the glochidia to new suitable aquatic habitat. If fish passage is restricted during large flood events potentially infested fish will not be able to disperse the glochidia. Infested fish may also move up the diversion channel and become stranded, or the glochidia could drop off in the diversion channel in unsuitable permanent habitat. Infested fish moving in the diversion channel could result in the loss of larval stage mussels, and reduce the reproductive success and dispersion of various mussel species.

PROPOSED MINIMIZATION AND MITIGATION ACTIVITIES

1. Construction of two or more fish bypass channels is proposed to improve fish passage around the Red River and Wild Rice control structures during large flow events when the gates will be closed. (LPP and ND 35K Alternatives)
    a. Bypass channels will be 40 feet wide and a total length of 900 feet consisting of a series of pools and riffles.
2. Completion of Drayton Dam fish passage to improve connectivity and off-set operational impacts to fish passage at the Red River and Wild Rice River control structures. (LPP Alternative)
3. Stream restoration and implementation of fish passage at existing dams with the Red River and it's tributaries (All Alternatives)
4. Construction of two bypass channels is proposed to improve fish passage around the Red River control structure during large flow events when the gates will be closed. (FCP Alternative)
    a. Bypass channels will be 40 feet wide and a total length of 900 feet consisting of a series of pools and riffles.
5. A natural substrate will be maintained under the Red River and Wild Rice control structures and aqueduct structures on the Sheyenne and Maple Rivers to allow for complex flow regimes, which will allow for better fish passage through the structures. (All Alternatives as appropriate)
6. Maintain a meandering base flow channel within the diversion channel to assist in minimizing fish stranding. (All Alternatives)
7. Allow the bottom of the diversion channel function as aquatic and seasonal wetland habitats to provide habitat to local wildlife. (All Alternatives)
8. The abandoned Lower Rush and Rush River channels to function as seasonal wetlands and aquatic habitats to benefit local wildlife species. (LPP and ND 35K Alternatives)
9. All wetland impacts will be replaced at a ratio to meet or exceed the Compensatory Mitigation Standards of the Clean Water Act, Section 404 Permit Program. State wetland laws will also be satisfied. (All Alternatives)
10. Impacted forested areas will be replaced at a 1:1 ratio. (All Alternatives)
11. Grassland habitat impacts will be offset by the reconstruction of native prairie on the inside slope of the diversion channel following construction. (All Alternatives)
12. Adaptive Management measures will be implemented for the proposed project, which will entail various monitoring, assessments, operational changes, and additional mitigation if necessary. (All Alternatives)

RECOMMENDATIONS

1. Determine wetland acreage to be impacted directly or indirectly by the proposed project, and assess the functions and values of individual wetlands with an established method of assessment, such as the Minnesota Rapid Assessment Method (MnRAM).
    a. This recommendation was provided by the Service in 2010, and has been completed by the Corps.
2. Provide compensatory mitigation for all wetland impacts in accordance with the standards specified for a Section 404 Permit under the Clean Water Act. A final wetland mitigation plan should be coordinated with the Service and Corps Regulatory Project Manager.
3. Wetlands within the currently active floodplains of the Red, Wild Rice (ND), Sheyenne, Lower Rush, and Rush Rivers, downstream of the proposed structures and the diversion channel crossings or channel abandonments should be monitored for a 10 year period following the beginning of project flood reduction operations. This monitoring should focus on hydrologic impacts to the wetlands, wetland type conversions, and loss of wetlands. (All Alternatives as appropriate)
4. Utilize the data provided by the proposed geomorphic and biotic surveys within the potentially affected reaches of Red, Wild Rice (ND), Sheyenne, Maple, Lower Rush, and Rush Rivers to assess the quality of existing habitats and quantify impacts to the fish and wildlife resources.
5. Utilize native plant species in all aspects of mitigation, reconstruction, and replanting involved with the project.
6. Avoid impacts to migratory bird nesting habitats (woodlands, grasslands, and wetlands) during the primary nesting season, April 1st to August 31st, to the greatest extent that is feasible.
7. Provide equal mitigation (1:1) for lands currently enrolled in state or federally funded restoration or conservation programs that will be impacted by the proposed project.
8. Raptor nest surveys should be conducted every spring to determine the presence of existing or new nests that may be affected by the project construction and excavation activities. Surveys should be completed annually prior to “leaf out” until the project construction is complete.
9. Follow the Service’s National Bald Eagle Management Guidelines to minimize the likely-hood that the proposed project will affected any bald eagles nesting in the Fargo/Moorhead Project Area.
10. Allocate funding toward and coordinate with the Service to develop large scale wetland restoration areas within the upstream reaches of the Red River basin, which could help attenuate flood waters in the smaller more frequent storm events.
11. A survey for blooming western prairie fringed orchids will be coordinated with the Service, and will be completed at the identified location within the upstream staging area in Richland County, ND.

	LPP	FCP	ND 35K
Total Wetland Impacts	1,161 acres	972 acres	1,058 acres
Forest Impacts	199.3	89 acres	157 acres
Aquatic Riverine Impacts	46 acres	10 acres	37 acres
Red River Fish Passage Impacts	Yes	Yes	Yes
Red River Tributary Fish Passage Impacts	Yes	No	Yes
# of Rivers Impacted	6	1	6
Federal Threatened and Endangered Species Impacted	No	No	No
Bald Eagles Impacted	Unknown	No	No
Red River Sedimentation Impacts	Yes	Yes	Yes
Red River Tributary Sedimentation Impacts	Yes	No	Yes

Table 2. Impact Analysis Comparison Alternatives.

SUMMARY

River channel morphology is largely defined by the frequency and intensity of floods. Flood events and the intensity of their environmental effects are naturally unpredictable. The LPP, FCP, and ND 35K alternatives involve the construction and operation of a control structure within the Red River. Operation of the Red River control structure and the associated diversion channel will, reduce the magnitude of flood flows, into the Fargo – Moorhead Metro Area. This reduction in peak flow could affect sediment loads and deposition within the Red River. The LPP and ND 35K alternatives also includes a second control structure within the Wild Rice (ND) River, diversion channel crossing structures on the Sheyenne and Maple Rivers, and the abandonment of portions of the Lower Rush and Rush Rivers.

All proposed alternatives will result in direct and indirect wetland impacts. The LPP and ND 35K Alternative will impact more wetlands then the FCP alternative. There will be some wetland loss through direct excavation and/or fill of wetlands during channel, levee, and structure construction. Riparian wetlands along the river corridors are likely to incur some indirect impacts as the change in flood elevations may result in changes to the hydrologic inputs to some of these wetlands. The exact extent of wetland impacts cannot be quantified at this time as the footprint and design of the project have not been finalized. Wetland mitigation needed to address these issues should be carried out concurrent with project construction.

All alternatives may impact fish passage, fish spawning areas, mussel beds, and terrestrial wildlife habitat during construction, excavation, operation, and maintenance of the proposed Fargo-Moorhead Flood Reduction Project. The LPP and ND 35K Alternative as proposed will result in greater ecological impacts, then the FCP Alternative. The LPP and ND 35K Alternative impacts are greater due to the higher number of rivers affected by the diversion channel, greater potential for fish connectivity impediment, and wildlife habitat disturbance. Outside of work within the Red River and the adjacent riparian habitat the FCP alternative primarily affects agricultural lands.

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APPENDIX 1

FISH AND WILDLIFE RESOURCES OF THE RED RIVER

Table 1. Fish species present in the Red River drainage. (Aadland et al. 2005)

Common Name	**Scientific Name**
Chestnut lamprey	*Ichthyomyzon castaneus*
Silver lamprey	*Ichthyomyzon unicuspis*
White sucker	*Catostomus commersoni*
Silver redhorse	*Moxostoma anisurum*
Golden redhorse	*Moxostoma erythrurum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Greater redhorse	*Moxostoma valenciennesi*
Spotfin shiner	*Cyprinella spiloptera*
Carp	*Cyprinus carpio*
Brassy Minnow*	*Hybognathus hankinsoni*
Common shiner	*Luxilus cornutus*
Bowfin	*Amia calva*
Emerald shiner	*Notropis atherinoides*
Bigmouth shiner	*Notropis dorsalis*
Blackchin shiner*	*Notropis heterodon*
Blacknose shiner*	*Notropis heterolepis*
Sand shiner	*Notropis stramineus*
River shiner	*Notropis blennius*
Spottail shiner	*Notropis hudsonius*
Carmine shiner*	*Notropis percobromus*
Northern redbelly dace*	*Phoxinus eos*
Fathead minnow	*Pimephales promelas*
Western blacknose dace*	*Rhinichthys obtusus*
Longnose dace	*Rhinichthys cataractae*
Creek chub	*Semotilus atromaculatus*
Black bullhead	*Ameiurus melas*
Yellow bullhead	*Ameiurus natalis*
Brown bullhead	*Ameiurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Tadpole madtom	*Noturus gyrinus*
Central Mudminnow	*Umbra limi*
Northern pike	*Esox Lucius*
Trout-perch	*Percopsis omiscomaycus*
Rock bass	*Ambloplites rupestris*
Pumpkinseed*	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Largemouth bass*	*Micropterus salmoides*
Black crappie	*Pomoxis nigromaculatus*
White Crappie	*Pomoxis annularis*
Johnny darter	*Etheostoma nigrum*
Yellow perch	*Perca flavescens*
Blackside darter	*Percina maculate*
Logperch	*Percina caprodes*
Sauger	*Stizostedion canadense*
Walleye	*Stizostedion vitreum*
Freshwater drum	*Aplodinotus grunniens*

Table 1 cont'd. Fish species present in the Red River drainage. (Aadland et al. 2005)

Common Name	**Scientific Name**
Goldeye	*Hiodon alosoides*
Mooneye	*Hiodon tergisus*
Rainbow trout*	*Oncorhynchus mykiss*
Quillback	*Carpiodes cyprinus*
Bigmouth Buffalo	*Ictiobus cyprinellus*
Goldfish	*Carassius auratus*
Silver chub	*Macrhybopsis margarita*
Hornyhead chub	*Nocomis biguttatus*
Golden shiner	*Notemigonus chrysoleucas*
Bluntnose minnow	*Pimephales notatus*
Flathead chub	*Platygobio gracilis*
Stonecat	*Noturus flavus*
Muskellunge	*Esox masquinongy*
Rainbow smelt	*Osmerus mordax*
Banded killifish	*Fundulus diaphanous*
Burbot	*Lota lota*
White bass	*Morone chrysops*
Green sunfish	*Lepomis cyanellus*
Orangespotted sunfish	*Lepomis humilis*
Smallmouth bass	*Micropterus dolomieu*
Iowa Darter	*Etheostoma caeruleum*
Lake Sturgeon	*Acipenser fulvescens*

*Found in the tributaries to the Red River, but not in the main stem of the Red River.

Table 2. Mammals of the Fargo-Moorhead Project Area.

Common Name	Common Name
Grey fox	Fox squirrel
Red fox	Red squirrel
Raccoon	Northern flying squirrel
Striped skunk	Beaver
Coyote	Muskrat
Masked shrew	Deer mouse
Pygmy shrew	White-footed mouse
Short-tailed shrew	Southern red-backed vole
Star-nosed mole	Meadow vole
Little brown myotis	Prairie vole
Big brown bat	Norway rat
Red bat	House mouse
Eastern Cottontail Rabbit	Meadow jumping mouse
White-tailed jackrabbit	Plains pocket mouse
Eastern chipmunk	Ermine
Least chipmunk	Long-tailed weasel
Woodchuck	Least weasel
Thirteen-lied ground squirrel	Gray wolf
Franklin's ground squirrel	River otter
Eastern gray squirrel	Mink
White-tailed deer	Badger
Opossum	

Table 3. Amphibians and Reptiles of Clay County, Minnesota.

Common Name (Amphibians)	Common Name (Reptiles)
Northern leopard frog	Common garter snake
Wood frog	Redbelly snake
Gray treefrog	Plains hog nosed snake
Western chorus frog	Plains garter snake
Boreal chorus frog	Smooth green snake
American toad	Snapping turtle
Canadian toad	Painted turtle
Great plains toad	Prairie skink
Tiger salamander	

Table 4. Mussels in the Fargo-Moorhead Area. (Sietman 2008)

Common Name	Scientific Name
Fatmucket	*Lampsilis siliquoidea*
Threeridge	*Amblema plicata*
Giant floater	*Pyganodon grandis*
Black Sandshell	*Ligumia recta*

Table 5. Breeding Birds of Clay County, Minnesota. (MN DNR)

Common Name	Common Name
Canada goose	Sedge wren
Wood duck	Eastern bluebird
Mallard	Veery
Blue winged teal	American robin
Ring necked duck	Gray catbird
Pied billed grebe	Brown thrasher
Red necked grebe	European starling
Double crested cormorant	Cedar waxwing
Great blue heron	Yellow warbler
Northern harrier	Chestnut sided warbler
Red tailed hawk	American redstart
Killdeer	Ovenbird
Upland sandpiper	Common yellowthroat
Wilson's snipe	Scarlet tanager
Black tern	Chipping sparrow
Rock pigeon	Clay colored sparrow
Mourning dove	Field sparrow
Great horned owl	Vesper sparrow
Chimney swift	Savannah sparrow
Ruby throated hummingbird	Grasshopper sparrow
Red bellied Woodpecker	Le Conte's sparrow
Yellow bellied sapsucker	Song sparrow
Downy woodpecker	Swamp sparrow
Hairy woodpecker	Rose breasted grosbeak
Northern flicker	Indigo bunting
Eastern wood-pewee	Bobolink
Alder flycatcher	Red winged blackbird
Willow flycatcher	Western meadowlark
Least flycatcher	Yellow headed blackbird
Eastern phoebe	Brewer's blackbird
Great crested flycatcher	Common grackle
Western kingbird	Brown headed cowbird
Eastern kingbird	Baltimore oriole
Yellow throated vireo	American goldfinch
Warbling vireo	Baird's sparrow
Red eyed vireo	Bald eagle
Blue jay	Burrowing owl
American crow	Chestnut collared longspur
Horned lark	Greater prairie chicken
Tree swallow	Henslow's sparrow
Bank swallow	Loggerhead shrike
Barn swallow	Marbled godwit
Black capped chickadee	Nelson's sharp tailed sparrow
White breasted nuthatch	Sprague's pipit
House wren	Trumpeter swan
Wilson's phalarope	Yellow rail
Northern cardinal	

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Attachment 3

Fargo-Moorhead Metro

Supplemental Draft Feasibility Report and Environmental Impact Statement

April 2011

Cultural Resources Programmatic Agreement

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PROGRAMMATIC AGREEMENT
AMONG THE U.S. ARMY CORPS OF ENGINEERS, ST. PAUL DISTRICT,
THE NORTH DAKOTA STATE HISTORIC PRESERVATION OFFICER, AND
THE MINNESOTA STATE HISTORIC PRESERVATION OFFICER
REGARDING
THE FARGO-MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT,
CASS COUNTY, NORTH DAKOTA AND CLAY COUNTY, MINNESOTA

Draft – April 2011

WHEREAS, the St. Paul District, U.S. Army Corps of Engineers (Corps) is conducting a feasibility study of flood risk management measures for the cities of Fargo, Cass County, North Dakota and Moorhead, Clay County, Minnesota; and

WHEREAS, the Corps is considering the following flood risk management measures for the Fargo Moorhead metropolitan area and adjacent county areas (Figures 1 and 2): (1) Diversion channel on the east (Minnesota) side of the Red River of the North capable of passing 20,000 cfs [tentative National Economic Development (NED) Plan alternative] and (2) Diversion channel on the west (North Dakota) side of the Red River of the North capable of passing 35,000 cfs [Locally Preferred Plan alternative].

WHEREAS, the necessary cultural resources investigations, evaluations, and coordination for compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, cannot be completed by the Corps or its agent prior to starting the design stage of the Fargo-Moorhead Metropolitan Flood Risk Management Project (Project); and

WHEREAS, the Corps has established the Project's Area of Potential Effects (APE), as required by 36 CFR § 800.4(a)(1) and defined in section 800.16(d), as consisting of the footprint of the selected diversion plan including the diversion channel alignment, its associated tieback levee, associated construction work areas, construction staging areas, borrow areas, and disposal areas, as well as associated upstream and downstream water storage and water staging areas, project-related floodproofing locations, and the viewshed to one-half mile from the diversion channel's and tieback levee's centerlines; and

WHEREAS, the Corps has determined that the Project may have effects on historic properties within the APE and has consulted with the Advisory Council on Historic Preservation (Advisory Council) pursuant to section 800.2(b) of the regulations (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act (16 U.S.C. § 470f), and the Advisory Council has declined to participate in the Programmatic Agreement for this Project; and

WHEREAS, the City of Fargo, North Dakota, and the City of Moorhead, Minnesota (Cities), as the non-Federal sponsors for the Project, have participated in consultation on the Project's flood risk management measures and have been invited to concur in this Programmatic Agreement as consulting parties; and

WHEREAS, Cass County in North Dakota and Clay County in Minnesota are also interested parties and have been invited to participate in consultation on the Project's flood risk management measures and to concur in this Programmatic Agreement as consulting parties; and

WHEREAS, the Corps' St. Paul District Engineer initially contacted the chairman or chairwoman of the Sisseton-Wahpeton Oyate, the White Earth Band of Minnesota Chippewa, the Leech Lake Band of Ojibwe, the Turtle Mountain Band of Chippewa, the Upper Sioux Community of Minnesota, the Lower Sioux Indian Community, the Spirit Lake Tribe, and the Red Lake Band of Chippewa Indians, by letter dated April 8, 2009, and initially contacted the chairman or chairwoman of the Bois Forte Band of Chippewa Indians, the Three Affiliated Tribes (Mandan, Hidatsa and Arikara Nation), the Northern Cheyenne Tribe, the Standing Rock Sioux Tribe, the Yankton Sioux Tribe, and the Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, by letter dated October 7, 2010, to determine these tribes' interest in the Project, particularly regarding potential Project effects on properties important to their history, culture, or religion, including traditional cultural properties, and the Corps will consult with any of these tribes interested in this Project; and

WHEREAS, the general public's opinions and comments on the Project and its alternative alignments have been and will be solicited through public meetings, including those held to comply with the National Environmental Policy Act (NEPA);

NOW THEREFORE, the Corps, the North Dakota State Historic Preservation Officer (SHPO), and the Minnesota State Historic Preservation Officer agree that upon filing this Programmatic Agreement (PA) with the Advisory Council on Historic Preservation, the Corps will implement the following stipulations in order to comply with Section 106 of the National Historic Preservation Act, as amended, with respect to the Project.

STIPULATIONS

The Corps will ensure that the following measures are carried out prior to the start of construction on Project flood risk management features at the cities of Fargo, North Dakota, and Moorhead, Minnesota:

A. The Corps will ensure that archeologists, historians, and architectural historians meeting the Secretary of the Interior's professional qualification standards (given in Appendix A of 36 CFR Part 61) will conduct or directly supervise all cultural resources identification, evaluation, and mitigation related to this Project, to include archeological surveys and testing, historic structure inventories and evaluation, and data recovery and documentation mitigation, and be permitted in North Dakota pursuant to NDCC 55-03-01 and in Minnesota pursuant to Minnesota Statutes 138.31 to 138.42.

B. <u>Literature and Records Search</u> – Prior to conducting any fieldwork, the Corps or its contractors or the Cities' contractors shall at a minimum consult the site files, previous survey reports, and other documents at the Historic Preservation Division of the State Historical Society of North Dakota at Bismarck and at the State Historic Preservation Office at the Minnesota

Historical Society in St. Paul, for information on previously recorded cultural resources sites, site leads, and previously surveyed areas in the Project's APE.

C. Phase I Cultural Resources Investigation – The Corps or its contractors or the Cities' contractors will conduct a Phase I survey of all previously uninventoried project areas in order to locate any cultural resources (prehistoric, historic, and architectural) within the Project's APE. The cultural resources investigation will be an intensive, on-the-ground study of the area sufficient to determine the number and extent of the resources present and their relationships to Project features. The archeological investigations will take into account the unique geomorphology of the Red River Valley, and the potential for deeply buried soils.

D. Phase II Testing and Evaluation – The Corps or its contractors or the Cities' contractors will evaluate the National Register of Historic Places eligibility of all cultural resources sites or structures over 50 years old located within the APE. Evaluation shall include intensive testing to determine the information potential of prehistoric and historic archeological sites and archival research for historic archeological and architectural sites. The Corps will request the concurrence of the North Dakota SHPO or Minnesota SHPO, whichever is applicable, in determining each such site or structure's eligibility or non-eligibility to the National Register.

E. Phase III Mitigation – The Corps will avoid or minimize Project-related adverse effects to historic properties (National Register of Historic Places-listed or eligible sites, structures, buildings, districts, or objects) to the extent practicable. Where adverse effects due to the Project are not avoidable, the Corps will coordinate a data recovery or mitigation plan with the North Dakota and/or Minnesota SHPO and the other consulting parties, any affected Indian tribes, and other interested parties, as applicable, to mitigate the adverse effects. The Corps or its contractor or the Cities' contractor will then implement the data recovery or mitigation plan, which will be completed prior to the start of Project construction in that area. Mitigation will specifically address Project-related adverse effects on the integrity and characteristics of a historic property which make it eligible to the National Register.

F. Burials – If any human burials are encountered during the cultural resources field work or Project construction, the Corps and its contractors and the Cities' contractors will comply with the Native American Graves Protection and Repatriation Act (NAGPRA) for federal or tribal lands, or with North Dakota Century Code Section 23-06-27, "Protection of Human Burial Sites, Human Remains, and Burial Goods," and North Dakota Administrative Code Chapter 40-02-03, "Protection of Prehistoric and Historic Human Burial Sites, Human Remains, and Burial Goods," for all other lands in North Dakota, or with Minnesota Statutes Section 307.08, Minnesota Private Cemeteries Act, for all other lands in Minnesota, whichever is applicable.

G. Traditional Cultural Properties – The Corps will consult and coordinate with the tribes listed in the 8th WHEREAS clause above to identify sites of traditional religious or cultural importance to the tribe or their members within the Project area. Such sites shall be avoided or adverse effects to them minimized to the extent practicable and the remaining effects mitigated per a plan developed between the Corps, the applicable SHPO, and the affected tribe(s).

H. Curation – The Corps or its contractors or the Cities' contractors shall ensure that all materials and records resulting from the survey, evaluation, and data recovery or mitigation conducted for the Project will be curated in accordance with 36 CFR Part 79, "Curation of Federally-Owned and Administered Archeological Collections" at a facility within the state of North Dakota or the state of Minnesota, depending upon the location of the cultural resources fieldwork or site(s) being investigated, unless the private landowner wishes to retain ownership of artifacts recovered from his/her land.

ADMINISTRATIVE PROCEDURES

I. Dispute Resolution – Should the North Dakota SHPO, the Minnesota SHPO, or a concurring party to the PA object to any plans, documents, or reports prepared under the terms of this PA within 30 days after receipt, the Corps shall consult with the party to resolve the objection. If the Corps determines that the objection cannot be resolved, the Corps shall forward all documentation relevant to the dispute to the Advisory Council. Any recommendation or comment provided by the Advisory Council will be understood to pertain only to the subject of the dispute. The Corps' responsibility to carry out all actions under this PA that are not the subject of the dispute will remain unchanged.

J. Amendments – Any party to this PA may request that it be amended, whereupon the parties will consult to consider such amendment. The PA may only be amended with the written concurrence of all parties who have signed the PA.

K. Termination – Any signatory party to this PA may terminate it by providing thirty (30) days notice to the other parties, provided that the parties will consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. In the event of termination, the Corps will coordinate with the Advisory Council in order to fulfill its compliance obligation under the National Historic Preservation Act.

L. Anti-Deficiency Provision – All obligations on the part of the Corps under this PA shall be subject to and dependent upon the appropriation and allocation of funds to the St. Paul District for such purposes.

M. Sunset Clause – This PA will continue in full force and effect for ten (10) years and all terms of the PA are met, unless the Project is terminated or authorization is rescinded.

Execution and implementation of this Programmatic Agreement evidences that the Corps has satisfied its Section 106 responsibilities for all aspects of this undertaking.

ST. PAUL DISTRICT, U.S. ARMY CORPS OF ENGINEERS

BY: ____ Date: ______________________

COL. Michael J. Price, District Engineer

NORTH DAKOTA STATE HISTORIC PRESERVATION OFFICER

BY: ___________________________________ Date: ___________________
Merlan E. Paaverud, Jr., State Historic Preservation Officer

MINNESOTA STATE HISTORIC PRESERVATION OFFICER

BY: ___________________________________ Date: ___________________
Britta Bloomberg, Deputy State Historic Preservation Officer

Concur:

CITY OF FARGO

BY: ___________________________________ Date: ___________________
Dennis Walaker, Mayor

CITY OF MOORHEAD

BY: ___________________________________ Date: ___________________
Mark Voxland, Mayor

CASS COUNTY BOARD OF COMMISSIONERS

BY: ___________________________________ Date: ___________________
Darrell Vanyo, Chairman

CLAY COUNTY BOARD OF COMMISSIONERS

BY: ___________________________________ Date: ___________________
Kevin Campbell, Chairman

Concur:

SISSETON WAHPETON OYATE

BY: ____ Date: ____________________________
Michael Selvage, Sr., Chairman

WHITE EARTH BAND OF MINNESOTA CHIPPEWA

BY: ____ Date: ____________________________
Erma Vizenor, Chairwoman

LEECH LAKE BAND OF OJIBWE

BY: ____ Date: ____________________________
Arthur “Archie” La Rose, Chairman

TURTLE MOUNTAIN BAND OF CHIPPEWA

BY: ____ Date: ____________________________
Richard Marcellais, Chairman

UPPER SIOUX COMMUNITY OF MINNESOTA

BY: ____ Date: ____________________________
Kevin Jensvold, Chairman

LOWER SIOUX INDIAN COMMUNITY

BY: ____ Date: ____________________________
Gabe Prescott, President

Concur:

SPIRIT LAKE TRIBE

BY: ____ Date: _________________________
Myra Pearson, Chairwoman

BOIS FORTE BAND OF CHIPPEWA INDIANS

BY: ____ Date: _________________________
Kevin Leecy, Chairman

THREE AFFILIATED TRIBES (MANDAN, HIDATSA AND ARIKARA NATION)

BY: ____ Date: _________________________
Marcus D. Levings, Jr., Chairman

NORTHERN CHEYENNE TRIBE

BY: ____ Date: _________________________
Leroy Spang, President

STANDING ROCK SIOUX TRIBE

BY: ____ Date: _________________________
Charles W. Murphy, Chairman

ASSINIBOINE AND SIOUX TRIBES OF THE FORT PECK INDIAN RESERVATION

BY: ____ Date: _________________________
A.T. “Rusty” Stafne, Chairman

Concur:

YANKTON SIOUX TRIBE

BY: ____ Date: ________________________

Bobby Cournoyer, Chairman

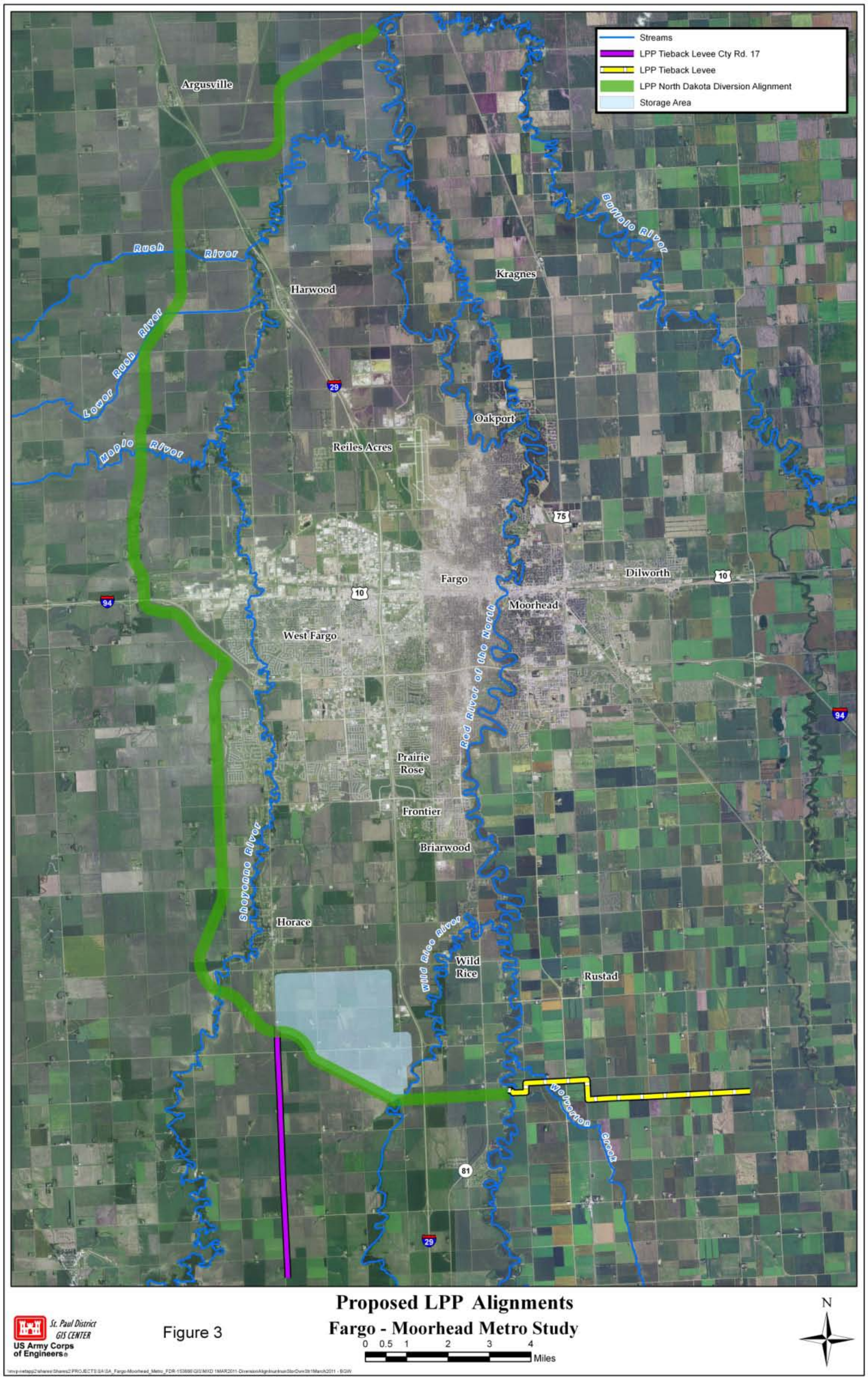

Figure 1. Proposed North Dakota Diversion alignments (LPP).

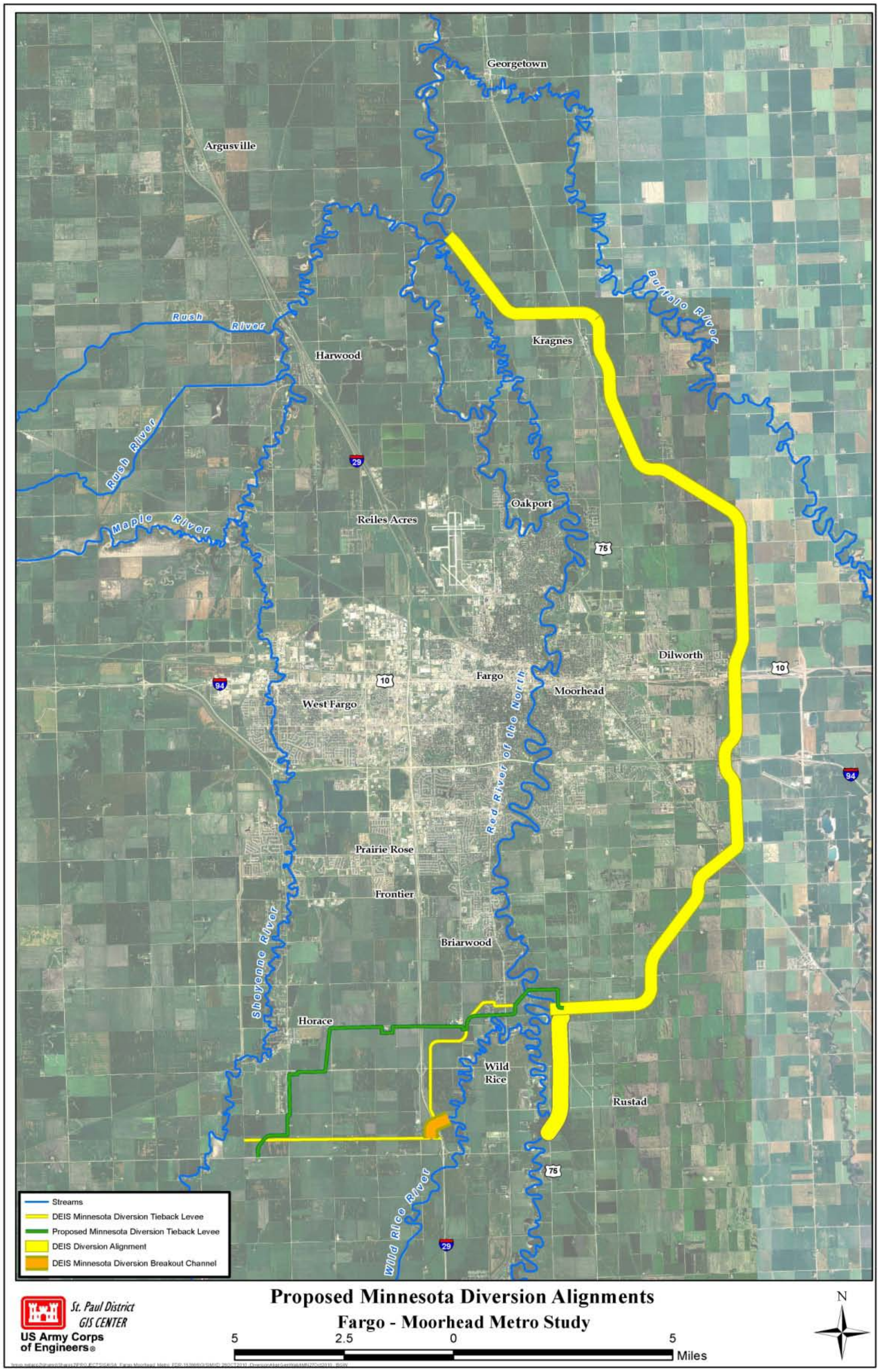

Figure 2. Proposed Minnesota Diversion alignments (FCP).

Attachment 4

Fargo-Moorhead Metro

Supplemental Draft Feasibility Report and Environmental Impact Statement

April 2011

Mailing List

PUBLIC RELEASE OF SDEIS - APRIL 2011							
EIS Contact Info. Fargo-Moorhead Project	Number of Copies: Hardcopy of Entire SDEIS Corps Report, Attachments, and Appendices.	Hardcopy of Corps Main SDEIS Report Only (report & attachments)	CD of Corps report, attachments, & appendices	CD of AE report	Hardcopy of Entire AE report	project summary (with DVDs)	Cultural appendix
FEDERAL AGENCIES							
Advisory Council on Historic Preservation							
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State Director ND State Farm Service Agency Office 1025 28th Street South Fargo, ND 58103		1	1	1			
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U.S. Forest Service Eastern Region-9 626 East Wisconsin Avenue Milwaukee, WI 53202 Phone: 414.297.3600 North Dakota		1	1	1			
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State Conservationist, Don A. Baloun United States Department of Agriculture Natural Resources Conservation Service 375 Jackson Street, Suite 600 Saint Paul, Minnesota 55101 Phone: 651. 602.7900		3	3	3			
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Federal Emergency Management Agency Federal Center Plaza Room 713 500 C Street, SW Washington, DC 20472 Phone: 202.646.2500		1	1	1				
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U.S. Geological Survey District Chief- Jim Stark 2280 Woodale Drive Mounds View, MN 55112 Phone: 763.783.3100		1	1	1				
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Director David Sprynczynatyk North Dakota Department of Emergency Services PO Box 5511 Bismarck, ND 58506-5511 Phone: 701.328.8100		1	1	1				
State Radio Director Mike Lynk North Dakota Department of Emergency Services PO Box 5511 Bismarck, ND 58506-5511 Phone: 701.328.8100		1	1	1				
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Director, Francis Ziegler North Dakota Department of Transportation 608 East Boulevard Avenue Bismarck, ND 58505-0020 Phone: 701.328.2500		1	1	1				
State Forester: Larry Kotchman North Dakota Forest Service Molber Forestry Center 307 First Street East Bottineau, ND 58318-1100 Phone: 701.228.5422		1	1	1				
Cass County, North Dakota P.O. Box 2806 Fargo, North Dakota 58108-2806		1	1	1				
Cass County Joint Water Resource District 1201 Main Ave. W. West Fargo, ND 58078-1301		1	1	1				
North Dakota Wildlife Federation ATTN: Charles Vasicek 1605 East Capitol Avenue Halkirk offices Suite #102 Bismarck, ND 58501-2102 Phone: 701.222.2557		1	1	1				

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Mayor Bill Rohrich City of Harwood PO Box 65 108 Main St. Harwood, ND 58042		1	1	1			
Mayor Shane Waloch City of Horace 215 Park Dr. E. Horace, ND 58047		1	1	1			
Mayor Jim Nyhof City of Oxbow 708 Riverbend Rd. Oxbow, ND 58047		1	1	1			
Mayor Mark Anderson City of Mapleton PO Box 94 Mapleton, ND 58059-0094		1	1	1			
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Mayor Rich Mattern City of West Fargo 800 4th Ave. W. West Fargo, ND 58078		1	1	1			
Mayor Jefferson Bay City of Reiles Acres 4515 35th Ave. N. Reiles Acres, ND 58102-5413		1	1	1			
Mayor David Susag City of North River 5302 River Dr. Fargo, ND 58102-7002		1	1	1			
Mayor Penny Kianian City of Prairie Rose 3308 40th Ave. S. Fargo, ND 58104-6626		1	1	1			
Mayor Barry Wegner City of Frontier 5301 33rd St. S. Fargo, ND 58104-6775		1	1	1			
Mayor John Adams City of Briarwood 8 Briarwood Place Briarwood, ND 58104-7308		1	1	1			
Mayor Wayne Lunder City of Kindred 230 Sheyanne St Kindred, ND 58051-4329		1	1	1			
Mayor of Hickson		1	1	1			
Mayor of Christine		1	1	1			
Mayor of Colfax		1	1	1			
Mayor of Walcott		1	1	1			
Mayor of Abercrombie		1	1	1			

LIBRARIES							
Fargo Public Library 102 N. 3rd Street Fargo, ND 58102-4899	1		1	1			
Annette Graves Administration/ HR Assistant Lake Aggasiz regional Library Distribute to: Moorhead Public Library 118 South 5th Street Moorhead, MN 56560-0076	1		1	1			
West Fargo Public Library 401 7th St. E West Fargo, ND 58078-2809	1		1	1			
Fargo Public Library, Carlson Branch 2801 32 Ave. South Fargo, ND 58103	1		1	1			
Annette Graves Administration/ HR Assistant Lake Aggasiz regional Library distribute to: Climax 118 South 5th Street Moorhead, MN 56560-0076	1		1	1			
Annette Graves Administration/ HR Assistant Lake Aggasiz regional Library Distribute to: Breckenridge 118 South 5th Street Moorhead, MN 56560-0076	1		1	1			
Kindred Public Library 330 Elm Street Kindred, ND 58051	1		1	1			
OTHERS							
Minnesota Center for Environmental Advocacy ATTN: Nancy Speer 26 East Exchange Street Suite 206 St. Paul, MN 55101-1667 Phone: 651.223.5969		1	1	1			
National Wildlife Federation 11100 Wildlife Center Drive Reston, VA 20190-5362 Phone: 800.822.9919		1	1	1			
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Attachment 4 - SDEIS Mailing List

PUBLIC							
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SPONSORS							
City of Fargo	1		1	1	1		
City of Moorhead	1		1	1	1		
Cass County	1		1	1			
Clay County	1		1	1			
St Paul district	1	21	225	225	1	200	

Attachment 5

Fargo-Moorhead Metro

Supplemental Draft Feasibility Report and Environmental Impact Statement

April 2011

Consultant's Report

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Attachment 6

Fargo-Moorhead Metro

Supplemental Draft Feasibility Report and Environmental Impact Statement

April 2011

DISCUSSION OF HABITAT LOSS, MITIGATION NEEDS AND ADAPTIVE MANAGEMENT

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1. Overview

Considerable efforts have been made with an interagency team to avoid and minimize project impacts by modifying alternative designs. However, the diversion channel alternatives would still result in the impacts identified in the main report for aquatic habitat, riparian forest and wetland resources. For these impacts, mitigation will be implemented to offset these adverse effects.

Corps regulations (ER 1105-2-100) require assessment of environmental impacts and associated mitigation actions in a manner that addresses changes in ecological resource quality. Changes to habitat must be assessed as a function of improvement or degradation in habitat quality and/or quantity, as expressed quantitatively in physical units or indexes (but not monetary units). In the case of mitigation for significant environmental impacts, ecosystem restoration actions must be formulated and evaluated in terms of their net contributions to increases in ecosystem value, expressed in non-monetary units. Mitigation actions also need to go through a Cost Effectiveness and Incremental Cost Analysis (CE/ICA) to ensure benefits are optimized relative to cost.

Corps regulations also require projects take an adaptive approach to implementing, monitoring and modifying mitigation actions to ensure they are offsetting significant project impacts (USACE Implementation Guidance for Section 2036a of WRDA 2007, Aug 2009). This guidance requires mitigation plans include: 1) monitoring until successful; 2) criteria for determining ecological success; 3) description of available lands and the basis for the determination of availability; 4) development of contingency plans (i.e., adaptive management); 5) identification of the entity responsible for monitoring; and 6) establishing a consultation process with appropriate federal and State agencies in determining the success of mitigation.

This attachment provides a detailed discussion on habitat impacts quantification, mitigation and adaptive implementation, all of which are intended to ensure adverse effects from the project are offset.

Section 2 provides a habitat-based assessment of impacts for aquatic habitat, connectivity, forest and wetland resources. It assesses losses of habitat, due to the division channel alternatives, over the next 50 years.

Section 3 provides the basis for mitigation planning. It describes various alternatives for mitigating habitat losses, and compares the costs and benefits of these basic alternatives. Given the limitations of the project schedule, specific mitigation sites have not been finalized here. For this analysis, benefits of mitigation measures are based on their potential resulting habitat conditions. A CE/ICA was performed with these various alternatives to determine which provided the best option for mitigation. The amount of mitigation needed to offset project impacts is identified, and costs for implementing this mitigation is estimated. It should be noted that the Corps has and continues to coordinate with local agencies to identify potential sites for mitigation. The Corps has identified preliminary candidate sites, and will continue to pursue specific sites in the months ahead.

Section 4 outlines the adaptive process where project impacts will be verified, along with the effectiveness of project mitigation, through pre- and post- construction monitoring. It identifies the entities involved with collaboration, monitoring and data review. It also overviews a contingency process where corrective actions could be pursued should impacts prove greater than anticipated; and/or if mitigation is proves less effective at offsetting impacts.

Section 5 outlines specific monitoring activities that will be done pre- and post-construction, including cost estimates for these activities.

Section 6 outlines performance standards/metrics that will be used to measure the success of mitigation. Collectively, this attachment will drive data collection and review. Monitoring results will be compared in the future to verify whether the impacts of the project have been offset by mitigation actions. It should be noted that many of these details are currently being developed, and will be finalized prior to construction. However, this forms the basis for confirming project impacts, and whether these impacts have been offset with mitigation.

2. ASSESSMENT OF IMPACTS AND HABITAT LOSS

The following discussion outlines how impacts are quantified in terms of habitat value. Habitat impacts will be further evaluated with detailed field assessments prior to any construction activities. The assessment here is provided based on the best existing information.

2.1 Project Impacts: Aquatic Habitat Footprint

Project impacts were first identified by reviewing features of the diversion channel alternatives and quantifying the amount of aquatic habitat impacted. To quantify footprint areas, aerial photos were reviewed within GIS to estimate the amount of riverine habitat directly affected by individual project features. The upstream and downstream extent of the footprint were first identified based on likely feature boundaries. The channel area was then identified laterally up the bank to approximately a bankfull elevation, typically identified by the presence of trees. A polygon was then established to quantify the amount of aquatic habitat impacted. These footprint areas are outlined in the main report.

The quality of these areas impacted was then quantified by using Index of Biotic Integrity (IBI) scores from EPA (1998). IBI scores from EPA (1998) were used in a fashion similar to those employed under the USFWS Habitat Evaluation Procedures (HEP). The approach here utilized the IBI scores as a qualitative description of habitat quality, scoring habitat conditions on a scale of 0.1 to 1.0 based on EPA (1998) IBI observations for the Red River Basin. IBI scores provide insight into biotic community structure, and thus aquatic health and habitat quality in stream areas. From field observations, EPA (1998) calculated quantitative scores, which were converted into the following integrity classes: Excellent, Good, Fair, Poor, and Very Poor. To apply the IBI as a quality factor, each of the classes was assigned a quantitative value between 0.1 and 1.0 (Table 1). To assess habitat quality in footprint impact areas, the closest IBI observation was used for each aquatic area (Figure 1). The applied quantitative score was multiplied by the acres impacted by the footprint to derive a total number of Habitat Units lost.

From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula: IBI score x Acres = HUs. While this not a formal HEP model, this approach does provide a method to assess habitat loss with available information. This approach suggests that, for the FCP, about 27-28 acres of footprint impact to aquatic habitat results in about 15.1 Habitat Units lost (Table 2). Conversely, for the ND35K and LPP, about 45.4 acres of footprint impact to aquatic habitat results in about 16.9 Habitat Units lost (Table 3).

For the purpose of this assessment, it is assumed that habitat within the footprint will be completely lost, with mitigation to create or improve habitat nearby. In reality, some habitat would exist within the newly excavated channels leading into and out of project structures. These newly excavated areas will be evaluated during post-project monitoring to determine what habitat they provide. However, to be conservative with our impact assessment and mitigation estimates, it is assumed that existing river channel substantially modified or abandoned under the project will be permanently lost.

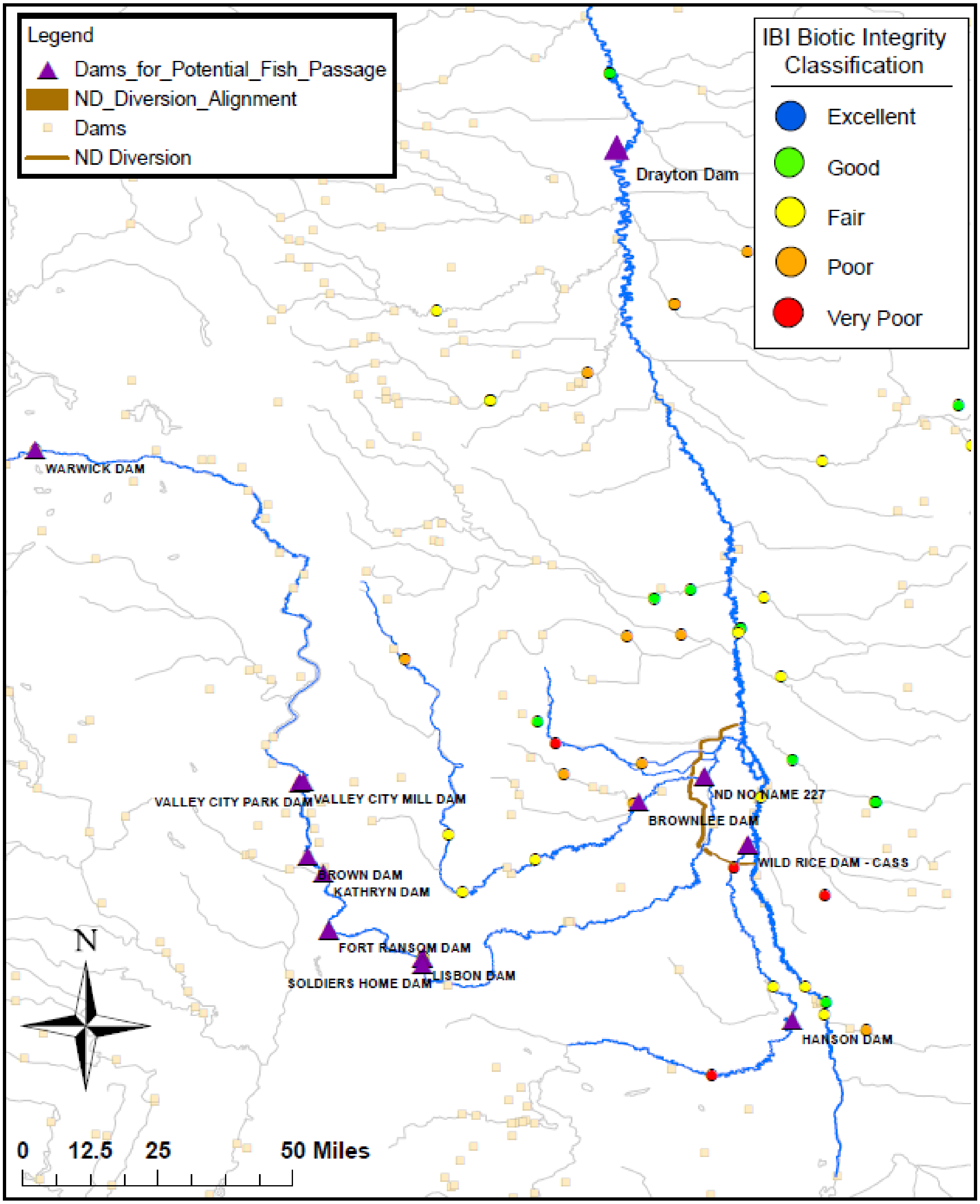


Figure 1. Index of Biotic Integrity observations (EPA 1998) for various tributaries in the Red River Basin. Dams considered for potential fish passage, as a mitigation approach, are also noted.

Table 1 Quantitative score assumed for each IBI integrity class from EPA (1998).

IBI Integrity Class (EPA 1998)	Applied Quantitative Score
Excellent	1.0
Good	0.8
Fair	0.55
Poor	0.3
Very Poor	0.1

Table 2 Footprint impact areas and corresponding habitat units for aquatic impacts by project features under the FCP.

Impact	Footprint Impact Area (ac)	IBI Integrity in Footprint Area*	Habitat Units
Red River Control Structure	27.5	0.55	15.1
Red River Outlet Structure	0**	0.55	0
Total	27.5		15.1

* IBI score based on the closest IBI observation to the impact area on the same stream.
** The outlet structure will have rock erosion protection that occurs within aquatic habitat. This footprint is not included here as it was determined to not be a significant loss or degradation to habitat that would require additional mitigation.

Table 3 Footprint impact areas and corresponding habitat units for aquatic impacts by project features under the ND35K and LPP alternatives.

Impact	Footprint Impact Area (ac)	IBI Integrity in Footprint Area*	Habitat Units
Red River Control Structure	13.9	0.55	7.6
Red River Outlet Structure	0**	0.55	0
Wild Rice River Control Structure	12.1	0.1	1.2
Sheyenne River Aquaduct	8.4	0.55	4.6
Maple River Aquaduct	10.7	0.3	3.2
Wolverton Creek Tie-back Levee	0.3	0.8	0.2
Total	45.4		16.9

* IBI score based on the closest IBI observation to the impact area on the same stream. No IBI observations were provided for Wolverton Creek. To be conservative, the IBI was assumed at 0.8 ("good" integrity), which is the highest score for any stream in the project area (e.g., sections of the Red River; Buffalo River (MN) and Goose River (ND)).
** The outlet structure will have rock erosion protection that occurs within aquatic habitat. This footprint is not included here as it was determined to not be a significant loss or degradation to habitat that would require additional mitigation.

One final aspect to assessing lost habitat is how conditions could change over time. Changes in the amount of habitat (and habitat units) could occur as habitat changes and is influenced over time by river and watershed conditions. Improved watershed conditions could improve stream health in the future, thus habitat loss could be greater over time. Conversely, continued degradation could further reduce the amount of habitat that is lost through these footprint impacts. To help identify general habitat changes over time, Habitat Units are averaged over the life of the project (50 years) to determine what is known as the Average Annual Habitat Units (AAHUs). AAHUs are used to estimate site-specific changes for the diversion channel alternatives.

There is great uncertainty with how future habitat conditions will ultimately change in the project area. Continued urbanization in combination with existing land use practices will further stress aquatic ecosystems, which could result in further degradation. Conversely, efforts are ongoing in some watershed locations to improve at least some aspects of land use, habitat connectivity and site-specific habitat conditions.

Given the uncertainty with whether habitat conditions might generally improve or degrade, or to what magnitude such changes would occur, it is assumed that conditions would remain constant over time. It is recognized that habitat conditions likely will not remain constant. However, this approach hopefully minimizes the potential to either underestimate or overestimate potential project impacts.

The impacts outlined would occur immediately when project features are constructed, and remain constant over the project life. This assumption results in a total of 16.3 and 16.9 AAHUs lost through footprint impacts, respectively, for the Minnesota (FCP) and North Dakota diversion channel alternatives (LPP and ND35K).

<u>2.2 Fish passage and Connectivity</u>

The FCP and ND35K already include two fish passage channels to minimize adverse effects to connectivity. It is unlikely these two alternatives would have substantial impacts to long-term fish population trends due to reduced connectivity associated with these alternatives. No further mitigation is proposed for connectivity impacts under these two alternatives.

As with the FCP and ND35K, the LPP already includes two fish passage channels within the design presented here. However, the LPP could potentially impact connectivity through a protracted period of operation, relative to the FCP and ND35K. Installation of additional fish passage channels at the Red River control structure would help alleviate this problem, though additional mitigation could be warranted. The frequency and timing of project operations, and thus the effects to connectivity, are outlined in the main report. This reduction in connectivity would reduce access to over 400 miles of river habitat (estimated at roughly 3,700 acres of aquatic habitat). Although observations are limited, this included areas observed by EPA (1998) as “fair” in terms of biotic integrity. Following the approach outlined above, this would equate to over 2,000 AAHUs that could be less available under the LPP. Given the concern with connectivity expressed by the natural resource agencies for the Red River, additional mitigation would be implemented to offset this impact.

Similarly, the LPP also could potentially impact connectivity on the Wild Rice River. The level of impact could be slightly different from that on the Red River, given limited connectivity and habitat integrity on the Wild Rice. The presence of two low-head dams already fragments connectivity on the Wild Rice (Figure 1), with a dam both upstream and downstream of the proposed structure. It should be noted that these two low-head dams likely are an impediment during low-flow periods, while the proposed Wild Rice structure would be an impediment during high-flow periods. Habitat value within the Wild

Rice appears limited, with IBI scores observed by EPA (1998) that ranged from “fair” to “very poor”. When operating, the project could reduce access to approximately 350 AAHUs of available Wild Rice River habitat (based on access to 1,400 acres of habitat, with a quality of 0.25). Given the expense of installing additional fish passage channels and the presence of other barriers to connectivity, it is possible that greater benefits could be obtained by implementing additional mitigation for connectivity impacts elsewhere on the Wild Rice River rather than installing additional fish passage features at the structure.

The LPP and ND35K could disrupt fish migrations by attracting fish into the diversion channel that would be unable to migrate through the upstream end of the diversion. The impact would likely be more pronounced under the LPP which would operate for a longer period of time. However, this impact is speculative, and difficult to assess prior to project operations. Moreover, fish would be able to migrate out of the diversion and back to the Red River. No mitigation is currently budgeted for resolving this impact. However, should the impact be found to be significant within the first few years of operation, construction funds could be used to consider and implement potential mitigation. Contingency funding for mitigation would likely cover this expense, depending on what solutions are identified.

2.3 Other Aquatic Impact Conclusions

No other mitigation is currently proposed for aquatic impacts.

As discussed in the main report, project features for the FCP, ND35K, and LPP would not be expected to result in significant adverse impacts to aquatic habitat via altered geomorphic conditions.

The LPP could have the potential to result in fish stranding in upstream areas where water staging occurs. However, this impact is largely unknown and will require project operation and monitoring to fully gage whether there are any substantial impacts. Any impacts would require further evaluation before mitigation would be pursued.

2.4 Project Impacts: Floodplain Forest

Construction of the three diversion channel alternatives for the Fargo Moorhead Metro Flood Risk Reduction Project would result in the loss of floodplain forest and upland forest. An estimated 117 acres of floodplain forest would be affected by both the ND35K and the LPP, and 42 acres of floodplain forest would be affected by the FCP. An additional 41.5 acres of upland forest will be lost for the ND35K, 82 acres for the LPP and 47 acres for the FCP. The upland forested acres mostly consist of shelter belts or small pockets of forest around farmsteads.

The U.S. Fish and Wildlife Service’s 1980 version of its Habitat Evaluation Procedures (HEP-80) was used to quantify and evaluate the potential project impacts on floodplain forests and to evaluate mitigation approaches. The HEP methodology utilizes a Habitat Suitability Index (HSI) to rate habitat quality on a scale of 0 to 1 (1 being optimum – see Table 4). The HSI is multiplied by the number of acres of available habitat to obtain Habitat Units (HU’s). One HU is defined as one acre of optimum habitat. By comparing existing HU’s with expected HU’s lost or gained with an alternative, impacts can be quantified.

Table 4 Habitat Suitability index rankings

Habitat Suitability Index	Verbal Equivalent
0.0 < 0.2	Poor
0.2 < 0.4	Marginal
0.4 < 0.6	Fair
0.6< 0.9	Good
0.9 < 1.0	Optimum

<u>HEP Model Selection</u>

Given the nature and types of impacts expected with the diversion channel alternatives, a riparian community model that addresses composition, structure, diversity and extent in the landscape would be most appropriate for the analysis of floodplain forest impacts. While there are several riparian/woodland community models that have been certified, there are no certified HSI community models available that would be applicable to the project area. Therefore, several existing species models were used to identify the range of effects on different components of the riparian community.

Through interagency coordination five species were selected in order to evaluate the area that would be impacted: the Belted Kingfisher (*Megaceryle alcyon)*, Gray Squirrel (*Sciurus griseus)*, Wood duck (*Aix sponsa),* Black-capped Chickadee (*Poecile atricapillus*), and Mink (*Mustela vison)*. Each one of these species requires habitat that is included in a riparian area. The kingfisher model and gray squirrel model were selected based on recommendations from the North Dakota Game and Fish (NDGF), because king fisher's are typically a bird of riparian habitat and the gray squirrel model measures the value of forest diversity. The wood duck model measures the availability of snags or cavity trees which are important for nesting, the black-capped chickadee looks at forest composition and the mink model measures vegetative cover near, in, and over the rivers. HSI values were calculated for the five species using field data collected in the floodplain forest along the Red River, Sheyenne River and Wild Rice River.

<u>Data Requirements</u>

Table 5 lists the model variables identified in each of the five species models, the method used for collecting the field data, and the HSI equation used for the analysis.

Table 5. Variables for each HEP model.

Belted Kingfisher	Variable	Variable Description
Measured	V2	Water Transparency
Measured	V3	% cover of emergent vegetation
Measured	V4	% of water deeper than 24 inches
Measured	V5	% riffles
Estimated	V6	Average shoreline subsection with perches
Estimated	V7	Distance to nearest suitable soil bank
HSI Equation		(SIV2 X SIV4 X SiV5)^1/3 X SIV3

Gray Squirrel	Variable	Variable Description
Measured	V1	% hard mast producing trees
Count	V2	# of hard mast producing trees
Measured	V3	% canopy cover
Measured	V4	% canopy cover
Measured	V5	Mean DBH of overstory
		(SIV1 X SIV2)^1/2 X SIV3 = SIWF
		(SIV4 X SIV5)^1/2 = SICR
Wood duck	Variable	Variable Description
Counted	V1	# of suitable cavities/acre
Counted	V2	# of nest boxes 0
Totaled	V3	total of V1 plus V2 (.18 X V1) + (.95 X V2)
measured	V4	% of water surface covered
Black-capped chickadee	Variable	Variable Description
measured	V1	% canopy cover
measured	V2	Average height of overstory
measured	V4	# of snags/acre
		(V1 X V2)^.5 = Food Life Requisite
		V4 = Reproduction Life Requisite
Mink	Variable	Variable Description
measured	V1	% tree/shrub canopy cover
measured	V2	% of year with surface water present
measured	V4	% cover trees/shrubs within 100m of water
		(V2^2 x V4)^.3333 = River Life requisite

The Corps of Engineers and the North Dakota Fish and Game Department collected baseline data in the riparian forests that would be potentially impacted by the diversion channel alternatives. This included the areas affected by the construction of the diversion control structure on the Red River, the construction of aquaducts on the Wild Rice and Sheyenne rivers, and areas that would be impacted by the proposed diversion channel construction for the FCP, the ND35K, and the LPP. The ND35K and LPP would also impact minimal forested land on the Maple River, but access was not granted at the time of the data collection. Forested land near the potentially affected area was observed and it was determined that the forested land was similar to lands that were surveyed on the Wild Rice River and Sheyenne River.

Data collection included transects through the forest stands, secchi readings, canopy closure measurements, tree measurements, basal area measurements, nest trees counts, and stream observations for woody debris. The data was collected using measurement techniques and protocols described in the HEP models or ocular estimations when direct measurements could not be taken. This data was compared to efforts previously completed in the region by Houston Engineering, for which they collected tree composition data on forested stands along the Red River. The analysis completed for this effort and the effort conducted by Houston Engineering showed consistent results. Maps, data sheets, and summaries of each stand inventory can be found in Appendix F.

Analysis

In the absence of a community model, and recognizing that quantified impacts and subsequent mitigation needs can be driven by the model that is selected, the HSI scores for the five species were averaged. This approach may slightly understate or overstate the potential impacts as the average often drifts towards the middle (i.e. HSI = .5) and limits the sensitivity of the analysis for subtle changes in habitat conditions. However, it does provide better insight on the overall forest community. As a sensitivity analysis, the range in impacts and potential mitigation needs were calculated for each of the species modeled.

Assumptions

The following assumptions were used for conducting the HEP analysis:

1. The habitat conditions along the Red River and the tributaries will remain essentially unchanged for the 50 year analysis period. While there may be some slight changes in acreage, the species composition and structure of the remaining woodlands is not expected to change dramatically.
2. The construction disturbance footprint of the diversion channel alternatives is mostly in bottomland hardwoods. While there would be other forested areas impacted with project construction, these areas are shelterbelt plantings and have been included in the total acreage of floodplain forest.
3. Any compensatory mitigation would involve the restoration of existing floodplain agricultural land to floodplain forest.
4. It would take 50 years for mature bottomland hardwood habitat to develop.
5. Floodplain agricultural land provides some limited habitat value.
6. Establishment of floodplain forest on floodplain agricultural lands would be an acceptable approach for mitigating for all unavoidable impacts associated with forest impacts.
7. The period of analysis is 50 years.

Existing Conditions: Existing riparian habitat conditions in the project area are generally considered to be fair with an average HSI for the five species of .51. Habitat conditions for the individual species range from poor (HSI=.17 for the wood duck and gray squirrel) to near optimum (HSI = .98 the mink).

Future Without Project Conditions: As noted above, woodland extent, structure and composition is assumed to remain fairly similar to existing condition. While habitat value for individual species may change over time as natural setback/succession processes occur on these established tracts, the overall habitat value for the riparian woodland community would remain essentially the same and be rated as fair with an HSI of .51.

Future With Project: Construction of the features of the ND35K alternative would potentially result in the loss of 159 acres of woodlands (30 acres along the Red River, 20 acres along the Wild Rice River, 10 acres along the Sheyenne River, 3 acres along the Maple River and 97 acres along the diversion channel route). Based on the existing HSI, this would result in the loss of 82 Average Annual Habitat Units (AAHU's). The FCP would potentially result in the loss of 89 acres of woodlands (42 acres along the Red

River and 47 acres along the diversion channel route). Based on the existing HSI, this would result in the loss of 46 AAHU’s. The LPP would potentially result in the loss of 199 acres of woodlands (30 acres along the Red River, 20 acres along the Wild Rice River, 10 acres along the Sheyenne, 3 acres along the Maple River, 97 acres along the diversion channel route, and 40 acres within the storage area). Based on the existing HSI, this would result in the loss of 103 AAHU’s.

2.5 Project Impacts: Wetland Habitat Footprint

As part of the assessment of impacts to aquatic resources and based on recommendations from the interagency team, the Minnesota Routine Assessment Methodology for Evaluating Wetland Functions (MnRAM Version 3.3) was used to assess the functions of wetlands within the diversion channel corridors. Due to the similarity of the identified wetlands, functionality was not assessed on every area determined to be wetland. Instead, at least one randomly-chosen area representative of each type of wetland found within the diversion channel alignments was assessed for typical functionality. The types of wetlands found within the diversion channel corridors, in accordance with Eggers & Reed are farmed seasonally flooded basin (PEMAf is the corresponding Cowardin classification), fresh wet meadow (PEMB), shallow marsh (PEMC), floodplain forest (PFO1A) and shallow open water (PUBH). Floodplain forest wetlands were assessed separately in Section 2.3 Project Impacts: Floodplain Forest and will not be analyzed further in this section except for brief description of functions. Table 6 below provides a breakdown, by type, of the total acreage of non-forested wetlands found in the project area.

European settlement of the project area involved extensive drainage in order to make production of agricultural crops possible, and much of the land within the proposed diversion channel alignments is currently used for agricultural purposes. Although the surface drainage systems (ditches) make agricultural production possible in many areas in most years, the ditches have not effectively removed all of the hydrology from the surface, and many wetlands remain. These wetlands are farmed year after year, although crops are often lost in the areas with shallow depressions. Wetlands in this area have been significantly impacted by the agricultural practices, including the drainage of the natural hydrology, plowing of the soils and loss of the natural vegetation. The shallow marsh and floodplain forest areas, although usually left untouched by direct planting, have been affected by the agricultural runoff containing eroded soils and agricultural chemicals.

Table 6 Acres of wetland impact, by wetland type, for the FCP, ND35K, and LPP alternatives. Acres rounded up to the nearest whole acres.

Wetland Type	Acreage in FCP Diversion Corridor	Acreage in North Dakota/ND35K Corridor	Acreage in North Dakota/LPP Corridor
Farmed, seasonally flooded basin	798.52	720.85	794.37
Wet meadow	54.93	121.16	141.62
Shallow marsh	46.28	41.91	51.36
Shallow open water	6.14	11.49	11.49
Total	905.87	895.41	998.84

<u>Farmed seasonally flooded</u>

As expected, wetlands found within those active agricultural lands provide limited levels of functionality due to the extensive drainage and overall alteration that has taken place in the region. Over seventy five percent of wetlands within the review area for the ND35K plan and over eighty percent of wetlands within the review area for the FCP are depressional field ditches and depressional isolated wetlands of the seasonally flooded basin type (see Picture 1). Due to the extensive drainage systems, these seasonally flooded wetlands generally function at a low level for *Maintenance of Hydrologic Regime* and *Maintenance of Wetland Water Quality*. When drainage moves water off the landscape more quickly than in a natural setting, wetlands do not have the opportunity to continually feed the downstream system with a supply of water, and the agricultural impacts directly affect the ability of the wetlands to maintain water quality within the basin. Because the wetlands are found within agricultural fields, they also function at a low level for *Maintenance of Character of Wildlife Habitat*, and A*esthetics/Recreation/Education/Cultural benefit*. Without natural vegetation, there is no opportunity to provide wildlife habitat and the wetlands do not provide any aesthetic or recreational value to the human landscape.

The depressional wetland within agricultural fields do, however, generally provide moderate to high functionality for *Flood/Storm-water Attenuation* and *Downstream Water Quality*. Those wetlands that have been shaped into shallow field ditches provide a moderate level of flood/storm water attenuation because they are able to hold some of the water on the landscape for at least a short period of time. Shallow isolated depressional wetlands provide a high level of functionality for flood/storm water attenuation, as they are able to hold the water on the landscape until it can infiltrate, rather than run off to nearby over-stressed water courses. All field wetlands provide a moderate level of functionality for protection of downstream water quality because they are able to filter at least some of the nutrients from the agricultural runoff before the water enters nearby waterways. The depressional wetlands generally do not provide any level of function for amphibian or fish habitat or shoreline protection, therefore functional analysis was not applicable in these areas.

Picture 1 Wetland in wheat field, (Farmed seasonally flooded)

Fresh Wet Meadow and Shallow Marsh

Fresh wet meadows and shallow marsh (Picture 2) wetlands that are not actively farmed within the diversion corridors provide similar levels of functionality as those described above for farmed seasonally flooded wetlands, with a few noted differences. For *Maintenance of Wetland Water Quality*, wet meadows and shallow marshes provide a moderate level of functionality. With natural vegetation present, such as cattails (*Typha sp*.), the water quality within the wetland is treated through the plants' uptake of nutrients. These wetlands also provide a moderate level of wildlife habitat because of the natural vegetation.

Picture 2Shallow Marsh along project corridor.

Floodplain Forest

Floodplain forest wetlands (Picture 3) provide a moderate level of functionality for maintenance of the hydrologic regime, as they are able to gradually feed the river system with water stored in the soils following flood events. In addition, the forest canopy provides the wetland with the opportunity to provide a moderate level of function for wildlife habitat. The floodplain forest wetland will not be discussed further in this section because they will be mitigated for as floodplain forests, which were discussed in section 2.3. Floodplain forest restoration is targeted for stream riparian areas. Thus, this mitigation also would include floodplain forest wetlands.

Picture 3Floodplain Forest

Shallow Open Water

In the North Dakota diversion channel corridor, there are two areas classified as shallow open water (Picture 4). One is a constructed storm water retention pond at west edge of Prairie Rose, and the other is located adjacent to the Wild Rice River and is surrounded by a forested floodplain on private property. The storm water retention pond functions at a high level for flood and stormwater attenuation as well as protection of downstream water quality, and it functions at a low to moderate level for most other functions, such as amphibian and wildlife habitat and maintenance of hydrologic regime. The shallow open water basin adjacent to the Wild Rice River performs at a low to moderate level for all measured functions. While it can provide a moderate level of flood/stormwater attenuation and water quality protection, its outlet to the Wild Rice River is too low and not constricted, minimizing its ability to retain water. This basin provides a moderate level of wildlife and fish habitat, providing protection for water fowl and spawning habitat for fish.

Picture 4 Shallow Open Water near Wild Rice River

3. Assessment of Mitigation Alternatives

The discussion below outlines the assessment of possible mitigation measures for offsetting habitat losses identified above.

3.1 Aquatic Habitat Mitigation

Footprint Impacts

Measures considered for aquatic habitat mitigation include performing full stream restoration, stream improvement via riparian corridor restoration, and construction of fish passage.

Stream and riparian corridor restoration are direct, site-specific tools that offsets project impacts by restoring a specific amount of habitat to replace a specific amount of habitat lost or impaired. It could be the best mitigation option in terms of measuring specific habitat replacement, and monitoring to evaluate success of the mitigation.

Conversely, fish passage provides benefits to the aquatic community by restoring migratory pathways that are otherwise limited. Benefits can be significant and substantial. However, it can be more difficult to identify exactly how many fish passage projects are needed to offset footprint impacts. It also may be more difficult to evaluate whether the mitigation is completely offsetting the identified impact, although monitoring how well fish can navigate through a fish passage structure is possible.

Lengthy coordination with the State and federal natural resource agencies identified differences of opinion in the preferred methods for mitigation. Minnesota Department of Natural Resources (DNR) stated that site-specific mitigation was needed to offset habitat losses and measure success. North Dakota Game and Fish (NDGF) identified that fish passage was generally preferred for offsetting the aquatic impacts identified above. NDGF would support an approach that used both site-specific habitat restoration and fish passage for mitigation. Though stream restoration could provide definite, and more easily quantifiable aquatic habitat benefits, NDGF had significant concern whether an adequate number of sites could be identified for stream restoration. The USFWS stated that an approach that used multiple mitigation techniques (i.e., habitat restoration and fish passage) could be a reasonable approach to offsetting identified impacts.

The two stream mitigation alternatives include: full stream restoration (to include steam remeandering, bank grading, riffles/grade control, riparian buffer strips and other actions); and stream improvement that relies solely on riparian buffer corridors (i.e., no other actions). Given the limitations of the project schedule, alternative mitigation sites have not been finalized for stream restoration. For this analysis, benefits of stream restoration are based on potential habitat conditions for a hypothetical reach in the project area. A Cost Effectiveness and Incremental Cost Analysis (CE/ICA) was performed with these two stream restoration alternatives to compare which provided the best option for mitigation using habitat restoration. The Corps has and continues to coordinate with local agencies to identify potential sites for stream restoration. Preliminary candidate sites have been identified, and additional sites will be pursued in the months ahead.

For fish passage restoration, 13 dams have been coarsely reviewed for the potential cost and benefits of constructing fish passage. The costs and benefits of these different fish passage projects are provided below. A CE/ICA was then performed to identify alternatives that may be most appropriate for offsetting project impacts.

Connectivity Impacts

Fish passage channels will be constructed to minimize connectivity impacts identified under all alternatives. Under the FCP and ND35K, fish passage channels would likely reduce impacts to levels that would be less than significant. For these two alternatives, additional measures would not be pursued for connectivity impacts.

Under the LPP, there is an elevated risk for additional connectivity impacts that could require additional mitigation. To address this remaining impact under the LPP, measures were considered for improving connectivity at other locations. Fish passage would be the best mitigation option in terms of replacing the specific habitat value or function lost. The dams considered for fish passage are identified in Figure 1. These 13 dams were evaluated and compared to determine which would provide the greatest benefits in terms of replaced connectivity, relative to their potential cost.

Mitigation Alternative 1: Full Stream Restoration

For this analysis, benefits of full stream restoration are based on potential habitat conditions for a representative reach in the project area. Within the project area, streams have IBI ratings ranging from “very poor” to “good,” with channelized streams likely being towards the middle or lower end of that range. It is assumed that candidate sites for stream restoration would be channelized streams having an IBI classification of “poor” (score of 0.3). Stream restoration would improve habitat and corresponding IBI scores. For the purpose of this assessment, it is assumed that restoration would improve habitat by one IBI classification. In this case, habitat would improve from “poor” to “fair” (score improvement from 0.3 to 0.55). Improvements would occur over time, potentially as shown in Table 7. It should be emphasized the improvements assumed here are based on professional judgment. While improvements could be more or less dramatic, other factors such as watershed land use, water quality, habitat fragmentation and other issues also limit the level of improvements in habitat quality for any individual site.

Table 7Potential quantitative habitat scores over a 50-year project life for hypothetical areas that could be targeted for stream restoration.

Year after implementing mitigation	YR 0	YR 1	YR 5	YR 10	YR 25	YR 50
IBI Score	0.30	0.32	0.40	0.50	0.55	0.55

Stream width varies by stream and reach. For the purpose of this analysis, it is assumed that a stream restoration site would have a top width of 50 feet. Though sites could be wider, assuming a narrower width is more conservative and provides a measure of safety for cost estimation.

Within the Red River basin, rivers and streams have a sinuosity ranging from 1.0 to at least 2.6. For this analysis, it is assumed that stream re-meandering would begin with a stream with a sinuosity of 1.0 (channelized stream), and end with a sinuosity of 2.0. This means that the amount of aquatic habitat could basically be doubled through stream re-meandering.

Given these assumptions, 24 acres of channelized stream habitat would be required to create about 17 AAHUs necessary to offset footprint impacts that would result from the LPP and ND35K alternatives. The preliminary estimated cost for this type of effort is $11.1M (Tables Table 8 and Table 9). Similarly, 21 acres of channelized stream habitat would be needed to create about 15 AAHUs necessary to offset footprint impacts from the FCP. Based on the same assumptions, the preliminary estimated cost for this effort is $9.7M.

Table 8 Potential habitat return and associated costs that could be realized through restoration of 24 acres of stream habitat for alternatives under a LPP or ND35K alternative. The pre-project acreage for restoration (24) was rounded up to the nearest whole acre needed to get at least 16.9 AAHU. This explains why the net future AAHUs (17.6) is slightly higher than the impacted AAHUs (16.9).

Re-meander Pre-Project Area (ac)	Re-meander Post-Project Area (ac)	Future W/O AAHUs	Future AAHUs	Net Future AAHUs	Alternative Cost	Average Annual Cost	Cost per AAHU
24*	48	7.2	24.8	17.6	$11,108,911	$528,240	$30,068

*Equates to about 4 miles of channelized stream restored, based on an average top width of 50 feet, and other listed assumptions.

Table 9<u>**Assumptions for River Restoration Alternative Cost Estimate**</u>

Assume 1/2 mile corridor needed, with 1/4 mile on each side of stream. This equates to 320 acres per mile of stream restored.

Assume 25% contingency on area of land to be purchased to account for flexibility for transactions. This results in 400 acres per mile of stream restored.

Assume the need to establish vegetation buffer of 150 feet on each side of the stream. This equates to 36 acres of land per mile of stream restored.

Assume channelized stream with incorporated meanders. Sinuousity would increase from 1.0 to 2.0 after restoration.

Cost Assumptions:

$4,000 per acre for real estate costs
$4,000 per acre for revegetation costs
$500,000 per mile for grading, structures and rip rap to recreate riffles and meanders

Cost Distribution

Real Estate:	$1,600,000
Revegetation:	$144,000
Grading:	$500,000
Total:	$2,244,000
Contingency 25%:	$561,000

Total Cost per Mile	$2,805,000

Acres of Aquatic Habitat per Mile at Assumed Stream Top Width of 50 feet:
6 aquatic acres pre-restoration; 12 aquatic acres post-project

Mitigation Alternative 2: Stream Restoration via Riparian Buffer Corridors

For this analysis, benefits of riparian buffer corridors on potential habitat are considered for a representative reach in the project area. The level of improvement for the buffer strip alternative would likely be less than that identified above for full stream restoration. It is assumed that candidate sites for riparian buffer strips would be channelized streams having an IBI classification of "poor" (score of 0.3). Riparian buffer strips would improve habitat and corresponding IBI scores. For the purpose of this assessment, it was assumed that restoration would improve habitat by half that of the full restoration alternative. In this case, habitat would improve from 0.3 ("poor") to 0.42 (between "poor" and "fair"). Improvements would occur over time, potentially as shown in Table 10It should be emphasized the improvements assumed here are based on professional judgment. While improvements could be more or less dramatic, other factors such as watershed land use, water quality, habitat fragmentation and other issues also limit the level of improvements in habitat quality for any individual site.

Table 10 Potential quantitative habitat scores over a 50-year project life for hypothetical areas that could be targeted for stream restoration.

Year after implementing mitigation	YR 0	YR 5	YR 10	YR 25	YR 50
IBI Score	0.30	0.35	0.40	0.42	0.42

Stream width varies by stream and reach. For the purpose of this analysis, it is assumed that a stream restoration site would have a width of 50 feet. Though sites could be wider, assuming a narrower width is more conservative and provides a measure of safety for cost estimation.

Given these assumptions, 165 acres of stream habitat would require buffering to improve habitat enough to create the 17 AAHUs necessary to offset footprint impacts that would result from LPP or ND35K alternatives. The preliminary estimated cost for this type of effort is $12.3M (Table Table 11). Similarly, 147 acres of stream habitat would require buffering to create the approximately 15 AAHUs needed to offset impacts that would result from the FCP. Based on the same assumptions (Table 10), the preliminary estimated cost for this effort is $10.9M.

Table 11Potential habitat return and associated costs that could be realized through buffering 165 acres of stream habitat under the LPP and ND35K alternatives.

Buffer Pre-Project Area (ac)	Buffer Post-Project Area (ac)	Future W/O AAHUs	Future AAHUs	Net Future AAHUs	Alternative Cost	Average Annual Cost	Cost per AAHU
165*	165	49.5	66.5	17.0	$12,252,475	$582,617	$34,282

*Equates to about 27.5 miles of channelized stream restored with an average top width of 50 feet.

Table 12. Assumptions for Riparian Buffer Alternative Cost Estimate.

Assume the need to establish vegetation buffer of 150 feet on each side of the stream. This equates to 36 acres of land per mile of stream restored.
Assume 50% contingency on area of land to be purchased to account for flexibility for transactions. This results in 54 acres per mile of stream restored.

Cost Assumptions:

$4,000 per acre for real estate costs
$4,000 per acre for revegetation costs

Cost Distribution

Real Estate:	$216,000
Revegetation:	$144,000
Total:	$360,000
Contingency 25%:	$90,000
Total Cost per Mile	**$450,000**

Acres of Aquatic Habitat per Mile at Assumed Stream Top Width of 50 feet:
6 aquatic acres pre-restoration; 6 aquatic acres post-project

Fish Passage Mitigation Alternatives:

For this analysis, benefits are based on habitat conditions made available with fish passage incorporated at potential dams identified on rivers with aquatic impacts. Both the habitat quantity and quality that would be made available are relevant to the analysis.

Many dams across the Red River basin impede fish movement. Thirteen potential sites for fish passages were initially identified through coordination with North Dakota Game and Fish Department. This includes Drayton Dam, where potential benefits would be shared by both North Dakota and Minnesota. Many additional dams are on Minnesota tributaries, and these could be favorable candidate sites as well.

To assess benefits from fish passage, dams with the potential to be candidate sites were first identified using both low-head dam points from State of North Dakota data and the USACE National Inventory of Dams. Then, stream area and stream quality that would be made available through fish passage were assessed.

Stream lengths were assessed through review of available stream networks in GIS (National Hydrology Data, NHD Medium Resolution, USGS). All stream areas upstream of a dam that could be made accessible to fish were quantified through use of stream networks. Available data on dams was combined with local insight to identify how far upstream fish would have access before encountering another dam. Stream lengths were then computed within GIS. Stream level information was determined by joining the primary GIS feature table to the NHDflowlineVAA table. Stream level was necessary to make a determination of the average stream width. Measurements were taken along numerous segments of each reach with the same stream level. Stream widths were measured through review of 2009 aerial photographs. Ultimately, stream areas were calculated by multiplying stream widths by stream lengths.

EPA (1998) provided IBI assessments of many stream reaches across the watershed. The IBI assessments are indicators of biotic integrity in these stream reaches, thus suggesting the quality of available habitat. To assess habitat quality in areas that would benefit from fish passage, the closest IBI observations were used for each tributary reach (Figure 1). Using the quantitative scores discussed above (Table 1), the applied quantitative score were multiplied by the acres of stream area to derive a total number of Habitat Units that would be provided through fish passage.

Given these assumptions, construction of fish passage could provide benefits that range from access to over 2,000 stream miles (over 7,700 HUs) to as little as 1.3 stream miles (4 HU) (Table 13). For cost estimation purposes, it was assumed that fish passage would be provided through the use of rock-riffle fishways across the entire width of the dam. These fishways have been used elsewhere in the basin and are believed to be passable to all species of fish under almost all hydrologic conditions. Using previous cost estimates as a guide, the preliminary estimated costs for this type of effort range from just under $2.0M to about $9.8M. It should be noted that costs can vary widely for these types of structures. Moreover, if dam removal is an option for constructing fish passage, than costs could be considerably less than those outlined here. The costs discussed here simply provide an initial estimate of the funds needed to construct fish passage at the dams identified.

Table 13 Potential habitat return and associated costs that could be realized through constructing fish passage at 16 various dams in the Red River Basin.

Dam	River	Estimated Cost	Avg Annual Cost (w/ O&M)	Stream Miles	Stream Area (acres)	Upstream Habitat Quality	Habitat Units (Q*AC)	Cost per Habitat Unit
Drayton	Red	$6,500,000	$314,082	2,167.8	14,575.1	0.53	7,724.8	$41
No Name 227	Maple	$4,470,000	$217,553	69.5	93.5	0.3	28.0	$7,760
Brownlee	Maple	$7,140,000	$344,514	211.0	314.4	0.38	119.5	$2,884
Lisbon	Sheyenne	$9,800,000	$471,000	54.7	248.8	0.55	136.8	$3,443
Kathryn	Sheyenne	$4,790,000	$232,769	11.9	64.1	0.55	35.3	$6,599
Warwick	Sheyenne	$2,670,000	$131,961	10.7	58.7	0.55	32.3	$4,091
Brown	Sheyenne	$3,130,000	$153,835	52.8	245.8	0.55	135.2	$1,138
Fort Ransom	Sheyenne	$5,990,000	$289,830	58.0	237.6	0.55	130.7	$2,218
Valley City Park	Sheyenne	$6,970,000	$336,430	1.3	8.1	0.55	4.4	$75,913
Valley City Mill	Sheyenne	$5,510,000	$267,006	47.9	194.2	0.55	106.8	$2,499
Soldiers Home	Sheyenne	$2,960,000	$145,751	6.2	24.3	0.55	13.3	$10,927
Wild Rice	Wild Rice	$6,860,000	$331,200	147.6	643.9	0.33	259.5	$1,276
Hanson	Wild Rice	$1,940,000	$97,249	277.0	1,208.6	0.1	120.9	$805

Aquatic Habitat Mitigation Alternative Comparison

To further compare the potential effectiveness of mitigation measures, the Corps performed a CE/ICA comparing the stream restoration alternatives, as well as fish passage alternatives. A Cost-Effectiveness (CE) analysis is conducted to ensure that the least-cost solution is identified for each possible level of environmental output (Orth,1994). Cost effectiveness means that no plan can provide the same benefits for less cost or more benefits for the same cost. An Incremental Cost Analysis (ICA) of the least-cost solutions is conducted to reveal changes in costs for increasing levels of environmental outputs. Plans that provide the greatest increase in benefits for the least increase in costs are identified as “Best Buy” plans. In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of environmental plans, cost-effectiveness and incremental cost analyses are valuable tools to assist in decision-making.

The CE/ICA was performed with IWRPlan, available from the USACE Institute for Water Resources. IWRPlan assists with plan formulation by combining user-defined solutions to planning problems and calculating the effects of each combination, or "plan." The program can assist with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are the best financial investments and displaying the effects of each on a range of decision variables.

IWRPlan was run for the two stream restoration alternatives, comparing average annual cost to average annual benefits. Similarly, IWRPlan also was run for the various fish passage alternatives (i.e., each individual site) to compare their average annual costs and benefits.

A CE/ICA analysis was not performed to compare site-specific habitat restoration to fish passage alternatives. Although both analyses computed both average annual costs and benefits, the output metrics do not allow for a direct comparison within a CE/ICA. In other words, an AAHU for fish passage does not directly compare to an AAHU for site-specific habitat restoration. Although both forms of mitigation provide highly-valuable habitat values and functions, those values and functions are quite different, and do not easily compare to each other. Thus, these two restoration techniques will be qualitatively compared to each other below under *Mitigation Alternative Selection*.

Stream Restoration Alternatives

Comparison of the two stream restoration alternatives suggested a similar ratio of environmental output to cost Figure 2and Figure 3). While stream buffering is identified as “Non Cost Effective” (meaning it provides less environmental outputs environmental outputs for higher cost), the costs and benefits comparison was similar to full stream restoration. Of these two alternatives, full stream restoration would be given preference as a site-specific restoration measure. However, both measures could provide a similar level of value in terms of environmental output per unit of cost. Stream buffering will be considered for mitigation if full stream restoration cannot be used to fulfill needed mitigation.

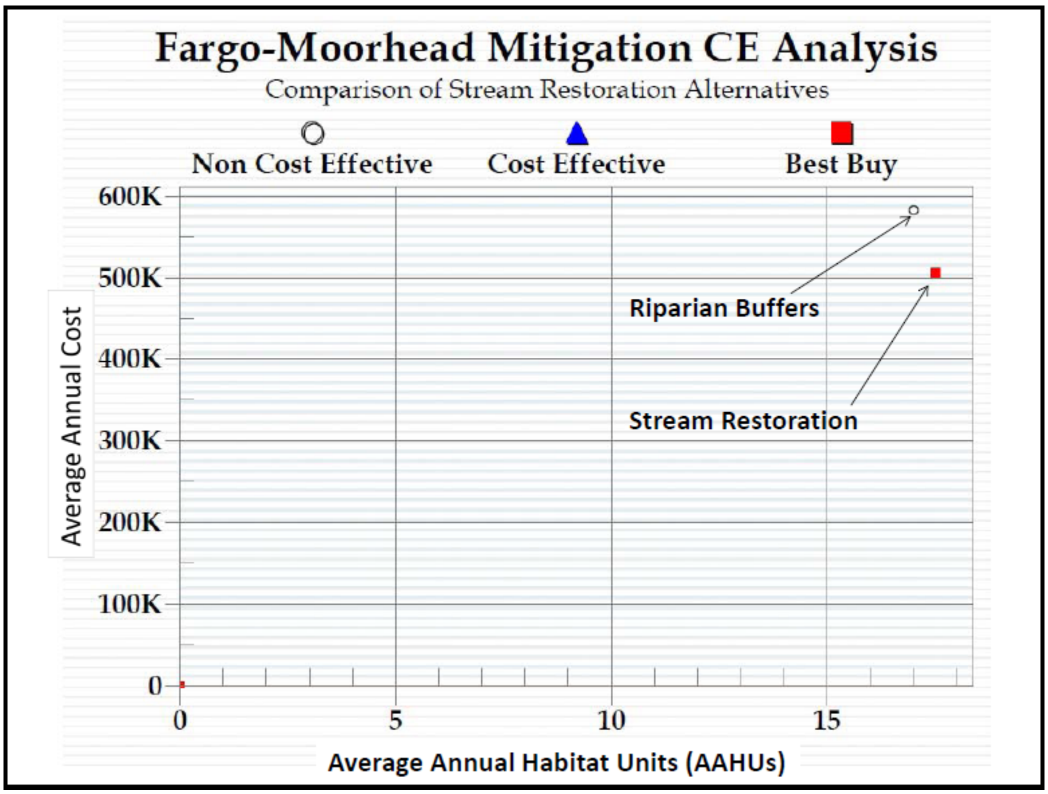


Figure 2 Cost Effectiveness analysis for the two stream restoration alternatives considered for mitigation of aquatic habitat impacts under the Fargo-Moorhead Flood Risk Management Study.

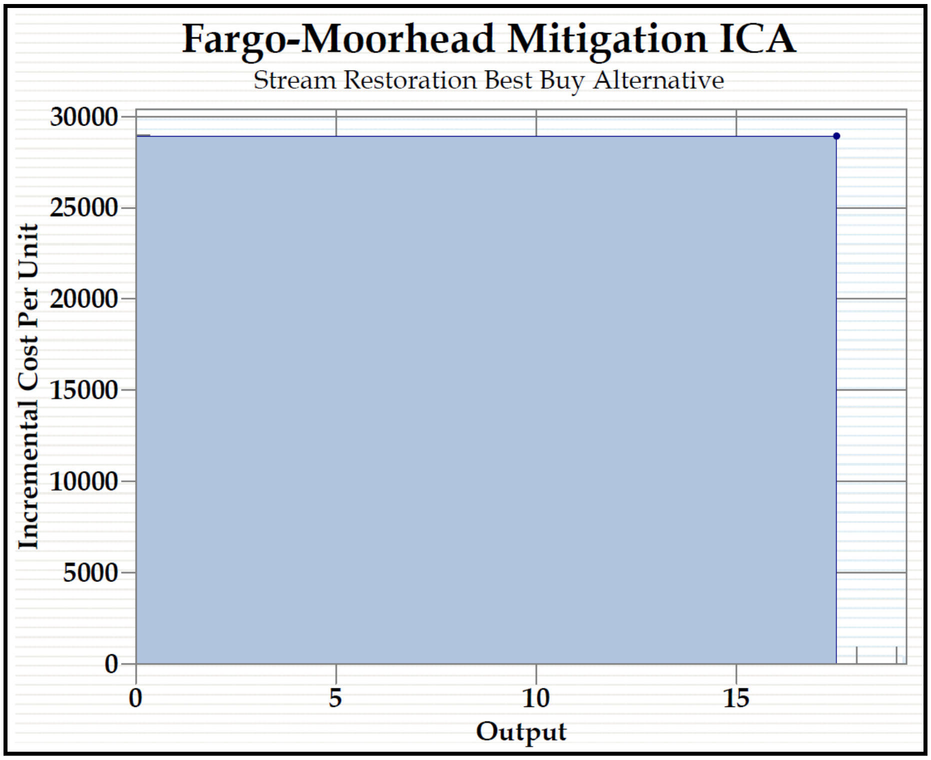


Figure 3 Incremental Cost Analysis for the single Best Buy stream restoration alternative considered for mitigation of aquatic habitat impacts for the Fargo-Moorhead Flood Risk Management Study.

Fish Passage Alternatives

Comparison of the 13 possible fish passage sites suggests Drayton Dam provides the greatest environmental output for the assumed cost (Figure 4 and Figure 5). Within IWRPlan, this is identified as a "Best Buy" Plan. Fish passage at Brown Dam and Hanson Dam also were identified from the remaining alternatives as being "cost effective" when considering costs and benefits. These two dams are, however, similar to other potential sites in terms of their value when comparing potential benefits for given economic costs.

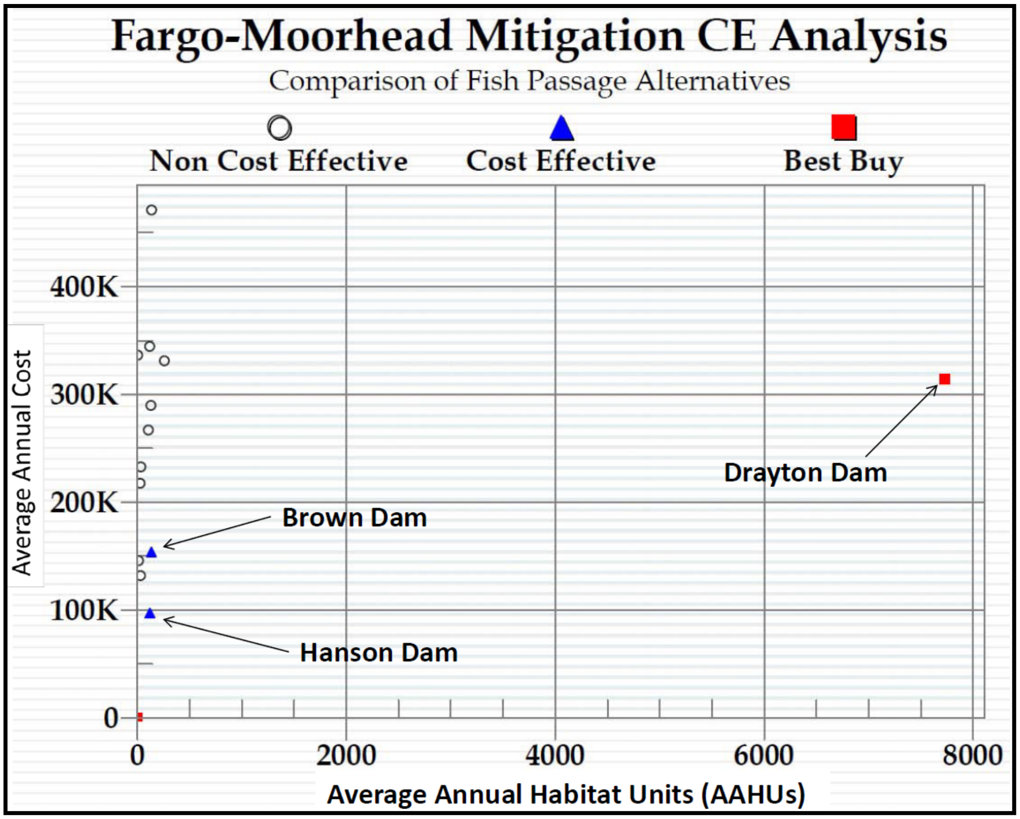


Figure 4 Cost Effectiveness analysis for 13 fish passage sites considered for mitigation of aquatic habitat impacts for the Fargo-Moorhead Flood Risk Management Study.

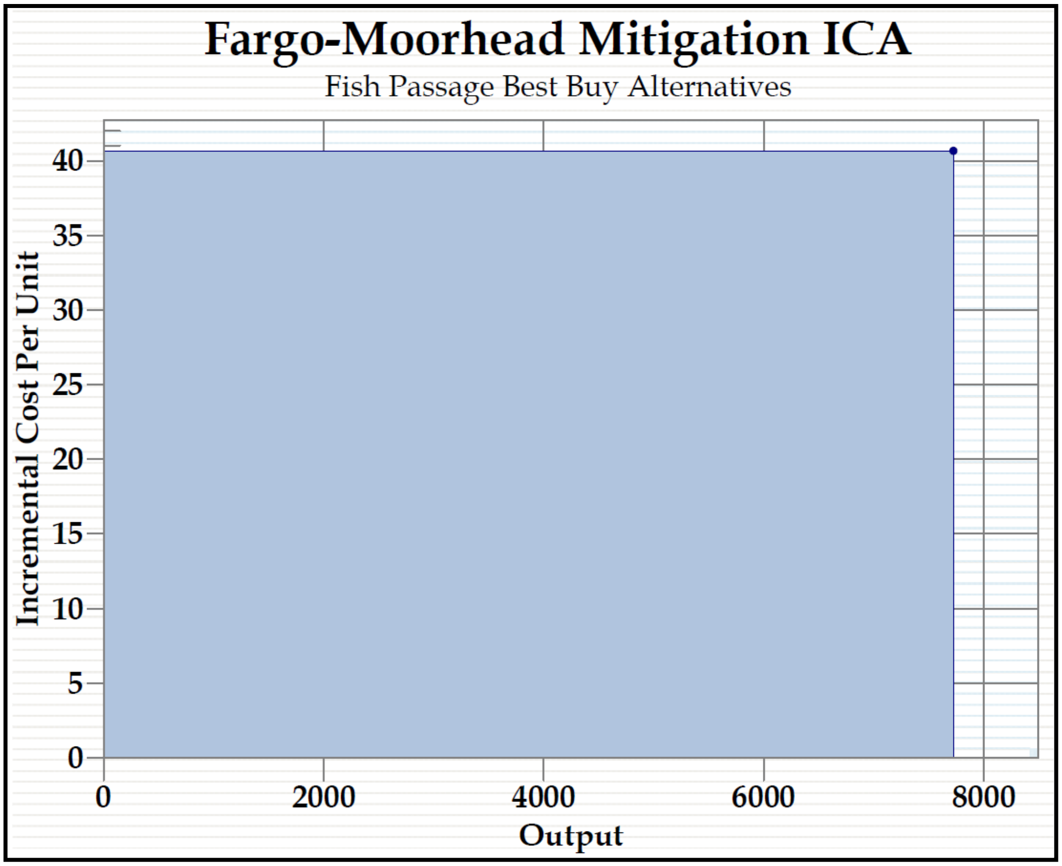


Figure 5 Incremental Cost Analysis for the Best Buy fish passage site considered for mitigation of aquatic habitat impacts for the Fargo-Moorhead Flood Risk Management Study.

Mitigation Alternative Selection and Implementation for Aquatic Habitat

Footprint Impacts

Site specific mitigation actions can improve habitat and be used to offset site-specific footprint impacts. However, such actions may be challenging to implement in this project area. Discussions with local resource managers suggests the likelihood of finding landowners willing to provide the real estate requirements for stream restoration could be low. Based on the assumptions made here, several miles of channelized, degraded habitat would be needed to offset impacts under any diversion channel alternative. Within the Red River basin, other outside efforts are assessing potential stream restoration activities. Possible mitigation sites include restoration projects along the Buffalo River, Wild Rice River and Mustinka River (Minnesota). It may be possible to use some of these sites for mitigation. Coordination with NRCS suggests additional sites with willing landowners may exist along the Sheyenne, Maple and Wild Rice rivers. However, even with these various options, many obstacles appear evident that could make implementation problematic.

NDGF and USFWS support a mitigation approach that considers both fish passage and site-specific stream restoration. Constructing fish passage will provide access to higher quality habitats. These benefits could be more substantial and meaningful for aquatic biota compared to restoration of individual stream reaches. The likelihood of finding willing landowners also appears higher for fish passage. In the case of Drayton Dam, a planning study currently underway for fish passage indicates that the Dam can be utilized as a mitigation site that will provide significant benefits. There are many dams that can be considered for fish passage, as outlined above; other dam owners will be consulted to determine their interest in participation. There are also many other dams outside of those identified that could be considered should the owners of the dams listed above not be interested in participating.

Given the challenges in identifying interested landowners, the following approach will be utilized. Site-specific stream restoration will first be pursued to offset identified aquatic impacts. To the extent practical, this form of mitigation will be used for impacts that are partially or entirely within Minnesota, including at least 7.6 AAHUs for the LPP and ND35K or 15.1 AAHUs for the FCP.

For site-specific aquatic impacts that occur on North Dakota tributaries, site specific habitat restoration opportunities will be pursued within similar areas. After site-specific habitat restoration opportunities have been thoroughly investigated, fish passage will then be considered to fill remaining mitigation needs for footprint impacts. Given the high value that fish passage appears to have, construction of fish passage should provide as many overall benefits, and be as effective, as site-specific restoration.

Connectivity Impacts

Potentially significant impacts to connectivity have been identified under the LPP for both the Red River and the Wild Rice River. To address these impacts, additional fish passages will be constructed at existing barriers on the river of concern.

To address connectivity impacts to the Red River under the LPP, two features will be constructed. First, three fish passage channels, in addition to the two fish passage channels that would be constructed with any of the diversion channel alternatives, will be constructed to provide connectivity during floods up to an approximate peak discharge of 20,000 cfs. These three additional channels would cost approximately $10M in total. Second, to address any lingering concerns that fish passage channels are only partially effective at passing fish during a period of operation that could be a few weeks or longer, a fish passage at Drayton Dam will be constructed. This project would cost approximately $6.5M.This is the last remaining dam on the Red River in the United States, and would provide substantial connectivity benefits. Fish passage at this location would provide connectivity throughout the Red River mainstem during periods when Drayton Dam would typically be impassable. This occurs under conditions when the Red River is not flooding, and can occur frequently during the period May through July

Given the collective benefits of additional fish passage channels and the construction of a fish passage at Drayton Dam, any potentially significant impacts to connectivity should be mitigated.

To address remaining impacts to connectivity on the Wild Rice River, fish passage will be proposed at the Wild Rice Dam and the Hanson Dam. This will be fully coordinated with the natural resource agencies and dam owners to further verify appropriateness. The Wild Rice Dam would cost approximately $6.9M, and the Hanson Dam would cost approximately $1.9M. These are two low-head dams immediately downstream and upstream of the proposed control structure. Improving fish passage at these two dams will allow fish to pass these dams under all flow conditions. Currently, fish could only pass when these dams are washed out during high flows. The Wild Rice River structure under the LPP, as currently designed, would include two fish passage channels yet remain a complete barrier during portions of a flood when upstream water elevations would be mismatched with fish passage gate elevations. Constructing these two fish passage projects would mitigate this impact by providing passage across a broader period of time, and allow passage throughout the river when the project is not operating. Currently, these two dams are likely barriers during lower flow conditions. Construction of these two fish passage projects also would likely be more cost effective than constructing additional fish passage channels at the Wild Rice River control structure. Although a barrier would still exist, this would occur early during the spring when migrations are only beginning. The two fish passage projects should provide significant benefits across most flow conditions, including periods later in spring and summer when larger migrations of fish are potentially occurring. Ultimately the proposed mitigation projects should offset connectivity impacts on the Wild Rice River.

3.2 **Floodplain Forest Habitat Mitigation**

Opportunities to acquire/manage existing riparian woodlands are considered to be almost non-existent and would not be a feasible approach for offsetting woodland losses associated with project construction. The interagency team agreed that the most feasible approach would be the acquisition of floodplain lands that are currently in agriculture or pasture, and re-establishing woodland on those tracts. The following objectives were identified:

1. Restore native floodplain forest and herbaceous vegetation. The floodplain forest should include green ash, cottonwood, black willow, hackberry, silver maple, American elm, American basswood, and bur oak.
2. Restore stand density with an average of 300 trees per acre over 80 percent of the mitigation site(s) with diameter at breast height (DBH) of 2 inches within 10 years. This tree density is typical for the Red River Basin floodplain forest in the project vicinity.
3. Restore floodplain forest community with a target species composition of at least 10 percent (by number of individual trees) bur oak and hackberry, with the rest a mix of green ash, cottonwood, black willow, boxelder, American elm, silver maple and American basswood.
4. Allow some regeneration of native herbaceous plants, shrubs, and trees from locally produced propagules on 20 percent of the mitigation land area, to create diversity in forest and herbaceous vegetation in the mitigation area.
5. Protect and manage the site(s) in perpetuity by an agreement for management as a wildlife management area by the Minnesota Department of Natural Resources or North Dakota Game and Fish Department.

Using the average HSI of .51 from section 2.3 and assuming the restoration occurs in a timely manner, the number of acres needed to replace the lost Average Annual Habitat Units would be 232 acres for the ND35K, 290.5 acres for the LPP or 130 acres for the FCP. Each species was also looked at separately to get a range of replacement ratios and number of acres to replace the lost habitat for each species (see Table 14). For example, to replace woodland that would support habitat for the Belted Kingfisher the mitigation requirement would be 191 acres for the ND35K, 239 acres for the LPP, or 107 acres for the FCP. Table 14shows the ratios for the other four models used for this analysis. Mitigation land would be planted with floodplain forest tree species representative of the impacted area.

Table 14 Ratios and acreages to replace per species.

Species	Ratio	ND35K	FCP	LPP
Belted Kingfisher	1.2 to 1	191	107	239
Gray Squirrel	2.07 to 1	329	184	412
Wood Duck	2.04 to 1	324	182	406
Black-capped Chickadee	1.93 to 1	307	172	384
Mink	1.15 to 1	183	102	99

None of the models used considered fragmentation, which is a concern because the forested land in this region is highly fragmented. For example, the models do not take into consideration forest connectivity and the width of the forested corridor. The project area has extremely long linear forested stands broken up by agriculture fields; there are very few areas in this region with large blocks of contiguous forested land. Based on the above sensitivity analysis, professional judgment, the absence of a community based model, the inability to capture the negative impacts of fragmentation, and the input from cooperating agencies, the team recommends a 2:1 ratio be used for mitigation for the lost forest. Therefore, it is recommended that 318 acres of agricultural land be converted to floodplain forest for the ND35K, 398 acres for the LPP, or 178 acres for the FCP.

Floodplain Forest Mitigation Restoration Objective and Alternatives

The primary objective of the mitigation is to restore floodplain forest. Alternatives include different restoration methods:

1) Acquire the mitigation land and direct seed with tree species, supplemented by planting seedlings of selected species as required.
2) Acquire the mitigation land and plant seedling trees
3) Acquire the mitigation land and let natural vegetation succession occur (no active restoration)

Alternative 1: Direct Seeding – Planting the site by direct seeding species that are readily available and planting bare-root seedlings of species that are not readily available has been found to be the most effective way to restore floodplain forest. The work would include woody debris removal, disking, herbicide treatment, and direct seeding with seeds of cottonwood (Populus deltoids), black willow (Salix nigra), green ash (Fraxinus pennsylvanica), hackberry (Celtis occidentalis), bur oak (Quercus macrocarpa), American elm (*Ulmus Americana),* silver maple (*Acer sacharinum*) and American basswood (Tilia americana). If seeds for any of these tree species are not available, those tree species would be planted as bare-root seedlings. Monitoring would be conducted and additional seedlings would be planted if the tree density targets are not attained.

Direct seeding appears to be the best option for a number of reasons:

- It produces a more natural looking forest
- It quickly produces a dense cover that shades out competition.
- By producing stem counts upwards of 15,000 seedlings an acre, rodents and deer should have a negligible impact on the planting.

Table 15 Alternative 1: Direct Seeding

Alternative 1: Direct Seeding				
Description	Unit	Unit Cost	Units per acre	Project Cost per acre year 1
Spring herbicide treatment (Roundup)	acre	$60	1	$60
Fall herbicide treatment (Roundup)	acre	$60	1	$60
Spring disking	acre	$20	1	$20
Spring herbicide treatment (Oust)	acre	$47	1	$47
Spread tree seeds	acre	$20	1	$20

Cottonwood seeds	ounce	$25	16	$400
Black willow seeds	bushel (fluffy)	$15	1	$15
Green ash seeds	gallon	$30	2	$60
Hackberry seeds	lbs	$72	2	$144
Bur oak seeds	bushel	$50	2	$100
American basswood seeds	lbs	$30	5	$150
O and M cost				$50
Fall herbicide treatment (Oust)	acre	$47	1	$47
Real Estate Cost				$4000
Total				$5173

Cost
Real Estate: $1,112,000 for 278 acres
Restoration: $326,094 first cost ($1173/acre)
Total average annual cost $75,716 (average annual cost/AAHU = $760.82)

The habitat value of this alternative would increase over time after planting, attaining a net increase of 27 AAHU over the 50-year planning period.

<u>Alternative 2 – Plant seedlings</u> - This alternative would include purchasing the mitigation land and restoration of floodplain forest by planting seedlings. The cost estimate was prepared assuming the worse-case scenario that the mitigation land would need a season of site preparation. The work would include woody debris removal, disking, herbicide treatment for at least 4 years, mechanical planting of seedlings, monitoring and additional seedling planting if necessary.

Table 16 Alternative 2: Seedling Planting

Alternative 2: Seedling Planting					
Description	Seedling age/size	Unit	Unit Cost	Units per acre	Project Cost per acre year 1
Mechanical tree planting		tree	$1	300	$300
Fall herbicide treatment		acre	$60	1	$60
Plow and disc site prep		acre	$20	1	$20
Plow and disc site prep previous summer		acre	$20	1	$20
American Elm seedling	12-18''	tree	$2	100	$200
Cottonwood seedling	12-18"	rooted cutting	$1	100	$100

Black willow seedling	12-18"	rooted cutting	$1	100	$100
Green ash seedling	2 years	tree	$0.30	100	$30
hackberry seedling	2-3 feet	tree	$2	100	$200
bur oak seedling	3-4 feet	tree	$2	100	$200
American basswood	18-24"	tree	$1.8	100	$180
O and M					$100
Real Estate Cost					$4000
Total					$5510

Cost
Real Estate: $ 1,112,000 for 278 acres
Restoration: $419,780 first cost ($1510/acre)
Total Average annual cost $76,760 (average annual cost/AAHU = $741.65)

The habitat value of this alternative would increase over time after planting, attaining a net increase of 32 AAHU over the 50-year planning period.

Alternative 3: Natural Vegetation Succession - This alternative would involve purchasing the real estate and site preparation. Most of the mitigation land area would be floodplain agricultural land lacking native vegetation. Over time, seeds and propagules would be brought into the area(s) by wind and during floods. Box elder and green ash may be the most abundant tree seed sources in the Red River basin. Over the course of as few as five years, most of the area would become densely colonized by box elder and green ash. Box elder exudes herbicidal metabolites from its roots, resulting in nearly monotypic stands with little ground cover. This condition would result in less than one third of the habitat value of a more diverse floodplain forest.

Table 17 Alternative 3: Natural Regeneration.

Alternative 3: Natural Regeneration					
Description	Seedling age/size	Unit	Unit Cost	Units per acre	Project Cost per acre year 1

Fall herbicide treatment		acre	$60	1	$60
Plow and disc site prep		acre	$20	1	$20
Plow and disc site prep previous summer		acre	$20	1	$20
O and M					$200
Real Estate Cost					$4000
Total					$4300

Cost
Real Estate: $1,112,000 for 278 acres
Restoration: $83,400 first cost ($300/acre)
Total average annual cost $60,782 (average annual cost/AAHU = $774.30)

Floodplain Forest Mitigation Alternative Comparison

To further compare the potential effectiveness of the mitigation measures, a CE/ICA was performed comparing the three alternatives for floodplain forest mitigation. For the CE/ICA the most current version of IWRPlan available from the USACE Institute for Water Resources was used. IWRPlan assists with the plan formulation by combining user-defined solutions to planning problems and calculating the effects of each combination, or "plan". The program assists with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the best buy plan, and determining whether the plans are cost effective.

IWRPlan was run for the three floodplain forest mitigation alternatives, comparing average annual cost to average annual benefits. Comparison of the three alternatives suggested that alternative 1 would be the best buy plan; however all of the alternatives are incrementally justifiable (Figure 6).

Alternatives 1 and 2 would establish diverse native floodplain forest on the mitigation land through restoration. Alternative 1 would be most likely of the three alternatives to succeed, given the experience with other floodplain forest restoration efforts on the upper Mississippi River in St Paul District. The majority of the mitigation cost would be for land acquisition. The measures to restore floodplain forest would be cost effective.

Alternative 3 would not meet the objective of restoring native floodplain forest. Following several years of dense annual weeds, boxelder (*Acer negundo*) would probably establish dense stands with lower habitat value than a more diverse native floodplain forest. Alternative 3 may be used in conjunction with the other alternatives for a portion of the mitigation properties.

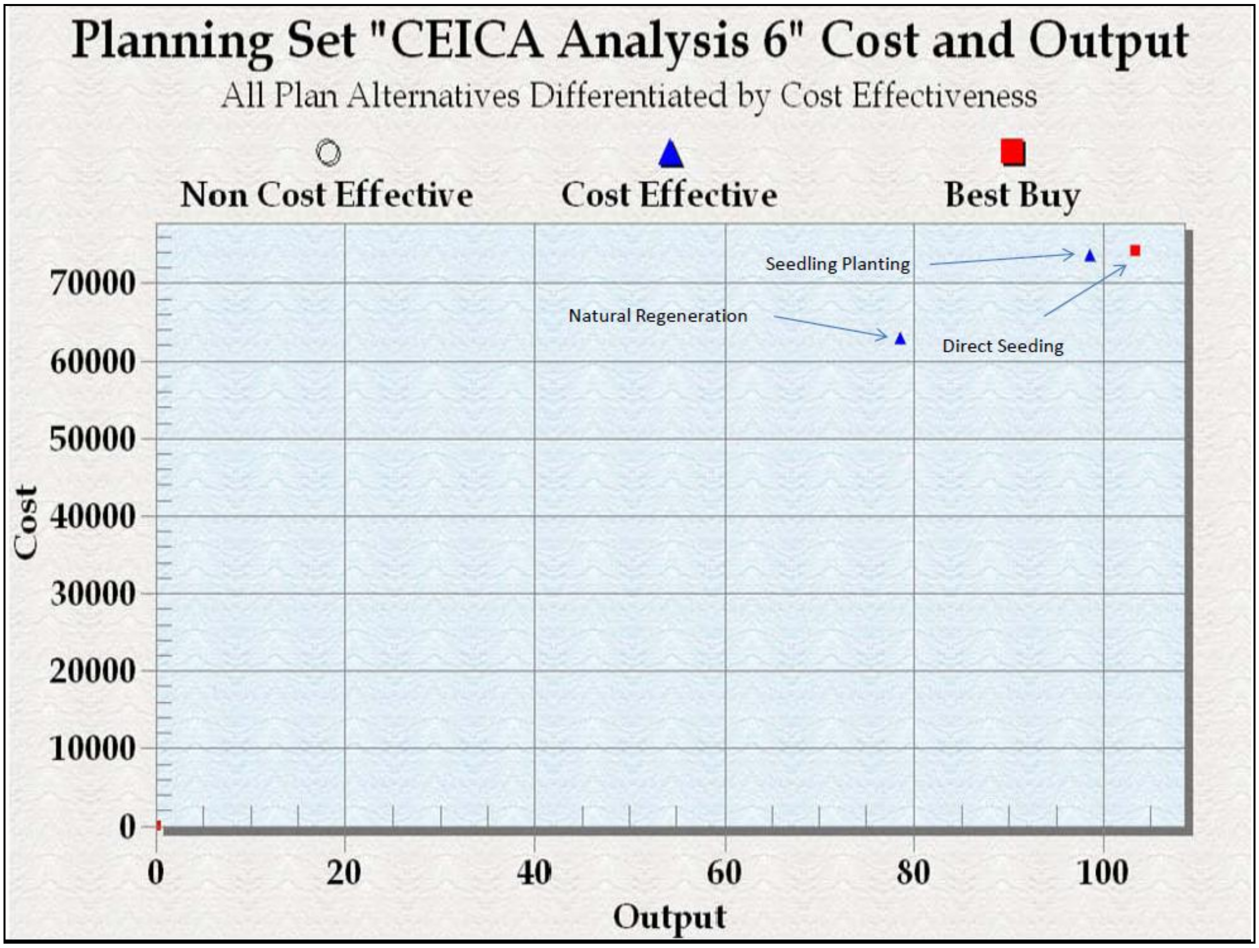


Figure 6 CE/ICA analysis for floodplain mitigation alternatives.

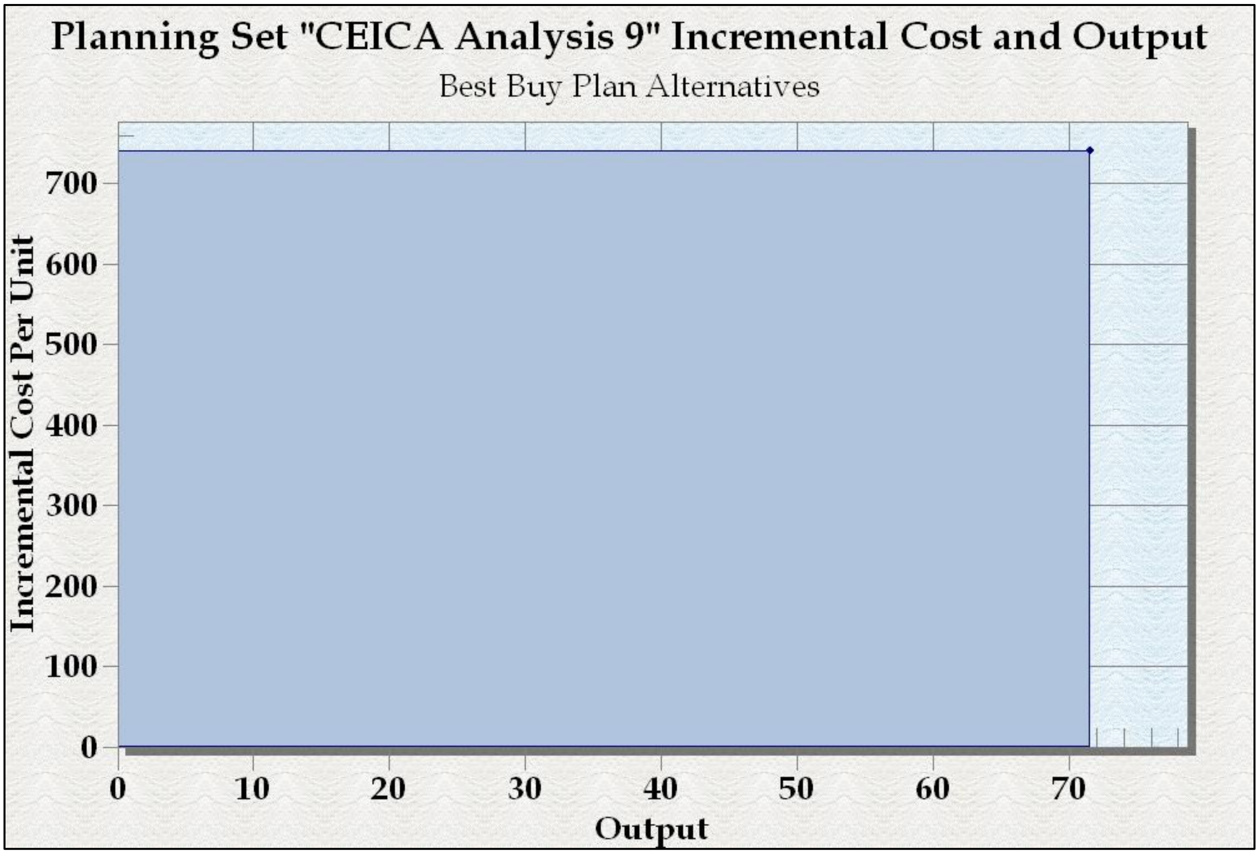


Figure 7 Incremental Cost Analysis for the Best Buy floodplain forest mitigation.

Mitigation Alternative Selection and Implementation for Floodplain Forest Impacts

Alternative 1, direct seeding, is selected as the best buy plan for floodplain forest mitigation. Upon purchasing the mitigation site(s), the Corps of Engineers and/or non-federal sponsors would conduct the following work:

1. Perform elevation survey and topographic mapping.
2. Prepare a detailed restoration plan with task list, schedule, budget and maps.
3. Delineate tree planting areas to cover at least about 80 percent of total area. The remaining 20 percent of the mitigation area would be allowed to grow in with native forbs, shrubs, trees and germinated from locally grown propagules. These areas of local vegetation would be interspersed between the tree planting areas.
4. Clear and grub the tree planting area and properly dispose of significant woody debris if necessary.
5. Treat the site with glyphosate after spring green-up and again in early fall.
6. The following spring, disc the site to expose mineral soil and treat with the pre-emergent herbicide Oust.
7. Direct seed the entire acreage with cottonwood (Populus deltoids), American elm (*Ulmus americana*), silver maple (*Acer sacharinum*), black willow (Salix nigra), green ash (Fraxinus pennsylvanica), hackberry (Celtis occidentalis), bur oak (Quercus macrocarpa), and

American basswood (Tilia americana). The site should then be lightly dragged to ensure good soil/seed contact. If large quantities of seed from any of the selected species are not available, the Corps would plant these species as bare-root seedlings. The bare-root seedlings would be planted by machine, and seedlings would be planted in meandering rows to better imitate a natural forest.

8. Assuming good germination and growth, apply Oust XP or another approved and appropriate herbicide in the fall after the seedlings go dormant to help ensure that there would be minimal weed problems in the following growing season.

9. If the direct seeding is not successful, plant seedling trees using power auger or tractor mounted tree planter. Install grow-tubes to protect against deer and beaver browsing and weed barrier mats to limit weed competition. Water the planted trees at planting and three more times within the next month if rainfall is less than 1 inch each week.

10. Monitor tree survival annually for 5 years.

11. Monitor tree survival and composition at 10 years. Replant as needed to attain target average of 300 trees per acre over the planted area with at least 10 percent hackberry and bur oak at 10 years after the initial planting.

12. If necessary, remove and properly dispose of the grow tubes when the trees reach 8 feet tall and more than 1 inch DBH.

13. Monitor tree survival and composition every 5 years thereafter and following major wind storms. Manage the forest to maintain the target tree density and composition.

3.3 Wetland Habitat Mitigation

The design of the diversion channel for each alternative includes a sinuous low-flow channel, which offsets the proposed loss of wetlands due to the project. The diversion channel alternatives have the opportunity to return lost functions back to the area. The low-flow channel within the diversion channel would be meandering, with a slope as low as .00013 for a sinuosity of 1.5. The channel would be planted with native wetland species on the bottom and the fringe of the side slopes of the channel, with the remainder of the side slopes being planted as a prairie swale type community. Appropriate native seed mixes may be those developed for ditch/swales, sedge/wet meadow or wetland fringe. A buffer strip of several hundred feet on either side of the diversion channel up to the embankment top would help limit encroachment from agricultural activities and would provide filtering of surface runoff into the diversion channel wetlands. Grade control structures would be required to avoid erosion during high flow events in the diversion channel. These structures would also benefit the creation of wetlands.

Creating and restoring wetlands within the diversion channel footprint will increase the ability of the landscape to retain and treat flood and storm water. Wetlands within the diversion channel, no longer subject to regular farming, will reestablish natural vegetation that will increase the water quality within the wetland, resulting in improved downstream water quality. This natural vegetation will also improve wildlife habitat in the area, providing refuge for wildlife and increasing diversity of species seen in the area. Given the quantity and quality of wetlands that would be created within the diversion channel , no additional mitigation is proposed for wetland resources. This large corridor of wetland habitat will be a continuous habitat corridor that rarely exists in this region, which will make it very desirable to a wide array of existing wildlife species.

3.3 Total Proposed Mitigation

The total mitigation proposed for the diversion channel alternatives is listed in Table 18.

Table 18 Mitigation costs and Impact Magnitude

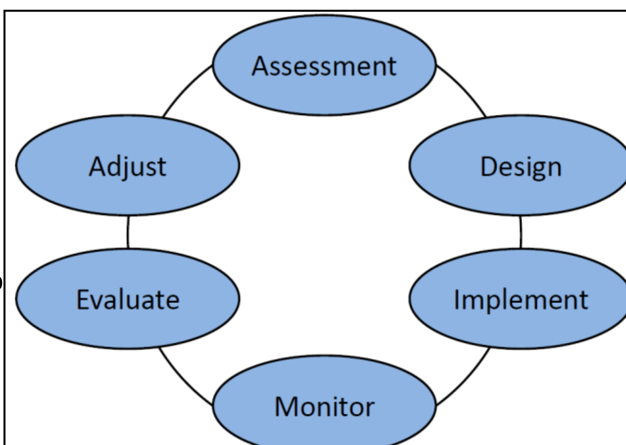
Resource	Impact Type	Impact (acres)	Impact (AAHUs)	Alternative	Mitigation Action	Cost
Red River	Aquatic Footprint	14 acres	7.6	LPP; ND35K	Stream Restoration	$5,000,000
Red River	Aquatic Footprint	30 acres	15.1	FCP	Stream Restoration	$9,700,000
Wild Rice River	Aquatic Footprint	12 acres	1.2	LPP; ND35K	Stream Restoration	$790,000
Sheyenne River	Aquatic Footprint	8 to 9 acres	4.6	LPP; ND35K	Stream Restoration	$3,100,000
Maple River	Aquatic Footprint	11 acres	3.2	LPP; ND35K	Stream Restoration	$2,100,000
Wolverton Creek	Aquatic Footprint	0.3 acre	0.2	LPP: ND35K	Stream Restoration	$110,000

Red River	Connectivity	Portions of hydrograph w/ complete disconnect		LPP	Implement additional fish passage channels	$ 10,000,000
Red River	Connectivity	Entire hydrograph at least partially impeded		LPP	Construct Drayton Dam Fish Passage	$6,500,000
Wild Rice	Connectivity	Portions of hydrograph w/ partial or complete disconnect		LPP	Construct Wild Rice Dam and Hanson Dam Fish Passage	$6,900,000 + $1,900,000
Study Area	Wetlands	905 acres		FCP	Wetland Restoration	18,100,000
Study Area	Wetlands	895 acres		ND35K	Wetland Restoration	17,900,000
Study Area	Wetlands	998 acres		LPP	Wetland Restoration	19,960,000
Study Area	Forest	89 acres		FCP	Forest Restoration	890,000
Study Area	Forest	159 acres		ND35K	Forest Restoration	1,590,000
Study Area	Forest	199 acres		LPP	Forest Restoration	1,990,000
Total:					LPP	$58,350,000
					FCP	$28,690,000
					ND35K	$30,590,000

4. Adaptive Management

4.1 Adaptive Management Approach:

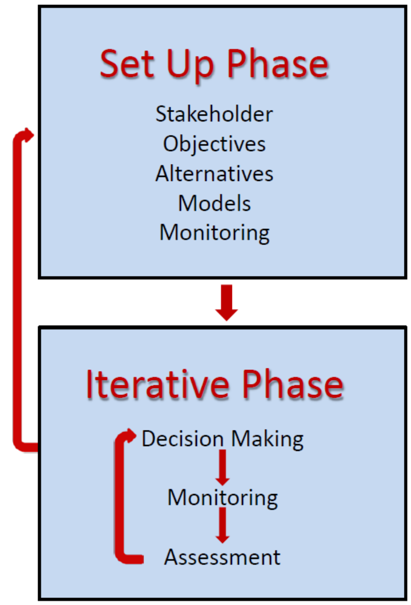
The purpose of this section is to begin laying out an adaptive strategy for a successful monitoring program in support of the project. Adaptive management (AM) is a "learning by doing" management approach which promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (National Academy of Sciences 2004). It is used to address the uncertainties often associated with complex, large scale projects. In AM, a structured process is used so that the "learning by doing" is not simply a "trial and error" process (Walters, 1986).



Source: Nyberg, B. 1999.

The basic elements of an AM process are: (1) Assess; (2) Design; (3) Implement; (4) Monitor; (5) Evaluate; and (6) Adjust. In practice, AM is implemented in a non-linear sequence, in an iterative way, starting at various points in the process and repeating steps based on improved knowledge.

Application of AM should occur in two phases as suggested by the *Adaptive Management: U.S. Department of the Interior Technical Guide (2007)*. A setup phase would involve the development of key components and an iterative phase would link these components in a sequential decision process. Elements of the set-up phase include: stakeholder involvement, defining management or mitigation objectives, identifying potential management or mitigation actions, identifying or building predictive modeling or assessment tools, specifying performance measures and/or risk endpoints, and creating monitoring plans. In addition, values for the monitored measures that would trigger AM should be determined in this phase. The iterative phase uses these elements in an ongoing cycle of learning about system structure and function, and managing based on what is learned. The elements of the iterative phase include decision making, follow-up monitoring, and assessment.



Source: Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2007

<u>4.2 Establish an Adaptive Management Team</u>

An Adaptive Management Team (AMT) would provide essential support to the project in meeting its goals and objectives through the application of a systemic approach to evaluating project impacts, mitigation and mitigation effectiveness. The AMT should consist of a multi-agency (State and federal) staff from the appropriate disciplines, including engineering, planning, environmental science and resource management. The non-federal sponsors would participate directly on the AMT and serve as the AMT leader. The exact members of the AMT will be determined during development of detailed project plans, but would likely include: the Corps, non-federal sponsors, U.S. Fish and Wildlife Service (FWS), Environmental Protection Agency (EPA), Natural Resource Conservation Service (NRCS), North Dakota Game and Fish (NDGF), North Dakota Department of Health (NDDoH), North Dakota State Water Commission, Minnesota Department of Natural Resources (MnDNR) and Minnesota Pollution Control Agency (MnPCA). The AMT would oversee the decision–making processes to plan and evaluate project features and mitigation to ensure project impacts remain less than significant.

<u>4.3 Establish Goals, Objectives and Performance Standards Metrics</u>

Clearly focused and quantitative goals and objectives are essential to AM. They should be logically linked to mitigation actions, action agencies, indicators/metrics, monitoring activities, and ecosystem values. Goals and objectives will be specifically identified during detailed mitigation planning. These goals and objectives will be critical elements of the project, with implementation concurrent with overall project construction.

Performance metrics would be used during two AM processes: plan evaluation (evaluation performance measures and metrics like those described above to predict project impacts) and assessment of actual plan performance (assessment performance measures following project implementation). In many cases, these processes would be the same, allowing predictions to be compared to actual responses.

Performance standards/metrics are further discussed in Section 6. This includes potential metrics for quantifying impacts following project construction, and how mitigation effectiveness will be measured. These standards/metrics will be fully developed based on input from the AMT during future planning for monitoring and evaluation. At a minimum, the goal of mitigation will be to replace the habitat value lost through project impacts. Performance standards/metrics will allow for this evaluation of mitigation effectiveness.

4.4 Develop and Implement Monitoring Plans

The CEQ NEPA Task Force (CEQ 2003) suggests that the effectiveness of adaptive management hinges upon an effective monitoring program to establish objectives, thresholds, and baseline conditions. This will be achieved through a stepwise process that includes both pre-construction studies of biota and physical habitat, and post-construction studies of biota and physical habitat. These studies are scheduled for both impact and mitigation sites, allowing impacts to verified, and for mitigation effectiveness to be evaluated.

Monitoring programs are a key component of AM. Monitoring provides feedback between decision making and system response relative to management goals and objectives. An essential element of AM is the development and execution of a scientifically rigorous monitoring and assessment program to analyze and understand system response to project implementation. It is recognized that project level monitoring would be limited by cost and duration based on current regulations and that project level AM plans would need to be designed to reflect this constraint. However, post project monitoring would be a part of project implementation, with monitoring required from the non-federal sponsors as a part of project operation and maintenance.

Following the adaptive framework of this document, impacts would be monitored over time and performance of measures would be assessed to determine whether additional avoidance, minimization, or mitigation measures are needed. Future monitoring will provide information on the accuracy of the conclusions reached on the extent of impacts from the project features and evaluate the effectiveness of mitigation. Monitoring activities, including review of results, will be performed collaboratively with the AMT.

Pre- and post-project monitoring is discussed in greater detail below in Section 5. Specific proposed sampling methodologies are being designed to address the performance standards/metrics outlined in Section 6.

4.5 Contingency Plans

Post-project monitoring will include an evaluation of mitigation effectiveness. Should mitigation prove ineffective, or should impacts prove more significant than previously anticipated, then additional mitigation may be warranted.

The AMT must first identify which resources still have remaining impacts needing mitigation. This remaining impact should be quantified. Potential mitigation can then be identified to offset this remaining impact.

Funding mechanisms for implementing additional mitigation must then be identified. In some instances, recent large-scale projects constructed by the Corps of Engineers have included authorization language specifying a federal funding source for future mitigation needs. This has also included appropriation of such funds. Under these circumstances, projects have a specific mechanism to implement contingency mitigation plans in cases where project impacts have not been appropriately mitigated.

Unfortunately, contingency plans for mitigation are not included as an authorization of most projects, and are ultimately the decision of the U.S. Congress. At this time, it is assumed that the project would follow a typical authorization for Specifically Authorized Corps projects. In this case, federal project funding would be provided through construction and until the project is turned over to the non-federal sponsors. Thus, funding would be provided for construction of planned mitigation projects, and potentially some of the initial post-project monitoring. It cannot be guaranteed that federal funds would be available, specific to this project, for contingency mitigation.

The non-federal sponsors will be responsible for contingency mitigation. They may elect to collaborate with the AMT and other appropriate local, state and federal agency representatives to identify the appropriate funding source. This could include the use of local or State funds to address remaining mitigation needs. The non-federal sponsors could also coordinate with USACE for possible funding under the Corps' Continuing Authorities Program (CAP). The non-federal sponsors also could coordinate with their congressional leaders for authorization and appropriation of additional funds to address contingency mitigation.

5. MONITORING

The purpose of this section is to lay out the plan for pre- and post-construction monitoring. Monitoring will be done in concert with the overall adaptive management approach outlined above.

The purpose of monitoring is to better characterize pre-project conditions for key resources, characterize these resources following project implementation, verify resulting project impacts, and verify whether mitigation is offsetting these project impacts. An overview of methodologies is provided, and costs associated with monitoring is summarized in Table 19 and Table 20. Pre-construction monitoring efforts will be led by the Corps and the non-federal sponsors. Following construction, monitoring and adaptive management would be the responsibility of the non-federal sponsors. All monitoring will be done collaboratively with the AMT.

5.1 Aquatic Habitat:
Monitoring for aquatic habitat will be focused to answer the following specific questions:

1) What is the quality of aquatic habitat directly lost, or potential altered, through project features?
2) Has the project impacted physical aquatic habitat and physical river processes in areas where hydraulics or geomorphic conditions are changed?
3) How effective has mitigation been at offsetting impacts to aquatic habitat and biotic integrity?

These questions will be addressed within all impact areas for aquatic habitat. They also will be addressed for mitigation areas.

To address these questions the following field investigations will be performed:

1) Geomorphic assessments
2) Fisheries Assessments
3) Macroinvertebrate Assessments
4) Physical Habitat Assessments
5) Mussel surveys

Geomorphology

Geomorphic assessments will help answer the following specific question:

- Has the project impacted physical aquatic habitat and physical river processes in areas where hydraulics or geomorphic conditions are changed?

The tasks to be completed for geomorphology are outlined within a Scope of Work (SOW) protocol for performing the geomorphic assessment (available upon request). This includes analysis of hydrology, bank stability, sediment transport and morphological classification. Work under this SOW was initiated in 2010 and will continue in 2011, providing key pre-project observations that will form the basis for future comparison. In addition to work outlined in the SOW, additional data has been collected to support geomorphic assessments. This includes LIDAR data collected for the Red River basin during

2008 and 2009; bathymetric data collected in 2010 for the Red River from Abercrombie to Perley, Minnesota; and sediment transport data for the Red River and select tributaries during the spring flood of 2010. The USGS also has been contracted to collect additional sediment transport data from the Red River during spring of 2011.

The geomorphic study area will include the following locations in the project area (Figure 8and Figure 9):

- Red River of the North from Abercrombie to Perley, Minnesota
- Wild Rice River from Abercrombie, North Dakota to the Red River of the North
- Sheyenne River from Kindred, North Dakota to the Red River of the North
- Sheyenne River Diversion Channel from Horace to West Fargo, North Dakota
- Rush River from Prosper, North Dakota to the Sheyenne River
- Lower Branch Rush River from Prosper, North Dakota to the Sheyenne River
- Maple River from Mapleton, North Dakota to the Sheyenne River
- Buffalo River from 1 mile upstream of Georgetown, Minnesota to the Red River of the North
- Wolverton Creek for 3 miles upstream of the Red River of the North

Geomorphic surveys will be performed once prior to construction, and at least twice following construction. The results of these assessments will be compared to verify changes in geomorphic conditions, and the likelihood that any changes are due to the project. The timing of post-construction monitoring is still being identified. Geomorphic changes often are triggered by flood events. Thus, changes may not occur until one or more 50-percent chance events have occurred at a project site. As such, scheduling specific years for post-construction geomorphic surveys is difficult. However, the first post-construction assessment would potentially be five to ten years following project completion. The second assessment would potentially be twenty years following project completion. Additional future geomorphic surveys could be warranted, the need for which will be collaboratively discussed by the AMT.

Biotic Assessments

Biotic assessments will help answer the following specific questions:

- What is the quality of aquatic habitat directly lost, or potential altered, through project features?
- How effective has mitigation been at offsetting impacts to aquatic habitat and biotic integrity?

Biotic assessments will include a series of field investigations:

- Fisheries Assessment
- Macroinvertebrate Assessment
- Physical Habitat Assessment
- Mussel surveys

Biotic assessments outlined here will identify general biotic conditions of the project area. While there could be some seasonal variability in fish and macroinvertebrate use of select areas, the assessments outlined below are targeted at assessing the general biotic condition and integrity of the project area. Concerns with connectivity and associated monitoring are addressed separately below.

The general study approach for biotic assessments in impact areas will be a "Before-After-Test-Control" design, allowing multiple forms of comparison. First, sampling prior to and following construction will allow a "Before-After" comparison. Similarly, sampling areas potentially impacted by the project, as well as adjacent control sites, will allow a "Test-Control" comparison to further verify potential changes due to the project.

The study locations for biotic assessments could include those identified in Figure 10. The exact locations may shift based on further project design or site conditions. Sites will include areas directly within the project footprint, areas either downstream or upstream of project structures where hydraulics could change, and nearby control sites.

Post-construction surveys will include assessing biotic conditions within newly created stream channels that route flow through project structures. In the case of the Rush and Lower Rush rivers, these stream channels will be re-routed as a single channel in the bottom of the diversion channel. This new channel will be assessed at one or two locations post-construction. This approach will help determine habitat quality and biotic integrity within these new stream channels.

Additional surveys also will be performed in potential mitigation sites. However, since mitigation sites are still being formulated, these survey locations have yet to be determined. Stream restoration will be a primary mitigation method for aquatic impacts, with fish passage also providing mitigation. Monitoring will be needed to verify effectiveness of the mitigation. Mitigation sites will include pre- and post-project sampling. They also may include additional control sites. This plan will be updated as final mitigation sites are selected.

For each sampling site (Figure 10), the following activities will be performed.

1) Site Reconnaissance Investigation
2) Fisheries Assessment
3) Macroinvertebrate Assessment
4) Physical Habitat Assessment

The methodologies to perform the above sampling will largely be adapted from methodologies developed by NDDoH. Both states are developing respective fish and invertebrate IBI scoring systems for the Red River Basin, and these will generally be used to assess rivers in the respective states. Given that the majority of assessments will be performed in North Dakota, the DoH methodology will serve as the source for the majority of methodologies.

First, site reconnaissance will be performed to establish survey sites and identify appropriate sampling methods for fish, invertebrates and physical habitat based on survey site characteristics. The methodologies for site reconnaissance (available upon request) are from MnPCA. Site reconnaissance will be performed during June or July.

Fisheries assessments would then be performed following the fisheries sampling methodology developed by NDDoH (available upon request). Methodology for fish sampling is defined by whether the river is characterized as "wadeable" or "nonwadeable." Site conditions will dictate which sampling methodology is used. Methodology may need to be modified to accommodate rivers in the project area, some of which are likely borderline between being either wadeable or non-wadeable. Sampling in Wolverton Creek (MN) and the Red River also will follow the fish methodology outlined by NDDoH. Fisheries sampling for all sites will occur during the low-flow summer period (i.e., July thru September).

Macroinvertebrate surveys would then be performed by methodology also developed NDDoH (available upon request) for streams that can be characterized as "wadeable" streams. Methodology for all invertebrate sampling will follow that developed by NDDoH. For streams that are considered "non-wadeable" the methodology will be modified, if possible, to facilitate sampling. This could include sampling macroinvertebrates in near-shore areas that could be accessible by wading. Macroinvertebrate sampling from a boat also will be considered (methodology for all invertebrate sampling available upon request). If acceptable sampling conditions are not available, then macroinvertebrate sampling may be dropped from those survey sites. This could potentially be an issue on the Red River, as well as the larger North Dakota tributaries. The ability to perform macroinvertebrate sampling will be evaluated during both the site reconnaissance and fisheries assessments. A decision will be made at that time where macroinvertebrate surveys will be performed. This could result in some locations dropping from consideration for future macroinvetebrate sampling under this plan. Invertebrate sampling will occur after fisheries sampling during the low-flow summer period (i.e., July thru September).

Lastly, a habitat assessment will be performed to characterize in-stream habitat conditions. For wadeable streams, the MnPCA protocol to assess physical habitat and water chemistry will be used to characterize habitat. For non-wadeable streams, the MnPCA protocol for Stream Habitat Assessment (MSHA) will be followed (habitat assessment methodologies available upon request). These two methodologies will be applied to all rivers sampled. The methodologies are similar to those applied by NDDoH and provide a convenient set of methods for both wadeable and non-wadable streams. Habitat assessments will be completed after fisheries sampling has been completed.

Where needed, all of the above methodologies may be modified to adjust to site conditions. As outlined, river depths may warrant switching between protocol for wadeable and non-wadeable streams. River conditions also could require modifications to sampling equipment or methods. Survey station lengths may be modified, particularly in footprint areas where additional sampling may be done to cover an entire footprint area. Any modifications will be coordinated with the AMT and reflected within the more detailed Scope of Work that will be developed for executing sampling.

As of this report date, the locations, methodology and number of mussel survey sites are still being developed. Mussel surveys can be labor intensive, with mussel distribution often spotty or sparse, especially in poor habitat areas. The methods outlined above for macroinvertebrates will assess general biotic condition of the project area. However, to address remaining specific concerns for mussels, mussel surveys will be considered in footprint impact areas, and potentially other sites. Review of recent mussel survey data may help direct and streamline mussel sampling. Sampling methodology and survey sites will be coordinated with partner agencies.

Biotic surveys for fish and macroinvertebrates would be performed twice prior to construction. A third year of sampling will be considered based on results observed during the first two sampling efforts, and funding availability. A single sampling event for mussels would be performed. The timing of post-construction biotic monitoring is also under discussion, but will include at least two surveys performed over the first 20 years following project completion. Surveys would be performed in the same locations as those for the pre-construction surveys to identify any changes to habitat quality.

Connectivity (Fish Passage) Assessments

Monitoring will be done to assess the effects of project features on fish migration. This will include monitoring to assess potential fish movement through project structures, fish passage channels, and fish movements up the diversion channel from the Red River. Similarly, for mitigation accomplished via construction of fish passage, monitoring would be performed post construction to verify fish passage is working effectively.

Monitoring to assess potential impacts to fish migration would be done once project features are in place and the project is put into operation (post-construction monitoring). No pre-project monitoring is currently planned to assess fish movements.

During coordination in winter 2010-2011, natural resource agencies expressed a preference to perform pre-project fisheries monitoring to assess fish migration. This would include detailed assessments to document the timing and duration of migration for most Red River species and movement of fish back forth between the Red River and project area tributaries. However, while this could be helpful information, pre-project migrational assessments currently are not planned for the following reasons. First, existing data is available to suggest the timing and duration of migration for several species in the Red River basin. Second, this report assumes fish have the ability to migrate freely through the upper Red River at any time under pre-project conditions. This includes assuming fish passage will soon be constructed at Christine and Hickson dams. Third, collection of detailed information on fish migrations would be expensive compared to other baseline monitoring. Fourth, data such as fish telemetry data is highly variable, and may not provide a substantial improvement over existing knowledge. For these reasons, the Corps concluded that pre-project monitoring for fish migrations would not be completed. This conclusion could be revisited if more cost-effective means are identified to collect such information.

For post-construction monitoring, the exact methodology for assessing this issue is under discussion, but could include activities such as netting, radio telemetry and/or hydroaccoustic monitoring.

Netting could be done immediately above the control structures or fish passage channels, and would provide insight into which species are able to migrate through these features. Netting is a fairly easy and inexpensive method to evaluate whether fish are able to pass through project structures.

Radio telemetry could be used to assess how many fish approach the structures, and what portions of those fish are able to migrate through these structures. This information would be extremely beneficial for not only assessing fish movement through project structures, but could provide general knowledge on effectiveness of features like fish passage channels and rock-riffle fishways that have not been evaluated in great detail. The drawback is that radio telemetry studies can be considerably more expensive, particularly for the equipment that is involved. It also requires the collection of fish and attachment or surgical implantation, which is labor intensive. Radio telemetry is biased toward larger bodied fish that can better handle the radio transmitter. There are also limitations in how long radio transmitters may last, which is problematic given that we do not know when there will be flooding events significant enough to activate the project.

Hydroaccoustic monitoring can detect the presence of fish much like a camera, but work effectively in turbid waters. Hydroaccoustic monitoring (e.g., imaging sonars such as the DIDSON) can monitor presence of fish below a potential impediment, and could monitor fish migration through structures. This technology has limitations in how effectively it may work under conditions with heavy debris flow. It also generally does not differentiate species of fish, only fish size.

The exact methodology to evaluate fish migration has not been developed given this monitoring will not be performed until after the project is operational, and it will be at least 10 years until the project would operate. The AMT will further develop this specific methodology in the years ahead.

5.2 Floodplain Forest Habitat:

The majority of baseline data needed to quantify existing habitat value of floodplain forest impact areas has been collected (Appendix F). Additional surveys could be performed prior to construction; however these efforts would likely be small in scope. Following construction, survey transects would likely be established in floodplain forest mitigation areas to determine the condition of these habitat types and the overall effectiveness of their mitigation; see section 6 for a detailed monitoring plan and performance standards/metrics.

5.3 Wetland Habitats:

The National Wetland Inventory was used as a preliminary method to identify impacted wetlands; this information is what was reported in the DEIS. For the SDEIS, a more detailed wetland determination has been conducted along the alignments for the diversion channel alternatives to include MNRAM functionality assessments. This information will be used to verify the mitigation approach for these wetlands. Surveys of the diversion channel will be performed to verify that wetland type and function present are offsetting wetland areas lost through construction.

Annual mitigation monitoring reports shall be submitted on the status of the mitigation. The reports shall be submitted by December 31 following each of the first five growing seasons. The reports shall, at a minimum, include the following information:

1. All plant species along with their percent cover, identified by meandering through each vegetative community, including upland buffers, and list commonly encountered – or dominant and co-dominant species observed. In addition, the presence, location and percent cover of invasive, noxious and/or non-native species in any of plant communities shall be noted.
2. Vegetation cover maps at an appropriate scale shall be submitted for each reported growing season.
3. Photographs showing all representative areas of the mitigation site taken at least once each reported growing season during the period of July 1 to September 30. Photographs shall be taken from a height of approximately five to six feet from at least one location per acre. Photos shall be taken from the same reference point and direction of view each reporting year. Location of the photographs should be mapped on a GPS unit
4. Surface water and groundwater elevations in representative areas (e.g., at least one sample point in each plant community) recorded at least once each week for the first 10 weeks of each

growing season, thereafter taken monthly for the remainder of each growing season. The location of each monitoring site shall be shown on a plan view of the site.

5. If non-compliance activities are occurring on the site, make note of the activity, photograph the activity and map the location of the location of the non compliance activity on a GPS unit. Use your best professional judgment to determine if the activity is not compliance with easement or mitigation site plan.

A wetland delineation of the site applying the *Corps of Engineers Wetlands Delineation Manual*, *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0)* and guidance shall be submitted at the close of the monitoring period. This delineation shall be prepared by a wetland professional.

Over two-thirds of the wetlands that are impacted are seasonally flooded wetlands or farmed wetlands; these wetlands have very poor function. It is not environmentally preferable to compensate for impacts to degraded wetlands by deliberately providing degraded compensatory mitigation projects . A compensation project should result in high quality wetlands that provide optimum functions within its landscape context, taking into account unavoidable constraints. Typically the Corps requires impacts to even the most degraded wetlands to be mitigated at 1:1 (compensation acres: impact acres). In rare situations, the minimum compensation ratio can be lowered if it is determined that the impacted wetland is so degraded that it provides minimal wetland functions. Even though the wetlands impacted by the project are generally highly degraded they should be mitigated for by restoring equal acres of wetland or by restoring functions that are lacking in the Red River Basin watershed.

5.4 Cost Estimate for Project Monitoring:

A preliminary cost estimate for monitoring is provided in Table 19and Table 20 for the FCP and the ND35K and LPP. This is strictly a preliminary estimate of what survey costs could be to assess how well mitigation sites are actually performing. The monitoring costs for mitigation will continue to be refined, and could increase or decrease depending on the number and location of mitigation sites ultimately chosen.

Table 19 Overview costs for monitoring, including post-construction evaluation of impacts and mitigation effectiveness, for the FCP.

Studies	Cost
Study Area Geomorphic Assessment: Pre-construction (1 event)*	$1,000,000
Study Area Geomorphic Assessment: Post-construction (2 events)	$1,000,000
Connectivity/Fish Passage Assessment: Post Construction	$5,000,000
Biotic Use: Pre-construction (3 events)	$2,250,000
Biotic Use: Post-construction (3 events)	$2,250,000
Diversion Channel Wetlands Monitoring Post Construction	$100,000

Total Pre-Project Monitoring	$3,250,000
Total Post-Project Monitoring	$8,350,000

*Costs for pre-project geomorphic surveys are based on work already underway. Pre-project surveys will be more extensive than needed for the FCP as survey work is being completed to cover all three diversion channel alternatives.

Table 20 Overview of costs for monitoring, including post-construction evaluation of impacts and mitigation effectiveness, for the ND35K and LPP.

Studies	Cost
Study Area Geomorphic Assessment: Pre-construction (1 event)	$1,000,000
Study Area Geomorphic Assessment: Post-construction (2 events)	$2,000,000
Connectivity/Fish Passage Assessment: Post Construction	$5,000,000
Biotic Use: Pre-construction (3 events)	$3,500,000
Biotic Use: Post-construction (3 events)	$3,500,000
Diversion Channel Wetlands Monitoring Post Construction	$100,000
Total Pre-Project Monitoring	$4,500,000
Total Post-Project Monitoring	$10,600,000

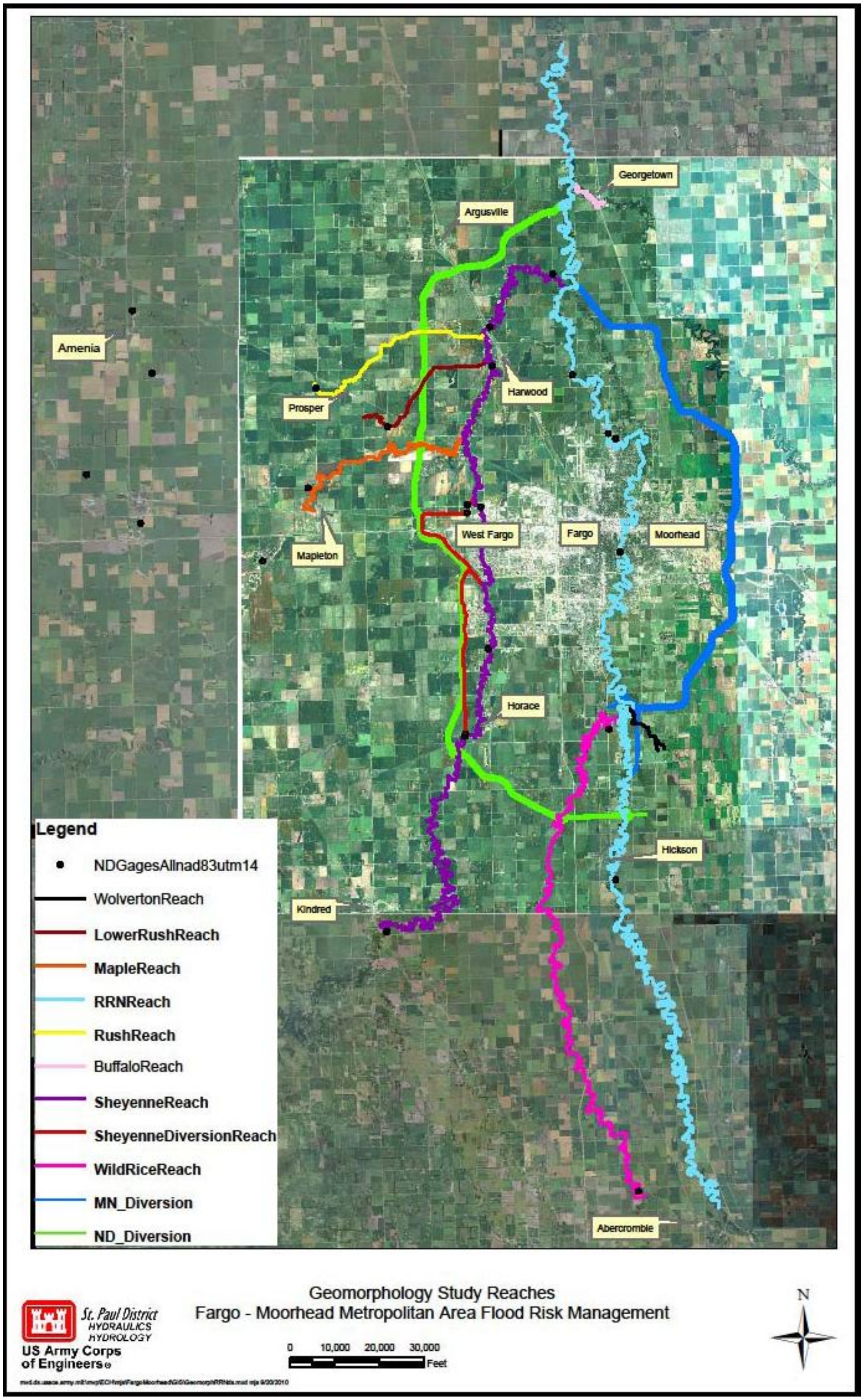


Figure 8 Geomorphic study reaches for pre-project monitoring.

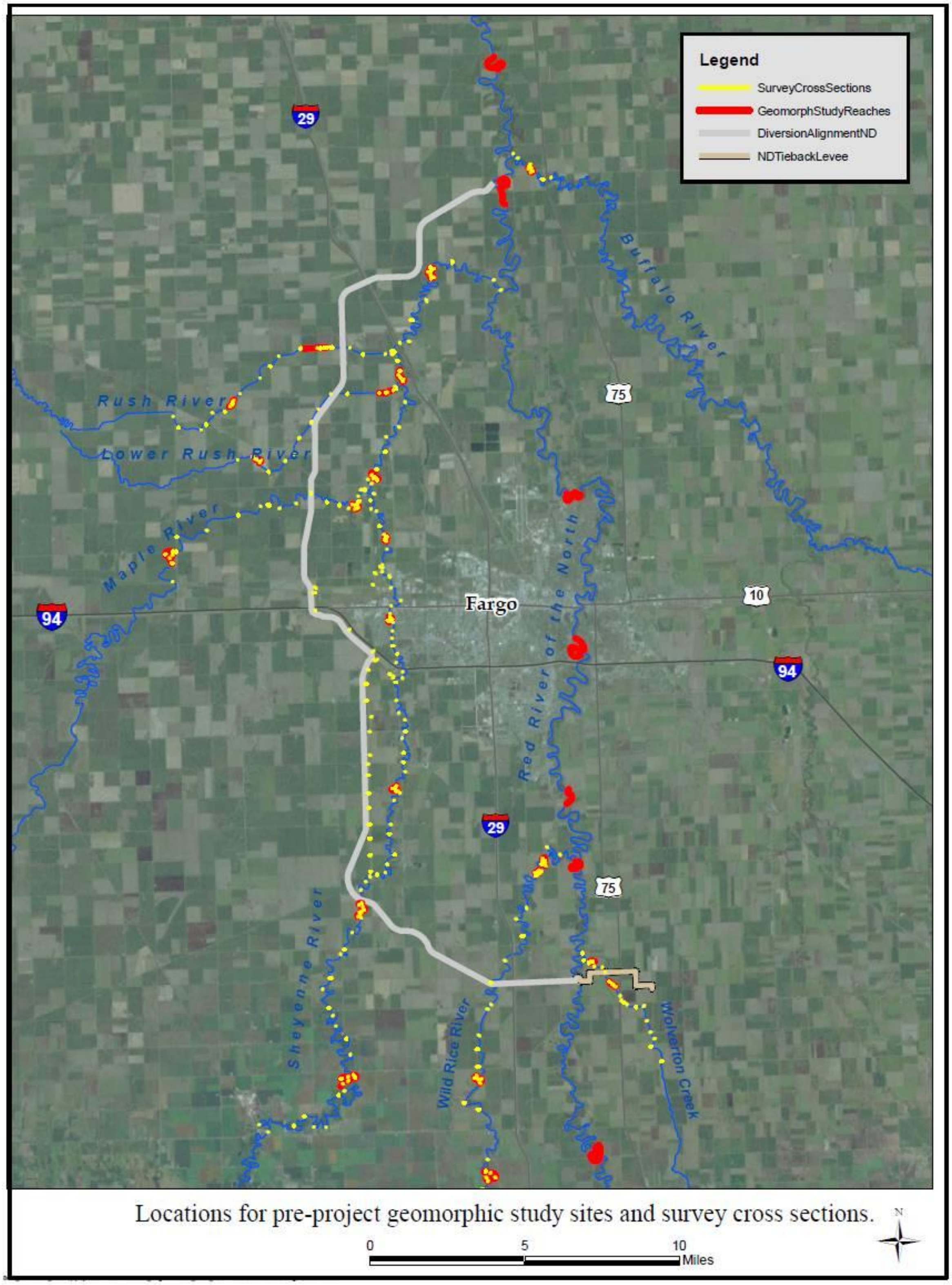


Figure 9 Geomorphic study reaches and survey cross-sections for pre-project monitoring.

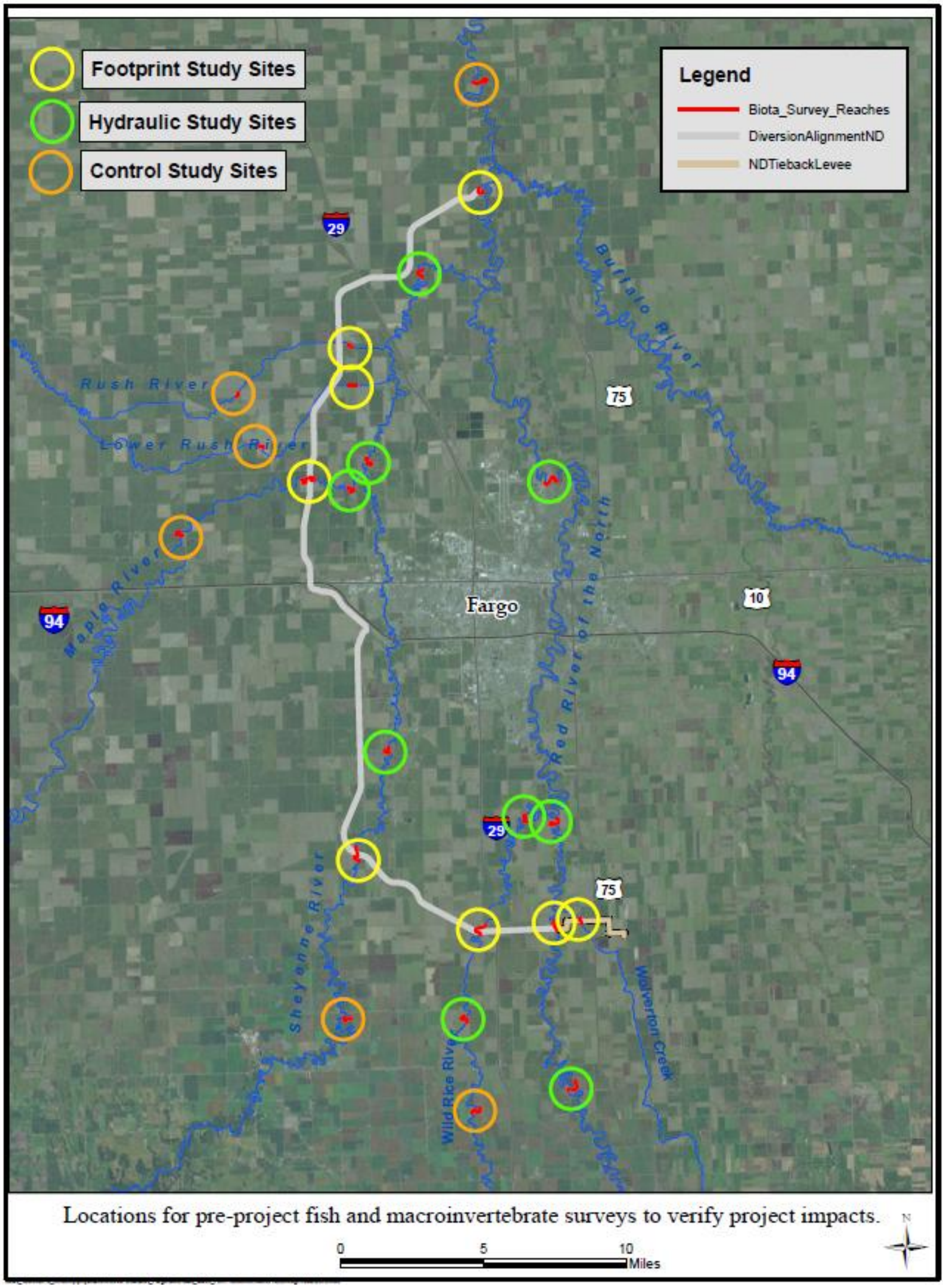


Figure 10 Biotic study reaches for pre-project monitoring. Biotic monitoring to include fisheries, macroinvertebrate and physical habitat observations at each identified site. Mussel survey may be performed at select sites.

6. Performance Standards/Metrics

Corps regulations require that projects include the development and use of criteria for determining ecological success of mitigation, to ensure project impacts are offset. The exact criteria for verifying impacts and mitigation effectiveness is still under development. However, there are several metrics under consideration to quantify effectiveness of mitigation, and whether project impacts have been mitigated.

Geomorphology

For geomorphic concerns, impacts will be verified through collection of pre- and post-project geomorphic data. Factors such as channel stability, channel location and cross-sections, slope and other factors will be compared for potential change. Exact thresholds of geomorphic change are difficult to specific. Thus, whether any substantial changes have occurred will be determined collaboratively amongst the AMT.

Aquatic Habitat and Biotic Integrity

For biotic use and integrity, impacts will be verified through collection of pre- and post-project fish and invertebrate data. This data could be compared in several ways. At a minimum, an IBI will be generated from project data, with scores compared before and after construction to verify resulting impacts. IBI scores also would be generated for mitigation sites to quantify the amount of mitigation created compared to the habitat lost through construction. An IBI scoring system had previously been generated in the Red River basin back in the 1990s to describe general biotic conditions (EPA 1998). Both Minnesota and North Dakota are currently developing their own IBI scoring system for the Red River Basin. Both of these systems will be used to quantify biotic condition within impacted rivers. The North Dakota IBI system will be used for North Dakota tributaries and the Red River. The Minnesota IBI will be used for Wolverton Creek, and could also be used for the Red River as another metric for comparison.

In addition to IBI scoring, project data could produce various diversity indices as an indicator of habitat quality. Relative abundance also could be factored in to verify biotic condition of survey sites. These combinations of diversity and abundance could be compared pre- versus post-project, and impact versus control site, to verify project impacts and mitigation effectiveness. Considering multiple metrics may allow for a better comparison and determination of potential change due to the project. Whether any substantial changes have occurred will be determined collaboratively amongst the AMT.

Whatever metrics are utilized, impacts to aquatic habitat will be evaluated by calculating a “Habitat Unit” as Impact Area multiplied by Habitat Quality (as identified from one or more of the above metrics). The effectiveness of mitigation will be determined as the Habitat Units lost through impact, compared to the Habitat Units gained through mitigation. This shall also take into account the Habitat Units that are present within any newly constructed river channels to facilitate routing flow through project features (e.g., water control structures, aqueducts, etc). The net result of impacts and mitigation would be at least zero Habitat Units (break even between habitat lost through impacts and habitat gained through mitigation and newly created channels).

Connectivity

Impacts to connectivity also will be assessed, although the effectiveness of fish passage and associated mitigation may be more subjective. At a minimum, mitigation must offset lost connectivity with restored connectivity. The AMT will collaboratively work to assess the effectiveness of mitigation. Similarly, mitigation that uses connectivity to offset site-specific aquatic habitat impacts will be evaluated by the AMT to consider effectiveness.

Floodplain Forest

The monitoring results will be compiled, interpreted and described in letter reports. The monitoring reports will be provided to the partnering agencies and the public upon request.

Vegetation will be monitored annually for the first 5 years following planting using stratified random sampling. At each randomly generated point within the areas planted, plots of 0.01 acre will be surveyed. An average of at least one plot per acre will be surveyed. Tree survival and composition will be monitored every 10 years and following major flooding. Trees will be replanted as needed to meet the target vegetation cover (see Performance Standards below). Invasive and/or non-native plant species will be controlled for 3 full growing seasons. Control will consist of mowing, burning, disking, mulching, biocontrol and/or herbicide treatments as needed. By the third growing season, any planted areas one-half acre in size or larger that have greater than 50 percent areal cover of invasive and/or non-native species will be treated (e.g., herbicide) and/or cleared (e.g., disked) and then replanted with trees.

Performance Standards:

1. Restore native floodplain forest and herbaceous vegetation. The floodplain forest should include green ash, cottonwood, black willow, hackberry, silver maple, American elm, American basswood, and bur oak.
2. Restore stand density with an average of 300 trees per acre over 80 percent of the mitigation site(s) with diameter at breast height (DBH) of 2 inches within 10 years. This tree density is typical for the Red River Basin floodplain forest in the project vicinity.
3. Restore floodplain forest community with a target species composition of at least 10 percent by number of individual trees to be bur oak and hackberry, with the rest a mix of green ash, cottonwood, black willow, boxelder, American elm, silver maple and American basswood.
4. Allow some regeneration of native herbaceous plants, shrubs, and trees from locally produced propagules on 20 percent of the mitigation land area, to create diversity in forest and herbaceous vegetation in the mitigation area.
5. Protect and manage the site(s) in perpetuity by an agreement for management as a wildlife management area by the Minnesota Department of Natural Resources or North Dakota Game and Fish department.

Wetlands

The monitoring results will be compiled, interpreted and described in letter reports. The monitoring reports will be provided to the partnering agencies and the public upon request.

Performance Standards:

Hydrology

1. **Seasonally Flooded Basins.** Hydrology shall consist of inundation by a few inches to 24 inches of water for a minimum of 15 consecutive days during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation shall be typically absent following the first 6 weeks of the growing season and soil saturation drops below 12 inches from the surface for the majority of the growing season in most years.

2. **Fresh (Wet) Meadows, Sedge Meadows and Wet Prairies (Mineral Soils).** Hydrology shall consist of saturation at or within 12 inches of the surface for a minimum of 30 consecutive days, or two periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation during the growing season shall not occur except following the 10-percent chance or larger event. The depth of inundation shall be 6 inches or less and the duration of any inundation event shall be less than 15 days. An exception can be made for sites with hummocky microtopography -- hollows between hummocks can have standing water depths of up to 6 inches for extended duration.

3. **Shallow Marshes.** Hydrology shall consist of saturation to the surface, to inundation by up to 6 inches of water, for a minimum of 60 consecutive days or two periods of 30 consecutive days or four periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). During the growing season, inundation by up to 18 inches of water following the 50-percent chance or larger event is permissible provided that the duration does not exceed 30 days (e.g., water depth drops from 18 inches to 6 inches within the 30 days).

4. **Deep Marshes.** Hydrology shall consist of inundation by 6 to 36 inches of water throughout the growing season, except in drought years (driest 10 percent of most recent 30-year period of precipitation record).

Vegetation

1. **Herbaceous Species Composition**:

   a. Fresh (wet) meadows, sedge meadows, wet prairies, and seasonally flooded plant communities (Type 1 and Type 2 wetlands) shall each achieve a species composition that includes 10 or more species of native/non-invasive grasses, sedges, ferns, rushes and/or forbs by year 5. Alternatively, a MnRAM vegetative diversity and integrity score of "high quality" by year 5 would also satisfy this performance standard.

   b. Shallow marsh and deep marsh plant communities shall be dominated by 3 or more native aquatic species, with at least 4 native plant species occurring within the shallow marsh communities on the site by year 5. A MnRAM vegetative diversity and integrity score of "high quality" for each these plant communities will also satisfy this performance standard.

c. Restored tallgrass prairie in the upland buffer and interior banks of the diversion channel shall be dominated by 3 or more species of native grasses, sedges, rushes, forbs and/or ferns, with approximately 80% or greater areal coverage of the total mitigation site, and at least 10 native species occurring within the area of the upland communities on the site by year 5.

2. **Hydrophytes.** More than 50% of all plant species within the wetland communities of the mitigation site shall be facultative (FAC) or wetter (FACW or OBL) excluding FAC-.

3. **Control of Invasive and/or Non-Native Species**: Control of invasive and/or non-native plant species shall be carried out for five full growing seasons. Control shall consist of mowing, burning, disking, mulching, biocontrol and/or herbicide treatments. By the third growing season, any areas one-quarter acre in size or larger that have greater than 50 percent areal cover of invasive and/or non-native species shall be treated (e.g., herbicide) and/or cleared (e.g., disked) and then reseeded. Follow-up control of invasive and/or non-native species shall be implemented as stated above.

Attachment 7

Fargo-Moorhead Metro

Supplemental Draft Feasibility Report and Environmental Impact Statement

April 2011

Electronic Copy of Main Report and Appendices