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FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT: FARGO-MOORHEAD METROPOLITAN AREA FLOOD RISK MANAGEMENT, JULY 2011

COMMUNICATION

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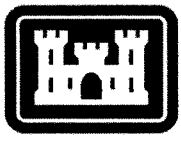
Final Feasibility Report and Environmental Impact Statement

Fargo-Moorhead Metropolitan Area Flood Risk Management

Volume 5
Appendices J-P

July 2011



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Appendix J
Structural

Fargo-Moorhead Metropolitan Area Flood Risk Management

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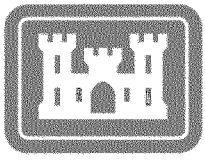

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FARGO-MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT,

FEASIBILITY STUDY, PHASE 4

STRUCTURAL SUMMARY

APPENDIX J

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PURPOSE

The following cover the description and selection of the major structural features in the project. The primary objective of this effort was to determine feasibility of design and establish reasonable quantities for the baseline cost estimate. The level of design was conducted to sufficient detail to attain the objective. There are Bridges Appendix E and Hydraulic Structures Appendix F included in Attachment 5. The contents of these appendices are summarized in the following paragraphs:

DESIGN AND ANALYSIS OF STRUCTURAL FEATURES

BRIDGES SUMMARY

The F-M Metro Flood Risk Management Project Feasibility Study, Phase 4 includes the evaluation of two diversion concepts. These include the Minnesota Diversion alternative (Federally Comparable Plan – FCP) and the North Dakota Diversion alternative (Locally Preferred Plan – LPP). This section documents the preliminary bridge design procedure used to develop cost estimates and preliminary bridge layout drawings for the two diversion alternatives under consideration, see Attachment 5, Appendix E. The two diversion alternatives require differing amounts of bridges as follows:

Alignment	No. of Highway Bridges	No. of RR Bridges
FCP	20	4
LPP	19	4

(Crossings at divided highways such as I-94 are counted as two bridges)
The following table shows the locations of the bridges for each of the alignments.

BRIDGE LOCATIONS

FCP	LPP
* Interstate 29 (SB)	County Highway 81 (South)
* Interstate 29 (NB)	Interstate 29 (NB-South)
+ 110th Avenue S	Interstate 29 (SB-South)
State Highway 75 (South)	48th Street SE
RR Bridge 4 near Hwy 75 South	170th Avenue SE
80th Avenue S	RR Bridge 4 near 46th Street N
60th Avenue S	46th Street SE
CSAH 52	44th Street SE
RR Bridge near CSAH 52	41st Street SE
50th Avenue S	Interstate 94 (EB)
Interstate 94 (EB)	Interstate 94 (WB)
Interstate 94 (WB)	RR Bridge 3 near I-94
RR Bridge 2 @ Dilworth Yard	36th Street SE
US Highway 10 (EB)	33rd Street SE
US Highway 10 (WB)	RR Bridge 2 near 33rd Street SE
28th Avenue N	31st Street SE
57th Avenue N	28th Street SE
CR 14	Interstate 29 (SB-North)
90th Avenue N	Interstate 29 (NB-North)
100th Avenue N	RR Bridge 1 near Co Hwy 81
State Highway 75 (North)	County Hwy 81 (North)
RR Bridge 1 near Hwy 75 North	25th Street SE
110th Avenue NW	173rd Avenue SE
15th Street NW	

* Wild Rice breakout channel
+ Auxiliary channel

DESIGN BASIS

The conceptual bridge designs were developed in accordance with the following specifications and manuals: AASHTO LRFD Bridge Design Specifications, Current Edition; Current MnDOT LRFD Bridge Design Manual; Current NDDOT LRFD Bridge Design Manual.

The superstructures for all of the bridges are of prestressed concrete girders with cast in place concrete decks. Steel plate girder superstructures were evaluated for comparison, but were found to be more costly than the prestressed concrete bridges, and therefore, are not presented here. The substructures consist of concrete wall piers and concrete abutments supported on steel H-piling. The pile termination elevation was assumed to be approximately 100 feet below existing grade, which is consistent with typical bridges in the area. A typical section and elevation views of the bridge structures are included in Plates 1 through 11 of Attachment 5, Appendix E.

Approach costs were estimated based on raising the roadways to tie into the proposed bridge elevations. Minimum vertical and horizontal (if applicable) curves were designed and fill quantities were estimated based on the difference between proposed and existing grades. Pavement, guardrail, aggregate base, embankment, and other misc. costs were included in the estimates.

Preliminary designs were performed for each type of bridge (based on roadway classification) for both the FCP and LPP alternatives.

The bridge types and associated width are as follows:

MN Divided Highway (I-94 and US 10)	42' clear roadway
MN State Highway	48' clear roadway
MN Local Roads	32' clear roadway
ND Divided Highway (I-29 and I-94)	40' clear roadway
ND Local Roads	28' clear roadway

BRIDGE LENGTH DETERMINATION

Bridge lengths were calculated for each bridge location for each of the alternatives using Excel spreadsheets. The bridge lengths were based on the channel bottom width and elevation, channel slopes consistent with the rest of the channel geometrics (7:1 slopes, bench, then 7:1 slopes), and the estimated deck elevation. The deck elevation was computed by taking the 500-year water surface elevation at the structure and adding freeboard and the superstructure depth. The freeboard was assumed to be 3'-0" and the superstructure depth was approximately 5'-5". The water surface elevations, channel bottom elevations, and existing ground elevations were taken from the HEC-RAS models provided by Moore Engineering, Inc.

For some bridge locations, the calculated deck elevation was lower than the existing ground elevation. In those cases, the bridge length was based on matching the bridge deck elevation to the existing ground elevation.

Exhibit A shows the Bridge Length Determination spreadsheets for the Minnesota Diversion (FCP) and North Dakota Diversion (LPP) alternatives. The calculated bridge lengths were averaged and rounded to the nearest 20 feet.

COST BASIS

A detailed cost estimate was performed for two bridges of varying length and span counts to establish an average superstructure unit cost per square foot of bridge deck. The superstructure unit cost for each bridge type was then applied to the bridge widths and lengths determined for each bridge location. Site specific pier costs were calculated and added to the superstructure cost to account for the various pier heights and span counts found at each bridge. Pier heights for each bridge were assumed to be the same independent of channel slope to be conservative for estimating. The quantities used in the detailed cost estimates were estimated using an Excel spreadsheet, with estimated

dimensions of all of the bridge components. The unit prices used in the detailed cost estimates were based on recent average bid prices obtained from websites of the Minnesota and North Dakota Departments of Transportation. See Exhibit B for a Detailed Cost Estimate example spreadsheet.

RAILROAD BRIDGE COST ESTIMATES

The railroad bridge locations for both the Minnesota Diversion (FCP) and North Dakota Diversion (LPP) Alternatives are listed in the above table for reference only. The costs estimates associated with these structures were developed separately and are included in Attachment 5, Appendix G, the Cost Appendix.

HYDRAULIC STRUCTURES SUMMARY

INTRODUCTION

This Appendix F of the February 28, 2011 submittal (Phase 4 report) represents an updated and revised version of the Appendix F included in the August 6, 2010 submittal (Phase 3 report). The updates and revisions have been driven by design modifications primarily associated with changes to the hydrology and hydraulic modeling. The updates and revisions presented include staging of water upstream of the Diversion Channel, construction of an engineered storage area, more detailed hydraulic modeling including use of a HEC-RAS unsteady flow model for project feasibility design, revised hydrology (in particular, for the ND tributaries: Wild Rice River, Sheyenne River, Maple River, Lower Rush River and Rush River), additional fish passage and ice control considerations, new geotechnical information and analysis, different structural design criteria, and enhanced grading development of the hydraulic structures. Furthermore, the updates and revisions incorporate the majority of the comments received from the U.S. Army Corps of Engineers (USACE) Project Delivery Team (PDT), USACE Agency Technical Review (ATR), USACE Independent External Peer Review (IEPR), the City of Fargo (North Dakota), the City of Moorhead (Minnesota), and the Natural Resources Agencies.

This Appendix F of the Phase 4 report presents the feasibility design of the major hydraulic structures required for two alternatives:

- Minnesota Short Alignment 35,000 cfs Alternative (MN Short 35K), Federally Comparable Plan (FCP); and

- North Dakota East Alignment, Locally Preferred Plan (LPP).

The FCP alternative corresponds to a target diversion flow (35,000 cfs when the 500-yr flood event occurs in the Red River of the North) and no staging or storage upstream of the diversion works, which results in some impacts on flood levels downstream of the diversion (henceforth referred to as downstream impacts). Hydraulic structures along the FCP were not redesigned during Phase 4. Feasibility designs of the FCP presented in this Appendix F refer to Phase 3 hydrology using a HEC-RAS steady flow model and are included for completeness. The LPP alternative corresponds to target stages (water surface elevations) at the U.S. Geological Survey (USGS) gage in Fargo for specific design flood events in the Red River of the North, but including staging and storage immediately upstream of the diversion works to eliminate downstream impacts. The major hydraulic structures included in the two alternatives are presented in Table F1, and their approximate locations are presented in Figure F01.

The design presented here has been carried out to a feasibility level using general hydrologic, hydraulic, environmental, geotechnical, structural and civil design considerations. Given the constraints imposed by the amount and quality of the information available and the timeframe to complete the feasibility study of

the project, these designs are deemed sufficient to develop Class 3 cost estimates (see Appendix G) for congressional budgetary appropriation per USACE Engineer Regulation ER 1110-2-1302. However, it is acknowledged that additional investigations on fish passage, ice engineering and sediment transport; future updates to the hydrology; refinements of the HEC-RAS unsteady flow model; physical modeling of some of the hydraulic structures; detailed structural design; and additional site specific information (e.g., topography, soil borings, soil mechanics laboratory tests, field-scale pile driving tests) that become available for further evaluation of the alternative selected in the next stage of study and design may result in changes to the proposed configuration and functioning of the hydraulic structures.

Federally Comparable Plan (FCP)
The following information regarding the FCP was previously presented as part of Appendix F in the Phase 3 report, and is included here for completeness. The FCP results and hydraulic structure designs discussed below refer to the HEC-RAS steady flow models developed as part of the Phase 3 feasibility analysis.

Section F2.1 of Appendix F (included in attachment 5) discusses the feasibility design of the Control Structure and Fishway on the Red River of the North and Inlet Structure of the Diversion Channel for the FCP. The flows to divert from the Red River of the North into the FCP Diversion Channel for the Year 0, 25 and 50 hydrology are presented in Figure F17, whereas the general layout and cross sections of these diversion structures are presented in Drawings S-401 through S-405.

Section F2.1 also discusses the feasibility design of the Outlet to the Red River of the North from the FCP Diversion Channel. The general layout of this structure is presented in Drawing S-406.

Control Structure on Red River of the North, (FCP)
The general design considerations discussed below also apply to the Red River Control Structure for the LPP.

For the FCP, a Control Structure located on the Red River of the North immediately downstream of the Inlet Structure of the Diversion Channel is necessary to limit the amount of water flowing into the Protected Area (i.e., the Cities of Fargo, ND and Moorhead, MN). Another design goal for this structure is to avoid increasing water surface elevations upstream in the Red River of the North for the 100-yr and 500-yr flood events, while minimizing differences in water surface elevations between existing conditions and with-project for smaller flood events. Because of the former consideration, using gates that are raised from the bottom of the Red River of the North, as in the Manitoba Floodway, is not a feasible option. Maintaining the rating curve upstream of the diversion would help to keep the observed (natural) runoff storage in the floodplain upstream of the study area, and consequently, to keep the associated peak flow attenuation effect. In addition, maintaining the rating curve upstream of the

diversion should help to reduce the potential for adverse morphologic impacts in the Red River of the North (e.g., development of head cutting along the main channel as a result of increased flow velocities due to stage reduction without discharge reduction). See attachment 5, Appendix F, Section F2.1.1, for detailed discussion and description of the design.

Fish Passage on Red River of the North, (FCP)
The general design considerations discussed below also apply to the fish bypass channel on the Red River of the North for the LPP.

Fish passage consisting of multiple parallel channels of alternating pools and riffles would allow fish to move upstream of the Control Structure for flows up to the 50-yr flood event on the Red River of the North. Additional details, tables, and figures regarding the design of fish passages at the FCP Control Structure are presented in Exhibit G. See attachment 5, Appendix F, Section F2.1.2, for detailed discussion and description of the design.

Inlet Weir on Red River of the North, (FCP)
The configuration of the Inlet Structure on the Diversion Channel depends on the configuration of the Red River Control Structure. Different combinations of proposed configurations for these two hydraulic structures are presented in Exhibit B, including a qualitative assessment of the advantages and disadvantages of each concept in terms of hydraulic performance, handling of flood flows and low flows, potential environmental impacts, permitting, and operation and maintenance. For this feasibility design, the concept selected for the Inlet Structure on the Diversion Channel is the one that (when combined with the Red River Control Structure) would better accomplish the project goals outlined above. This concept consists of a passive (i.e., no gates or movable parts) compound weir with a crest elevation approximately 0.5 ft above the water surface elevation for the 3.6-yr event (9,600 cfs). The compound weir has been selected to maximize diversion efficiency for the different return periods analyzed while not modifying flood elevations upstream of the Control Structure. See Attachment 5, Appendix F, Section F2.1.3, for detailed discussion and description of the design.

Outlet to Red River of the North, (FCP)
Similar to the design for the Breckenridge Diversion Project, the Outlet of the FCP Diversion Channel into the Red River of the North consists of riprap over approximately the downstream 300 ft of the Diversion Channel. See Attachment 5, Appendix F, Section F1.1.4, for detailed discussion and description of the design.

Locally Preferred Plan (LPP)
The feasibility design of the LPP hydraulic structures was developed together with the feasibility design of the LPP Diversion Channel (see Figures F02 and F04; or for more details see Consultant's Appendix C), such that the incorporation of staging and storage immediately upstream of the diversion works

(see Figure F03) would not only allow to meet the stages at the USGS gage in Fargo that were met in Phase 3 (i.e., project benefits in Phase 4 would be the same as in Phase 3), but would also help to eliminate downstream impacts. Thus, the overall concept of the LPP evolved from diversion only in Phase 3 to diversion and staging/storage in Phase 4.

Control Structure on Red River of the North, (LPP)
For the LPP, a Control Structure located on the Red River of the North immediately downstream of the Connecting Channel (but upstream of the confluence with the Wild Rice River) is necessary to limit the amount of water flowing into the Protected Area (i.e., the Cities of Fargo, ND and Moorhead, MN). Another design goal for this structure is to increase water surface elevations upstream in the Red River of the North during flood events, in order to eliminate downstream impacts. As indicated in Appendix C, one main objective of the Fargo Moorhead diversion project is to lower stages sufficiently on the Red River of the North to significantly reduce flood damages in the Protected Area and thus to provide benefits that would justify the relatively elevated project cost. Therefore, a great level of active control and management (through gates operation) of the flows that pass into the cities is warranted.

The configuration of the Red River Control Structure (and also that of the Wild Rice River Control Structure) depends on the configuration of the primary Diversion Inlet Structure (see Section F2.2.3). Different combinations of proposed configurations for these two hydraulic structures are presented in Exhibit B, including a qualitative assessment of the advantages and disadvantages of each concept in terms of hydraulic performance, handling of flood flows and low flows, potential environmental impacts, permitting, and operation and maintenance. For this feasibility design, the concept selected for the Red River Control Structure is the one that would better accomplish the project goals outlined above. This concept consists of a concrete gravity dam with three 50 ft-wide bays (other possible gates configurations are presented in Exhibit D), each including a lower ungated area and an upper gated area per bay (using primary tainter gates, and secondary bulkheads in case the tainter gates malfunction), and wingwalls. In addition, a gated secondary by-pass channel for fish passage (i.e., the fishway) will be located on one of the sides of the primary Control Structure. Following discussions with the USACE-PDT, the Control Structure is recommended to be built off the existing Red River of the North channel. See attachment 5, Appendix F, Section F2.2.1, for detailed discussion and description of the design.

Fish Passage on Red River of the North, (LPP)
A fish passage channel was designed to allow fish to travel from downstream to upstream of the Red River Control Structure when the gates are partially closed and flow velocities are very high at the primary bays. The fish passage would allow fish migration for flows up to the 50-yr flood event on the Red River of the North. Fish passages at the Red River Control Structure (and also at the Wild Rice River, Lower Rush River and Rush River) are designed with consideration

to several criteria based on discussions with the USACE-Environmental, the Natural Resources Agencies, and the feasibility design in the USACE"s Lock and Dam 22 Fish Passage Improvement Project Implementation Report – Appendix H. See attachment 5, Appendix F, Section F2.2.2, for detailed discussion and description of the design.

Diversion Inlet Structure, (LPP)
Because of the upstream staging required in the Phase 4 feasibility design, the Wild Rice River east and west weirs considered in Phase 3 have been dropped in Phase 4. It is also important to indicate that the Connecting Channel between the Red River of the North and Wild Rice River and the one between the Wild Rice River and the Diversion Inlet Structure are mostly intended to facilitate drainage during average flow to frequent flood events rather than to enhance hydraulic conveyance in these areas during the larger design floods. See Attachment 5, Appendix F, Section F2.2.3, for detailed discussion and description of the design.

Control Structure on Wild Rice River, (LPP)
For the LPP, a Control Structure located on the Wild Rice River north (immediately downstream) of the Connecting Channel (but upstream of the confluence with the Red River of the North) is necessary to limit the amount of water flowing into the Protected Area (i.e., the cities of Fargo and Moorhead). The design goal for this structure is similar to that for the one on the Red River of the North, and the qualitative assessment of alternative concepts presented in Exhibit B also applies to this structure.

For this feasibility design, the concept selected for the Wild Rice River Control Structure is the one that would better accomplish the project goals, with the understanding that a single large pool will form upstream of the Control Structures at the Red River of the North and Wild Rice River, from which water will be diverted through the Diversion Inlet Structure into the LPP Diversion Channel. The concept for the Wild Rice River Control Structure consists of a concrete gravity dam with two 30 ft-wide bays (using primary tainter gates, and secondary bulkheads in case the tainter gates malfunction), and wingwalls. In addition, a gated secondary by-pass channel for fish passage (i.e., the fishway) will be located on one of the sides of the primary Control Structure. Following discussions with the USACE-PDT, the Control Structure is recommended to be built off the existing Wild Rice River channel. See Attachment 5, Appendix F, Section F2.2.4, for detailed discussion and description of the design.

Fish Passage on Wild Rice River, (LPP)
A fish passage channel was designed to allow fish to travel from downstream to upstream of the Control Structure for flows up to the 50-yr flood event on the Wild Rice River. The feasibility design considerations used to size the fish passage facility on the Wild Rice River are very similar to those on the Red River of the North. Therefore, they will not be repeated here, except for some specifics applicable to this facility. Details, tables, and figures regarding the design of fish

passages at the LPP Control Structure are presented in Exhibit G. See Attachment 5, Appendix F, Section F2.2.5, for detailed discussion and description of the design.

Diversion Channel Transition and Aqueduct at the Sheyenne River, (LPP)
A combination of three hydraulic structures is proposed at the LPP Diversion Channel crossing of the Sheyenne River; a transition on the Diversion Channel, and an aqueduct and a spillway on the tributary. An aqueduct structure was chosen for three main reasons: there is a significant difference in the elevations (approximately 15 ft) of the thalweg in the Sheyenne River and the invert of the Diversion Channel, local sponsors prefer to minimize the number of "active operation" structures, and it provides a good solution for fish and ice passage. One intention of these structures is to allow conveyance of the entire tributary flow into the Protected Area for flows up to the local 2-yr flood event in the Sheyenne River. Allowing flows up to the 2-yr event will minimize impacts to aquatic ecosystems, fish passage, sediment transport and channel morphology upstream and downstream of the proposed diversion. On the other hand, the other intention of these structures is to maximize diversion of tributary flows into the LPP Diversion Channel for flows larger than the local 2-yr flood event in the Sheyenne River. During these times when a portion of the flow is diverted, the structures will allow a fraction of the Sheyenne River flow (somewhat greater than the local 2-yr flow) to pass through the aqueduct to the Protected Area while maximizing flows diverted (through the spillway) to the diversion channel. See Attachment 5, Appendix F, Section F2.2.6, for detailed discussion and description of the design.

Spillway at Sheyenne River, (LPP)
A weir spillway has been selected to divert waters from the tributary into the LPP Diversion Channel. The main design criteria used for designing the weir spillway are:

- The crest of the weir spillway will be set, as a minimum, at the water surface elevation on the tributary associated with the 2-yr local flood event, allowing the entire 2-yr flow to pass into the Protected Area of the tributary;
- The length of the weir spillway will be such to maximize diversion flows into the LPP Diversion Channel, hence to minimize the maximum flow into the Protected Area of the tributary during the occurrence of the 500-yr local flood event; and
- The weir spillway can maximize diversion flows from the tributary into the LPP Diversion Channel for coincidental events, when the anticipated head available could be less than for local events.

See Attachment 5, Appendix F, Section F2.2.7, for detailed discussion and description of the design.

Diversion Channel Transition and Aqueduct at Maple River, (LPP)

A combination of three hydraulic structures is proposed at the LPP Diversion Channel crossing of the Maple River; a transition on the Diversion Channel, and an aqueduct and a spillway on the tributary. An aqueduct structure was chosen for three main reasons: there is a significant difference in the elevations (approximately 7 ft) of the thalweg in the Maple River and the invert of the Diversion Channel, local sponsors prefer to minimize the number of "active operation" structures, and it provides a good solution for fish and ice passage. One intention of these structures is to allow conveyance of the entire tributary flow into the Protected Area for flows up to the local equivalent 2-yr flood event in the Maple River. The term equivalent is used here because the 2-yr local flows along the Rush River and Lower Rush River are included in this quantity. The Lower Rush and Rush Rivers are entirely diverted into the Diversion Channel. Therefore, the 2-yr equivalent flow from those rivers (717 cfs combined) is added to the Maple River 2-yr local flow (970 cfs) to obtain the equivalent 2-yr local flow (1,687 cfs). Allowing flows up to the 2-yr event will minimize impacts to aquatic ecosystems, fish passage, sediment transport and channel morphology upstream and downstream of the proposed diversion. On the other hand, the other intention of these structures is to maximize diversion of tributary flows into the LPP Diversion Channel for flows larger than the equivalent 2-yr flood event in the Maple River. During these times when a portion of the flow is diverted, the structures will allow a fraction of the Maple River flow (somewhat greater than the equivalent 2-yr flow) to pass through the aqueduct to the Protected Area while maximizing flows diverted (through the spillway) to the Diversion Channel. See Attachment 5, Appendix F, Section F2.2.8, for detailed discussion and description of the design.

Spillway at Maple River, (LPP)

A weir spillway has been selected to divert waters from the tributary into the LPP Diversion Channel. The main design criteria used for designing the weir spillway are:

- The crest of the weir spillway will be set, as a minimum, at the water surface elevation on the tributary associated with the equivalent 2-yr local flood event, allowing the entire 2-yr flow to pass into the Protected Area of the tributary;
- The length of the weir spillway will be such to maximize diversion flows into the LPP Diversion Channel, hence to minimize the maximum flow into the Protected Area of the tributary during the occurrence of the 500-yr local flood event; and
- The weir spillway can maximize diversion flows from the tributary into the LPP Diversion Channel for coincidental events, when the anticipated head available could be less than for local events.

The design concept for the spillway from the Maple River to the LPP Diversion Channel is similar to that used for the spillway from the Sheyenne River to the LPP Diversion Channel. See Attachment 5, Appendix F, Section F2.2.9, for detailed discussion and description of the design.

Drop Structure at Lower Rush River, (LPP)
The type of structure recommended for the Lower Rush River is a stepped concrete spillway that will divert all flows directly into the LPP Diversion Channel. Fish passage between the upstream portion of these rivers and the LPP Diversion Channel would be accommodated by a separate low flow channel. The existing portions of the Lower Rush River and Rush River downstream of the Diversion Channel are primarily straight drainage channels and do not display many characteristics typically associated with natural streams. Downstream of the confluence of the Lower Rush fish passage and the LPP Diversion Channel, habitat enhancements and low flow channel meandering would be implemented, thereby increasing the quality and quantity of habitat in these rivers, when compared to existing conditions. This is further discussed in Exhibit K. See Attachment 5, Appendix F, Section F2.2.10, for detailed discussion and description of the design.

Fish Passage on Lower Rush River, (LPP)
Fish passage consisting of a single channel of alternating pools and riffles allows fish to move between the Diversion Channel and the Lower Rush River for events ranging up to approximately the 10-yr event on the Red River. Additional details, tables, and figures pertaining to the design of fish passage at the Lower Rush River Drop Structure is included in Exhibit G. See Attachment 5, Appendix F, Section F2.2.11, for detailed discussion and description of the design.

Drop Structure at Rush River, (LPP)
The design of the drop structure at the Rush River is similar to the design for the Lower Rush River outlined in Section 2.2.10. Exhibit D presents the hydraulic design for the diversion structures on the Rush River. The rise and run of the drop structure steps are 1.1 and 1.7 ft, respectively. The stepped spillway is placed several feet upstream of the confluence of the river bed and the LPP Diversion Channel side slope. The stilling basin downstream of the stepped spillways has been sized by calculating the head loss over the steps under skimming flow during 10-yr floods and larger events. Tailwater effect was not incorporated in sizing the stilling basins. The channel bed from downstream of the stilling basin to the bed of the LPP Diversion Channel is assumed to be lined with riprap. The resulting designs are presented in Table F10. See attachment 5, Appendix F, Section F2.2.12, for detailed discussion and description of the design.

Fish Passage on Rush River, (LPP)
The design considerations used for the fish passage at the Rush River are similar to those at the Lower Rush River (see Section F2.2.11), and they will not be repeated here except for some specifics applicable to this facility. Additional details, tables, and figures regarding the design of fish passages at the Rush River Drop Structure are presented in Exhibit G. See Attachment 5, Appendix F, Section F2.2.13, for detailed discussion and description of the design.

Outlet Structure to Red River of the North, (LPP)

The Phase 3 Outlet of the Diversion Channel into the Red River of the North consisted of riprap over the downstream 300 ft of the Diversion Channel. This outlet configuration was possible because the Outlet Structure elevation was near the bottom of the Red River. However, with the introduction of staging in Phase 4, the peak flows diverted through the Diversion Inlet Structure was reduced from 35,000 cfs down to 19,000 cfs. As a result the cross sectional area of the Diversion Channel was reduced and the bottom invert was raised. As a consequence of these changes, the drop into the Red River at the Outlet Structure has increased from approximately 11 ft to 20 ft. See Attachment 5, Appendix F, Section F2.2.14, for detailed discussion and description of the design.

Storage Area 1, (LPP)
The hydraulic design of Storage Area 1 focused on assessing alternatives inlet and outlet controls. Exhibit E presents the feasibility design analysis for Storage Area 1. This feasibility design is also presented in Drawings S-414 and S-418 through S-420. The footprint of Storage Area 1 is 4360-acres. The peak storage during the 100-yr and 500-yr design flood events is over 55,000 acre-ft. During flood events water enters and leaves Storage Area 1 through the 1400-ft wide Inlet-Outlet Opening near the Wild Rice River Control Structure at the southeast corner of the storage area. The hydraulic analysis of Storage Area 1 evaluated the benefits of different opening widths, inlet elevations and locations along the south side of the storage area.

The inlet elevation generally has the largest effect on smaller flood events. A higher inlet elevation delays the point at which Storage Area 1 begins receiving water from the diversion system. It also increases the amount of water that is retained in the storage area after the flood has passed. Existing ground elevations set the practical lower limit for an inlet elevation. The existing ground along the southern portion of Storage Area1 ranges from elevation 911 to 915. The preliminary design uses an elevation of 910, with the assumption that some grading will be required to facilitate internal drainage within the storage area and also provide a way for water to enter the area that is slightly below existing grades. By setting the inlet elevation as low as feasibly possible, the storage area can be utilized during smaller flood events as well as large ones. See Attachment 5, Appendix F, Section F2.2.15, for detailed discussion and description of the design.

Wolverton Creek Control Structure, (LPP)
For the LPP, a Control Structure located on Wolverton Creek is necessary to limit the amount of water flowing into the Protected Area (i.e., the cities of Fargo and Moorhead). The proposed Wolverton Creek Control Structure functions as an open-close structure and is shown in Drawings S-411 and S-412. In other words, the Control Structure remains completely open during low flow events when it is desirable to have little impact on flows and water surface elevations during the smaller, more frequent flood events. During larger flood events the gates are completely closed. The flows on Wolverton Creek are very small compared to

flows on the Red River and Wild Rice River which determine how high water is staged upstream of the project. For this reason, the gates on Wolverton Creek are fully closed, and flows conveyed into the Protected Area are controlled by the gates located on the Red River and Wild Rice River. The gates at the Wolverton Creek Control Structure would be opened following the flood event. See Attachment 5, Appendix F, Section F2.2.16, for detailed discussion and description of the design.

Local Drains Drop Structure, (LPP)
The design of the drop structure at Drain 14 is similar to the design for the Rush River and Lower Rush River (see Sections F2.2.10 and F2.2.12). Exhibit F presents the hydraulic design for the stepped drop structure. The drop structure is also shown in Drawing S-430. The rise and run of the drop structure steps are 0.7 and 1.5 ft, respectively. The stilling basin downstream of the stepped spillway has been sized by calculating the head loss over the steps under skimming flow during 10-yr floods and larger events. Tailwater effect was not incorporated in sizing the stilling basins. The channel bed from downstream of the stilling basin to the bed of the LPP Diversion Channel is assumed to be lined with riprap. See Attachment 5, Appendix F, Section F2.2.17, for detailed discussion and description of the design.

Standard Project Flood (SPF) Analysis
The tie-back levees south of the project were determined by analysis of the Standard Project Flood (SPF). Levee heights were selected so that during an SPF event, which is larger than the 500-yr event, flows will overtop County Road 17 and be conveyed west prior to overtopping the main east-west levee and flowing into the Protected Area. SPF hydrographs were provided by the USACE in order to set the levee heights south of the project.

The top of the north-south levee along County Road 17 was set at elevation 923, or the elevation to which water is staged during floods larger than the 100-yr event. The top of the east-west levee (i.e., the main levee that runs through the Control Structures on the Wild Rice River, Red River, and Wolverton Creek) was set at elevation 927. See Attachment 5, Appendix F, Section F2.2.18, for detailed discussion and description of the design.

GEOTECHNICAL ENGINEERING
The geotechnical engineering of the hydraulic structures, including description of available geotechnical data, seepage analysis, slope stability and pile capacity, are described below. See Attachment 5, Appendix F, Section F3.0, for detailed discussion and description of the design.

STRUCTURAL DESIGN
The structural design of the hydraulic structures, including loads, load combinations, reinforced concrete design, pile design, sheet piles, and assumptions are described below. The structural design performed for this Phase 4 study is at the feasibility level only, to support feasibility cost estimates for the

proposed project. See Attachment 5, Appendix F, Section F4.0, for detailed discussion and description of the structural design.

CIVIL DESIGN AT HYDRAULIC STRUCTURES

The purpose of this section of Appendix F is to provide general information related to the siting and civil site design of the hydraulic structures associated with this project. After providing some general background data related to the sources of the data used in the civil design the discussion will address each major structure. Structures addressed will include:

- The Red River and Wild Rice River Control Structures
- The Sheyenne and Maple River Aqueducts
- The Lower Rush and Rush River drop structures
- The connecting channel weir, the primary Inlet Structure to the Diversion and Outlet Structure to the Red River of the North
- Additional structures related to Wolverton Creek, Drain 14, and Storage Area 1
- Storage Area 1

See Attachment 5, Appendix F, Section F5.0, for detailed discussion and description of the design.

ICE IMPACTS ON PRELIMINARY DESIGNS

An independent study on the impact of ice on the preliminary structural design was conducted by the Ice Engineering Group, part of the US Army Engineer Research and Development Center. The report and figures are included In Attachment 5, Appendix F, Exhibit J-Ice.

- Although peak stages on the Red River of the North (RRN) are often ice-affected, the ice breakup on the RRN is typically gradual with little dynamic movement of ice floes. Ice jams do occur however, and when the river is already at or above flood stage, these jams can greatly exacerbate the situation. During the peak floods 1997 and 2009, much flow was out of bank with short sections of sheet ice remaining in the channel bends.

- The long-term RRN gage data suggest an increasing trend in annual peak discharge magnitude and variability, with the bulk of the peak flow events occurring during the ice season. If it is decided that these trends are real, some conservatism may need to be added to design to accommodate increased future peak discharges.

- Under flood conditions, in the area of the proposed diversion structure, the 40-50 ft depths and low approach velocities will cause sheet ice and large floes to accumulate upstream of the structure without passing the gates. Provided the floes accumulate edge-to-edge and do not thicken into a multi-layer ice accumulation, this does not pose a problem in terms of ice passing into the diversion channel, provided the ice can be retained in the RRN (see Item 4 below).

  Ice may pass the gates at the 2 and 5 year discharges provided the ice floes do not arch and stop upstream of the gate opening(s).

- The project design must include provisions to prevent RRN ice floes from entering the diversion canal(s). This might consist of rows of piers or piles to retain the floes in the main channel of the RRN. Depending on hydraulic conditions it may be possible to retain the ice floes in the main river channel using the less expensive alternative of ice booms. The necessity and design of ice retention schemes will depend on further analysis of expected ice conditions and ice processes in the vicinity of the canal entrances need to be examined in detail.

- The crossing structure at the Wild Rice River will have similar ice issues as the RRN diversion structure. It is predicted that the gated structure will retain Wild Rice river ice under all but the lowest flood discharges. At the Sheyenne and Maple crossing structures, ice accumulations are possible at the transitions from the natural channels to the aqueducts. This will be acceptable as long as the accumulated ice does not shove-thicken into a multi-layer ice jam. As with the RRN diversion structure, provisions will be

needed retain ice in tributary channels and prevent it from passing into the diversion canal.

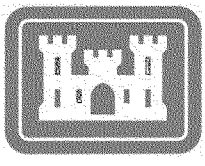
- Changes in the breakup period hydrograph as a result of the project, and how the bypassed flow re-enters the RRN need to be examined, particularly in terms of causing ice jams where none occurred before.

Appendix K
Civil Engineering

Fargo-Moorhead Metropolitan Area Flood Risk Management

Final Feasibility Report and Environmental Impact Statement

July 2011



US Army Corps of Engineers ®

Prepared by:
U.S. Army Corps of Engineers
St. Paul District
180 Fifth Street East, Suite 700
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USACE-MVP-0000088173

Fargo – Moorhead Metro Feasibility Report
Fargo, North Dakota and Moorhead, Minnesota
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1.0 PROJECT LAYOUT AND TOPOGRAPHY

The Fargo-Moorhead area is characterized by relatively flat topography deposited by glacial Lake Agassiz. Typically levees have been used as the primary feature for many of the CORPS constructed projects in the Red River Valley. The flat topography results in the Red River having very little slope, generally less than one half of a foot per mile. While the flat terrain contributes to the potential for widespread flooding, it also allows for the potential to construct diversion channels around the community on either the east or west without creating extremely deep excavations.

1.1 CONSIDERATIONS IN ALIGNMENT SELECTION

1.1.1 DIVERSION CHANNELS

The main considerations used in the selection of diversion channel alignments are as follows:

- Alignments were shortened where reasonable to reduce footprint and cost.
- Alignments were moved to relatively lower ground to minimize the excavation required.
- Alignments cross roads and railroads at or as close to 90 degrees as possible to minimize bridge lengths.
- Populated areas were avoided to minimize buyouts where possible.
- North Dakota alignment crosses rivers at or as close to 90 degrees as possible to minimize hydraulic structure size and cost.
- Alignments were located in areas that minimize geotechnical concerns related to known aquifers.

1.1.2.1 Minnesota Short Alignment (FCP)

The Minnesota alignment serves as the FCP of this study. It starts just north of the confluence of the Red and Wild Rice Rivers and extends north around the Cities of Moorhead and Dilworth and ultimately re-enters the Red River near the confluence of the Red and Sheyenne Rivers. The alignment is approximately 25 miles long. The FCP design was not changed from the previous phase design.

1.1.2.2 North Dakota East Alignment

The North Dakota east 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. While the alignment has remained largely unchanged from its initial layout, some modifications have been made. The north end of the alignment was adjusted near Argusville to avoid interference with Cass County Drain 13. It was determined that Drain 13 was already an efficiently functioning legal drain so it could be utilized for its capacity separately from the diversion. The alignment was shifted to the south and east to accommodate this change. In other areas, minor changes were also incorporated where existing homes and buildings could be reasonably avoided. The LPP diversion channel incorporates the existing Horace Diversion channel, so the alignment was adjusted so that the east side of the LPP diversion matched the existing Horace Diversion channel.

Storage and staging on the upstream side of the project has been included. This storage reduces the discharge that must pass through the diversion to the downstream end of the project. Thus, the size of diversion channel was reduced to handle the smaller discharges associated with the updated design. The configuration of the channel cross section was determined through a combination of the hydraulic capacity, geotechnical constraints, and minimum depth constraints related to the tributary hydraulic structures, specifically the Sheyenne and Maple River structures.

A combination of control structures on the Red and Wild Rice Rivers at the south end of the project, along with a weir on the diversion channel, control the flow split between the Red and Wild Rice River channels and the diversion channel and produce the required staging. Additionally, the alignment crosses several rivers, including the Sheyenne, Maple, Lower Rush, and Rush Rivers. Aqueducts are necessary at the point where the diversion channel crosses the Sheyenne and Maple Rivers. The purpose of these aqueducts is to allow a minimum of a 50-percent chance event to continue down the various rivers while diverting excess water during flood events to the diversion channel. The result of this is added flood protection along all of the affected rivers. The Rush and Lower Rush Rivers, which currently consist of constructed trapezoidal channels, would be allowed to flow into the diversion channel resulting in cutting off the downstream portion of these rivers. The tie-back levee associated with this alternative extends east from the Red River control structure to high ground on the Minnesota side. Additionally, tie-back levees on the North Dakota side contain the flows within the designated staging and storage areas. Further discussion of these structures is included in Appendix J.

1.2 PROJECT LAYOUT

The North Dakota Diversion LPP layout and the FCP layout are included in the feasibility drawing documents at the end of this appendix.

1.3 UTILITIES

Each of the proposed diversion alternatives impact existing utilities. The utilities impacted by the diversion alignments include electric, natural gas, petroleum transmission, water supply, wastewater transmission, and various communication utilities. An inventory of existing utilities was obtained from the various providers. The locations of these utilities are included on the project drawings.

1.4 OTHER LOCAL IMPACTED STRUCTURES AND FEATURES

While efforts were made to minimize impacts to existing home and other structures, each of the diversion alternative alignments studied impacts existing structures. Any of the proposed diversion alignments would require acquisition and relocation.

The main feature impacted by a diversion alternative besides existing structures is agricultural land. As the proposed diversion alternatives generally avoid the developed metropolitan area, agricultural land would be removed from production to accommodate a diversion.

As discussed in the description of the North Dakota Alignments, a North Dakota diversion alternative would impact several other regional rivers, including the Sheyenne, Maple, and Rush and Lower Rush Rivers. Due to the proximity of these rivers to the Fargo Moorhead Metro area, any diversion alignment would cross these rivers. The alignment chosen cross each of these rivers a single time. Generally, the diversion alignments cross the Sheyenne River near Horace and continue northward paralleling the Sheyenne River. The design of these river crossings is discussed in detail in Appendices B and J.

All of the diversion alternatives studied also impact existing local drainage facilities. On both sides of the Red River, a significant drainage system is maintained throughout the region. Impacts to the existing system, generally consisting of open ditches, should be minimal. Existing drains would simply be allowed to flow into the diversion channel rather than continuing into what would be the protected area. A control structure for each significant drainage area intersected by the diversion alignment would be included along with additional collector drainage channels in locations where existing localized drainage in blocked. A more detailed discussion of the side ditch inlets is found in Appendix A.

The construction of the proposed North Dakota Diversion (LPP) and Minnesota Diversion (FCP) channels will require the construction of bridges at major roadways and railroads. For the LPP, 20 highway and 4 railroad bridges will be constructed, while for the FCP, 19 highway and 4 railroad bridges will be constructed. The major impacts as a result of the construction of these bridge structures will involve temporary closures or detours during construction activities.

1.5 SPOIL DISPOSAL

Construction of a diversion alternative would require considerable space for disposal of excess soil. Excess soil would be disposed of adjacent to the diversion channel. The geotechnical parameters define the side slopes as well as the maximum embankment height of the spoil piles. The spoil slopes are 1V on 7H and 1V on 10H for the diversion side and outside slopes respectively and the maximum spoil height is 15 feet. The width of spoil piles is controlled by the total volume of material to be disposed of. Spoil pile footprints are included in the project drawings.

1.6 RIGHT OF WAY

The proposed diversion alternatives will require acquisition of a right of way corridor wide enough to allow for the footprint of the diversion channel as well as the adjacent spoil piles. Additional right of way will also be necessary for tie-back levees. The parameters for right of way acquisition are as follows:

- Permanent easement to 30' outside the toe of spoil or levee
- Temporary easement 15' beyond the permanent easement for construction limits

All permanent and temporary easements are shown on the project drawings. Real Estate drawings are included in Appendix G, Real Estate.

1.7 SURVEY AND DATUM INFORMATION

The base mapping and the design:
North Dakota, South Zone NAD 83 (Horizontal Datum)
NAVD88 (Vertical Datum)

Topographic Mapping Summery;

Digital Terrain Models (DTM) was created from the 2008 lidar, Total area=482 sq miles. Area is broken into approximately 368 tiles. The tiles are approximately 6,562'x 6,562'. A digital terrain model was created for each tile. The dtm is compatible with inroads software. An index file was developed to show each dtm boundary and the corresponding tile number. Contours are displayed in .dgn file/or files at 1"=100' foot scale. All files are compatible with Bentley Microstation V8 XM.

Required accuracy for mapping, 1" = 100' with 2' contours.
2-Foot Elevation Contour Vector Data: Contours were created as continuous vectors with elevation attributes assigned. Index contours are compiled at an interval of 10 feet. Final contours are displayed in .dgn file/or files at 1"=100' foot scale. All files are compatible with Bentley Microstation V8 XM.

US Army Corps
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St Paul District

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA

JULY 2011

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO, NORTH DAKOTA, MOORHEAD MINNESOTA
COVER SHEET

Sheet
G-001

is: USACE-MVP-0000088174

FARGO MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY, NORTH DAKOTA
CLAY COUNTY, MINNESOTA
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
VICINITY AND LOCATION MAPS
Sheet ID
G-002
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
COMPANY NO.
PLOT SCALE
PLOT DATE
FILE NAME
DESIGN
DRAWN
CHECK
SUBMITTED
DATE
DESCRIPTION
ELEVATION DATUM (VERTICAL CONTROL): NORTH DAKOTA STATE PLANE SOUTH ZONE SURVEY FEET
NAVD 1988
GEOID08
CONVERSION SCALE: TO BE DETERMINED
LOCATION MAP
PROJECT LOCATION
LEGEND
STATE BOUNDARIES
RIVERS & LAKES
DISTANCE BOUNDARIES
NATIONAL BOUNDARIES
LOCK AND DAM
SCALE IN MILES
CANADA
MINNESOTA
NORTH DAKOTA
SOUTH DAKOTA
IOWA
WISCONSIN
MICHIGAN
VICINITY MAP
CASS COUNTY, NORTH DAKOTA
CLAY COUNTY, MINNESOTA
NORTH DAKOTA DIVERSION CHANNEL (LPP)
MINNESOTA DIVERSION CHANNEL (FCP)
RED RIVER OF THE NORTH
BUFFALO RIVER
WILD RICE RIVER
SHEYENNE RIVER
MAPLE RIVER
DILWORTH
CITY OF MOORHEAD
CITY OF FARGO
WEST FARGO
HORACE
HARWOOD
GEORGETOWN
U.S. HWY 75
U.S. HWY 10
I-94
I-29
I:\...\USACE-MVP-0000088174

CONSTRUCTION DRAWING INDEX

AS-BUILT DRAWING NO.	SHEET REF.	DESCRIPTION	PRODUCT I.D.
		GENERAL SHEETS	
	G-001	COVER SHEET	FMM_G-001---.DGN
	G-002	VICINITY AND LOCATION MAPS	FMM_G-002---.DGN
	G-003	DRAWING INDEX, LEGEND AND GENERAL NOTES	FMM_G-003---.DGN
		MINNESOTA DIVERSION (FCP)	
		CIVIL SITE DRAWINGS	
	CS100	MINNESOTA DIVERSION (FCP) GENERAL PLAN	FMM-CS100---.DGN
	CS101	MINNESOTA DIVERSION (FCP) PLAN STA 0+00 - STA 290+00	FMM-CS101---.DGN
	CS102	MINNESOTA DIVERSION (FCP) PLAN STA 290+00 - STA 530+00	FMM-CS102---.DGN
	CS103	MINNESOTA DIVERSION (FCP) PLAN STA 530+00 - STA 780+00	FMM-CS103---.DGN
	CS104	MINNESOTA DIVERSION (FCP) PLAN STA 780+00 - STA 970+00	FMM-CS104---.DGN
	CS105	MINNESOTA DIVERSION (FCP) PLAN STA 970+00 - STA 1300+00	FMM-CS105---.DGN
	CS106	MINNESOTA DIVERSION (FCP) PLAN STA 1200+00 - STA 1310+00 & TIEBACK LEVEE	FMM-CS106---.DGN
	CS107	MINNESOTA DIVERSION (FCP) PLAN TIEBACK LEVEE STA 270+00 - STA 550+28	FMM-CS107---.DGN
	CS201	MINNESOTA DIVERSION (FCP) PROFILE STA 0+00-STA 480+00	FMM_CS201---.DGN
	CS202	MINNESOTA DIVERSION (FCP) PROFILE STA 480+00-STA 960+00	FMM_CS202---.DGN
	CS203	MINNESOTA DIVERSION (FCP) PROFILE STA 960+00-STA 1310+00	FMM_CS203---.DGN
	CS301	MINNESOTA DIVERSION (FCP) TYPICAL SECTIONS A & B	FMM-CS301---.DGN
	CS302	MINNESOTA DIVERSION (FCP) TYPICAL SECTIONS C & D	FMM-CS302---.DGN
	CS303	MINNESOTA DIVERSION (FCP) TYPICAL SECTIONS E & F	FMM-CS303---.DGN
	CS304	MINNESOTA DIVERSION (FCP) TYPICAL SECTIONS G & H	FMM-CS304---.DGN
	CS305	MINNESOTA DIVERSION (FCP) TYPICAL SECTIONS I & J	FMM-CS305---.DGN
	CS306	MINNESOTA DIVERSION (FCP) TYPICAL SECTIONS K & L	FMM-CS306---.DGN
	CS307	MINNESOTA DIVERSION (FCP) TYPICAL SECTIONS M & N AND DETAIL 12	FMM-CS307---.DGN
	CS401	MINNESOTA DIVERSION (FCP) DETAIL OUTLET STRUCTURE	FMM_CS401---.DGN
	CS402	MINNESOTA DIVERSION (FCP) DETAIL INLET STRUCTURE	FMM_CS402---.DGN
		NORTH DAKOTA DIVERSION (LPP)	
		CIVIL SITE DRAWINGS	
	CS108	NORTH DAKOTA DIVERSION (LPP) GENERAL PLAN	FMM-CS108---.DGN
	CS109	NORTH DAKOTA DIVERSION (LPP) PLAN STA 0+00 - STA 240+00	FMM-CS109---.DGN
	CS110	NORTH DAKOTA DIVERSION (LPP) PLAN STA 240+00 - STA 480+00	FMM-CS110---.DGN
	CS111	NORTH DAKOTA DIVERSION (LPP) PLAN STA 480+00 - STA 740+00	FMM-CS111---.DGN
	CS112	NORTH DAKOTA DIVERSION (LPP) PLAN STA 740+00 - STA 960+00	FMM-CS112---.DGN
	CS113	NORTH DAKOTA DIVERSION (LPP) PLAN STA 960+00 - STA 1200+00	FMM-CS113---.DGN
	CS114	NORTH DAKOTA DIVERSION (LPP) PLAN STA 1200+00 - STA 1440+00	FMM-CS114---.DGN
	CS115	NORTH DAKOTA DIVERSION (LPP) PLAN STA 1440+00 - STA 1680+00	FMM-CS115---.DGN
	CS116	NORTH DAKOTA DIVERSION (LPP) PLAN STA 1680+00 - STA 1920+00 & TIEBACK LEVEE	FMM-CS116---.DGN
	CS117	NORTH DAKOTA DIVERSION (LPP) PLAN EAST OPTION TIEBACK LEVEE	FMM-CS117---.DGN
	CS118	NORTH DAKOTA DIVERSION (LPP) PLAN CASS COUNTY ROAD 17 TIEBACK LEVEE	FMM-CS118---.DGN
	CS204	NORTH DAKOTA DIVERSION (LPP) PROFILE STA 0+00-STA 480+00	FMM_CS204---.DGN
	CS205	NORTH DAKOTA DIVERSION (LPP) PROFILE STA 480+00-STA 960+00	FMM_CS205---.DGN
	CS206	NORTH DAKOTA DIVERSION (LPP) PROFILE STA 960+00-STA 1400+00	FMM_CS206---.DGN
	CS207	NORTH DAKOTA DIVERSION (LPP) PROFILE STA 1400+00-STA 1920+00	FMM_CS207---.DGN
	CS308	NORTH DAKOTA DIVERSION (LPP) TYPICAL SECTIONS O & P	FMM-CS308---.DGN
	CS309	NORTH DAKOTA DIVERSION (LPP) TYPICAL SECTIONS Q & R	FMM-CS309---.DGN
	CS310	NORTH DAKOTA DIVERSION (LPP) TYPICAL SECTIONS S & T	FMM-CS310---.DGN
	CS311	NORTH DAKOTA DIVERSION (LPP) TYPICAL SECTIONS U & V	FMM-CS311---.DGN
	CS312	NORTH DAKOTA DIVERSION (LPP) TYPICAL SECTIONS W & X	FMM-CS312---.DGN
	CS313	NORTH DAKOTA DIVERSION (LPP) TYPICAL SECTIONS - TIEBACK LEVEES Y & Z	FMM-CS313---.DGN
	CS403	NORTH DAKOTA DIVERSION (LPP) DETAIL OUTLET STRUCTURE	FMM_CS403---.DGN
	CS404	NORTH DAKOTA DIVERSION (LPP) DETAIL RUSH RIVER DROP STRUCTURE	FMM_CS404---.DGN
	CS405	NORTH DAKOTA DIVERSION (LPP) DETAIL LOWER RUSH RIVER DROP STRUCTURE	FMM_CS405---.DGN
	CS406	NORTH DAKOTA DIVERSION (LPP) DETAIL MAPLE RIVER AQUEDUCT	FMM_CS406---.DGN
	CS407	NORTH DAKOTA DIVERSION (LPP) DETAIL SHEYENNE RIVER AQUEDUCT	FMM_CS407---.DGN
	CS408	NORTH DAKOTA DIVERSION (LPP) DETAIL DIVERSION INLET WEIR	FMM_CS408---.DGN
	CS409	NORTH DAKOTA DIVERSION (LPP) DETAIL STORAGE AREA 1	FMM_CS409---.DGN
	CS410	NORTH DAKOTA DIVERSION (LPP) DETAIL WILD RICE CONTROL STRUCTURE	FMM_CS410---.DGN
	CS411	NORTH DAKOTA DIVERSION (LPP) DETAIL CONTROL STRUCTURE	FMM_CS411---.DGN
	CS501	NORTH DAKOTA DIVERSION (LPP) DETAILS LOW FLOW CHANNEL	FMM_CS501---.DGN

GENERAL CIVIL NOTES:

1. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
2. CADD UPDATE USACE ST. PAUL DISTRICT.
3. THE INFORMATION ON THESE DRAWINGS CONCERNING TYPE AND LOCATION OF EXISTING UTILITIES MAY NOT BE ACCURATE OR ALL INCLUSIVE. THEY ARE INCLUDED IN THIS DOCUMENT FOR INFORMATION PURPOSES ONLY.
4. SEE ATTACHMENT 5, CONSULTANTS REPORT FOR ALL CALLOUTS OR REFERENCES TO STRUCTURAL DRAWINGS (S-XXX).

NOTES: GENERAL CROSS-REFERENCING SYMBOLS

D5 / 2 — DETAIL/SECTION — SUPPLEMENTAL INFORMATION — SCALE: — SECTION/DETAIL TITLE ON SAME DRAWING (CENTERED UNDER SECTION/DETAIL)

D5 / C-102 — DETAIL/SECTION — SUPPLEMENTAL INFORMATION — SCALE: — SECTION/DETAIL TITLE ON ANOTHER DRAWING (CENTERED UNDER SECTION/DETAIL)

TOP, FRONT, SIDE, ELEVATION, SECTION — VIEW SUBTITLE (CENTERED UNDER EACH VIEW)

D5 — SECTION CUT W/ VIEW SHOWN ON SAME DRAWING

D5 / C-302 — SECTION CUT W/ VIEW SHOWN ON ANOTHER DRAWING

A — DETAIL SYMBOL W/ VIEW SHOWN ON SAME DRAWING

A / C-501 — DETAIL SYMBOL W/ VIEW SHOWN ON ANOTHER DRAWING

ABBREVIATIONS

* UNLESS OTHERWISE NOTED ON EACH SHEET

APPROX	APPROXIMATE	HT	HEIGHT
ALT W	ALTERNATE WITH	IF	INSIDE FACE
ALUM	ALUMINUM	LG	LONG
BITUM	BITUMINOUS	LW	LANDWARD
BOT	BOTTOM	MAX	MAXIMUM
CL	CENTER LINE	MIN	MINIMUM
C&G	CURB & GUTTER	MIRR	MIRRORED
CLR	CLEAR	MISC	MISCELLANEOUS
CJ	CONSTRUCTION JOINT	NF	NEAR FACE
CMP	CORRUGATED METAL PIPE	NO	NUMBER
CONC	CONCRETE	OF	OUTSIDE FACE
		OC	ON CENTER
DIA	DIAMETER	R/W	RIVERWARD
DWG	DRAWING	SAN	SANITARY
EF	EACH FACE	Spec	SPECIFICATIONS
EJ	EXPANSION JOINT	SST	STAINLESS STEEL
EL	ELEVATION	TB#	TOP AND BOTTOM
EW	EACH WAY	TYP	TYPICAL
EXIST	EXISTING	UNO	UNLESS NOTED OTHERWISE
FF	FAN FACE	UGND	UNDERGROUND
FES	FLARED END SECTION	W	WIDTH
GALV	GALVANIZED	WM	WATER MAIN

GENERAL LEGEND

- P.I. POINT
- FIRE HYDRANT
- MANHOLE
- CB — CATCHBASIN
- WATER VALVE
- REMOVED BUILDINGS
- S S — NEW SANITARY SEWER
- S D — NEW STORM SEWER
- $S S_X$ — EXISTING SANITARY SEWER
- $S D_X$ — EXISTING STORM SEWER
- W_X — WATERMAIN
- OP — EXISTING OVERHEAD POWER
- U_X — EXISTING UNDERGROUND DUCT
- G — EXISTING GAS
- 97-41M — BORING LOCATION AND NUMBER
- TEMPORARY EASEMENT
- FILL
- CUT
- SHEET ID X-000 — DWG OUTLINE AND NUMBER
- LEVEE

ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83 (2011) EPOCH 2010.00
ALL ELEVATIONS SHOWN ARE IN NAVD88 GEOID09 — UNITS: U.S. SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED

US Army Corps of Engineers — ST. PAUL DISTRICT

NO.	DESCRIPTION	DATE	APPD.	NO.	DESCRIPTION	DATE	APPD.

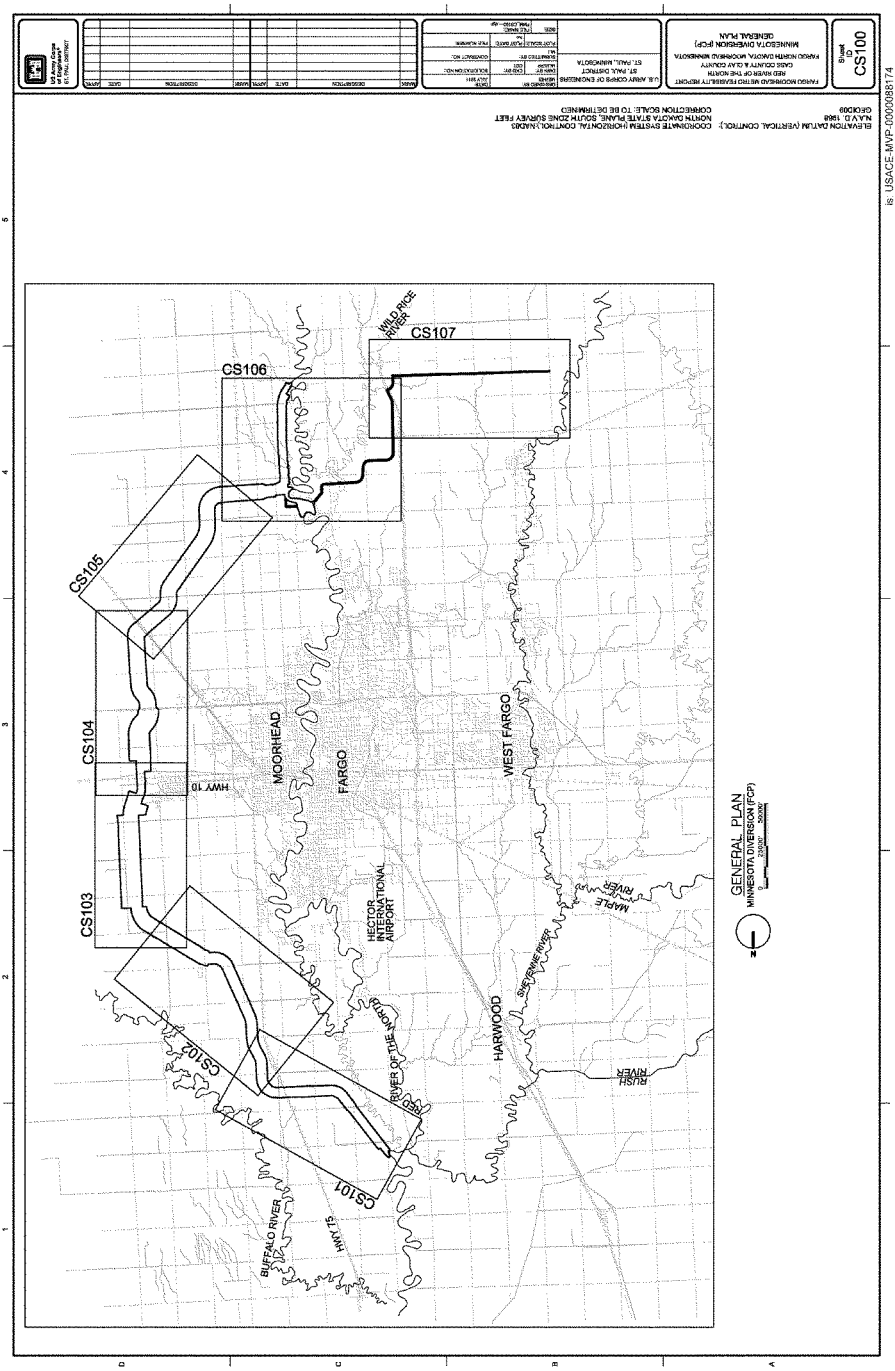
U.S. ARMY CORPS OF ENGINEERS — ST. PAUL DISTRICT — ST. PAUL, MINNESOTA

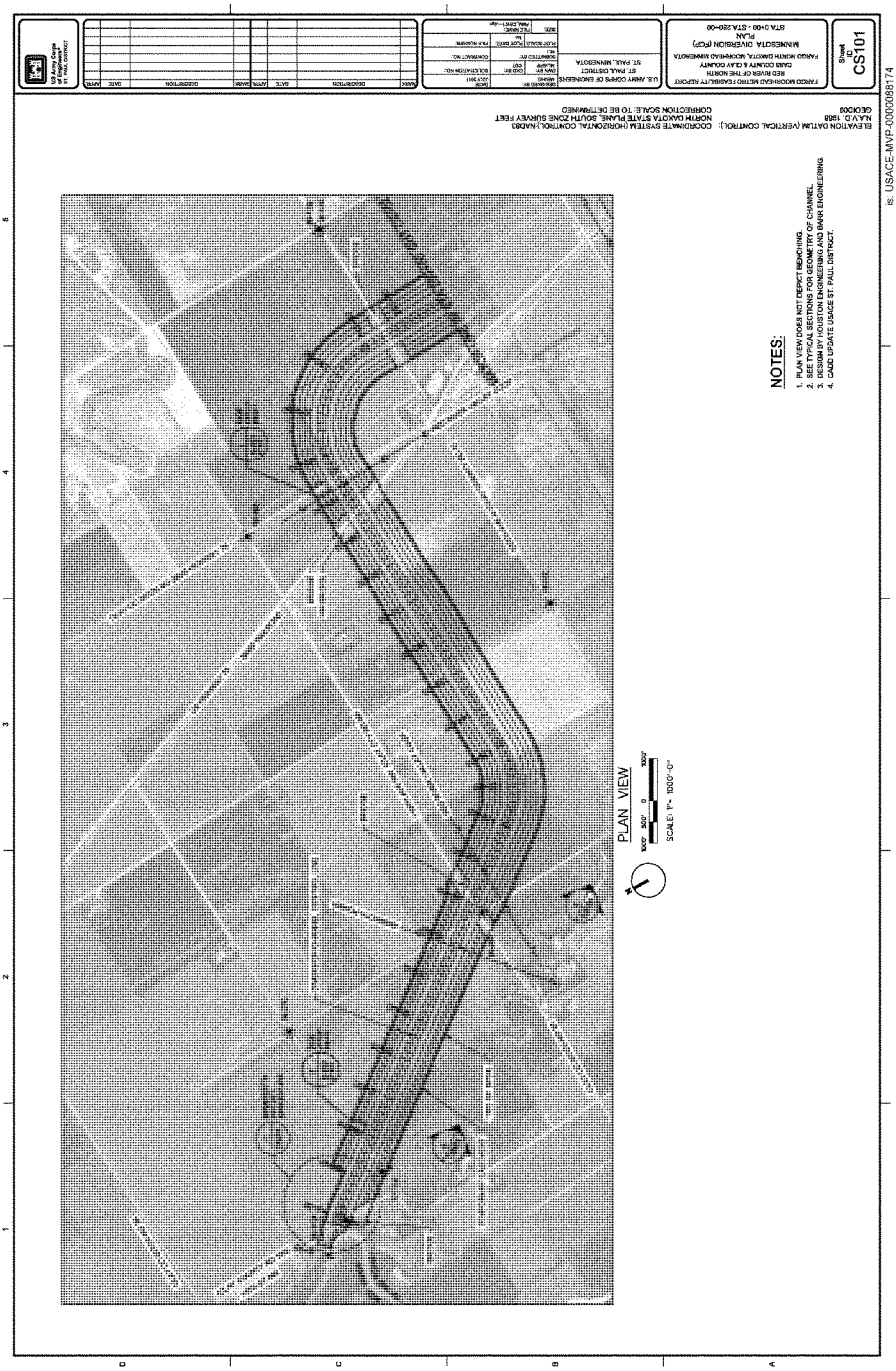
DESIGNED BY: | DRAWN BY: | CHECKED BY: | SUBMITTED BY: | APPROVED BY:
LAST PLOT: | RECEIVED NO.: | CONTRACT NO.: | FILE NUMBER:
PLOT SCALE: 1" = 1" | PLOT SPEED: 1 | DATA TYPE: RASTER | FILE NAME: G-003.dgn

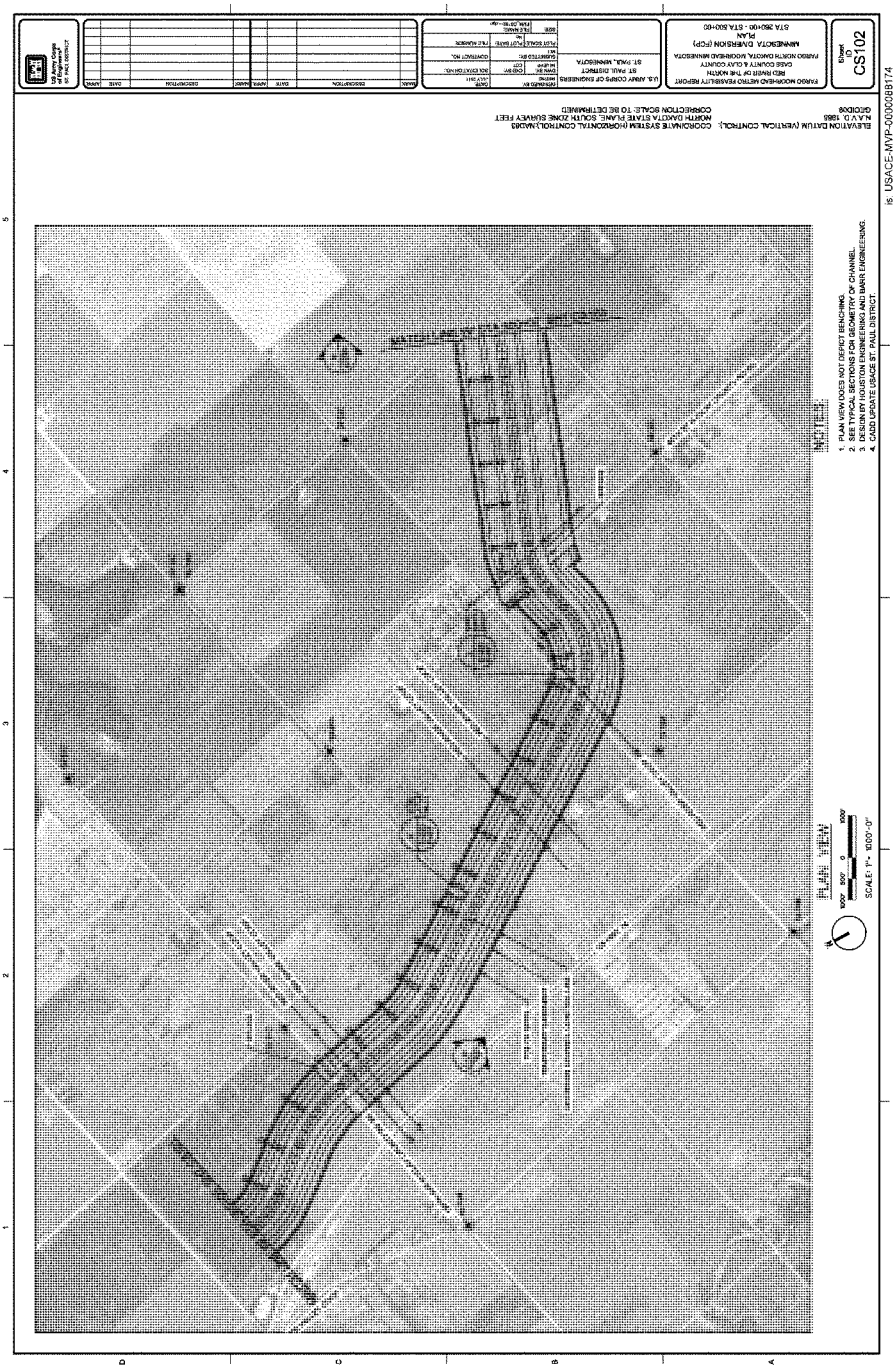
FARGO MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH BASIN
CASS COUNTY & CLAY COUNTY
FARGO, NORTH DAKOTA & MOORHEAD, MINNESOTA
FINAL
LEGENDS & GENERAL NOTES

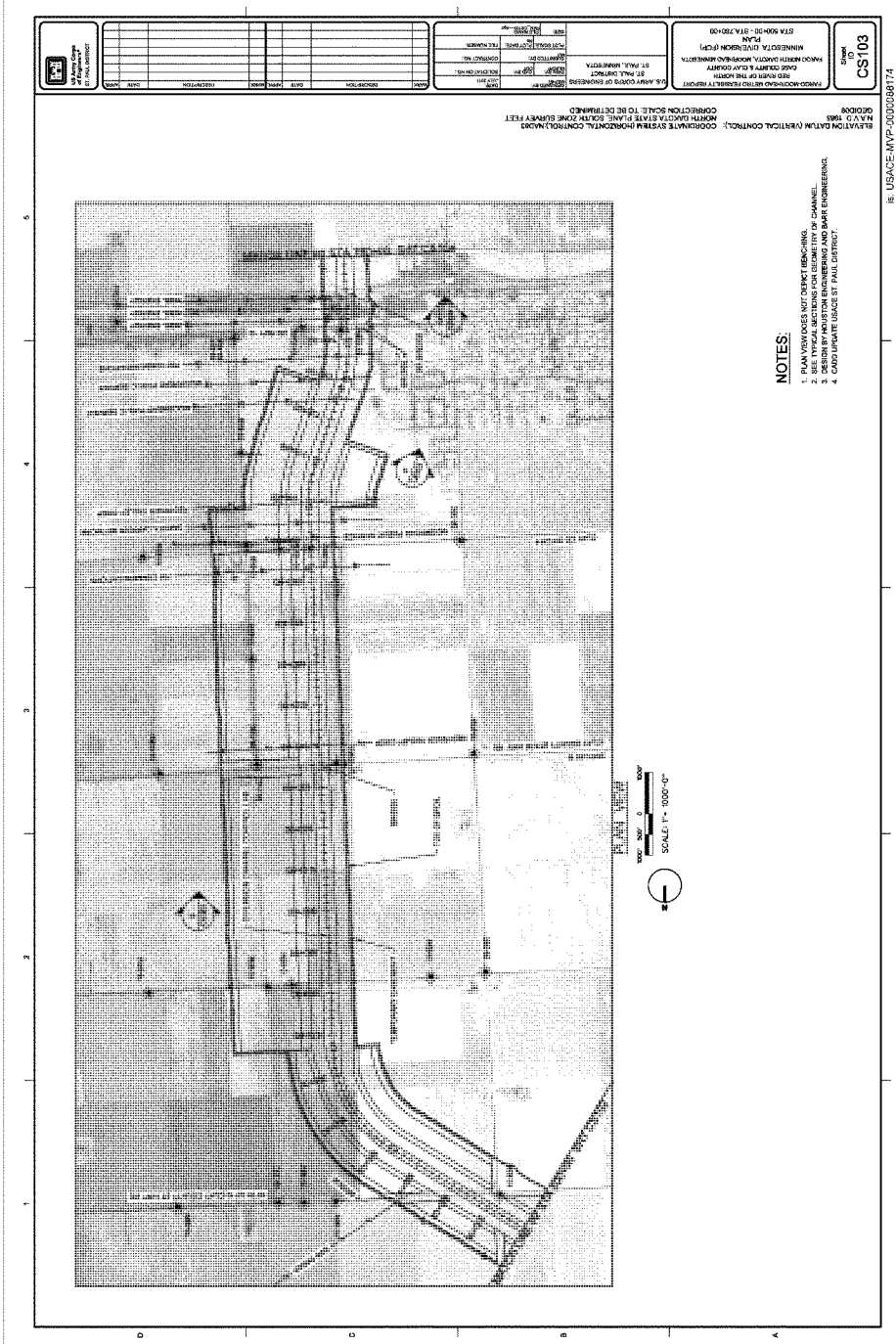
Sheet ID: G-003

is: USACE-MVP-0000088174

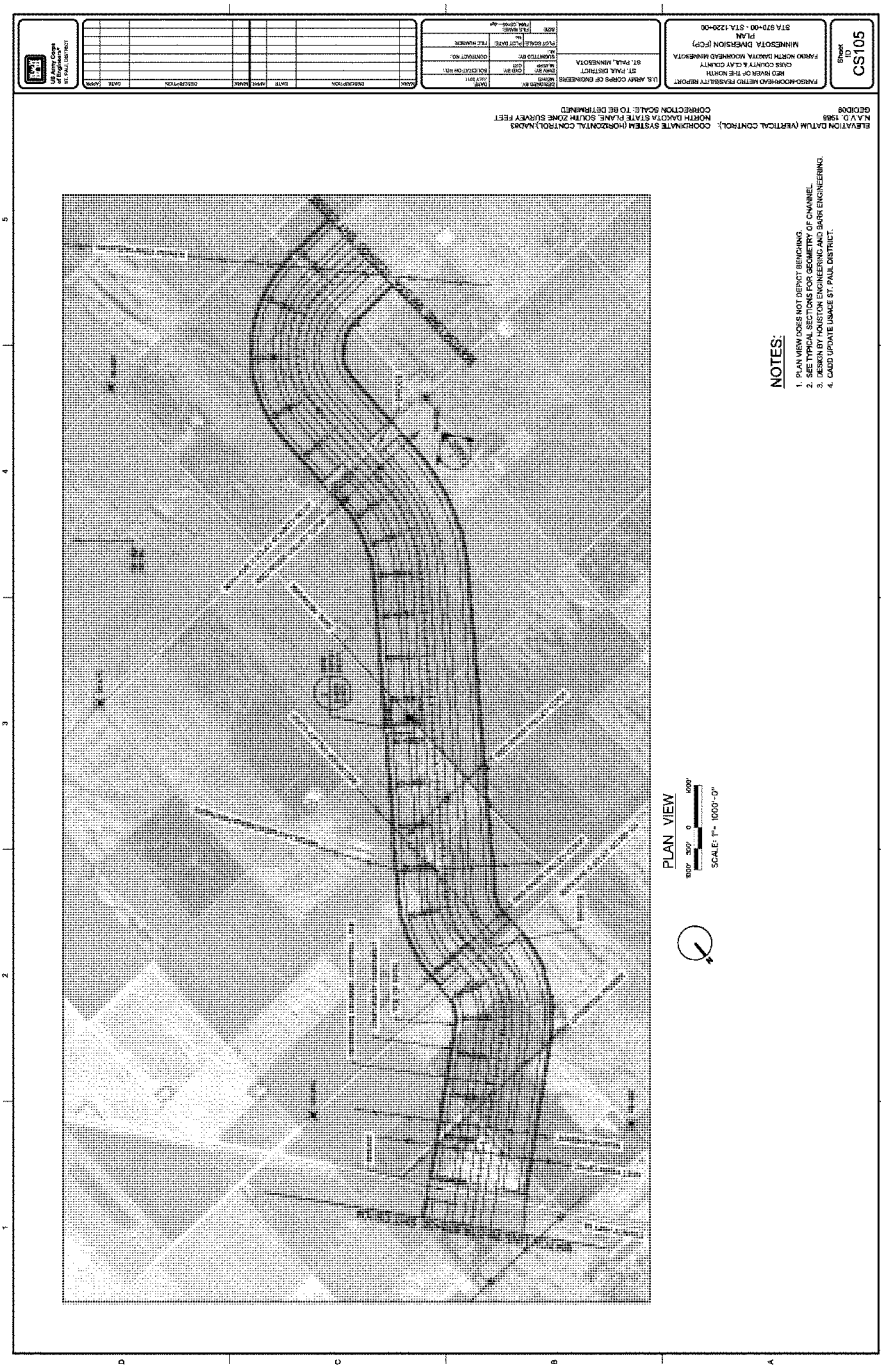

FARGO MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY, N. DAKOTA & CLAY COUNTY
MINNESOTA DIVERSION (FCP)
FARGO, NORTH DAKOTA, MOORHEAD, MINNESOTA
GENERAL PLAN
Sheet ID
CS100
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL DATUM):
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09 CORRECTION SCALE: TO BE DETERMINED
GENERAL PLAN
MINNESOTA DIVERSION (FCP)
CS101
CS102
CS103
CS104
CS105
CS106
CS107
HWY 10
HWY 75
MOORHEAD
FARGO
WEST FARGO
HARWOOD
HECTOR INTERNATIONAL AIRPORT
WILD RICE RIVER
RED RIVER OF THE NORTH
MAPLE RIVER
SHEYENNE RIVER
PUSH RIVER
BUFFALO RIVER
N
is: USACE-MVP-0000088174

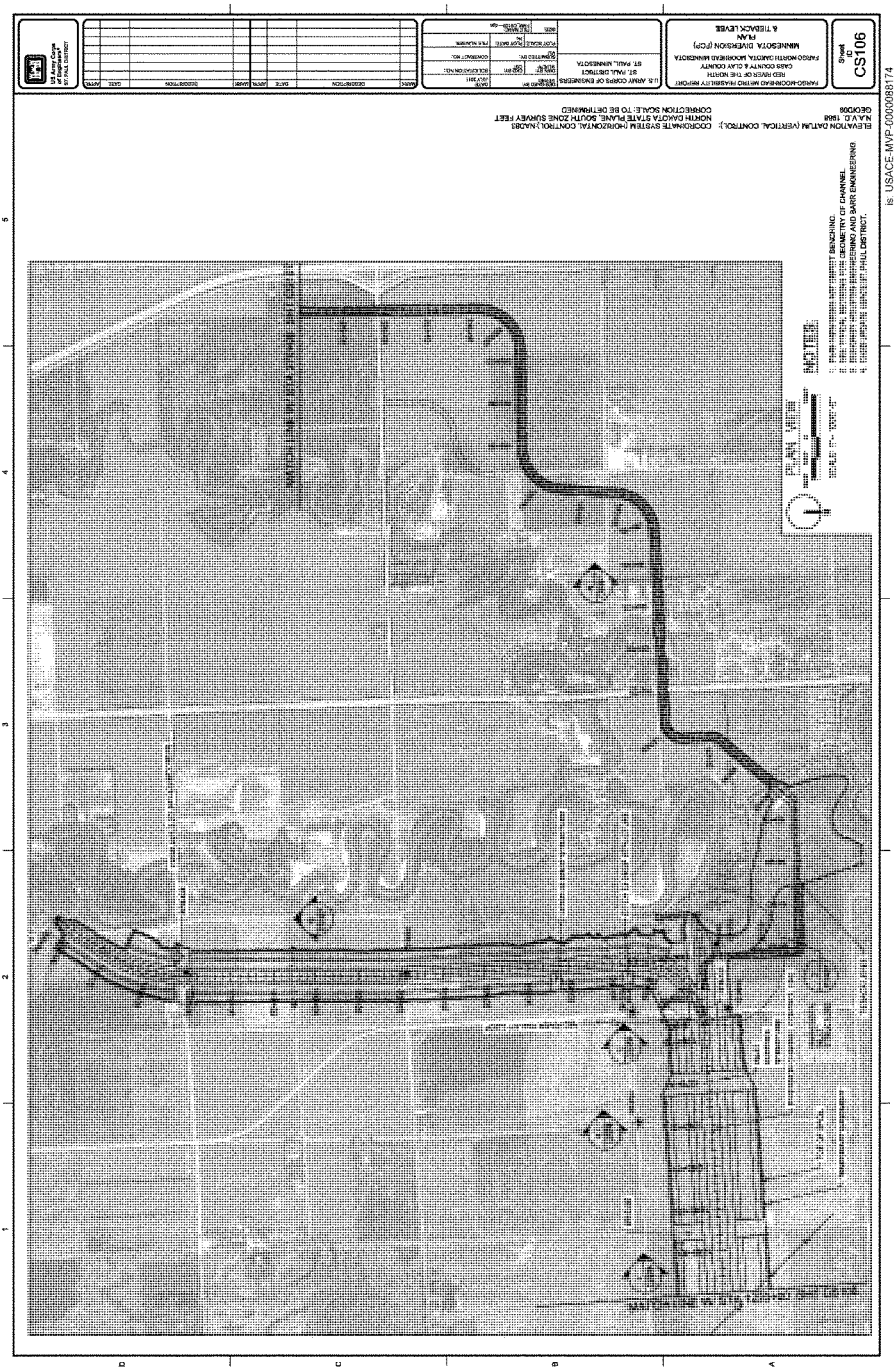

FARGO MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DIKE/OL NORHEAD MANDENTA
MINNESOTA, DIVERSION (PCP)
PLAN
STA 0+00 - STA 220+00
Sheet ID
CS101
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
QUALITY CHK
SUPERVISOR
APPROVED BY
DATE
SCALE
AS NOTED
FILE NAME
DESCRIPTION
DATE
APVD.
NOTES:
1. PLAN VIEW DOES NOT DEPICT RENCHING.
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND EMARK ENGINEERING.
4. CADD UPDATE ISSUED BY: PAUL DISTRICT.
PLAN VIEW
SCALE: 1" = 1000'-0"
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL) NUMBER:
NAVD 88
NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09
CORRECTION SCALE: TO BE DETERMINED
IS: USACE-MVP-0000086174

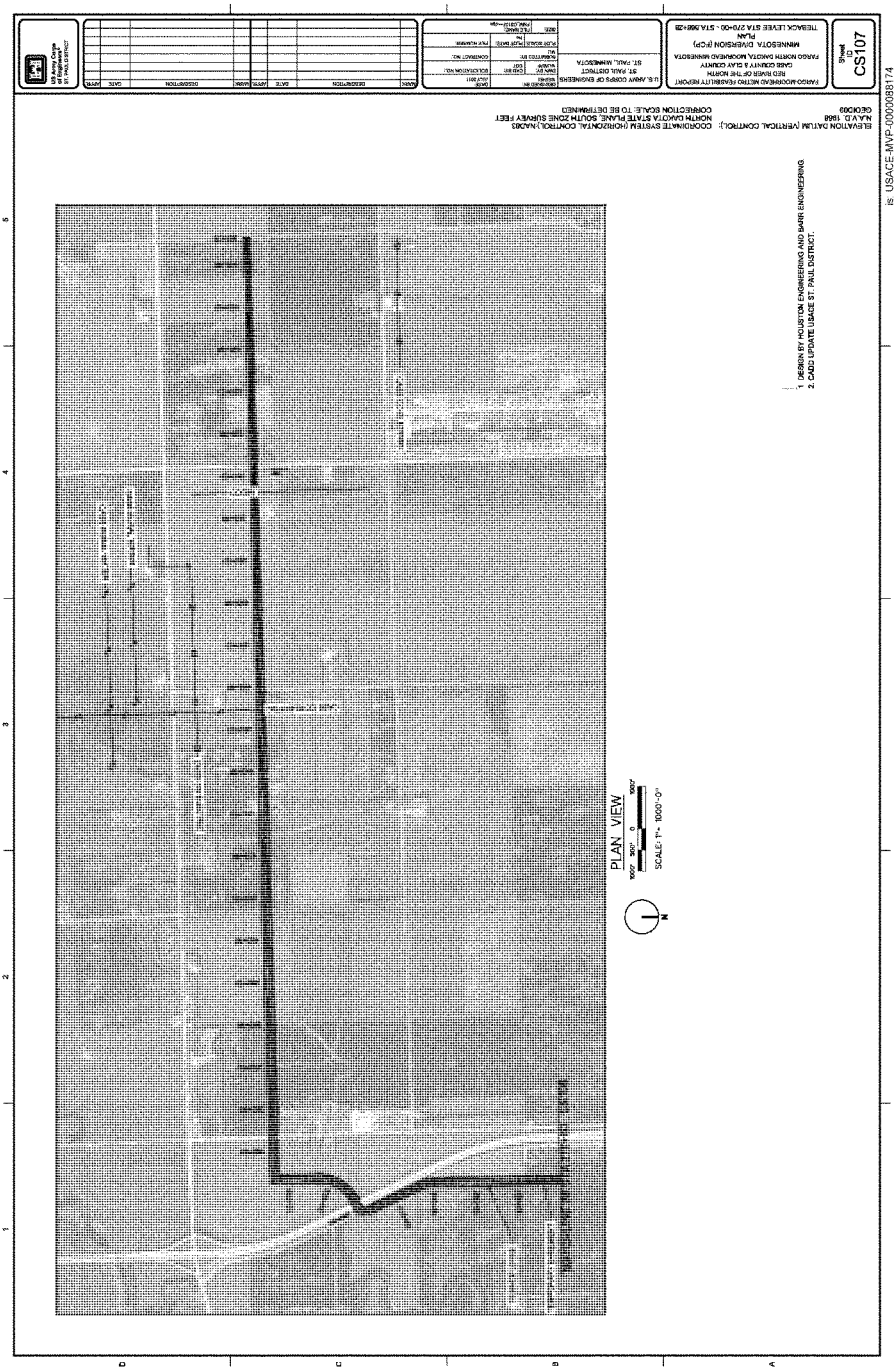

FARGO NORTHERN REACH FEASIBILITY REPORT
RED RIVER OF THE NORTH
FARGO-MOORHEAD METRO FRMA
CASS COUNTY & CLAY COUNTY
MINNESOTA & NORTH DAKOTA
PLAN
CS102
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOID06
COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
PLAN VIEW
SCALE: 1" = 1000'-0"
1000' 0 1000' 2000'
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENDING.
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE USACE ST. PAUL DISTRICT.
15 USACE-MVP-0000089174

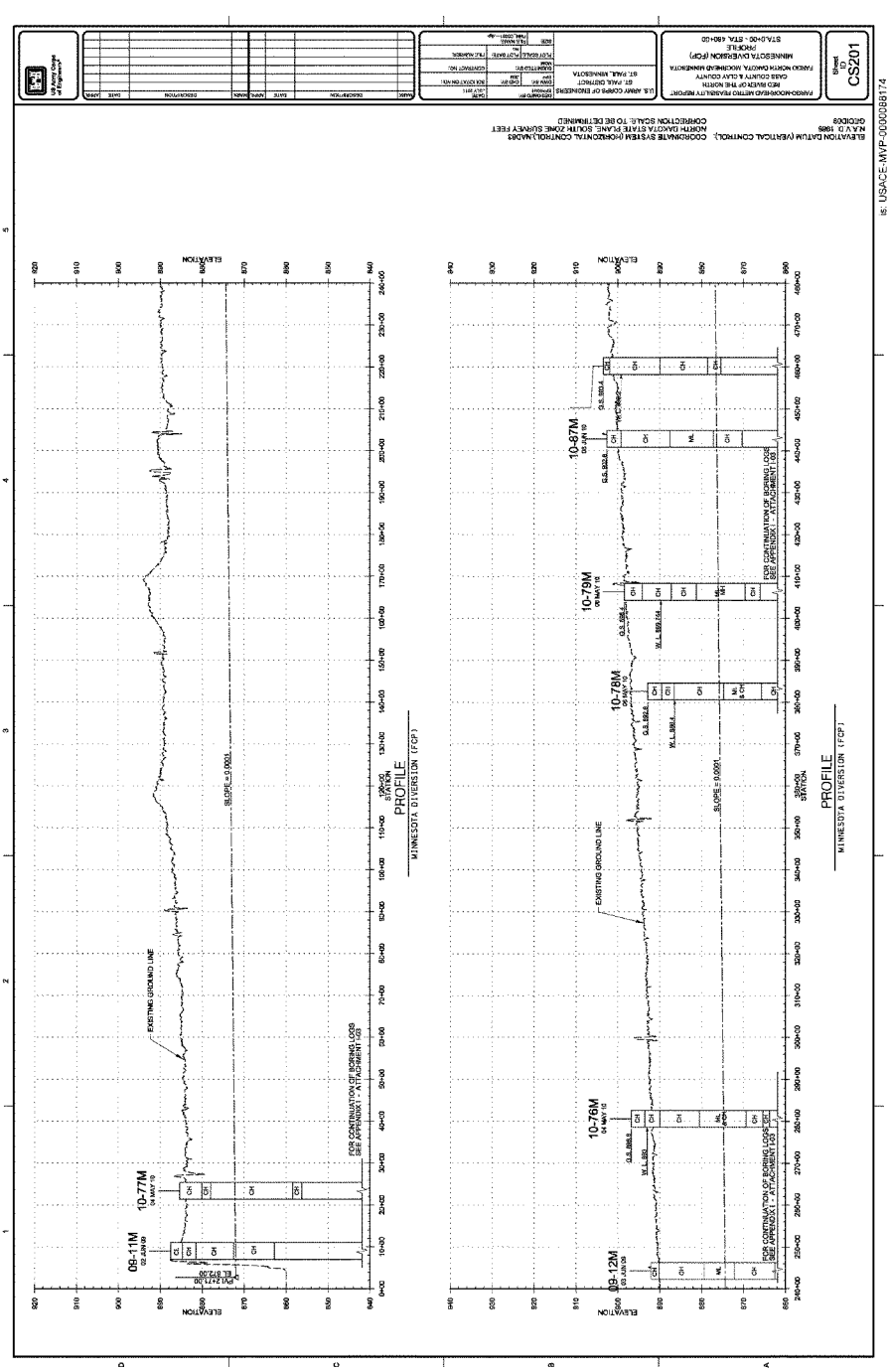

FARGO-MOORHEAD METRO DIVERSION PROJECT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO, NORTH DAKOTA, MOORHEAD, MINNESOTA
MINNESOTA DIVERSION (CPP)
PLAN
STA 500+00 - STA 730+00
Sheet ID
CS103
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING.
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE USACE ST. PAUL DISTRICT.
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID18 CORRECTION SCALE: TO BE DETERMINED
PLAN VIEW
SCALE: 1" = 1000'-0"
1000' 0 2000'
fs: USACE-MVP-000088174

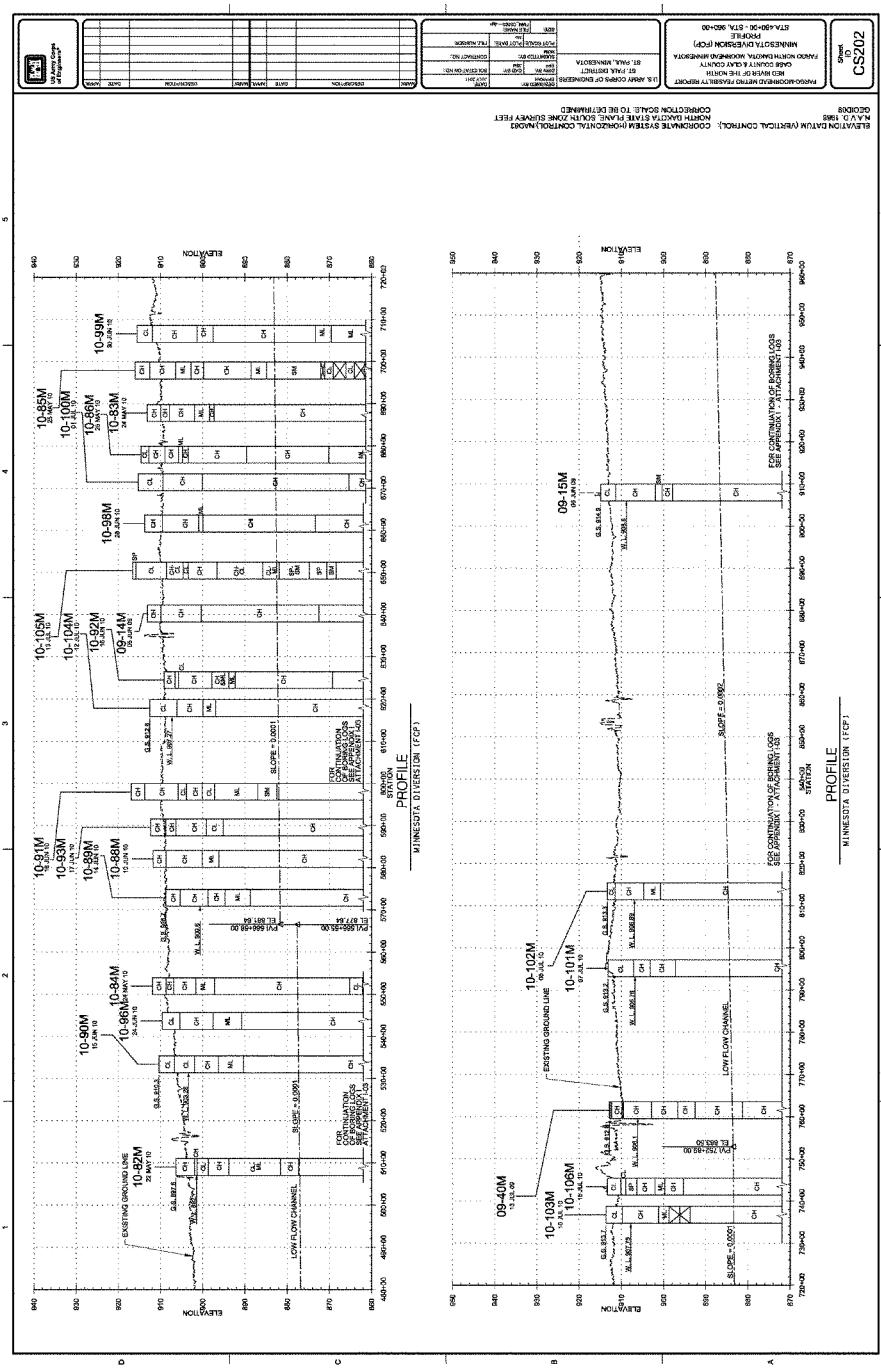
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
MINNESOTA DIVERSION (FCP)
PLAN
STA 740+00 - STA 970+00
Sheet ID
CS104
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
COVERSHEET NO.
PLOT SCALE
PLOT MODE
FILE NUMBER
REF.
DATE
DESCRIPTION
DATE
APPR.
MARK
DESCRIPTION
DATE
APPR.
MARK
PLAN VIEW
SCALE: 1"= 1000'-0"
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING.
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE USACE ST. PAUL DISTRICT.
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOID09
COORDINATE SYSTEM (HORIZONTAL CONTROL): NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
is: USACE-MVP-0000088174

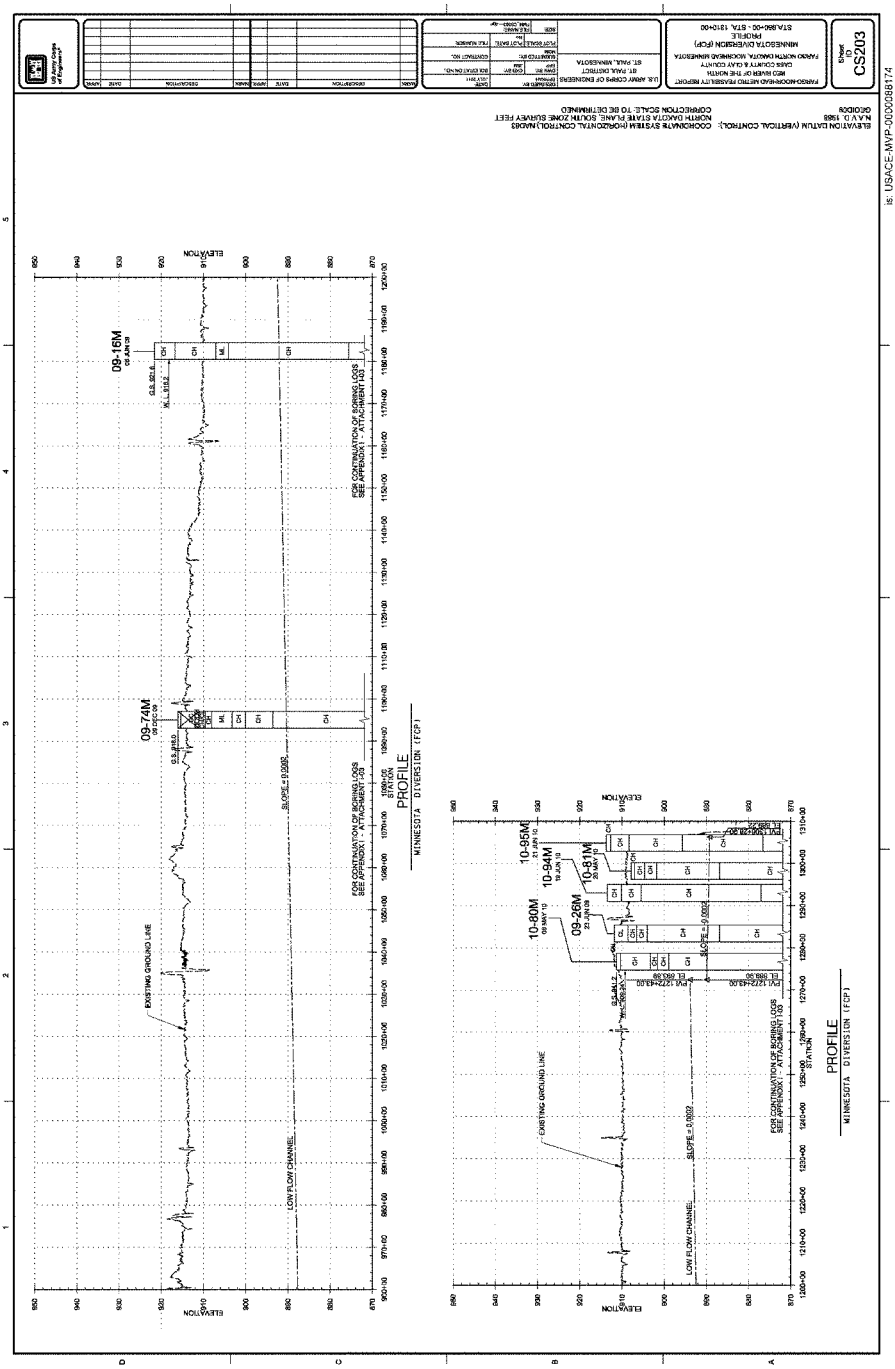

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
MINNESOTA DIVERSION (FCP)
PLAN
STA 920+00 - STA 1220+00
Sheet ID
CS105
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
PLAN VIEW
SCALE: 1"= 1000'-0"
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENDING
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE ISSUED BY: PAUL DISTRICT.
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL) NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09 CONVERSION SCALE: TO BE DETERMINED
IS: USACE-MVP-0000088174

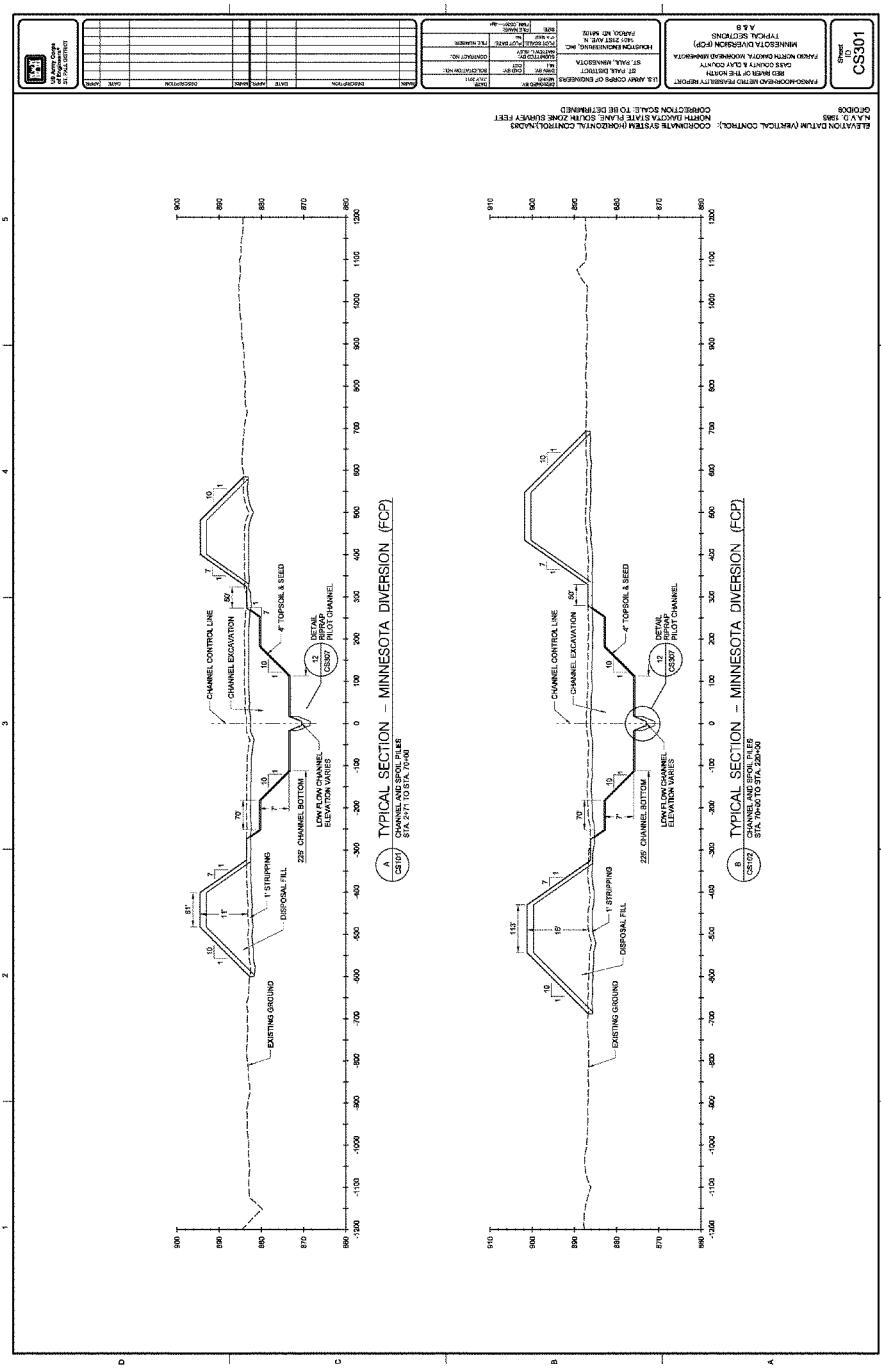

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
MINNESOTA DIVERSION (TCP)
PLAN
& TIEBACK LEVEE
Sheet No.
CS106
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED
DRAWN
CHECKED
QUANTITIES CK'D
SUBMITTED BY
PROJECT MGR.
CHIEF, ENGINEERING BR.
CHIEF, REAL ESTATE
CHIEF, OPERATIONS BR.
CHIEF, PLANNING BR.
CHIEF, PROJECT MGMT. BR.
CHIEF, CONSTRUCTION BR.
CHIEF, CONTRACTING BR.
CHIEF, ENGINEERING BR.
DEPUTY DISTRICT ENGINEER
DISTRICT ENGINEER
APPROVED
DATE
DESCRIPTION
MARK
U.S. Army Corps of Engineers
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
N.A.V.D. 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID06 CORRECTION SCALE: TO BE DETERMINED
1. ALL CONSTRUCTION SHALL CONFORM TO CORPS OF ENGINEERS STANDARDS.
2. ALL ELEVATIONS ARE IN FEET REFERENCED TO NGVD 1929 DATUM.
3. ALL DIMENSIONS ARE IN FEET AND DECIMALS THEREOF.
4. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
EARTHWORK SPECIFICATIONS.
5. ALL CONCRETE SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
CONCRETE SPECIFICATIONS.
6. ALL REINFORCING STEEL SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
REINFORCING STEEL SPECIFICATIONS.
7. ALL STRUCTURAL STEEL SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
STRUCTURAL STEEL SPECIFICATIONS.
8. ALL WELDING SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
WELDING SPECIFICATIONS.
9. ALL PAINTING SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
PAINTING SPECIFICATIONS.
10. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
CONSTRUCTION SPECIFICATIONS.
11. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
CONSTRUCTION SPECIFICATIONS.
12. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH CORPS OF ENGINEERS
CONSTRUCTION SPECIFICATIONS.

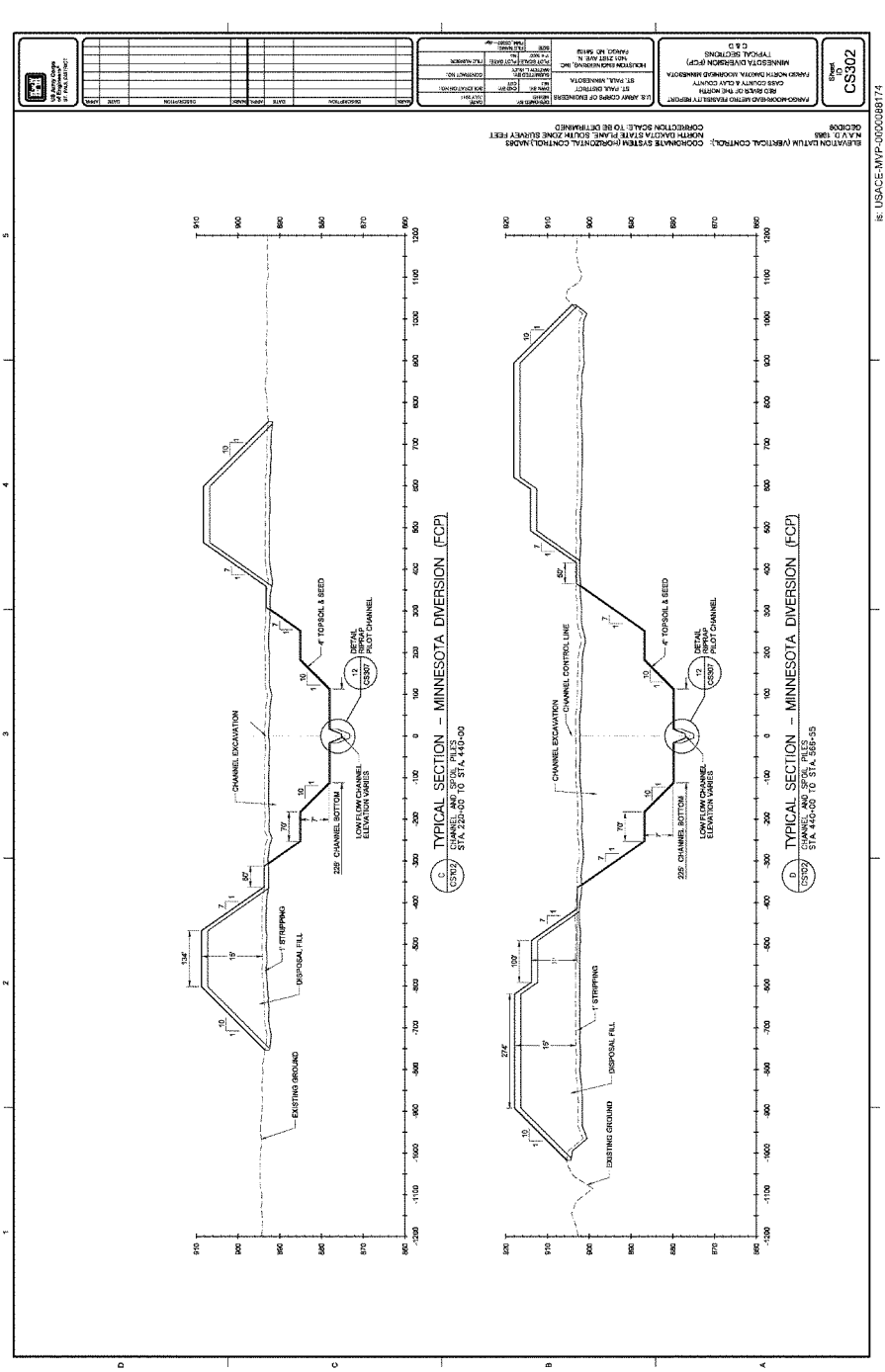

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
MINNESOTA DIVERSION (FCP)
PLAN
TIEBACK LEVEE STA 270+00 - STA 306+28
Sheet ID
CS107
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
QUALITY CHECK BY
SUPERVISED BY
APPROVED BY
DATE
SCALE
FILE NAME
DESCRIPTION
DATE
APPR.
DRAWN
DESCRIPTION
DATE
APPR.
PLAN VIEW
SCALE: 1"= 1000'-0"
1000'
0
2000'
N
ELEVATION DATUM (VERTICAL CONTROL): NAVD 88
GEOID09
COORDINATE SYSTEM (HORIZONTAL CONTROL): NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CONNECTION SCALE: TO BE DETERMINED
1. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING
2. CADD UPDATE USACE ST. PAUL DISTRICT.
IS: USACE-MVP-0000088174

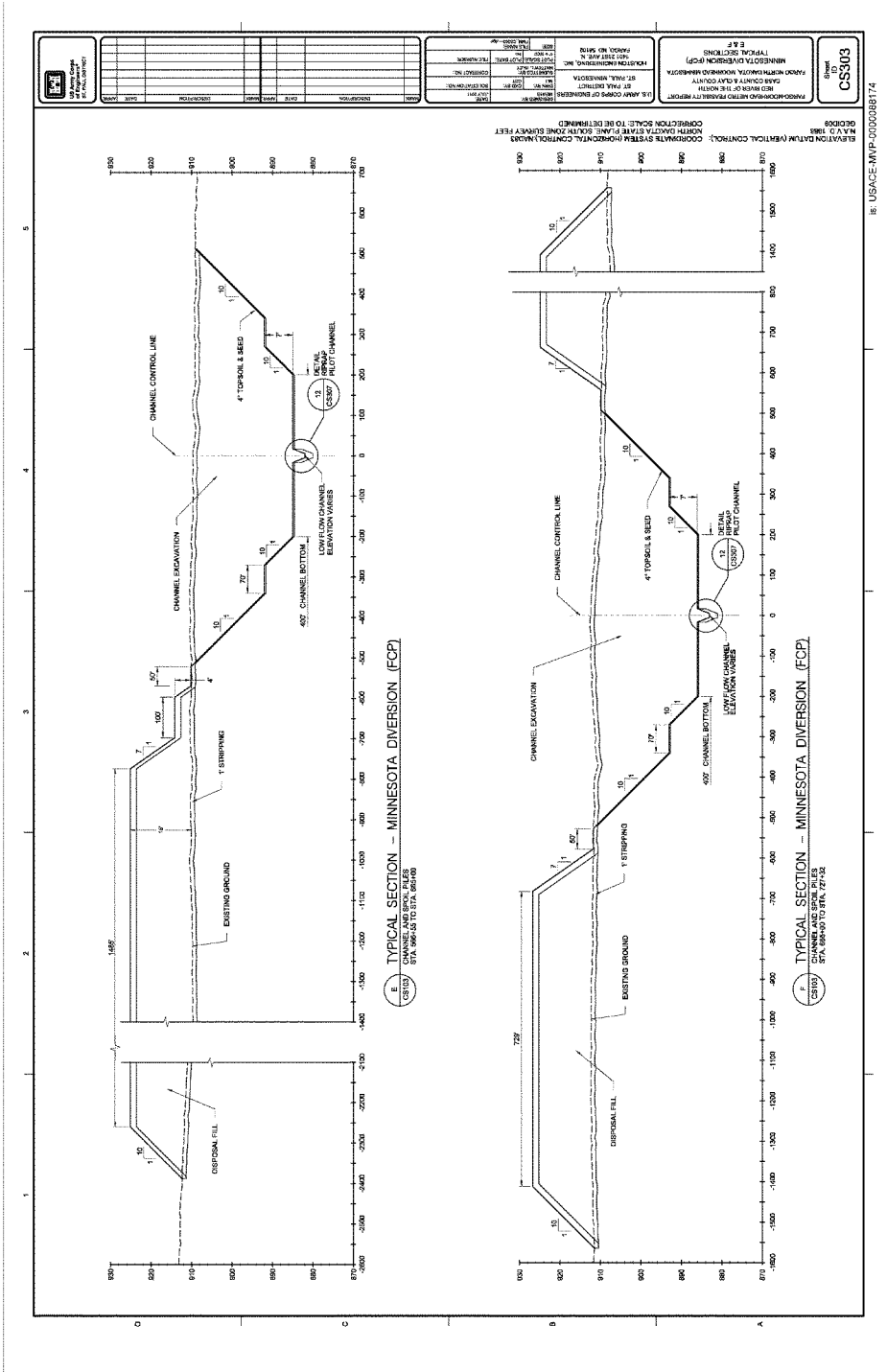

PROFILE
MINNESOTA DIVERSION (FCP)
EXISTING GROUND LINE
ELEVATION
09-11M
09-12M
10-76M
10-77M
10-78M
10-79M
10-87M
FOR CONTINUATION OF BORING LOGS SEE APPENDIX I - ATTACHMENT I-03
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOIDO8
NORTH DAKOTA STATE PLANE SOUTH ZONE SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
RED RIVER OF THE NORTH
FARGO-MOORHEAD METRO FEASIBILITY REPORT
CASS COUNTY & CLAY COUNTY
MINNESOTA / NORTH DAKOTA
STA 0+00 - STA 490+00
Sheet ID
CS201
is: USACE-MVP-0000088174

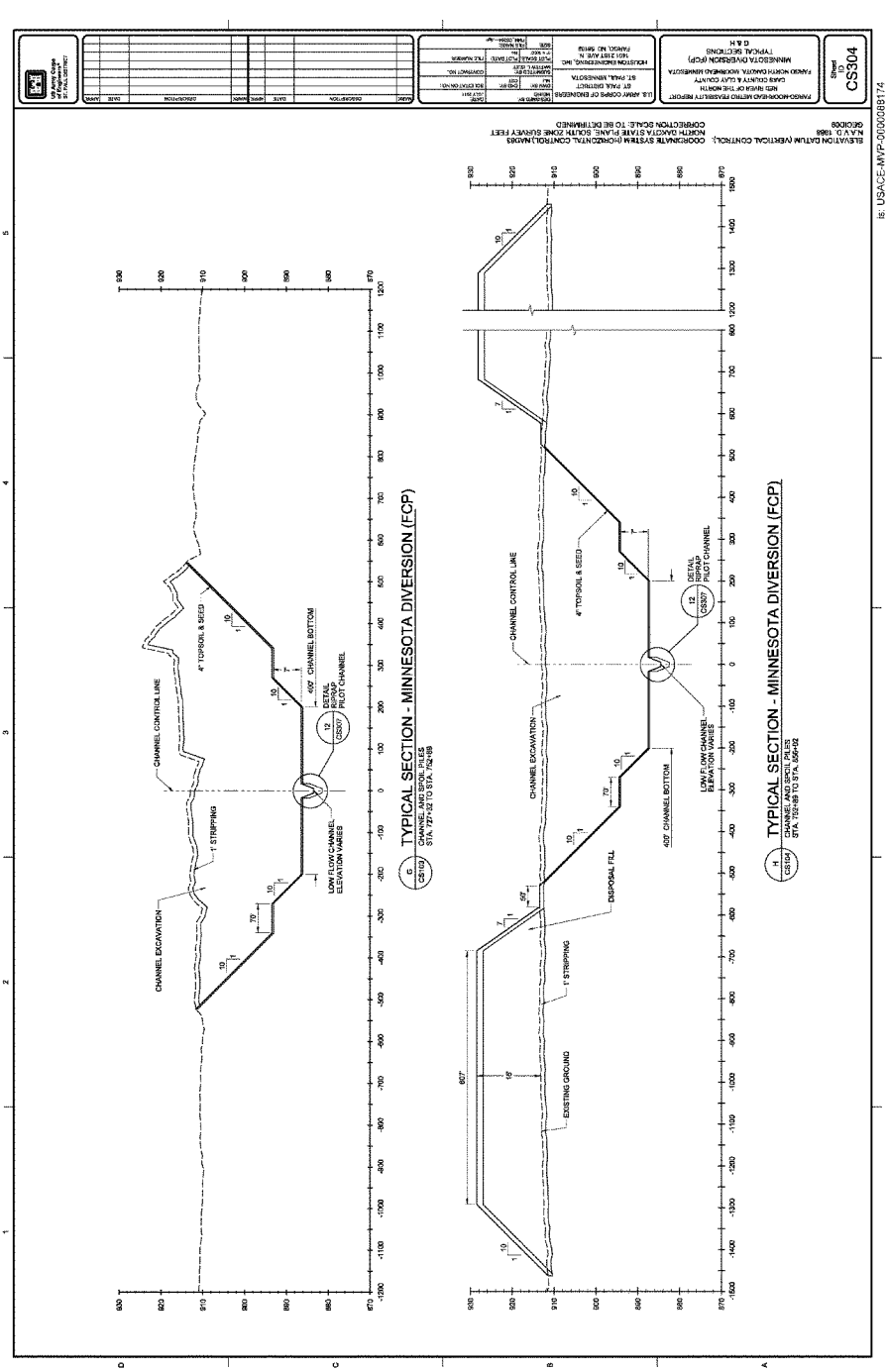

PROFILE
MINNESOTA DIVERSION (FCP)
ELEVATION
STATION
EXISTING GROUND LINE
LOW FLOW CHANNEL
FOR CONTINUATION OF BORING LOGS SEE APPENDIX I - ATTACHMENT I-03
09-40M
10-101M
10-102M
10-103M
10-106M
09-15M
10-81M
10-82M
10-83M
10-84M
10-85M
10-86M
10-87M
10-88M
10-89M
10-90M
10-91M
10-92M
10-93M
10-94M
10-95M
10-96M
10-97M
10-98M
10-99M
09-14M
10-104M
10-105M
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOID18
COORDINATE SYSTEM (HORIZONTAL CONTROL): NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CORRECTION SCALE TO BE DETERMINED
PARSHALL-HORNBECK METRO TRANSIT REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
MINNESOTA DIVERSION (FCP)
PROFILE
ETA-430-30 - STA. 363+00
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
Sheet ID
CS202
IS: USACE-MVP-0000088174

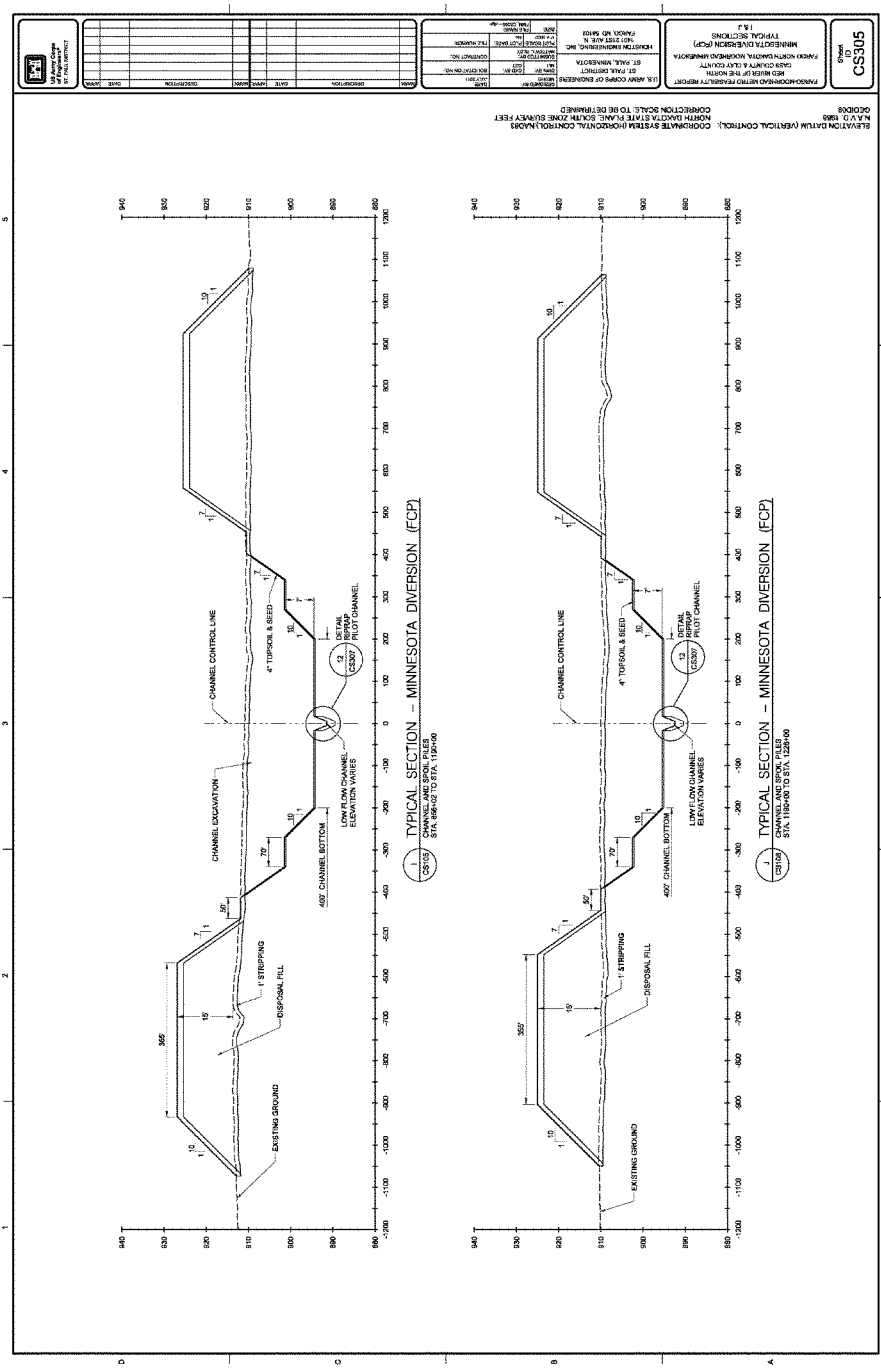

PROFILE
MINNESOTA DIVERSION (FCP)
EXISTING GROUND LINE
LOW FLOW CHANNEL
SLOPE = 0.0005
09-74M
09-16M
10-80M
09-26M
10-94M
10-81M
10-95M
ELEVATION
STA 890+00 - STA 1310+00
CS203
USACE-MVP-0000088174

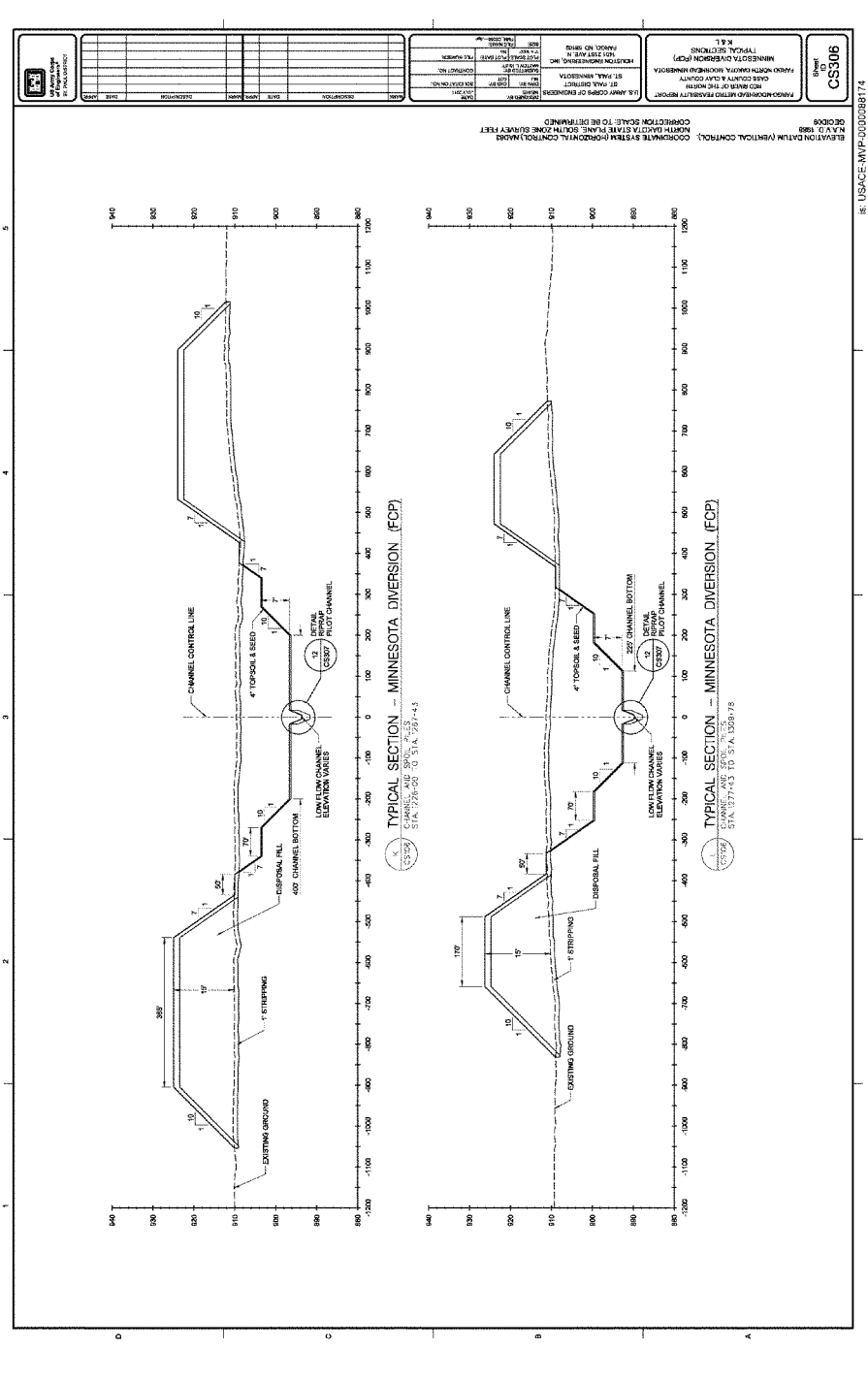

TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 1+47 TO STA. 70+00
TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 70+00 TO STA. 230+00
CHANNEL CONTROL LINE
CHANNEL EXCAVATION
4" TOPSOIL & SEED
DETAIL REFUGE PILOT CHANNEL
LOW FLOW CHANNEL ELEVATION VARIES
225' CHANNEL BOTTOM
1' STRIPPING
DISPOSAL FILL
EXISTING GROUND
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
MINNESOTA DIVERSION (FCP)
TYPICAL SECTIONS
A.4.8
Sheet ID
CS301
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09 CORRECTION SCALE: TO BE DETERMINED
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
HOUSTON ENGINEERING, INC.
1401 21ST AVE. N
FARGO, ND 58102
is: USACE-MVP-0000088174

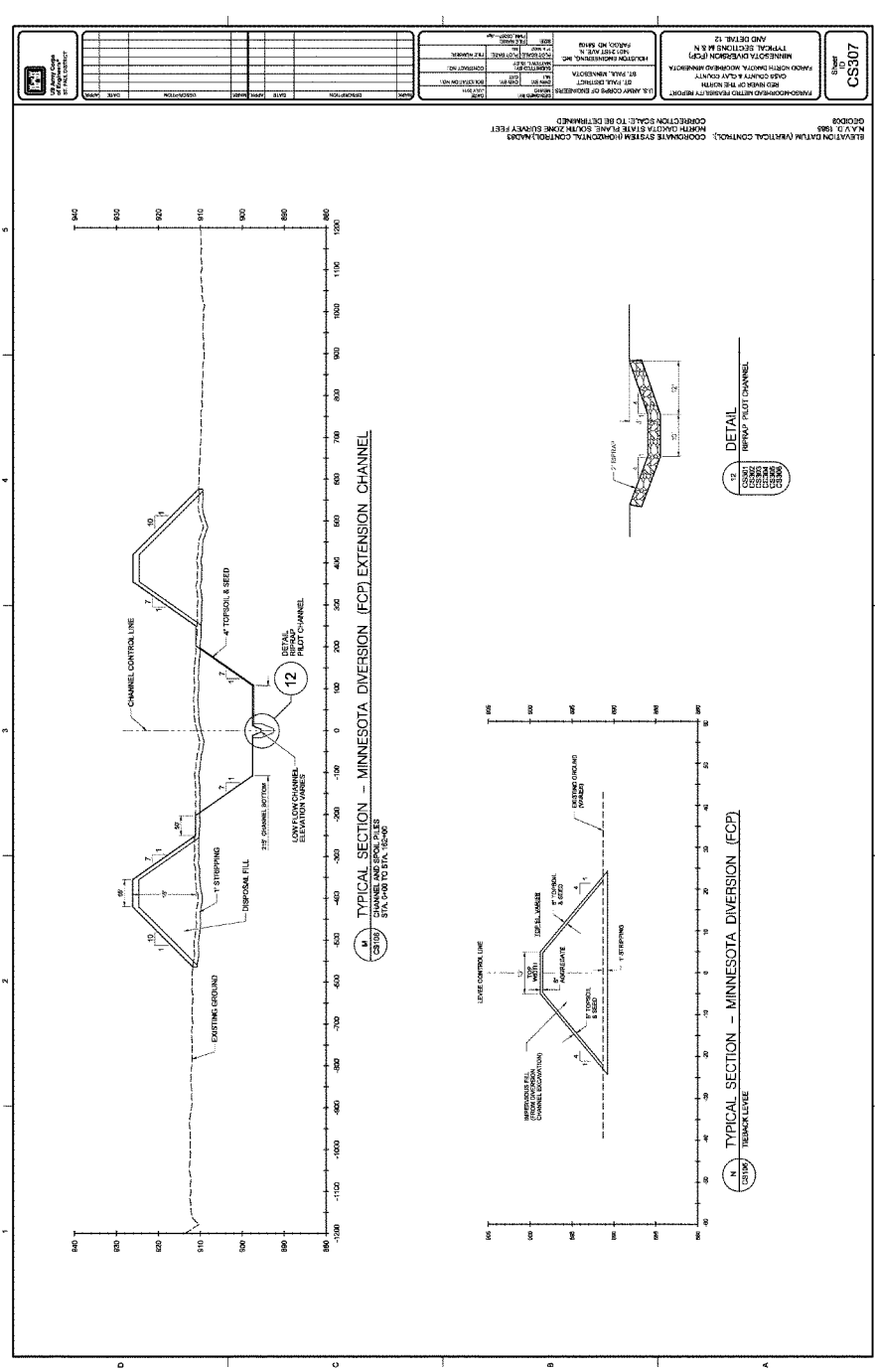

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
MINNESOTA DIVERSION (FCP)
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
TYPICAL SECTIONS
C & D
Sheet No.
CS302
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL MINNESOTA
HOUSTON ENGINEERING, INC
MINNEAPOLIS, MINNESOTA
NO. 21ST AVE. N.
FARGO ND 58102
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
CONSTRUCT NO.
PLOT SCALE
PLOT DATE
TITLE NUMBER
DATE
DESCRIPTION
MARK
APPR.
MARK
DATE
DESCRIPTION
MARK
APPR.
MARK
DATE
C
TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 220+00 TO STA. 440+00
CS302
EXISTING GROUND
DISPOSAL FILL
1' STRIPPING
CHANNEL EXCAVATION
4' TOPSOIL & SEED
DETAIL THROUGH PILOT CHANNEL
CS307
LOW FLOW CHANNEL ELEVATION VARIES
225' CHANNEL BOTTOM
D
TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 440+00 TO STA. 569+55
CS303
EXISTING GROUND
DISPOSAL FILL
1' STRIPPING
CHANNEL EXCAVATION
CHANNEL CONTROL LINE
4' TOPSOIL & SEED
DETAIL THROUGH PILOT CHANNEL
CS307
LOW FLOW CHANNEL ELEVATION VARIES
225' CHANNEL BOTTOM
ELEVATION DATUM: NAVD 1988
HORIZONTAL CONTROL: COORDINATE SYSTEM NORTH DAKOTA STATE PLANE SOUTH ZONE SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
DECIDOB
is: USACE-MVP-0000088174

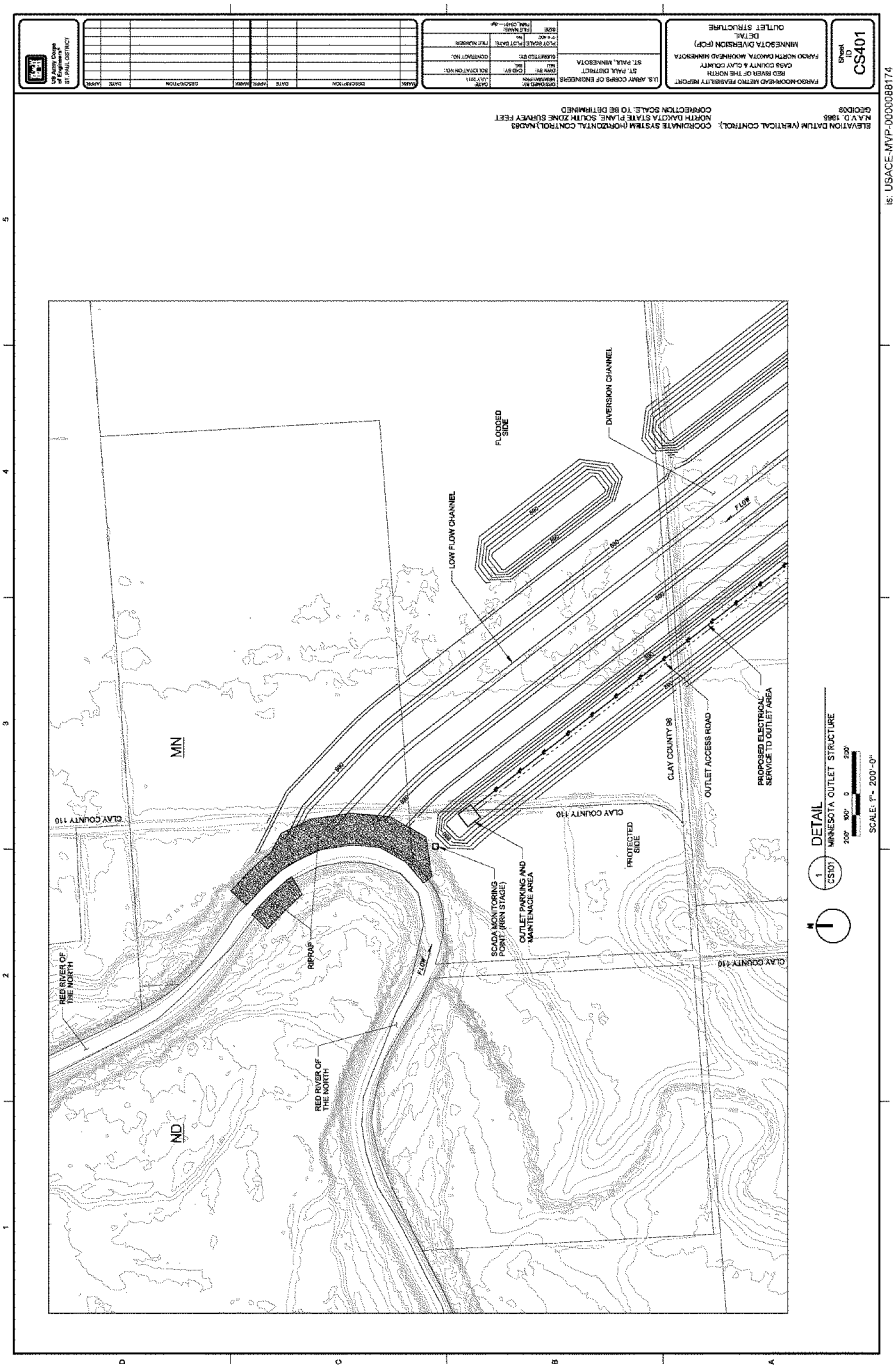

TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 666+00 TO STA. 727+32
TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 566+45 TO STA. 665+00
CHANNEL CONTROL LINE
CHANNEL EXCAVATION
CHANNEL BOTTOM
EXISTING GROUND
DISPOSAL FILL
4" TOPSOIL & SEED
1' STRIPPING
METAL RIPRAP PILOT CHANNEL
LOW FLOW CHANNEL ELEVATION VARIES
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09 CORRECTION SCALE: TO BE DETERMINED
PARSONS-BRINKERHOFF
RED RIVER OF THE NORTH FEASIBILITY REPORT
HOUSTON ENGINEERING, INC.
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
CASS COUNTY, N DAKOTA CLAY COUNTY
MINNESOTA DIVERSION (FCP)
TYPICAL SECTIONS
E & F
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
Sheet ID
CS303
IS: USACE-MVP-0000088174

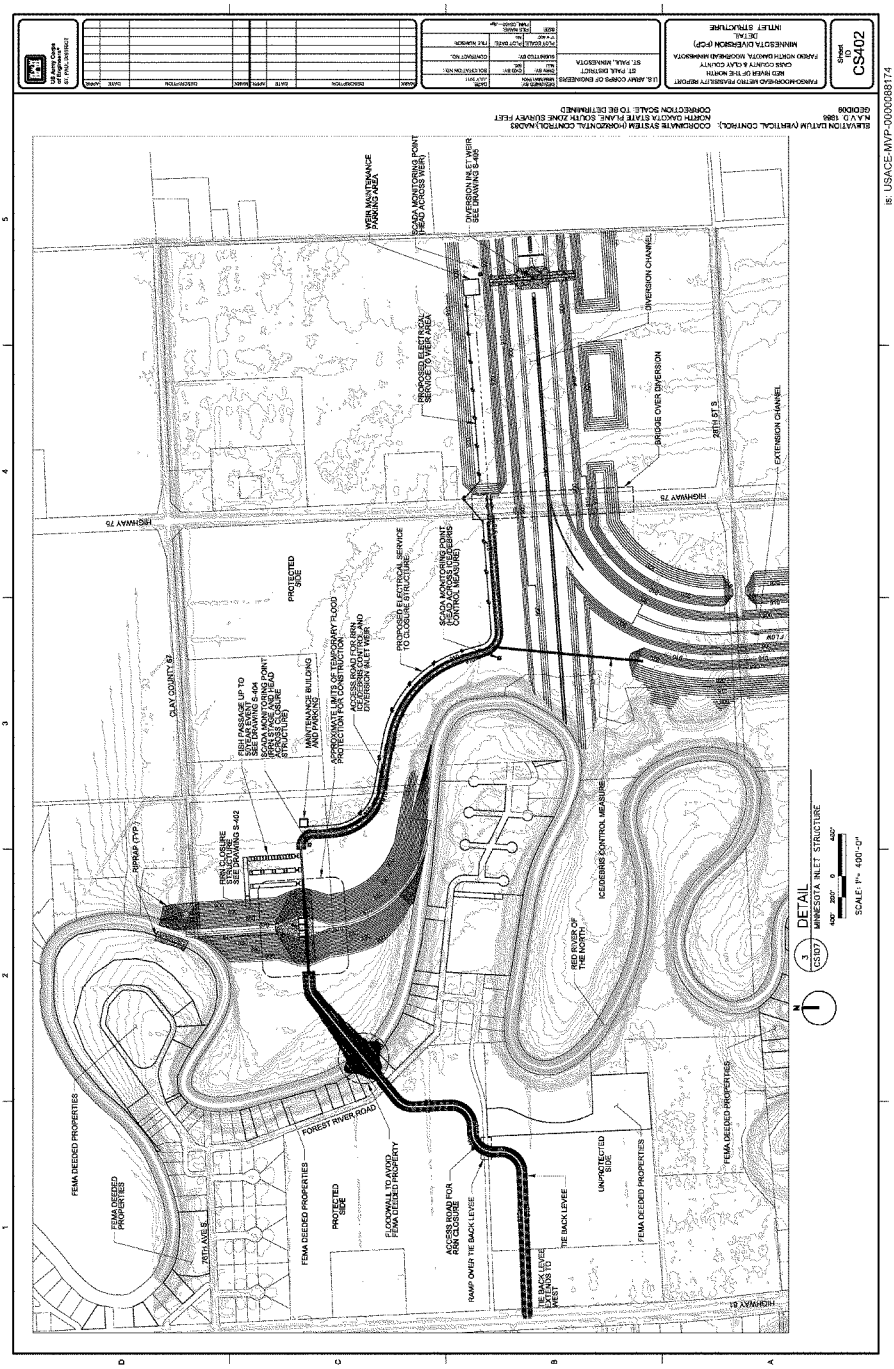

TYPICAL SECTION - MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 727+89 TO STA. 756+92
TYPICAL SECTION - MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL PILES
STA. 727+89 TO STA. 756+92
CHANNEL CONTROL LINE
4" TOPSOIL & SEED
1' STRIPPING
CHANNEL EXCAVATION
407' CHANNEL BOTTOM
DETAIL RIPRAP PILOT CHANNEL
LOW FLOW CHANNEL ELEVATION VARIES
EXISTING GROUND
DISPOSAL FILL
607'
US ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
HOUSTON ENGINEERING, INC
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY, N. DAKOTA & CLAY COUNTY
MINNESOTA DIVERSION (FCP)
TYPICAL SECTIONS
G & H
Sheet ID
CS304
ELEVATION DATUM: VERTICAL CONTROL: COORDINATE SYSTEM: HORIZONTAL CONTROL DATUM:
N.A.V.D. 1988
NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
DESIGNED BY
DRAWN BY
CHECKED BY
QUALITY CHECK BY
SCALE
AS SHOWN
PROJECT NO.
CS304
DATE
07/01/2011
SUBMITTED BY
CONTRACT NO.
FILE NUMBER
APPROVED BY
DATE
FARGO, ND
NORTH DAKOTA
MINNESOTA
USACE-MVP-0000089174

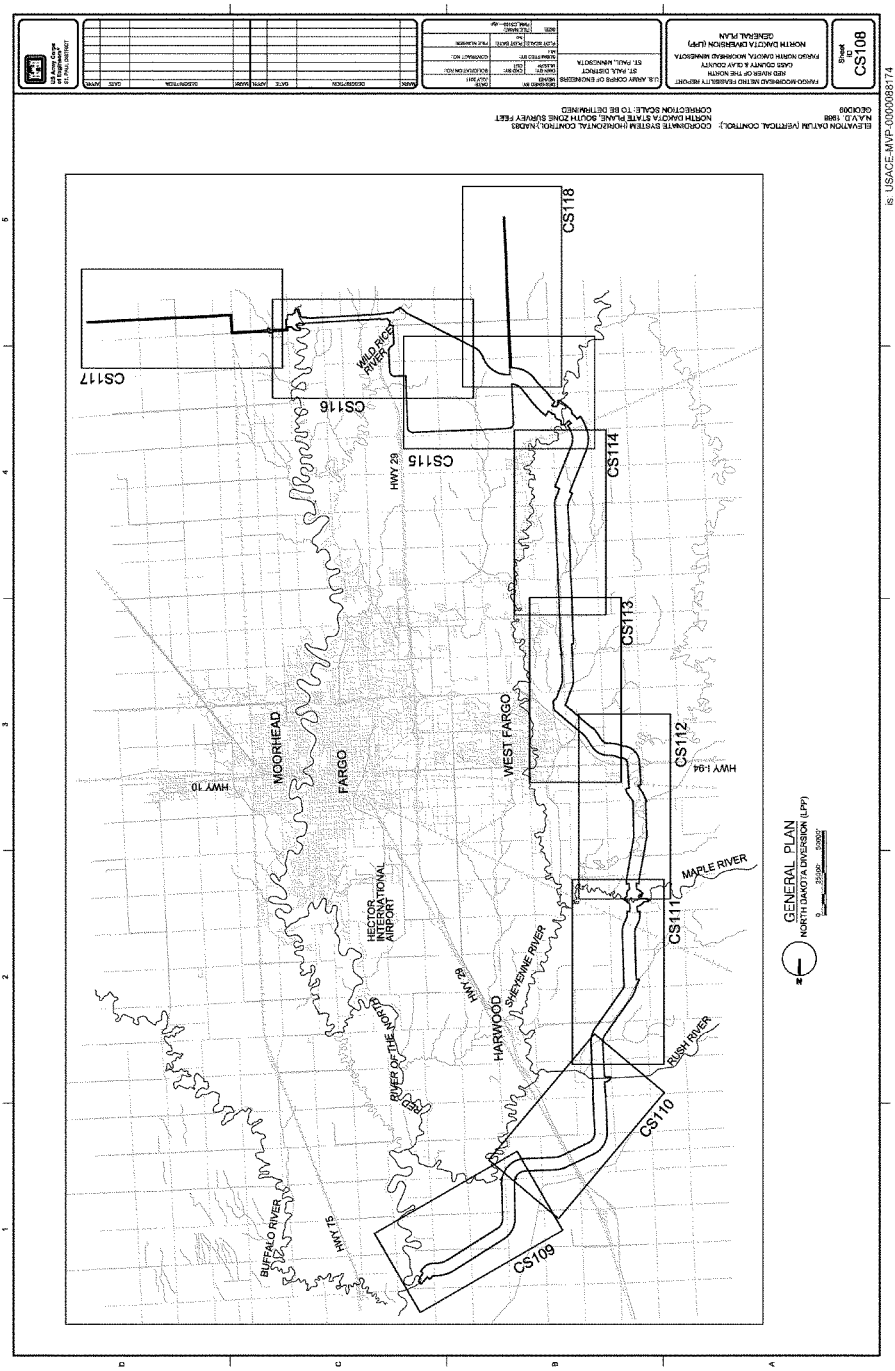

TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AND SPOIL FILES
STA 1109+00 TO STA 1129+00
CHANNEL CONTROL LINE
CHANNEL EXCAVATION
4" TOPSOIL & SEED
1' STRIPPING
DISPOSAL FILL
EXISTING GROUND
400' CHANNEL BOTTOM
LOW FLOW CHANNEL
ELEVATION VARIES
DETAIL
RIPRAP
PILOT CHANNEL
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
NAVD 1988
GEOID09
CORRECTION SCALE: TO BE DETERMINED
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO, NORTH DAKOTA, MOORHEAD, MINNESOTA
MINNESOTA DIVERSION (FCP)
TYPICAL SECTIONS
Sheet ID
CS305
HOUSTON ENGINEERING, INC.
ST. PAUL, MINNESOTA
FINAL DESIGN
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
FARGO, ND SHEQ
USACE-MVP-0000088174

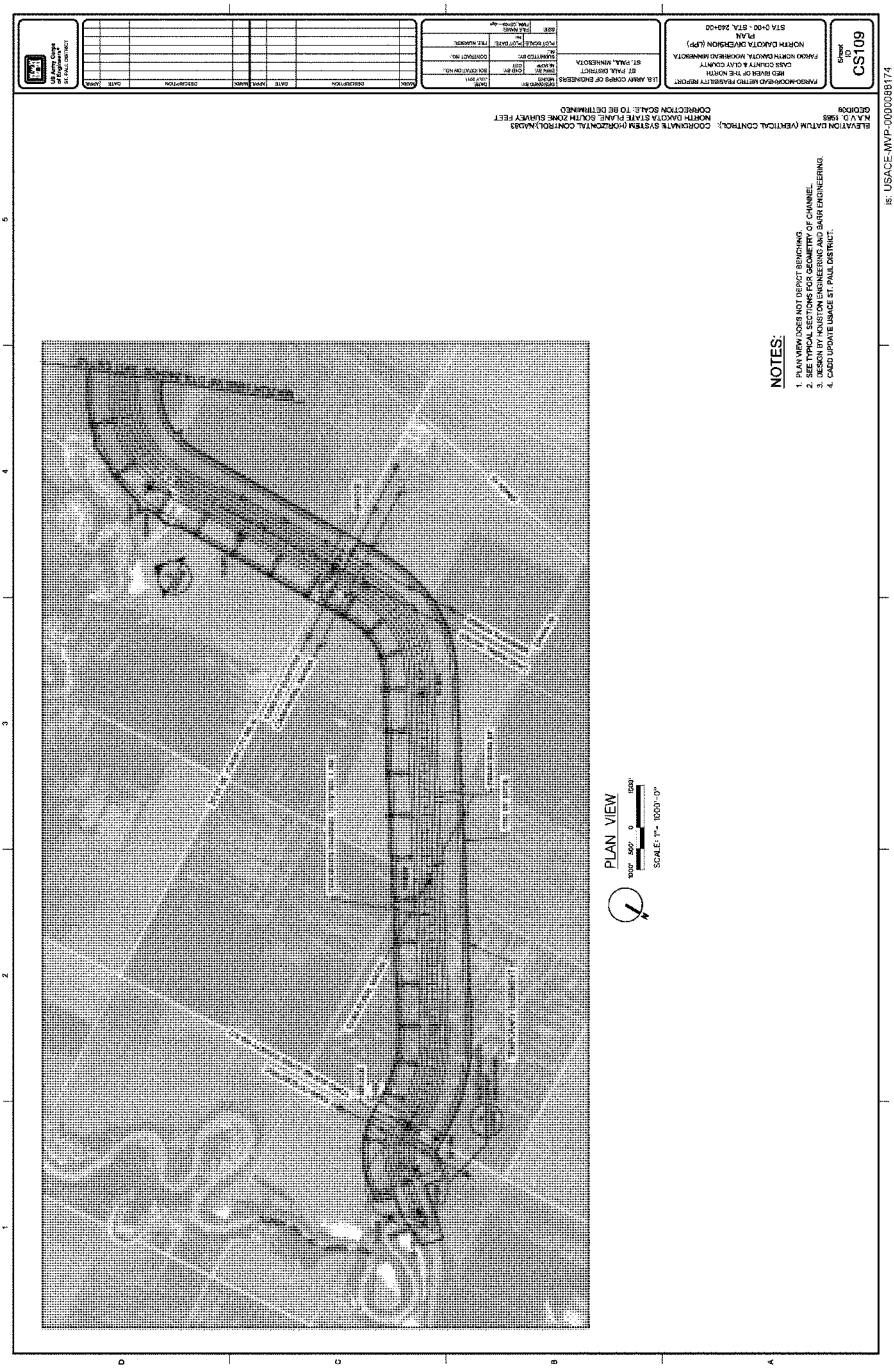

TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AXIS STA. 1226+00 TO STA. 1797+43
TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CHANNEL AXIS STA. 1797+43 TO STA. 1829+78
CHANNEL CONTROL LINE
EXISTING GROUND
1' STRIPPING
DISPOSAL FILL
4' TOPSOIL & SEED
400' CHANNEL BOTTOM
225' CHANNEL BOTTOM
LOW FLOW CHANNEL ELEVATION VARIES
DETAIL CS307 RIPRAP PILOT CHANNEL
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
FARGO-NORTH DAKOTA, MOORHEAD-MINNESOTA
CASS COUNTY A CLAY COUNTY
MINNESOTA DIVERSION (FCP)
TYPICAL SECTIONS
K&L
Sheet ID
CS306
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
HOUSTON ENGINEERING, INC
1401 31ST AVE. N
FARGO, ND 58102
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL) MAPS
N.A.V.D. 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
GEOCODE CORRECTION SCALE: TO BE DETERMINED
DESIGNED BY
DRAWN BY
CHECKED BY
DATE
JULY 2011
CONTRACT NO.
FILE NUMBER
SCALE
AS NOTED
DESCRIPTION
DATE
APPR.
DRAWN
DESIGN PHASE
DATE
APPR.
is: USACE-MVP-0000088174

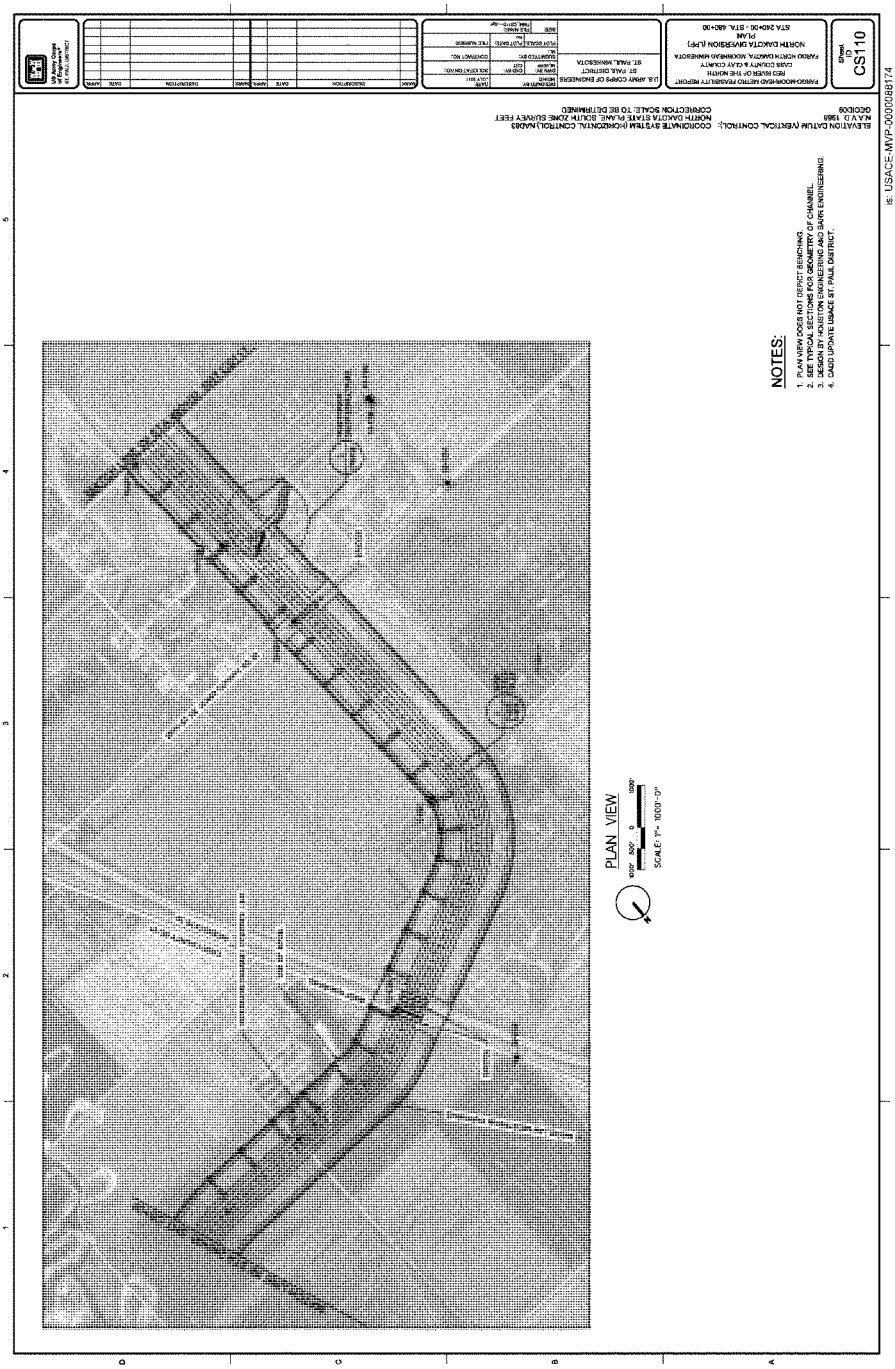

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
MINNESOTA DIVERSION (FCP)
TYPICAL SECTIONS M & N
AND DETAIL 12
Sheet ID
CS307
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
HOUSTON ENGINEERING, INC
MOORHEAD, MINNESOTA
ST. PAUL, MINNESOTA
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL) NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
GEOID18 CORRECTION SCALE: TO BE DETERMINED
EXISTING GROUND
DISPOSAL FILL
1' STRIPPING
21'0" CHANNEL BOTTOM
LOW FLOW CHANNEL ELEVATION VARIES
CHANNEL CONTROL LINE
4" TOPSOIL & SEED
DETAIL RIPRAP PILOT CHANNEL
M
TYPICAL SECTION – MINNESOTA DIVERSION (FCP) EXTENSION CHANNEL
CS1108
CHANNEL ENG DEPOL PLES
STA. 0+00 TO STA. 162+00
LEVEE CONTROL LINE
10'0" WIDTH
12'0" SL. VARIES
8" TOPSOIL & SEED
AGGREGATE
1' STRIPPING
EXISTING GROUND VARIES
IMPERVIOUS FILL (FROM ON-SITE CHANNEL EXCAVATION)
N
TYPICAL SECTION – MINNESOTA DIVERSION (FCP)
CS1106
TIEBACK LEVEE
12
DETAIL
RIPRAP PILOT CHANNEL
CS1001
CS1002
CS1003
CS1004
CS1005
CS1006
1' RIPRAP
is: USACE-MVP-0000088174

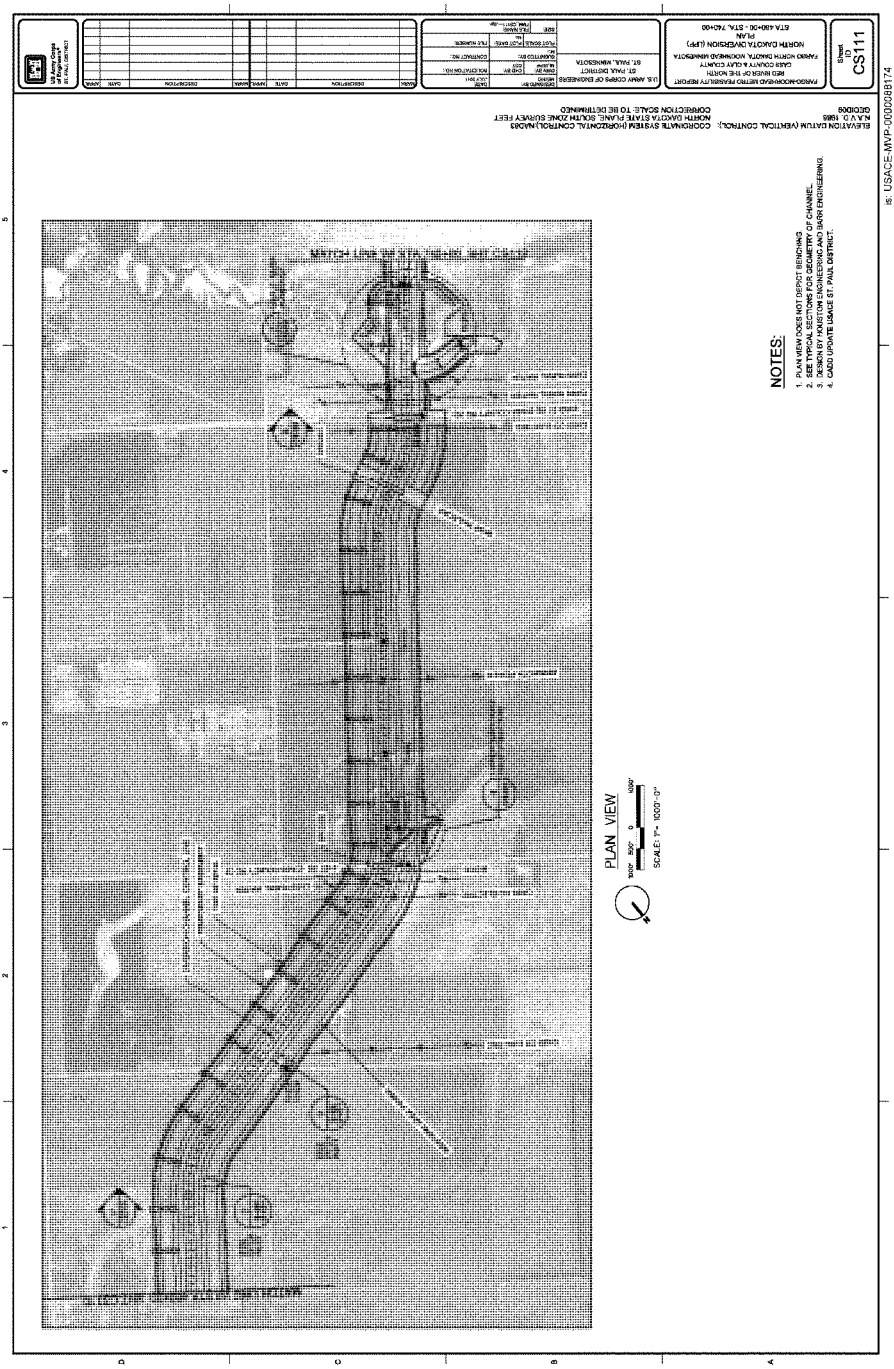

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY, N DAKOTA & CLAY COUNTY
MINNESOTA DIVERSION (PCP)
DETAIL
OUTLET STRUCTURE
Sheet ID
CS401
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
SCALE
HORIZ
VERT
CONTRACT NO.
SEE CONTR DWG NO.
TAC NUMBER
DATE
DESCRIPTION
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
N.A.V.D. 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
GEOID09B CORRECTION SCALE: TO BE DETERMINED
is: USACE-MVP-0000088174
MN
ND
CLAY COUNTY 110
CLAY COUNTY 98
RED RIVER OF THE NORTH
RIPRAP
ROADA MONITORING WELL (APPX 5 WELL)
OUTLET PARKING AND TURNAROUND AREA
LOW FLOW CHANNEL
FLOODED SIDE
DIVERSION CHANNEL
PROTECTED SIDE
OUTLET ACCESS ROAD
PROPOSED ELECTRICAL SERVICE TO OUTLET AREA
DETAIL
MINNESOTA OUTLET STRUCTURE
SCALE: 1" = 200'-0"

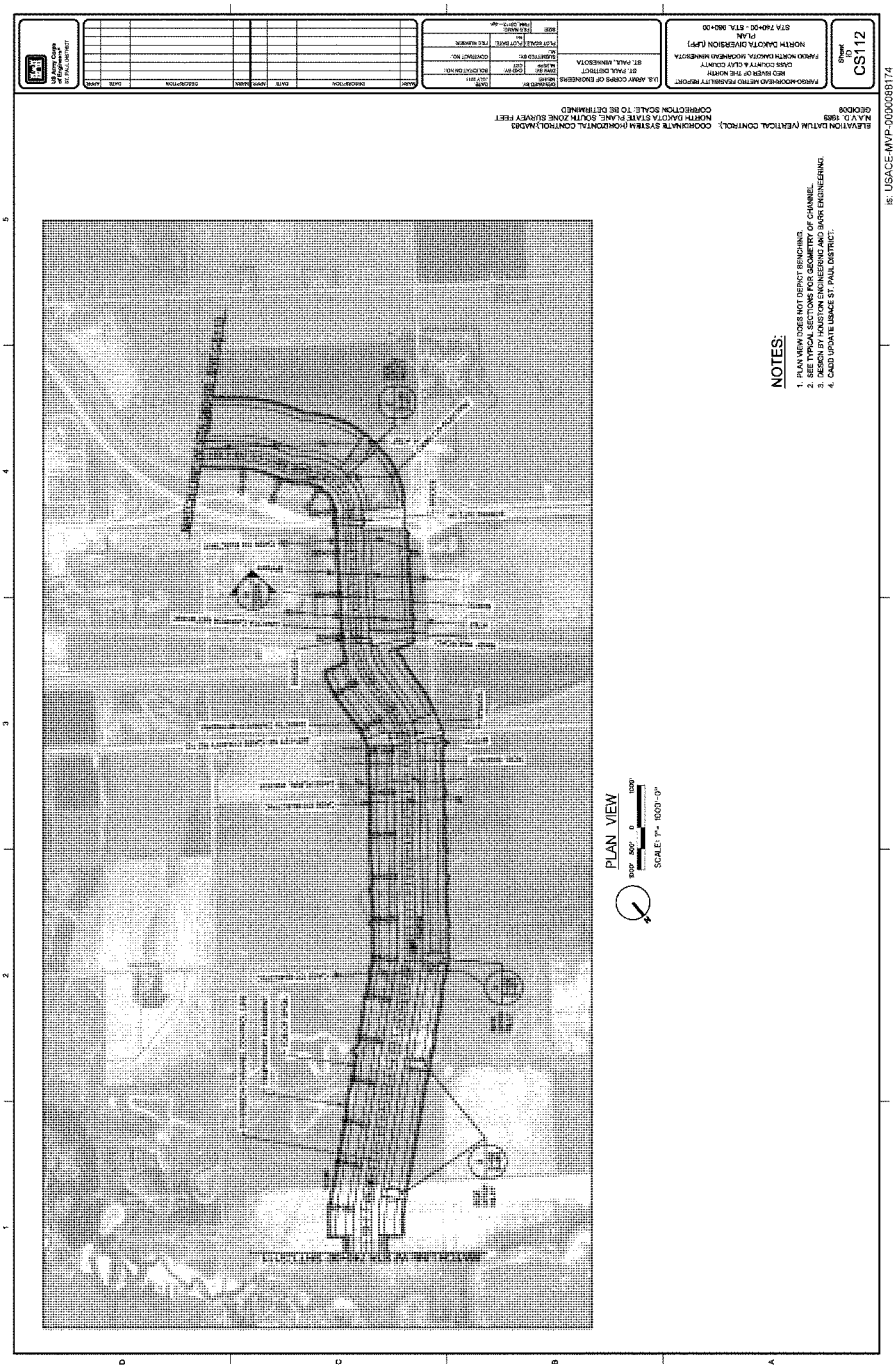

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
MINNESOTA DIVERSION (FCP)
DETAIL
INLET STRUCTURE
Sheet ID
CS402
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
SCALE
DATE
COMPUTER FILE NO.
BOX DIMENSIONS
DESIGN
DRAWING
CHECK
SUBMITTED
APPROVED
DATE
REVISION
DESCRIPTION
CHECK
DATE
APPR.
DRWN.
DESCRIPTION
DATE
APPR.
US Army Corps of Engineers
St. Paul District
ELEVATION DATUM (VERTICAL CONTROL) COORDINATE SYSTEM (HORIZONTAL CONTROL) NADB3
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID18 CORRECTION SCALE TO BE DETERMINED
FEMA DEEDED PROPERTIES
RIPRAP (TYP.)
FEMA PASSAGE UP TO 35,000 CFS FOR EVENT SIMILAR TO 1-PM
SCADA MONITORING POINT (TYP.) SEE DRAWING S-402 FOR DETAILS
PROTECTED SIDE
MAINTENANCE BUILDING AND PARKING
APPROXIMATE LIMITS OF TEMPORARY FLOOD PROTECTION FOR CONSTRUCTION
PROPOSED ELECTRICAL SERVICE TO DEBRIS CONTROL AND DIVERSION INLET WEIR
SCADA MONITORING POINT (TYP.) SEE DRAWING S-403
PROPOSED ELECTRICAL SERVICE TO WEIR AREA
NEW MAINTENANCE PARKING AREA
SCADA MONITORING POINT (TYP.) SEE DRAWING S-403
DIVERSION INLET WEIR SEE DRAWING S-403
DIVERSION CHANNEL
BRIDGE OVER DIVERSION
EXTENSION CHANNEL
HIGHWAY 75
CLAY COUNTY 52
FEMA DEEDED PROPERTIES
FEMA DEEDED PROPERTIES
40TH AVE S
FEMA DEEDED PROPERTIES
PROTECTED SIDE
FLOODWALL TO AVOID FEMA DEEDED PROPERTY
ACCESS ROAD FOR RRR CLOSURE
RAMP OVER TIE BACK LEVEE
TIE BACK LEVEE TO HIGH WEST
TIE BACK LEVEE
UNPROTECTED SIDE
FEMA DEEDED PROPERTIES
FEMA DEEDED PROPERTIES
HIGHWAY 81
FOREST RIVER ROAD
RRR CLOSURE SEE DRAWING S-402
ICE/DEBRIS CONTROL MEASURE
RED RIVER OF THE NORTH
HIGHWAY 75
28TH ST S
N
3
CS307
DETAIL
MINNESOTA INLET STRUCTURE
400' 200' 0 400'
SCALE: 1"= 400'-0"
is: USACE-MVP-000008174


FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
CASS COUNTY & CLAY COUNTY
NORTH DAKOTA DIVERSION (LPP)
GENERAL PLAN
Sheet ID
CS108
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09 CORRECTION SCALE: TO BE DETERMINED
GENERAL PLAN
NORTH DAKOTA DIVERSION (LPP)
CS117
CS116
CS115
CS118
CS114
CS113
CS112
CS111
CS110
CS109
WILD RICE RIVER
HWY 29
MOORHEAD
FARGO
WEST FARGO
HWY 10
HWY 94
MAPLE RIVER
HECTOR INTERNATIONAL AIRPORT
HWY 18
HARWOOD
SHEYENNE RIVER
RED RIVER OF THE NORTH
RUSH RIVER
BUFFALO RIVER
HWY 75
is: USACE-MVP-0000088174

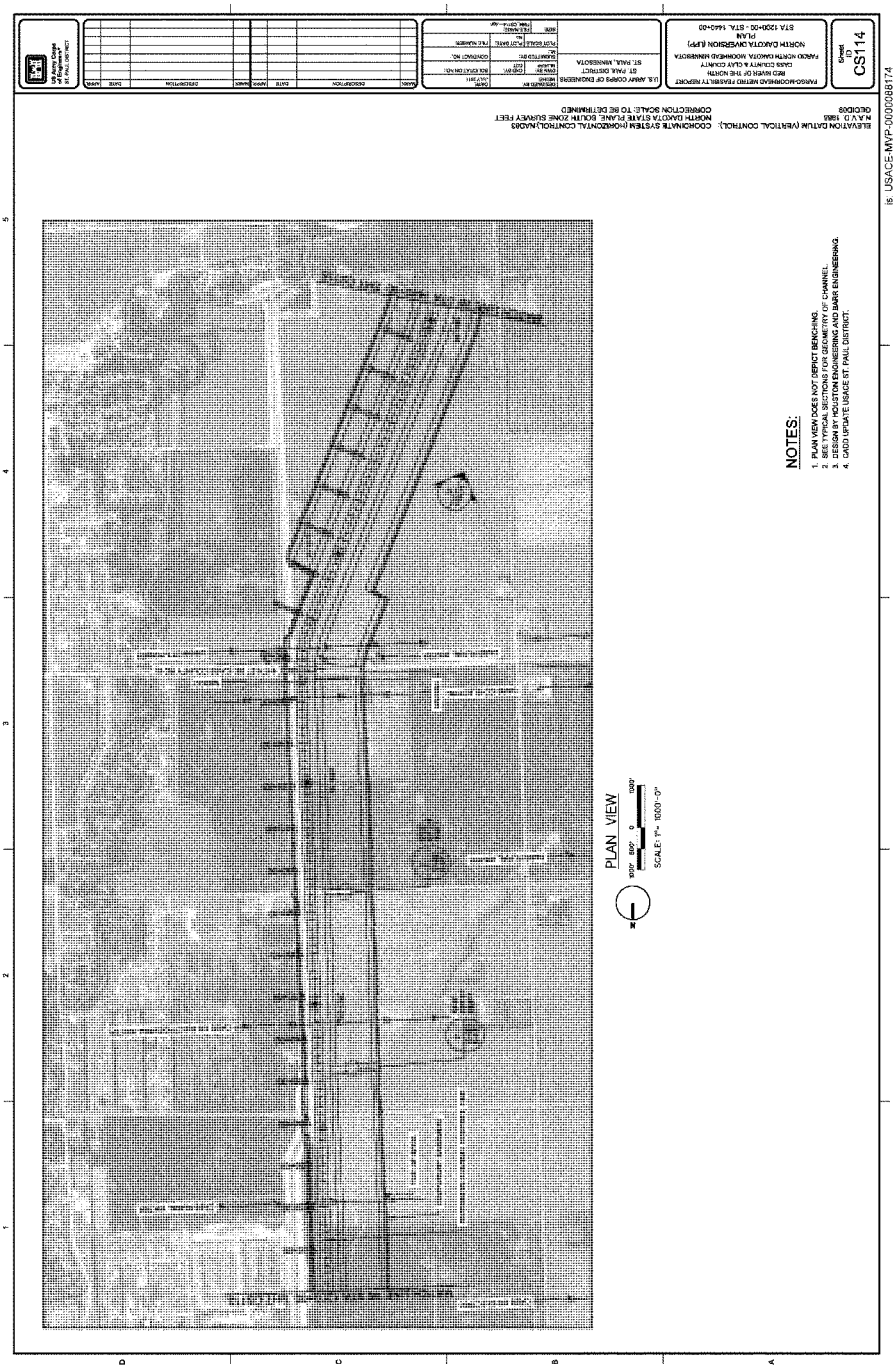

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PLAN
STA 0+00 - STA 240+00
CS109
Sheet ID
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
PLAN VIEW
SCALE: 1" = 1000'-0"
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING.
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE ISSUE ST. PAUL DISTRICT.
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOID09
COORDINATE SYSTEM (HORIZONTAL CONTROL): NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
CONNECTION SCALE: TO BE DETERMINED
IS: USACE-MVP-0000098174

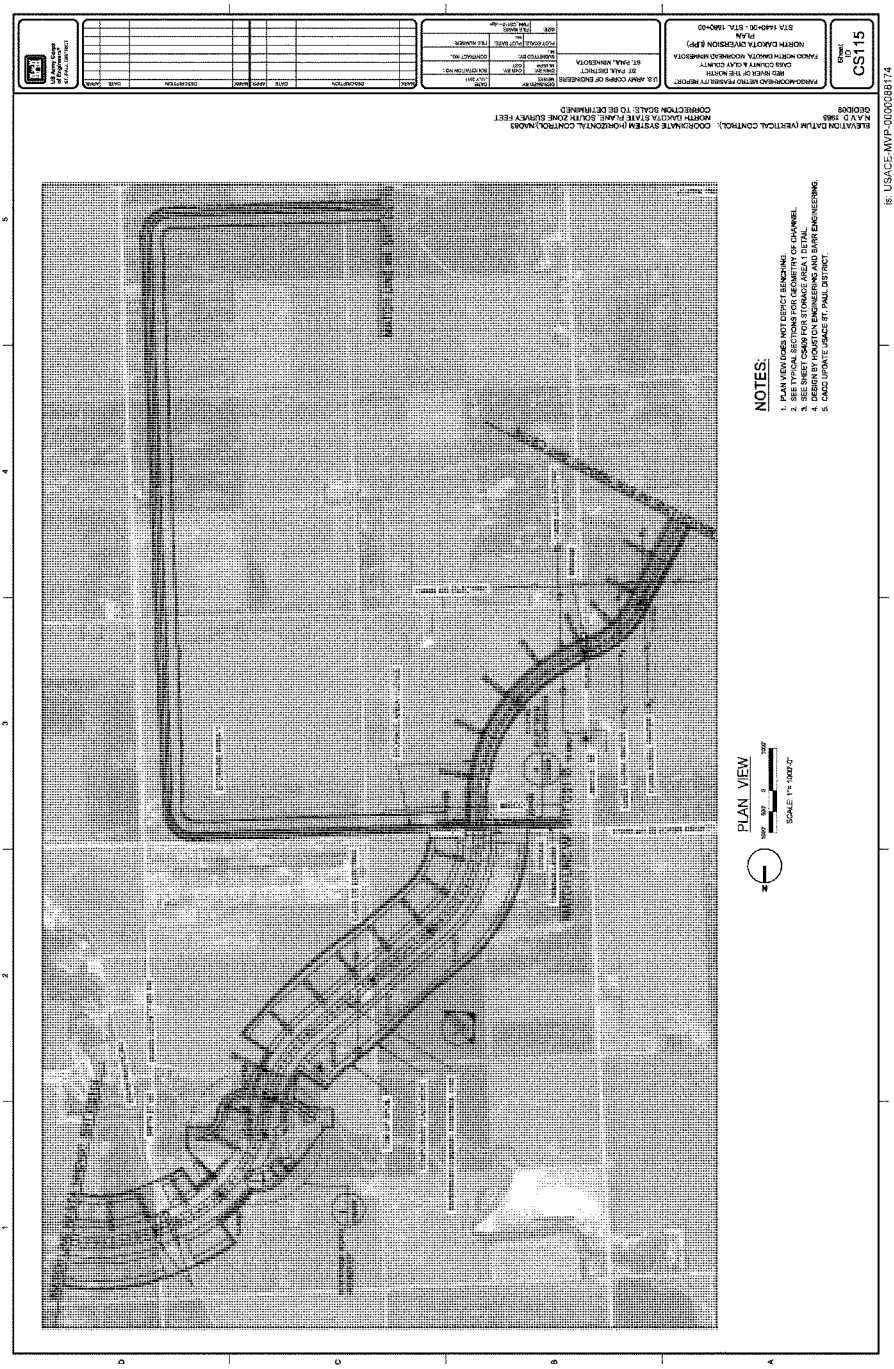

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO-NORTH DAKOTA, MOORHEAD-MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PLAN
STA 240+00 - STA. 480+00
Sheet ID
CS110
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
QUANTITIES BY
QUANTITIES NO.
PLOT SCALE
PLOT DATE
FILE NUMBER
DESCRIPTION
DATE
APPR.
MARK
DATE
APPR.
MARK
DESCRIPTION
NOTES:
1. PLAN VIEW DOES NOT REPORT BENCHMAR
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE USACE ST. PAUL DISTRICT.
PLAN VIEW
SCALE: 1"= 1000'-0"
ELEVATION DATUM VERTICAL CONTROL: COORDINATE SYSTEM HORIZONTAL CONTROL:
NAVD 1988 NORTH DAKOTA STATE PLANE SOUTH ZONE SURVEY FEET
GEOID09 CORRECTION SCALE: TO BE DETRMINED
is: USACE-MVP-0000086174

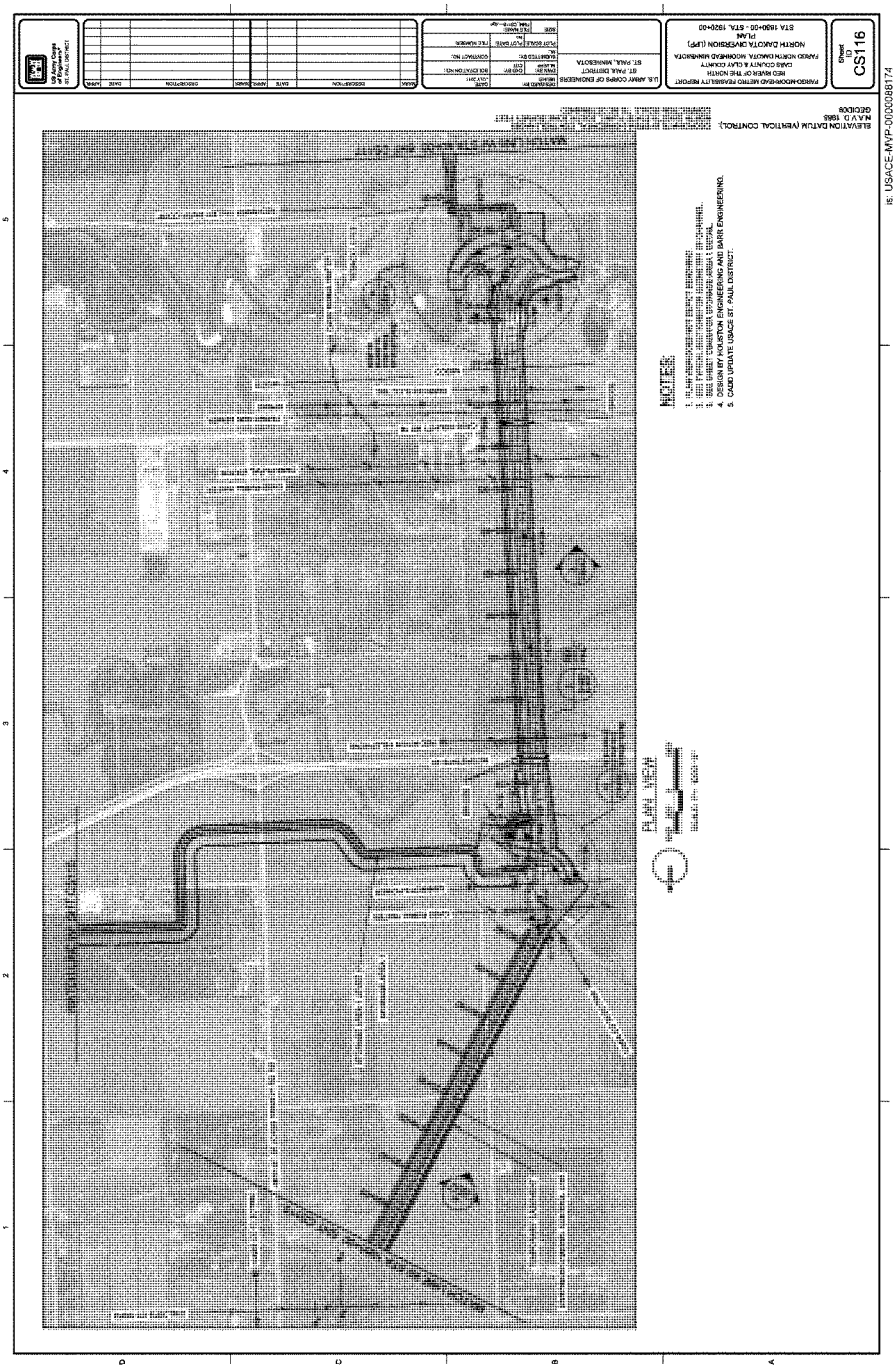

FARGO-MOORHEAD METRO DIVERSION PROJECT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PLAN
57A 480-00 - STA. 742+00
CS111
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
PLAN VIEW
SCALE: 1" = 1000'-0"
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE ISSUE BY: PAUL DISTRICT.
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOID09
COORDINATE SYSTEM (HORIZONTAL CONTROL): NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
IS: USACE-MVP-0000098174

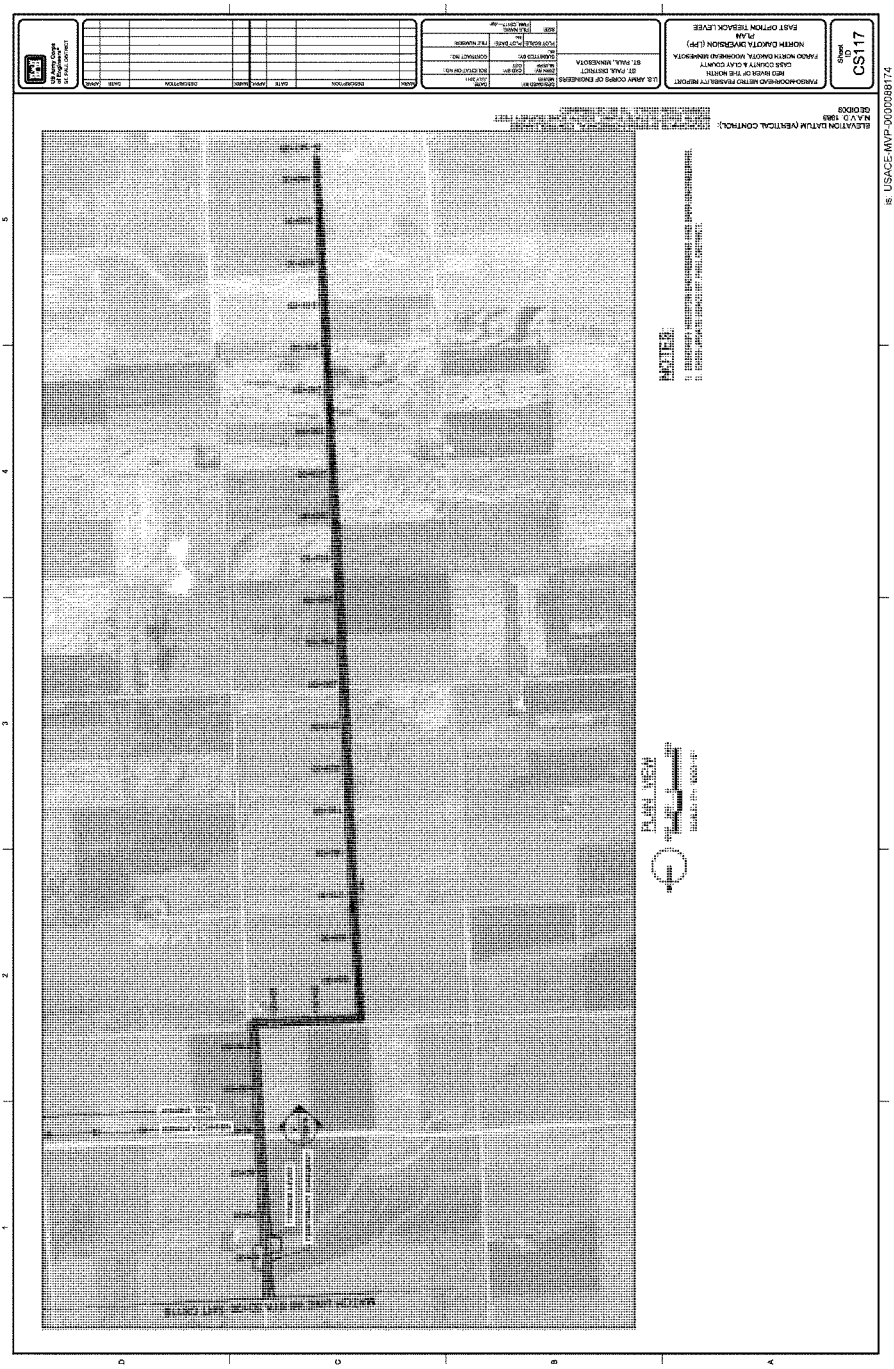

PLAN VIEW
SCALE: 1"= 1000'-0"
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING.
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE USACE ST. PAUL DISTRICT.
ELEVATION DATUM VERTICAL CONTROL: NAVD 1988
GEOIDO8
COORDINATE SYSTEM HORIZONTAL CONTROL:NAD83 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
FARGO-MOORHEAD METRO FEASIBILITY REPORT RED RIVER OF THE NORTH CASS COUNTY,N.DAK. CLAY COUNTY, MINN. NORTH DAKOTA DIVERSION (LPP) PLAN STA 740+00 - STA. 980+00
Sheet ID CS112
U.S. ARMY CORPS OF ENGINEERS ST. PAUL DISTRICT
US Army Corps of Engineers
is: USACE-MVP-0000089174

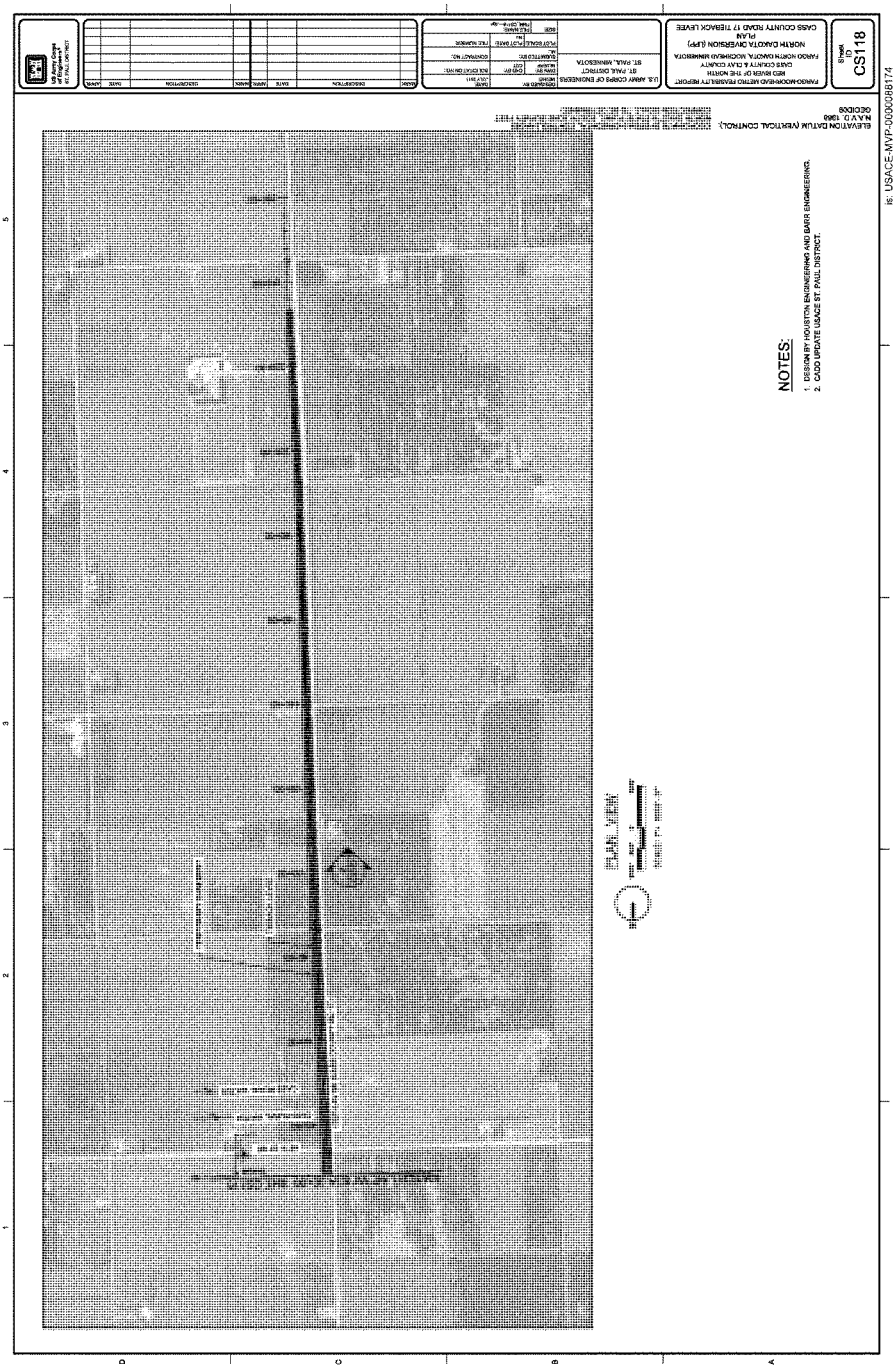
FARGO-MOORHEAD METRO PROJECT
RED RIVER A TO THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PLAN
STA 960+00 - STA 1200+00
Sheet ID
CS113
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
ST. PAUL DISTRICT
PLOT SCALE
PLOT DATE
PLOT NUMBER
FILE NUMBER
DESIGNED BY
DRAWN
CHECKED
SUBMITTED BY
CONTRACT NO.
DATE
DESCRIPTION
CHK'D
APVD
DATE
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING
4. CADD UPDATE USACE ST. PAUL DISTRICT.
PLAN VIEW
SCALE: 1" = 1000'-0"
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOIDXX
COORDINATE SYSTEM (HORIZONTAL CONTROL): NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CORRECTION SCALE TO BE DETERMINED
IS: USACE-MVP-0000088174

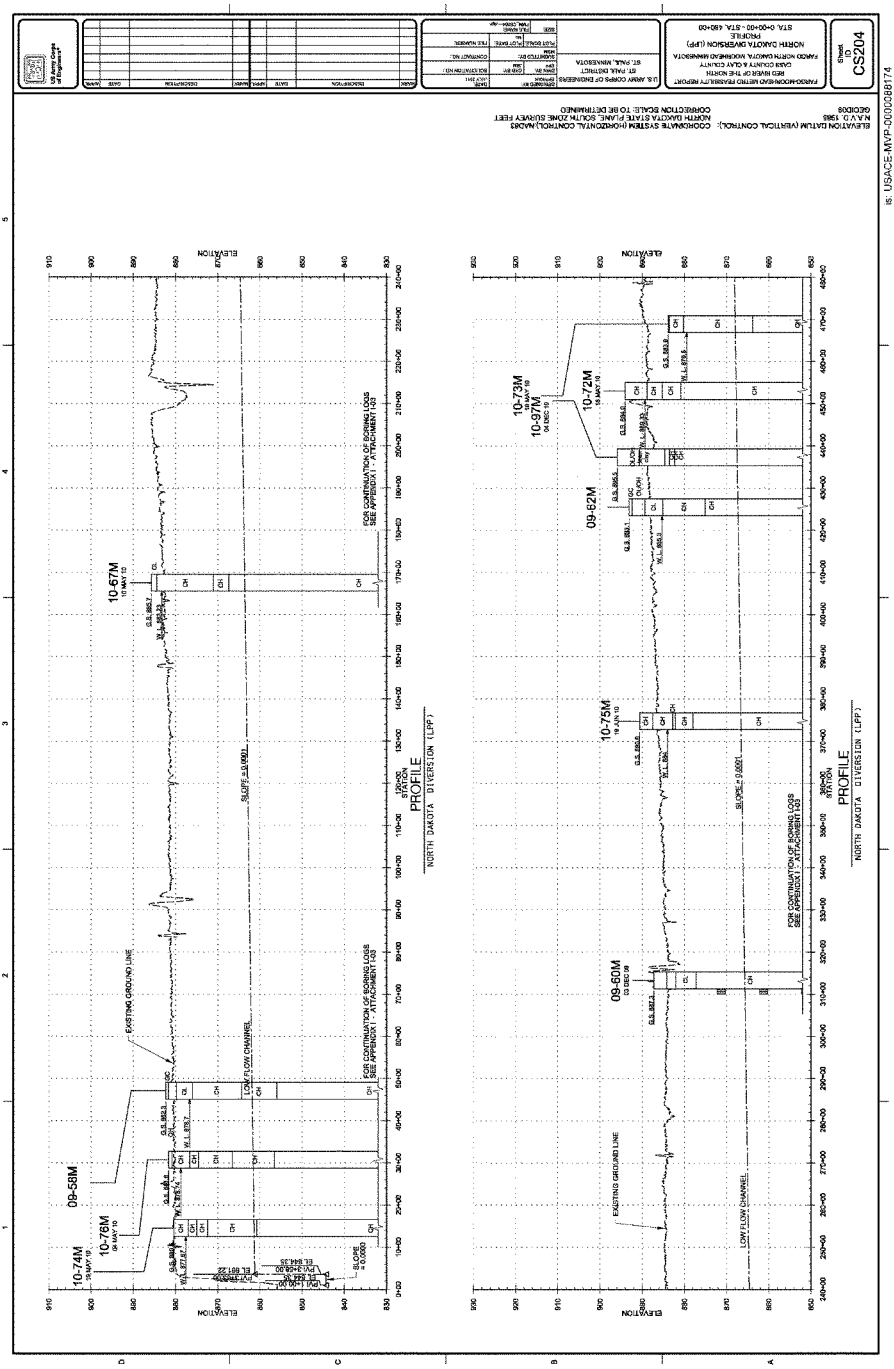

PLAN VIEW
SCALE: 1" = 1000'-0"
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING
2. SEE STRUCTURAL SHEETS FOR DETAILS OF CHANNEL
3. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
4. CADD UPDATE USACE ST. PAUL DISTRICT.
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
N.A.V.D. 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
DEC/DD88 CORRECTION SCALE: TO BE DETERMINED
FARGO-MOORHEAD METRO FEASIBILITY STUDY
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO, NORTH DAKOTA, MOORHEAD, MINNESOTA
NORTH DAKOTA OVERSIGN (UPP)
PLAN
STA 1200+00 - STA. 1440+00
Sheet ID
CS114
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
15 USACE-MVP-0000088174

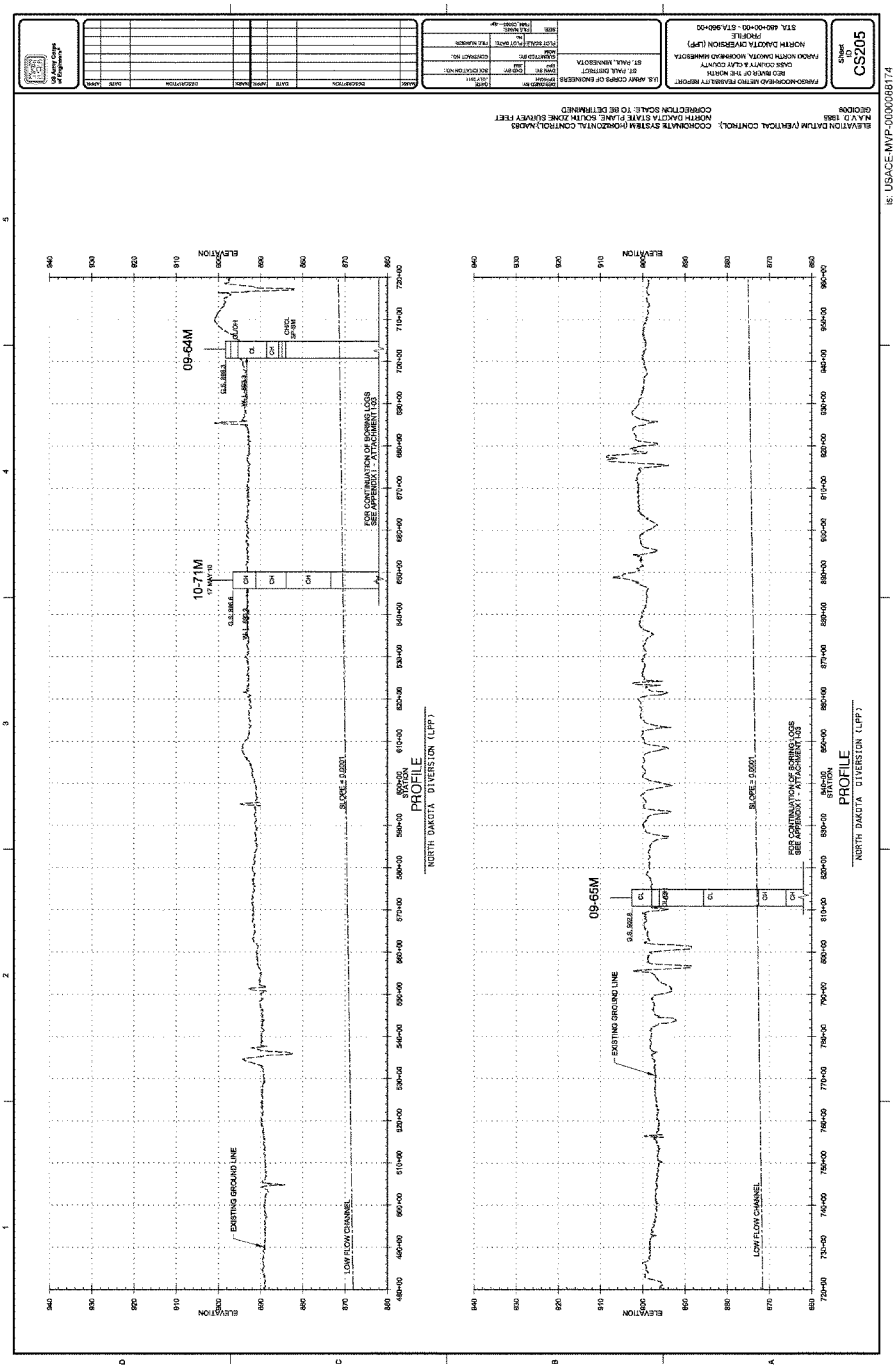

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PLAN
STA 1440+00 - STA. 1660+00
Sheet ID
CS115
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
ST. PAUL DISTRICT
PLAN VIEW
SCALE: 1"= 1000'-0"
NOTES:
1. PLAN VIEW DOES NOT DEPICT BENCHING.
2. SEE TYPICAL SECTIONS FOR GEOMETRY OF CHANNEL.
3. SEE SHEET CS4409 FOR STORAGE AREA 1 DETAIL.
4. SEE SHEET CS4410 FOR STORAGE AREA 2 DETAIL.
5. CADD UPDATE: USACE ST. PAUL DISTRICT
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID18 CORRECTION SCALE: TO BE DETERMINED
is: USACE-MVP-0000088174

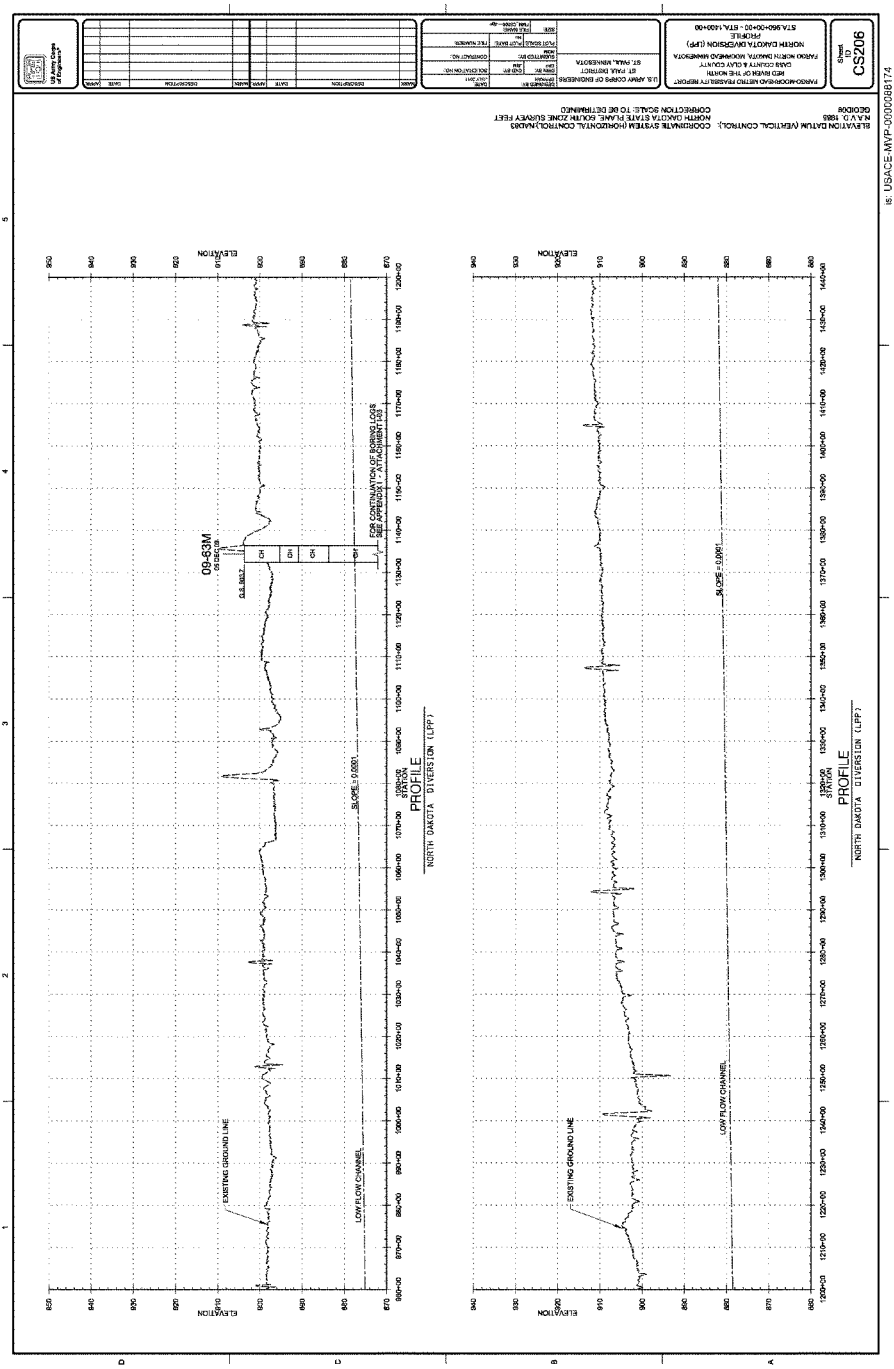

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO, NORTH DAKOTA, MOORHEAD, MINNESOTA
NORTH DAKOTA OVERSIGHT (JPP)
PLAN
STA 1880+00 - STA. 1920+00
Sheet ID
CS116
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
ELEVATION DATUM (VERTICAL CONTROL):
N.A.V.D. 1988
GEOID06
NOTES:
1. ALL ELEVATIONS ARE IN FEET.
2. ALL HORIZONTAL DATUM IS IN NAD 1983 (2011) ADJ.
3. BASE SHEET: "GRADING_DTP_PHASE_AREA 1.DGN".
4. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
5. CADD UPDATE USACE ST. PAUL DISTRICT.
PLAN VIEW
US Army Corps of Engineers
St. Paul District
DESIGNED BY
DRAWN BY
CHECKED BY
SCALE AS SHOWN
DATE
DESCRIPTION
DRAWING NO.
CONTRACT NO.
FILE NAME
IS: USACE-MVP-0000086174

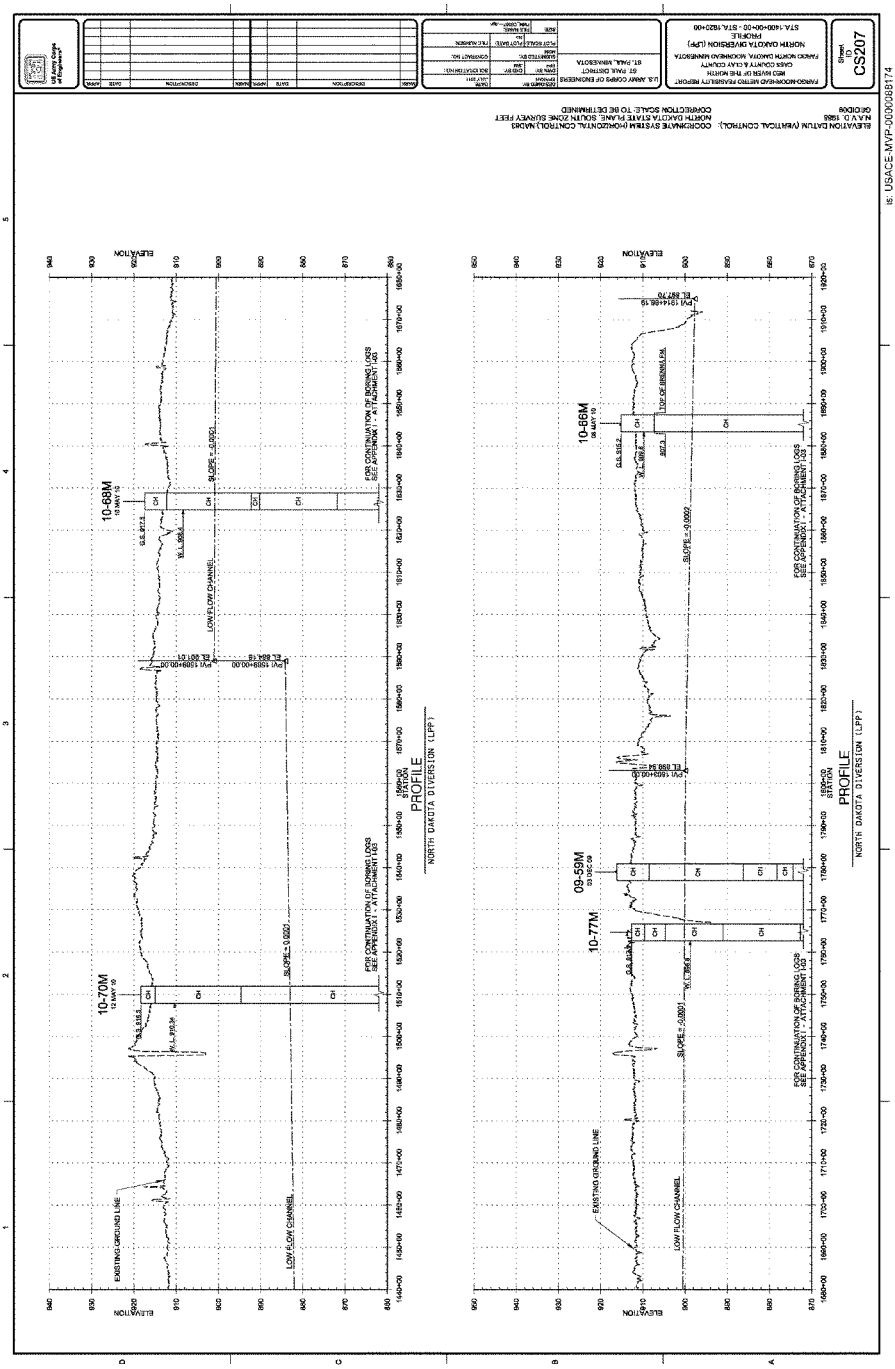

FARGO-MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PLAN
EAST OPTION TREASON LEVEE
Sheet ID
CS117
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
ELEVATION DATUM VERTICAL CONTROL:
NAVD 1988
GEOID09
NOTES:
USACE-MVP-0000088174

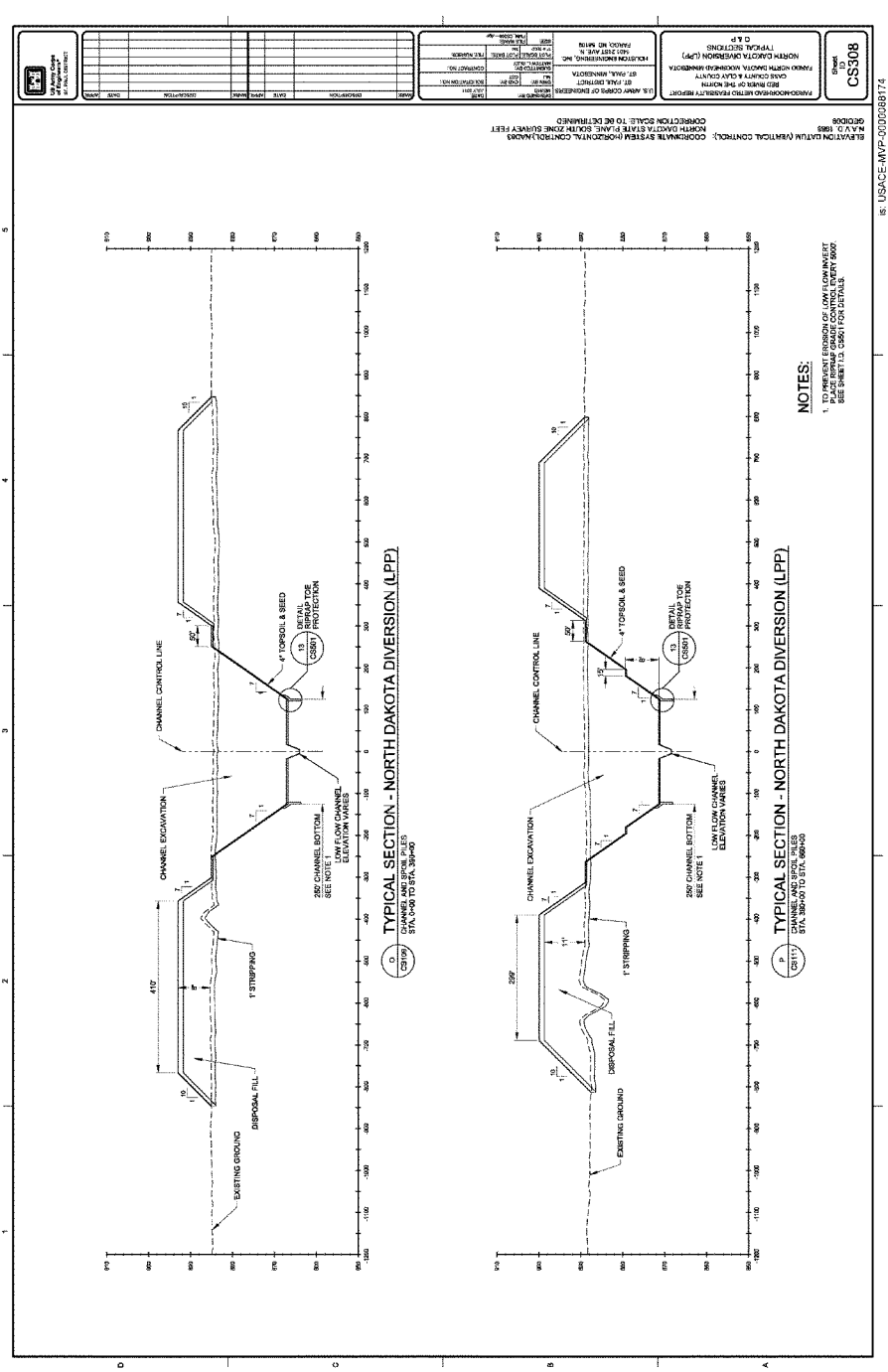

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO-NORTH DAKOTA, MOORHEAD-MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PLAN
CASS COUNTY ROAD 17 SETBACK LEVEE
Sheet ID
CS118
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
NOTES:
1. DESIGN BY HOUSTON ENGINEERING AND BARR ENGINEERING.
2. CADD UPDATE USACE ST. PAUL DISTRICT.
ELEVATION DATUM VERTICAL CONTROL:
NAVD 1988
GEOIDO8
PLAN VIEW
PROFILE VIEW
1
2
3
4
5
A
B
C
D
is: USACE-MVP-0000086174

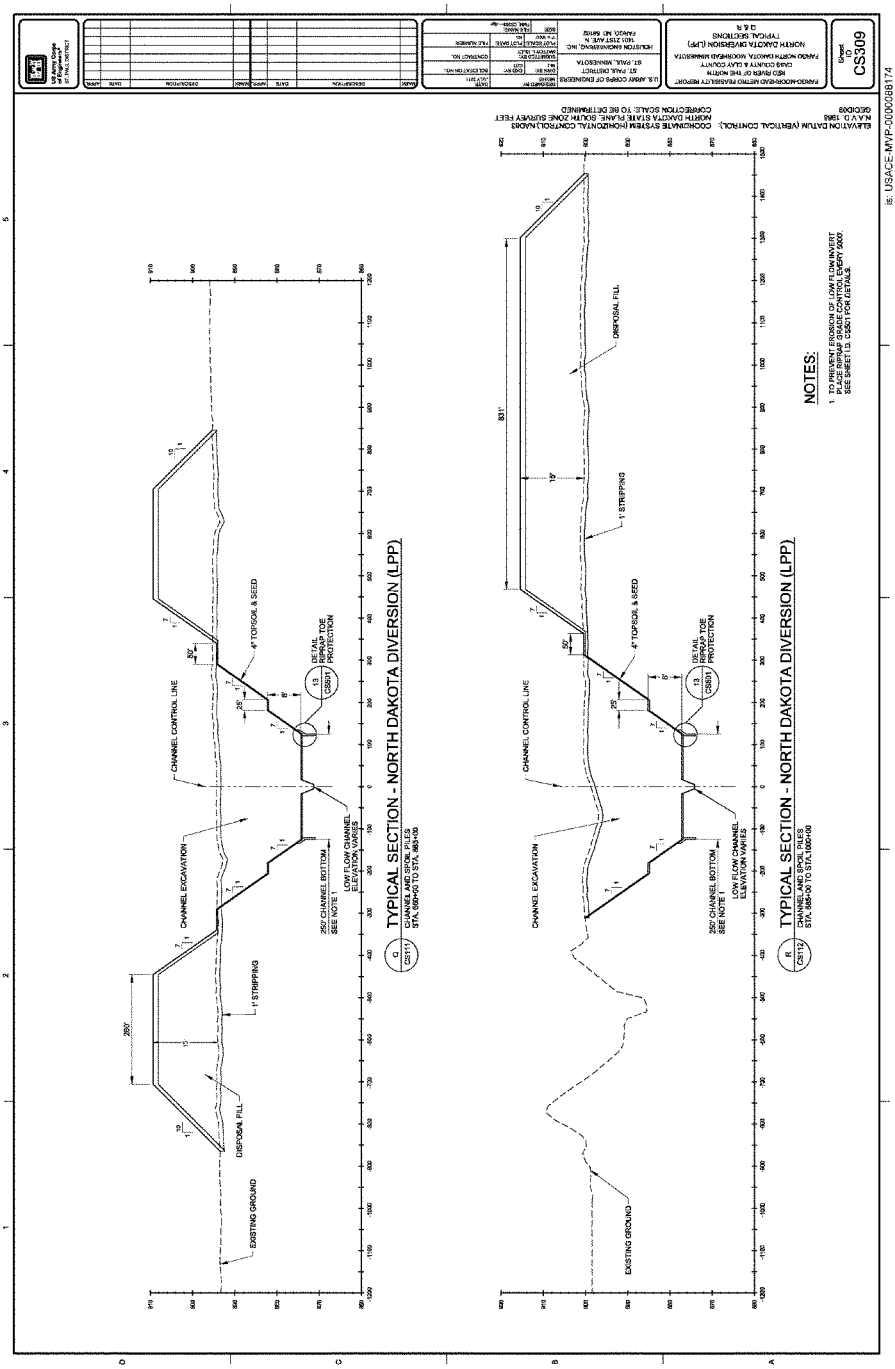

PROFILE
NORTH DAKOTA DIVERSION (LPP)
EXISTING GROUND LINE
LOW FLOW CHANNEL
FOR CONTINUATION OF BORING LOGS SEE APPENDIX I - ATTACHMENT I-03
09-58M
10-74M
10-76M
10-67M
09-62M
10-73M
10-37M
10-72M
10-75M
09-60M
ELEVATION
STATION
CS204
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL) MADE
NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
NAVD 1988
GEOID18
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PROFILE
STA 0+00+00 - STA 490+00
Sheet ID
CS204
IS: USACE-MVP-0000028174

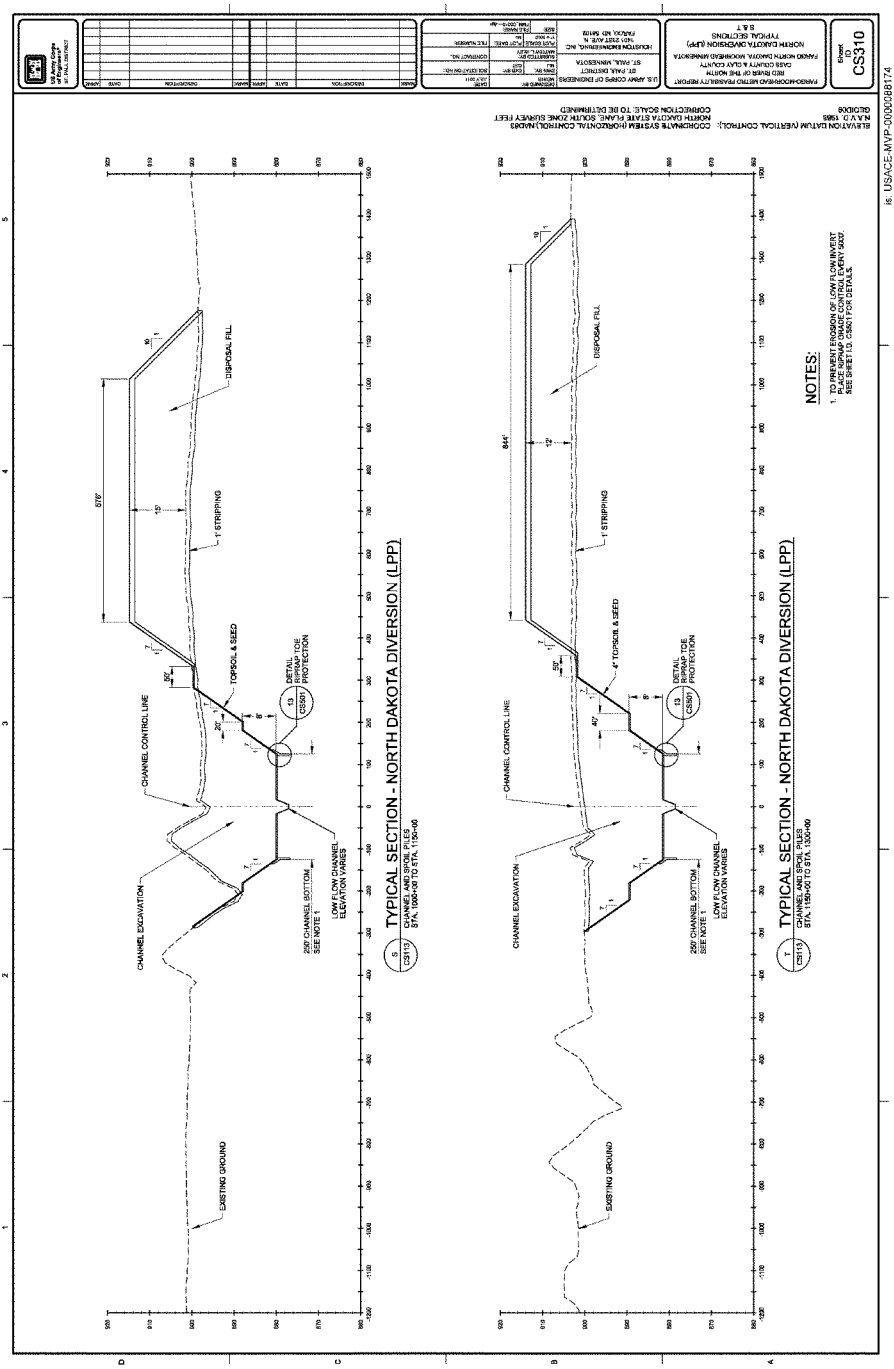

PROFILE
NORTH DAKOTA DIVERSION (LPP)
EXISTING GROUND LINE
LOW FLOW CHANNEL
09-64M
10-71M
09-65M
ELEVATION
STATION
SLOPE = 0.0001
FOR CONTINUATION OF BORING LOGS SEE APPROACH ATTACHMENT 103
FOR CONTINUATION OF BORING LOGS SEE APPROACH ATTACHMENT 104
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
NAVD 1988
GEOID06
NORTH DAKOTA STATE PLANE SOUTH ZONE SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
FARGO NORTH DAKOTA DIVERSION (LPP)
CASS COUNTY, A CITY OF FARGO
NORTH DAKOTA DIVERSION (LPP)
PROFILE
STA. 480+00 TO STA. 960+00
Sheet ID
CS205
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
US Army Corps of Engineers
is: USACE-MVP-0000086174

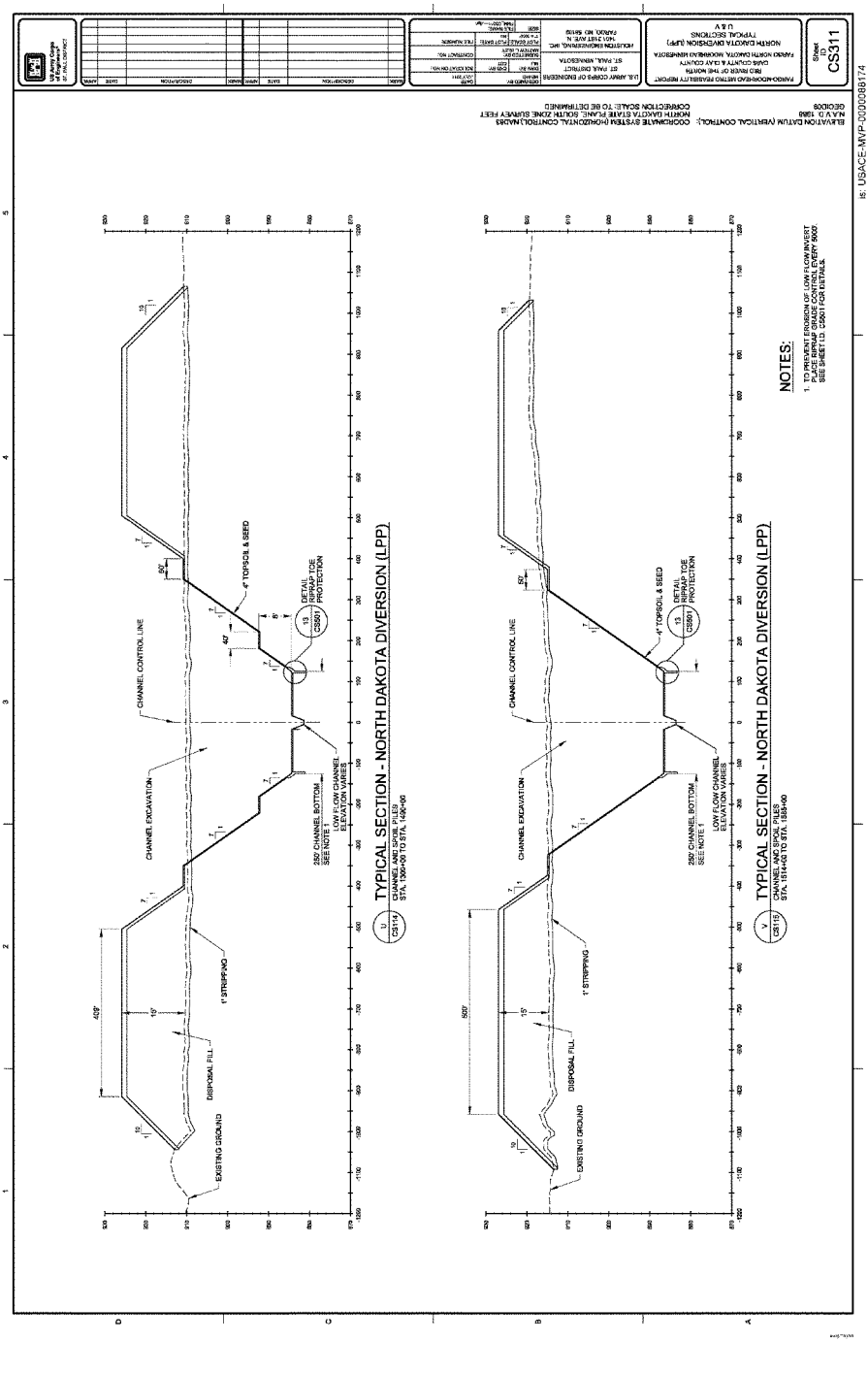

PROFILE
NORTH DAKOTA DIVERSION (LPP)
EXISTING GROUND LINE
LOW FLOW CHANNEL
09-63M
PROFILE
NORTH DAKOTA DIVERSION (LPP)
EXISTING GROUND LINE
LOW FLOW CHANNEL
CS206
USACE-MVP-0000088174

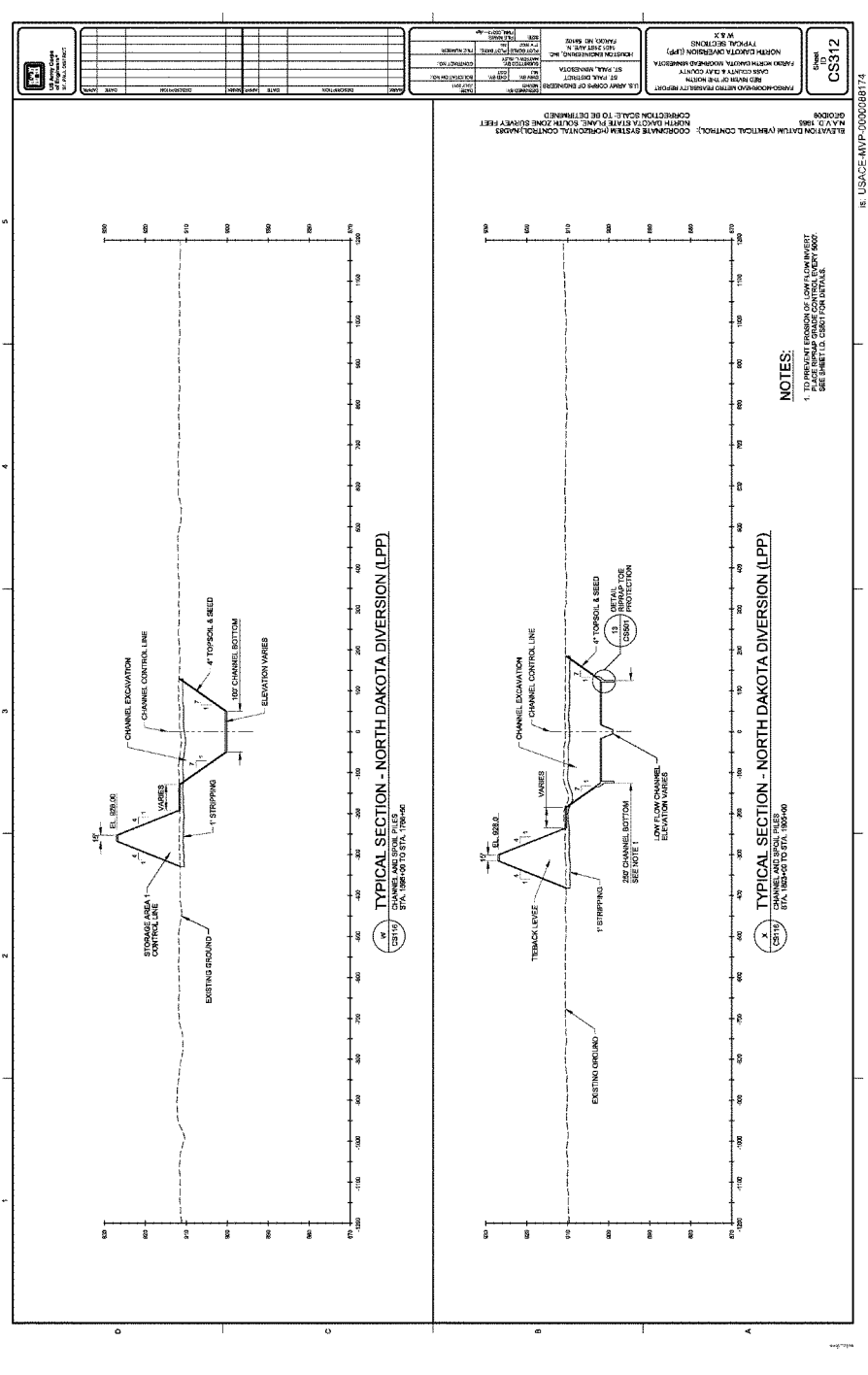

PROFILE
NORTH DAKOTA DIVERSION (LPP)
ELEVATION
STATION
EXISTING GROUND LINE
LOW FLOW CHANNEL
10-70M
10-68M
10-66M
09-59M
10-77M
SLOPE = 0.0002
SLOPE = 0.0001
SLOPE = 0.0000
FOR CONTINUATION OF BORING LOGS SEE APPENDIX I - ATTACHMENT I-03
LOG OF BORING N/A
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO-NORTH DAKOTA DIVERSION MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
PROFILE
STA 1400+00 - STA 1820+00
CS207
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
GRID DOB CONSTRUCTION SCALE: TO BE DETERMINED
IS: USACE-MVP-0000088174

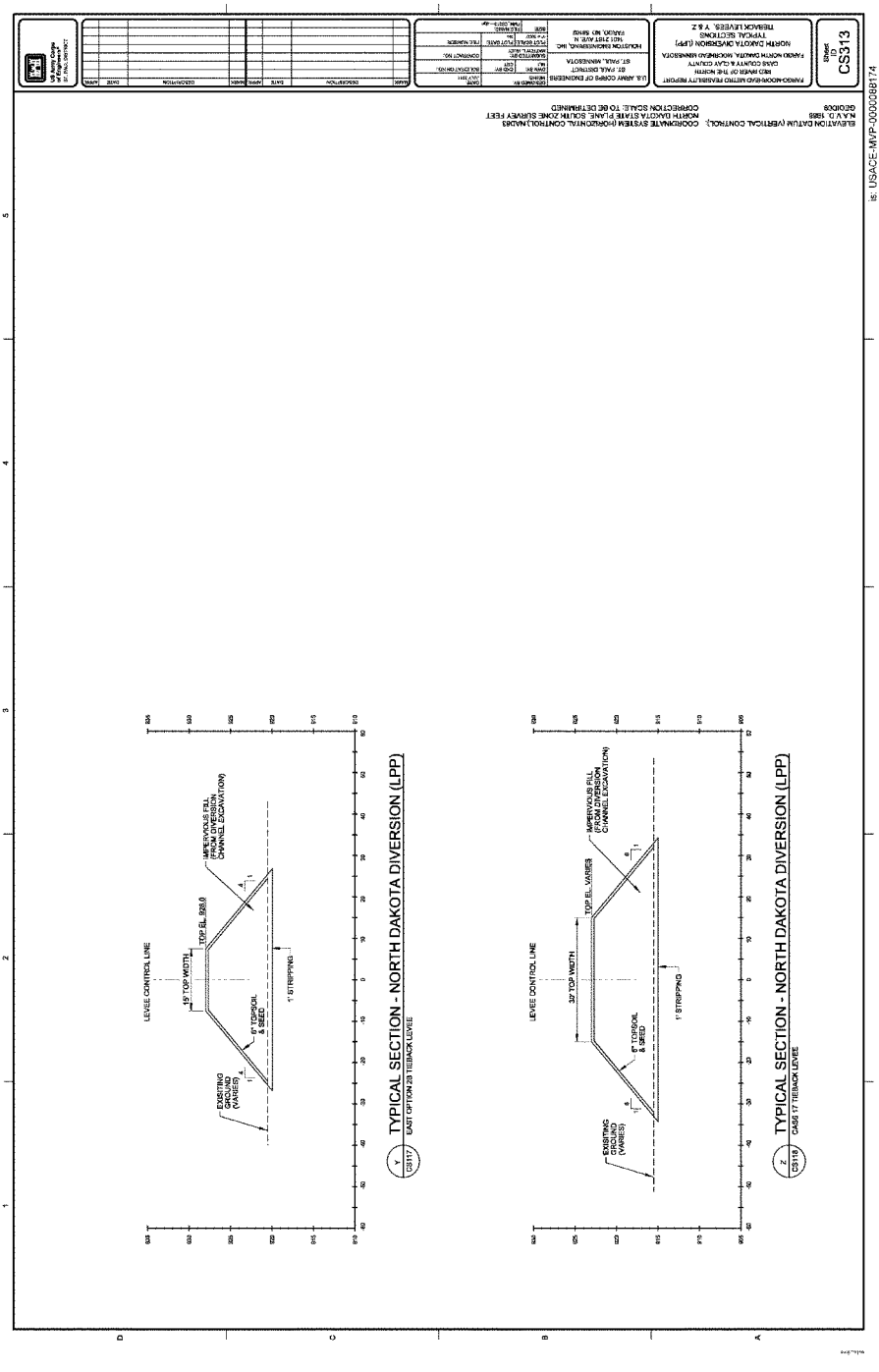

TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL AND SPOIL PILES
STA. 0+00 TO STA. 330+00
CS108
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL AND SPOIL PILES
STA. 330+00 TO STA. 660+00
CS111
CHANNEL CONTROL LINE
CHANNEL EXCAVATION
4' TOPSOIL & SEED
DETAIL RIPRAP TOE PROTECTION
CS501
1' STRIPPING
DISPOSAL FILL
EXISTING GROUND
410'
297'
257' CHANNEL BOTTOM
SEE NOTE 1
LOW FLOW CHANNEL
ELEVATION VARIES
NOTES:
1. TO PREVENT EROSION OF LOW FLOW INVERT PLACE RIPRAP GRADE CONTROL EVERY 500' SEE SHEET I.D. CS501 FOR DETAILS.
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
N.A.V.D. 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
GEOID09 CORRECTION SCALE: TO BE DETERMINED
PARSHO-HONEYBO METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO-NORTH DAKOTA, MOORHEAD-MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
TYPICAL SECTIONS
D.A.P.
Sheet ID
CS308
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
HOUSTON ENGINEERING, INC.
1401 21ST AVE. N.
FARGO, ND 58102
DESIGNED BY
DRAWN BY
CHECKED BY
QUALITY CHECK BY
SUBMITTED BY
SUBMITTED TO
CONTRACT NO.
DESCRIPTION
DATE
APVD.
DRAWN
DESIGN APVD.
DATE
DESCRIPTION
US Army Corps of Engineers St. Paul District
IS: USACE-MVP-0000088174

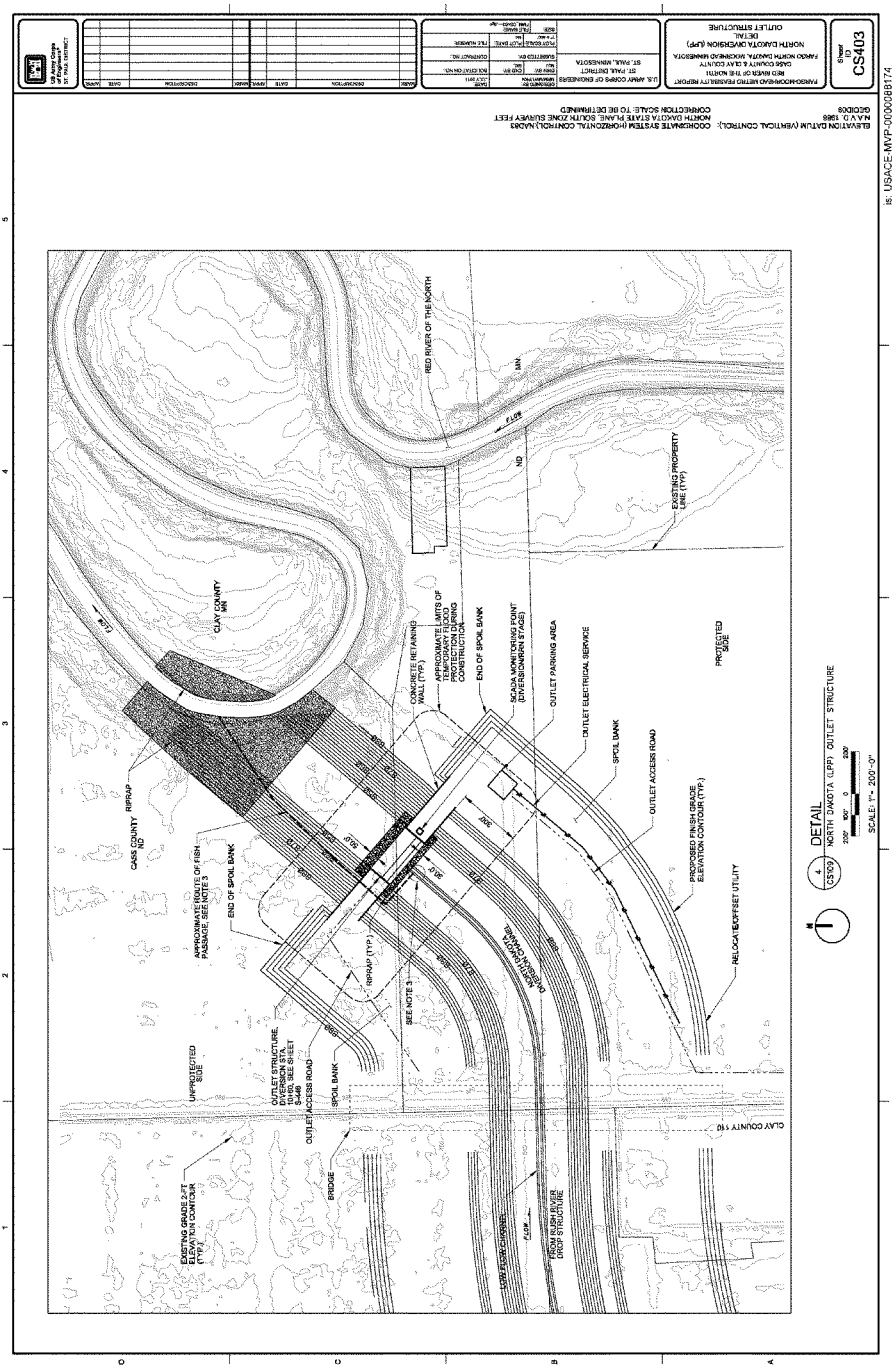

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
FARGO-NORTH DAKOTA DIVERSION (LPP)
CASS COUNTY & CLAY COUNTY
NORTH DAKOTA DIVERSION (LPP)
TYPICAL SECTIONS
U.S.A.R.N
Sheet ID
CS309
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
HOUSTON ENGINEERING, INC
ST. PAUL, MINNESOTA
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL EXCAVATION
DISPOSAL FILL
EXISTING GROUND
CHANNEL CONTROL LINE
4' TOPSOIL & SEED
1' STRIPPING
DETAIL RIPRAP TOE PROTECTION
LOW FLOW CHANNEL ELEVATION VARIES
250' CHANNEL BOTTOM SEE NOTE 1
NOTES:
1. TO PREVENT EROSION OF LOW FLOW INVERT PLACE RIPRAP BLANKET CONTROL ENTRY GATE. SEE SHEET I.D. CS301 FOR DETAILS.
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
NAVD 1988
DECIDUS
CORRECTION SCALE: TO BE DETERMINED
IS: USACE-MVP-0000088174

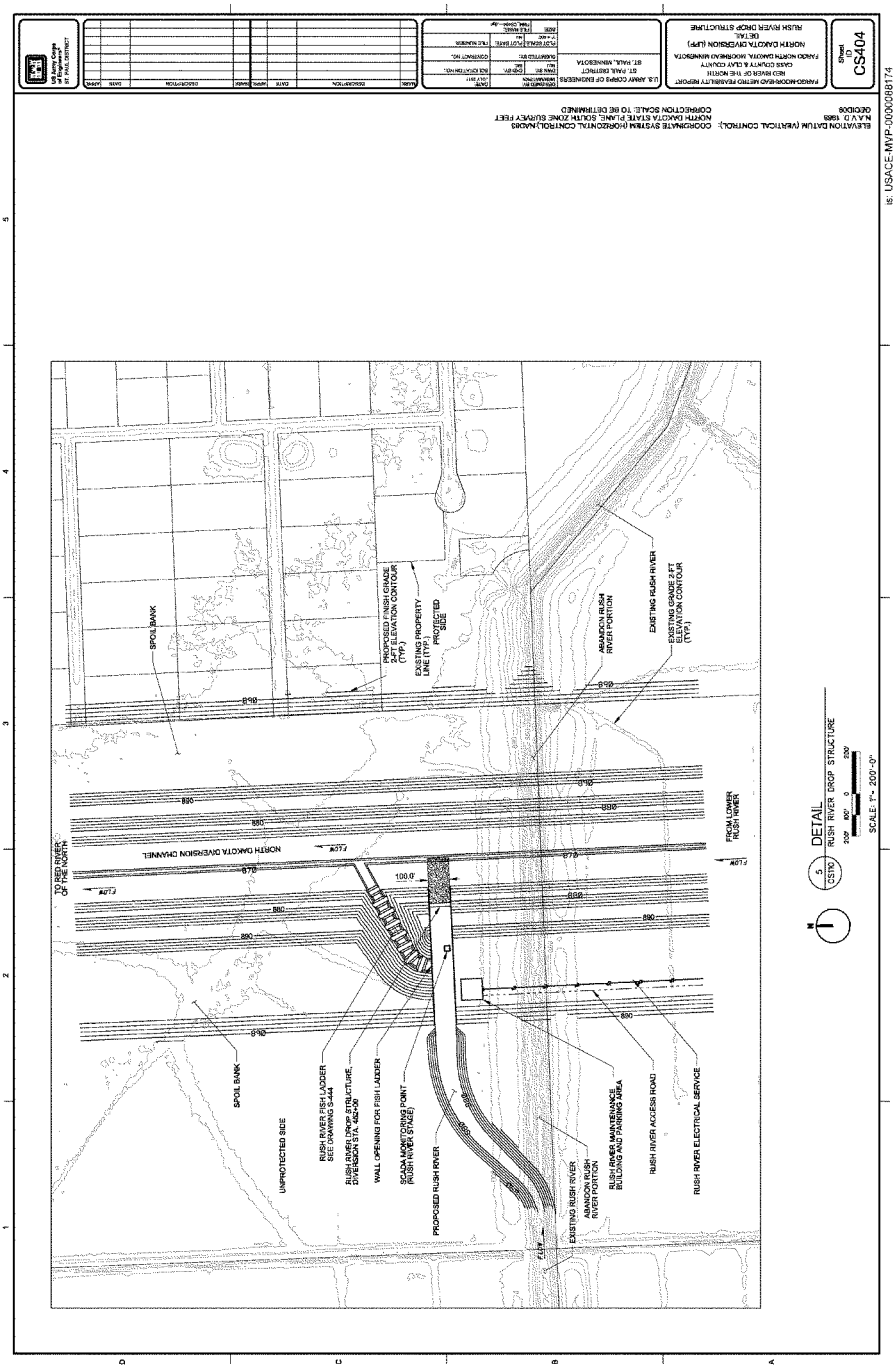

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
FARGO NORTH DAKOTA DIVERSION (LPP)
CASS COUNTY & CLAY COUNTY
NORTH DAKOTA, MINNESOTA
TYPICAL SECTIONS
B.4.7
CS310
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
HOUSTON ENGINEERING, INC.
1401 21ST AVE. N.
FARGO, ND 58102
ELEVATION DATUM VERTICAL CONTROL: COORDINATE SYSTEM HORIZONTAL CONTROL DATUM:
N.A.V.D. 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
GEOID18 CORRECTION SCALE: TO BE DETERMINED
CHANNEL EXCAVATION
CHANNEL CONTROL LINE
EXISTING GROUND
DISPOSAL FILL
T STRIPPING
TOPSOIL & SEED
4" TOPSOIL & SEED
DETAIL RIPRAP TOE PROTECTION
250' CHANNEL BOTTOM SEE NOTE 1
LOW FLOW CHANNEL ELEVATION VARIES
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL AND SPOIL PILES
STA. 1000+00 TO STA. 1150+00
CHANNEL AND SPOIL PILES
STA. 1150+00 TO STA. 1300+00
NOTES:
1. TO PREVENT EROSION OF LOW FLOW INVERT PLACE TEMPORARY CONTROL (CONST.) JOINT. SEE SHEET I.D. CS501 FOR DETAILS.
Sheet ID CS310
id: USACE-MVP-0000088174

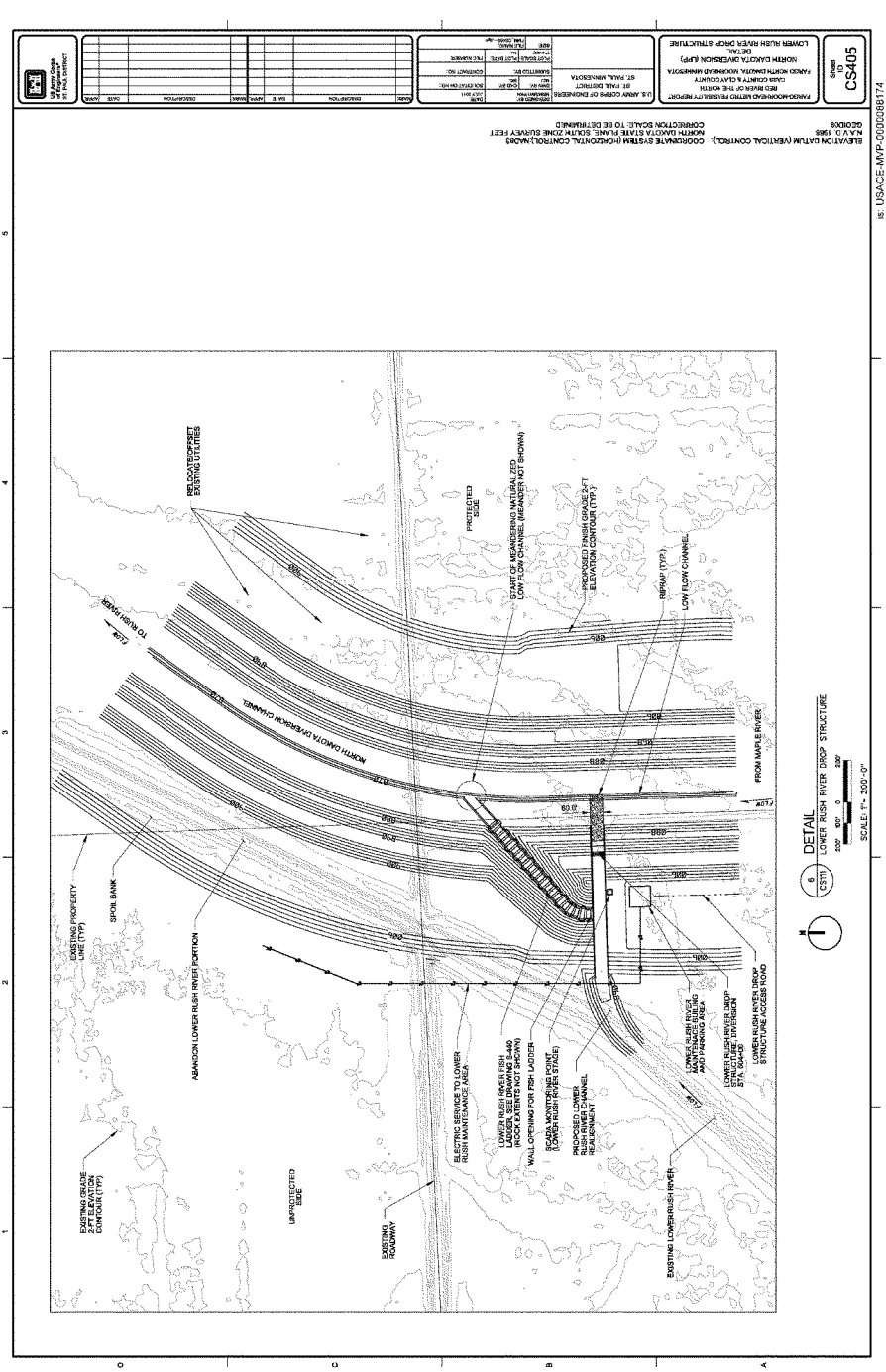

FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
TYPICAL SECTIONS
U.S.A.V
Sheet ID
CS311
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
HOUSTON ENGINEERING, INC.
1401 21ST AVE. N
FARGO, ND 58102
DESIGNED BY
DRAWN BY
CHECKED BY
DATE
SCALE
CONTRACT NO.
FILE NUMBER
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL) NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE, SURVEY FEET
CONSTRUCTION SCALE: TO BE DETERMINED
GEOCODE
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL EXCAVATION, STA 1304+00 TO STA. 1406+00
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL EXCAVATION, STA. 1514+00 TO STA. 1589+00
CHANNEL CONTROL LINE
CHANNEL EXCAVATION
EXISTING GROUND
DISPOSAL FILL
1' STRIPPING
4' TOPSOIL & SEED
DETAIL RIPRAP TOE PROTECTION
CS501
25' CHANNEL BOTTOM
SEE NOTE 1
LOW FLOW CHANNEL ELEVATION VARIES
NOTES:
1. TO PREVENT EROSION OF LOW FLOW INVERT PLACE RIPRAP AS SHOWN ON DETAIL CS501-9400
SEE SHEET I.D. CS501 FOR DETAILS.
is: USACE-MVP-0000088174

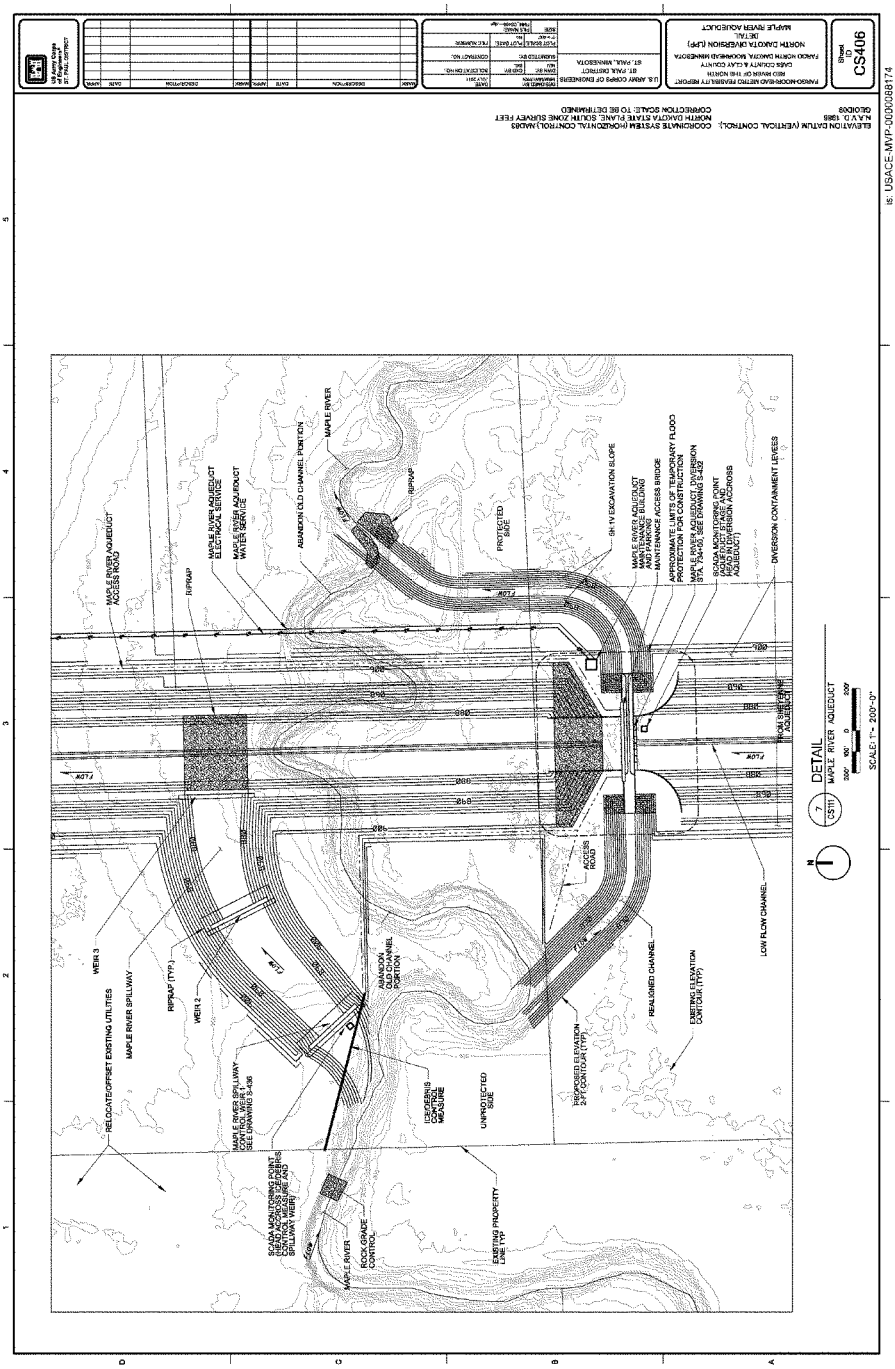

TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL AND SPOIL PILES
STA. 1598+00 TO STA. 1798+00
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CHANNEL AND SPOIL PILES
STA. 1803+00 TO STA. 1905+00
CHANNEL EXCAVATION
CHANNEL CONTROL LINE
4" TOPSOIL & SEED
100' CHANNEL BOTTOM
ELEVATION VARIES
1' STRIPPING
EXISTING GROUND
STORAGE AREA 1 CONTROL LINE
TIEBACK LEVEE
VARIES
DETAIL RIPRAP TOE PROTECTION
250' CHANNEL BOTTOM SEE NOTE 1
LOW FLOW CHANNEL ELEVATION VARIES
NOTES:
1. TO CONSTRUCT EXPANSION OF LOW FLOW INVERT PLACE RIPRAP GRADE CONTROL EVERY 5000' SEE SHEET I.D. CS501 FOR DETAILS.
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09 CORRECTION SCALE: TO BE DETERMINED
FARGO-MOORHEAD METRO PHASE IV REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
TYPICAL SECTIONS
M & N
Sheet ID
CS312
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
HOUSTON ENGINEERING, INC.
1401 21ST AVE. N.
FARGO, ND 58102
DESIGNED BY
DRAWN BY
CHECKED BY
QUALITY CHK BY
PROJECT MGR.
PROJECT ENGR.
CONTRACT NO.
DATE
DESCRIPTION
CHKD
APVD
USACE-MVP-0000088174


TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
EAST OPTION 2B TIEBACK LEVEE
TYPICAL SECTION - NORTH DAKOTA DIVERSION (LPP)
CASS 17 TIEBACK LEVEE
LEVEE CONTROL LINE
EXISTING GROUND (VARIES)
IMPERVIOUS FILL (FROM DIVERSION CHANNEL EXCAVATION)
1' STRIPPING
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
HOUSTON ENGINEERING, INC
CS313


DETAIL
NORTH DAKOTA (LPP) OUTLET STRUCTURE
SCALE 1"= 200'-0"
RED RIVER OF THE NORTH
EXISTING PROPERTY LINE (TYP)
CLAY COUNTY RD
CASS COUNTY RD
RIPRAP
APPROXIMATE LIMITS OF TEMPORARY FLOOD PROTECTION DURING CONSTRUCTION
CONCRETE RETAINING WALL (TYP)
END OF SPOIL BANK
SCADA MONITORING POINT (OVERSEER/ADCIRC STAGE)
OUTLET PARKING AREA
OUTLET ELECTRICAL SERVICE
SPOIL BANK
OUTLET ACCESS ROAD
PROTECTED SIDE
UNPROTECTED SIDE
APPROXIMATE ROUTE OF FISH PASSAGE. SEE NOTE 3
OUTLET STRUCTURE, DOWNSTREAM FACE, 10 BAY, SEE SHEET C403
BRIDGE
SEE NOTE 5
RIPRAP (TYP.)
MEDIAN EXCAVATION
PROPOSED FINISH GRADE ELEVATION CONTOUR (TYP.)
RELOCATE/DEPOSIT UTILITY
EXISTING GRADE 2-FT ELEVATION CONTOUR (TYP.)
CLAY COUNTY 510
LOW FLOW CHANNEL
FLOW FROM RUSH RIVER
RIPRAP STRUCTURE
ELEVATION DATUM (VERTICAL CONTROL): NAVD 88
GEOID18
HORIZONTAL CONTROL: NAD83
NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CONNECTION SCALE: TO BE DETERMINED
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
DETAIL
OUTLET STRUCTURE
Sheet ID
CS403
US Army Corps of Engineers St. Paul District
is: USACE-MVP-0000028174


FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO-NORTH DAKOTA DIVERSION (LPP)
NORTH DAKOTA DIVERSION MINNESOTA
DETAIL
RUSH RIVER DROP STRUCTURE
Sheet ID
CS404
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED
DRAWN
CHECKED
SCALE AS NOTED
PLOT SCALE
PLOT DATE
CONTRACT NO.
FILE NUMBER
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL):
N.A.V.D. 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID06 CORRECTION SCALE: TO BE DETERMINED
DETAIL
RUSH RIVER DROP STRUCTURE
SCALE: 1" = 200'-0"
TO RED RIVER OF THE NORTH
NORTH DAKOTA DIVERSION CHANNEL
FLOW
SPOIL BANK
UNPROTECTED SIDE
RUSH RIVER FISH LADDER SEE DRAWING S-444
RUSH RIVER DROP STRUCTURE DIVERSION STA. 482+00
WALL OPENING FOR FISH LADDER
SCADA MONITORING POINT (RUSH RIVER STAGE)
PROPOSED RUSH RIVER
EXISTING RUSH RIVER
ABANDON RUSH RIVER PORTION
RUSH RIVER MAINTENANCE BUILDING AND PARKING AREA
RUSH RIVER ACCESS ROAD
RUSH RIVER ELECTRICAL SERVICE
FROM LOWER RUSH RIVER
ABANDON RUSH RIVER PORTION
EXISTING RUSH RIVER
EXISTING GRADE 2 FT ELEVATION CONTOUR (TYP.)
PROPOSED FINISH GRADE 2 FT ELEVATION CONTOUR (TYP.)
EXISTING PROPERTY LINE (TYP.)
PROTECTED SIDE
SPOIL BANK
100.0'
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
200
400'
0
200
SCALE: 1" = 200'-0"
is: USACE-MVP-0000086174


FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
DETAIL
LOWER RUSH RIVER DROP STRUCTURE
Sheet ID
CS405
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
ELEVATION DATUM (VERTICAL CONTROL): NAVD 1988
GEOID09
COORDINATE SYSTEM (HORIZONTAL CONTROL): NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CORRECTION SCALE: TO BE DETERMINED
EXISTING GRADE 2-FT ELEVATION CONTOUR (TYP)
EXISTING PROPERTY LINE (TYP)
SPOIL BANK
ABANDON LOWER RUSH RIVER PORTION
UNPROTECTED SIDE
EXISTING ROADWAY
ELECTRIC SERVICE TO LOWER RUSH MAINTENANCE AREA
LOWER RUSH RIVER FISH LADDER, SEE DRAWING S-440 (ROCK EXTENTS NOT SHOWN)
WALL OPENING FOR FISH LADDER
BOARD MONITORING POINT (TYP. 3 PLACES)
PROPOSED LOWER RUSH RIVER CHANNEL REALIGNMENT
LOWER RUSH RIVER MAINTENANCE BUILDING AND PARKING AREA
LOWER RUSH RIVER DROP STRUCTURE ACCESS ROAD
EXISTING LOWER RUSH RIVER
LOWER RUSH RIVER DROP STRUCTURE, SEE DRAWING S-441
FROM MAPLE RIVER
RIPRAP (TYP.)
LOW FLOW CHANNEL
PROPOSED FINISH GRADE 2-FT ELEVATION CONTOUR (TYP.)
START OF MEANDERING NATURALIZED LOW FLOW CHANNEL (MEANDER NOT SHOWN)
PROTECTED SIDE
RELOCATE/PROTECT EXISTING UTILITIES
NORTH DAKOTA DIVERSION CHANNEL
TO RUSH RIVER
FLOW
DETAIL
LOWER RUSH RIVER DROP STRUCTURE
SCALE 1" = 200'-0"
200' 100' 0 200'
is: USACE-MVP-000008174


FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY, NORTH DAKOTA & CLAY COUNTY, MINNESOTA
FARGO-NORTH DAKOTA DIVERSION (DPH)
NORTH DAKOTA DIVERSION
DETAIL
MAPLE RIVER AQUEDUCT
Sheet ID
CS406
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
CONTRACT NO.
PLOT SCALE
PLOT DATE
TILE NUMBER
DATE
SUBMITTED
APPROVED
DESCRIPTION
DATE
DRAWN
CHKD.
APVD.
ELEVATION DATUM (VERTICAL CONTROL): COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD83
N.A.V.D. 1988
NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09
CONSTRUCTION SCALE: TO BE DETERMINED
MAPLE RIVER AQUEDUCT ACCESS ROAD
RIPRAP
MAPLE RIVER AQUEDUCT ELECTRICAL SERVICE
MAPLE RIVER AQUEDUCT WATER SERVICE
ABANDON OLD CHANNEL PORTION
MAPLE RIVER
RIPRAP
PROTECTED SIDE
6H-1V EXCAVATION SLOPE
MAPLE RIVER AQUEDUCT ACCESS BRIDGE AND PARKING
APPROXIMATE LIMITS OF TEMPORARY FLOOD PROTECTION FOR CONSTRUCTION
MAPLE RIVER AQUEDUCT DIVERSION STRUCTURE (SHEET PILE)
SR-1A MONITORING POINT
ROCK RIFFLE STAGE AND DISCHARGE (FUTURE ADJACENT AQUEDUCT)
DIVERSION CONTAINMENT LEVEES
FLOW
FROM SHEYENNE AQUEDUCT
ACCESS ROAD
LOW FLOW CHANNEL
REALIGNED CHANNEL
EXISTING ELEVATION CONTOUR (TYP)
RAISED ELEVATION 24'F CONTOUR (TYP)
UNPROTECTED SIDE
DEBRIS MEASURE
OLD CHANNEL PORTION
WEIR 3
MAPLE RIVER SPILLWAY
RIPRAP (TYP.)
WEIR 2
MAPLE RIVER SPILLWAY CONTROL WEIR 1 & 1A
SR-2A MONITORING POINT
ROCK GRADE CONTROL
MAPLE RIVER
EXISTING PROPERTY LINE TYP
RELOCATE/OFFSET EXISTING UTILITIES
N
7
CS111
DETAIL
MAPLE RIVER AQUEDUCT
SCALE: 1" = 200'-0"
200' 100' 0 200'
1
2
3
4
5
A
B
C
D
IS: USACE-MVP-0000088174

FARGO-MOORHEAD METRO AREA FLOOD RISK MANAGEMENT PROJECT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
DETAIL
SHEYENNE RIVER AQUEDUCT
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA
Sheet ID
CS407
ELEVATION DATUM (VERTICAL CONTROL) COORDINATE SYSTEM (HORIZONTAL CONTROL) NAD83
NAVD 1988 NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09 CORRECTION SCALE TO BE DETERMINED
DETAIL
SHEYENNE RIVER AQUEDUCT
SCALE 1" = 200'-0"
EXISTING PROPERTY LINE (TYP.)
APPROXIMATE LIMITS OF TEMPORARY FLOOD PROTECTION FOR CONSTRUCTION MAINTENANCE BRIDGE ACCESS
SCADA MONITORING POINT AND STAGE GAGE (TYP.) (ADJACENT TO DIVERSION ACROSS AQUEDUCT)
SHEYENNE AQUEDUCT DIVERSION STA. 10+00 (SEE GRADING CS-03)
LOW FLOW CHANNEL
FROM DIVERSION INLET WEIR
EXISTING BRIDGE OVER SHEYENNE RIVER AQUEDUCT
MAINTENANCE BUILDING AND PARKING AREA
RIPRAP EXCAVATION SLOPE
REALIGNED CHANNEL
RIPRAP
ROCK GRADE CONTROL
SHEYENNE RIVER
ABANDON AND FILL EXISTING CHANNEL PORTION
ACCESS ROAD
ABANDON AND FILL EXISTING CHANNEL PORTION
PROTECTED SIDE
EXISTING AQUEDUCT ACCESS ROAD
RIPRAP
SHEYENNE RIVER
TO MAPLE RIVER CONFLUENCE
SPILLWAY FROM SHEYENNE INTO MAIN DIVERSION
WEIR 4
WEIR 3
WEIR 2
WEIR 1
RIPRAP (TYP.)
PROPOSED ELEVATION 2-FT CONTOUR (TYP.)
SHEYENNE RIVER SPILLWAY CONTROL WEIR
SHEYENNE RIVER SPILLWAY CONTROL WEIR
SCADA MONITORING POINT AND STAGE GAGE (TYP.) (HEAD ACROSS SHEYENNE SPILLWAY CONTROL WEIR)
EXISTING GRADE ELEVATION CONTOUR (TYP.)
UNPROTECTED SIDE
ICEBERG® CONTROL MEASURE
SCADA MONITORING POINT AND STAGE GAGE (TYP.) (ADJACENT TO ICEBERG® CONTROL MEASURE)
SHEYENNE RIVER
8 CS150 DETAIL
SHEYENNE RIVER AQUEDUCT
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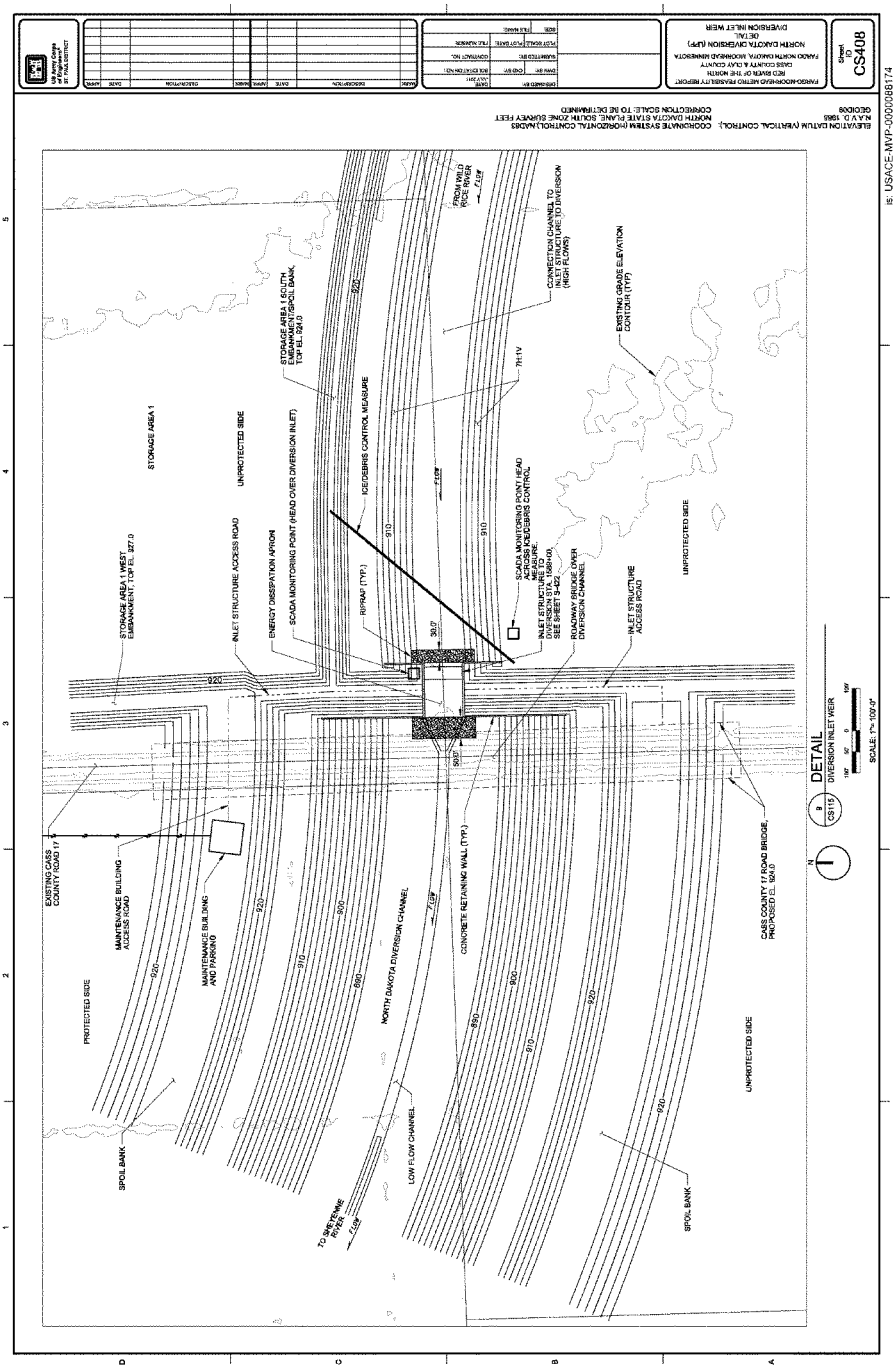
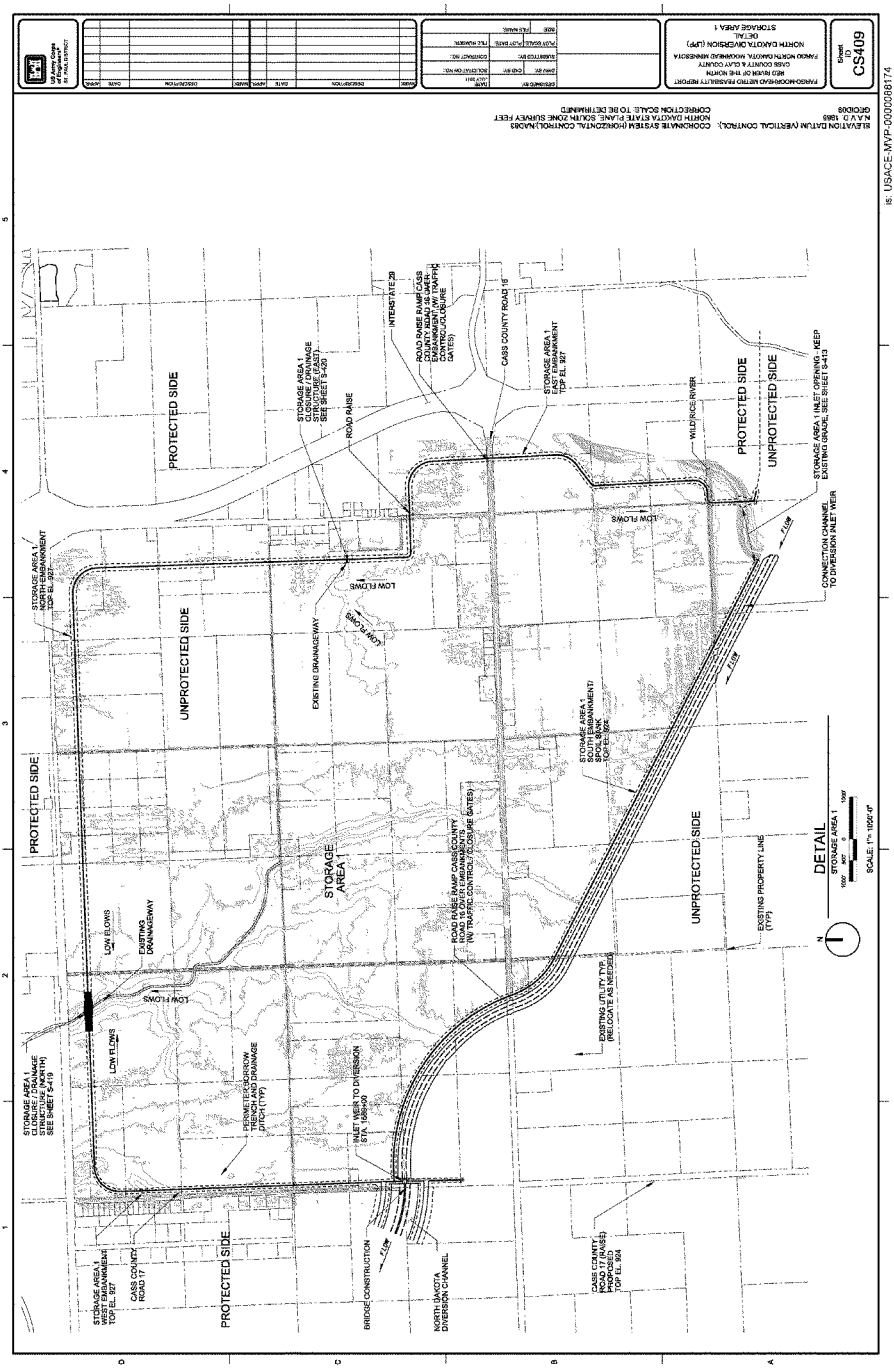

FARGO-MOORHEAD METRO FEASIBILITY STUDY
RED RIVER OF THE NORTH
CASS COUNTY, A DAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
DETAIL
DIVERSION INLET WEIR
Sheet ID
CS408
DESIGNED BY
DRAWN BY
CHECKED BY
QUALITY CONTROL BY
SUBMITTED BY
APPROVED BY
SIZE
FILE NAME
CONTRACT NO.
FILE NUMBER
DATE
DESCRIPTION
DATE
DESCRIPTION
DATE
APVD
MARK
DATE
APVD
DESCRIPTION
DATE
APVD
US Army Corps of Engineers St. Paul District
ELEVATION DATUM VERTICAL CONTROL: NORTH DAKOTA STATE PLANE SOUTH ZONE SURVEY FEET
N.A.V.D. 1988 CONVERSION SCALE: TO BE DETERMINED
GEOCODE
IS: USACE-MVP-0000088174
STORAGE AREA 1 WEST EMBANKMENT, TOP EL. 927.0
STORAGE AREA 1
INLET STRUCTURE ACCESS ROAD
UNPROTECTED SIDE
ENERGY DISSIPATION APRON
SCADA MONITORING POINT (HEAD OVER DIVERSION INLET)
RIPRAP (TYP.)
KOEBSBRIS CONTROL MEASURE
STORAGE AREA 1 SOUTH EMBANKMENT, SPOIL BANK, TOP EL. 924.0
FROM WILD RICE RIVER
CONVEYANCE CHANNEL TO DIVERSION INLET WEIR (HIGH FLOWS)
EXISTING GRADE ELEVATION CONTOUR (TYP.)
SCADA MONITORING POINT HEAD ACROSS KOEBSBRIS CONTROL MEASURE
INLET STRUCTURE FOOTPRINT SEE SHEET S1402 (S881H)
ROADWAY BRIDGE OVER DIVERSION CHANNEL
INLET STRUCTURE ACCESS ROAD
UNPROTECTED SIDE
EXISTING CASS COUNTY ROAD 17
MAINTENANCE BUILDING ACCESS ROAD
MAINTENANCE BUILDING AND PARKING
PROTECTED SIDE
SPOIL BANK
NORTH DAKOTA DIVERSION CHANNEL
CONCRETE RETAINING WALL (TYP.)
LOW FLOW CHANNEL
TO RED RIVER
CASS COUNTY 17 ROAD BRIDGE, PROPOSED EL. 924.0
UNPROTECTED SIDE
SPOIL BANK
DETAIL
DIVERSION INLET WEIR
SCALE: 1"= 100'-0"


FARGO-MOORHEAD METRO FEASIBILITY REPORT
RED RIVER OF THE NORTH
CASS COUNTY & CLAY COUNTY
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
NORTH DAKOTA DIVERSION (LPP)
DETAIL
STORAGE AREA 1
Sheet ID
CS409
US Army Corps of Engineers St. Paul District
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
SCALE
DATE
DESCRIPTION
DATE
APVD
DESCRIPTION
DATE
APVD
ELEVATION DATUM VERTICAL CONTROL, NAVD 1988
GEOID18
COORDINATE SYSTEM HORIZONTAL CONTROL, NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
CORRECTION SCALE TO BE DETERMINED
PROTECTED SIDE
UNPROTECTED SIDE
STORAGE AREA 1
EXISTING DRAINAGEWAY
LOW FLOWS
ROAD RAISE
INTERSTATE 29
CASS COUNTY ROAD 16
WILDRIDGE RIVER
CASS COUNTY ROAD 17
NORTH DAKOTA DIVERSION CHANNEL
BRIDGE CONSTRUCTION
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DETAIL
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SCALE: 1"= 1000'-0"
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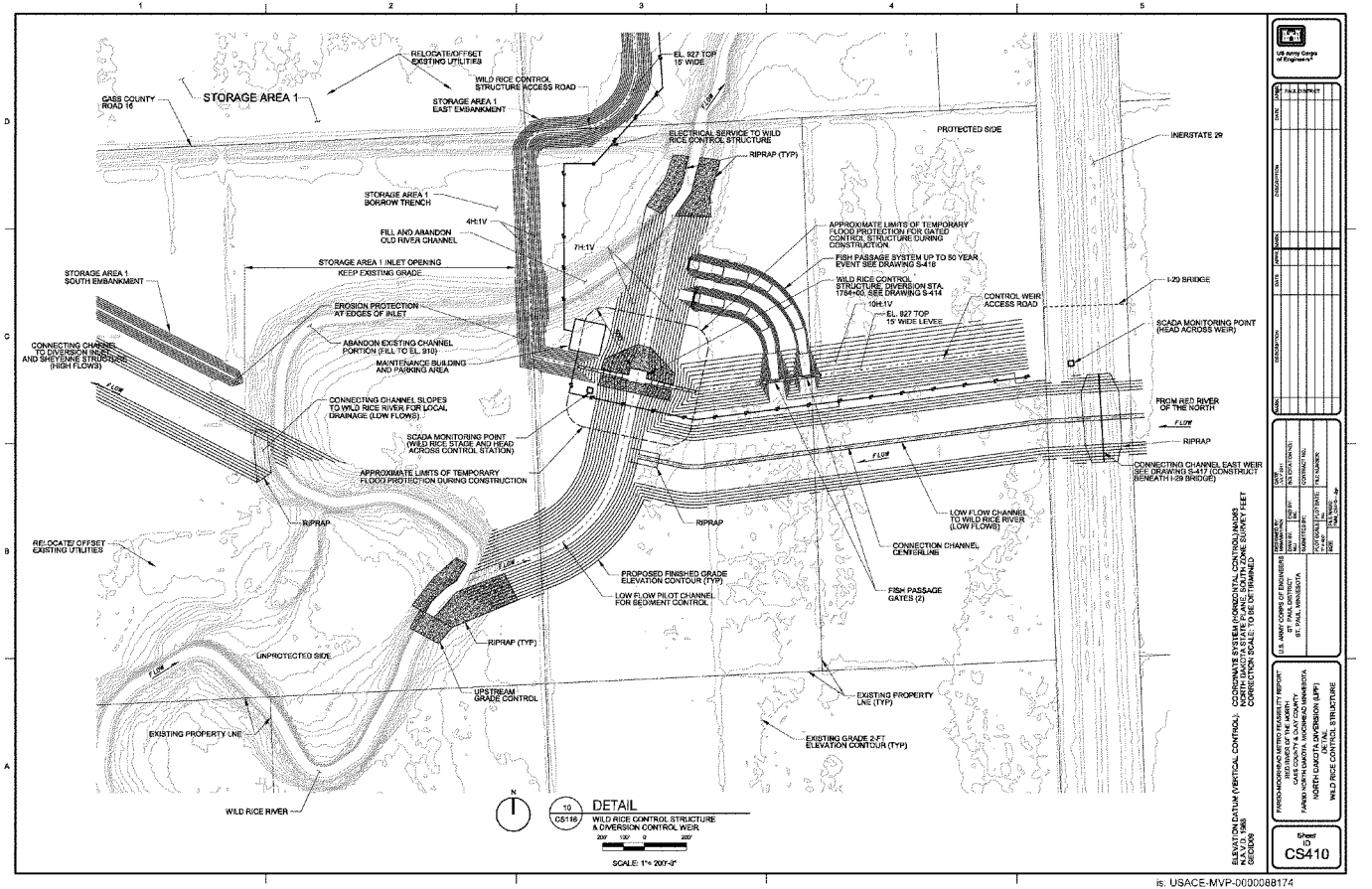

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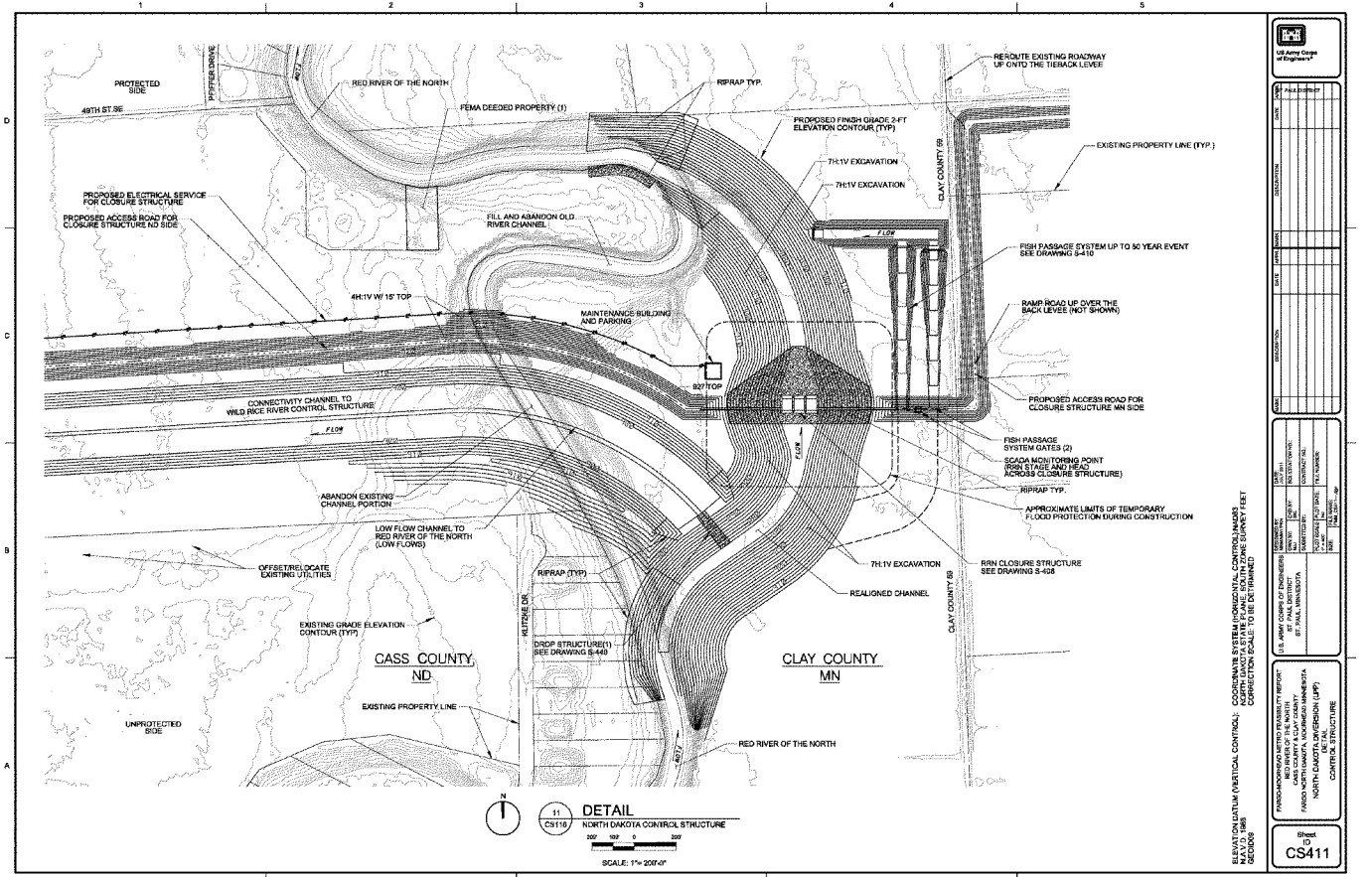

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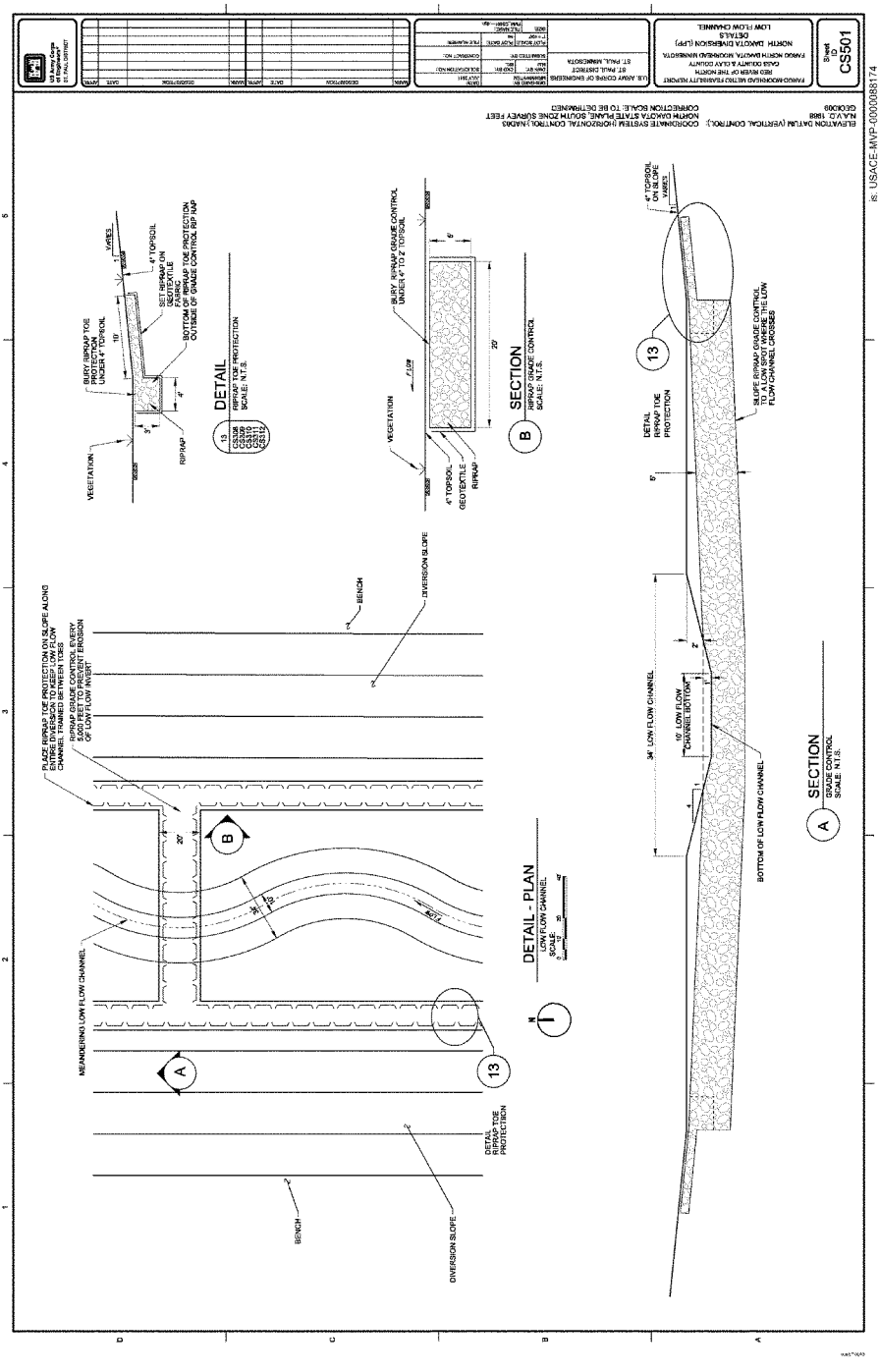
FARGO-MOORHEAD METRO FEASIBILITY STUDY
RED RIVER OF THE NORTH
FARGO, NORTH DAKOTA, MOORHEAD, MINNESOTA
CASS COUNTY, N. DAKOTA & CLAY COUNTY
FARGO NORTH DIVERSION (LPP)
NORTH DAKOTA DIVERSION
DETAILS
LOW FLOW CHANNEL
Sheet ID
CS501
U.S. Army Corps of Engineers
St. Paul District
ST. PAUL DISTRICT
ELEVATION DATUM (VERTICAL CONTROL): CONVERSATE SYSTEM (HORIZONTAL CONTROL) DATUM:
N.A.V.D. 1988
NORTH DAKOTA STATE PLANE, SOUTH ZONE SURVEY FEET
GEOID09
CORRECTION SCALE: TO BE DETERMINED
DETAIL
RIPRAP TOE PROTECTION
SCALE: N.T.S.
SECTION
RIPRAP GRADE CONTROL
SCALE: N.T.S.
DETAIL - PLAN
LOW FLOW CHANNEL
SECTION
GRADE CONTROL
SCALE: N.T.S.
MEANDERING LOW FLOW CHANNEL
BENCH
DIVERSION SLOPE
BOTTOM OF LOW FLOW CHANNEL
SLOPE RIPRAP GRADE CONTROL TO A LOW SPOT WHERE THE LOW FLOW CHANNEL CROSSES
4" TOPSOIL ON SLOPE
RIPRAP
GEOTEXTILE
4" TOPSOIL
VEGETATION
FLOW
BURY RIPRAP GRADE CONTROL UNDER 4" TO 2' TOPSOIL
SET RIPRAP ON GEOTEXTILE FABRIC
BOTTOM OF RIPRAP TOE PROTECTION OUTSIDE OF GRADE CONTROL RIP-RAP
BURY RIPRAP TOE PROTECTION UNDER 4" TOPSOIL
PLACE RIPRAP TOE PROTECTION ON SLOPE ALONG BOTH SIDES OF MEANDERING LOW FLOW CHANNEL TRAINED BETWEEN TOES
RIPRAP GRADE CONTROL EVERY 500 FEET TO MAINTAIN INVERT ELEVATION OF LOW FLOW INVERT
34' LOW FLOW CHANNEL
10' LOW FLOW CHANNEL BOTTOM
DETAIL RIPRAP TOE PROTECTION
DETAIL RIPRAP TOE PROTECTION
VARIES
4" TOPSOIL
RIPRAP
VEGETATION
BENCH
DIVERSION SLOPE
20'
10'
4'
3'
1'
2'
6'
1
2
3
4
5
A
B
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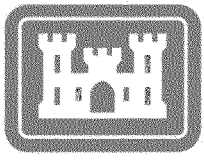
13
N
S: USACE-MVP-0000088174

Appendix L
Cost Engineering

Fargo-Moorhead Metropolitan Area Flood Risk Management

Final Feasibility Report and Environmental Impact Statement

July 2011



US Army Corps of Engineers ®

Prepared by:
U.S. Army Corps of Engineers
St. Paul District
180 Fifth Street East, Suite 700
St. Paul, Minnesota 55101-1678

USACE-MVP-0000088005

APPENDIX L
FARGO-MOORHEAD METRO FEASIBILITY STUDY
COST ENGINEERING

L1.0 INTRODUCTION

This appendix contains a summary of the detailed Phase 4 cost estimates prepared for the Final Fargo-Moorhead Metro Feasibility Study for the Flood Risk Management Report on the Red River of the North (RRN) in the cities of Fargo, ND, Moorhead, MN and the surrounding Metro area. Input for the cost estimates was obtained primarily from the Project Delivery Team (PDT) consisting of the St Paul District, US Army Corps of Engineers (USACE), the City of Fargo, North Dakota, the City of Moorhead, Minnesota, the team of consulting engineering firms lead by Moore Engineering of West Fargo, ND, and the Resource Agencies (in particular the Minnesota Department of Natural Resources, the North Dakota Fish and Game Department, and the US Fish and Wildlife Service) during several meetings with the design team. Guidance for the preparation of the estimates was obtained from ER 1110-2-1150, Engineering and Design for Civil Works Projects and ER 1110-2-1302, Civil Works Cost Engineering. The estimates were prepared using Micro-Computer Aided Cost Estimating System (MCACES), MII, version 3.01.

Cost estimates were conducted for the two different Phase 4 diversion channel alternatives, one is located in Minnesota around the city of Moorhead, MN, known as the Federal Comparable Plan (FCP) and the other alternative is the Local Sponsor's selected Locally Preferred Plan (LPP) located in North Dakota around the city of Fargo, ND with upstream storage. For a discussion of how the FCP is related to the National Economic Development (NED) plan, see the main feasibility report write-up.

A cost estimate summary for a third diversion channel alternative in North Dakota known as the ND35K Phase 3, which did not have any upstream storage but had significant downstream impacts, is included for reference only. Work on the ND35K Phase 3 estimate was halted when downstream impacts stretched all the way to the Canadian border and still had not reached a point of zero impacts. The ND35K Phase 3 cost estimate, while not finalized, was developed to the same comprehensive level of work as the LPP ND Phase 4 cost estimate.

Cost estimate calculations for this Feasibility Estimate of the Fargo-Moorhead Metro Flood Risk Management Feasibility Study, Phase 4 have been prepared and completed for the two diversion channel alignments using the approved Corps of Engineers Micro-Computer Aided Cost Estimating System (MCACES) MII, ver. 3.01, cost estimating program. The designs have been carried out to a feasibility level using general hydrologic, hydraulic, environmental, geotechnical and structural considerations.

The cost estimates discussed here are for the construction costs of the proposed diversion channel excavation, hydraulic structures, tie-back levees, roadway bridges, railroad bridges, utility relocations, mitigation efforts and recreational features for inclusion in the overall feasibility level cost estimates. Dimensions shown on the drawings and the quantities are at a feasibility level.

L2.0 PRICE LEVEL

Project costs are presented in August 2010 dollars and all project costs have been indexed to October 2011 price levels. Labor rates for the estimates have been adjusted from the local Davis-Bacon wage determinations to account for a competitive labor market and for the likelihood of large contracts attracting a regional and/or national workforce. After analyzing local, regional and Twin Cities wage determinations, labor rates for skilled workers, such as equipment operators, use a Twin Cities Davis-Bacon wage rate (Hennepin County) for work in both MN and ND. The skilled workers wage rates include a $7.50/hour subsistence or per diem allowance to account for needing to attract a workforce from a larger pool than from the local area. For basic common laborers, enough of a local workforce should be available that the estimates apply a Cass County, ND Davis-Bacon wage rates for work in North Dakota and a Clay County, MN wage rate for work in Minnesota. The work schedule is assumed to be 10 hour shifts including overtime for over 8 hours per shift.

Equipment rates used for the work are from the 2009 Region 4 Equipment rates in EP-1110-1-8 Construction Equipment Ownership and Operating Expense Schedule.

The estimates use the 2008 MII English Cost Book.

The costs in the FCP MN Plan and the LPP ND Plan estimates are considered fair and reasonable to a prudent and capable contractor and include overhead and profit.

L3.0 ESTIMATE STRUCTURE

The cost estimates for both the FCP MN Plan and the LPP ND Plan have been estimated jointly by the St Paul District Corps of Engineers (USACE-MVP) and by the Consultant Team.

The St Paul District completed the portions of the cost estimates in this Appendix L for constructing the following project features in the Total Project Cost Summary (TPCS) according to the Civil Works – Work Breakdown Structure:

01 Lands and Damages. Includes the real estate acquisition of project lands, easements and right-of-ways.
02 Relocations – Utility Relocations. Includes the cost for the relocation of utility lines that will be impacted by the project.
06 Fish and Wildlife Features. Includes the estimated cost for Environmental Mitigation features associated with project impacts caused by the proposed diversion channel.
11 Levees, Floodwalls and Flood Proofing – Non-Structural Flood Proofing. Provides cost estimates for non-structural flood proofing alternatives as developed by the members of the Corps of Engineers National Nonstructural/Flood Proofing Committee (NFPC) with the Omaha District Corps of Engineers.
14 Recreation Facilities. Includes costs for recreational features such as trails, trail facilities and recreational landscaping.

30 Planning, Engineering and Design (PED). Provides the estimated engineering design costs based on a percentage of the construction cost features.
31 Construction Management (CM). Provides the estimated Construction Management or Supervision and Administration costs based on a percentage of the construction cost features.

Contingencies are added to the cost estimates in the TPCS based on the results of the Cost and Schedule Risk Analysis. Escalation factors to the Effective Price Level Date and the Fully Funded Project Estimate Amount to the end of construction have also been included as part of the TPCS.

Appendix L has limited discussion for the parts of the jointly estimated costs provided by the Consultant Team for the features list below. For a more in-depth discussion of these features, refer to the Appendix G of Attachment 5 of this Feasibility Report.

02 Relocations – Roadway Bridges. Includes the costs for roadway bridges and road raises constructed as result of the proposed diversion channel.
08 Roads, Railroads and Bridges. Provides estimated costs associated with constructing railroad bridges and track raises over the proposed diversion channel and the relocation of a railroad yard impacted by the project.
09 Channels and Canals. Includes estimated costs to excavate the proposed diversion channel and to construct the inlet and outlet control structure on the Red River of the North (RRN) and the other required hydraulic structures on the tributaries that the diversion channel intersects with.
11 Levees, Floodwalls and Flood Proofing - Levees. Includes the estimated costs for the tie-back levees and the containment levees for the Floodwater Storage Area 1 of the LPP ND Plan.

The general format of the cost estimate and key assumptions were formulated to reflect the Civil Works Breakdown Structure (CWBS) to the extent possible for this feasibility level of design. Key assumptions for the process of estimating the construction costs of the proposed diversion channel alternative components are as follows:

- Work analyses were performed on the major cost items based on the feasibility level of design.
- Lesser cost items (lump sum user costs) were allocated an assumed percentage of Labor, Material and Equipment, where possible.
- Price levels for materials were based on quotes from suppliers, conversations with contractors, costs from similar projects, historical cost data, published aggregate cost data and other sources appropriate for a feasibility level estimate.
- Digital 3-D grading models for the volume of each type of excavation were calculated based on the stratigraphic profiles developed, which were based on a number of soil borings performed by the Corps of Engineers.
- Cost estimates for the hydraulic structures were developed using quantity calculations based primarily on the hydraulic structure drawings and engineering quantity calculations.
- Direct costs for major work features were determined.

- Indirect costs were calculated as percentages, applied to either direct costs or as running total percentages.

L4.0 01 – LANDS AND DAMAGES

The cost estimate for Lands and Damages is based on the estimated acres impacted by the project footprints at a unit cost per acre and by the number of property sites impacted at a unit cost per structure. The estimated costs, before contingencies, were provided by the St Paul District Real Estate Division for the real estate easements and ROW required plus the estimated administrative costs. See Appendix G – Real Estate for more detailed information regarding the development of the cost for Lands and Damages.

L5.0 02 – RELOCATIONS

This section summarizes cost estimate information related to relocating utilities, transportation bridges, and road raises as a result of the Feasibility Study Project.

L5.1 Utility Relocations

Multiple utilities will be impacted by the excavation of the proposed diversion channel for either the FCP diversion alternative in Minnesota or the LPP diversion alternative in North Dakota. A list of the known utilities was assembled by the PDT and costs were developed by contacting the utilities to provide an estimate of the relocation costs and the methods involved to relocate the utility. Many of the utilities indicated that the preferred method to relocate would be to bore under the proposed diversion channel location. Some utilities indicated they would hang a conduit under one of the proposed bridges if it was located along the utility alignment. For the high voltage electric overhead power lines it was assumed that new towers would have to be relocated on each side of the proposed diversion channel to span it. It is possible that existing high voltage overhead power line towers may be outside of the proposed diversion channel footprint and not be impacted, but until a final alignment is laid out, it was assumed that the towers would have to be relocated.

L5.2 Road Bridges and Road Raises

Bridge costs for roadways and road raises were developed by the Consultant Team for each feasibility alternative using historical bridge cost data indicating that costs are in the range of $105/SF to $125/SF. Conversations with contractors indicate that a cost (before contingency) of $120/SF is in the upper range of typical road bridge costs. A preliminary review by the Office of Bridges and Structures at the Minnesota Department of Transportation (MnDOT) agreed with the methodology used for the estimated cost of bridges exhibited in a feasibility level estimate. Further discussion on the roadway bridges can be found in Appendix G of Attachment 5.

L6.0 06 – FISH AND WILDLIFE FACILITIES

An estimated cost for Environmental Mitigation features associated with the proposed diversion channel is based on preliminary discussions with the resource agencies for the expected environmental impacts, mitigation planning and adaptive implementation, all of which are intended to ensure adverse effects from the project are off-set with environmental mitigation features. Given the limitations of the project schedule, specific environmental mitigation sites have not been finalized. Candidate environmental mitigation sites have been preliminarily identified and additional specific sites will be pursued in the months ahead during detail design. Until specific sites are finalized, costs are based on typical values of impacted environmental mitigation features from other projects of a similar nature. See Appendix F – Environmental, for more detailed information regarding the development of the mitigation features and costs.

L7.0 08 – RAILROAD BRIDGES

Comprehensive feasibility level railroad bridge costs were developed for the FCP diversion alternative in Minnesota and for the LPP diversion alternative in North Dakota by the BNSF Railroad's consulting engineering firm of TKDA. The cost estimates for the railroad bridges includes appropriate track raises and shoo-fly costs. For the FCP diversion alternative in Minnesota, the cost information includes relocating the Dilworth railroad yard that is impacted by the diversion channel alignment. The railroad yard would be shifted to the east and most likely be relocated to the south side of the BNSF mainline tracks. Railroad signal system estimated costs were supplied by the BNSF Railroad. Additional discussion on the railroad bridges can be found in Appendix G of Attachment 5.

L8.0 09 – DIVERSION CHANNEL COST CONSIDERATIONS

L8.1 Diversion Channel Excavation

The cost estimate information related to constructing the diversion channel was completed by the Consultant Team and a more detailed discussion of the estimate assumptions, unit costs, quantities, excavation productivity rates, crew sizes, material hauling, disposal spoil areas and project costs can be found in Appendix G of Attachment 5.

L8.2 Hydraulic Structures

The cost estimate information related to constructing the hydraulic structures was completed by the Consultant Team and a more detailed discussion can be found in Appendix G of Attachment 5. Detailed assumptions, unit costs, quantities, material prices, pile and foundation design, loading condition, hydraulic gates, erosion control, fish passage considerations and project costs are included in the discussion. Considerations specific to each individual hydraulic structure can also be found in Appendix G of Attachment 5.

For additional discussion on the purpose and operation of the hydraulic structures, see also Appendix B – Hydraulic Engineering.

L9.0 11 – LEVEES AND FLOODPROOFING

L9.1 Levees

The levees associated with the proposed project are for tie-back levees on the upstream part of the project to keep flows contained in the diversion channel and to contain water within Storage Area 1. The same crews that are developed for the diversion channel earthwork are used for tie-back levees. However, additional crews are included to compact levee material. Additional information is included in the Consultant Appendix G of Attachment 5.

L9.2 Non-Structural Flood Proofing Assessment

A non-structural flood proofing analysis was performed and for the FCP Minnesota diversion alternatives plan there was an economic area tentatively deemed to have a feasible benefit cost ratio. Members of the Corps of Engineers National Nonstructural/Flood Proofing Committee (NFPC) in the Omaha District, Corps of Engineers, developed the Non-Structural Assessment, Appendix P, which details the analysis of existing conditions, evaluation, comparison, screening, costs and selection of the alternative non-structural flood proofing plan. There was not a non-structural flood proofing plan deemed feasible for the North Dakota diversion alternative. See Appendix P – Non-Structural, for the detailed information regarding the non-structural flood proofing assessment.

L10.0 14 – RECREATIONAL FEATURES

Project recreation features will provide four-season amenities for the community and its visitors and will enhance the recreational opportunities of the region by also utilizing the diversion channel and adjoining material spoil piles areas as recreational project features. Recreational features associated with the diversion alternatives include multipurpose trails, parking areas and trailhead facilities at a conceptual level of design and costs. General features to be included as part of a recreational plan, have been assigned costs without site specific design or information. It is assumed that general grading for the trails, parking areas and facilities would be accomplished during the excavation of the diversion channel or the construction of the levees. Costs for the approximate miles and types of trails, number of public use facilities and amenities were estimated for the project based on its size and expected use. See Appendix M – Recreation & Aesthetics, for more detailed information regarding the features of the recreational plan.

L11.0 CONTRACTOR AND INDIRECT COST CONSIDERATIONS

The cost estimate assumes the work is performed by a prime general contractor performing management duties, and a layer of discipline-specific subcontractors performing work tasks, which often occurs on large, complex projects. The estimates are divided into $200M/year funding scenarios based on the Draft Phasing Project Schedule as developed by HDR Engineering for the Corps of Engineers in June 2010. A brief discussion of the different indirect cost assumptions is presented here with a more detailed discussion presented in the Consultant Appendix G, Exhibit K of Attachment 5.

L11.1 Prime Contractor

The Prime Contractor Job Office Overhead (JOOH) is assumed to be 5% of construction costs. This percentage assumes the prime contractor functions as a management company in this estimate and only handles things like the field office administration and quality control (QC) and does not incur significant costs to manage the fleet of construction equipment (rather, this cost is incurred by the subcontractors). JOOH, sometimes referred to as Field Office Overhead, are those costs incurred at the project site specifically as a result of the costs encountered at a particular project site to carry out and manage the day to day operations.

The Home Office Overhead (HOOH) are those cost incurred by the Prime Contractor for the overall business management of its main office expenses and was set at 5% of the construction costs. The typical estimated costs associated with HOOH are for the contractor's main office building, furniture and equipment, equipment yard, management and staff, office utilities, corporate vehicles, business insurance and taxes.

The profit for the Prime Contractor was calculated to be 9% of the construction costs as determined by using the weighted guidelines method in ETL 1110-2-573. See Appendix G in Attachment 5 for calculations related to develop the profit rate.

Performance and Payment Bonding is required on all Government contracts and for the Prime Contractor it has been assumed to be 1% of the construction costs.

L11.2 Subcontractor

JOOH rates for the subcontractors vary dependent on the job specialty performed by each of them. The earthwork subcontractor JOOH is assumed to be 7% of the construction costs since the Prime Contractor is assumed to handle the items mentioned above like the field office administration and QC. Other subcontractor specialties vary up to 10% of construction costs for JOOH.

Mobilization and Demobilization is included as a separate markup from JOOH for subcontractors and is assumed to be 5% of construction costs. Mob/demob typically covers items the contractor requires to transfer equipment to the construction site, unload and get it ready, field office set-up and winter and seasonal preparation costs.

HOOH for the subcontractors is assumed to be 5% of construction costs to cover the subcontractor's business management and main office expenses. The HOOH for the subcontractors is in addition to that considered for the Prime Contractor.

Profit for the subcontractors varies from 5% to 9% of the construction costs.

L12.0 30 – PLANNING, ENGINEERING & DESIGN

The Planning, Engineering & Design (PED) costs are determined as a percentage of the estimated construction costs. For this feasibility level estimate, a percentage of 15% of the estimated construction costs was used. This percentage has been typically used in the District for Feasibility estimates of PED. The final configurations and designs for the

hydraulic structures on the Red River of the North and the tributary structures will require physical model studies, which are assumed to be included in the PED.

L13.0 31 – CONSTRUCTION MANAGEMENT

The Construction Management costs are determined as a percentage of the estimated construction costs. For this feasibility level estimate, a percentage of 7% of the estimated construction costs was used. This percentage has been typically used in the District for large civil works construction projects in the past.

L14.0 CONTINGENCY

Current Headquarters USACE guidance requires a formal analysis on all projects where the projected cost exceeds $40 million. The initial Cost and Schedule Risk Analysis (CSRA) meeting was held the beginning of January 2010 to determine the preliminary risk registers and was attended by the Project Delivery Team members from the Corps of Engineers, representatives from the local sponsors of the cities of Fargo and Moorhead and the key members of the consulting engineering firms engaged in the development of the feasibility study. The meeting was facilitated by a member of the Corps of Engineers Cost Engineering Center Directory of Expertise, Walla Walla (Cost Engineering Dx). The preliminary risk register indicates the perceived risks and the perceived impacts to the project. Cost and Schedule Risk Analysis models were developed for each alternative to determine an initial contingency level for the Alternative Formulation Briefing (AFB) phase, which at that stage of the draft feasibility study process really was best suited to pin-point areas of concern to mitigate and manage efforts to reduce the cost and schedule risks (contingencies) for the Final Feasibility Study Report.

The final CSRA was coordinated with the Cost Engineering Dx based on the Phase 4 Feasibility Study Cost Estimate to determine the appropriate amount of contingencies to be utilized in the project cost estimates. Based on the results of the CSRA analysis, the Cost Engineering Dx recommended that for the both the FCP and the LPP, a contingency level of 26% should be used in the cost estimates. The *Project Cost and Schedule Risk Analysis Report* for the Minnesota Option and the North Dakota Option are both presented in Appendix N.

Contingencies used are intended to identify an estimated construction cost amount that is not likely to be exceeded, given the current project scope. The CSRA contingency developed for this project is not a means of adding costs to the project for possible schedule slippage or future cost growth, or to cover items that are not specifically being considered in the current scope.

Unknowns that have been identified that could affect project costs and designs could affect design assumptions, pending a detailed design, include the following:

- actual structure site selection and topography;
- unanticipated construction phasing requirements;
- variation in estimated quantities;

- uncertain seasonal flood prevention requirements associated with operating construction sites near the Red River of the North and its tributaries; currently it is assumed that a minimum protection level will be required in the construction plans for the contractor to provide;
- minor operational appurtenances, safety requirements and permanent signage or lighting for hydraulic structures;
- development of detailed operational and maintenance procedures;
- dewatering and control of water uncertainties;
- seasonal working condition uncertainties and extended schedule;
- potential fluctuations in labor costs;
- unanticipated utilities at hydraulic structure locations, including communications utilities or unmarked or abandoned utilities;
- future design refinement resulting from further hydraulic modeling;
- unanticipated fluctuations in fuel costs and material costs;
- construction contracting structure (i.e. single, multiple, joint ventures, etc.);
- unexpected geotechnical or groundwater issues;
- unexpected hazardous waste;
- threat of lawsuits;
- new design requirements resulting from permitting;
- unexpected presence of historic sites, archaeological sites, endangered species or wetlands;
- delays in property, utility and easement acquisition;
- requirements from drinking water supply protection measures;
- unexpected contaminated soils;
- unexpected seismic considerations;
- subsurface drain tile flows and abandonment/rerouting measures;
- investigation into geomorphology and sediment delivery;
- requirements resulting from unsteady flow modeling;
- further investigation of ice behavior;
- unanticipated local, regional, national or global economic conditions;
- additional information resulting from investigations of allowable pile capacity design criteria, such as pile driving tests
- further investigation of ecological impacts and required mitigation
- changes to contractor assumptions;

L15.0 PROJECT SCHEDULE

Project schedules included in this appendix were initially developed by HDR Engineering for the Corps of Engineers in June 2010 and were updated in July 2011 for the final report. The schedule for the FCP alternative in Minnesota shows a 7.5 year scenario to construct the project from the downstream end to the upstream end which would require an approximate annual funding level of $170M. The LPP alternative in North Dakota shows an 8.5 year scenario to construct the project from the downstream to the upstream end that would require an approximate annual funding level of $233M.

An additional schedule for the LPP 8.5 year scenario, not shown in this report, was also developed with construction starting at the upstream end of the diversion channel through Storage Area 1 and then completing the rest of the diversion from the

downstream end, upstream to meet at Storage Area 1. This scenario was developed at the request of the local sponsor to investigate if project benefits could possibly be realized earlier during construction. A separate cost estimate was not prepared, but the schedule assumed the cost information elements would be the same as the LPP downstream to upstream scenario.

L16.0 OPERATIONS, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION (OMRR&R)

A detailed OMRR&R cost estimate for this project has been prepared and is attached to this appendix. The estimate is to account for future project costs to operate and maintain project features and to recognize costs for the repair, replacement and rehabilitation that will be required in the future to maintain the diversion channel flood reduction project.

L17.0 FINAL FEASIBILITY ESTIMATE

The Final Feasibility Estimates as presented in the Total Project Cost Summary (TPCS) for the Fargo-Moorhead Metro Feasibility Study have been reviewed by the Cost Engineering Dx during the Agency Technical Review (ATR) and have been certified to meet the regulations in accordance with ER 1110-2-1150 Engineering and Design for Civil Work and with ER 110-2-1302 Civil Works Cost Engineering. The final feasibility estimated costs for the project report are:

FCP
FY2012 Price Level: $1,236,700,000
Fully Funded Amount: $1,363,631,000

LPP
FY2012 Price Level: $1,781,347,000
Fully Funded Amount: $2,007,791,000

****** TOTAL PROJECT COST SUMMARY ******
FCP MN Phase 4

Printed:6/28/2011

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	BASE COST TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	FIRST COST TOTAL ($K)	Spent Thru: 1-Oct-2011 ($K)		FULLY FUNDED PROJECT ESTIMATE COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
02	RELOCATIONS	$84,956	$22,089	26%	$107,045	2.5%	$87,071	$22,638	$109,709			$94,141	$24,477	$118,618
06	FISH & WILDLIFE FACILITIES	$19,424	$5,050	26%	$24,474	2.4%	$19,884	$5,170	$25,053			$21,531	$5,598	$27,129
08	ROADS, RAILROADS & BRIDGES	$127,294	$33,097	26%	$160,391	2.5%	$130,463	$33,920	$164,383			$140,281	$36,473	$176,754
09	CHANNELS & CANALS	$469,948	$122,187	26%	$592,135	2.0%	$479,473	$124,663	$604,135			$526,920	$136,999	$663,920
11	LEVEES, FLOODWALLS & FLOODPROOFING	$19,634	$5,105	26%	$24,739	2.4%	$20,101	$5,226	$25,328			$21,917	$5,698	$27,615
14	RECREATION FACILITIES	$19,969	$5,192	26%	$25,160	2.7%	$20,512	$5,333	$25,845			$22,406	$5,826	$28,232
	CONSTRUCTION ESTIMATE TOTALS:	$741,225	$192,719		$933,944	2.2%	$757,502	$196,951	$954,453			$827,197	$215,071	$1,042,268
01	LANDS AND DAMAGES	$57,007	$14,822	26%	$71,829	2.5%	$58,426	$15,191	$73,617			$61,913	$16,097	$78,010
30	PLANNING, ENGINEERING & DESIGN	$111,186	$28,908	26%	$140,094	1.5%	$112,896	$29,353	$142,249			$129,268	$33,610	$162,878
31	CONSTRUCTION MANAGEMENT	$51,886	$13,490	26%	$65,376	1.5%	$52,684	$13,698	$66,382			$53,869	$16,606	$80,475
	PROJECT COST TOTALS:	$961,305	$249,939	26%	$1,211,244	2.1%	$981,508	$255,192	$1,236,700			$1,082,247	$281,384	$1,363,631

CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

PROJECT CO- MANAGERS, Brett R Coleman & Terryl L Williams

CHIEF, REAL ESTATE, John P Albrecht

ESTIMATED FEDERAL COST (1):	64.6%	**$881,140**
ESTIMATED NON-FEDERAL COST:	35.4%	$482,491
ESTIMATED TOTAL PROJECT COST:		**$1,363,631**

(1) Estimated Federal Cost is limited to 65% of the Fully Funded Cost without Recreation plus 50% of the Recreation costs.

O&M OUTSIDE OF TOTAL PROJECT COST:

****** TOTAL PROJECT COST SUMMARY ******

FCP MN Phase 4

**** CONTRACT COST SUMMARY ****

REACH 1 - 2013

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	RISK BASED COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 1 - 2013													
02	RELOCATIONS	$6,870	$1,786	26%	$8,657	2.5%	$7,041	$1,831	$8,872	2013Q4	2.8%	$7,237	$1,882	$9,118
06	FISH & WILDLIFE FACILITIES	$3,237	$842	26%	$4,079	2.4%	$3,314	$862	$4,176	2014Q2	3.7%	$3,436	$893	$4,329
08	ROADS, RAILROADS & BRIDGES	$15,382	$3,999	26%	$19,381	2.5%	$15,764	$4,099	$19,863	2014Q2	3.7%	$16,344	$4,249	$20,593
09	CHANNELS & CANALS	$12,283	$3,194	26%	$15,476	2.0%	$12,532	$3,258	$15,790	2014Q2	3.7%	$12,992	$3,378	$16,370
11	LEVEES, FLOODWALLS & FLOODPROOFING	$5,491	$1,428	26%	$6,919	2.4%	$5,622	$1,462	$7,083	2014Q2	3.7%	$5,828	$1,515	$7,344
14	RECREATION FACILITIES	$3,328	$865	26%	$4,193	2.7%	$3,419	$889	$4,307	2014Q4	4.6%	$3,574	$929	$4,504
	CONSTRUCTION ESTIMATE TOTALS:	$46,591	$12,114	26%	**$58,705**		$47,692	$12,400	$60,092			$49,411	$12,847	$62,258
01	LANDS AND DAMAGES	$9,501	$2,470	26%	$11,972	2.5%	$9,738	$2,532	$12,269	2013Q1	1.5%	$9,888	$2,571	$12,459
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$466	$121	26%	$587	1.5%	$473	$123	$596	2012Q3	1.0%	$478	$124	$602
2.0%	Planning & Environmental Compliance	$932	$242	26%	$1,174	1.5%	$946	$246	$1,192	2012Q3	1.0%	$956	$248	$1,204
8.0%	Engineering & Design	$3,727	$969	26%	$4,696	1.5%	$3,784	$984	$4,768	2012Q3	1.0%	$3,821	$994	$4,815
1.0%	Engineering Tech Review ITR & VE	$466	$121	26%	$587	1.5%	$473	$123	$596	2012Q3	1.0%	$478	$124	$602
1.0%	Contracting & Reprographics	$466	$121	26%	$587	1.5%	$473	$123	$596	2012Q3	1.0%	$478	$124	$602
1.0%	Engineering During Construction	$466	$121	26%	$587	1.5%	$473	$123	$596	2014Q2	7.7%	$509	$132	$642
1.0%	Planning During Construction	$466	$121	26%	$587	1.5%	$473	$123	$596	2014Q2	7.7%	$509	$132	$642
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$3,261	$848	26%	$4,109	1.5%	$3,311	$861	$4,172	2014Q2	7.7%	$3,565	$927	$4,492
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$66,342	$17,249		**$83,592**		$67,837	$17,638	$85,475			$70,093	$18,224	**$88,318**

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****** TOTAL PROJECT COST SUMMARY ******
FCP MN Phase 4
**** CONTRACT COST SUMMARY ****
REACH 2 - 2014

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	REACH 2 - 2014													
02	RELOCATIONS	$11,894	$3,092	26%	$14,987	2.5%	$12,190	$3,169	$15,360	2014Q4	4.6%	$12,746	$3,314	$16,060
06	FISH & WILDLIFE FACILITIES	$3,237	$842	26%	$4,079	2.4%	$3,314	$862	$4,176	2015Q2	5.4%	$3,494	$908	$4,403
08	ROADS, RAILROADS & BRIDGES	$0	$0	26%	$0	2.5%	$0	$0	$0	2015Q2	5.4%	$0	$0	$0
09	CHANNELS & CANALS	$35,206	$9,154	26%	$44,361	2.0%	$35,921	$9,339	$45,261	2015Q2	5.4%	$37,874	$9,847	$47,722
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$3,328	$865	26%	$4,193	2.7%	$3,419	$889	$4,307	2015Q4	6.3%	$3,535	$945	$4,580
	CONSTRUCTION ESTIMATE TOTALS:	$53,667	$13,953	26%	**$67,621**		$54,844	$14,259	$69,103			$57,750	$15,015	$72,764
01	LANDS AND DAMAGES	$9,501	$2,470	26%	$11,972	2.5%	$9,738	$2,532	$12,269	2014Q1	3.2%	$10,053	$2,614	$12,666
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$537	$140	26%	$677	1.5%	$545	$142	$687	2013Q3	4.3%	$569	$148	$717
2.0%	Planning & Environmental Compliance	$1,073	$279	26%	$1,352	1.5%	$1,089	$283	$1,373	2013Q3	4.3%	$1,136	$295	$1,432
8.0%	Engineering & Design	$4,293	$1,116	26%	$5,409	1.5%	$4,359	$1,133	$5,492	2013Q3	4.3%	$4,546	$1,182	$5,728
1.0%	Engineering Tech Review ITR & VE	$537	$140	26%	$677	1.5%	$545	$142	$687	2013Q3	4.3%	$569	$148	$717
1.0%	Contracting & Reprographics	$537	$140	26%	$677	1.5%	$545	$142	$687	2013Q3	4.3%	$569	$148	$717
1.0%	Engineering During Construction	$537	$140	26%	$677	1.5%	$545	$142	$687	2015Q2	12.1%	$611	$159	$770
1.0%	Planning During Construction	$537	$140	26%	$677	1.5%	$545	$142	$687	2015Q2	12.1%	$611	$159	$770
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$3,757	$977	26%	$4,734	1.5%	$3,815	$992	$4,807	2015Q2	12.1%	$4,275	$1,112	$5,387
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$74,976	$19,494		**$94,470**		$76,571	$19,908	$96,480			$80,668	$20,979	**$101,667**

****** TOTAL PROJECT COST SUMMARY ******

FCP MN Phase 4

**** CONTRACT COST SUMMARY ****

REACH 3 - 2015

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 3 - 2015													
02	RELOCATIONS	$19,103	$4,967	26%	$24,070	2.5%	$19,579	$5,090	$24,669	2015Q4	6.3%	$20,819	$5,413	$26,232
06	FISH & WILDLIFE FACILITIES	$3,237	$842	26%	$4,079	2.4%	$3,314	$862	$4,176	2016Q2	7.2%	$3,554	$924	$4,477
08	ROADS, RAILROADS & BRIDGES	$83,787	$21,785	26%	$105,572	2.5%	$85,873	$22,327	$108,199	2016Q2	7.2%	$92,082	$23,941	$116,023
09	CHANNELS & CANALS	$103,556	$26,925	26%	$130,480	2.0%	$105,655	$27,470	$133,125	2016Q2	7.2%	$113,294	$29,456	$142,751
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$3,328	$865	26%	$4,193	2.7%	$3,419	$889	$4,307	2016Q4	8.1%	$3,697	$961	$4,658
	CONSTRUCTION ESTIMATE TOTALS:	$213,012	$55,383	26%	**$268,395**		$217,838	$56,638	$274,476			$233,445	$60,696	$294,141
01	LANDS AND DAMAGES	$9,501	$2,470	26%	$11,972	2.5%	$9,738	$2,532	$12,269	2015Q1	5.0%	$10,223	$2,658	$12,882
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$2,130	$554	26%	$2,684	1.5%	$2,163	$562	$2,725	2014Q3	8.8%	$2,352	$612	$2,964
2.0%	Planning & Environmental Compliance	$4,260	$1,108	26%	$5,368	1.5%	$4,326	$1,125	$5,450	2014Q3	8.8%	$4,705	$1,223	$5,928
8.0%	Engineering & Design	$17,041	$4,431	26%	$21,472	1.5%	$17,303	$4,499	$21,802	2014Q3	8.8%	$18,820	$4,893	$23,714
1.0%	Engineering Tech Review ITR & VE	$2,130	$554	26%	$2,684	1.5%	$2,163	$562	$2,725	2014Q3	8.8%	$2,352	$612	$2,964
1.0%	Contracting & Reprographics	$2,130	$554	26%	$2,684	1.5%	$2,163	$562	$2,725	2014Q3	8.8%	$2,352	$612	$2,964
1.0%	Engineering During Construction	$2,130	$554	26%	$2,684	1.5%	$2,163	$562	$2,725	2016Q2	16.6%	$2,521	$655	$3,176
1.0%	Planning During Construction	$2,130	$554	26%	$2,684	1.5%	$2,163	$562	$2,725	2016Q2	16.6%	$2,521	$655	$3,176
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$14,911	$3,877	26%	$18,788	1.5%	$15,140	$3,936	$19,077	2016Q2	16.6%	$17,648	$4,588	$22,236
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$269,375	$70,037		**$339,412**		$275,159	$71,541	$346,700			$296,941	$77,205	**$374,145**

****** TOTAL PROJECT COST SUMMARY ******
FCP MN Phase 4
**** CONTRACT COST SUMMARY ****
REACH 4 - 2016

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 4 - 2016													
02	RELOCATIONS	$16,638	$4,326	26%	$20,964	2.5%	$17,052	$4,434	$21,486	2016Q4	8.1%	$18,441	$4,795	$23,236
06	FISH & WILDLIFE FACILITIES	$3,237	$842	26%	$4,079	2.4%	$3,314	$862	$4,176	2017Q2	9.1%	$3,617	$940	$4,558
08	ROADS, RAILROADS & BRIDGES	$18,436	$4,793	26%	$23,229	2.5%	$18,895	$4,913	$23,807	2017Q2	9.1%	$20,623	$5,362	$25,985
09	CHANNELS & CANALS	$77,076	$20,040	26%	$97,115	2.0%	$78,638	$20,446	$99,084	2017Q2	9.1%	$85,831	$22,316	$108,147
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$3,328	$865	26%	$4,193	2.7%	$3,419	$889	$4,307	2017Q4	10.1%	$3,765	$979	$4,744
	CONSTRUCTION ESTIMATE TOTALS:	$118,715	$30,866	26%	**$149,581**		$121,317	$31,543	$152,860			$132,277	$34,392	$166,669
01	LANDS AND DAMAGES	$9,501	$2,470	26%	$11,972	2.5%	$9,738	$2,532	$12,269	2016Q1	6.6%	$10,397	$2,703	$13,100
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$1,187	$309	26%	$1,496	1.5%	$1,205	$313	$1,519	2015Q3	13.2%	$1,364	$355	$1,719
2.0%	Planning & Environmental Compliance	$2,374	$617	26%	$2,991	1.5%	$2,411	$627	$3,037	2015Q3	13.2%	$2,728	$709	$3,438
8.0%	Engineering & Design	$9,497	$2,469	26%	$11,966	1.5%	$9,643	$2,507	$12,150	2015Q3	13.2%	$10,915	$2,838	$13,753
1.0%	Engineering Tech Review ITR & VE	$1,187	$309	26%	$1,496	1.5%	$1,205	$313	$1,519	2015Q3	13.2%	$1,364	$355	$1,719
1.0%	Contracting & Reprographics	$1,187	$309	26%	$1,496	1.5%	$1,205	$313	$1,519	2015Q3	13.2%	$1,364	$355	$1,719
1.0%	Engineering During Construction	$1,187	$309	26%	$1,496	1.5%	$1,205	$313	$1,519	2017Q2	21.1%	$1,459	$379	$1,838
1.0%	Planning During Construction	$1,187	$309	26%	$1,496	1.5%	$1,205	$313	$1,519	2017Q2	21.1%	$1,459	$379	$1,838
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$8,310	$2,161	26%	$10,471	1.5%	$8,438	$2,194	$10,632	2017Q2	21.1%	$10,214	$2,656	$12,870
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$154,333	$40,126		**$194,459**		$157,573	$40,969	$198,542			$173,543	$45,121	**$218,664**

****** TOTAL PROJECT COST SUMMARY ******

FCP MN Phase 4

**** CONTRACT COST SUMMARY ****

REACH 5 - 2017

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 5 - 2017													
02	RELOCATIONS	$4,434	$1,153	26%	$5,586	2.5%	$4,544	$1,181	$5,725	2017Q4	10.1%	$5,004	$1,301	$6,305
06	FISH & WILDLIFE FACILITIES	$3,237	$842	26%	$4,079	2.4%	$3,314	$862	$4,176	2018Q2	11.1%	$3,682	$957	$4,640
08	ROADS, RAILROADS & BRIDGES			26%										
09	CHANNELS & CANALS	$105,318	$27,383	26%	$132,701	2.0%	$107,452	$27,938	$135,390	2018Q2	11.1%	$119,393	$31,042	$150,435
11	LEVEES, FLOODWALLS & FLOODPROOFING	$14,143	$3,677	26%	$17,820	2.4%	$14,480	$3,765	$18,244	2018Q2	11.1%	$16,089	$4,183	$20,272
14	RECREATION FACILITIES	$3,328	$865	26%	$4,193	2.7%	$3,419	$889	$4,307	2018Q4	12.1%	$3,833	$997	$4,829
	CONSTRUCTION ESTIMATE TOTALS:	$130,460	$33,920	26%	**$164,380**		$133,209	$34,634	$167,843			$148,001	$38,480	$186,481
01	LANDS AND DAMAGES	$9,501	$2,470	26%	$11,972	2.5%	$9,738	$2,532	$12,269	2017Q1	8.7%	$10,580	$2,751	$13,331
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$1,305	$339	26%	$1,644	1.5%	$1,325	$345	$1,670	2016Q3	17.7%	$1,559	$405	$1,965
2.0%	Planning & Environmental Compliance	$2,609	$678	26%	$3,287	1.5%	$2,649	$689	$3,338	2016Q3	17.7%	$3,118	$811	$3,928
8.0%	Engineering & Design	$10,437	$2,714	26%	$13,151	1.5%	$10,597	$2,755	$13,353	2016Q3	17.7%	$12,472	$3,243	$15,714
1.0%	Engineering Tech Review ITR & VE	$1,305	$339	26%	$1,644	1.5%	$1,325	$345	$1,670	2016Q3	17.7%	$1,559	$405	$1,965
1.0%	Contracting & Reprographics	$1,305	$339	26%	$1,644	1.5%	$1,325	$345	$1,670	2016Q3	17.7%	$1,559	$405	$1,965
1.0%	Engineering During Construction	$1,305	$339	26%	$1,644	1.5%	$1,325	$345	$1,670	2018Q2	25.5%	$1,664	$433	$2,096
1.0%	Planning During Construction	$1,305	$339	26%	$1,644	1.5%	$1,325	$345	$1,670	2018Q2	25.5%	$1,664	$433	$2,096
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$9,132	$2,374	26%	$11,506	1.5%	$9,272	$2,411	$11,683	2018Q2	25.5%	$11,641	$3,027	$14,668
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$168,664	$43,853		**$212,517**		$172,091	$44,744	$216,834			$193,617	$50,392	**$244,210**

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****** TOTAL PROJECT COST SUMMARY ******
FCP MN Phase 4
**** CONTRACT COST SUMMARY ****
REACH 6 - 2018

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 6 - 2018													
02	RELOCATIONS	$26,017	$6,764	26%	$32,781	2.5%	$26,664	$6,933	$33,597	2018Q4	12.1%	$29,894	$7,772	$37,666
06	FISH & WILDLIFE FACILITIES	$3,237	$842	26%	$4,079	2.4%	$3,314	$862	$4,176	2019Q2	13.1%	$3,748	$975	$4,723
08	ROADS, RAILROADS & BRIDGES	$9,690	$2,519	26%	$12,209	2.5%	$9,931	$2,582	$12,513	2019Q2	13.1%	$11,233	$2,921	$14,153
09	CHANNELS & CANALS	$136,508	$35,492	26%	$172,000	2.0%	$139,275	$36,211	$175,486	2019Q2	13.1%	$157,536	$40,959	$198,496
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$3,328	$865	26%	$4,193	2.7%	$3,419	$889	$4,307	2019Q4	14.1%	$3,902	$1,014	$4,916
	CONSTRUCTION ESTIMATE TOTALS:	$178,780	$46,483	26%	**$225,263**		$182,602	$47,477	$230,079			$206,313	$53,641	$259,955
01	LANDS AND DAMAGES	$9,501	$2,470	26%	$11,972	2.5%	$9,738	$2,532	$12,269	2018Q1	10.6%	$10,771	$2,800	$13,571
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$1,788	$465	26%	$2,253	1.5%	$1,815	$472	$2,288	2017Q3	22.2%	$2,218	$577	$2,795
2.0%	Planning & Environmental Compliance	$3,576	$930	26%	$4,506	1.5%	$3,631	$944	$4,575	2017Q3	22.2%	$4,436	$1,153	$5,590
8.0%	Engineering & Design	$14,302	$3,719	26%	$18,021	1.5%	$14,522	$3,776	$18,298	2017Q3	22.2%	$17,743	$4,613	$22,356
1.0%	Engineering Tech Review ITR & VE	$1,788	$465	26%	$2,253	1.5%	$1,815	$472	$2,288	2017Q3	22.2%	$2,218	$577	$2,795
1.0%	Contracting & Reprographics	$1,788	$465	26%	$2,253	1.5%	$1,815	$472	$2,288	2017Q3	22.2%	$2,218	$577	$2,795
1.0%	Engineering During Construction	$1,788	$465	26%	$2,253	1.5%	$1,815	$472	$2,288	2019Q2	30.0%	$2,361	$614	$2,975
1.0%	Planning During Construction	$1,788	$465	26%	$2,253	1.5%	$1,815	$472	$2,288	2019Q2	30.0%	$2,361	$614	$2,975
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$12,515	$3,254	26%	$15,769	1.5%	$12,707	$3,304	$16,011	2019Q2	30.0%	$16,525	$4,297	$20,822
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$227,614	$59,180		**$286,794**		$232,278	$60,392	$292,670			$267,165	$69,463	**$336,627**

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT and REHABILITAION

Life Cycle 50 Years
Rate of Return 4.375%
Date Prepared: 28-Apr-2011

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - FCP MN Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT					O&M and MAJOR REPLACEMENT COSTS				EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE		
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	PROJECT UNIT PRICE	O&M AMOUNT	PRESENT VALUE	ANNUAL COST	COMMENTS
									$71,566,798	$3,548,079	Percentage of Construction 0.38%
00	**PERIODIC INSPECTIONS**										
	Periodic Inspections										
	1st 5 years	1 Year	1.00	1	1	JOB	$50,000	$50,000	220,266	10,920	
	Year 7, 9 and 11	2 Years	1.00	1	1	JOB	$40,000	$40,000	81,823	4,057	Cost of periodics decreases after the 1st 5 years.
	Every 5 years beginning year 15	5 Years	1.00	1	1	JOB	$30,000	$30,000	67,119	3,328	
	Routine Annual Inspections	1 Year	1.00	1	1	JOB	$10,000	$10,000	201,706	10,000	
	Total Inspections								570,913	28,304	
02	**RELOCATIONS**										
	ROADS										
	Interstate 29 (NB-South)	10 Years	0.10	1.0	0.10	LS	$2,479,200.00	$247,920	409,323	20,293	
	Interstate 29 (SB-South)	10 Years	0.10	1.0	0.10	LS	$2,303,600.00	$230,360	380,331	18,856	
	State Highway 75 (South)	10 Years	0.10	1.0	0.10	LS	$4,627,800.00	$462,780	764,063	37,880	
	110th Avenue S	10 Years	0.10	1.0	0.10	LS	$2,303,600.00	$230,360	380,331	18,856	
	80th Avenue S	10 Years	0.10	1.0	0.10	LS	$3,718,800.00	$371,880	613,984	30,440	
	60th Avenue S	10 Years	0.10	1.0	0.10	LS	$3,605,200.00	$360,520	595,229	29,510	
	CSAH 52	10 Years	0.10	1.0	0.10	LS	$3,687,800.00	$368,780	608,866	30,186	
	50th Avenue S	10 Years	0.10	1.0	0.10	LS	$3,646,500.00	$364,650	602,047	29,848	
	Interstate 94 (EB)	10 Years	0.10	1.0	0.10	LS	$4,948,100.00	$494,810	816,945	40,502	
	Interstate 94 (WB)	10 Years	0.10	1.0	0.10	LS	$4,948,100.00	$494,810	816,945	40,502	
	US Highway 10 (EB)	10 Years	0.10	1.0	0.10	LS	$5,113,400.00	$511,340	844,237	41,855	
	US Highway 10 (WB)	10 Years	0.10	1.0	0.10	LS	$5,113,400.00	$511,340	844,237	41,855	
	28th Avenue N	10 Years	0.10	1.0	0.10	LS	$4,101,000.00	$410,100	677,087	33,568	
	57th Avenue N	10 Years	0.10	1.0	0.10	LS	$3,491,500.00	$349,150	576,456	28,579	
	CR 14	10 Years	0.10	1.0	0.10	LS	$3,388,200.00	$338,820	559,401	27,734	
	90th Avenue N	10 Years	0.10	1.0	0.10	LS	$3,408,900.00	$340,890	562,819	27,903	
	100th Avenue N	10 Years	0.10	1.0	0.10	LS	$3,512,200.00	$351,220	579,874	28,749	
	State Highway 75 (North)	10 Years	0.10	1.0	0.10	LS	$4,844,800.00	$484,480	799,890	39,656	
	110th Avenue NW	10 Years	0.10	1.0	0.10	LS	$3,450,200.00	$345,020	569,638	28,241	
	15 Street NW	10 Years	0.10	1.0	0.10	LS	$3,346,900.00	$334,690	552,583	27,395	
06	FISH AND WILDLIFE FACILITIES										
	Aquatic Footprint Maintenance	10 Years	0.01	3.6	0.04	LS	$742,650.00	$26,364	43,528	2,158	
	Fish PassageOperation	10 Years	0.01	1.0	0.01	LS	$0.00	$0	0	0	
	Wetlands Footprint Maintenance	10 Years	0.01	905.0	9.05	LS	$14,000.00	$126,700	209,185	10,371	
	Riparian Forest Footprint Maintenance	10 Years	0.01	89.0	0.89	LS	$9,750.00	$8,678	14,327	710	
	Adaptive Management	10 Years	1.00	1.0	1.00	LS	$5,100,000.00	$5,100,000	8,420,243	417,452	
08	RAILROAD BRIDGE										
	RR Bridge 1 BNSF P-Line Subdivision	10 Years	0.10	1.0	0.10	LS	$4,400,000.00	$440,000	726,452	36,015	
	RR Bridge 2 BNSF Mainline	10 Years	0.10	1.0	0.10	LS	$18,435,900.00	$1,843,590	3,043,819	150,904	
	RR Bridge 3 OTVR	10 Years	0.10	1.0	0.10	LS	$4,462,700.00	$446,270	736,804	36,529	
	RR Bridge 4 BNSF Moorhead Subdivision	10 Years	0.10	1.0	0.10	LS	$4,469,000.00	$446,900	737,844	36,580	

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT and REHABILITAION

Life Cycle 50 Years

Rate of Return 4.375%

Date Prepared: 28-Apr-2011

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - FCP MN Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT					O&M and MAJOR REPLACEMENT COSTS				EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE		
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	PROJECT UNIT PRICE	O&M AMOUNT	PRESENT VALUE	ANNUAL COST	COMMENTS
									$71,566,798	$3,548,079	Percentage of Construction 0.38%
09	**CHANNELS & CANALS**										
	CHANNELS										
	DIVERSION CHANNEL EXCAVATION & SPOIL BERMS										
	REACH 1 - 2013										
	Channel Slope Maintenance - Type 1	10 Years	0.05	727,151.0	36357.55	LS	$3.50	$127,251	210,096	10,416	
	Excavate Sediment from Channel - Type 2	10 Years	0.05	338,286.0	16914.30	LS	$3.95	$66,811	110,308	5,469	
	Channel Slope Maintenance - Type 3	10 Years	0.05	0.0	0.00	LS	$0.00	$0			
	Excavate Sediment from Channel - Type 4	10 Years	0.10	0.0	0.00	LS	$0.00	$0			
	Repair Riprap Channel Bank Protection	10 Years	0.05	13,410.0	670.50	LS	$122.11	$81,875	135,178	6,702	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	629.0	31.45	LS	$106.39	$3,346	12,367	613	
	Channel Topsoil Maintenance	10 Years	0.10	51,762.0	5176.20	LS	$1.91	$9,887	16,323	809	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	278,571.0	13928.55	LS	$1.84	$25,629	11,799	585	
	Turf Maintenance / Replacement	10 Years	0.05	198.0	9.90	LS	$4,260.00	$42,174	69,630	3,452	
	Mowing	1 Year	2.00	198.0	396.00	ACRE	$20.00	$7,920	159,751	7,920	2 mowings per year @ $20 / acre
	REACH 2 - 2014										
	Channel Slope Maintenance - Type 1	10 Years	0.05	2,017,993.0	100899.65	LS	$3.50	$353,149	583,059	28,906	
	Excavate Sediment from Channel - Type 2	10 Years	0.05	2,369,143.0	118457.15	LS	$3.95	$467,906	772,525	38,300	
	Channel Slope Maintenance - Type 3	10 Years	0.05	0.0	0.00	LS	$0.00	$0			
	Excavate Sediment from Channel - Type 4	10 Years	0.10	0.0	0.00	LS	$0.00	$0			
	Repair Riprap Channel Bank Protection	10 Years	0.05	34,222.0	1711.10	LS	$122.11	$208,942	344,970	17,103	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	1,605.0	80.25	LS	$106.39	$8,536	31,558	1,565	
	Channel Topsoil Maintenance	10 Years	0.10	161,259.0	16125.90	LS	$1.91	$30,800	50,852	2,521	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	945,023.0	47251.15	LS	$1.84	$86,942	40,026	1,984	
	Turf Maintenance / Replacement	10 Years	0.05	669.0	33.45	LS	$4,260.00	$142,497	235,267	11,664	
	Mowing	1 Year	2.00	669.0	1,338.00	ACRE	$20.00	$26,760	539,765	26,760	2 mowings per year @ $20 / acre
	REACH 3 - 2015										
	Channel Slope Maintenance - Type 1	10 Years	0.05	3,755,851.0	187792.55	LS	$3.50	$657,274	1,085,178	53,800	
	Channel Slope Maintenance - Type 2	10 Years	0.05	11,119,325.0	555966.25	LS	$3.95	$2,196,067	3,625,768	179,755	
	Channel Slope Maintenance - Type 3	10 Years	0.05	0.0	0.00	LS	$0.00	$0			
	Excavate Sediment from Channel - Type 4	10 Years	0.10	1,404,324.0	140432.40	LS	$6.70	$940,897	1,553,447	77,016	
	Repair Riprap Channel Bank Protection	10 Years	0.05	57,363.0	2868.15	LS	$122.11	$350,230	578,239	28,667	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	2,691.0	134.55	LS	$106.39	$14,315	52,911	2,623	
	Channel Topsoil Maintenance	10 Years	0.10	321,616.0	32161.60	LS	$1.91	$61,429	101,420	5,028	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	2,209,112.0	110455.60	LS	$1.84	$203,238	93,566	4,639	
	Turf Maintenance / Replacement	10 Years	0.05	1,541.0	77.05	LS	$4,260.00	$326,233	541,922	26,867	
	Mowing	1 Year	2.00	1,541.0	3,082.00	ACRE	$20.00	$61,640	1,243,314	61,640	2 mowings per year @ $20 / acre

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT and REHABILITAION

Life Cycle 50 Years

Rate of Return 4.375%

Date Prepared: 28-Apr-2011

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - FCP MN Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT					O&M and MAJOR REPLACEMENT COSTS				EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE		
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	PROJECT UNIT PRICE	O&M AMOUNT	PRESENT VALUE	ANNUAL COST	COMMENTS
									$71,566,798	$3,548,079	Percentage of Construction 0.38%
09	REACH 4 - 2016										
	Channel Slope Maintenance - Type 1	10 Years	0.05	2,600,814.0	130040.70	LS	$3.50	$455,142	751,453	37,255	
	Channel Slope Maintenance - Type 2	10 Years	0.05	6,511,502.0	325575.10	LS	$3.95	$1,286,022	2,123,258	105,265	
	Channel Slope Maintenance - Type 3	10 Years	0.05	795,024.0	39751.20	LS	$5.21	$207,104	341,934	16,952	
	Excavate Sediment from Channel - Type 4	10 Years	0.10	1,861,980.0	186198.00	LS	$6.70	$1,247,527	2,059,701	102,114	
	Repair Riprap Channel Bank Protection	10 Years	0.05	28,664.0	1433.20	LS	$122.11	$175,008	288,943	14,325	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	1,345.0	67.25	LS	$106.39	$7,155	26,446	1,311	
	Channel Topsoil Maintenance	10 Years	0.10	207,663.0	20766.30	LS	$1.91	$39,664	65,486	3,247	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	1,288,260.0	64413.00	LS	$1.84	$118,520	54,564	2,705	
	Turf Maintenance / Replacement	10 Years	0.05	913.0	45.65	LS	$4,260.00	$194,469	321,074	15,918	
	Mowing	1 Year	2.00	913.0	1,826.00	ACRE	$20.00	$36,520	736,629	36,520	2 mowings per year @ $20 / acre
	REACH 5 - 2017										
	Channel Slope Maintenance - Type 1	10 Years	0.05	2,144,360.0	107219.00	LS	$3.50	$375,267	619,575	30,717	
	Channel Slope Maintenance - Type 2	10 Years	0.05	3,635,924.0	181796.20	LS	$3.95	$718,095	1,185,595	58,778	
	Channel Slope Maintenance - Type 3	10 Years	0.05	147,721.0	7386.05	LS	$5.21	$38,481	63,534	3,150	
	Excavate Sediment from Channel - Type 4	10 Years	0.10	623,200.0	62320.00	LS	$6.70	$417,544	689,377	34,177	
	Repair Riprap Channel Bank Protection	10 Years	0.05	20,533.0	1026.65	LS	$122.11	$125,364	206,980	10,261	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	963.0	48.15	LS	$106.39	$5,123	18,935	939	
	Channel Topsoil Maintenance	10 Years	0.10	129,444.0	12944.40	LS	$1.91	$24,724	40,820	2,024	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	871,562.0	43578.10	LS	$1.84	$80,184	36,915	1,830	
	Turf Maintenance / Replacement	10 Years	0.05	611.0	30.55	LS	$4,260.00	$130,143	214,870	10,653	
	Mowing	1 Year	2.00	611.0	1,222.00	ACRE	$20.00	$24,440	492,969	24,440	2 mowings per year @ $20 / acre
	REACH 6 - 2018										
	Channel Slope Maintenance - Type 1	10 Years	0.05	6,984,125.0	349206.25	LS	$3.50	$1,222,222	2,017,922	100,043	
	Channel Slope Maintenance - Type 2	10 Years	0.05	5,599,732.0	279966.60	LS	$3.95	$1,105,947	1,825,950	90,525	
	Channel Slope Maintenance - Type 3	10 Years	0.05	5,336,045.0	266802.25	LS	$5.21	$1,390,040	2,294,994	113,779	
	Excavate Sediment from Channel - Type 4	10 Years	0.10	2,246,186.0	224618.60	LS	$6.70	$1,504,945	2,484,706	123,185	
	Repair Riprap Channel Bank Protection	10 Years	0.05	84,858.0	4242.90	LS	$122.11	$518,101	855,398	42,408	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	3,981.0	199.05	LS	$106.39	$21,177	78,275	3,881	
	Channel Topsoil Maintenance	10 Years	0.10	1.0	0.10	LS	$2,788,300.00	$278,830	460,356	22,823	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	2,905,687.0	145284.35	LS	$1.84	$267,323	123,069	6,101	
	Turf Maintenance / Replacement	10 Years	0.05	2,033.0	101.65	LS	$4,260.00	$433,029	714,943	35,445	
	Mowing	1 Year	2.00	2,033.0	4,066.00	ACRE	$20.00	$81,320	1,640,271	81,320	2 mowings per year @ $20 / acre

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OPERATION, MAINTENANCE, REPAIR, REPLACEMENT and REHABILITAION

Life Cycle 50 Years
Rate of Return 4.375%
Date Prepared: 28-Apr-2011

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - FCP MN Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT					O&M and MAJOR REPLACEMENT COSTS				EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE		
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	PROJECT UNIT PRICE	O&M AMOUNT	PRESENT VALUE	ANNUAL COST	COMMENTS
									$71,566,798	$3,548,079	Percentage of Construction 0.38%
09	**RED RIVER INLET CONTROL STRUCTURE**										
	RRN GATED INLET CONTROL STRUCTURE										
	Gated Structure										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$3,900,300.00	$1,950,150	229,215	11,364	
	Gates and Bulkheads - Major Rehab	50 Years	0.50	1.0	0.50	LS	$5,638,400.00	$2,819,200	331,361	16,428	
	Gates and Bulkheads - Annual O & M	1 Year	1.00	1	1	LS	$30,000	$30,000	605,117	30,000	
	Wingwalls - Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$5,644,700.00	$2,822,350	331,731	16,446	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$2,788,300.00	$139,415	230,178	11,412	
	Fish Passage System Maintenance	10 Years	0.05	1.0	0.05	LS	$5,487,200.00	$274,360	452,976	22,457	
	Mech, Elect, SCADA, Ice Control & Misc. Items	1 Year	0.02	1.0	0.02	LS	$5,677,500.00	$113,550	2,290,369	113,550	Annual O&M costs = 2.0% of construction
	RRN INLET WEIR TO DIVERSION										
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$4,522,000.00	$226,100	373,297	18,507	
	SCADA	1 Year	0.02	1.0	0.02	LS	$77,700.00	$1,554	31,345	1,554	Annual O&M costs = 2.0% of construction
	RRN INLET WEIR TO EXTENSION CHANNEL										
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$1,884,100.00	$94,205	155,535	7,711	
	SCADA	1 Year	0.02	1.0	0.02	LS	$77,700.00	$1,554	31,345	1,554	Annual O&M costs = 2.0% of construction
	RED RIVER DIVERSION CHANNEL DROP STRUCTURE										
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$1,730,300.00	$86,515	142,839	7,082	
	RED RIVER OUTLET CONTROL STRUCTURE										
	Repair Riprap Erosion Protection	10 Years	0.05	9,722.0	486.10	LS	$146.41	$71,170	117,503	5,825	
	SCADA	1 Year	0.02	1.0	0.02	LS	$15,200.00	$304	6,132	304	Annual O&M costs = 2.0% of construction
	SMALL DRAINS	10 Years	0.05	3.0	0.15	LS	$261,800.00	$39,270	64,836	3,214	
	SIDE CHANNEL INLET MANHOLES - 72-INCH	10 Years	0.05	7.0	0.35	LS	$454,400.00	$159,040	262,579	13,016	
	SIDE CHANNEL INLET MH - TWIN 72-INCH	10 Years	0.05	11.0	0.55	LS	$825,100.00	$453,805	749,245	37,145	
	DIVERSION LANDSCAPE PLANTINGS										
	Main Diversion Channel Plantings	10 Years	0.01	24.6	0.25	LS	$30,000.00	$7,380	12,185	604	
	Extension Diversion Channel Plantings	10 Years	0.01	3.0	0.03	LS	$30,000.00	$900	1,486	74	
11	**LEVEES, FLOODWALLS & FLOODPROOFING**										
	LEVEES										
	TIE-BACK LEVEES										
	Levee Embankment Maintenance	10 Years	0.05	575,000.0	28750.00	LS	$17.17	$493,638	815,009	40,406	
	Levee Topsoil Maintenance	10 Years	0.05	165,000.0	8250.00	LS	$11.55	$95,288	157,322	7,800	
	Levee Turf Maintenance / Replacement	10 Years	0.05	170.0	8.50	LS	$4,217.00	$35,845	59,180	2,934	
	Mowing	1 Year	4.00	170.0	680.00	ACRE	$20.00	$13,600	274,320	13,600	4 mowings per year @ $20 / acre
	Fertilizing & Weed Control	1 Year	1.00	170.0	170.00	ACRE	$250.00	$42,500	857,250	42,500	
	Floodwall										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$1,016,200.00	$508,100	59,721	2,961	
	NON-STRUCTURAL FLOODPROOFING										
	Floodwall										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$348,000.00	$174,000	20,451	1,014	

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT and REHABILITAION

Life Cycle 50 Years Date Prepared: 28-Apr-2011
Rate of Return 4.375%

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - FCP MN Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT					O&M and MAJOR REPLACEMENT COSTS				EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE		
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	PROJECT UNIT PRICE	O&M AMOUNT	PRESENT VALUE	ANNUAL COST	COMMENTS
									$71,566,798	$3,548,079	Percentage of Construction 0.38%
14	**RECREATIONAL FACILITIES**										
	Multi-Purpose Trails	20 Years	0.05	30.0	1.50	MI	$270,000.00	$405,000	263,826	13,080	
	Soft Trails	10 Years	0.05	18.0	0.90	MI	$105,400.00	$94,860	156,617	7,765	
	Trail River Crossing	20 Years	0.05	2.0	0.10	EA	$2,850,000.00	$285,000	185,656	9,204	
	Trailhead Facilities	20 Years	0.05	3.0	0.15	EA	$152,600.00	$22,890	14,911	739	
	Parking Facilities										
	Car Parking Lots	10 Years	0.10	3.0	0.30	EA	$88,100.00	$26,430	43,637	2,163	
	Car/Trailer Park Lots	10 Years	0.10	2.0	0.20	EA	$193,100.00	$38,620	63,763	3,161	
	Interpretive Signage	5 Years	0.10	1.0	0.10	LS	$33,100.00	$3,310	12,235	607	
	Landscaping	25 Years	0.05	100.0	5.00	ACRE	$31,300.00	$156,500	72,049	3,572	
	Total O&M								**$71,566,798**	**$3,548,079**	

****** TOTAL PROJECT COST SUMMARY ******
LPP North Dakota Phase 4

Printed:6/28/2011

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN

DISTRICT: St Paul District - MVP
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

PREPARED: 4/28/2011

This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	BASE COST TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	FIRST COST TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Spent Thru: 1-Oct-2011 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
02	RELOCATIONS	$119,480	$31,065	26%	$150,544	2.5%	$122,453	$31,838	**$154,291**			$137,127	$35,653	$172,779
06	FISH & WILDLIFE FACILITIES	$48,059	$12,495	26%	$60,555	2.4%	$49,196	$12,791	**$61,987**			$54,244	$14,103	$68,347
08	ROADS, RAILROADS & BRIDGES	$46,498	$12,089	26%	$58,587	2.5%	$47,655	$12,390	**$60,045**			$51,605	$13,417	$65,023
09	CHANNELS & CANALS	$609,689	$158,519	26%	$768,209	2.0%	$622,046	$161,732	**$783,778**			$693,331	$180,266	$873,597
11	LEVEES, FLOODWALLS & FLOODPROOFING	$111,191	$28,910	26%	$140,100	2.4%	$113,837	$29,598	**$143,435**			$131,521	$34,196	$165,717
14	RECREATION FACILITIES	$23,024	$5,986	26%	$29,011	2.7%	$23,650	$6,149	**$29,800**			$26,308	$6,840	$33,148
	CONSTRUCTION ESTIMATE TOTALS:	$957,941	$249,065		**$1,207,005**	2.2%	$978,838	$254,498	**$1,233,336**			$1,094,136	$284,475	$1,378,611
01	LANDS AND DAMAGES	$215,565	$56,047	26%	$271,612	2.5%	$220,930	$57,442	**$278,372**			$238,338	$61,968	$300,306
30	PLANNING, ENGINEERING & DESIGN	$143,703	$37,363	26%	$181,066	1.5%	$145,913	$37,937	**$183,850**			$175,332	$45,586	$220,919
31	CONSTRUCTION MANAGEMENT	$67,056	$17,435	26%	$84,491	1.5%	$68,087	$17,703	**$85,790**			$85,679	$22,277	$107,956
	PROJECT COST TOTALS:	$1,384,265	$359,909	26%	**$1,744,174**	2.1%	$1,413,768	$367,580	**$1,781,347**			$1,593,485	$414,306	$2,007,791

CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

PROJECT CO-MANAGERS, Brett R Coleman & Terryl L Williams

CHIEF, REAL ESTATE, John P Albrecht

ESTIMATED FEDERAL COST (1):	44.0%	**$884,272**
ESTIMATED NON-FEDERAL COST:	56.0%	**$1,123,519**
ESTIMATED TOTAL PROJECT COST:		**$2,007,791**

(1) Estimated Federal Cost is limited to 65% of the FCP MN Phase 4 Fully Funded Cost without Recreation costs plus 50% of the LPP ND Phase 4 Recreation costs

O&M OUTSIDE OF TOTAL PROJECT COST:

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****** TOTAL PROJECT COST SUMMARY ******

LPP North Dakota Phase 4

**** CONTRACT COST SUMMARY ****

REACH 1 - 2013

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report: Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	RISK BASED COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 1 - 2013													
02	RELOCATIONS	$3,259	$847	26%	$4,106	2.5%	$3,340	$868	$4,208	2013Q4	2.8%	$3,432	$892	$4,325
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$7,569	2.4%	$6,150	$1,599	$7,748	2014Q2	3.7%	$6,375	$1,658	$8,033
08	ROADS, RAILROADS & BRIDGES			26%										
09	CHANNELS & CANALS	$24,015	$6,244	26%	$30,259	2.0%	$24,502	$6,370	$30,872	2014Q2	3.7%	$25,402	$6,605	$32,007
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$2,878	$748	26%	$3,626	2.7%	$2,956	$769	$3,725	2014Q4	4.6%	$3,091	$804	$3,895
	CONSTRUCTION ESTIMATE TOTALS:	$36,159	$9,401	26%	**$45,560**		$36,947	$9,606	$46,554			$38,301	$9,958	$48,259
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$33,951	2.5%	$27,616	$7,180	$34,796	2013Q1	1.5%	$28,043	$7,291	$35,334
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$362	$94	26%	$456	1.5%	$368	$96	$463	2012Q3	1.0%	$371	$97	$468
2.0%	Planning & Environmental Compliance	$723	$188	26%	$911	1.5%	$734	$191	$925	2012Q3	1.0%	$741	$193	$934
8.0%	Engineering & Design	$2,893	$752	26%	$3,645	1.5%	$2,937	$764	$3,701	2012Q3	1.0%	$2,966	$771	$3,737
1.0%	Engineering Tech Review ITR & VE	$362	$94	26%	$456	1.5%	$368	$96	$463	2012Q3	1.0%	$371	$97	$468
1.0%	Contracting & Reprographics	$362	$94	26%	$456	1.5%	$368	$96	$463	2012Q3	1.0%	$371	$97	$468
1.0%	Engineering During Construction	$362	$94	26%	$456	1.5%	$368	$96	$463	2014Q2	7.7%	$396	$103	$499
1.0%	Planning During Construction	$362	$94	26%	$456	1.5%	$368	$96	$463	2014Q2	7.7%	$396	$103	$499
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$2,531	$658	26%	$3,189	1.5%	$2,570	$668	$3,238	2014Q2	7.7%	$2,767	$719	$3,486
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$71,062	$18,476		**$89,538**		$72,643	$18,887	$91,530			$74,724	$19,428	**$94,152**

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****** TOTAL PROJECT COST SUMMARY ******
LPP North Dakota Phase 4
**** CONTRACT COST SUMMARY ****
REACH 2 - 2014

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report: Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

PREPARED: 4/28/2011

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	REACH 2 - 2014													
02	RELOCATIONS	$4,286	$1,115	26%	$5,403	2.5%	$4,395	$1,143	$5,537	2014Q4	4.6%	$4,595	$1,195	$5,790
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$7,569	2.4%	$6,150	$1,599	$7,748	2015Q2	5.4%	$6,464	$1,686	$8,170
08	ROADS, RAILROADS & BRIDGES	$7,868	$2,046	26%	$9,913	2.5%	$8,063	$2,096	$10,160	2015Q2	5.4%	$8,502	$2,210	$10,712
09	CHANNELS & CANALS	$50,130	$13,034	26%	$63,164	2.0%	$51,146	$13,298	$64,444	2015Q2	5.4%	$53,928	$14,021	$67,949
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$2,878	$748	26%	$3,626	2.7%	$2,956	$769	$3,725	2015Q4	6.3%	$3,144	$817	$3,961
	CONSTRUCTION ESTIMATE TOTALS:	$71,171	$18,504	26%	**$89,676**		$72,710	$18,905	$91,615			$76,652	$19,929	$96,581
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$33,951	2.5%	$27,616	$7,180	$34,796	2014Q1	3.2%	$28,509	$7,412	$35,922
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$712	$185	26%	$897	1.5%	$723	$188	$911	2013Q3	4.3%	$754	$196	$950
2.0%	Planning & Environmental Compliance	$1,423	$370	26%	$1,793	1.5%	$1,445	$376	$1,821	2013Q3	4.3%	$1,507	$392	$1,899
8.0%	Engineering & Design	$5,694	$1,480	26%	$7,174	1.5%	$5,782	$1,503	$7,285	2013Q3	4.3%	$6,030	$1,568	$7,598
1.0%	Engineering Tech Review ITR & VE	$712	$185	26%	$897	1.5%	$723	$188	$911	2013Q3	4.3%	$754	$196	$950
1.0%	Contracting & Reprographics	$712	$185	26%	$897	1.5%	$723	$188	$911	2013Q3	4.3%	$754	$196	$950
1.0%	Engineering During Construction	$712	$185	26%	$897	1.5%	$723	$188	$911	2015Q2	12.1%	$810	$211	$1,021
1.0%	Planning During Construction	$712	$185	26%	$897	1.5%	$723	$188	$911	2015Q2	12.1%	$810	$211	$1,021
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$4,982	$1,295	26%	$6,277	1.5%	$5,059	$1,315	$6,374	2015Q2	12.1%	$5,669	$1,474	$7,143
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$113,776	$29,582		**$143,357**		$116,226	$30,219	$146,445			$122,250	$31,785	**$154,034**

****** TOTAL PROJECT COST SUMMARY ******
LPP North Dakota Phase 4
**** CONTRACT COST SUMMARY ****
REACH 3 - 2015

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 3 - 2015													
02	RELOCATIONS	$15,500	$4,030	26%	$19,530	2.5%	$15,886	$4,130	$20,016	2015Q4	6.3%	$16,892	$4,392	$21,284
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$7,569	2.4%	$6,150	$1,599	$7,748	2016Q2	7.2%	$6,594	$1,714	$8,309
08	ROADS, RAILROADS & BRIDGES	$20,743	$5,393	26%	$26,136	2.5%	$21,259	$5,527	$26,786	2016Q2	7.2%	$22,796	$5,927	$28,723
09	CHANNELS & CANALS	$30,525	$7,937	26%	$38,462	2.0%	$31,144	$8,097	$39,241	2016Q2	7.2%	$33,396	$8,683	$42,079
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$2,878	$748	26%	$3,626	2.7%	$2,956	$769	$3,725	2016Q4	8.1%	$3,197	$831	$4,028
	CONSTRUCTION ESTIMATE TOTALS:	$75,653	$19,670	26%	**$95,323**		$77,394	$20,123	$97,517			$82,875	$21,548	$104,423
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$33,951	2.5%	$27,616	$7,180	$34,796	2015Q1	5.0%	$28,994	$7,538	$36,532
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$757	$197	26%	$954	1.5%	$769	$200	$968	2014Q3	8.8%	$836	$217	$1,053
2.0%	Planning & Environmental Compliance	$1,513	$393	26%	$1,906	1.5%	$1,536	$399	$1,936	2014Q3	8.8%	$1,671	$434	$2,105
8.0%	Engineering & Design	$6,052	$1,574	26%	$7,626	1.5%	$6,145	$1,598	$7,743	2014Q3	8.8%	$6,684	$1,738	$8,422
1.0%	Engineering Tech Review ITR & VE	$757	$197	26%	$954	1.5%	$769	$200	$968	2014Q3	8.8%	$836	$217	$1,053
1.0%	Contracting & Reprographics	$757	$197	26%	$954	1.5%	$769	$200	$968	2014Q3	8.8%	$836	$217	$1,053
1.0%	Engineering During Construction	$757	$197	26%	$954	1.5%	$769	$200	$968	2016Q2	16.6%	$896	$233	$1,129
1.0%	Planning During Construction	$757	$197	26%	$954	1.5%	$769	$200	$968	2016Q2	16.6%	$896	$233	$1,129
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$5,296	$1,377	26%	$6,673	1.5%	$5,377	$1,398	$6,776	2016Q2	16.6%	$6,268	$1,630	$7,898
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$119,245	$31,004		**$150,249**		$121,913	$31,697	$153,610			$130,792	$34,006	**$164,798**

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****** TOTAL PROJECT COST SUMMARY ******
LPP North Dakota Phase 4
**** CONTRACT COST SUMMARY ****
REACH 4 - 2016

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 4 - 2016													
02	RELOCATIONS	$16,770	$4,360	26%	$21,131	2.5%	$17,188	$4,469	$21,656	2016Q4	8.1%	$18,587	$4,833	$23,420
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$7,569	2.4%	$6,150	$1,599	$7,748	2017Q2	9.1%	$6,712	$1,745	$8,457
08	ROADS, RAILROADS & BRIDGES	$10,548	$2,743	26%	$13,291	2.5%	$10,811	$2,811	$13,622	2017Q2	9.1%	$11,800	$3,068	$14,868
09	CHANNELS & CANALS	$108,550	$28,223	26%	$136,773	2.0%	$110,750	$28,795	$139,545	2017Q2	9.1%	$120,880	$31,429	$152,309
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$2,878	$748	26%	$3,626	2.7%	$2,956	$769	$3,725	2017Q4	10.1%	$3,256	$847	$4,102
	CONSTRUCTION ESTIMATE TOTALS:	$144,754	$37,636	26%	**$182,390**		$147,854	$38,442	$186,297			$161,235	$41,921	$203,156
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$33,951	2.5%	$27,616	$7,180	$34,796	2016Q1	6.8%	$29,497	$7,667	$37,163
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$1,448	$376	26%	$1,824	1.5%	$1,470	$382	$1,853	2015Q3	13.2%	$1,664	$433	$2,097
2.0%	Planning & Environmental Compliance	$2,895	$753	26%	$3,648	1.5%	$2,940	$764	$3,704	2015Q3	13.2%	$3,327	$865	$4,192
8.0%	Engineering & Design	$11,580	$3,011	26%	$14,591	1.5%	$11,758	$3,057	$14,815	2015Q3	13.2%	$13,309	$3,460	$16,769
1.0%	Engineering Tech Review ITR & VE	$1,448	$376	26%	$1,824	1.5%	$1,470	$382	$1,853	2015Q3	13.2%	$1,664	$433	$2,097
1.0%	Contracting & Reprographics	$1,448	$376	26%	$1,824	1.5%	$1,470	$382	$1,853	2015Q3	13.2%	$1,664	$433	$2,097
1.0%	Engineering During Construction	$1,448	$376	26%	$1,824	1.5%	$1,470	$382	$1,853	2017Q2	21.1%	$1,780	$463	$2,243
1.0%	Planning During Construction	$1,448	$376	26%	$1,824	1.5%	$1,470	$382	$1,853	2017Q2	21.1%	$1,780	$463	$2,243
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$10,133	$2,635	26%	$12,768	1.5%	$10,289	$2,675	$12,964	2017Q2	21.1%	$12,455	$3,238	$15,693
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$203,548	$52,922		**$256,470**		$207,808	$54,030	$261,839			$228,365	$59,375	**$287,740**

FULLY FUNDED PROJECT ESTIMATE

****** TOTAL PROJECT COST SUMMARY ******

LPP North Dakota Phase 4

**** CONTRACT COST SUMMARY ****

REACH 5 - 2017

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report: Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O	FULLY FUNDED PROJECT ESTIMATE
	REACH 5 - 2017													
02	RELOCATIONS	$4,466	$1,161	26%	$5,627	2.5%	$4,577	$1,190	$5,767	2017Q4	10.1%	$5,041	$1,311	$6,351
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$7,569	2.4%	$6,150	$1,599	$7,748	2018Q2	11.1%	$6,833	$1,777	$8,609
08	ROADS, RAILROADS & BRIDGES			26%										
09	CHANNELS & CANALS	$58,912	$15,317	26%	$74,229	2.0%	$60,106	$15,628	$75,734	2018Q2	11.1%	$66,785	$17,364	$84,149
11	LEVEES, FLOODWALLS & FLOODPROOFING			26%										
14	RECREATION FACILITIES	$2,878	$748	26%	$3,626	2.7%	$2,956	$769	$3,725	2018Q4	12.1%	$3,314	$862	$4,176
	CONSTRUCTION ESTIMATE TOTALS:	$72,263	$18,788	26%	**$91,052**		$73,789	$19,185	$92,974			$81,973	$21,313	$103,286
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$33,951	2.5%	$27,616	$7,180	$34,796	2017Q1	8.7%	$30,006	$7,802	$37,808
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$723	$188	26%	$911	1.5%	$734	$191	$925	2016Q3	17.7%	$864	$225	$1,089
2.0%	Planning & Environmental Compliance	$1,445	$376	26%	$1,821	1.5%	$1,467	$381	$1,849	2016Q3	17.7%	$1,727	$449	$2,176
8.0%	Engineering & Design	$5,781	$1,503	26%	$7,284	1.5%	$5,870	$1,526	$7,396	2016Q3	17.7%	$6,908	$1,796	$8,704
1.0%	Engineering Tech Review ITR & VE	$723	$188	26%	$911	1.5%	$734	$191	$925	2016Q3	17.7%	$864	$225	$1,089
1.0%	Contracting & Reprographics	$723	$188	26%	$911	1.5%	$734	$191	$925	2016Q3	17.7%	$864	$225	$1,089
1.0%	Engineering During Construction	$723	$188	26%	$911	1.5%	$734	$191	$925	2018Q2	25.5%	$922	$240	$1,161
1.0%	Planning During Construction	$723	$188	26%	$911	1.5%	$734	$191	$925	2018Q2	25.5%	$922	$240	$1,161
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$5,058	$1,315	26%	$6,373	1.5%	$5,136	$1,335	$6,471	2018Q2	25.5%	$6,448	$1,676	$8,124
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$115,108	$29,928		**$145,036**		$117,549	$30,563	$148,111			$131,497	$34,189	**$165,686**

****** TOTAL PROJECT COST SUMMARY ******
LPP North Dakota Phase 4
**** CONTRACT COST SUMMARY ****
REACH 6 - 2018

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 6 - 2018													
02	RELOCATIONS	$18,595	$4,835	26%	$23,429	2.5%	$19,057	$4,955	$24,012	2018Q4	12.1%	$21,366	$5,555	$26,921
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$7,569	2.4%	$6,150	$1,599	$7,748	2019Q2	13.1%	$6,956	$1,809	$8,764
08	ROADS, RAILROADS & BRIDGES	$7,339	$1,908	26%	$9,247	2.5%	$7,522	$1,956	$9,477	2019Q2	13.1%	$8,508	$2,212	$10,720
09	CHANNELS & CANALS	$235,434	$61,213	26%	$296,647	2.0%	$240,206	$62,454	$302,659	2019Q2	13.1%	$271,701	$70,642	$342,344
11	LEVEES, FLOODWALLS & FLOODPROOFING	$6,802	$1,768	26%	$8,570	2.4%	$6,964	$1,811	$8,774	2019Q2	13.1%	$7,877	$2,048	$9,925
14	RECREATION FACILITIES	$2,878	$748	26%	$3,626	2.7%	$2,956	$769	$3,725	2019Q4	14.1%	$3,374	$877	$4,251
	CONSTRUCTION ESTIMATE TOTALS:	$277,055	$72,034	26%	**$349,089**		$282,854	$73,542	$356,396			$319,781	**$83,143**	$402,924
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$33,951	2.5%	$27,616	$7,180	$34,796	2018Q1	10.6%	$30,546	$7,942	$38,488
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$2,771	$720	26%	$3,491	1.5%	$2,814	$732	$3,545	2017Q3	22.2%	$3,438	$894	$4,331
2.0%	Planning & Environmental Compliance	$5,541	$1,441	26%	$6,982	1.5%	$5,626	$1,463	$7,089	2017Q3	22.2%	$6,874	$1,787	$8,661
8.0%	Engineering & Design	$22,164	$5,763	26%	$27,927	1.5%	$22,505	$5,851	$28,356	2017Q3	22.2%	$27,496	$7,149	$34,645
1.0%	Engineering Tech Review ITR & VE	$2,771	$720	26%	$3,491	1.5%	$2,814	$732	$3,545	2017Q3	22.2%	$3,438	$894	$4,331
1.0%	Contracting & Reprographics	$2,771	$720	26%	$3,491	1.5%	$2,814	$732	$3,545	2017Q3	22.2%	$3,438	$894	$4,331
1.0%	Engineering During Construction	$2,771	$720	26%	$3,491	1.5%	$2,814	$732	$3,545	2018Q2	25.5%	$3,532	$918	$4,451
1.0%	Planning During Construction	$2,771	$720	26%	$3,491	1.5%	$2,814	$732	$3,545	2018Q2	25.5%	$3,532	$918	$4,451
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$19,394	$5,042	26%	$24,436	1.5%	$19,692	$5,120	$24,812	2018Q2	25.5%	$24,724	$6,428	$31,152
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$364,954	$94,888		**$459,843**		$372,362	$96,814	$469,176			$426,799	$110,968	**$537,767**

****** TOTAL PROJECT COST SUMMARY ******

LPP North Dakota Phase 4

**** CONTRACT COST SUMMARY ****

REACH 7 - 2019

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report: Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

Estimate Prepared: 1-Aug-2010
Effective Price Level: 1 OCT 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 7 - 2019													
02	RELOCATIONS	$8,911	$2,317	26%	$11,227	2.5%	$9,132	$2,374	$11,507	2019Q4	14.1%	$10,423	$2,710	$13,133
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$7,569	2.4%	$6,150	$1,599	$7,748	2020Q2	15.1%	$7,081	$1,841	$8,922
08	ROADS, RAILROADS & BRIDGES			26%										
09	CHANNELS & CANALS	$42,301	$10,998	26%	$53,299	2.0%	$43,158	$11,221	$54,379	2020Q2	15.1%	$49,695	$12,921	$62,616
11	LEVEES, FLOODWALLS & FLOODPROOFING	$76,992	$20,018	26%	$97,010	2.4%	$78,825	$20,494	$99,319	2020Q2	15.1%	$90,766	$23,599	$114,365
14	RECREATION FACILITIES	$2,878	$748	26%	$3,626	2.7%	$2,956	$769	$3,725	2020Q4	16.2%	$3,435	$893	$4,328
	CONSTRUCTION ESTIMATE TOTALS:	$137,089	$35,643	26%	**$172,732**		$140,221	$36,457	$176,678			$161,400	$41,964	$203,363
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$33,951	2.5%	$27,616	$7,180	$34,796	2019Q1	12.6%	$31,096	$8,085	$39,181
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$1,371	$356	26%	$1,727	1.5%	$1,392	$362	$1,754	2018Q3	26.7%	$1,763	$458	$2,222
2.0%	Planning & Environmental Compliance	$2,742	$713	26%	$3,455	1.5%	$2,784	$724	$3,508	2018Q3	26.7%	$3,527	$917	$4,444
8.0%	Engineering & Design	$10,967	$2,851	26%	$13,818	1.5%	$11,136	$2,895	$14,031	2018Q3	26.7%	$14,106	$3,668	$17,773
1.0%	Engineering Tech Review ITR & VE	$1,371	$356	26%	$1,727	1.5%	$1,392	$362	$1,754	2018Q3	26.7%	$1,763	$458	$2,222
1.0%	Contracting & Reprographics	$1,371	$356	26%	$1,727	1.5%	$1,392	$362	$1,754	2018Q3	26.7%	$1,763	$458	$2,222
1.0%	Engineering During Construction	$1,371	$356	26%	$1,727	1.5%	$1,392	$362	$1,754	2020Q2	34.6%	$1,874	$487	$2,362
1.0%	Planning During Construction	$1,371	$356	26%	$1,727	1.5%	$1,392	$362	$1,754	2020Q2	34.6%	$1,874	$487	$2,362
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$9,596	$2,495	26%	$12,091	1.5%	$9,744	$2,533	$12,277	2020Q2	34.6%	$13,118	$3,411	$16,529
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$194,194	$50,491		**$244,685**		$198,461	$51,600	$250,060			$232,286	$60,394	**$292,680**

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****** TOTAL PROJECT COST SUMMARY ******
LPP North Dakota Phase 4

Printed:6/28/2011

**** CONTRACT COST SUMMARY ****
REACH 8 - 2020

PROJECT: Fargo-Moorhead Metro Feasibility Study
LOCATION: Fargo, ND & Moorhead, MN
This Estimate reflects the scope and schedule in report; Final Fargo-Moorhead Metro Feasibility Report and Environmental Impact Statement

DISTRICT: St Paul District - MVP PREPARED: 4/28/2011
POC: CHIEF, COST ENGINEERING, James D Sentz, PE, CCE

		Estimate Prepared: 1-Aug-2010 Effective Price Level: 1 OCT 2010				Program Year (Budget EC): 2012 Effective Price Level Date: 1 OCT 11				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	REACH 8 - 2020													
02	RELOCATIONS	$47,692	$12,400	26%	$ 60,092	2.5%	$48,879	$12,709	$61,588	2020Q4	16.2%	$56,790	$14,766	$71,556
06	FISH & WILDLIFE FACILITIES	$6,007	$1,562	26%	$ 7,569	2.4%	$6,150	$1,599	$7,748	2021Q2	17.2%	$7,208	$1,874	$9,083
08	ROADS, RAILROADS & BRIDGES			26%	$ -									
09	CHANNELS & CANALS	$59,822	$15,554	26%	$ 75,376	2.0%	$61,034	$15,869	$76,903	2021Q2	17.2%	$71,544	$18,602	$90,146
11	LEVEES, FLOODWALLS & FLOODPROOFING	$27,397	$7,123	26%	$ 34,520	2.4%	$28,049	$7,293	$35,341	2021Q2	17.2%	$32,879	$8,549	$41,427
14	RECREATION FACILITIES	$2,878	$748	26%	$ 3,626	2.7%	$2,956	$769	$3,725	2021Q4	18.3%	$3,497	$909	$4,406
	CONSTRUCTION ESTIMATE TOTALS:	$143,796	$37,387	26%	**181,183**		$147,068	$38,238	$185,306			$171,919	$44,699	$216,618
01	LANDS AND DAMAGES	$26,946	$7,006	26%	$ 33,951	2.5%	$27,616	$7,180	$34,796	2020Q1	14.6%	$31,656	$8,231	$39,886
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$1,438	$374	26%	1,812	1.5%	$1,460	$380	$1,840	2019Q3	31.2%	$1,916	$498	$2,414
2.0%	Planning & Environmental Compliance	$2,876	$748	26%	3,624	1.5%	$2,920	$759	$3,679	2019Q3	31.2%	$3,831	$996	$4,827
8.0%	Engineering & Design	$11,504	$2,991	26%	14,495	1.5%	$11,681	$3,037	$14,718	2019Q3	31.2%	$15,324	$3,984	$19,309
1.0%	Engineering Tech Review ITR & VE	$1,438	$374	26%	1,812	1.5%	$1,460	$380	$1,840	2019Q3	31.2%	$1,916	$498	$2,414
1.0%	Contracting & Reprographics	$1,438	$374	26%	1,812	1.5%	$1,460	$380	$1,840	2019Q3	31.2%	$1,916	$498	$2,414
1.0%	Engineering During Construction	$1,438	$374	26%	1,812	1.5%	$1,460	$380	$1,840	2021Q2	39.2%	$2,033	$529	$2,561
1.0%	Planning During Construction	$1,438	$374	26%	1,812	1.5%	$1,460	$380	$1,840	2021Q2	39.2%	$2,033	$529	$2,561
	Project Operations			26%										
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	$10,066	$2,617	26%	12,683	1.5%	$10,221	$2,657	$12,878	2021Q2	39.2%	$14,230	$3,700	$17,930
	Project Operation:			26%										
	Project Management			26%										
	CONTRACT COST TOTALS:	$202,378	$52,618		**254,996**		$206,807	$53,770	$260,576			$246,773	$64,161	**$310,934**

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OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Life Cycle 50 Years Date Prepared: 28-Apr-2011
Rate of Return 4.375%

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - LLP ND Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT

CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	UNIT PRICE	AMOUNT	EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE PRESENT VALUE	ANNUAL COST	COMMENTS
		O&M and MAJOR REPLACEMENT COSTS							$73,241,069	$3,631,084	Percentage of Construction 0.31%
00	**PERIODIC INSPECTIONS**										
	Periodic Inspections										
	1st 5 years	1 Year	1.00	1	1	JOB	$50,000	$50,000	220,266	10,920	
	Year 7, 9 and 11	2 Years	1.00	1	1	JOB	$40,000	$40,000	61,823	4,057	Cost of periodics decreases after the 1st 5 years.
	Every 5 years beginning year 15	5 Years	1.00	1	1	JOB	$30,000	$30,000	67,119	3,328	
	Routine Annual Inspections	1 Year	1.00	1	1	JOB	$10,000	$10,000	201,706	10,000	
	Total Inspections								570,913	28,304	
02	**RELOCATIONS**										
	ROADS										
	County Hwy 81 (South)	10 Years	0.10	1.0	0.10	LS	$3,670,000.00	$367,000	605,927	30,040	
	Interstate 29 (NB-South)	10 Years	0.10	1.0	0.10	LS	$3,660,000.00	$366,000	604,276	29,958	
	Interstate 29 (SB-South)	10 Years	0.10	1.0	0.10	LS	$3,650,000.00	$365,000	602,625	29,876	
	45th Street SE	10 Years	0.10	1.0	0.10	LS	$2,500,000.00	$250,000	412,757	20,463	
	170th Avenue SE	10 Years	0.10	1.0	0.10	LS	$2,750,000.00	$275,000	454,033	22,510	
	46th Street SE	10 Years	0.10	1.0	0.10	LS	$3,280,000.00	$328,000	541,537	26,848	
	44th Street SE	10 Years	0.10	1.0	0.10	LS	$3,010,000.00	$301,000	496,959	24,638	
	41st Street SE	10 Years	0.10	1.0	0.10	LS	$3,530,000.00	$353,000	582,813	28,894	
	Interstate 94 (EB)	10 Years	0.10	1.0	0.10	LS	$3,690,000.00	$369,000	609,229	30,204	
	Interstate 94 (WB)	10 Years	0.10	1.0	0.10	LS	$3,690,000.00	$369,000	609,229	30,204	
	36th Street SE	10 Years	0.10	1.0	0.10	LS	$3,310,000.00	$331,000	546,490	27,093	
	33rd Street SE	10 Years	0.10	1.0	0.10	LS	$3,560,000.00	$356,000	587,766	29,140	
	31st Street SE	10 Years	0.10	1.0	0.10	LS	$2,890,000.00	$289,000	477,147	23,656	
	28th Street SE	10 Years	0.10	1.0	0.10	LS	$2,840,000.00	$284,000	468,892	23,246	
	Interstate 29 (SB-North)	10 Years	0.10	1.0	0.10	LS	$3,720,000.00	$372,000	614,182	30,449	
	Interstate 29 (NB-North)	10 Years	0.10	1.0	0.10	LS	$3,730,000.00	$373,000	615,833	30,531	
	County Hwy 81 (North)	10 Years	0.10	1.0	0.10	LS	$3,360,000.00	$336,000	554,745	27,503	
	25th Street SE	10 Years	0.10	1.0	0.10	LS	$2,900,000.00	$290,000	478,798	23,737	
	173rd Avenue SE	10 Years	0.10	1.0	0.10	LS	$2,880,000.00	$288,000	475,496	23,574	
06	**FISH AND WILDLIFE FACILITIES**										
	Aquatic Footprint Maintenance	10 Years	0.01	1.0	0.01	MI	$2,518,200.00	$25,182	41,576	2,061	
	Fish PassageOperation	10 Years	0.01	1.0	0.01	LS	$25,350,000.00	$253,500	418,536	20,750	
	Wetlands Footprint Maintenance	10 Years	0.01	998.0	9.98	ACRE	$13,750.00	$137,225	226,562	11,232	
	Riparian Forest Footprint Maintenance	10 Years	0.01	199.0	1.99	ACRE	$11,550.00	$22,985	37,948	1,881	
	Adaptive Management	10 Years	1.00	1.0	1.00	LS	$6,440,000.00	$6,440,000	10,632,620	527,135	
08	**RAILROAD BRIDGES**										
	RR Bridge 1 BSNF Hillsboro Subdivision	10 Years	0.10	1.0	0.10	LS	$3,463,100.00	$346,310	571,767	28,347	
	RR Bridge 2 BNSF Prosper Subdivision	10 Years	0.10	1.0	0.10	LS	$3,728,200.00	$372,820	615,536	30,517	
	RR Bridge 3 BNSF KO Subdivision	10 Years	0.10	1.0	0.10	LS	$6,607,700.00	$660,770	1,090,950	54,086	
	RR Bridge 4 RRVW 4th Subdivision	10 Years	0.10	1.0	0.10	LS	$3,987,300.00	$398,730	658,314	32,637	

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Life Cycle 50 Years | Date Prepared: 28-Apr-2011

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FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - LLP ND Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT

CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M and MAJOR REPLACEMENT COSTS: O&M QUANTITY	UNIT	UNIT PRICE	AMOUNT	EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE: PRESENT VALUE	ANNUAL COST	COMMENTS
									$73,241,069	$3,631,084	Percentage of Construction 0.31%
09	**CHANNELS & CANALS**										
	CHANNELS										
	DIVERSION CHANNEL EXCAVATION & SPOIL BERMS										
	REACH 1										
	Channel Slope Maintenance - Type 1	10 Years	0.05	34,231.0	1,712.0	CY	$3.40	$5,821	9,610	476	
	Excavate Sediment from Channel - Type 2	10 Years	0.10	68,334.0	6,833.0	CY	$3.83	$26,170	43,208	2,142	
	Repair Riprap Channel Bank Protection	10 Years	0.05	815.0	41.0	CY	$119.90	$4,916	8,116	402	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	38.0	2.0	CY	$104.42	$209	772	38	
	Channel Topsoil Maintenance	10 Years	0.10	2,702.0	270.0	CY	$1.86	$502	829	41	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	18,620.0	931.0	CY	$1.78	$1,657	763	38	
	Turf Maintenance / Replacement	10 Years	0.05	13.0	1.0	ACRE	$4,156.00	$4,156	6,862	340	
	Mowing	1 Year	2.00	13.0	26.00	ACRE	$20.00	$520	10,489	520	2 mowings per year @ $20 / acre
	REACH 2										
	Channel Slope Maintenance - Type 1	10 Years	0.05	161,848.0	8,092.0	CY	$3.40	$27,513	45,424	2,252	
	Channel Slope Maintenance - Type 2	10 Years	0.05	192,083.0	9,604.0	CY	$3.83	$36,783	60,730	3,011	
	Excavate Sediment from Channel - Type 3	10 Years	0.10	204,197.0	20,420.0	CY	$5.03	$102,713	169,581	8,407	
	Repair Riprap Channel Bank Protection	10 Years	0.05	3,096.0	155.0	CY	$119.91	$18,586	30,686	1,521	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	145.0	7.0	CY	$104.47	$731	2,703	134	
	Channel Topsoil Maintenance	10 Years	0.10	12,824.0	1,282.0	CY	$1.86	$2,385	3,937	195	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	80,881.0	4,044.0	CY	$1.78	$7,198	3,314	164	
	Turf Maintenance / Replacement	10 Years	0.05	58.0	3.0	ACRE	$4,156.00	$12,468	20,585	1,021	
	Mowing	1 Year	2.00	58.0	116.00	ACRE	$20.00	$2,320	46,796	2,320	2 mowings per year @ $20 / acre
	REACH 3										
	Channel Slope Maintenance - Type 1	10 Years	0.05	1,042,050.0	52,103.0	CY	$3.40	$177,150	292,480	14,500	
	Channel Slope Maintenance - Type 2	10 Years	0.05	1,638,021.0	81,901.0	CY	$3.83	$313,681	517,896	25,676	
	Channel Slope Maintenance - Type 3	10 Years	0.05	1,473,360.0	73,668.0	CY	$5.03	$370,550	611,788	30,331	
	Excavate Sediment from Channel - Type 4	10 Years	0.10	27,490.0	2,749.0	CY	$6.47	$17,786	29,365	1,456	
	Repair Riprap Channel Bank Protection	10 Years	0.05	21,511.0	1,076.0	CY	$119.91	$129,023	213,021	10,561	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	1,009.0	50.0	CY	$104.46	$5,223	19,305	957	
	Channel Topsoil Maintenance	10 Years	0.10	89,967.0	8,997.0	CY	$1.86	$16,734	27,629	1,370	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	664,769.0	33,238.0	CY	$1.78	$59,164	27,237	1,350	
	Turf Maintenance / Replacement	10 Years	0.05	467.0	23.0	ACRE	$4,156.00	$95,588	157,816	7,824	
	Mowing	1 Year	2.00	467.0	934.00	ACRE	$20.00	$18,680	376,786	18,680	2 mowings per year @ $20 / acre
	REACH 4										
	Channel Slope Maintenance - Type 1	10 Years	0.05	3,111,316.0	155,566.0	CY	$3.40	$528,924	873,269	43,294	
	Channel Slope Maintenance - Type 2	10 Years	0.05	3,898,771.0	194,939.0	CY	$3.83	$746,616	1,232,685	61,113	
	Channel Slope Maintenance - Type 3	10 Years	0.05	5,622,796.0	281,140.0	CY	$5.03	$1,414,134	2,334,775	115,752	
	Excavate Sediment from Channel - Type 4	10 Years	0.10	278,868.0	27,887.0	CY	$6.47	$180,299	297,680	14,758	
	Repair Riprap Channel Bank Protection	10 Years	0.05	83,111.0	4,156.0	CY	$119.91	$498,346	822,783	40,791	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	3,899.0	195.0	CY	$104.46	$20,370	75,291	3,733	
	Channel Topsoil Maintenance	10 Years	0.10	311,941.0	31,194.0	CY	$1.86	$58,021	95,794	4,749	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	2,680,432.0	134,022.0	CY	$1.78	$238,559	109,827	5,445	
	Turf Maintenance / Replacement	10 Years	0.05	1,855.0	93.0	ACRE	$4,156.00	$386,508	638,136	31,637	
	Mowing	1 Year	2.00	1,855.0	3,710.00	ACRE	$20.00	$74,200	1,496,657	74,200	2 mowings per year @ $20 / acre

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Life Cycle 50 Years Date Prepared: 28-Apr-2011

Rate of Return 4.375%

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - LLP ND Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT					O&M and MAJOR REPLACEMENT COSTS				EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE		
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	UNIT PRICE	AMOUNT	PRESENT VALUE	ANNUAL COST	COMMENTS
									$73,241,069	$3,631,084	Percentage of Construction 0.31%
09	**REACH 5**										
	Channel Slope Maintenance - Type 1	10 Years	0.05	881,257.0	44,063.0	CY	$3.40	$149,814	247,347	12,263	
	Channel Slope Maintenance - Type 2	10 Years	0.05	1,406,889.0	70,344.0	CY	$3.83	$269,418	444,816	22,053	
	Excavate Sediment from Channel - Type 3	10 Years	0.10	575,447.0	57,545.0	CY	$5.03	$289,451	477,892	23,693	
	Repair Riprap Channel Bank Protection	10 Years	0.05	22,978.0	1,149.0	CY	$119.91	$137,777	227,473	11,277	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	1,078.0	54.0	CY	$104.46	$5,641	20,850	1,034	
	Channel Topsoil Maintenance	10 Years	0.10	75,899.0	7,590.0	CY	$1.86	$14,117	23,308	1,156	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	759,026.0	37,951.0	CY	$1.78	$67,553	31,100	1,542	
	Turf Maintenance / Replacement	10 Years	0.05	517.0	26.0	ACRE	$4,156.00	$108,056	178,403	8,845	
	Mowing	1 Year	2.00	517.0	1,034.00	ACRE	$20.00	$20,680	417,128	20,680	2 mowings per year @ $20 / acre
	REACH 6										
	Channel Slope Maintenance - Type 1	10 Years	0.05	5,204,698.0	260,235.0	CY	$3.40	$884,799	1,460,828	72,424	
	Channel Slope Maintenance - Type 2	10 Years	0.05	5,405,183.0	270,259.0	CY	$3.83	$1,035,092	1,708,966	84,726	
	Channel Slope Maintenance - Type 3	10 Years	0.05	9,514,452.0	475,723.0	CY	$5.03	$2,392,887	3,950,723	195,866	
	Excavate Sediment from Channel - Type 4	10 Years	0.10	3,521,106.0	352,111.0	CY	$6.47	$2,278,156	3,761,303	186,475	
	Repair Riprap Channel Bank Protection	10 Years	0.05	110,081.0	5,504.0	CY	$119.91	$659,985	1,089,653	54,022	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	5,164.0	258.0	CY	$104.46	$26,951	99,616	4,939	
	Channel Topsoil Maintenance	10 Years	0.10	486,703.0	48,670.0	CY	$1.86	$90,526	149,461	7,410	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	3,461,308.0	173,065.0	CY	$1.78	$308,056	141,821	7,031	
	Turf Maintenance / Replacement	10 Years	0.05	2,468.0	123.0	ACRE	$4,156.00	$511,188	843,986	41,842	
	Mowing	1 Year	2.00	2,468.0	4,936.00	ACRE	$20.00	$98,720	1,991,239	98,720	2 mowings per year @ $20 / acre
	REACH 7										
	Channel Slope Maintenance - Type 1	10 Years	0.05	538,568.0	26,928.0	CY	$3.40	$91,555	151,160	7,494	
	Channel Slope Maintenance - Type 2	10 Years	0.05	256,705.0	12,835.0	CY	$3.83	$49,158	81,161	4,024	
	Excavate Sediment from Channel - Type 3	10 Years	0.10	290,406.0	29,041.0	CY	$5.03	$146,076	241,176	11,957	
	Repair Riprap Channel Bank Protection	10 Years	0.05	23,874.0	1,194.0	CY	$119.91	$143,173	236,382	11,719	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	1,120.0	56.0	CY	$104.46	$5,850	21,622	1,072	
	Channel Topsoil Maintenance	10 Years	0.10	52,244.0	5,224.0	CY	$1.86	$9,717	16,042	795	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	58,838.0	2,942.0	CY	$1.78	$5,237	2,411	120	
	Turf Maintenance / Replacement	10 Years	0.05	128.0	6.0	ACRE	$4,156.00	$24,936	41,170	2,041	
	Mowing	1 Year	2.00	128.0	256.00	ACRE	$20.00	$5,120	103,273	5,120	2 mowings per year @ $20 / acre
	REACH 8										
	Slope Maintenance - Type 1	10 Years	0.05	100,000.0	5,000.0	CY	$3.40	$17,000	28,067	1,392	
	Slope Maintenance - Type 2	10 Years	0.05	30,884.0	1,544.0	CY	$3.83	$5,914	9,763	484	
	Excavate Sediment from Channel - Type 3	10 Years	0.10	135,516.0	13,552.0	CY	$5.03	$68,167	112,545	5,580	
	Repair Riprap Channel Bank Protection	10 Years	0.05	13,353.0	668.0	CY	$119.91	$80,100	132,247	6,556	
	Repair Low Flow Channel Riprap Protection	5 Years	0.05	627.0	31.0	CY	$104.46	$3,238	11,969	593	
	Channel Topsoil Maintenance	10 Years	0.10	33,493.0	3,349.0	CY	$1.86	$6,229	10,284	510	
	Spoil Berm Topsoil Maintenance	25 Years	0.05	220,624.0	11,031.0	CY	$1.78	$19,635	9,040	448	
	Turf Maintenance / Replacement	10 Years	0.05	157.0	8.0	ACRE	$4,156.00	$33,248	54,893	2,721	
	Mowing	1 Year	2.00	157.0	314.00	ACRE	$20.00	$6,280	126,671	6,280	2 mowings per year @ $20 / acre

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Life Cycle: 50 Years | Date Prepared: 28-Apr-2011
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CHANNEL DIVERSION - LLP ND Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT

CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	UNIT PRICE	AMOUNT	EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE: PRESENT VALUE	EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE: ANNUAL COST	COMMENTS
	O&M and MAJOR REPLACEMENT COSTS								$73,241,069	$3,631,084	Percentage of Construction 0.31%
09	**RED RIVER INLET CONTROL STRUCTURE**										
	RRN GATED CONTROL STRUCTURE										
	Gated Structure										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$3,619,300.00	$1,809,650	212,701	10,545	
	Gates and Bulkheads - Major Rehab	50 Years	0.50	1.0	0.50	LS	$5,931,200.00	$2,965,600	348,569	17,281	
	Gates and Bulkheads - Annual O & M	1 Year	1.00	1.0	1.0	LS	$30,000	$30,000	605,117	30,000	
	Wingwalls - Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$5,633,000.00	$2,816,500	331,044	16,412	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$3,398,700.00	$169,935	280,567	13,910	
	Fish Passage System Miantenance	10 Years	0.05	1.0	0.05	LS	$5,950,300.00	$297,515	491,206	24,353	
	Mech, Elect, SCADA, Ice Control & Misc. Items	1 Year	0.02	1.0	0.02	LS	$1,024,600.00	$20,492	413,335	20,492	Annual O&M costs = 2.0% of construction
	WOLVERTON CREEK CLOSURE/DRAINAGE STRUCTURE										
	WOLVERTON CREEK STRUCTURE										
	Gated Structure										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$1,627,400.00	$813,700	95,640	4,742	
	Gates and Bulkheads - Major Rehab	50 Years	0.50	1.0	0.50	LS	$637,300.00	$318,650	37,453	1,857	
	Gates and Bulkheads - Annual O & M	1 Year	1.00	1.0	1.0	LS	$30,000	$30,000	605,117	30,000	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$57,200.00	$2,860	4,722	234	
	Mech, Elect, SCADA, Ice Control & Misc. Items	1 Year	0.02	1.0	0.02	LS	$256,200.00	$5,124	103,354	5,124	Annual O&M costs = 2.0% of construction
	WILD RICE RIVER CONTROL STRUCTURES										
	WWR GATED CONSTROL STRUCTURE										
	Gated Structure										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$1,505,600.00	$752,800	88,482	4,387	
	Gates and Bulkheads - Major Rehab	50 Years	0.50	1.0	0.50	LS	$1,753,900.00	$876,950	103,074	5,110	
	Gates and Bulkheads - Annual O & M	1 Year	1.00	1.0	1.0	LS	$30,000	$30,000	605,117	30,000	
	Wingwalls - Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$2,545,400.00	$1,272,700	149,590	7,416	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$1,632,000.00	$81,600	134,724	6,679	
	Fish Passage System Miantenance	10 Years	0.05	1.0	0.05	LS	$4,550,300.00	$227,515	375,634	18,623	
	Mech, Elect, SCADA, Ice Control & Misc. Items	1 Year	0.02	1.0	0.02	LS	$3,962,000.00	$79,240	1,598,317	79,240	Annual O&M costs = 2.0% of construction
	EAST WEIR (at Connecting Channel)										
	EAST WEIR STRUCTURE										
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$47,600.00	$2,380	3,929	195	
	SCADA	1 Year	0.02	1.0	0.02	LS	$75,100.00	$1,502	30,296	1,502	Annual O&M costs = 2.0% of construction
	INLET WEIR TO DIVERSION STRUCTURE										
	INLET WEIR STRUCTURE										
	Concrete Rollway Structure	50 Years	0.50	1.0	0.50	LS	$956,800.00	$478,400	56,230	2,788	
	Structure Walls	50 Years	0.50	1.0	0.50	LS	$2,118,100.00	$1,059,050	124,478	6,171	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$171,300.00	$8,565	14,141	701	
	Mech, Electrical, SCADA & Misc. Features	1 Year	0.02	1.0	0.02	LS	$2,322,700.00	$46,454	937,004	46,454	Annual O&M costs = 2.0% of construction

115

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Life Cycle: 50 Years | Date Prepared: 28-Apr-2011
Rate of Return: 4.375%

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - LLP ND Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT

CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M and MAJOR REPLACEMENT COSTS: O&M QUANTITY	UNIT	UNIT PRICE	AMOUNT	EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE: PRESENT VALUE	ANNUAL COST	COMMENTS
									$73,241,069	$3,631,084	Percentage of Construction 0.31%
09	**SHEYENNE RIVER AQUEDUCT STRUCTURES**										
	SHEYENNE RIVER AQUEDUCT STRUCTURE										
	Gated Aqueduct Structure & Wingwalls										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$13,193,300.00	$6,596,650	775,352	38,440	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$1,569,900.00	$78,495	129,597	6,425	
	Mech, Elect, SCADA, Ice Control & Misc. Items	1 Year	0.02	1.0	0.02	LS	$2,722,000.00	$54,440	1,098,086	54,440	Annual O&M costs = 2.0% of construction
	SHEYENNE RIVER SPILLWAY WEIR TO DIVERSION CHANNEL										
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$2,727,500.00	$136,375	225,159	11,163	
	Concrete Wall & Steel Reinforcement Rehab	50 Years	0.50	1.0	0.50	LS	$394,700.00	$197,350	23,196	1,150	
	MAPLE RIVER CONTROL STRUCTURE										
	MAPLE RIVER GATED CONTROL STRUCTURE										
	Gated Aqueduct Structure & Wingwalls										
	Concrete - Major Rehab	50 Years	0.50	1.0	0.50	LS	$13,036,200.00	$6,518,100	766,120	37,982	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$1,411,300.00	$70,565	116,505	5,776	
	Mech, Elect, SCADA, Ice Control & Misc. Items	1 Year	0.02	1.0	0.02	LS	$2,621,300.00	$52,426	1,057,463	52,426	Annual O&M costs = 2.0% of construction
	MAPLE RIVER SPILLWAY WEIR TO DIVERSION CHANNEL										
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$2,362,800.00	$118,140	195,052	9,670	
	Concrete Wall & Steel Reinforcement Rehab	50 Years	0.50	1.0	0.50	LS	$153,200.00	$76,600	9,003	446	
	DRAIN 14 - LARGE DRAIN STRUCTURE										
	DRAIN 14 STRUCTURE										
	Drop Structure & Walls - Concrete Major Rehab	50 Years	0.50	1.0	0.50	LS	$2,915,900.00	$1,457,950	171,363	8,496	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$164,100.00	$8,205	13,547	672	
	SCADA, & Misc. Safety Items	1 Year	0.02	1.0	0.02	LS	$35,200.00	$704	14,200	704	Annual O&M costs = 2.0% of construction
	LOWER RUSH RIVER DROP STRUCTURE										
	Drop Structure & Walls - Concrete Major Rehab	50 Years	0.50	1.0	0.50	LS	$3,005,900.00	$1,502,950	176,653	8,758	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$428,200.00	$21,410	35,349	1,752	
	Fish Passage System Maintenance	10 Years	0.05	1.0	0.05	LS	$1,826,800.00	$91,340	150,805	7,476	
	Mech, Elect, SCADA, & Misc. Items	1 Year	0.02	1.0	0.02	LS	$477,200.00	$9,544	192,508	9,544	Annual O&M costs = 2.0% of construction
	RUSH RIVER DROP STRUCTURE										
	Drop Structure & Walls - Concrete Major Rehab	50 Years	0.50	1.0	0.50	LS	$3,436,300.00	$1,718,150	201,947	10,012	
	Repair Riprap Erosion Protection	10 Years	0.05	1.0	0.05	LS	$475,300.00	$23,765	39,237	1,945	
	Fish Passage System Maintenance	10 Years	0.05	1.0	0.05	LS	$1,247,200.00	$62,360	102,958	5,104	
	Mech, Elect, SCADA, & Misc. Items	1 Year	0.00	1.0	0.00	LS	$447,100.00	$0	0	0	
	LARGE DRAIN	10 Years	0.05	1.0	0.05	EA	$447,400.00	$22,370	36,933	1,831	
	SMALL DRAINS	10 Years	0.05	2.0	0.10	EA	$127,200.00	$12,720	21,001	1,041	
	SIDE CHANNEL INLET MANHOLES - 72-INCH	10 Years	0.05	19.0	0.95	EA	$444,900.00	$422,655	697,815	34,596	
	SIDE CHANNEL INLET MH - TWIN 72-INCH	10 Years	0.05	7.0	0.35	EA	$808,900.00	$283,115	467,431	23,174	
	RED RIVER OUTLET CONTROL STRUCTURE										
	Riprap Erosion Protection	10 Years	0.05	1.0	0.05	CY	$1,260,300.00	$63,015	104,040	5,158	
	DIVERSION LANDSCAPE PLANTINGS	10 Years	0.01	36.6	0.37	MI	$30,000.00	$10,980	18,128	899	

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Life Cycle 50 Years Date Prepared: 28-Apr-2011
Rate of Return 4.375%

FARGO-MOORHEAD METRO FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CHANNEL DIVERSION - LLP ND Phase 4

FARGO-MOORHEAD METRO FEASIBILITY REPORT					O&M and MAJOR REPLACEMENT COSTS				EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE		
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M QUANTITY	UNIT	UNIT PRICE	AMOUNT	PRESENT VALUE	ANNUAL COST	COMMENTS
									$73,241,069	$3,631,084	Percentage of Construction 0.31%
11	**LEVEES & FLOODWALLS**										
	LEVEES										
	TIE-BACK LEVEES										
	Levee Embankment Maintenance	10 Years	0.05	835,320.0	41766.00	CY	$17.51	$731,323	1,207,434	59,861	
	Levee Topsoil Maintenance	10 Years	0.05	110,024.0	5501.20	CY	$1.81	$9,957	16,440	815	
	Levee Turf Maintenance / Replacement	10 Years	0.05	1.0	0.05	ACRE	$2,750,700.00	$137,535	227,074	11,258	
	Mowing	1 Year	4.00	1.0	4.00	ACRE	$20.00	$80	1,614	80	4 mowings per year @ $20 / acre
	Fertilizing & Weed Control	1 Year	1.00	1.0	1.00	ACRE	$250.00	$250	5,043	250	
14	**RECREATIONAL FACILITIES**										
	Multi-Purpose Trails	10 Years	0.05	19.0	0.95	MI	310,600.00	$295,070	487,169	24,152	
	Soft Trails	10 Years	0.05	25.0	1.25	MI	106,400.00	$133,000	219,587	10,886	
	Trail River Crossing	10 Years	0.05	3.0	0.15	EA	2,850,000.00	$427,500	705,814	34,992	
	Trailhead Facilities	5 Years	0.05	3.0	0.15	EA	166,600.00	$24,990	92,369	4,579	
	Restroom Facilities Maintenance	1 Years	1.00	3.0	1.00	LS	42,500.00	$42,500	857,250	42,500	Maint person = 1 FT @ 60K / yr + 1 PT @ 25K / yr for 6 mo
	Restroom Facilities Operating Utilitites	1 Years	1.00	3.0	3.00	EA	1,200.00	$3,600	72,614	3,600	Utilities each site @ $200 / month for 6 months
	Parking Facilities										
	Car Parking Lots	10 Years	0.10	4.0	0.40	EA	45,900.00	$18,360	30,313	1,503	
	Car/Trailer Park Lots	10 Years	0.10	2.0	0.20	EA	146,800.00	$29,360	48,474	2,403	
	Wildlife Viewing Overlooks	10 Years	0.10	2.0	0.20	EA	7,900.00	$1,580	2,609	129	
	Interpretive Siganage	10 Years	0.10	30.0	3.00	LS	1,100.00	$3,300	5,448	270	
	Fishing Sites	10 Years	0.10	4.0	0.40	EA	32,000.00	$12,800	21,133	1,048	
	Landscaping Maintenance	10 Years	0.01	150.0	1.50	ACRE	31,300.00	$46,950	77,516	3,843	
	Total O&M								**$73,241,069**	**$3,631,084**	

PROJECT COST SUMMARY SHEET

FARGO MOORHEAD METRO FEASIBILITY STUDY

CHANNEL DIVERSION - ND35K Phase 3

(Included for REFERENCE ONLY)

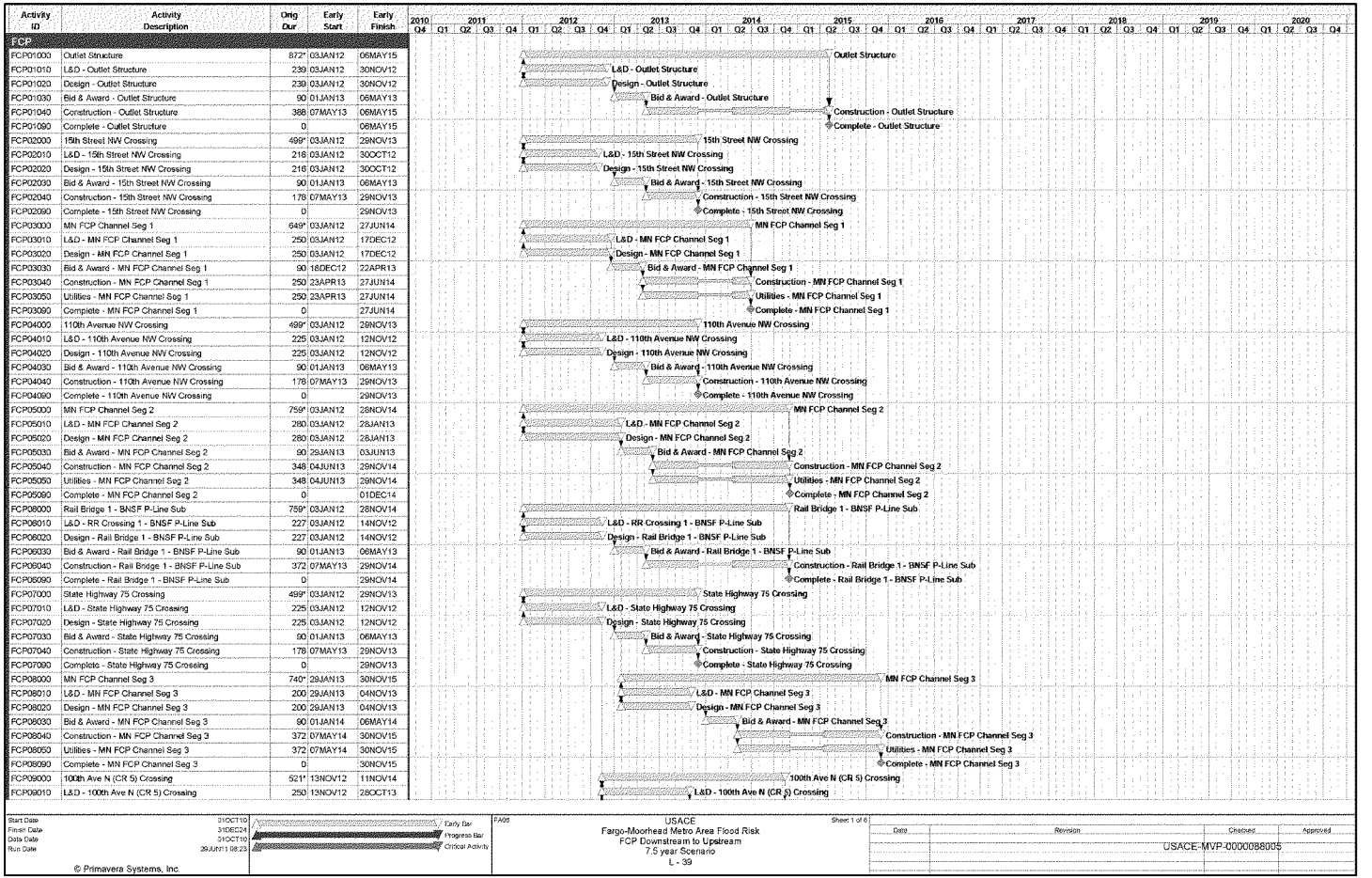
Project: Fargo Moorhead Metro Draft Feasibility Study Cost Estimate
Location: Fargo, North Dakota and Moorhead, Minnesota

Date: September 1, 2010

PREPARED BY: Moore Engineering, Inc.
Jeffrey L. Hansen, CEMVP-EC-D

Item	Item Description	Total Estimated Amount	Contingency Amount	Contingency Percent	Estimated Amount Plus Contingency	Index Factor To 10 / 2011	Index Cost To 10 / 2011	Midpoint Of Featue Year	Index to Midpoint Factor	Fully Funded Amount Plus Contingency
01	Lands & Damages	$48,200,000	$12,050,000	25%	$60,250,000	0.017	$61,274,000	OCT 2014	0.070	$65,563,000
02	Relocations	$80,564,000	$20,142,000	25%	$100,706,000	0.017	$102,418,000	DEC 2015	0.093	$111,943,000
06	Fish & Wildlife Facilities	$73,136,000	$18,284,000	25%	$91,420,000	0.017	$92,974,000	APR 2016	0.099	$102,179,000
08	Roads, Railroads and Bridges	$47,845,000	$11,961,000	25%	$59,806,000	0.017	$60,823,000	APR 2016	0.099	$66,844,000
09	Channels & Canals	$640,208,000	$160,055,000	25%	$800,263,000	0.017	$813,867,000	APR 2016	0.099	$894,440,000
11	Levees and Floodwalls	$2,905,000	$726,000	25%	$3,631,000	0.017	$3,693,000	APR 2016	0.099	$4,058,000
14	Recreation Facilities	$23,220,000	$5,805,000	25%	$29,025,000	0.017	$29,518,000	APR 2016	0.099	$32,441,000
30	Planning, Engineering and Design	$130,182,000	$32,546,000	25%	$162,728,000	0.039	$169,074,000	DEC 2015	0.164	$196,803,000
31	Construction Management	$60,751,000	$15,188,000	25%	$75,939,000	0.039	$78,901,000	APR 2016	0.245	$98,231,000
	Estimated Project Cost	$1,107,011,000	$276,757,000	25%	$1,383,768,000		$1,412,542,000			$1,572,502,000

NOTES:
Costs are based on August 2010 unit pricing.
The ND35K Phase 3 cost estimate is included for REFERENCE ONLY. Work was halted in September 2010 when downstream impacts stretched all the way to the Canadian border and still had not reached a point of zero impacts.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Orig Dur
Early Start
Early Finish
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FCP
FCP01000 Outlet Structure 872* 03JAN12 06MAY15 Outlet Structure
FCP01010 L&D - Outlet Structure 239 03JAN12 30NOV12 L&D - Outlet Structure
FCP01020 Design - Outlet Structure 239 03JAN12 30NOV12 Design - Outlet Structure
FCP01030 Bid & Award - Outlet Structure 90 01JAN13 06MAY13 Bid & Award - Outlet Structure
FCP01040 Construction - Outlet Structure 388 07MAY13 06MAY15 Construction - Outlet Structure
FCP01090 Complete - Outlet Structure 0 06MAY15 Complete - Outlet Structure
FCP02000 15th Street NW Crossing 499* 03JAN12 29NOV13 15th Street NW Crossing
FCP02010 L&D - 15th Street NW Crossing 216 03JAN12 30OCT12 L&D - 15th Street NW Crossing
FCP02020 Design - 15th Street NW Crossing 216 03JAN12 30OCT12 Design - 15th Street NW Crossing
FCP02030 Bid & Award - 15th Street NW Crossing 90 01JAN13 06MAY13 Bid & Award - 15th Street NW Crossing
FCP02040 Construction - 15th Street NW Crossing 178 07MAY13 29NOV13 Construction - 15th Street NW Crossing
FCP02090 Complete - 15th Street NW Crossing 0 29NOV13 Complete - 15th Street NW Crossing
FCP03000 MN FCP Channel Seg 1 649* 03JAN12 27JUN14 MN FCP Channel Seg 1
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FCP03020 Design - MN FCP Channel Seg 1 250 03JAN12 17DEC12 Design - MN FCP Channel Seg 1
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FCP04000 110th Avenue NW Crossing 499* 03JAN12 29NOV13 110th Avenue NW Crossing
FCP04010 L&D - 110th Avenue NW Crossing 225 03JAN12 12NOV12 L&D - 110th Avenue NW Crossing
FCP04020 Design - 110th Avenue NW Crossing 225 03JAN12 12NOV12 Design - 110th Avenue NW Crossing
FCP04030 Bid & Award - 110th Avenue NW Crossing 90 01JAN13 06MAY13 Bid & Award - 110th Avenue NW Crossing
FCP04040 Construction - 110th Avenue NW Crossing 178 07MAY13 29NOV13 Construction - 110th Avenue NW Crossing
FCP04090 Complete - 110th Avenue NW Crossing 0 29NOV13 Complete - 110th Avenue NW Crossing
FCP05000 MN FCP Channel Seg 2 759* 03JAN12 28NOV14 MN FCP Channel Seg 2
FCP05010 L&D - MN FCP Channel Seg 2 280 03JAN12 28JAN13 L&D - MN FCP Channel Seg 2
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FCP08000 Rail Bridge 1 - BNSF P-Line Sub 759* 03JAN12 28NOV14 Rail Bridge 1 - BNSF P-Line Sub
FCP06010 L&D - RR Crossing 1 - BNSF P-Line Sub 227 03JAN12 14NOV12 L&D - RR Crossing 1 - BNSF P-Line Sub
FCP06020 Design - Rail Bridge 1 - BNSF P-Line Sub 227 03JAN12 14NOV12 Design - Rail Bridge 1 - BNSF P-Line Sub
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FCP07000 State Highway 75 Crossing 499* 03JAN12 29NOV13 State Highway 75 Crossing
FCP07010 L&D - State Highway 75 Crossing 225 03JAN12 12NOV12 L&D - State Highway 75 Crossing
FCP07020 Design - State Highway 75 Crossing 225 03JAN12 12NOV12 Design - State Highway 75 Crossing
FCP07030 Bid & Award - State Highway 75 Crossing 90 01JAN13 06MAY13 Bid & Award - State Highway 75 Crossing
FCP07040 Construction - State Highway 75 Crossing 178 07MAY13 29NOV13 Construction - State Highway 75 Crossing
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FCP08000 MN FCP Channel Seg 3 740* 29JAN13 30NOV15 MN FCP Channel Seg 3
FCP08010 L&D - MN FCP Channel Seg 3 200 29JAN13 04NOV13 L&D - MN FCP Channel Seg 3
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FCP08040 Construction - MN FCP Channel Seg 3 372 07MAY14 30NOV15 Construction - MN FCP Channel Seg 3
FCP08050 Utilities - MN FCP Channel Seg 3 372 07MAY14 30NOV15 Utilities - MN FCP Channel Seg 3
FCP08090 Complete - MN FCP Channel Seg 3 0 30NOV15 Complete - MN FCP Channel Seg 3
FCP09000 100th Ave N (CR 5) Crossing 521* 13NOV12 11NOV14 100th Ave N (CR 5) Crossing
FCP09010 L&D - 100th Ave N (CR 5) Crossing 250 13NOV12 28OCT13 L&D - 100th Ave N (CR 5) Crossing
Start Date 31OCT10
Finish Date 31DEC24
Data Date 31OCT10
Run Date 29JUN11 08:23
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Critical Activity
© Primavera Systems, Inc
FA08
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Fargo-Moorhead Metro Area Flood Risk
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7.5 year Scenario
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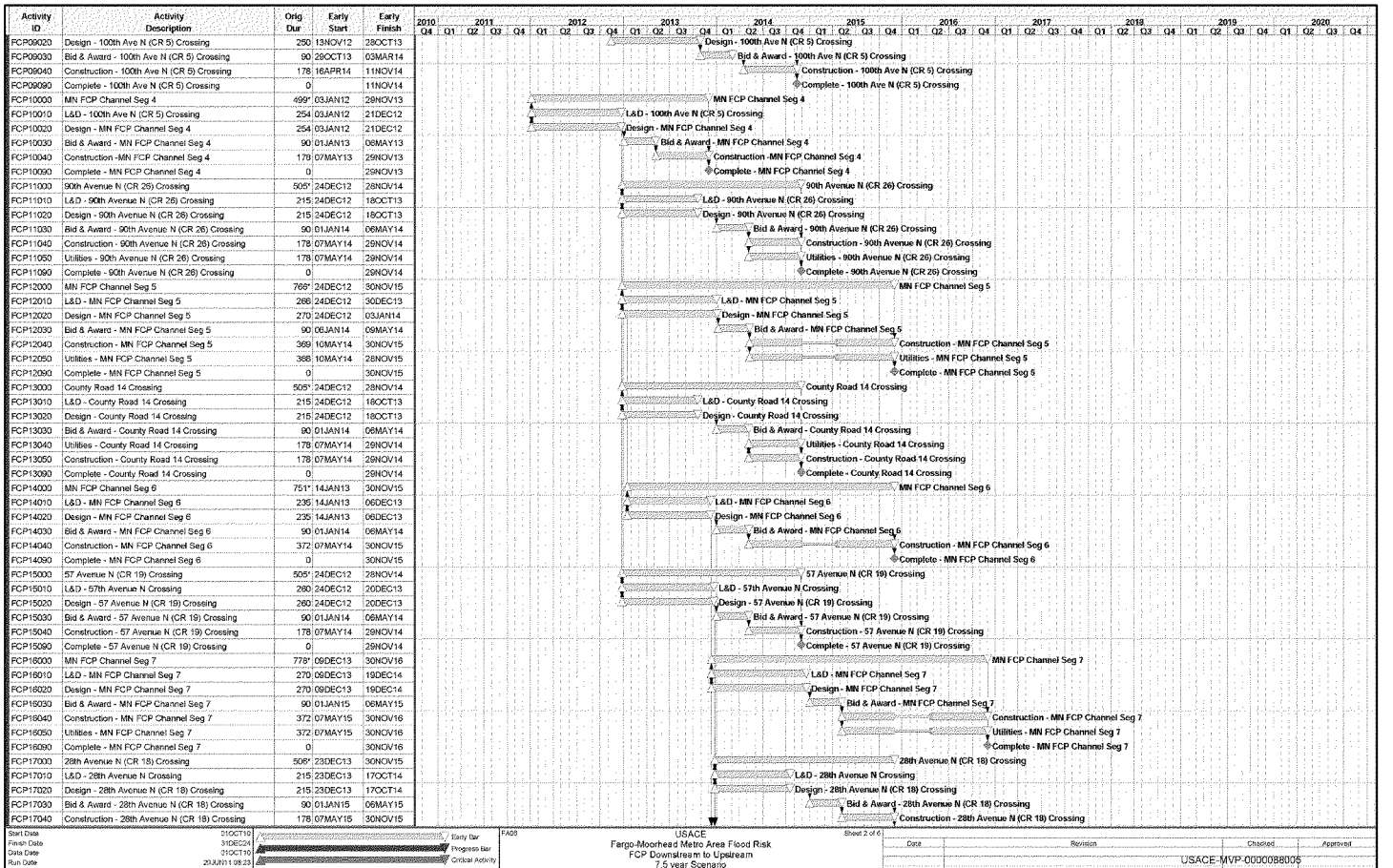
Sheet 1 of 6
Date
Revision
Checked
Approved
USACE-MVP-0000088005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FCP09020 | Design - 100th Ave N (CR 5) Crossing | 250 | 13NOV12 | 28OCT13
FCP09030 | Bid & Award - 100th Ave N (CR 5) Crossing | 90 | 29OCT13 | 03MAR14
FCP09040 | Construction - 100th Ave N (CR 5) Crossing | 178 | 16APR14 | 11NOV14
FCP09090 | Complete - 100th Ave N (CR 5) Crossing | 0 | | 11NOV14
FCP10000 | MN FCP Channel Seg 4 | 499* | 03JAN12 | 29NOV13
FCP10010 | L&D - 100th Ave N (CR 5) Crossing | 254 | 03JAN12 | 21DEC12
FCP10020 | Design - MN FCP Channel Seg 4 | 254 | 03JAN12 | 21DEC12
FCP10030 | Bid & Award - MN FCP Channel Seg 4 | 90 | 01JAN13 | 06MAY13
FCP10040 | Construction -MN FCP Channel Seg 4 | 178 | 07MAY13 | 29NOV13
FCP10090 | Complete - MN FCP Channel Seg 4 | 0 | | 29NOV13
FCP11000 | 90th Avenue N (CR 26) Crossing | 505* | 24DEC12 | 28NOV14
FCP11010 | L&D - 90th Avenue N (CR 26) Crossing | 215 | 24DEC12 | 18OCT13
FCP11020 | Design - 90th Avenue N (CR 26) Crossing | 215 | 24DEC12 | 18OCT13
FCP11030 | Bid & Award - 90th Avenue N (CR 26) Crossing | 90 | 01JAN14 | 06MAY14
FCP11040 | Construction - 90th Avenue N (CR 26) Crossing | 178 | 07MAY14 | 29NOV14
FCP11050 | Utilities - 90th Avenue N (CR 26) Crossing | 178 | 07MAY14 | 29NOV14
FCP11090 | Complete - 90th Avenue N (CR 26) Crossing | 0 | | 29NOV14
FCP12000 | MN FCP Channel Seg 5 | 766* | 24DEC12 | 30NOV15
FCP12010 | L&D - MN FCP Channel Seg 5 | 266 | 24DEC12 | 30DEC13
FCP12020 | Design - MN FCP Channel Seg 5 | 270 | 24DEC12 | 03JAN14
FCP12030 | Bid & Award - MN FCP Channel Seg 5 | 90 | 06JAN14 | 09MAY14
FCP12040 | Construction - MN FCP Channel Seg 5 | 369 | 10MAY14 | 30NOV15
FCP12050 | Utilities - MN FCP Channel Seg 5 | 368 | 10MAY14 | 28NOV15
FCP12090 | Complete - MN FCP Channel Seg 5 | 0 | | 30NOV15
FCP13000 | County Road 14 Crossing | 505* | 24DEC12 | 28NOV14
FCP13010 | L&D - County Road 14 Crossing | 215 | 24DEC12 | 18OCT13
FCP13020 | Design - County Road 14 Crossing | 215 | 24DEC12 | 18OCT13
FCP13030 | Bid & Award - County Road 14 Crossing | 90 | 01JAN14 | 06MAY14
FCP13040 | Utilities - County Road 14 Crossing | 178 | 07MAY14 | 29NOV14
FCP13050 | Construction - County Road 14 Crossing | 178 | 07MAY14 | 29NOV14
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FCP14000 | MN FCP Channel Seg 6 | 751* | 14JAN13 | 30NOV15
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FCP14020 | Design - MN FCP Channel Seg 6 | 235 | 14JAN13 | 06DEC13
FCP14030 | Bid & Award - MN FCP Channel Seg 6 | 90 | 01JAN14 | 06MAY14
FCP14040 | Construction - MN FCP Channel Seg 6 | 372 | 07MAY14 | 30NOV15
FCP14090 | Complete - MN FCP Channel Seg 6 | 0 | | 30NOV15
FCP15000 | 57 Avenue N (CR 19) Crossing | 505* | 24DEC12 | 28NOV14
FCP15010 | L&D - 57th Avenue N Crossing | 260 | 24DEC12 | 20DEC13
FCP15020 | Design - 57 Avenue N (CR 19) Crossing | 260 | 24DEC12 | 20DEC13
FCP15030 | Bid & Award - 57 Avenue N (CR 19) Crossing | 90 | 01JAN14 | 06MAY14
FCP15040 | Construction - 57 Avenue N (CR 19) Crossing | 178 | 07MAY14 | 29NOV14
FCP15090 | Complete - 57 Avenue N (CR 19) Crossing | 0 | | 29NOV14
FCP16000 | MN FCP Channel Seg 7 | 778* | 09DEC13 | 30NOV16
FCP16010 | L&D - MN FCP Channel Seg 7 | 270 | 09DEC13 | 19DEC14
FCP16020 | Design - MN FCP Channel Seg 7 | 270 | 09DEC13 | 19DEC14
FCP16030 | Bid & Award - MN FCP Channel Seg 7 | 90 | 01JAN15 | 06MAY15
FCP16040 | Construction - MN FCP Channel Seg 7 | 372 | 07MAY15 | 30NOV16
FCP16050 | Utilities - MN FCP Channel Seg 7 | 372 | 07MAY15 | 30NOV16
FCP16090 | Complete - MN FCP Channel Seg 7 | 0 | | 30NOV16
FCP17000 | 28th Avenue N (CR 18) Crossing | 506* | 23DEC13 | 30NOV15
FCP17010 | L&D - 28th Avenue N Crossing | 215 | 23DEC13 | 17OCT14
FCP17020 | Design - 28th Avenue N (CR 18) Crossing | 215 | 23DEC13 | 17OCT14
FCP17030 | Bid & Award - 28th Avenue N (CR 18) Crossing | 90 | 01JAN15 | 06MAY15
FCP17040 | Construction - 28th Avenue N (CR 18) Crossing | 178 | 07MAY15 | 30NOV15
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Q4 Q1 Q2 Q3 Q4
Design - 100th Ave N (CR 5) Crossing
Bid & Award - 100th Ave N (CR 5) Crossing
Construction - 100th Ave N (CR 5) Crossing
Complete - 100th Ave N (CR 5) Crossing
MN FCP Channel Seg 4
L&D - 100th Ave N (CR 5) Crossing
Design - MN FCP Channel Seg 4
Bid & Award - MN FCP Channel Seg 4
Construction -MN FCP Channel Seg 4
Complete - MN FCP Channel Seg 4
90th Avenue N (CR 26) Crossing
L&D - 90th Avenue N (CR 26) Crossing
Design - 90th Avenue N (CR 26) Crossing
Bid & Award - 90th Avenue N (CR 26) Crossing
Construction - 90th Avenue N (CR 26) Crossing
Utilities - 90th Avenue N (CR 26) Crossing
Complete - 90th Avenue N (CR 26) Crossing
MN FCP Channel Seg 5
L&D - MN FCP Channel Seg 5
Design - MN FCP Channel Seg 5
Bid & Award - MN FCP Channel Seg 5
Construction - MN FCP Channel Seg 5
Utilities - MN FCP Channel Seg 5
Complete - MN FCP Channel Seg 5
County Road 14 Crossing
L&D - County Road 14 Crossing
Design - County Road 14 Crossing
Bid & Award - County Road 14 Crossing
Utilities - County Road 14 Crossing
Construction - County Road 14 Crossing
Complete - County Road 14 Crossing
MN FCP Channel Seg 6
L&D - MN FCP Channel Seg 6
Design - MN FCP Channel Seg 6
Bid & Award - MN FCP Channel Seg 6
Construction - MN FCP Channel Seg 6
Complete - MN FCP Channel Seg 6
57 Avenue N (CR 19) Crossing
L&D - 57th Avenue N Crossing
Design - 57 Avenue N (CR 19) Crossing
Bid & Award - 57 Avenue N (CR 19) Crossing
Construction - 57 Avenue N (CR 19) Crossing
Complete - 57 Avenue N (CR 19) Crossing
MN FCP Channel Seg 7
L&D - MN FCP Channel Seg 7
Design - MN FCP Channel Seg 7
Bid & Award - MN FCP Channel Seg 7
Construction - MN FCP Channel Seg 7
Utilities - MN FCP Channel Seg 7
Complete - MN FCP Channel Seg 7
28th Avenue N (CR 18) Crossing
L&D - 28th Avenue N Crossing
Design - 28th Avenue N (CR 18) Crossing
Bid & Award - 28th Avenue N (CR 18) Crossing
Construction - 28th Avenue N (CR 18) Crossing
Start Date 31OCT10
Finish Date 31DEC24
Data Date 31OCT10
Run Date 29JUN11 08:23
Early Bar
Progress Bar
Critical Activity
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FA08
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Fargo-Moorhead Metro Area Flood Risk
FCP Downstream to Upstream
7.5 year Scenario
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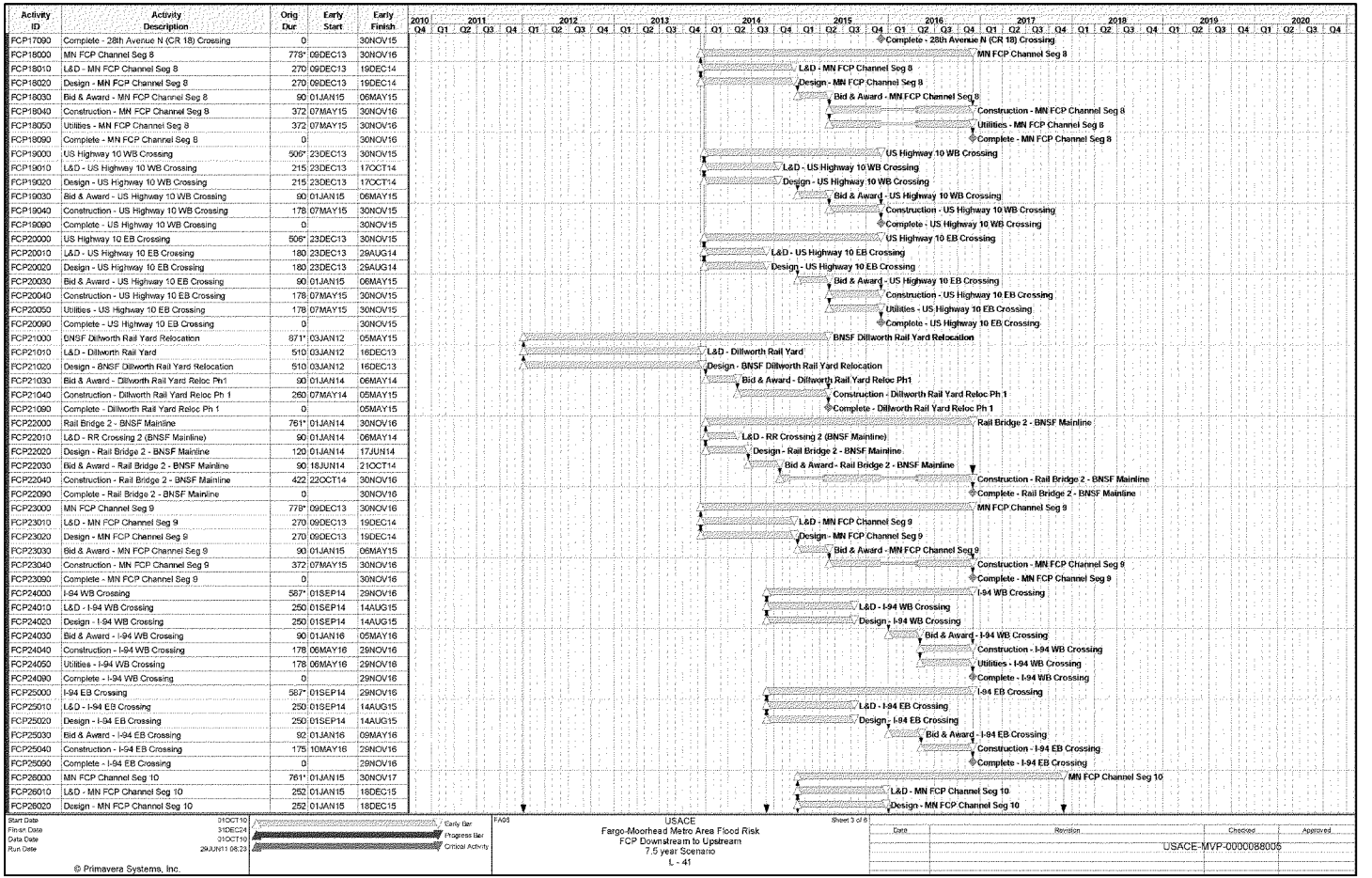
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FCP19010 L&D - US Highway 10 WB Crossing 215 23DEC13 17OCT14
FCP19020 Design - US Highway 10 WB Crossing 215 23DEC13 17OCT14
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FCP20000 US Highway 10 EB Crossing 506* 23DEC13 30NOV15
FCP20010 L&D - US Highway 10 EB Crossing 180 23DEC13 29AUG14
FCP20020 Design - US Highway 10 EB Crossing 180 23DEC13 29AUG14
FCP20030 Bid & Award - US Highway 10 EB Crossing 90 01JAN15 06MAY15
FCP20040 Construction - US Highway 10 EB Crossing 178 07MAY15 30NOV15
FCP20050 Utilities - US Highway 10 EB Crossing 178 07MAY15 30NOV15
FCP20090 Complete - US Highway 10 EB Crossing 0 30NOV15
FCP21000 BNSF Dilworth Rail Yard Relocation 671* 03JAN12 05MAY15
FCP21010 L&D - Dilworth Rail Yard 510 03JAN12 16DEC13
FCP21020 Design - BNSF Dilworth Rail Yard Relocation 510 03JAN12 16DEC13
FCP21030 Bid & Award - Dilworth Rail Yard Reloc Ph1 90 01JAN14 06MAY14
FCP21040 Construction - Dilworth Rail Yard Reloc Ph 1 260 07MAY14 05MAY15
FCP21090 Complete - Dilworth Rail Yard Reloc Ph 1 0 05MAY15
FCP22000 Rail Bridge 2 - BNSF Mainline 761* 01JAN14 30NOV16
FCP22010 L&D - RR Crossing 2 (BNSF Mainline) 90 01JAN14 06MAY14
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FCP23040 Construction - MN FCP Channel Seg 9 372 07MAY15 30NOV16
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FCP24010 L&D - I-94 WB Crossing 250 01SEP14 14AUG15
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Complete - 28th Avenue N (CR 18) Crossing
MN FCP Channel Seg 8
L&D - MN FCP Channel Seg 8
Design - MN FCP Channel Seg 8
Bid & Award - MN FCP Channel Seg 8
Construction - MN FCP Channel Seg 8
Utilities - MN FCP Channel Seg 8
Complete - MN FCP Channel Seg 8
US Highway 10 WB Crossing
L&D - US Highway 10 WB Crossing
Design - US Highway 10 WB Crossing
Bid & Award - US Highway 10 WB Crossing
Construction - US Highway 10 WB Crossing
Complete - US Highway 10 WB Crossing
US Highway 10 EB Crossing
L&D - US Highway 10 EB Crossing
Design - US Highway 10 EB Crossing
Bid & Award - US Highway 10 EB Crossing
Construction - US Highway 10 EB Crossing
Utilities - US Highway 10 EB Crossing
Complete - US Highway 10 EB Crossing
BNSF Dilworth Rail Yard Relocation
L&D - Dilworth Rail Yard
Design - BNSF Dilworth Rail Yard Relocation
Bid & Award - Dilworth Rail Yard Reloc Ph1
Construction - Dilworth Rail Yard Reloc Ph 1
Complete - Dilworth Rail Yard Reloc Ph 1
Rail Bridge 2 - BNSF Mainline
L&D - RR Crossing 2 (BNSF Mainline)
Design - Rail Bridge 2 - BNSF Mainline
Bid & Award - Rail Bridge 2 - BNSF Mainline
Construction - Rail Bridge 2 - BNSF Mainline
Complete - Rail Bridge 2 - BNSF Mainline
MN FCP Channel Seg 9
L&D - MN FCP Channel Seg 9
Design - MN FCP Channel Seg 9
Bid & Award - MN FCP Channel Seg 9
Construction - MN FCP Channel Seg 9
Complete - MN FCP Channel Seg 9
I-94 WB Crossing
L&D - I-94 WB Crossing
Design - I-94 WB Crossing
Bid & Award - I-94 WB Crossing
Construction - I-94 WB Crossing
Utilities - I-94 WB Crossing
Complete - I-94 WB Crossing
I-94 EB Crossing
L&D - I-94 EB Crossing
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Construction - I-94 EB Crossing
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MN FCP Channel Seg 10
L&D - MN FCP Channel Seg 10
Design - MN FCP Channel Seg 10
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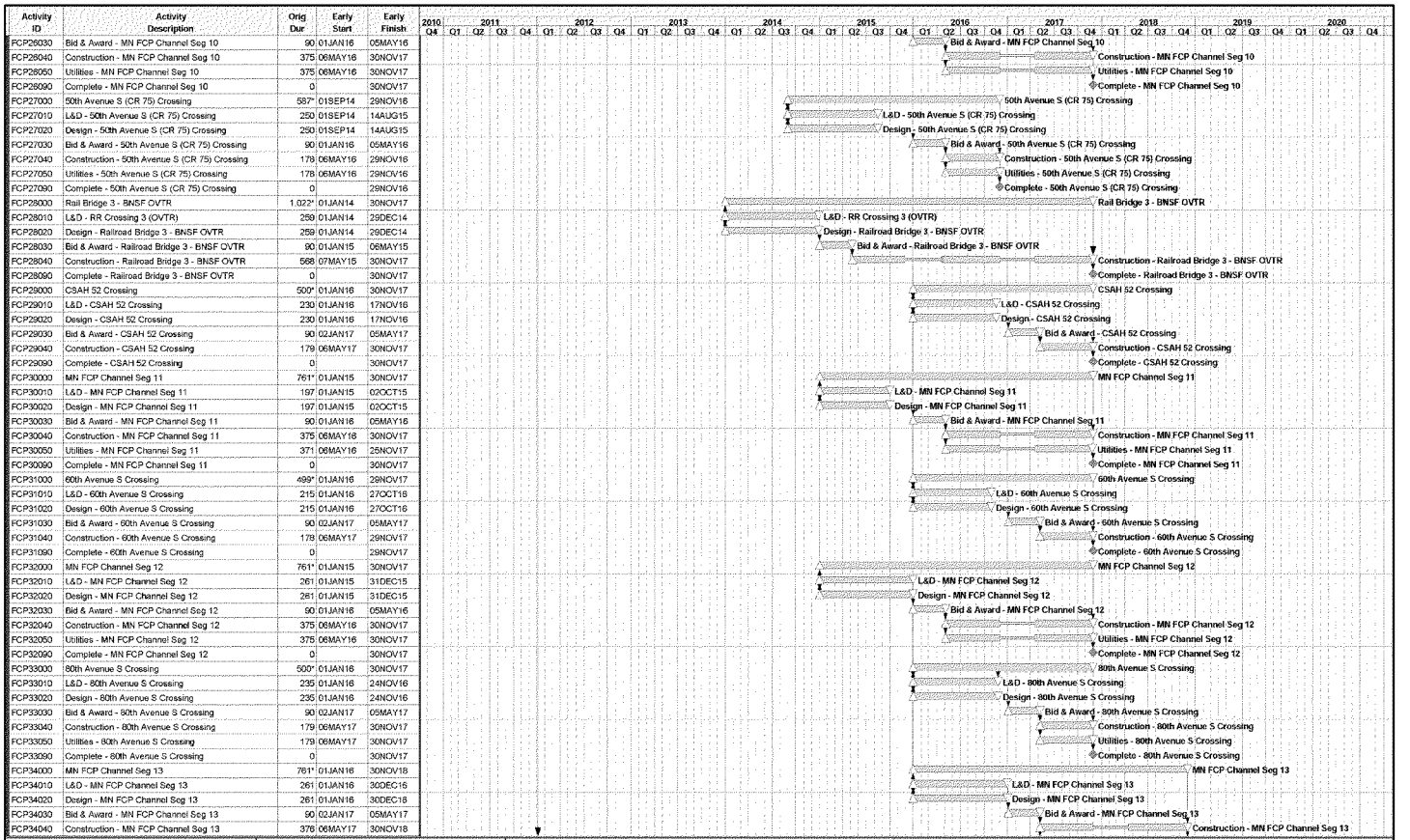
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FCP28010 L&D - RR Crossing 3 (OVTR) 259 01JAN14 29DEC14
FCP28020 Design - Railroad Bridge 3 - BNSF OVTR 259 01JAN14 29DEC14
FCP28030 Bid & Award - Railroad Bridge 3 - BNSF OVTR 90 01JAN15 06MAY15
FCP28040 Construction - Railroad Bridge 3 - BNSF OVTR 568 07MAY15 30NOV17
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FCP29000 CSAH 52 Crossing 500* 01JAN16 30NOV17
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Construction - MN FCP Channel Seg 10
Utilities - MN FCP Channel Seg 10
Complete - MN FCP Channel Seg 10
50th Avenue S (CR 75) Crossing
L&D - 50th Avenue S (CR 75) Crossing
Design - 50th Avenue S (CR 75) Crossing
Bid & Award - 50th Avenue S (CR 75) Crossing
Construction - 50th Avenue S (CR 75) Crossing
Utilities - 50th Avenue S (CR 75) Crossing
Complete - 50th Avenue S (CR 75) Crossing
Rail Bridge 3 - BNSF OVTR
L&D - RR Crossing 3 (OVTR)
Design - Railroad Bridge 3 - BNSF OVTR
Bid & Award - Railroad Bridge 3 - BNSF OVTR
Construction - Railroad Bridge 3 - BNSF OVTR
Complete - Railroad Bridge 3 - BNSF OVTR
CSAH 52 Crossing
L&D - CSAH 52 Crossing
Design - CSAH 52 Crossing
Bid & Award - CSAH 52 Crossing
Construction - CSAH 52 Crossing
Complete - CSAH 52 Crossing
MN FCP Channel Seg 11
L&D - MN FCP Channel Seg 11
Design - MN FCP Channel Seg 11
Bid & Award - MN FCP Channel Seg 11
Construction - MN FCP Channel Seg 11
Utilities - MN FCP Channel Seg 11
Complete - MN FCP Channel Seg 11
60th Avenue S Crossing
L&D - 60th Avenue S Crossing
Design - 60th Avenue S Crossing
Bid & Award - 60th Avenue S Crossing
Construction - 60th Avenue S Crossing
Complete - 60th Avenue S Crossing
MN FCP Channel Seg 12
L&D - MN FCP Channel Seg 12
Design - MN FCP Channel Seg 12
Bid & Award - MN FCP Channel Seg 12
Construction - MN FCP Channel Seg 12
Utilities - MN FCP Channel Seg 12
Complete - MN FCP Channel Seg 12
80th Avenue S Crossing
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Design - 80th Avenue S Crossing
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Complete - 80th Avenue S Crossing
MN FCP Channel Seg 13
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Construction - MN FCP Channel Seg 13
Start Date 31OCT19
Finish Date 31DEC24
Data Date 31OCT19
Run Date 29JUN11 08:23
Early Bar
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Critical Activity
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FA05
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Fargo-Moorhead Metro Area Flood Risk
FCP Downstream to Upstream
7.5 year Scenario
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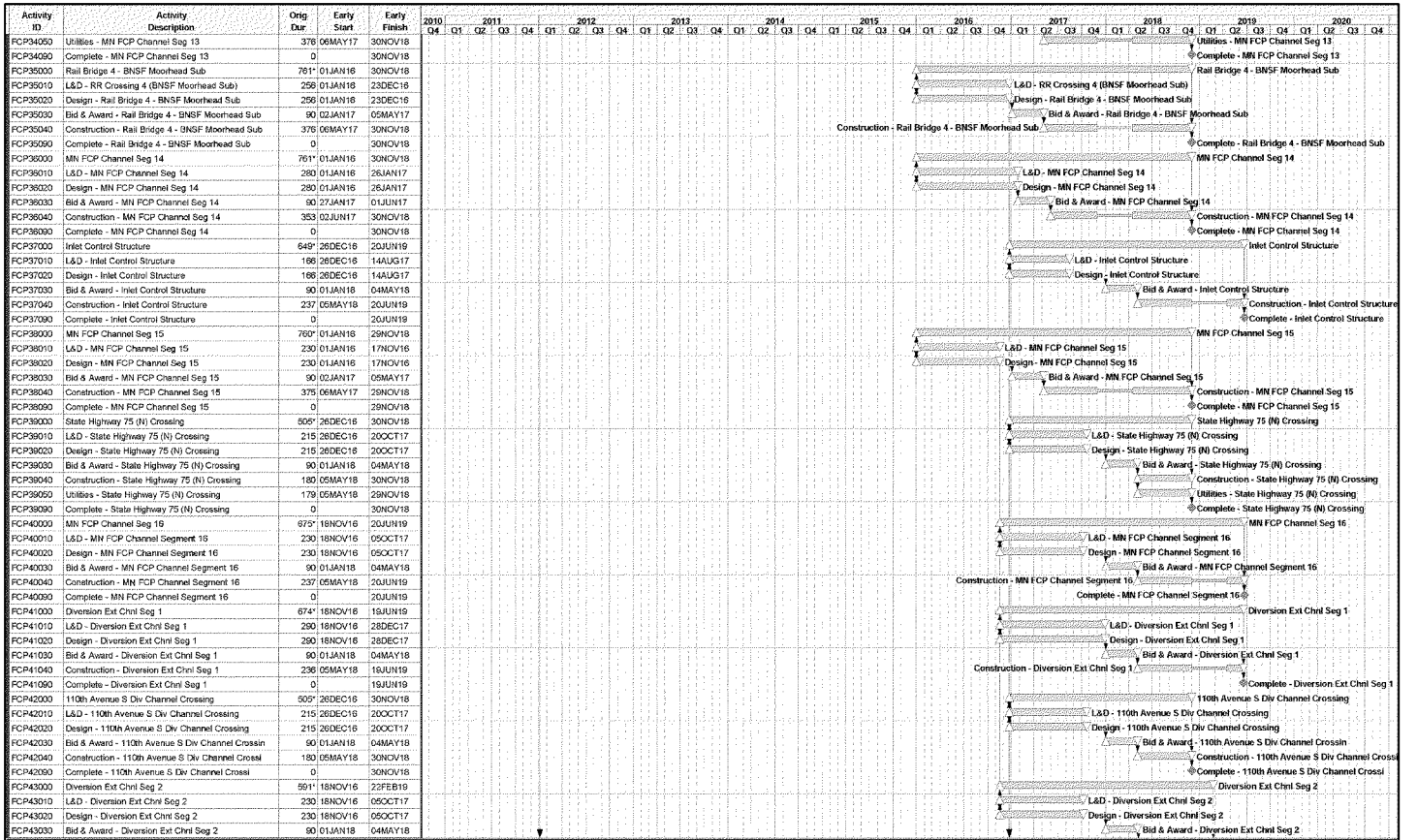
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Early Bar
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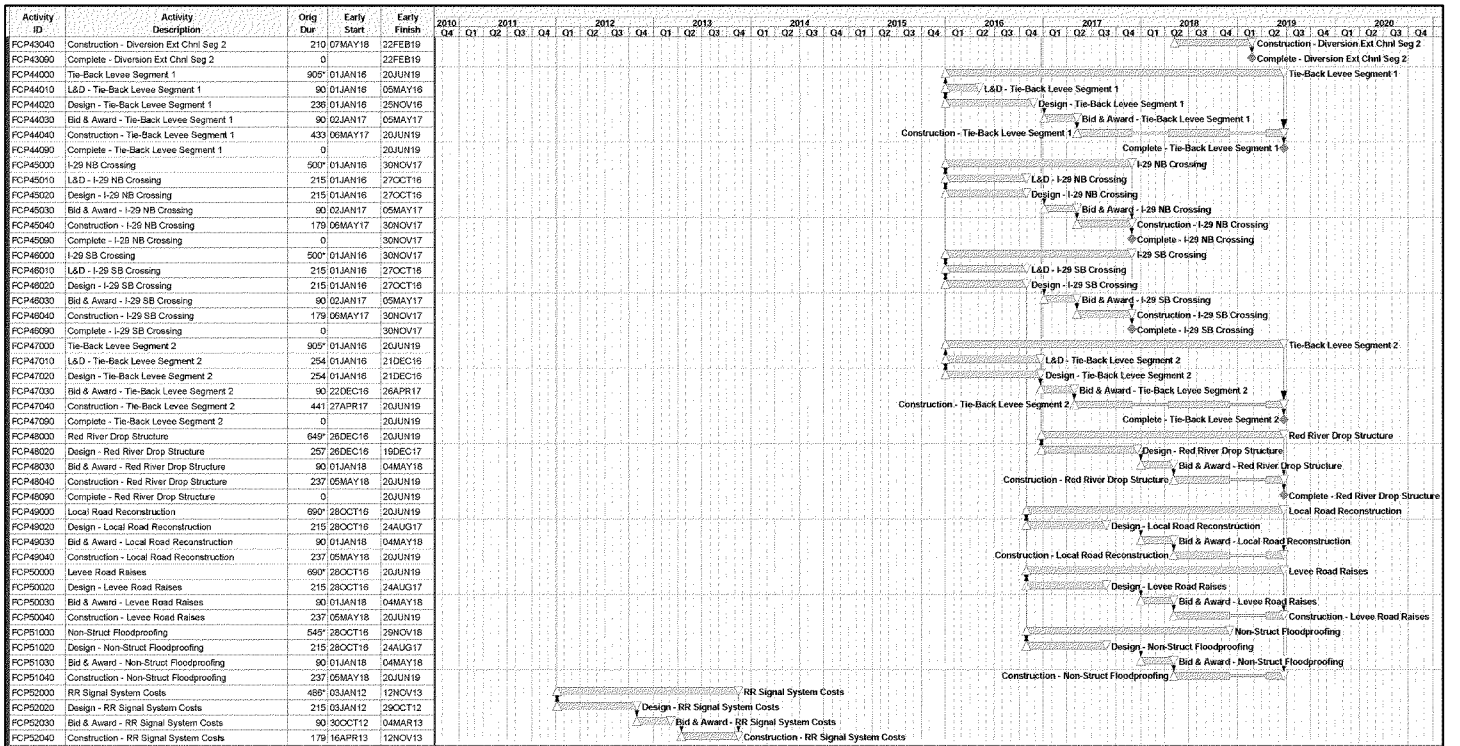
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FCP50020 Design - Levee Road Raises 215 28OCT16 24AUG17
FCP50030 Bid & Award - Levee Road Raises 90 01JAN18 04MAY18
FCP50040 Construction - Levee Road Raises 237 05MAY18 20JUN19
FCP51000 Non-Struct Floodproofing 545* 28OCT16 29NOV18
FCP51020 Design - Non-Struct Floodproofing 215 28OCT16 24AUG17
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FCP51040 Construction - Non-Struct Floodproofing 237 05MAY18 20JUN19
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FCP52030 Bid & Award - RR Signal System Costs 90 30OCT12 04MAR13
FCP52040 Construction - RR Signal System Costs 179 16APR13 12NOV13
Construction - Diversion Ext Chnl Seg 2
Complete - Diversion Ext Chnl Seg 2
Tie-Back Levee Segment 1
L&D - Tie-Back Levee Segment 1
Design - Tie-Back Levee Segment 1
Bid & Award - Tie-Back Levee Segment 1
Construction - Tie-Back Levee Segment 1
Complete - Tie-Back Levee Segment 1
I-29 NB Crossing
L&D - I-29 NB Crossing
Design - I-29 NB Crossing
Bid & Award - I-29 NB Crossing
Construction - I-29 NB Crossing
Complete - I-29 NB Crossing
I-29 SB Crossing
L&D - I-29 SB Crossing
Design - I-29 SB Crossing
Bid & Award - I-29 SB Crossing
Construction - I-29 SB Crossing
Complete - I-29 SB Crossing
Tie-Back Levee Segment 2
L&D - Tie-Back Levee Segment 2
Design - Tie-Back Levee Segment 2
Bid & Award - Tie-Back Levee Segment 2
Construction - Tie-Back Levee Segment 2
Complete - Tie-Back Levee Segment 2
Red River Drop Structure
Design - Red River Drop Structure
Bid & Award - Red River Drop Structure
Construction - Red River Drop Structure
Complete - Red River Drop Structure
Local Road Reconstruction
Design - Local Road Reconstruction
Bid & Award - Local Road Reconstruction
Construction - Local Road Reconstruction
Levee Road Raises
Design - Levee Road Raises
Bid & Award - Levee Road Raises
Construction - Levee Road Raises
Non-Struct Floodproofing
Design - Non-Struct Floodproofing
Bid & Award - Non-Struct Floodproofing
Construction - Non-Struct Floodproofing
RR Signal System Costs
Design - RR Signal System Costs
Bid & Award - RR Signal System Costs
Construction - RR Signal System Costs
Start Date 01OCT10
Finish Date 31DEC24
Data Date 01OCT10
Run Date 29JUN11 08:23
Early Bar
Progress Bar
Critical Activity
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FA05
USACE
Fargo-Moorhead Metro Area Flood Risk
FCP Downstream to Upstream
7.5 year Scenario
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North Dakota
Minnesota
Moorhead
Fargo
North River
Hector International Airport
Fargo-Moorhead Diversion
Diversion Inlet
Diversion Outlet
Proposed Alignment
Proposed Structure
Municipal Boundary
River
Main Road
City Road
Railroad
State
Construction Limit Cells
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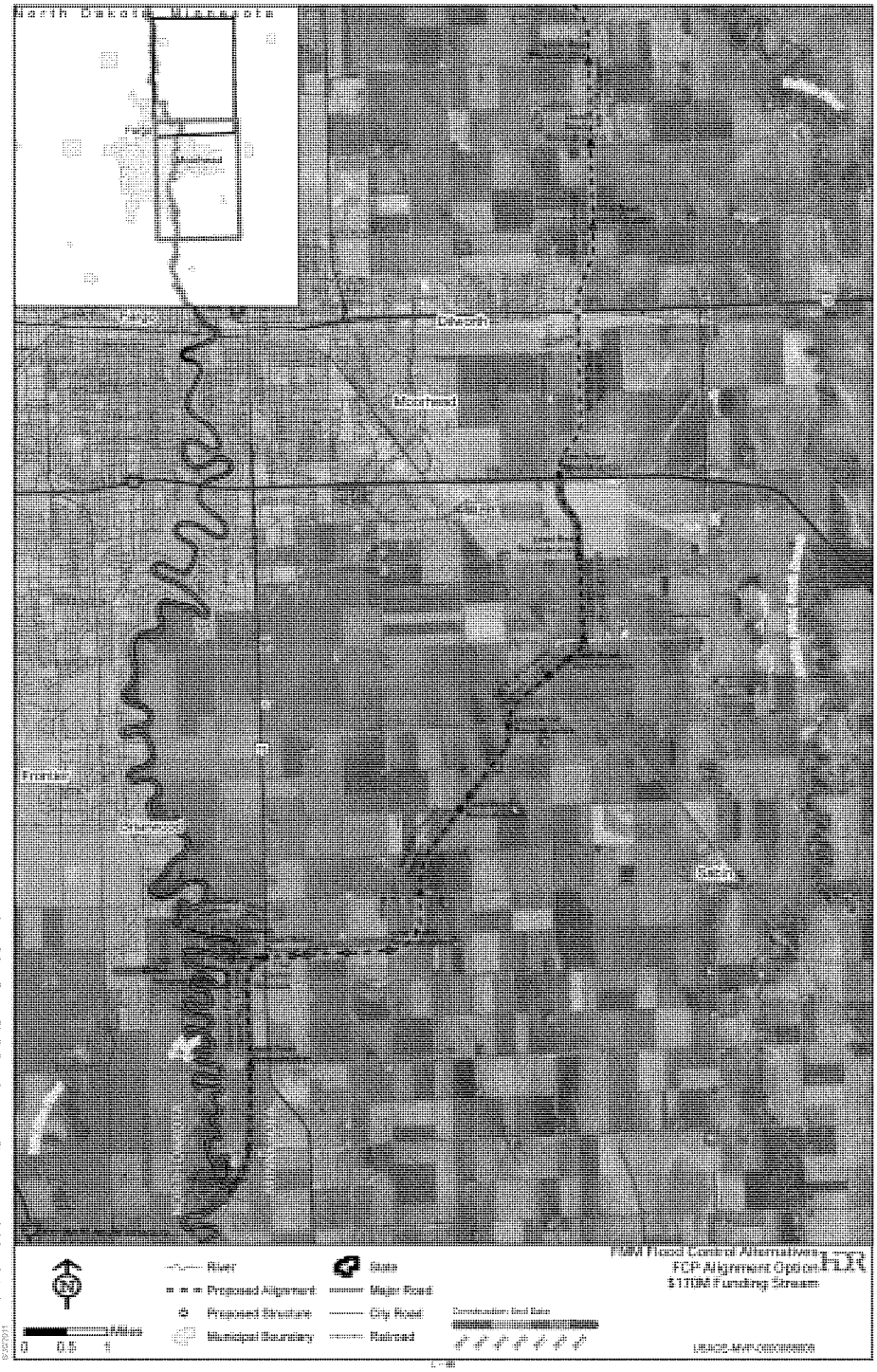
1 Miles
FCP Alignment Option
$170M Funding Stream
FDR


North Dakota
Minnesota
Moorhead
Fargo
Oakcreek
Moorhead
Frontage
Shanedale
Roberts
River
Proposed Alignment
Proposed Structure
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Major Road
City Road
Railroad
Miles
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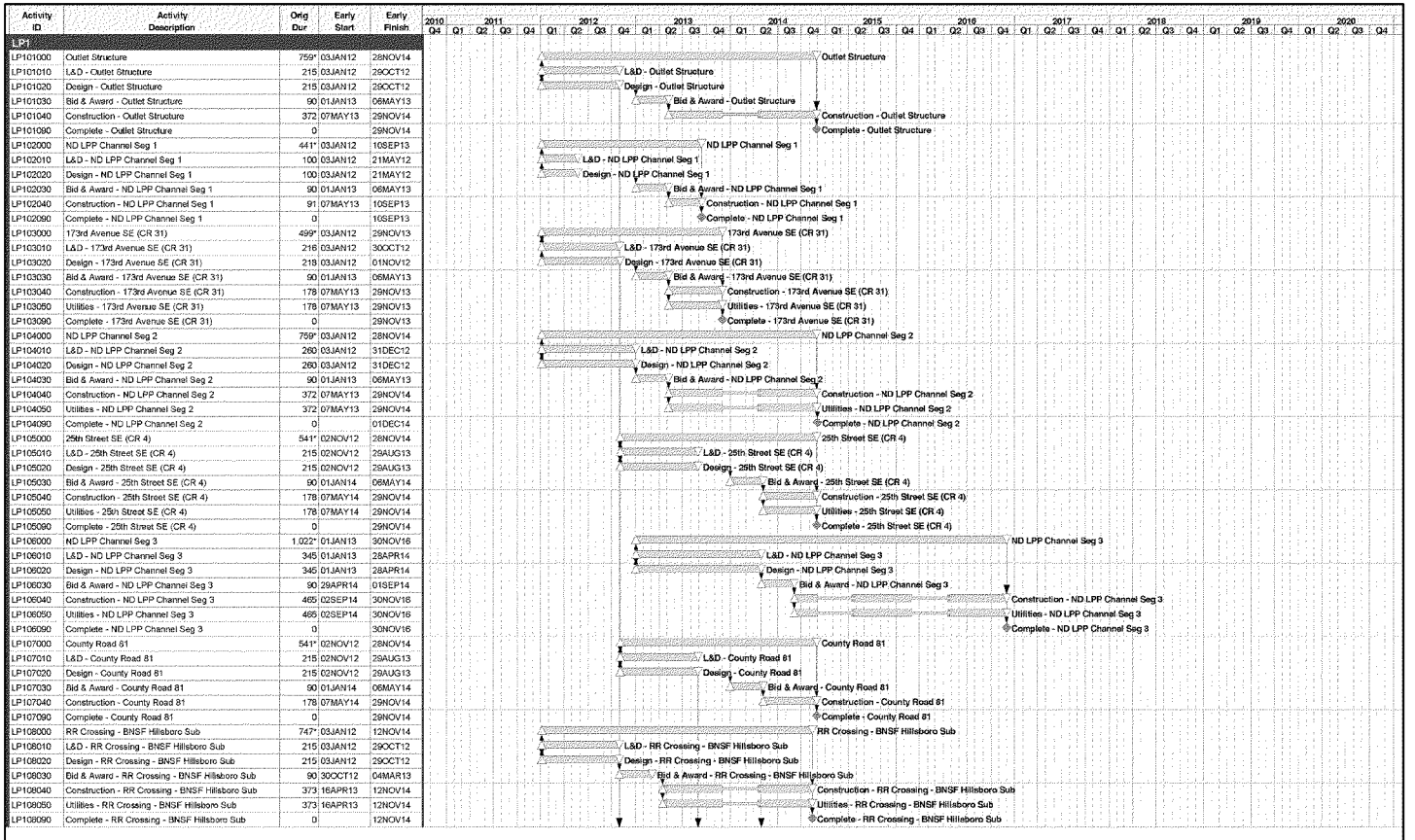
FCP Alignment Option 1
Red River
Fargo Flood Control Alternatives
HDR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LP101040 Construction - Outlet Structure 372 07MAY13 29NOV14
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LP102000 ND LPP Channel Seg 1 441* 03JAN12 10SEP13
LP102010 L&D - ND LPP Channel Seg 1 100 03JAN12 21MAY12
LP102020 Design - ND LPP Channel Seg 1 100 03JAN12 21MAY12
LP102030 Bid & Award - ND LPP Channel Seg 1 90 01JAN13 06MAY13
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LP103040 Construction - 173rd Avenue SE (CR 31) 178 07MAY13 29NOV13
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LP104010 L&D - ND LPP Channel Seg 2 260 03JAN12 31DEC12
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LP104090 Complete - ND LPP Channel Seg 2 0 01DEC14
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LP106040 Construction - ND LPP Channel Seg 3 465 02SEP14 30NOV16
LP106050 Utilities - ND LPP Channel Seg 3 465 02SEP14 30NOV16
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LP107010 L&D - County Road 81 215 02NOV12 29AUG13
LP107020 Design - County Road 81 215 02NOV12 29AUG13
LP107030 Bid & Award - County Road 81 90 01JAN14 06MAY14
LP107040 Construction - County Road 81 178 07MAY14 29NOV14
LP107090 Complete - County Road 81 0 29NOV14
LP108000 RR Crossing - BNSF Hillsboro Sub 747* 03JAN12 12NOV14
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Outlet Structure
L&D - Outlet Structure
Design - Outlet Structure
Bid & Award - Outlet Structure
Construction - Outlet Structure
Complete - Outlet Structure
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Design - ND LPP Channel Seg 1
Bid & Award - ND LPP Channel Seg 1
Construction - ND LPP Channel Seg 1
Complete - ND LPP Channel Seg 1
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Design - 173rd Avenue SE (CR 31)
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Utilities - 173rd Avenue SE (CR 31)
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Design - ND LPP Channel Seg 2
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Construction - ND LPP Channel Seg 2
Utilities - ND LPP Channel Seg 2
Complete - ND LPP Channel Seg 2
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Construction - 25th Street SE (CR 4)
Utilities - 25th Street SE (CR 4)
Complete - 25th Street SE (CR 4)
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L&D - ND LPP Channel Seg 3
Design - ND LPP Channel Seg 3
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Construction - ND LPP Channel Seg 3
Utilities - ND LPP Channel Seg 3
Complete - ND LPP Channel Seg 3
County Road 81
L&D - County Road 81
Design - County Road 81
Bid & Award - County Road 81
Construction - County Road 81
Complete - County Road 81
RR Crossing - BNSF Hillsboro Sub
L&D - RR Crossing - BNSF Hillsboro Sub
Design - RR Crossing - BNSF Hillsboro Sub
Bid & Award - RR Crossing - BNSF Hillsboro Sub
Construction - RR Crossing - BNSF Hillsboro Sub
Utilities - RR Crossing - BNSF Hillsboro Sub
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Start Date 01OCT10
Finish Date 31DEC24
Data Date 01OCT10
Run Date 29JUN11 08:21
Early Bar
Progress Bar
Critical Activity
FA08
USACE
Fargo-Moorhead Metro Area Flood Risk
LPP Downstream to Upstream
8.5 year Scenario
L - 47
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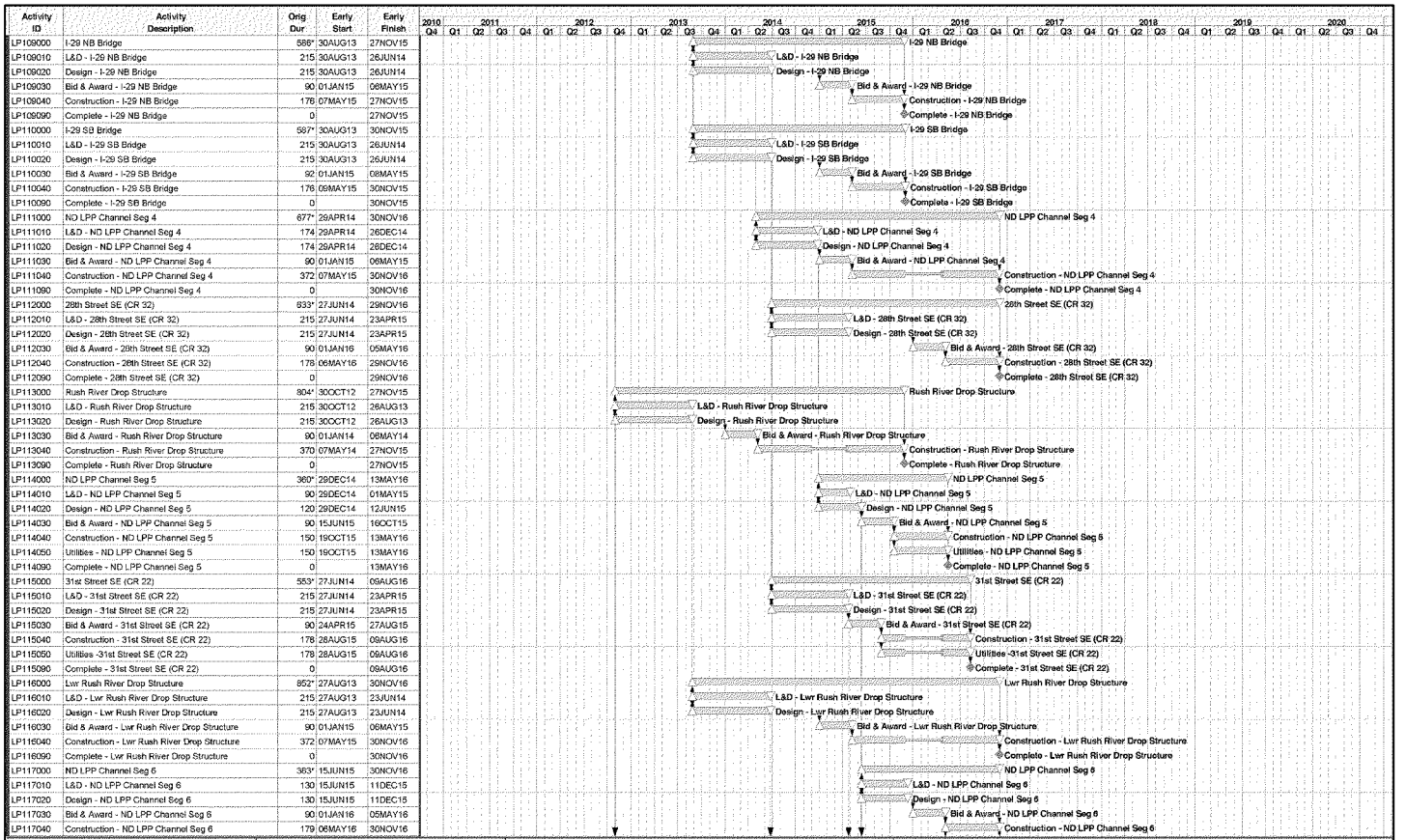
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LP109040 Construction - I-29 NB Bridge 178 07MAY15 27NOV15
LP109090 Complete - I-29 NB Bridge 0 27NOV15
LP110000 I-29 SB Bridge 587* 30AUG13 30NOV15
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LP110020 Design - I-29 SB Bridge 215 30AUG13 26JUN14
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LP111020 Design - ND LPP Channel Seg 4 174 29APR14 26DEC14
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LP111090 Complete - ND LPP Channel Seg 4 0 30NOV16
LP112000 28th Street SE (CR 32) 833* 27JUN14 29NOV16
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I-29 NB Bridge
L&D - I-29 NB Bridge
Design - I-29 NB Bridge
Bid & Award - I-29 NB Bridge
Construction - I-29 NB Bridge
Complete - I-29 NB Bridge
I-29 SB Bridge
L&D - I-29 SB Bridge
Design - I-29 SB Bridge
Bid & Award - I-29 SB Bridge
Construction - I-29 SB Bridge
Complete - I-29 SB Bridge
ND LPP Channel Seg 4
L&D - ND LPP Channel Seg 4
Design - ND LPP Channel Seg 4
Bid & Award - ND LPP Channel Seg 4
Construction - ND LPP Channel Seg 4
Complete - ND LPP Channel Seg 4
28th Street SE (CR 32)
L&D - 28th Street SE (CR 32)
Design - 28th Street SE (CR 32)
Bid & Award - 28th Street SE (CR 32)
Construction - 28th Street SE (CR 32)
Complete - 28th Street SE (CR 32)
Rush River Drop Structure
L&D - Rush River Drop Structure
Design - Rush River Drop Structure
Bid & Award - Rush River Drop Structure
Construction - Rush River Drop Structure
Complete - Rush River Drop Structure
ND LPP Channel Seg 5
L&D - ND LPP Channel Seg 5
Design - ND LPP Channel Seg 5
Bid & Award - ND LPP Channel Seg 5
Construction - ND LPP Channel Seg 5
Utilities - ND LPP Channel Seg 5
Complete - ND LPP Channel Seg 5
31st Street SE (CR 22)
L&D - 31st Street SE (CR 22)
Design - 31st Street SE (CR 22)
Bid & Award - 31st Street SE (CR 22)
Construction - 31st Street SE (CR 22)
Utilities -31st Street SE (CR 22)
Complete - 31st Street SE (CR 22)
Lwr Rush River Drop Structure
L&D - Lwr Rush River Drop Structure
Design - Lwr Rush River Drop Structure
Bid & Award - Lwr Rush River Drop Structure
Construction - Lwr Rush River Drop Structure
Complete - Lwr Rush River Drop Structure
ND LPP Channel Seg 6
L&D - ND LPP Channel Seg 6
Design - ND LPP Channel Seg 6
Bid & Award - ND LPP Channel Seg 6
Construction - ND LPP Channel Seg 6
Start Date 31OCT10
Finish Date 31DEC24
Data Date 31OCT10
Run Date 26JUN11 08:21
Early Bar
Progress Bar
Critical Activity
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FA06
USACE
Fargo-Moorhead Metro Area Flood Risk
LPP Downstream to Upstream
8.5 year Scenario
L - 48
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Approved
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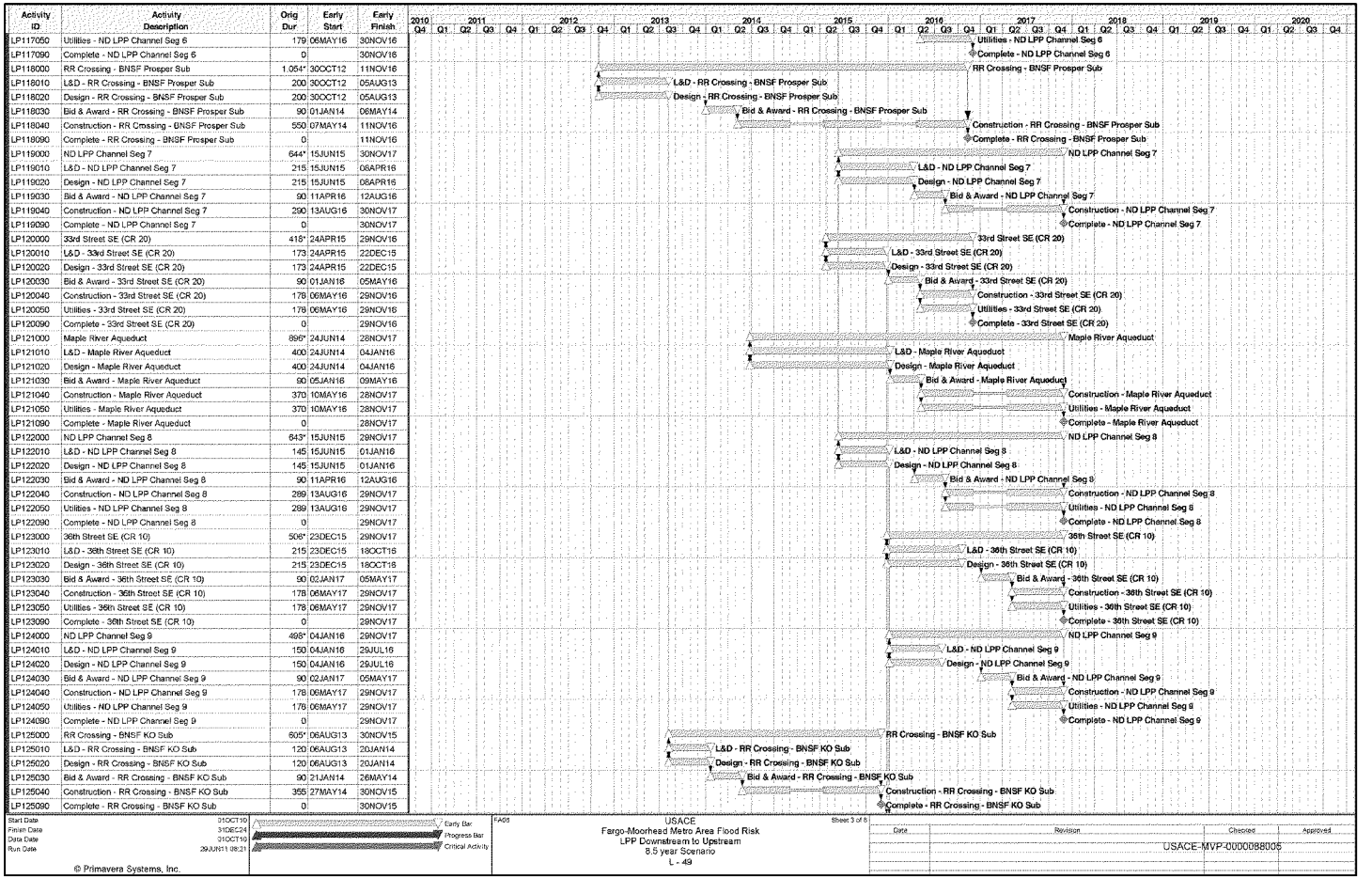
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LP124020 Design - ND LPP Channel Seg 9 150 04JAN16 25JUL16
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LP124090 Complete - ND LPP Channel Seg 9 0 29NOV17
LP125000 RR Crossing - BNSF KO Sub 605* 06AUG13 30NOV15
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Complete - ND LPP Channel Seg 6
RR Crossing - BNSF Prosper Sub
L&D - RR Crossing - BNSF Prosper Sub
Design - RR Crossing - BNSF Prosper Sub
Bid & Award - RR Crossing - BNSF Prosper Sub
Construction - RR Crossing - BNSF Prosper Sub
Complete - RR Crossing - BNSF Prosper Sub
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L&D - ND LPP Channel Seg 7
Design - ND LPP Channel Seg 7
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Construction - 33rd Street SE (CR 20)
Utilities - 33rd Street SE (CR 20)
Complete - 33rd Street SE (CR 20)
Maple River Aqueduct
L&D - Maple River Aqueduct
Design - Maple River Aqueduct
Bid & Award - Maple River Aqueduct
Construction - Maple River Aqueduct
Utilities - Maple River Aqueduct
Complete - Maple River Aqueduct
ND LPP Channel Seg 8
L&D - ND LPP Channel Seg 8
Design - ND LPP Channel Seg 8
Bid & Award - ND LPP Channel Seg 8
Construction - ND LPP Channel Seg 8
Utilities - ND LPP Channel Seg 8
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Design - 36th Street SE (CR 10)
Bid & Award - 36th Street SE (CR 10)
Construction - 36th Street SE (CR 10)
Utilities - 36th Street SE (CR 10)
Complete - 36th Street SE (CR 10)
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Construction - ND LPP Channel Seg 9
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Complete - ND LPP Channel Seg 9
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L&D - RR Crossing - BNSF KO Sub
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Construction - RR Crossing - BNSF KO Sub
Complete - RR Crossing - BNSF KO Sub
Start Date 31OCT10
Finish Date 31DEC24
Data Date 31OCT10
Run Date 29JUN11 08:21
Early Bar
Progress Bar
Critical Activity
FA05
USACE
Fargo-Moorhead Metro Area Flood Risk
LPP Downstream to Upstream
8.5 year Scenario
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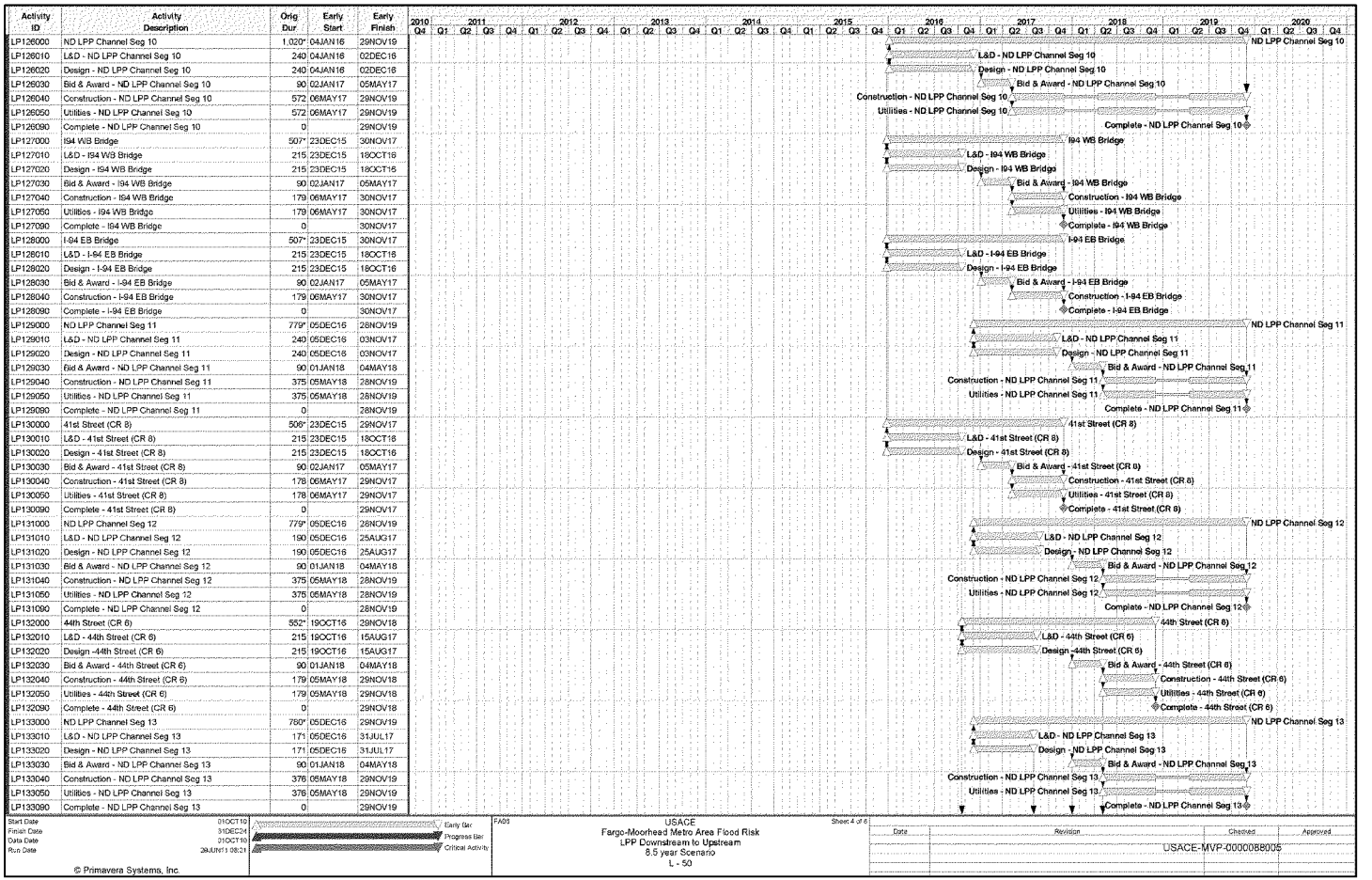
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LP127050 Utilities - I94 WB Bridge 179 08MAY17 30NOV17
LP127090 Complete - I94 WB Bridge 0 30NOV17
LP128000 I-94 EB Bridge 507* 23DEC15 30NOV17
LP128010 L&D - I-94 EB Bridge 215 23DEC15 18OCT16
LP128020 Design - I-94 EB Bridge 215 23DEC15 18OCT16
LP128030 Bid & Award - I-94 EB Bridge 90 02JAN17 05MAY17
LP128040 Construction - I-94 EB Bridge 179 08MAY17 30NOV17
LP128090 Complete - I-94 EB Bridge 0 30NOV17
LP129000 ND LPP Channel Seg 11 779* 05DEC16 28NOV19
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LP129030 Bid & Award - ND LPP Channel Seg 11 90 01JAN18 04MAY18
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LP129050 Utilities - ND LPP Channel Seg 11 375 05MAY18 28NOV19
LP129090 Complete - ND LPP Channel Seg 11 0 28NOV19
LP130000 41st Street (CR 8) 506* 23DEC15 29NOV17
LP130010 L&D - 41st Street (CR 8) 215 23DEC15 18OCT16
LP130020 Design - 41st Street (CR 8) 215 23DEC15 18OCT16
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LP130040 Construction - 41st Street (CR 8) 178 08MAY17 29NOV17
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LP130090 Complete - 41st Street (CR 8) 0 29NOV17
LP131000 ND LPP Channel Seg 12 779* 05DEC16 28NOV19
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LP131020 Design - ND LPP Channel Seg 12 190 05DEC16 25AUG17
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LP131040 Construction - ND LPP Channel Seg 12 375 05MAY18 28NOV19
LP131050 Utilities - ND LPP Channel Seg 12 375 05MAY18 28NOV19
LP131090 Complete - ND LPP Channel Seg 12 0 28NOV19
LP132000 44th Street (CR 6) 552* 19OCT16 29NOV18
LP132010 L&D - 44th Street (CR 6) 215 19OCT16 15AUG17
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L&D - ND LPP Channel Seg 10
Design - ND LPP Channel Seg 10
Bid & Award - ND LPP Channel Seg 10
Construction - ND LPP Channel Seg 10
Utilities - ND LPP Channel Seg 10
Complete - ND LPP Channel Seg 10
I94 WB Bridge
L&D - I94 WB Bridge
Design - I94 WB Bridge
Bid & Award - I94 WB Bridge
Construction - I94 WB Bridge
Utilities - I94 WB Bridge
Complete - I94 WB Bridge
I-94 EB Bridge
L&D - I-94 EB Bridge
Design - I-94 EB Bridge
Bid & Award - I-94 EB Bridge
Construction - I-94 EB Bridge
Complete - I-94 EB Bridge
ND LPP Channel Seg 11
L&D - ND LPP Channel Seg 11
Design - ND LPP Channel Seg 11
Bid & Award - ND LPP Channel Seg 11
Construction - ND LPP Channel Seg 11
Utilities - ND LPP Channel Seg 11
Complete - ND LPP Channel Seg 11
41st Street (CR 8)
L&D - 41st Street (CR 8)
Design - 41st Street (CR 8)
Bid & Award - 41st Street (CR 8)
Construction - 41st Street (CR 8)
Utilities - 41st Street (CR 8)
Complete - 41st Street (CR 8)
ND LPP Channel Seg 12
L&D - ND LPP Channel Seg 12
Design - ND LPP Channel Seg 12
Bid & Award - ND LPP Channel Seg 12
Construction - ND LPP Channel Seg 12
Utilities - ND LPP Channel Seg 12
Complete - ND LPP Channel Seg 12
44th Street (CR 6)
L&D - 44th Street (CR 6)
Design -44th Street (CR 6)
Bid & Award - 44th Street (CR 6)
Construction - 44th Street (CR 6)
Utilities - 44th Street (CR 6)
Complete - 44th Street (CR 6)
ND LPP Channel Seg 13
L&D - ND LPP Channel Seg 13
Design - ND LPP Channel Seg 13
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Construction - ND LPP Channel Seg 13
Utilities - ND LPP Channel Seg 13
Complete - ND LPP Channel Seg 13
Start Date 01OCT10
Finish Date 31DEC24
Data Date 01OCT10
Run Date 28JUN11 08:21
Early Bar
Progress Bar
Critical Activity
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FA05
USACE
Fargo-Moorhead Metro Area Flood Risk
LPP Downstream to Upstream
8.5 year Scenario
L - 50
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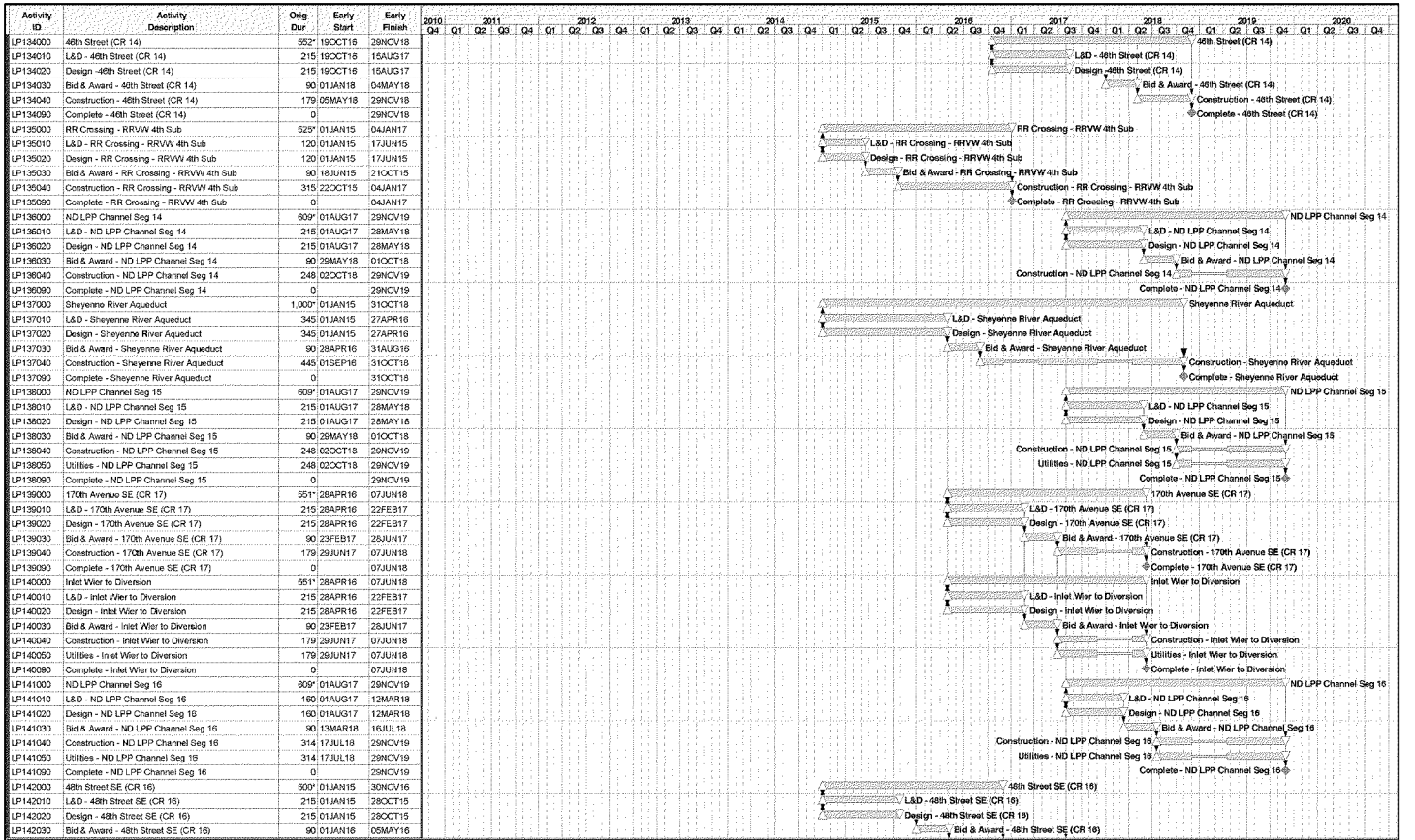
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LP134040 Construction - 46th Street (CR 14) 179 05MAY18 29NOV18
LP134090 Complete - 46th Street (CR 14) 0 29NOV18
LP135000 RR Crossing - RRVW 4th Sub 525* 01JAN15 04JAN17
LP135010 L&D - RR Crossing - RRVW 4th Sub 120 01JAN15 17JUN15
LP135020 Design - RR Crossing - RRVW 4th Sub 120 01JAN15 17JUN15
LP135030 Bid & Award - RR Crossing - RRVW 4th Sub 90 18JUN15 21OCT15
LP135040 Construction - RR Crossing - RRVW 4th Sub 315 22OCT15 04JAN17
LP135090 Complete - RR Crossing - RRVW 4th Sub 0 04JAN17
LP136000 ND LPP Channel Seg 14 609* 01AUG17 29NOV19
LP136010 L&D - ND LPP Channel Seg 14 215 01AUG17 28MAY18
LP136020 Design - ND LPP Channel Seg 14 215 01AUG17 28MAY18
LP136030 Bid & Award - ND LPP Channel Seg 14 90 29MAY18 01OCT18
LP136040 Construction - ND LPP Channel Seg 14 248 02OCT18 29NOV19
LP136090 Complete - ND LPP Channel Seg 14 0 29NOV19
LP137000 Sheyenne River Aqueduct 1,000* 01JAN15 31OCT18
LP137010 L&D - Sheyenne River Aqueduct 345 01JAN15 27APR16
LP137020 Design - Sheyenne River Aqueduct 345 01JAN15 27APR16
LP137030 Bid & Award - Sheyenne River Aqueduct 90 28APR16 31AUG16
LP137040 Construction - Sheyenne River Aqueduct 445 01SEP16 31OCT18
LP137090 Complete - Sheyenne River Aqueduct 0 31OCT18
LP138000 ND LPP Channel Seg 15 609* 01AUG17 29NOV19
LP138010 L&D - ND LPP Channel Seg 15 215 01AUG17 28MAY18
LP138020 Design - ND LPP Channel Seg 15 215 01AUG17 28MAY18
LP138030 Bid & Award - ND LPP Channel Seg 15 90 29MAY18 01OCT18
LP138040 Construction - ND LPP Channel Seg 15 248 02OCT18 29NOV19
LP138050 Utilities - ND LPP Channel Seg 15 248 02OCT18 29NOV19
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LP139000 170th Avenue SE (CR 17) 551* 28APR16 07JUN18
LP139010 L&D - 170th Avenue SE (CR 17) 215 28APR16 22FEB17
LP139020 Design - 170th Avenue SE (CR 17) 215 28APR16 22FEB17
LP139030 Bid & Award - 170th Avenue SE (CR 17) 90 23FEB17 28JUN17
LP139040 Construction - 170th Avenue SE (CR 17) 179 29JUN17 07JUN18
LP139090 Complete - 170th Avenue SE (CR 17) 0 07JUN18
LP140000 Inlet Weir to Diversion 551* 28APR16 07JUN18
LP140010 L&D - Inlet Weir to Diversion 215 28APR16 22FEB17
LP140020 Design - Inlet Weir to Diversion 215 28APR16 22FEB17
LP140030 Bid & Award - Inlet Weir to Diversion 90 23FEB17 28JUN17
LP140040 Construction - Inlet Weir to Diversion 179 29JUN17 07JUN18
LP140050 Utilities - Inlet Weir to Diversion 179 29JUN17 07JUN18
LP140090 Complete - Inlet Weir to Diversion 0 07JUN18
LP141000 ND LPP Channel Seg 16 609* 01AUG17 29NOV19
LP141010 L&D - ND LPP Channel Seg 16 160 01AUG17 12MAR18
LP141020 Design - ND LPP Channel Seg 16 160 01AUG17 12MAR18
LP141030 Bid & Award - ND LPP Channel Seg 16 90 13MAR18 16JUL18
LP141040 Construction - ND LPP Channel Seg 16 314 17JUL18 29NOV19
LP141050 Utilities - ND LPP Channel Seg 16 314 17JUL18 29NOV19
LP141090 Complete - ND LPP Channel Seg 16 0 29NOV19
LP142000 48th Street SE (CR 16) 500* 01JAN15 30NOV16
LP142010 L&D - 48th Street SE (CR 16) 215 01JAN15 28OCT15
LP142020 Design - 48th Street SE (CR 16) 215 01JAN15 28OCT15
LP142030 Bid & Award - 48th Street SE (CR 16) 90 01JAN16 05MAY16
46th Street (CR 14)
L&D - 46th Street (CR 14)
Design -46th Street (CR 14)
Bid & Award - 46th Street (CR 14)
Construction - 46th Street (CR 14)
Complete - 46th Street (CR 14)
RR Crossing - RRVW 4th Sub
L&D - RR Crossing - RRVW 4th Sub
Design - RR Crossing - RRVW 4th Sub
Bid & Award - RR Crossing - RRVW 4th Sub
Construction - RR Crossing - RRVW 4th Sub
Complete - RR Crossing - RRVW 4th Sub
ND LPP Channel Seg 14
L&D - ND LPP Channel Seg 14
Design - ND LPP Channel Seg 14
Bid & Award - ND LPP Channel Seg 14
Construction - ND LPP Channel Seg 14
Complete - ND LPP Channel Seg 14
Sheyenne River Aqueduct
L&D - Sheyenne River Aqueduct
Design - Sheyenne River Aqueduct
Bid & Award - Sheyenne River Aqueduct
Construction - Sheyenne River Aqueduct
Complete - Sheyenne River Aqueduct
ND LPP Channel Seg 15
L&D - ND LPP Channel Seg 15
Design - ND LPP Channel Seg 15
Bid & Award - ND LPP Channel Seg 15
Construction - ND LPP Channel Seg 15
Utilities - ND LPP Channel Seg 15
Complete - ND LPP Channel Seg 15
170th Avenue SE (CR 17)
L&D - 170th Avenue SE (CR 17)
Design - 170th Avenue SE (CR 17)
Bid & Award - 170th Avenue SE (CR 17)
Construction - 170th Avenue SE (CR 17)
Complete - 170th Avenue SE (CR 17)
Inlet Weir to Diversion
L&D - Inlet Weir to Diversion
Design - Inlet Weir to Diversion
Bid & Award - Inlet Weir to Diversion
Construction - Inlet Weir to Diversion
Utilities - Inlet Weir to Diversion
Complete - Inlet Weir to Diversion
ND LPP Channel Seg 16
L&D - ND LPP Channel Seg 16
Design - ND LPP Channel Seg 16
Bid & Award - ND LPP Channel Seg 16
Construction - ND LPP Channel Seg 16
Utilities - ND LPP Channel Seg 16
Complete - ND LPP Channel Seg 16
48th Street SE (CR 16)
L&D - 48th Street SE (CR 16)
Design - 48th Street SE (CR 16)
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Start Date 31OCT16
Finish Date 31DEC24
Data Date 31OCT16
Run Date 29JUN11 08:21
Early Bar
Progress Bar
Critical Activity
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LPP Downstream to Upstream
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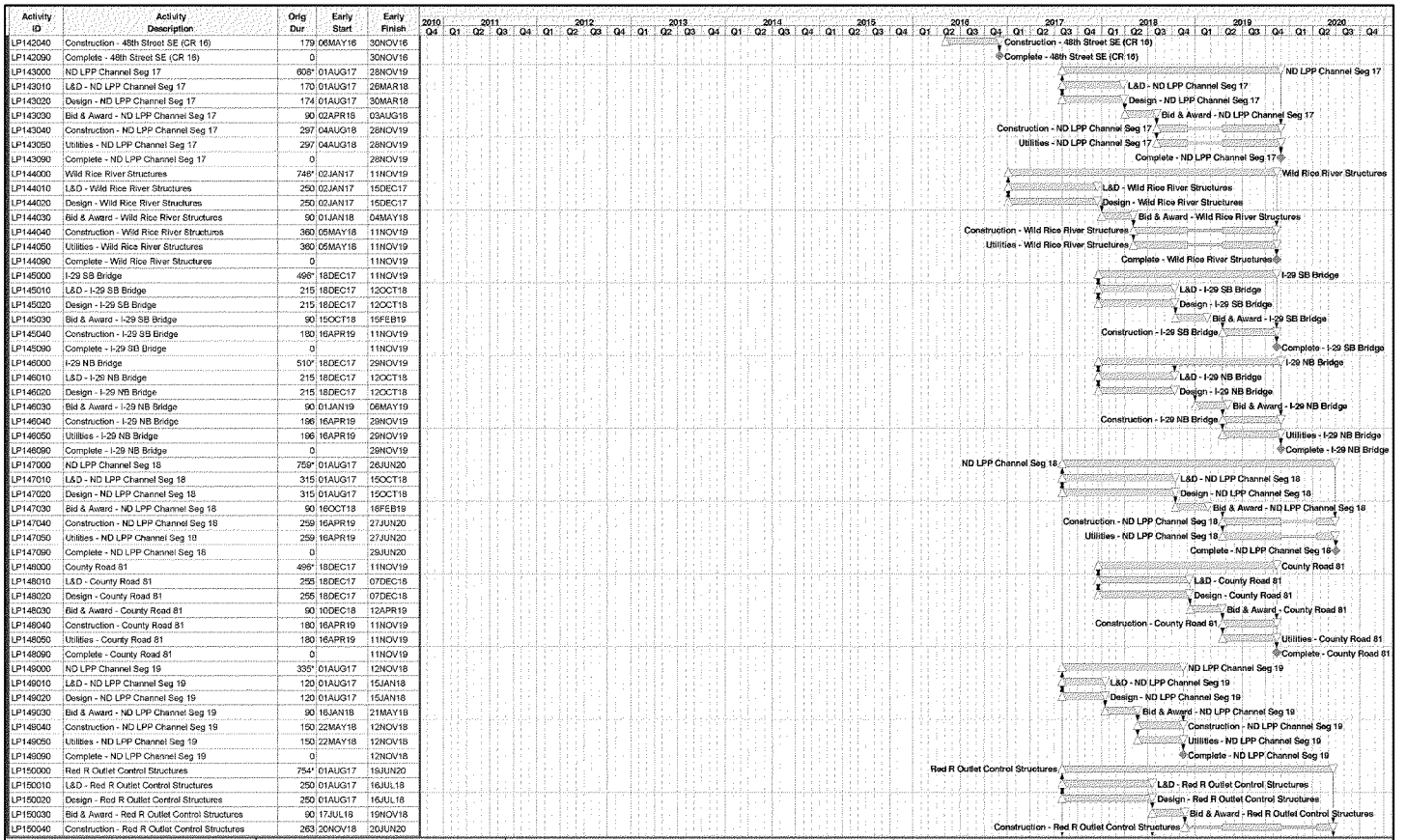
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Activity Description
Orig Dur
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Early Finish
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LP143000 ND LPP Channel Seg 17 608* 01AUG17 28NOV19
LP143010 L&D - ND LPP Channel Seg 17 170 01AUG17 26MAR18
LP143020 Design - ND LPP Channel Seg 17 174 01AUG17 30MAR18
LP143030 Bid & Award - ND LPP Channel Seg 17 90 02APR18 03AUG18
LP143040 Construction - ND LPP Channel Seg 17 297 04AUG18 28NOV19
LP143050 Utilities - ND LPP Channel Seg 17 297 04AUG18 28NOV19
LP143090 Complete - ND LPP Channel Seg 17 0 28NOV19
LP144000 Wild Rice River Structures 748* 02JAN17 11NOV19
LP144010 L&D - Wild Rice River Structures 250 02JAN17 15DEC17
LP144020 Design - Wild Rice River Structures 250 02JAN17 15DEC17
LP144030 Bid & Award - Wild Rice River Structures 90 01JAN18 04MAY18
LP144040 Construction - Wild Rice River Structures 360 05MAY18 11NOV19
LP144050 Utilities - Wild Rice River Structures 360 05MAY18 11NOV19
LP144090 Complete - Wild Rice River Structures 0 11NOV19
LP145000 I-29 SB Bridge 496* 18DEC17 11NOV19
LP145010 L&D - I-29 SB Bridge 215 18DEC17 12OCT18
LP145020 Design - I-29 SB Bridge 215 18DEC17 12OCT18
LP145030 Bid & Award - I-29 SB Bridge 90 15OCT18 15FEB19
LP145040 Construction - I-29 SB Bridge 180 16APR19 11NOV19
LP145090 Complete - I-29 SB Bridge 0 11NOV19
LP146000 I-29 NB Bridge 510* 18DEC17 29NOV19
LP146010 L&D - I-29 NB Bridge 215 18DEC17 12OCT18
LP146020 Design - I-29 NB Bridge 215 18DEC17 12OCT18
LP146030 Bid & Award - I-29 NB Bridge 90 01JAN19 06MAY19
LP146040 Construction - I-29 NB Bridge 196 16APR19 29NOV19
LP146050 Utilities - I-29 NB Bridge 196 16APR19 29NOV19
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LP147000 ND LPP Channel Seg 18 759* 01AUG17 26JUN20
LP147010 L&D - ND LPP Channel Seg 18 315 01AUG17 15OCT18
LP147020 Design - ND LPP Channel Seg 18 315 01AUG17 15OCT18
LP147030 Bid & Award - ND LPP Channel Seg 18 90 16OCT18 16FEB19
LP147040 Construction - ND LPP Channel Seg 18 259 16APR19 27JUN20
LP147050 Utilities - ND LPP Channel Seg 18 259 16APR19 27JUN20
LP147090 Complete - ND LPP Channel Seg 18 0 26JUN20
LP148000 County Road 81 496* 18DEC17 11NOV19
LP148010 L&D - County Road 81 255 18DEC17 07DEC18
LP148020 Design - County Road 81 255 18DEC17 07DEC18
LP148030 Bid & Award - County Road 81 90 10DEC18 12APR19
LP148040 Construction - County Road 81 180 16APR19 11NOV19
LP148050 Utilities - County Road 81 180 16APR19 11NOV19
LP148090 Complete - County Road 81 0 11NOV19
LP149000 ND LPP Channel Seg 19 335* 01AUG17 12NOV18
LP149010 L&D - ND LPP Channel Seg 19 120 01AUG17 15JAN18
LP149020 Design - ND LPP Channel Seg 19 120 01AUG17 15JAN18
LP149030 Bid & Award - ND LPP Channel Seg 19 90 16JAN18 21MAY18
LP149040 Construction - ND LPP Channel Seg 19 150 22MAY18 12NOV18
LP149050 Utilities - ND LPP Channel Seg 19 150 22MAY18 12NOV18
LP149090 Complete - ND LPP Channel Seg 19 0 12NOV18
LP150000 Red R Outlet Control Structures 754* 01AUG17 15JUN20
LP150010 L&D - Red R Outlet Control Structures 250 01AUG17 16JUL18
LP150020 Design - Red R Outlet Control Structures 250 01AUG17 16JUL18
LP150030 Bid & Award - Red R Outlet Control Structures 90 17JUL18 19NOV18
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Construction - 48th Street SE (CR 16)
Complete - 48th Street SE (CR 16)
ND LPP Channel Seg 17
L&D - ND LPP Channel Seg 17
Design - ND LPP Channel Seg 17
Bid & Award - ND LPP Channel Seg 17
Construction - ND LPP Channel Seg 17
Utilities - ND LPP Channel Seg 17
Complete - ND LPP Channel Seg 17
Wild Rice River Structures
L&D - Wild Rice River Structures
Design - Wild Rice River Structures
Bid & Award - Wild Rice River Structures
Construction - Wild Rice River Structures
Utilities - Wild Rice River Structures
Complete - Wild Rice River Structures
I-29 SB Bridge
L&D - I-29 SB Bridge
Design - I-29 SB Bridge
Bid & Award - I-29 SB Bridge
Construction - I-29 SB Bridge
Complete - I-29 SB Bridge
I-29 NB Bridge
L&D - I-29 NB Bridge
Design - I-29 NB Bridge
Bid & Award - I-29 NB Bridge
Construction - I-29 NB Bridge
Utilities - I-29 NB Bridge
Complete - I-29 NB Bridge
ND LPP Channel Seg 18
L&D - ND LPP Channel Seg 18
Design - ND LPP Channel Seg 18
Bid & Award - ND LPP Channel Seg 18
Construction - ND LPP Channel Seg 18
Utilities - ND LPP Channel Seg 18
Complete - ND LPP Channel Seg 18
County Road 81
L&D - County Road 81
Design - County Road 81
Bid & Award - County Road 81
Construction - County Road 81
Utilities - County Road 81
Complete - County Road 81
ND LPP Channel Seg 19
L&D - ND LPP Channel Seg 19
Design - ND LPP Channel Seg 19
Bid & Award - ND LPP Channel Seg 19
Construction - ND LPP Channel Seg 19
Utilities - ND LPP Channel Seg 19
Complete - ND LPP Channel Seg 19
Red R Outlet Control Structures
L&D - Red R Outlet Control Structures
Design - Red R Outlet Control Structures
Bid & Award - Red R Outlet Control Structures
Construction - Red R Outlet Control Structures
Start Date 01OCT10
Finish Date 31DEC24
Data Date 21OCT10
Run Date 29JUN11 08:21
Early Bar
Progress Bar
Critical Activity
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FA05
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LPP Downstream to Upstream
8.5 year Scenario
L - 52
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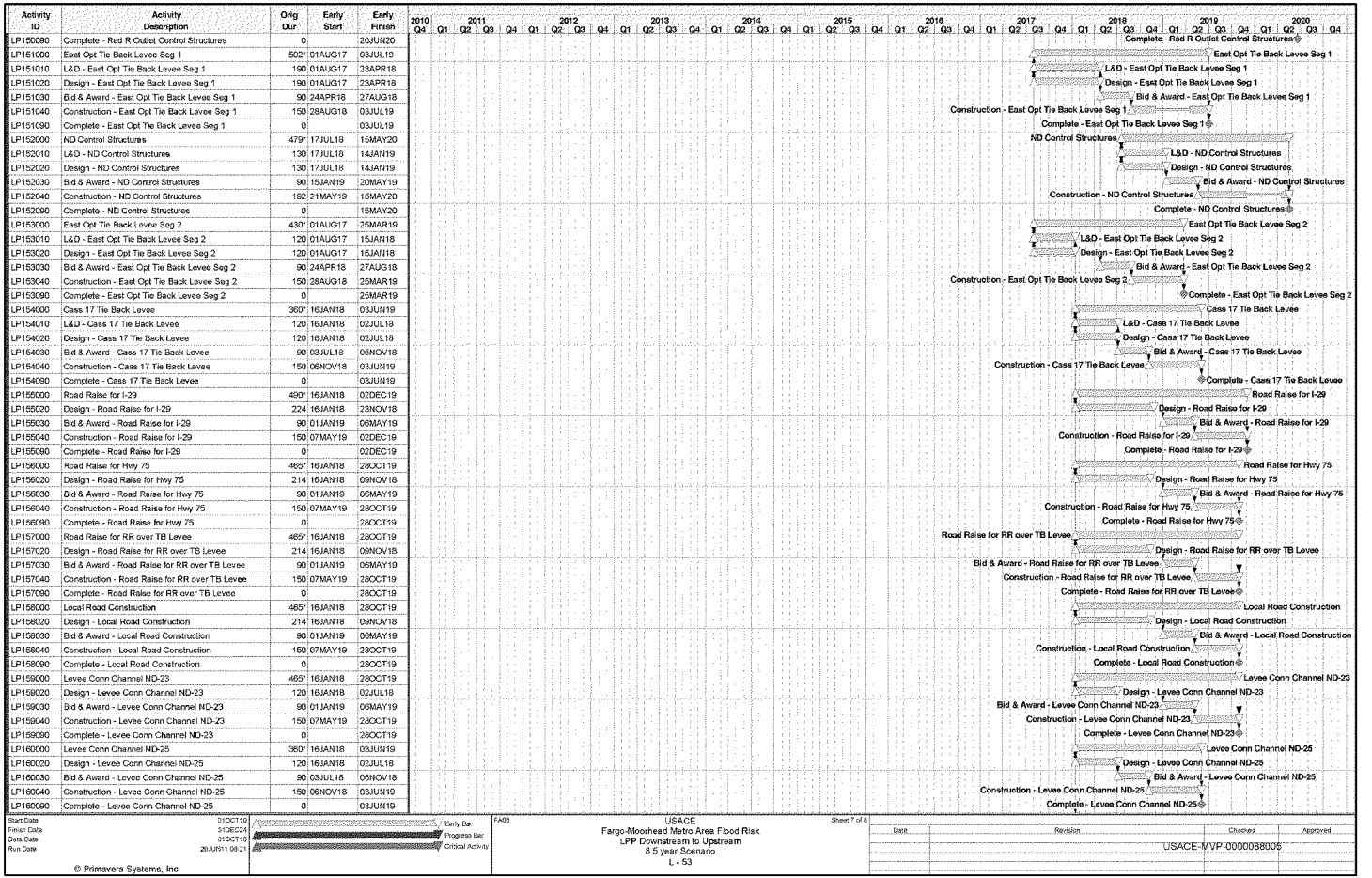
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LP151020 Design - East Opt Tie Back Levee Seg 1 190 01AUG17 23APR18
LP151030 Bid & Award - East Opt Tie Back Levee Seg 1 90 24APR18 27AUG18
LP151040 Construction - East Opt Tie Back Levee Seg 1 150 28AUG18 03JUL19
LP151090 Complete - East Opt Tie Back Levee Seg 1 0 03JUL19
LP152000 ND Control Structures 479* 17JUL18 15MAY20
LP152010 L&D - ND Control Structures 130 17JUL18 14JAN19
LP152020 Design - ND Control Structures 130 17JUL18 14JAN19
LP152030 Bid & Award - ND Control Structures 90 15JAN19 20MAY19
LP152040 Construction - ND Control Structures 192 21MAY19 15MAY20
LP152090 Complete - ND Control Structures 0 15MAY20
LP153000 East Opt Tie Back Levee Seg 2 430* 01AUG17 25MAR19
LP153010 L&D - East Opt Tie Back Levee Seg 2 120 01AUG17 15JAN18
LP153020 Design - East Opt Tie Back Levee Seg 2 120 01AUG17 15JAN18
LP153030 Bid & Award - East Opt Tie Back Levee Seg 2 90 24APR18 27AUG18
LP153040 Construction - East Opt Tie Back Levee Seg 2 150 28AUG18 25MAR19
LP153090 Complete - East Opt Tie Back Levee Seg 2 0 25MAR19
LP154000 Cass 17 Tie Back Levee 360* 16JAN18 03JUN19
LP154010 L&D - Cass 17 Tie Back Levee 120 16JAN18 02JUL18
LP154020 Design - Cass 17 Tie Back Levee 120 16JAN18 02JUL18
LP154030 Bid & Award - Cass 17 Tie Back Levee 90 03JUL18 05NOV18
LP154040 Construction - Cass 17 Tie Back Levee 150 06NOV18 03JUN19
LP154090 Complete - Cass 17 Tie Back Levee 0 03JUN19
LP155000 Road Raise for I-29 490* 16JAN18 02DEC19
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LP155040 Construction - Road Raise for I-29 150 07MAY19 02DEC19
LP155090 Complete - Road Raise for I-29 0 02DEC19
LP156000 Road Raise for Hwy 75 465* 16JAN18 28OCT19
LP156020 Design - Road Raise for Hwy 75 214 16JAN18 09NOV18
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LP156040 Construction - Road Raise for Hwy 75 150 07MAY19 28OCT19
LP156090 Complete - Road Raise for Hwy 75 0 28OCT19
LP157000 Road Raise for RR over TB Levee 465* 16JAN18 28OCT19
LP157020 Design - Road Raise for RR over TB Levee 214 16JAN18 09NOV18
LP157030 Bid & Award - Road Raise for RR over TB Levee 90 01JAN19 06MAY19
LP157040 Construction - Road Raise for RR over TB Levee 150 07MAY19 28OCT19
LP157090 Complete - Road Raise for RR over TB Levee 0 28OCT19
LP158000 Local Road Construction 465* 16JAN18 28OCT19
LP158020 Design - Local Road Construction 214 16JAN18 09NOV18
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LP158040 Construction - Local Road Construction 150 07MAY19 28OCT19
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LP159000 Levee Conn Channel ND-23 465* 16JAN18 28OCT19
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LP159040 Construction - Levee Conn Channel ND-23 150 07MAY19 28OCT19
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LP160000 Levee Conn Channel ND-25 360* 16JAN18 03JUN19
LP160020 Design - Levee Conn Channel ND-25 120 16JAN18 02JUL18
LP160030 Bid & Award - Levee Conn Channel ND-25 90 03JUL18 05NOV18
LP160040 Construction - Levee Conn Channel ND-25 150 06NOV18 03JUN19
LP160090 Complete - Levee Conn Channel ND-25 0 03JUN19
Complete - Red R Outlet Control Structures
East Opt Tie Back Levee Seg 1
L&D - East Opt Tie Back Levee Seg 1
Design - East Opt Tie Back Levee Seg 1
Bid & Award - East Opt Tie Back Levee Seg 1
Construction - East Opt Tie Back Levee Seg 1
Complete - East Opt Tie Back Levee Seg 1
ND Control Structures
L&D - ND Control Structures
Design - ND Control Structures
Bid & Award - ND Control Structures
Construction - ND Control Structures
Complete - ND Control Structures
East Opt Tie Back Levee Seg 2
L&D - East Opt Tie Back Levee Seg 2
Design - East Opt Tie Back Levee Seg 2
Bid & Award - East Opt Tie Back Levee Seg 2
Construction - East Opt Tie Back Levee Seg 2
Complete - East Opt Tie Back Levee Seg 2
Cass 17 Tie Back Levee
L&D - Cass 17 Tie Back Levee
Design - Cass 17 Tie Back Levee
Bid & Award - Cass 17 Tie Back Levee
Construction - Cass 17 Tie Back Levee
Complete - Cass 17 Tie Back Levee
Road Raise for I-29
Design - Road Raise for I-29
Bid & Award - Road Raise for I-29
Construction - Road Raise for I-29
Complete - Road Raise for I-29
Road Raise for Hwy 75
Design - Road Raise for Hwy 75
Bid & Award - Road Raise for Hwy 75
Construction - Road Raise for Hwy 75
Complete - Road Raise for Hwy 75
Road Raise for RR over TB Levee
Design - Road Raise for RR over TB Levee
Bid & Award - Road Raise for RR over TB Levee
Construction - Road Raise for RR over TB Levee
Complete - Road Raise for RR over TB Levee
Local Road Construction
Design - Local Road Construction
Bid & Award - Local Road Construction
Construction - Local Road Construction
Complete - Local Road Construction
Levee Conn Channel ND-23
Design - Levee Conn Channel ND-23
Bid & Award - Levee Conn Channel ND-23
Construction - Levee Conn Channel ND-23
Complete - Levee Conn Channel ND-23
Levee Conn Channel ND-25
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Start Date 31OCT19
Finish Date 31DEC24
Data Date 31OCT19
Run Date 29JUN11 08:21
Early Bar
Progress Bar
Critical Activity
FA09
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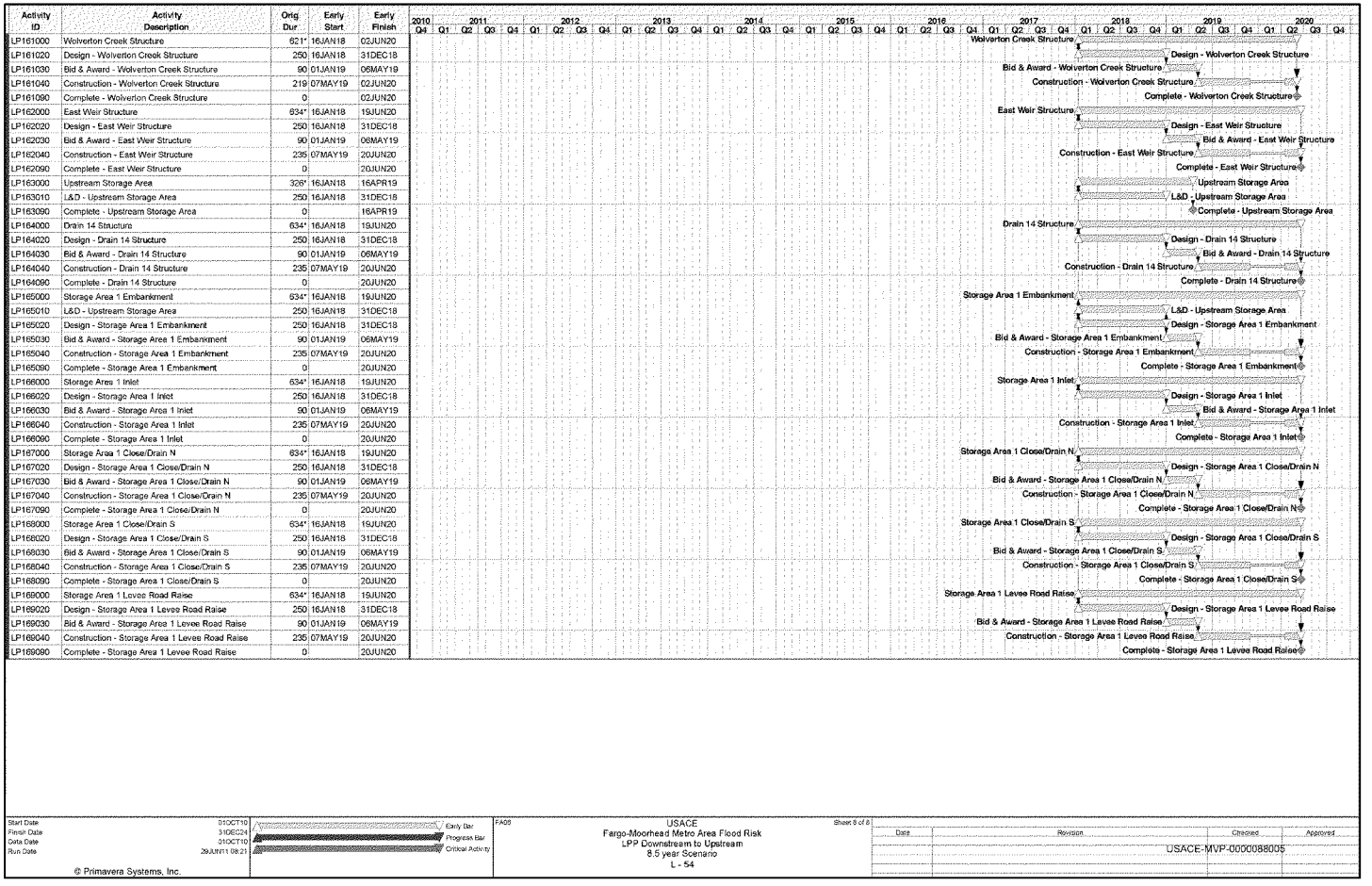
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USACE
Fargo-Moorhead Metro Area Flood Risk
LPP Downstream to Upstream
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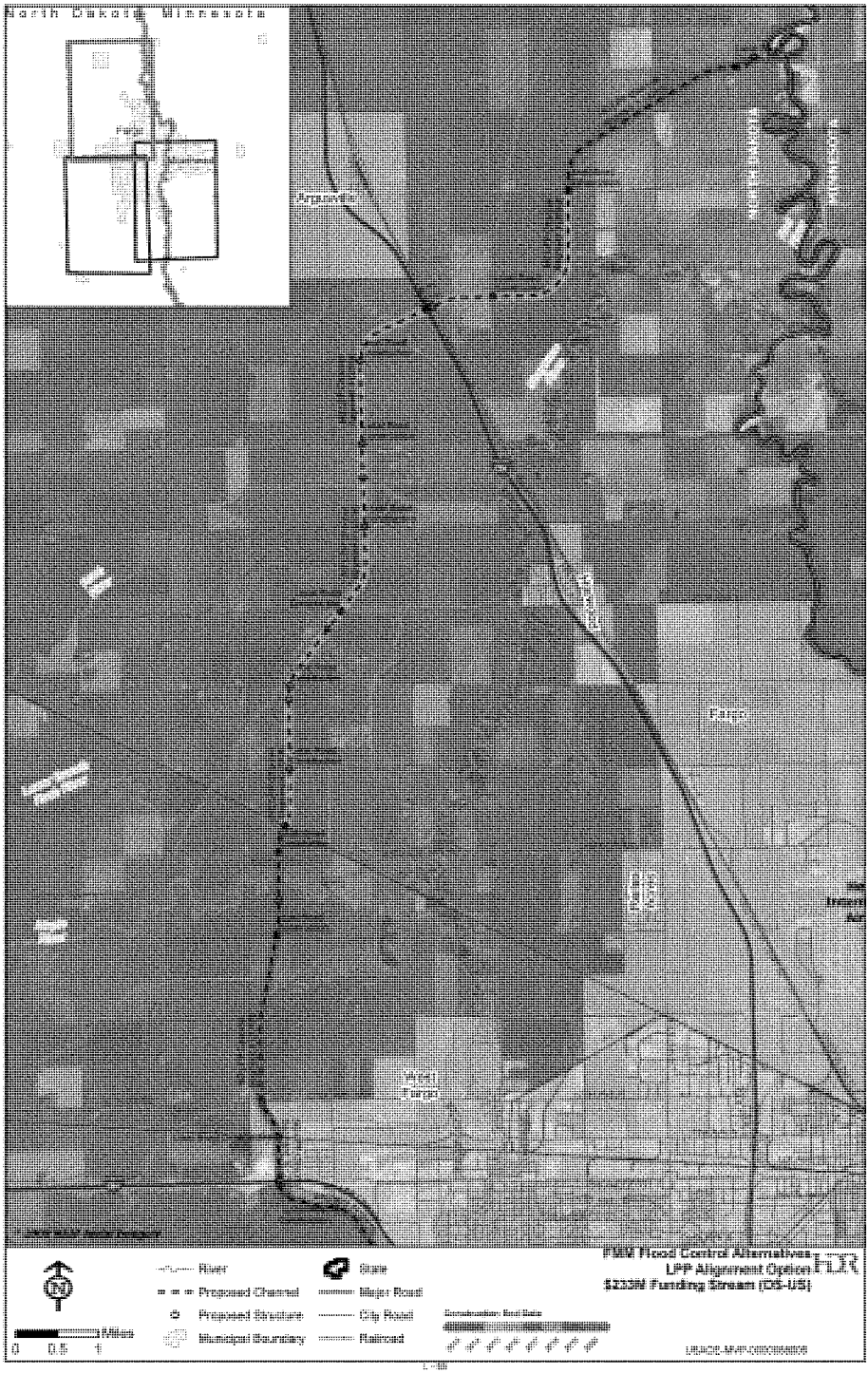
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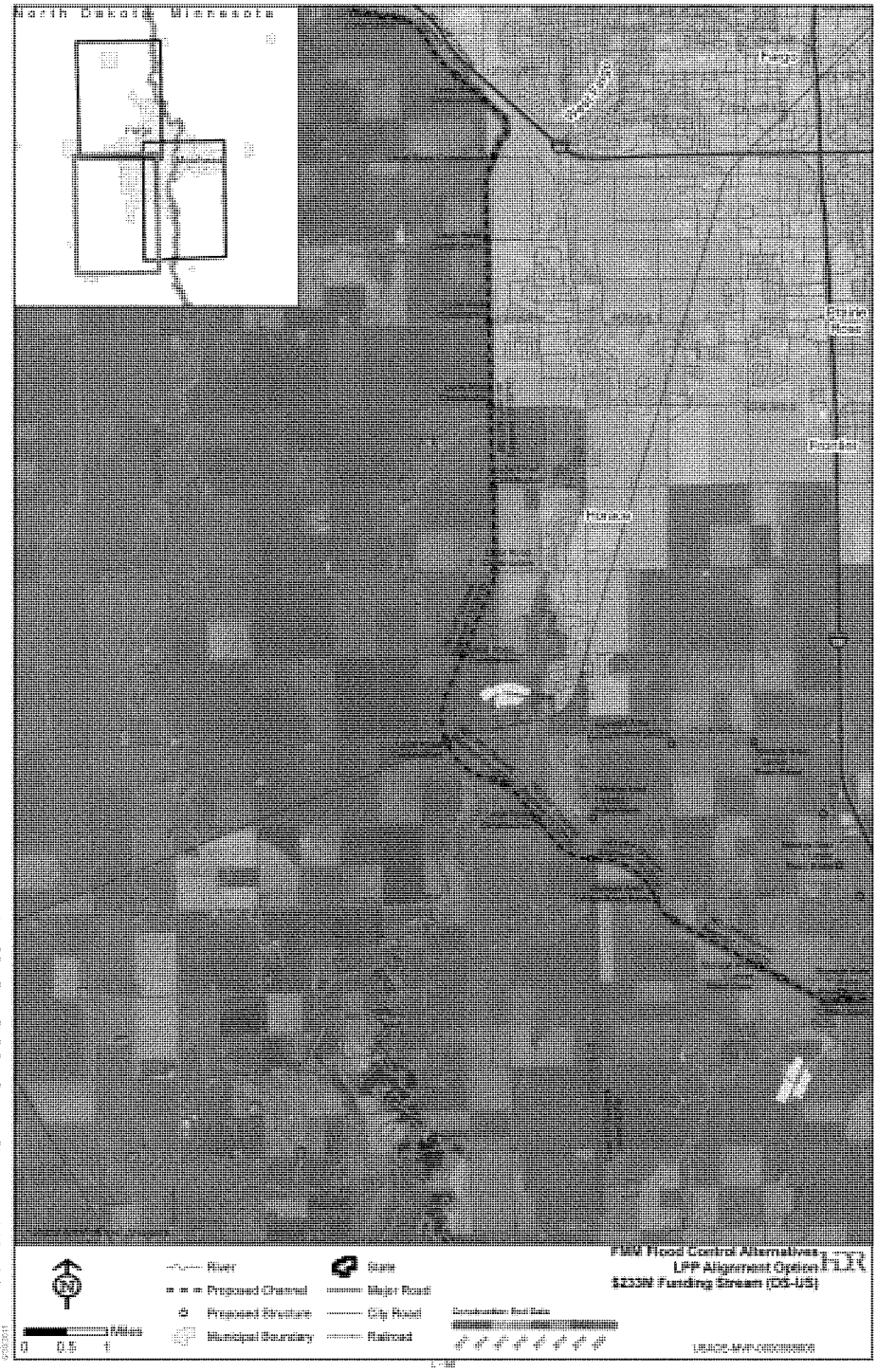
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FARGO MOORHEAD METRO STUDY
USACE – ST PAUL DISTRICT

COST ENGINEERING DX - TPCS ATR CERTIFICATION

For the Fargo Moorhead Metro Study, as presented by St Paul District, the Walla Walla Cost Dx representatives have completed an Agency Technical Review (ATR) of the 2012 Budget and Total Project Cost. The ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies in accordance with ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of 21 June 2011, the Walla Walla District, Cost Engineering Directory of Expertise (Dx) for Civil Works, certifies the estimated total project cost of the Fargo Moorhead Metro Study estimated values of:

FCP
FY 2012 Price Level: $1,236,700,000
Fully Funded Amount: $1,363,631,000

LPP
FY 2012 Price Level $1,781,347,000
Fully Funded: $2,007,791,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report.

21 Jun 2011
Date

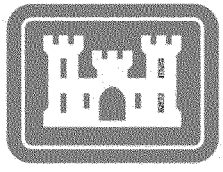
for **Kim C. Callan, PE, CCE, PM1**
Chief, Cost Engineering
Walla Walla District

Appendix M
Recreation and Aesthetics

Fargo-Moorhead Metropolitan Area Flood Risk Management

Final Feasibility Report and Environmental Impact Statement

July 2011



US Army Corps of Engineers ®

Prepared by:
U.S. Army Corps of Engineers
St. Paul District
180 Fifth Street East, Suite 700
St. Paul, Minnesota 55101-1678

APPENDIX M – RECREATION and AESTHETICS

Fargo, North Dakota – Moorhead, Minnesota

1.1 PURPOSE

The purpose of this study is to quantify and evaluate recreational resources available to the residents of Fargo, North Dakota, and Moorhead, Minnesota and the recreation potential of the area. This study examines the recreation resources of the two cities and of the area readily accessible to the recreation users: i.e., the area of influence. This area of regional influence is held to recreation resources that can be reached within 1/2 hour or within a 25-mile radius of the population center.

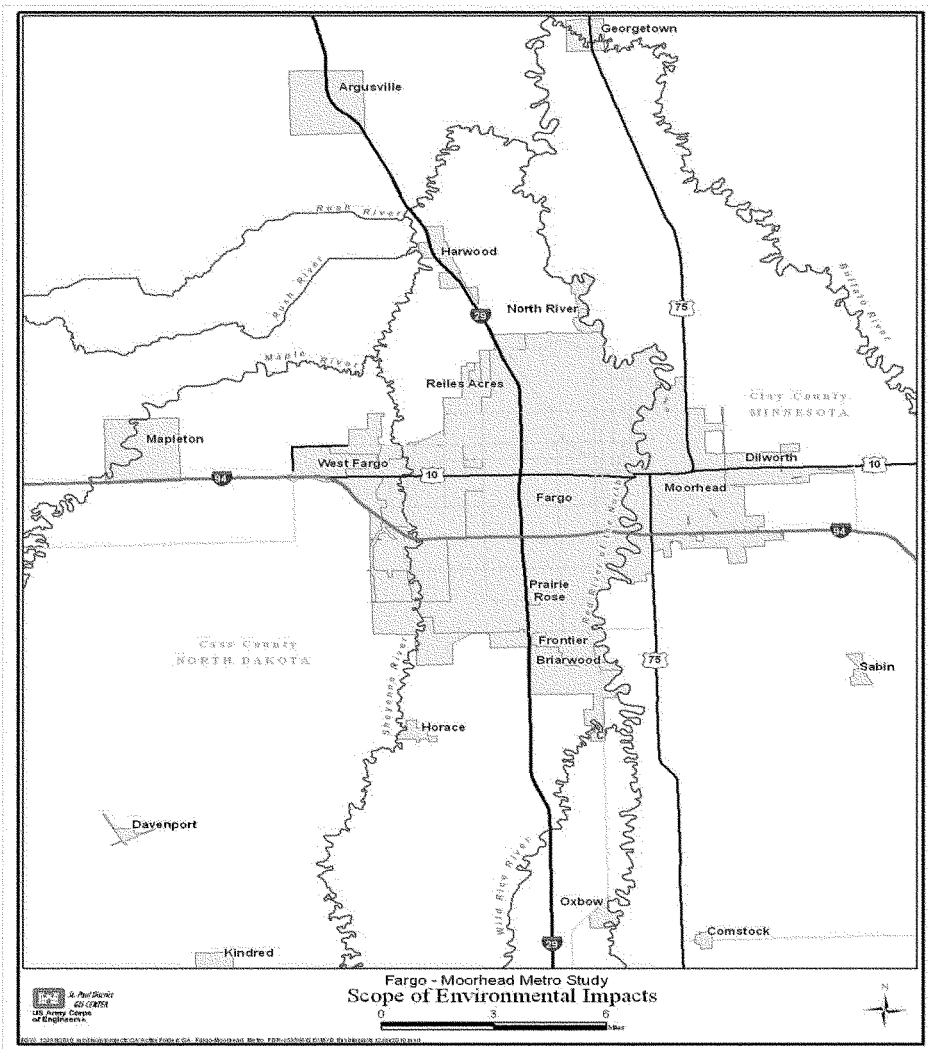
1.2 GENERAL

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. Due to the large drainage area and the physiography and climate, these rivers tend to flood frequently. In 2009, the record-setting Red River of the North flood occurred on March 28th. This event was the maximum flood of record in Fargo and crested at a stage of 40.82 feet.

Fargo is the county seat of Cass County. With an estimated 90,599 people living in Fargo, (2000 Census) it is the largest city in North Dakota. Moorhead is the county seat of Clay County and is the largest city in northwest Minnesota with a population of 32,177 at the 2000 Census. Moorhead is bordered on the west by the Red River of the North and its twin city Fargo, North Dakota. On the east, Moorhead is bordered by Dilworth, Minnesota. Together along with West Fargo, North Dakota, the communities comprise the core of the Fargo-Moorhead Metropolitan Area. (The Census Bureau defines the Fargo-Moorhead Metropolitan Area as comprising all of Cass County, North Dakota and Clay County, Minnesota. The metropolitan area has an area of 7,278 km^2 (2,810 mi^2), and its population, according to the 2000 census, was 174,367). The city's largest suburb of West Fargo has nearly doubled in the last six years and this trend is expected to continue.

In recent years, Fargo-Moorhead has seen relatively strong growth both in population and economic activity. Several businesses now have major operations in the community. It has also had consistently one of the lowest unemployment rates among metropolitan areas of similar size in the United States. This fact along with low crime rate has ranked Fargo on Money Magazine's annual list of most livable cities throughout the late 1990s and early 2000s.

Figure 1 – Project Market Area



The city of Fargo is the crossroads and economic center of a large portion of eastern North Dakota and a portion of northwestern Minnesota. Fargo is a retail, manufacturing, healthcare, and educational center for the region. Fargo is home to North Dakota State University. The city motto is "Gateway to the West" and was founded in 1871.

Fargo is a major transportation hub for the surrounding region. It sits at the intersection of Interstate 29 and Interstate 94. U.S. Highway 81 and U.S. Highway 10 also run through the community and is the home of a major airport. The BNSF Railway runs through the metropolitan area. Amtrak service is provided via the Empire Builder passenger train at the Fargo Amtrak station

Moorhead was platted in 1871 and a permanent name was assigned to the town on October 6, 1871. According to Moorhead's official city website, Moorhead is considered a transcontinental crossing. Interstates 94 and 29 intersect just west of the city limits. While distribution and transfer industries remain vital, education and service industries play an increasingly important role; Moorhead is home to Concordia College and Minnesota State University Moorhead.

1.3 CLIMATE

The study area is in a region classified as a sub humid 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. The average temperature between November and March is below 32°F, resulting in an average of 185 days per year at or below 32°F. The average temperature of the warmest month, July, is 71.1°F. The annual average normal temperature of 41.2°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.

1.4 PHYSICAL GEOGRAPHY

The Red River of the North flows generally northward in the fertile Red River Valley, forming a meandering border between North Dakota and Minnesota. The river valley is the bed of the former glacial Lake Agassiz. At its maximum extent, Lake Agassiz was about 700 miles long, 200 miles wide and 650 feet deep. The Red River of the North drains into Lake Winnipeg, which is a remnant of Lake Agassiz. The characteristic fertile soil and exceptionally flat topography in this area are a result of its glacial history. The lack of significant areas of tree cover combined with the absence of vertical relief in the landscape can result in the wind becoming a major factor in outdoor activities of any kind. As a relatively young landscape there are a few small valleys (a few hundred yards wide) along the rivers and even smaller coulees carved by precipitation run-off and creeks. The last natural biota of the region was tall grass prairie; at present, land use is overwhelmingly agricultural.

1.5 EXISTING RECREATION

It is the mission of the Fargo Park District and Moorhead Parks and Recreation Division is to improve the quality of life for all its citizens by providing a comprehensive system of parks, recreation, cultural, and human service programs that encourage health, fitness, relaxation, and cultural enrichment, as well as providing opportunities for conservation, education, and community involvement. Fargo-Moorhead strives to preserve and enhance the land and facilities and look for ways to achieve greater recreational opportunities and connectivity between facilities.

1.5.1 Local Recreation Opportunities

The metropolitan area offers a wide variety of parks and recreational facilities for all ages. 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. The outdoor public recreation opportunities within Fargo-Moorhead include:

- Ball Fields
- Basketball Courts
- Bocce Ball Courts
- Cricket Field
- Skate Parks
- Sand Volleyball
- Tennis Courts
- Wading Pools
- Dog Parks
- Disc Golf
- Fishing
- Outdoor Skating Rinks
- Camping
- Picnic Shelters
- Neighborhood Parks

- Golf Courses:
  The Meadows, Village Green, Edgewood, El Zagal, Osgood, Prairiewood and Rose Creek

- Canoe landings:
  M.B. Johnson Park, Convent Landing and Dike East. Canoe and Kayak rentals are available through River Keepers at the S.S. Ruby pontoon dock.

- Cross Country Ski Trails:
  Fargo-Moorhead offers many groomed ski trails throughout the city: Edgewood Golf course, Dike East to Lindenwood Trail, Rose Creek Golf Course Trail, Prairiewood Golf Course, Woodlawn Park, Viking Ship/Riverfront Park, Gooseberry Park, River Oaks Park and M.B. Johnson Park.

- Multi-Use Trail System:
  The Fargo-Moorhead Park and Recreation District/Division along with Metro COG, strive to provide a comprehensive trail system for the community. This trail system not only provides a plethora of recreation opportunities but is vital to the metropolitan area's Short and Long-Range Metropolitan Transportation Plan as well as the Bicycle and Pedestrian Plan. The Fargo Park District's goal for the trail system is to provide safe and enjoyable trails for bicycle riders, walkers, runners, and in-line skaters. The trail system also has four bridges complementing the recreational trails. Three bridges connect the Fargo and Moorhead park systems over the Red River at Oak Grove, Lindenwood Park and Dike East. The bridges at Oak Grove and Lindenwood are typically in use June-February, weather permitting. The bridge at Dike East is typically in use June-October, weather permitting. The fourth bridge is over the Sheyenne River near Osgood and is open year round. Typical examples of a multi-use trail are the Red River Trail (approx. 5 miles) and the Milwaukee Trail (approx. 3 miles). These asphalt trails are scenic, popular and are used as both recreational and commuter routes for bicyclists.

- Regional/Community Parks:
  The Fargo-Moorhead area boasts of numerous parks. Below is a list of notable places of interest:

  M.B. Johnson
  M.B. Johnson Park is located on the north side of Moorhead along the Red River. The park is made up of approximately 106.6 acres consisting of a combination of mowed lawn area, wooded slopes approaching the river, and a wetland.

  Centennial
  Centennial Park is an athletic park located on both sides of 15th Avenue N approximately ½ mile east of CSAH 3. The park consists of baseball and softball fields, football fields and a newly constructed dog park.

  Viking Ship, Riverfront, Memorial and W. H. Davy
  These four parks connect along the riverfront on the north side of downtown Moorhead to create a large linear park area with a variety of facilities. One of the most heavily used facilities of this park system is the bike trail along the Red River.

  Woodlawn
  Woodlawn Park is located along the Red River immediately south of downtown Moorhead. The park is a very popular facility, mainly due to its Frisbee golf facility. A baseball diamond, wading pool, playground, tennis courts, and basketball court are also provided.

  Gooseberry Mound
  Gooseberry Mound Park, commonly known as Gooseberry Park, is also a large riverfront park. Two large picnic shelters and a large playground are the main attractions to this facility.

Horizon Shores
Horizon Shores Park is designed around a water feature. The water feature serves as storm water retention for the surrounding development. The water feature is split into three distinct segments by two collector streets that cross it.

Southside
Southside Park is located north of 40th Avenue S. and east of 20th Street S. This park consists of soccer fields, youth baseball diamonds, and picnic shelters, parking lots, bike trails and a 10-acre storm water retention pond.

Iwen
Iwen Park is located at 52ne Ave S and the Red River in Fargo. This park is a 9-hole disc golf course that is very popular.

Lemke
Lemke Park is located at 32nd Ave S along the Red River in Fargo. This park consists of a playground, outdoor skating and a warming house.

Lindenwood
Lindenwood Park is a popular park and is located at 5th Street S along the Red River in Fargo. This heavily wooded park provides camping and picnicking and has sports and multi-purpose fields, trails, concessions and restrooms.

Island Park
Island Park is located at 2ns Ave and 7th St S in Fargo. Along with trails, this park's attraction is its tennis courts and swimming pool. It also provides restrooms, concessions and picnic facilities.

Dike West
Dike West is a very popular skate board park located at 4th Street S along the Red River. This park also has basketball courts as well as concessions and a restroom facility. This park is also used for sledding during the winter months.

Trefoil
Trefoil Park in Fargo is a quiet park located on Elm Street along the Red River. It is a lovely park for picnicking and also has a multi-purpose trail.

Oak Grove
Oak Grove Park located on Maple St N along the Red River in Fargo consists of tennis, disc golf, horseshoes, picnic shelter, playgrounds and restroom facilities.

Elephant/ Percy Goodwin
Elephant Percy Goodwin Park in Fargo is located at 19th Ave and 3rd St N. This park provides multipurpose fields as wells as softball and baseball/youth fields. The park also consists of basketball courts, playground, and picnic and restroom facilities.

Trollwood
Trollwood Park located at Kandi Land and Elm St. N along the Red River in Fargo provides ample recreation including trails, a picnic shelter, playground, grilling and restrooms.

1.5.2 Regional Recreation Opportunities

Five area state parks 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.

1.5.2.1 Minnesota

- Buffalo River State Park (15 miles east of Fargo-Moorhead)
  This state park provides numerous trails that wind through one of Minnesota's finest and largest remnant prairies. It also includes a picnic area, swimming area and campground located in the hardwood forest along the Buffalo River.

- Itasca State Park (115 miles northeast of Fargo-Moorhead)
  Established in 1891, Itasca is Minnesota's oldest state park. Today, the park totals more than 32,000 acres and includes more than 100 lakes. Home to the source of the Mississippi River, this park has camping and lodging opportunities as well as trails, picnic areas and shelters, playgrounds, volleyball and swimming.

- Maplewood State Park (55 miles southeast of Fargo-Moorhead)
  Eight major lakes and many ponds offer water lovers places to swim, fish, boat, and simply relax. Lake Lida has a sandy beach and large picnic areas for visitors. Drive along the scenic route to observe the wildlife: the park is host to 150 bird species and 50 species of mammals. The extensive trail system attracts hikers, horseback riders, and cross-country skiers.

1.5.2.2 North Dakota

- Turtle River State Park (95 miles northwest of Fargo-Moorhead)
  Situated on the meandering Turtle River, Turtle River State Park is located in a beautiful wooded valley. Constructed in the 1930s by the Civilian Conservation Corps, the park offers year-round recreational activities, including camping, picnicking, fishing and trails for hiking, mountain biking and cross country skiing. Rustic group cabins can also be rented.

- Fort Ransom State Park (75 miles southwest of Fargo-Moorhead)
  North Dakota's homesteading heritage is preserved at Fort Ransom State Park. The park, nestled in the picturesque and heavily-wooded Sheyenne River Valley, officially opened in July 1979. This park is managed as a natural and scenic area, and is located on one of North Dakota's officially designated Scenic Byways and Backways. The park is open for camping and picnicking year-round. Canoeing and kayaking are popular during the summer while corrals and trails are provided for groups bringing in their horses.

1.6 PREVIOUS STUDIES/PLANS

Numerous studies of the Red River of the North have been undertaken to better understand the nature of the river and the impact of surrounding development upon the river and the resources and opportunities (including recreation) the River offers. Such studies include: The Red River Action Plan (1989), The Red River Visions Study (1989), Fargo Riverfront Development Master Plan (2002), Four-Community Sports Facility Framework Plan for the Metropolitan Area (2005), Metro Bike and Pedestrian Plan (2006), The Fargo-Moorhead Downtown Framework Plan Update (2007), the Regional Park Framework Plan for the City of Moorhead (2007) and The Red River Greenway Study (2008). While each study focused on specific topics and often focused along the River, most of the studies spoke of the community desire of more trails and connectivity.

1.7 PROJECT RECREATION

Project recreation design will provide four-season recreation features and amenities for the community and its visitors. This design will enhance the recreation opportunities of the region while preserving all existing recreation including fishing. Preliminary recreation design utilizes project flood control features: the diversion channel and the spoil for outdoor recreation purposes, as illustrated in sheets LS101 – LS106. The LPP diversion channel starts approximately 9 river miles south of the confluence of the Red River of the North and Wild Rice River, leads west toward the existing Horace to West Fargo diversion, then north around the Cities of Fargo and West Fargo, and ultimately re-enters the Red River of the North 8 river miles north of its confluence with the Sheyenne River. The alignment is approximately 36 miles long. 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.

Project recreation features and benefits include:

- Pedestrian/bicycle trails
- Horseback riding trails
- Cross Country Skiing
- Snowmobiling
- Parking for recreation users, including trailer parking areas
- 3 trailheads
- Interpretive Kiosks
- Picnic Areas
- Rest rooms
- Interpretive signage
- Historical Markers for relocated properties
- Wildlife viewing structures
- Fishing
- Benches

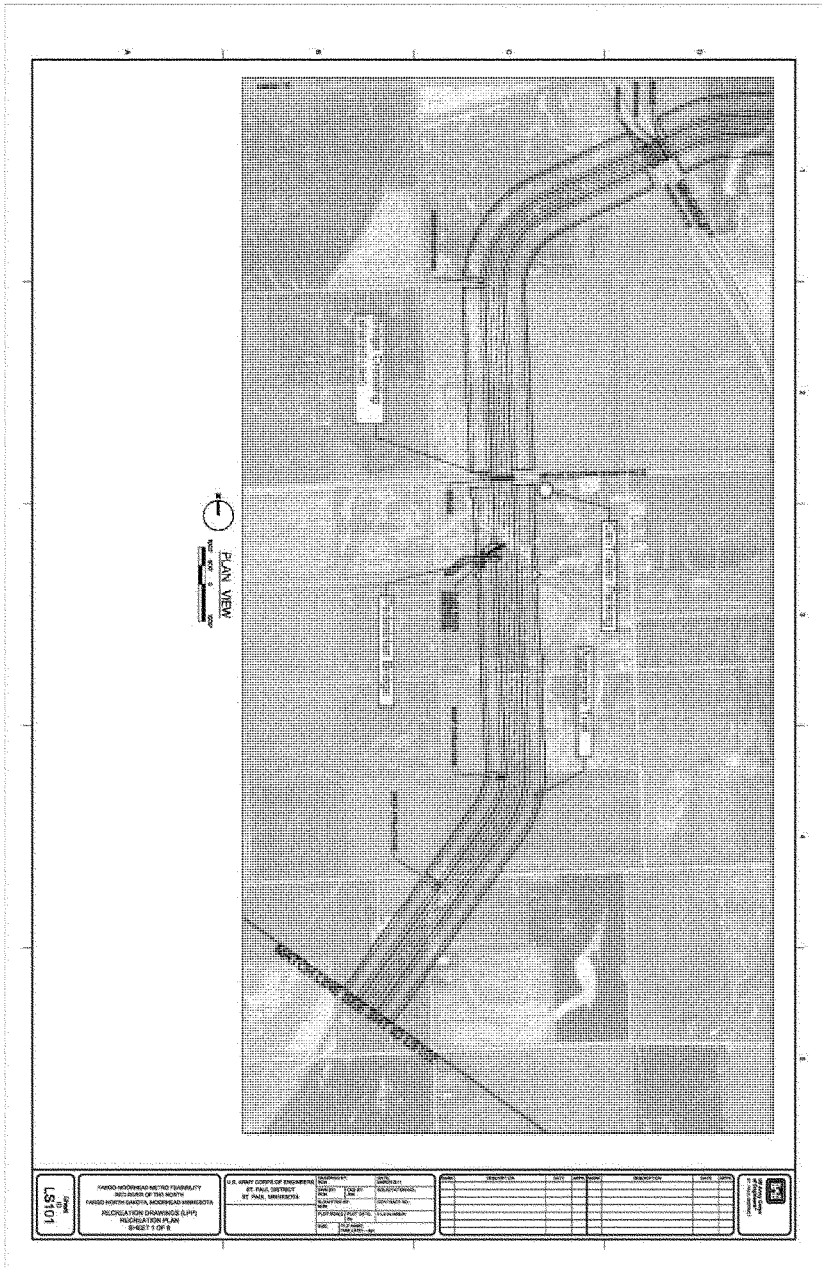
- Trees and landscaping
- Pedestrian bridges

TRAILS: Conceptual recreation design for the project calls for 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. This middle segment of trail starts at 36th Street SE and extends south to 44th Street SE and is approximately 19 miles in length. 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 31st 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. The aggregate multipurpose trails and levee crests will be ideal for winter use by cross-country (XC) skiers and snowmobiling enthusiasts. These aggregate trails will also be ideal for horseback riders any time during the year. The entire 44-mile trail system will attract bicyclists, hikers, joggers, bird watchers and other outdoor wildlife enthusiasts. Support facilities for the trails include 3 trailheads, where rest rooms, 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.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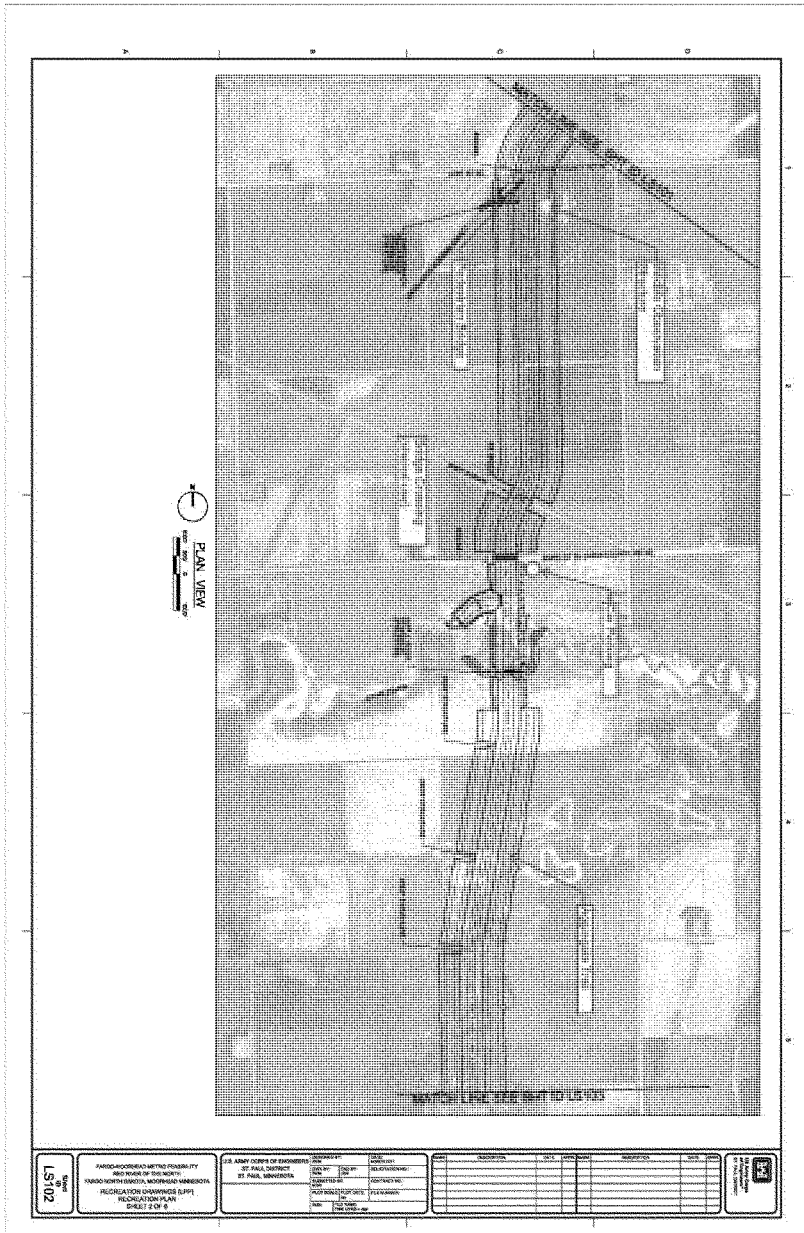
ST. PAUL, MINNESOTA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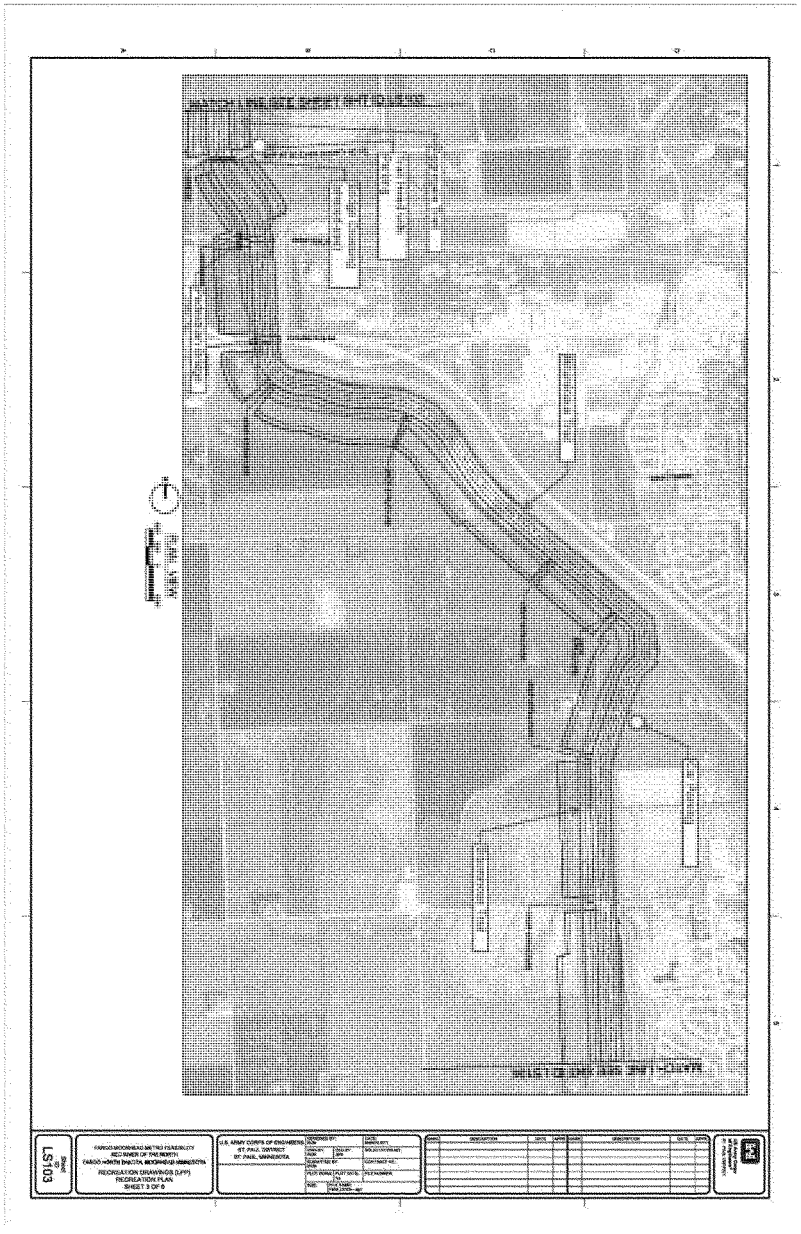
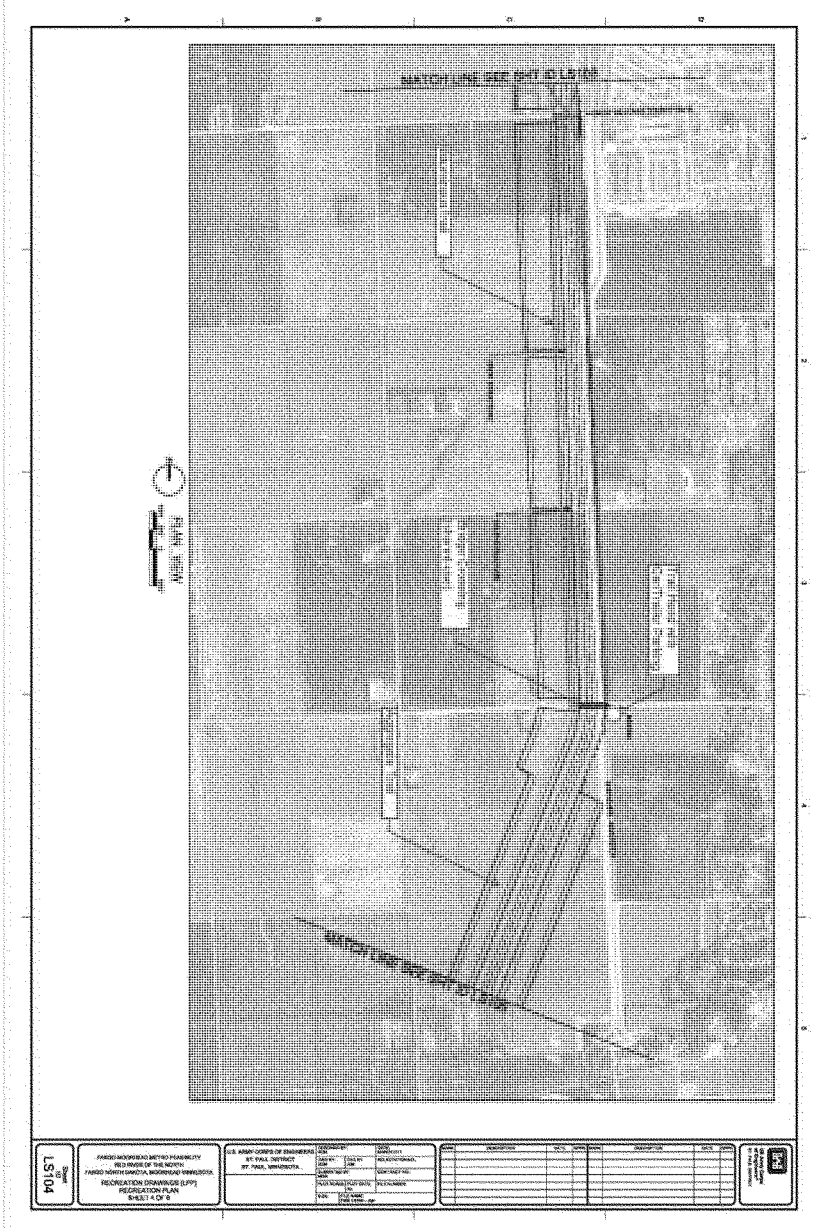
LS102
RECREATION DRAWINGS (LPP)
RECREATION PLAN
SHEET 2 OF 9
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

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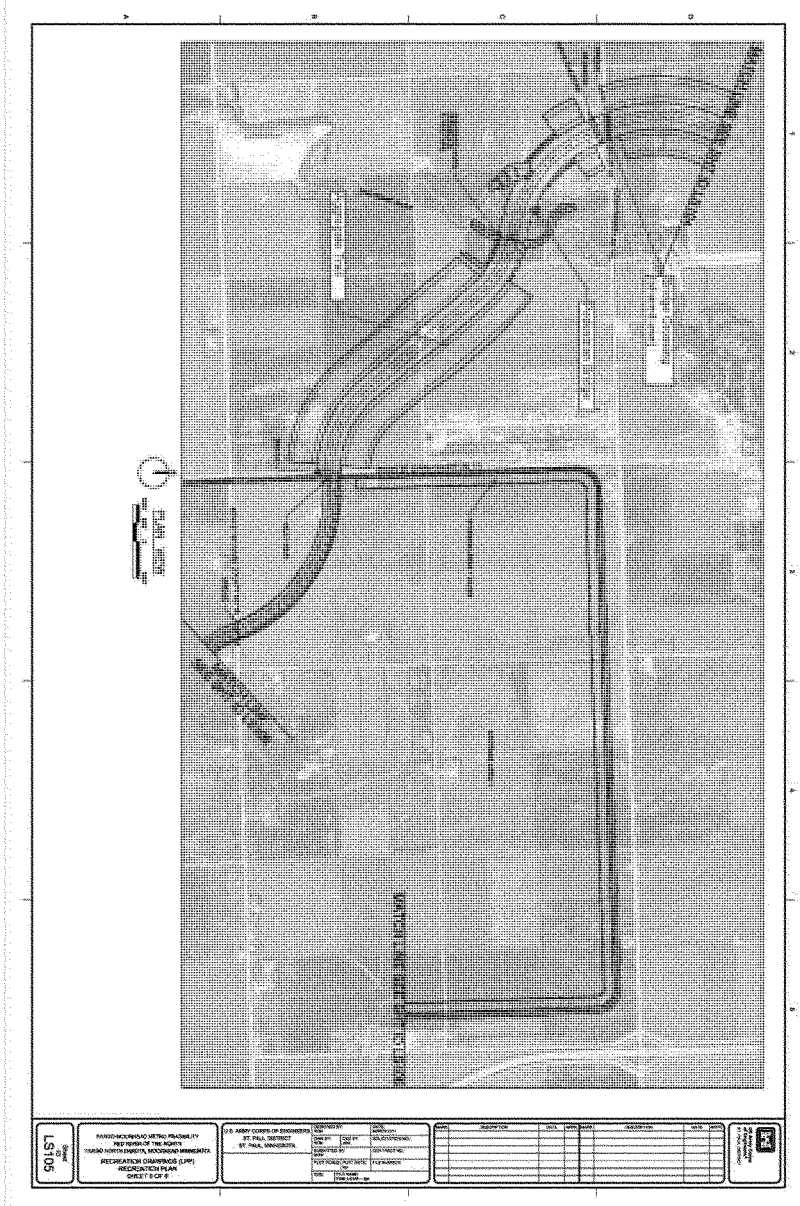
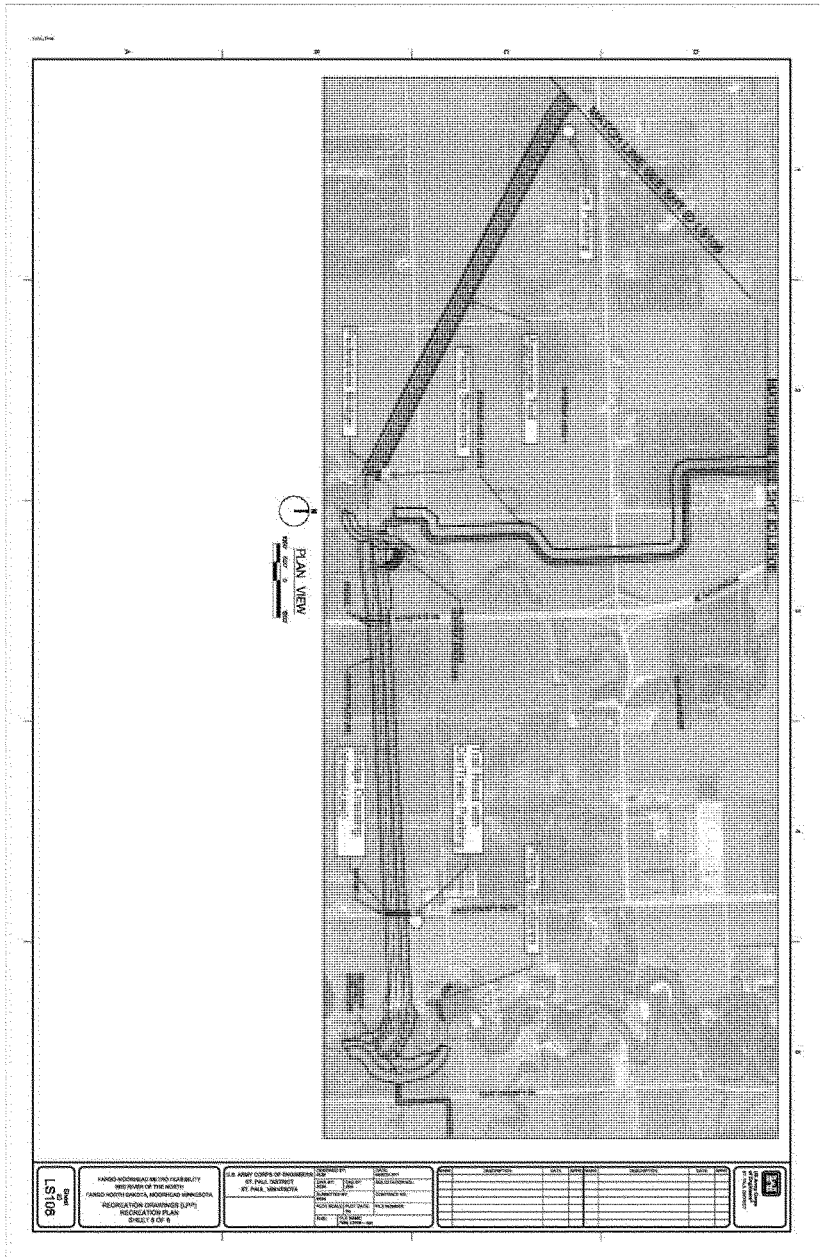
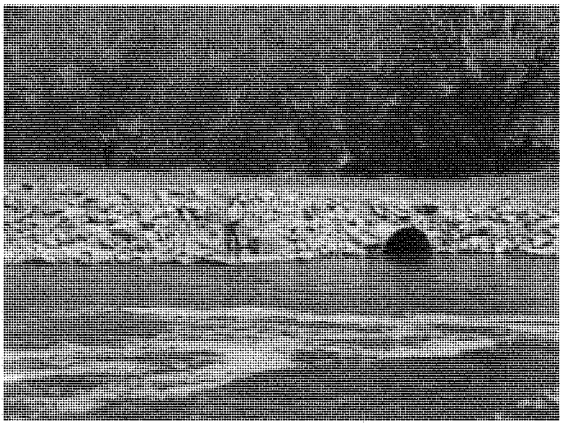
L3 104
FARGO-MOORHEAD METRO FEASIBILITY
RED RIVER OF THE NORTH
FARGO NORTH DAKOTA, MOORHEAD MINNESOTA
RECREATION DRAWINGS (LPP)
RECREATION PLAN
SHEET 4 OF 6
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA




PLAN VIEW
Sheet
LS108
FARGO-MOORHEAD METRO FEASIBILITY
RED RIVER OF THE NORTH
FARGO-NORTH DAKOTA, MOORHEAD-MINNESOTA
RECREATION DRAWINGS (LPP)
RECREATION PLAN
SHEET 8 OF 11
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA



Platform Fishing Structure Example 1

Platform Fishing Structure Example 2

1.8 MINNESOTA STATE COMPREHENSIVE OUTDOOR RECREATION PLAN

The 2008-2012 Minnesota State Comprehensive Outdoor Recreation Plan (SCORP) states that its key uses are to:

- Establish outdoor recreation priorities for Minnesota that will help outdoor recreation and natural resource managers, the state legislature, and the executive branch make decisions about the state's outdoor recreation system.
- Set out criteria to allocate the federal Land and Water Conservation Fund investment consistent with the state's outdoor recreation priorities defined in this plan.

Within the document, four strategies are listed and outlined for the state. Developed by an advisory group of outdoor recreation professionals and natural resource leaders, they document and establish the priorities for protection of the state's natural resources and the development policy of state recreation projects and agendas. These strategies are based on one goal:

"Increase participation in outdoor recreation by all Minnesotans and Visitors."

The list of strategies was formulated to help increase participation in outdoor recreation, these four strategies are:

- Acquire, protect, and restore Minnesota's natural resource base, on which outdoor recreation depends. This includes obtaining prime outdoor recreation areas throughout the state prior to anticipated land use changes.
- Develop and maintain a sustainable and resilient outdoor recreation infrastructure.
- Promote increased outdoor recreation participation through targeted programming and outreach.
- Evaluate and understand the outdoor recreation needs of Minnesotans and the ability of Minnesota's natural resources to support those needs.

1.9 NORTH DAKOTA STATE COMPREHENSIVE OUTDOOR RECREATION PLAN

The 2008-2012 North Dakota State Comprehensive Outdoor Recreation Plan (SCORP) is the eighth update of the SCORP. It is a guide for developing and managing North Dakota's recreation base to determine future outdoor recreation priorities. The SCORP is prepared every five years using grant money from the Land and Water Conservation Fund (LWCF). To determine people's attitudes and interests a household survey was conducted via telephone interview between June 11 and June 25, 2007. Survey participants included 1,200 residents 18 years and older. A public workshop was also held in each of eight regions across the State.

The results from the household survey showed that North Dakotans participate in a total of 62 different outdoor recreation activities (not including consumptive activities such as hunting and fishing.) Of these 62 activities, walking, jogging, and hiking are the most popular with 86.5% of North Dakotans responding that they participate in those activities at least once a year with an average of 111 days per year. Pleasure Driving was the

second most popular with 71.8% participating and a frequency of 35 days/year. Picnicking was third at 68.7% participating with only an average frequency of 13 days/year and bicycling came in fourth in popularity with 58.8% participating and an average frequency of 57 days/year.

Fargo is located in Region 5. An outdoor recreation facility inventory was collected at the public workshops for all the regions. The proposed recreation plan for the North Dakota east Diversion would provide for 6 of the 10 Region 5 priorities shown in the list below; including 5 of the top 6. Based on the facility inventories completed by the individual workshop participants, the top Region 5 priorities are:

1. Trails
2. Playgrounds/Picnic Areas
3. Golf Courses
4. Open Space Parks
5. Sports Fields
6. Winter Sports Facilities
7. Sports Courts
8. Pools/Beaches
9. Public Use Areas
10. Pet Parks.

Based on the votes of individual participants, the top five overall challenges/issues/needs in the region are:
1. Public demand increasing while fees expected to remain the same or decrease
2. Lack of education/lack of self-discipline
3. Cost
4. Creating awareness of availability of areas
5. Proximity/location related to health & fitness

As noted above, many of the Region 5 priorities will be provided by the proposed recreation plan for the North Dakota east Diversion. Demand for these priorities is only being partially met. The proposed recreation plan will help fill this void. Current and future demand for the proposed activities is illustrated in Table 7.

1.10 2004 OUTDOOR RECREATION PARTICIPATION SURVEY OF MINNESOTANS – REPORT ON FINDINGS

This report identified the outdoor recreation participation tends and patterns of adult Minnesotans through surveys and evaluation of these surveys. This data gathering was then used to help meet the need of the most recent State Comprehensive Outdoor Recreation Plan; and to better understand the changing nature of outdoor recreation in Minnesota.

To collect data from adult Minnesotans on their outdoor recreation participation, a mail survey to 4400 Minnesotans was conducted in March 2004. The mail-survey sample was allocated to five regions, with 1200 allocated to the Twin Cities metropolitan area and 800 to each of the four non-metropolitan regions. This regional stratification is intended

to produce region-specific results. The mail survey achieved nearly a 60 percent overall return rate after three mailings. Because the response rate was not higher (not above 70 percent), a non-respondent telephone survey was conducted to evaluate nonresponse bias. The results of the nonresponse bias survey, along with statistics on demographic characteristics important to outdoor recreation participation, were used to adjust—through sample weighting—the mail survey responses.

The survey results showed that outdoor recreation is an important part of most Minnesotans' lives. Nearly 60% indicated that outdoor recreation is "very important" to their life. The main reason why people choose to recreate outdoors is to enjoy nature, while exercise and feeling healthier was second in ranking. One of the main barriers to outdoor recreation that respondents mentioned is time followed by outdoor pests and cost and effort.

Most of Minnesotans' outdoor recreation occurs near home and within the state. Just under 67% of all recreation use (hours) is within a half-hour drive from home. The leading activity for Minnesota adults—in terms of the number that participates annually—is walking/hiking outdoors for exercise or pleasure (54% of adults participate annually). This is followed by boating of all types, including fishing from a boat (43%), Swimming (41%), Driving for Pleasure (37%) and then Picnicking (36%).

Moorhead is located in the Northwest region and while it follows most of the statewide trends, it has more participation in fishing, hunting, and snowmobiling than the state average. The leading activity for Minnesota adults in the Northwest region— in terms of the number that participates annually —is walking/hiking outdoors for exercise or pleasure (48% of adults that participate annually). This is followed by boating of all types, including fishing from a boat (43%). Driving for pleasure is next (40%), followed by Swimming (37%) and then Fishing (35%). The proposed recreation plan for the North Dakota east Diversion plan would provide trail facilities accommodating the needs for walking/hiking, the most popular activity in the region, as shown in Table 7.

1.11 LONG-TERM NATIONAL TRENDS IN OUTDOOR RECREATION ACTIVITY PARTICIPATION---1980 TO NOW, A RECREATION RESEARCH REPORT IN THE IRIS SERIES, MAY 2009.

In the United States interview surveys are conducted to track outdoor recreation trends to help aid in recreation planning and development across the nation. According to the 1982-83 Nationwide Recreation Survey (NRS), (National Park Service, NPS, US Department of the Interior, 1986), the first recreation outdoor participation interview surveys were conducted in 1960 by the Outdoor Recreation Resources Review Commission and have been irregularly conducted since. The latest NRS was conducted by the NPS in 1982-83. In 1994, the name of NRS was changed to the National Survey on Recreation and the Environment (NRSE). Although the name has changed, the methodology of collecting the recreation activity participation data has remained consistent throughout the years. The outdoor recreation participation estimates from the 1982-83 NRS and the 2005-09 NSRE were compared to track recreation trends up to 2009 and used to produce the Internet Research Information Series (IRIS) report.

The findings in this report show that the most popular recreational activity is walking outdoors. Both the percentage of population and the number of participants have steadily increased over time since 1982-83. Following in terms of growth of number of participants is viewing or photographing wild birds, attending outdoor sports events, day hiking, attending outdoor concerts/plays/other events, and visiting outdoor nature centers. The next activities in terms of growth of number of participants are swimming in natural waters, sightseeing, bicycling, running or jogging, and picnicking. The next three activities involve use of motors and include boating, driving for pleasure, and driving off road. Four activities declined between 1982-83 and 2005-09---tennis, ice skating, cross-country skiing, and snowmobiling.

1.12 RECREATION BENEFIT ANALYSIS

The Fargo Park District and Moorhead Parks and Recreation Division have long recognized that open space and recreation are a valuable resource to the community. An analysis of current local recreation, local user counts and studies, SCORP information, recreational professionals input and available State and Federal recreation was accomplished. Multi-Use Trails leads the list of the most important facilities participated in and requested.

1.12.1 Recreation Benefits Without Trail and Site Facilities

Without the cost-shared trail, trail heads, and pedestrian/shared-use bridges, recreation in the project area would be limited to grass on the spoil areas. Due to the lack of access to the project without the proposed recreation features, no recreation activities are forecasted to occur. Therefore no benefits were found for without-project conditions.

1.12.2 Population Market Area

Populations and population projections for the Fargo Moorhead Area are from the 2000 US Census and McKibben Demographic Research (as cited in Fargo-Moorhead Metropolitan Council of Governments, 2008) The average urban area population growth rates from 2000-2007 is 14.7%. Growth for Fargo is 11.3 % and Moorhead is 9.7%. West Fargo, which is part of the Fargo Moorhead metropolitan area, has seen much more growth during the same time period. West Fargo's growth is 45.2%.

For the purpose of this study, the local communities of Fargo-Moorhead, including all of Cass and Clay County have been included in the Market Area population, see Table 1. The population projections for 2010-2030 as shown in Table 1a are from the 2008 Metro Profile. For the period of analysis beyond 2030, a linear extrapolation of the 2010-2030 population projections, assuming a constant rate of change, was applied. This extrapolation methodology has been used in previous studies for MVP and is an acceptable method of acquiring quantifiable data and would reflect the best available data. Population projections for 2039-2068 are also shown in Table 1a.

Table 1 – Market Area Population

Place	Base Population			Population Change		
	1990	2000	2007	1980-90	1990-00	2000-07
Cass County	102,874	123,138	142,042	16.6%	16.1%	14.7%
Clay County	50,442	51,229	56,894	2.2%	1.6%	11.1%
Regional Totals	**153,316**	**174,367**	**198,936**			
City of Dilworth	2,562	3,001	3,584	-0.9%	17.1%	19.4%
City of Moorhead	32,295	32,177	35,294	7.7%	-0.4%	9.7%
City of West Fargo	12,287	14,940	21,700	21.7%	21.6%	45.2%
City of Fargo	74,111	90,599	100,806	20.7%	22.2%	11.3%

Table 1a – Market Area Population Trends

Place	Population Predictions*							
	2010	2030	2019	2029	2039	2049	2059	2068
Cass County	150,550	193,700	169,968	191,543	213,118	234,693	256,268	275,685
Clay County	59,630	76,510	67,226	75,666	84,106	92,546	93,460	108,582
Regional Totals	**210,180**	**270,210**	**237,194**	**267,209**	**297,224**	**327,239**	**349,728**	**384,267**
City of Dilworth	3,920	5,210	4,501	5,146	5,791	6,436	7,081	7,661
City of Moorhead	36,890	49,110	42,389	48,499	54,609	60,719	66,829	72,328
City of West Fargo	24,430	30,040	26,955	29,760	32,565	35,370	38,175	40,699
City of Fargo	105,600	135,050	118,853	133,578	148,303	163,028	177,753	191,005

*Linear extrapolation of 2010-2030 population projections, assuming a constant rate of change for years 2039-2068.

1.12.3 Participation and Demand

The participation rate in per capita activity days for recreation activity was derived from reviewing the 2004 Outdoor Recreation Participation Survey of Minnesotans – Report on Findings. The rates used were taken from the Northwest region for users within ½ hour drive of home. Due to the current trends in Running/Jogging and discussions with local recreation experts, it was felt that the rate from the 2004 Outdoor Recreation Participation study was too low. The participation rate in per capita activity days for Running/Jogging was therefore derived from the Projections of Future Participation and Needs in Outdoor Recreation for North Dakota, October 1985. This rate for Region 5 was then interpolated using participation rate change from 1982-1983 to 2005-2009 from the Long-Term National Trends in Outdoor Recreation Activity Participation---1980 to Now, A Recreation Research Report in the IRIS Series. The participation rate change for all of the primary activities from 1999-2001 to 2005-2009 is also from the Long-Term National Trends in Outdoor Recreation Activity Participation---1980 to Now, A Recreation Research Report in the IRIS Series. The rate was calculated up to project year 2024. This rate was held constant for all project years beyond 2024. These participation rates are shown in Table 2.

Table 2 – Participation Rates (in Per Capita Activity Days) by Recreation Activity

Primary Activity	Rate of Change*	2004	2019	2024	2029	2039	2049	2059	2068
Walking/Hiking	10%	22.1	23.77	24.33	24.33	24.33	24.33	24.33	24.33
Running/Jogging	13%	4.09	4.49	4.62	4.62	4.62	4.62	4.62	4.62
Picnicking*	0%	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
Wildlife Viewing	18%	8.43	9.59	9.98	9.98	9.98	9.98	9.98	9.98
Fishing	7%	1.65	1.74	1.77	1.77	1.77	1.77	1.77	1.77
X-C Skiing	-40%	0.24	0.17	0.14	0.14	0.14	0.14	0.14	0.14
Snowmobiling	-26%	1.39	1.12	1.03	1.03	1.03	1.03	1.03	1.03
Bicycling**	7%	5.5	5.78	5.87	5.87	5.87	5.87	5.87	5.87
Horseback Riding	8%	0.34	0.36	0.37	0.37	0.37	0.37	0.37	0.37

* No data was available for Rate of Change
** Used Statewide Participation Rate

Projected demands for (proposed) project-supported recreation activities are given in Table-3. The projected public use demand (in activity days) is calculated using recreation activity participation rates (Table-2), population projections for the neighboring towns and cities, from Table-1a, recreation years and participation rates (per activity), and professional judgment in consultation with staff of the park and recreation departments of Fargo and Moorhead. The years for depicting projected growth were chosen to reflect a fifty-year project life. Tables 2, 3, 5a and Table 7 show 2019 as the first project year. This year is used in the tables to be conservative because this is the proposed first year after project completion.

Table 3 – Market Area Activity Days

Primary Activity:	Year:										
	2019	2029	2020	2021	2022	2023	2029	2039	2049	2059	2068
Market Area Population:	237,194	267,209	240,195	243,197	246,198	249,200	267,209	297,224	327,239	349,728	384,267
WalkingHiking											
Participation Rate	23.77	24.33	23.83	23.89	23.94	24.00	24.33	24.33	24.33	24.33	24.33
Activity Days/Year	5,639,056	6,501,744	5,723,817	5,808,914	5,894,345	5,980,111	6,501,744	7,232,072	7,962,400	8,509,605	9,350,023
Running/Jogging											
Participation Rate	4.49	4.62	4.50	4.51	4.53	4.54	4.62	4.62	4.62	4.62	4.62
Activity Days/Year	1,063,981	1,234,503	1,080,670	1,097,440	1,114,291	1,131,222	1,234,503	1,373,173	1,511,842	1,615,741	1,775,314
Picnicking											
Participation Rate	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
Activity Days/Year	550,289	619,924	557,252	564,216	571,179	578,143	619,924	689,559	759,193	811,368	891,499
Wildlife Viewing											
Participation Rate	9.59	9.98	9.63	9.67	9.71	9.75	9.98	9.98	9.98	9.98	9.98
Activity Days/Year	2,275,478	2,667,040	2,313,587	2,351,928	2,390,502	2,429,309	2,667,040	2,966,623	3,266,207	3,490,672	3,835,415
Fishing											
Participation Rate	1.74	1.77	1.74	1.74	1.75	1.75	1.77	1.77	1.77	1.77	1.77
Activity Days/Year	411,916	472,959	417,930	423,964	430,019	436,093	472,959	526,086	579,212	619,018	680,153
X-C Skiing											
Participation Rate	0.17	0.14	0.17	0.16	0.16	0.16	0.14	0.14	0.14	0.14	0.14
Activity Days/Year	39,849	38,478	39,776	39,690	39,589	39,473	38,478	42,800	47,122	50,361	55,334
Snowmobiling											
Participation Rate	1.12	1.03	1.11	1.10	1.09	1.08	1.03	1.03	1.03	1.03	1.03
Activity Days/Year	265,408	274,851	266,596	267,730	268,810	269,836	274,851	305,724	336,598	359,730	395,257
Bicycling											
Participation Rate	5.78	5.87	5.79	5.79	5.80	5.81	5.87	5.87	5.87	5.87	5.87
Activity Days/Year	1,370,119	1,568,113	1,389,669	1,409,275	1,428,936	1,448,653	1,568,113	1,744,256	1,920,399	2,052,376	2,255,071
Horseback Riding											
Participation Rate	0.36	0.37	0.36	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.37
Activity Days/Year	85,606	98,301	86,856	88,111	89,370	90,633	98,301	109,343	120,384	128,658	141,364

1.12.4 Estimate of Current and Future Usage of Proposed Activities

Lacking a comprehensive site design, tables 4-4a and 5-5a, establishing the maximum design capacity value for new trail oriented activities and site activities, is a conservative estimate based on a concept (Sheets LS101 - LS106). Satisfactory limits on site visitation, feature conflicts, and neighborhood impacts would be established during the design phase of the proposed project. Visitation, parking, etc., will be adjusted to minimize negative social effects and over-use. Annual Primary Activity Days were developed for the five trail oriented recreational activities as well as site activities listed in the tables below. For trail activities, this was done by multiplying (miles of trail) x (users per mile) x (turnover per day) x (weeks in a season) and divided by (weekend day use) x (recreation season use). For site activities, a similar formula is used to determine the maximum capacity, (supply of units) x (people per unit) x (turnover rate) x (weeks in a season) and divided by (weekend day use) x (recreation season use). These formulas determine the annual activity occasions which in turn is used to develop Annual Primary Activity Days as shown in Table 4a and 5a. Activity occasions per mile were based on carrying capacity guidelines in the "Optimum Recreation Carrying Capacity" developed for the U.S. Department of the Interior in 1977. The report recommends average densities of 21 to 25 bicycles per lane/per mile, 200 feet between joggers, one group of skiers every 2-½ miles, and 275 feet between Snowmobiles. The carrying capacity report addressed general hiking rather than urban walking. Carrying capacity guidelines from an earlier Minnesota SCORP (MN Departments of Natural Resources and Trade and

Economic Development, 1990) suggest an average of 24 bicycles per mile, and 29 walkers/joggers per mile. To be on the conservative side, 12 bicycles per mile and 25 walkers/joggers per mile were selected for use in Table-4.

A Primary Activity Day (or visitor day) is a standard unit of use consisting of a visit by an individual to a recreation area during a 24-hour period. People often engage in more than one activity occasion during any given recreational site visit. A person engaged in bicycling, walking/jogging, or picnicking, etc., tends to participate in more than one activity per day; they might also bird watch or photograph the outdoors on the same day. The Primary Activity Day therefore, is considered to consist of 1.25 activity occasions/day for most types of recreation. The Annual Primary Activity Days listed in Table 4a and Table 5a were derived from dividing the annual capacity in occasions by the activity day factor. This was necessary so as to avoid double counting of visitors engaging in more than one activity during the day. In the case of X-C Skiing and Snowmobiling, the activity day factor was only 1.0 because it was assumed that that activity would be the only activity for the day.

Based upon the growth in usage the Fargo-Moorhead area has seen in its current trail system annual visitation for walking, running, wildlife viewing, x-c skiing, snowmobiling, biking and horseback riding was projected at 40 percent of capacity the first year, 50 percent of capacity the second year, 60 percent capacity the third year, 80 percent capacity the fourth year and full capacity the fifth year.

Table 4 – Project Recreation Features: Maximum Capacity and Expected Use, New Trail System

Trail Activities, Design Capacity Values*

Primary Activity	(u)= Miles of Trail	(p) = Users per Mile	(t) = Turnover Rate	(s) = Weeks in Season	(w) = Weekend Day Use	(y) = Recreation Season Use
Walking/Hiking - soft trail	25	25	3	42	30%	70%
Walking/Hiking - paved	19	25	4	42	30%	70%
Running/ Jogging	44	25	3.5	42	30%	80%
Biking	44	12	4	25	30%	70%
X-C Skiing	20	12	4	13	50%	100%
Snowmobiling	44	19	4	13	50%	100%
Horseback Riding	25	4	4	42	40%	70%

*Capacity of Recreation Use in Activity Occasions = upts/wy

Table 4a – Estimated Annual Primary Activity Days, New Trail System

Project Recreation Trails:							
	Primary Activity						
	Walking/ Hiking - soft trail	Walking/ Hiking - paved	Running/ Jogging	Biking	X-C Skiing	Snowmobiling	Horseback Riding
Annual Capacity in Activity Occasions	375000	360000	673750	251429	24960	86944	60000
Activity Day Factor	1.25	1.25	1.25	1.25	1.00	1.00	1.25
Annual Primary Activity Days*	**300000**	**304000**	**539000**	**201143**	**24960**	**86944**	**48000**

* Annual Primary Activity Day numbers may contain rounding errors.

Table 5 – Project Recreation Features: Maximum Capacity and Expected Use, Site Activities

Recreation Other Than Trails, Resource Capacity

Primary Activity	Area Per Unit	Supply
Picnicking	40 sq ft	15 tables
Wildlife Viewing		2.5% of total use

Recreation Other Than Trails, Design Capacity Values*

Primary Activity	(u)= Supply of Units	(p) = People per Unit	(t) = Turnover Rate	(s) = Weeks in Season	(w) = Weekend Day Use	(y) = Recreation Season Use
Picnicking	15	4	2	18	30%	70%
Fishing	4	2	2	22	20%	65%
Wildlife Viewing	2.5					

*Capacity of Recreation Use in Activity Occasions = upts/wy

Table-5a shows estimated recreation site capacity, from Table-5, converted to Annual Primary Activity Days, by major recreation activities that would be supported by the project.

Table 5a – Estimated Annual Primary Activity Days, Site Activities

	Activity Occasions*	Conversion Factor	Activity Days (2019)	Activity Days (2020)	Activity Days (2021)	Activity Days (2022)	Activity Days (2023-68)
Picnicking	10,286	1.25	3,291	4,114	4,937	6,583	8,229
Fishing	2,708	1.25	866	1,083	1,300	1,733	2,166
Total Site Activity Days			4,158	5,197	6,237	8,316	10,395
Total Trail Activity Days			601,619	752,023	902,428	1,203,237	1,504,047
SUBTOTAL ACTIVITY DAYS			605,777	757,221	908,665	1,211,553	1,514,442
Wildlife Viewing**	2.5%	1.25	12,116	15,144	18,173	24,231	30,289
TOTAL ANNUAL PRIMARY ACTIVITY DAYS***			617,892	772,365	926,838	1,235,784	1,544,730

*Capacity of Recreation Use in Activity Occasions = upts/wy
**2.5% of Total Activity Days for Site and Trail
***Annual Primary Activity Day numbers may contain rounding errors

1.12.5 Estimate of Current and Future Usage of Existing Activities

There are currently many miles of trails available to the public; however, for the purpose of this study, only 11 miles of bike trail was used, 25 miles of trail for walking and jogging and approximately 13 miles of x-c skiing. These trails were included in the study due to the similarities they have with the proposed trails; they are scenic, popular, in their own right-of -way and are used as both recreational and commuter routes for bicyclists.

These existing miles of trail supply some of the estimated demand from Fargo-Moorhead. Annual Primary Activity Days for bicycling, walking, jogging and x-c skiing on existing trails were derived using the capacity assumptions mentioned in 1.12.4 and shown in Table 4. This usage was assumed to be at the maximum capacity starting at project year 1 since they are established trails.

Table 6 – Project Recreation Features: Maximum Capacity and Expected Use, Existing Trail System

Trail Activities, Design Capacity Values*						
Primary Activity	(u)= Miles of Trail	(p) = Users per Mile	(t) = Turnover Rate	(s) = Weeks in Season	(w) = Weekend Day Use	(y) = Recreation Season Use
Walking/Hiking - paved	25	25	4	42	30%	70%
Running/ Jogging	25	25	3.5	42	30%	80%
Biking	11	12	4	25	30%	70%
X-C Skiing	13	12	4	13	50%	100%

*Capacity of Recreation Use in Activity Occasions = upts/wy

Table 6a – Estimated Annual Primary Activity Days, Existing Trail System

Project Recreation Trails:				
	Primary Activity			
	Walking/ Hiking - paved	Running/ Jogging	Biking	X-C Skiing
Annual Capacity in Activity Occasions	500000	382813	62857	16224
Activity Day Factor	1.25	1.25	1.25	1.0
Annual Primary Activity Days*	**400000**	**306250**	**50286**	**16224**

* Annual Primary Activity Day numbers may contain rounding errors.

1.12.6 Annual Recreation Benefits

Table-7 shows the projected recreation visitation over the life of the project. The design provides a positive social value in that less popular forms of recreation can also be supported and provided by the project's main features at little or no additional cost. Noting the excess demand for each activity, it is evident the project will provide a positive percentage of the market area recreation needs for years to come. Visitation growth of the project is tied to recreation activity growth as indicated by the Long-Term National Trends in Outdoor Recreation Activity Participation (2009) and the population growth expected for the region.

Recreation transfers to the proposed facilities from existing facilities must also be accounted for to avoid double counting of benefits. The net value of a transfer of use from one site to another is the difference in benefits per day for recreation at the two sites. Therefore, transfer demand was calculated for each primary activity. Transfer demand for horseback riding, snowmobiling, x-c skiing, picnicking, wildlife viewing and fishing were assumed to be 25% of the demand met by proposed activities. This percentage was based on discussions with staff from the Fargo and Moorhead park and recreation departments and planning departments (FMMS Non-Structural Alternatives Meeting, September 2009) and noting the existing recreation opportunities for these

activities are limited and therefore more new users would take advantage of the proposed facilities. The transfer demand for walking/hiking, running/jogging and biking was at a higher rate. Transfer demand for walking/hiking and running/jogging was assumed to be 75% of the demand met by proposed activities while transfer demand for biking was 80% of the proposed activity demand. This demand was also determined after talking to staff from the Fargo and Moorhead park and recreation departments and planning departments (FMMS Non-Structural Alternatives Meeting, September 2009). Currently, a large percentage of the population is already participating in these activities using existing facilities such as sidewalks, streets, trails etc. However, it is felt that a portion of these users would use a continuous trail system for recreating in a safer, more aesthetic setting, especially on the weekend and holidays. New demand was calculated by subtracting the transfer demand from the proposed activity demand for each primary activity.

Due to the large amount of unmet demand (other than X-C skiing), it is felt that all transfers will be replaced at existing facilities. Many of the transfers are assumed to be from ad hoc facilities such as city streets and sidewalks. Therefore demand met by existing facilities, as shown in Table 7, does not change because of transfers.

The numbers shown may be somewhat affected by final site design, as stated earlier. Other factors that could affect these values are: changes outside of the population value ranges estimated, enlarging the recreation sites and features, additional recreation features, climate change, or the addition of recreation features not supported by this project.

Table 7 – Project Recreation and Excess Demand

Primary Activity:		Year: 2019	2020	2021	2022	2023	2029	2039	2049	2059	2068
Walking/Hiking											
(Table 3)	Market Zone Demand	5,639,056	5,723,817	5,808,914	5,894,345	5,980,111	6,501,744	7,232,072	7,962,400	8,509,605	9,350,023
(Table 6a)	Demand Met by Ex Facilities	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000
	Remaining Demand	5,239,056	5,323,817	5,408,914	5,494,345	5,580,111	6,101,744	6,832,072	7,562,400	8,109,605	8,950,023
(Table 4a)	Demand Met by Proposed Facilities	241,600	302,000	362,400	483,200	604,000	604,000	604,000	604,000	604,000	604,000
	New Demand	60,400	75,500	90,600	120,800	151,000	151,000	151,000	151,000	151,000	151,000
	Transfer Demand	181,200	226,500	271,800	362,400	453,000	453,000	453,000	453,000	453,000	453,000
	Excess Demand	4,997,456	5,021,817	5,046,514	5,011,145	4,976,111	5,497,744	6,228,072	6,958,400	7,505,605	8,346,023
Running/Jogging											
(Table 3)	Market Zone Demand	1,063,981	1,080,670	1,097,440	1,114,291	1,131,222	1,234,503	1,373,173	1,511,842	1,615,741	1,775,314
(Table 6a)	Demand Met by Ex Facilities	306,250	306,250	306,250	306,250	306,250	306,250	306,250	306,250	306,250	306,250
	Remaining Demand	757,731	774,420	791,190	808,041	824,972	928,253	1,066,923	1,205,592	1,309,491	1,469,064
(Table 4a)	Demand Met by Proposed Facilities	215,600	269,500	323,400	431,200	539,000	539,000	539,000	539,000	539,000	539,000
	New Demand	53,900	67,375	80,850	107,800	134,750	134,750	134,750	134,750	134,750	134,750
	Transfer Demand	161,700	202,125	242,550	323,400	404,250	404,250	404,250	404,250	404,250	404,250
	Excess Demand	542,131	504,920	467,790	376,841	285,972	389,253	527,923	666,592	770,491	930,064
Picnicking											
(Table 3)	Market Zone Demand	550,289	557,252	564,216	571,179	578,143	619,924	689,559	759,193	811,368	891,499
(Table 5a)	Demand Met by Proposed Facilities	3,291	4,114	4,937	6,583	8,229	8,229	8,229	8,229	8,229	8,229
	New Demand	2,469	3,086	3,703	4,937	6,171	6,171	6,171	6,171	6,171	6,171
	Transfer Demand	823	1,029	1,234	1,646	2,057	2,057	2,057	2,057	2,057	2,057
	Excess Demand	546,997	553,138	559,279	564,597	569,914	611,695	681,330	750,965	803,139	883,271
Wildlife Viewing											
(Table 3)	Market Zone Demand	2,275,478	2,313,587	2,351,928	2,390,502	2,429,309	2,667,040	2,966,623	3,266,207	3,490,672	3,835,415
(Table 5a)	Demand Met by Proposed Facilities	12,116	15,144	18,173	24,231	30,289	30,289	30,289	30,289	30,289	30,289
	New Demand	9,087	11,358	13,630	18,173	22,717	22,717	22,717	22,717	22,717	22,717
	Transfer Demand	3,029	3,786	4,543	6,058	7,572	7,572	7,572	7,572	7,572	7,572
	Excess Demand	2,263,362	2,298,442	2,333,755	2,366,271	2,399,021	2,636,751	2,936,335	3,235,918	3,460,383	3,805,126

Table 7 Continued– Project Recreation and Excess Demand

Primary Activity:		Year: 2019	2020	2021	2022	2023	2029	2039	2049	2059	2068
Fishing											
(Table 3)	Market Zone Demand	411,916	417,930	423,964	430,019	436,093	472,959	526,086	579,212	619,018	680,153
(Table 5a)	Demand Met by Proposed Facilities	866	1,083	1,300	1,733	2,166	2,166	2,166	2,166	2,166	2,166
	New Demand	650	812	975	1,300	1,625	1,625	1,625	1,625	1,625	1,625
	Transfer Demand	217	271	325	433	542	542	542	542	542	542
	Excess Demand	411,050	416,847	422,665	428,286	433,927	470,793	523,919	577,046	616,852	677,986
X-C Skiing											
(Table 3)	Market Zone Demand	39,849	39,776	39,690	39,589	39,473	38,478	42,800	47,122	50,361	55,334
(Table 6a)	Demand Met by Ex Facilities	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224
	Remaining Demand	23,625	23,552	23,466	23,365	23,249	22,254	26,576	30,898	34,137	39,110
(Table 4a)	Demand Met by Proposed Facilities*	9,984	12,480	14,976	19,968	23,249	22,254	24,960	24,960	24,960	24,960
	New Demand	7,488	9,360	11,232	14,976	17,437	16,691	18,720	18,720	18,720	18,720
	Transfer Demand	2,496	3,120	3,744	4,992	5,812	5,564	6,240	6,240	6,240	6,240
	Excess Demand	13,641	11,072	8,490	3,397	0	0	1,616	5,938	9,177	14,150
Snowmobiling											
(Table 3)	Market Zone Demand	265,408	266,596	267,730	268,810	269,836	274,851	305,724	336,598	359,730	395,257
(Table 4a)	Demand Met by Proposed Facilities	34,778	43,472	52,166	69,555	86,944	86,944	86,944	86,944	86,944	86,944
	New Demand	26,083	32,604	39,125	52,166	65,208	65,208	65,208	65,208	65,208	65,208
	Transfer Demand	8,694	10,868	13,042	17,389	21,736	21,736	21,736	21,736	21,736	21,736
	Excess Demand	230,630	223,124	215,564	199,255	182,892	187,907	218,780	249,654	272,786	308,313
Bicycling											
(Table 3)	Market Zone Demand	1,370,119	1,389,669	1,409,275	1,428,936	1,448,653	1,568,113	1,744,256	1,920,399	2,052,376	2,255,071
(Table 6a)	Demand Met by Ex Facilities	50,286	50,286	50,286	50,286	50,286	50,286	50,286	50,286	50,286	50,286
	Remaining Demand	1,319,833	1,339,383	1,358,989	1,378,651	1,398,367	1,517,827	1,693,970	1,870,113	2,002,090	2,204,785
(Table 4a)	Demand Met by Proposed Facilities	80,457	100,571	120,686	160,914	201,143	201,143	201,143	201,143	201,143	201,143
	New Demand	16,091	20,114	24,137	32,183	40,229	40,229	40,229	40,229	40,229	40,229
	Transfer Demand	64,366	80,457	96,549	128,731	160,914	160,914	160,914	160,914	160,914	160,914
	Excess Demand	1,239,376	1,238,812	1,238,304	1,217,736	1,197,224	1,316,685	1,492,828	1,668,971	1,800,947	2,003,642
Horseback Riding											
(Table 3)	Market Zone Demand	85,606	86,856	88,111	89,370	90,633	98,301	109,343	120,384	128,658	141,364
(Table 4a)	Demand Met by Proposed Facilities	19,200	24,000	28,800	38,400	48,000	48,000	48,000	48,000	48,000	48,000
	New Demand	14,400	18,000	21,600	28,800	36,000	36,000	36,000	36,000	36,000	36,000
	Transfer Demand	4,800	6,000	7,200	9,600	12,000	12,000	12,000	12,000	12,000	12,000
	Excess Demand	66,406	62,856	59,311	50,970	42,633	50,301	61,343	72,384	80,658	93,364

*Carrying capacity of proposed trail for cross country skiing of 24,960 annually is not expected to be met from the year 2023-2039 period of analysis because slight declines of participation rates are not offset by regional population growth.

1.12.7 Unit Day Values

The Unit Day Value (UDV) method was used to determine daily recreation benefits. This method was chosen because of the exhaustive amount of studies already done for the region specifically on recreation needs. The local planners and recreation experts were extremely knowledgeable and provided ample data regarding the existing recreation opportunities as well as needs and priorities for the Fargo Moorhead community. UDV was also chosen because the cost of recreation facilities is small in comparison to the overall cost - approximately 3 percent of the project cost – and will not influence the project plan selection. Because the total project annual visits are forecasted to be more than 750,000, the rationale behind the selection of the UDV method was coordinated with IWR (S. Cone, personal communication, March 5, 2010), and MVD (L. Kilgo, personal communication, March 3, 2010). The participation rates and total visitation vary significantly among the different proposed activities and therefore analyzing the activities separately resulted in a more accurate account of recreation benefits for the project. It should be noted that each of the primary activities are forecasted to have less that 750,000 annual visits.

Unit day values were developed for each primary recreational activity. This methodology relies on professional judgment to assign point values to five specific criteria:

- Recreation Experience—pertains to the availability and quality of activities on site.
- Availability of Opportunity—is specific to travel times and scarcity of activities.
- Carrying Capacity—concerns the level of site recreation development.
- Accessibility—pertains to the ease of access, specifically by automobile.
- Environmental—is specific to the aesthetic qualities of the site and surrounding areas.

The total points assigned are converted to a Unit Day Value, which is then applied to the estimated visitation to derive the overall benefits. The points were assigned to the primary activities listed in Table-7. These points were then converted to a Unit Day Value using "General Recreation" point-to-value data for Fiscal Year 2011, with a range for general recreation of $3.58 -$10.75, and specialized recreation $14.56 - $42.57.

This method is outlined in the *Economics Guidance Memorandum 11-03, Unit Day Values for Recreation, Fiscal Year 2011*. The table provided in the memorandum was adjusted from Table K-3-1, Federal Register Vol. 44, No. 242, p.72962, December 4, 1979, using the CPI factor.

Point assignment for General Recreation is assumed using parameters outlined in the memorandum and assumptions by a recreation professional. Points are adjusted, from a maximum assignment, by judgment factors set forth for each criterion. Maximum points vary according to the criteria as shown in Table 8-8b. As mentioned in 1.12.6, the Unit Day Values must also account for transfers. The Unit Day Values assigned for existing primary activities and the proposed primary activities are shown in Table-8 and 8a,

respectively. The Unit Day Values for transfers, the difference between the Unit Day Values for each existing and proposed Primary Activity, are illustrated in Table 8b.

Table 8 – Unit Day Values for Existing Activities

	Primary Activity								
Criteria and (Maximum Points)	Walking/ Hiking	Running/ Jogging	Picnicking	Wildlife Viewing	Fishing	X-C Skiing	Snowmobiling	Bicycling	Horseback Riding
Recreation Experience (30)	6	6	7	5	10	6	5	6	6
Availability (18)	3	3	3	3	5	3	7	7	7
Carrying Capacity (14)	12	12	6	6	4	4	4	6	4
Accessibility (18)	10	5	5	5	5	5	5	5	5
Environmental Quality (20)	4	4	8	4	10	10	4	4	4
Total Points Assigned (100)	35	30	29	23	34	28	25	28	26
Unit Day Values*	**6.05**	**5.38**	**5.31**	**4.90**	**5.92**	**5.24**	**5.04**	**5.24**	**5.11**
2011 UDV = $3.58 -$10.75									

Table 8a– Unit Day Values for Proposed Activities

	Primary Activity								
Criteria and (Maximum Points)	Walking/ Hiking	Running/ Jogging	Picnicking	Wildlife Viewing	Fishing	X-C Skiing	Snowmobiling	Bicycling	Horseback Riding
Recreation Experience (30)	10	10	10	3	7	7	10	10	10
Availability (18)	3	3	3	3	3	3	7	7	7
Carrying Capacity (14)	12	12	12	12	10	12	12	12	12
Accessibility (18)	10	10	10	10	10	10	10	10	10
Environmental Quality (20)	10	12	10	6	10	10	12	12	10
Total Points Assigned (100)	45	47	45	34	40	42	51	51	49
Unit Day Values*	**7.17**	**7.35**	**7.17**	**5.92**	**6.72**	**6.90**	**7.69**	**7.69**	**7.53**
2011 UDV = $3.58 -$10.75									

Table 8b – Unit Day Values for Transfer Activities

	Primary Activity								
Criteria and (Maximum Points)	Walking/ Hiking	Running/ Jogging	Picnicking	Wildlife Viewing	Fishing	X-C Skiing	Snowmobiling	Bicycling	Horseback Riding
Unit Day Values*	**1.12**	**1.97**	**1.86**	**1.02**	**0.80**	**1.66**	**2.65**	**2.45**	**2.42**
2011 UDV = $3.58 -$10.75									

1.12.8 Benefit Computation

Recreation benefits attributable to the proposed trail system were based on projected demand for the recreational activities listed in Table 7. These demand estimates over the period of analysis were used in conjunction with Unit Day Values developed for each of the recreational activities shown in Table 8a and 8b. Demand at each project year was multiplied by the appropriate Unit Day Value for each recreation activity. The value of the recreation activity at each project year was converted to a present worth value using a 4 1/8 percent annual interest rate. The sum of these present worth values, by recreational activity were converted to an average annual dollar value, given a 50 year project life and a 4 1/8 percent annual interest rate. Table 9 shows the Average Annual Benefit summary.

Table 9 – Project Recreation Average Annual Benefit

Walking	$1,490,287
Running	$1,674,699
Picnicking	$45,057
Wildlife Viewing	$133,285
Fishing	$10,641
X-C Skiing	$157,228
Bicycling	$689,625
Snowmobiling	$523,980
Horseback Riding	$281,291
TOTAL ANNUAL AVG BENEFITS	**$5,006,093**

The present value of estimated construction costs, contingencies, engineering, design, construction management, and interest during construction were calculated to be $33,148,000. This present value was amortized at 4 1/8 percent over the 50-year life of the project. The resulting annualized cost of $1,576,220 was added to the estimated annual operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) cost of $129,905 for a total annual cost of $1,706,125. The net annual benefits, or the annual benefits minus the annual costs, are $3,299,968. The benefit-cost ratio, or the annual benefits divided by the annual costs, was calculated to be 2.93. Therefore, the Fargo-Moorhead proposed recreation plan is economically justified. The Federal costs of the Fargo Moorhead flood damage reduction project with the recreation facilities would be approximately 3.8 percent greater than the Federal costs of the project without the recreation facilities, less than the 10 percent limit, in accordance with ER 1105-2-100.

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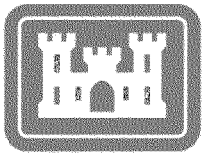
Appendix N
Project Cost and Schedule Risk Analysis Reports

Fargo-Moorhead Metropolitan Area Flood Risk Management

Final Feasibility Report and Environmental Impact Statement

July 2011



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Fargo-Moorhead Metro Flood Risk Management Project, Feasibility Study, Phase 4

National Economic Development Plan (NED) – Minnesota Option

Project Cost and Schedule Risk Analysis Report

Prepared for:

U.S. Army Corps of Engineers,
St. Paul District

Prepared by:

U.S. Army Corps of Engineers
Cost Engineering Directory of Expertise, Walla Walla

May 4, 2011

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EXECUTIVE SUMMARY

Under the auspices of the US Army Corps of Engineers (USACE), St. Paul District, this report presents a recommendation for the project cost and schedule contingencies for the Fargo-Moorhead Metro Flood Risk Management Project, Feasibility Study, Phase 4 National Economic Development Plan (NED) – Minnesota Option (Fargo-Moorhead FRM NED). In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis study was conducted for the development of contingency on the project cost. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated project cost.

Specific to the Fargo-Moorhead NED Project, the most likely project cost (at price level) is estimated at approximately $949 Million. Based on the results of the analysis, the Cost Engineering Directory of Expertise for Civil Works (Walla Walla District) recommends a contingency value of $245 Million, or 26%. This contingency includes $181 Million (19%) for cost growth potential due to risk analyzed in the base cost estimate and $65 Million (7%) for cost growth potential due to risk analyzed in the baseline schedule.

Walla Walla Cost Dx performed risk analysis using the *Monte Carlo* technique, producing the aforementioned contingencies and identifying key risk drivers.

The following table ES-1 portrays the development of contingencies (26%). The contingency is based on an 80% confidence level, as per USACE Civil Works guidance.

Table ES-1. Contingency Analysis Table

Most Likely Cost Estimate	**$1,387,078,819**	
Confidence Level	**Value ($$)**	**Contingency (%)**
5%	$1,011,329,628	6.62%
50%	$1,129,751,928	19.11%
80%	**$1,193,932,836**	**25.87%**
95%	$1,252,332,843	32.03%

The following table ES-2 portrays the full costs of the recommended alternative based on the anticipated contracts. The costs are intended to address the congressional request of estimates to implement the project. The contingency is based on an 80% confidence level, as per accepted USACE Civil Works guidance.

Table ES-2. Cost Summary

FARGO-MOORHEAD NED		COST ($1,000)	CNTG ($1,000)	TOTAL ($1,000)
01	LANDS AND DAMAGES	54,782	14,173	68,956
02	RELOCATIONS	84,956	21,980	106,936
06	FISH AND WILDLIFE FACILITIES	11,560	2,991	14,551
08	ROADS, RAILROADS, AND BRIDGES	127,294	32,933	160,228
09	CHANNELS AND CANALS	469,968	121,590	591,558
11	LEVEES AND FLOODWALLS	19,635	5,080	24,715
14	RECREATION FACILITIES	19,206	4,969	24,175
30	PLANNING, ENGINEERING AND DESIGN	109,859	28,423	138,282
31	CONSTRUCTION MANAGEMENT	51,268	13,264	64,532
	TOTAL PROJECT COSTS	**948,530**	**245,403**	**1,193,933**
	Schedule Completion with Contingency	**11 Jan 2018**	**105 months**	**4 Oct 2026**

Notes:
1) Costs include the recommended contingency of 26%.
2) Costs exclude O&M and Life Cycle Cost estimates.

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The key cost risk drivers identified through sensitivity analysis were Risks PPM-8 (Scope Changes), CON-6 (Contract Modifications), and CA-1 (Undefined Acquisition Strategy), which together contribute over 56 percent of the statistical cost variance. PPM-8 captures the risk that changes to scope, as required by stakeholders, may increase the cost of the project. CON-6 captures the risk that there may be cost growth due to post-award modifications to the contracts due to differing site conditions, engineering changes, and/or claims. CA-1 captures the risk that not having a fully developed contract acquisition strategy may result in cost growth.

The key schedule risk drivers identified through sensitivity analysis were Risk PR-1 (Uncertainty with Funding Stream), and PR-5 (Political Factors Change at State, Local, or Federal level), which together contribute over 78 percent of the statistical schedule variance. PR-1 covers the risk that delay in obtaining necessary funding increments my significantly delay the project. PR-5 captures the risk that political factors could change project support and scope, delaying the overall project implementation.

Recommendations, as detailed within the main report, include the implementation of cost and schedule contingencies, further iterative study of risks throughout the project life-cycle, potential mitigation throughout the PED phase, and proactive monitoring and control of risk identified in this study.

MAIN REPORT

1.0 PURPOSE

Under the auspices of the US Army Corps of Engineers (USACE), St. Paul District, this report presents a recommendation for the project cost and schedule contingencies for the Fargo-Moorhead Metro Flood Risk Management Project, Feasibility Study, Phase 4 Locally Preferred Plan (NED) – North Dakota Option (Fargo-Moorhead FRM NED).

2.0 BACKGROUND

The purpose of the Fargo-Moorhead Feasibility Study is to identify measures and develop a regional system to reduce flood risk along the Red River of the North for the entire Fargo-Moorhead metropolitan area. The study PDT collected, evaluated and screened an array of possible flood risk management plans to define the costs, benefits and impacts to the project area. The plans resulted in a diversion channel alternative as the best measures to reduce the flood risk. A diversion through Minnesota around the city of Moorhead offered the plan with the lowest cost having a B/C ratio over one. The local sponsors preferred a diversion alternative through North Dakota around the city of Fargo as a locally preferred plan. The PDT has developed plans and estimates for both the National Economic Development (NED) - Minnesota Plan and the NED – North Dakota plan.

St. Paul District is preparing a Feasibility Report. As a part of this effort, St. Paul District requested that the USACE Cost Engineering Directory of Expertise for Civil Works (Cost Engineering Dx) provide an agency technical review (ATR) of the cost estimate and schedule for LRR. That tasking also included providing a risk analysis study to establish the resulting contingencies.

3.0 REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for all project features. The study and presentation does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the most likely Micro Computer Aided Cost Estimating System (MCACES) cost estimate, schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the St. Paul District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of problems, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Dx. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering Dx.

- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008.

- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

4.0 METHODOLOGY / PROCESS

The Cost Engineering Dx assembled a team, also relying on local St. Paul District staff to further augment labor, expertise and information gathering. The Cost Engineering Dx team consisted of one senior civil cost engineer.

The Cost Engineering Dx cost engineer facilitated a risk identification meeting on site with the St. Paul PDT on January 7, 2010. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the framework for the risk analysis. The cost and schedule risk models were completed and results reported on January 29, 2010. Several subsequent revisions to the estimates and risk analyses took place between January 29, 2010 and April 17, 2011. The final results were reported on April 17, 2011.

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence.

In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Dx guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk averse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Formal PDT meetings were held for the purposes of identifying and assessing risk factors. The formal meeting conducted on January 7, 2010 included representatives from plan formulation, project management, geotechnical and hydraulic design, cost engineering, construction, environmental compliance, real estate, and the project sponsors.

The initial formal meetings focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Subsequent meetings focused primarily on risk factor assessment and quantification.

Additionally, numerous conference calls and informal meetings were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were quantified using probability distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the Fargo-Moorhead NED project.

a. The St. Paul District provided MII MCACES (Micro-Computer Aided Cost Estimating Software) files via email. The file title, "MVP FCP_MN_Diversion_Phase_4 with 2009 Equip Rate.mlp" was the basis for the cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level.

c. Schedules are analyzed for impact to the project cost in terms of both uncaptured escalation (variance from OMB factors and the local market) and unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay.

d. Per the CWCCIS Historical State Adjustment Factors in EM 1110-2-1304, State Adjustment Factors for Minnesota and North Dakota are 1.15 and 0.92, respectively. Taking this into account along with the historical RS Means labor inflation rate and Consumer Price Index (CPI) factor for Minnesota, the average suggests that true inflation is approximately 4.55% higher for the Fargo Metro area than for the national average. This rate was used to calculate the differential between the local market and OMB inflation factors for future construction. For the P80 schedule, this is approximately 1.34% of the contingency.

e. Per the data in the estimate, the Job Office Overhead (JOOH) amount comprises approximately 5% of the Project Cost at Baseline. Thus, the assumed residual fixed cost rate for this project is 5%. For the P80 schedule, this comprises approximately 5.49% of the total contingency due to the accrual of residual fixed costs associated with delay.

f. The Cost Dx guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

g. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk "watch list".

6.0 RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Contingency and Sensitivity Analysis

Table 1 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes only.

Contingency was quantified as approximately $245 Million at the P80 confidence level (26% of the baseline cost estimate). For comparison, the cost contingency at the P50 and P100 confidence levels was quantified as 19% and 49% of the baseline cost estimate, respectively.

Table 1. Project Cost Contingency Summary

Risk Analysis Forecast	Baseline Estimate	Total Contingency[1,2] ($)	Total Contingency (%)
50% Confidence Level			
Project Cost	$1,129,751,928	$181,221,713	19.11%
80% Confidence Level			
Project Cost	$1,193,932,836	$245,402,622	25.87%
100% Confidence Level			
Project Cost	$1,414,017,542	$465,487,327	49.07%

Notes:
1) These figures combine uncertainty in the baseline cost estimates and schedule.
2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of "unknown unknowns") makes 100% confidence a theoretical impossibility.

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high level schedule risks identified in the risk register.

6.3 Schedule and Contingency Risk Analysis

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 96 months based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were calculated by applying the high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs.

Table 2. Schedule Duration Contingency Summary

Risk Analysis Forecast	Baseline Schedule Duration (months)	Contingency[1] (months)
50% Confidence Level		
Project Duration	96	78
80% Confidence Level		
Project Duration	96	105
100% Confidence Level		
Project Duration	96	171

Notes:
1) The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented in Table 2.
2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of "unknown unknowns") makes 100% confidence a theoretical impossibility.

Figure 1. Cost Sensitivity Analysis

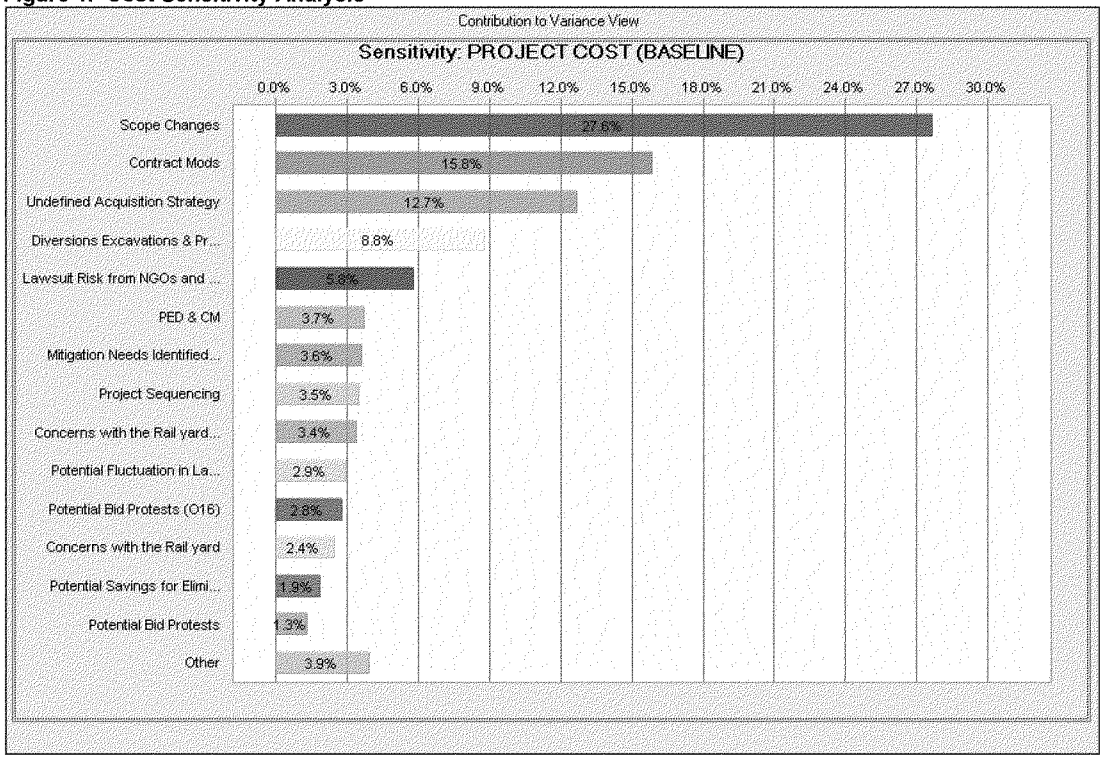
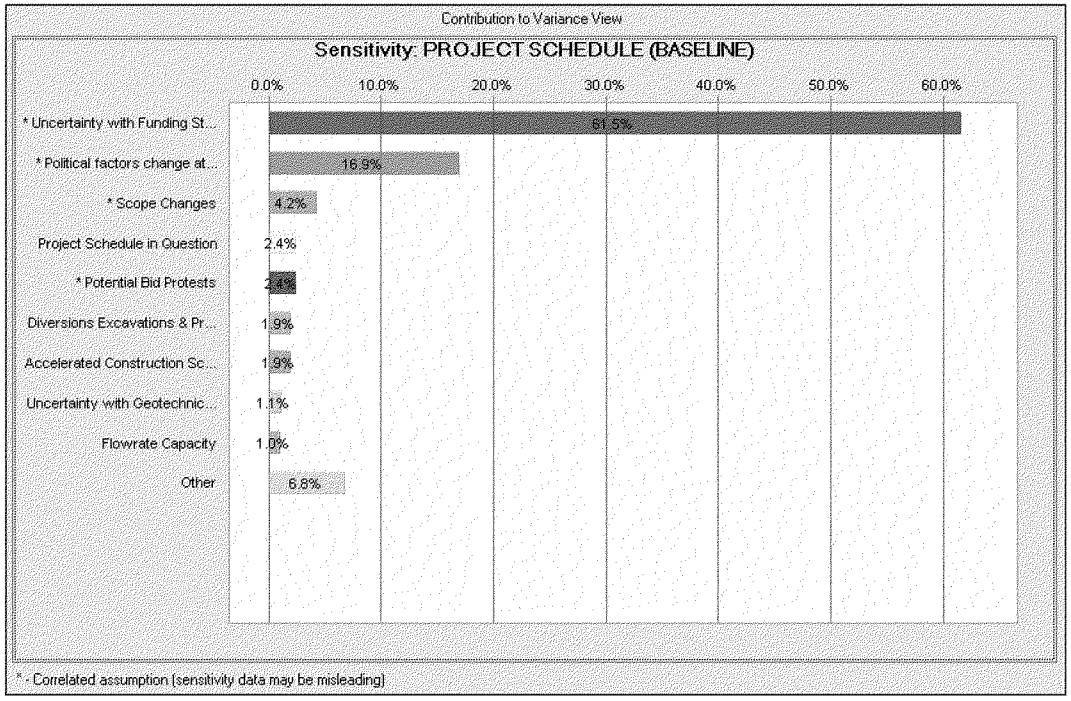


Figure 2. Schedule Sensitivity Analysis



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Project cost comparison summaries are provided in Table 3 and Figure 3. Additional major findings and observations of the risk analysis are listed below.

1. The key cost risk drivers identified through sensitivity analysis were Risks PPM-8 (Scope Changes), CON-6 (Contract Modifications), and CA-1 (Undefined Acquisition Strategy), which together contribute over 56 percent of the statistical cost variance.

2. The key schedule risk drivers identified through sensitivity analysis were Risk PR-1 (Uncertainty with Funding Stream), and PR-5 (Political Factors Change at State, Local, or Federal level), which together contribute over 78 percent of the statistical schedule variance.

3. Operation and maintenance activities were not included in the cost estimate or schedules. Therefore, a full lifecycle risk analysis could not be performed. Risk analysis results or conclusions could be significantly different if the necessary operation and maintenance activities were included.

Table 3. Project Cost Comparison Summary

Confidence Level	Project Cost ($)	Contingency (%)
P0	**$887,943,310**	**-6.39%**
P5	**$1,011,329,628**	**6.62%**
P10	**$1,035,273,666**	**9.15%**
P15	**$1,051,942,210**	**10.90%**
P20	**$1,065,481,512**	**12.33%**
P25	**$1,078,099,735**	**13.66%**
P30	**$1,089,103,081**	**14.82%**
P35	**$1,099,626,512**	**15.93%**
P40	**$1,109,631,700**	**16.98%**
P45	**$1,119,542,602**	**18.03%**
P50	**$1,129,751,928**	**19.11%**
P55	**$1,139,446,444**	**20.13%**
P60	**$1,149,883,372**	**21.23%**
P65	**$1,159,801,199**	**22.27%**
P70	**$1,170,131,865**	**23.36%**
P75	**$1,181,672,791**	**24.58%**
P80	**$1,193,932,836**	**25.87%**
P85	**$1,207,714,410**	**27.32%**
P90	**$1,226,509,041**	**29.31%**
P95	**$1,252,332,843**	**32.03%**
P100	**$1,414,017,542**	**49.07%**

Figure 3. Project Cost Summary

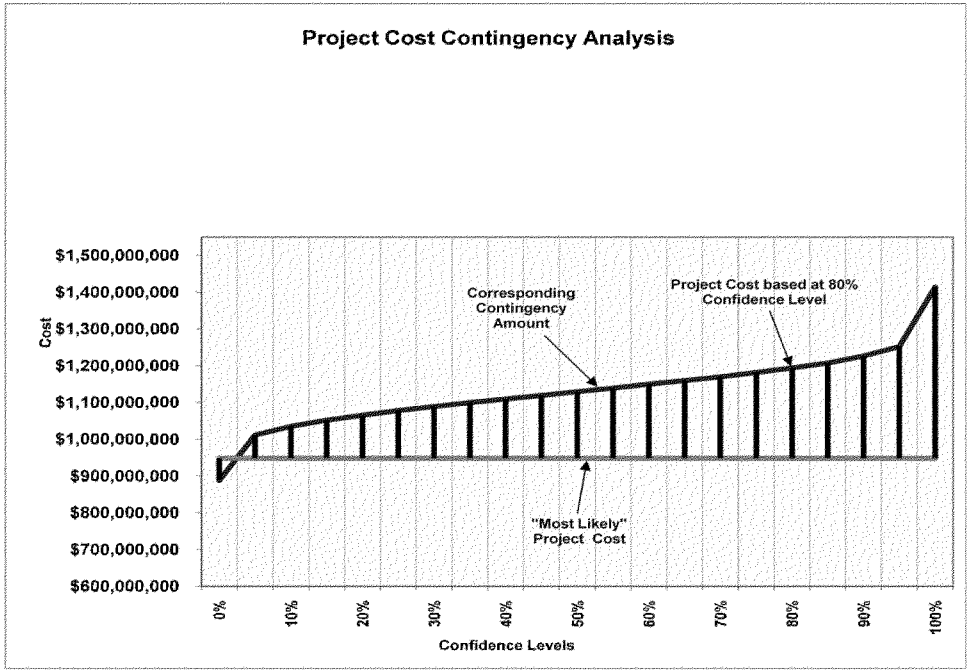
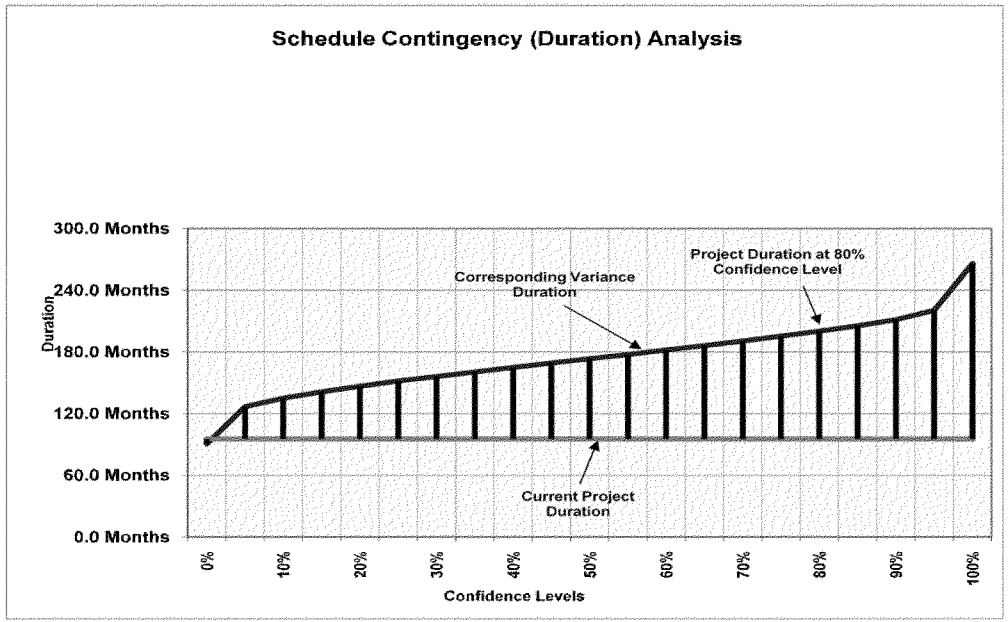


Figure 4. Project Duration Summary



7.2 Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 4th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The Cost and Schedule Risk Analysis (CSRA) produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

1. Key Cost Risk Drivers: The key cost risk drivers identified through sensitivity analysis were Risks PPM-8 (Scope Changes), CON-6 (Contract Modifications), and CA-1 (Undefined Acquisition Strategy), which together contribute over 56 percent of the statistical cost variance.

a) Scope Changes: Project leadership should attempt to capture and finalize the scope of the project to the maximum extent possible. It is imperative to identify all features of work and probable methodologies, along with the accompanying risks associated with implementation. Iterative quantification (risk analysis) may be necessary to further develop and pinpoint sources of risk to identify needs for risk treatment in the risk response and management plan.

b) Contract Modifications: Project leadership should attempt to capture and finalize the scope of the project to the maximum extent possible. It is imperative to identify all features of work and probable methodologies, along with the accompanying risks associated with implementation. Iterative quantification (risk analysis) may be necessary to further develop and pinpoint sources of risk to identify needs for risk treatment in the risk response and management plan. Additionally, project leadership should determine acquisition strategy and make decisions early to impact the completion of contract documents as to minimize risk of engineering changes and potential claims.

c) Undefined Acquisition Strategy: Project leadership should take proactive measures to obtain decisions regarding acquisition strategy, as well as communication to management regarding the impact of those decisions on cost performance. Project leadership should develop the acquisition strategy to maximize competition and cost control, and so that current working estimates can capture the probable costs.

2. Key Schedule Risk Drivers: The key schedule risk drivers identified through sensitivity analysis were Risk PR-1 (Uncertainty with Funding Stream), and PR-5 (Political Factors Change at State, Local, or Federal level), which together contribute over 78 percent of the statistical schedule variance.

a) Uncertainty with Funding Stream: Project leadership should project leadership proactively develop accurate funding profile projections to capture probable funding requirements. Ultimately, this is an external risk, and its impacts must be communicated to management.

b) Political Factors Change at State, Local, or Federal level: Project leadership should attempt to communicate and coordinate effectively with District management and the other involved project partners and sponsors. Ultimately, this is an external risk, and its impacts must be communicated to management, and funds should be maintained in project reserve for treatment of this risk.

3. Risk Management: Project leadership should use of the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

4. Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

APPENDIX A

MVP - Fargo/Moorhead Feasibility Report (FCP - Minnesota Option) - PDT Risk Register

Overall Project Scope

The Fargo-Moorhead Feasibility Study purpose is to identify measures and develop a regional system to reduce flood risk along the Red River of the North for the entire F-M metroploitan area. The study PDT collected, evaluated and screened an array of possible flood risk management plans to define the costs, benefits and impacts to the project area. The plans resulted in a diversion channel alternative as the best measures to reduce the flood risk. A diversion through Minnesota around the city of Moorhead offered the plan with the lowest cost having a B/C ratio over one. The local sponsors preferred a diversion alternative through North Dakota around the city of Fargo as a locally preferred plan. The PDT has developed plans and estimates for both the MN Plan and the LPP ND plan.

Cost Impacts

For the Fargo/Moorhead Project, any cost impact of $10 Million or higher should be considered at least "Significant."

Anything over $5 Million should be considered at least "Marginal."

Schedule Impacts

For the Fargo/Moorhead Project, any schedule impact of 12 months or greater should be considered at least "Significant."

Anything over 6 months should be considered at least "Marginal."

Risk Level

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High

Impact or Consequence of Occurrence

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)															
	PROJECT & PROGRAM MGMT														
PPM-1	Project Schedule Accuracy	Due to the large project size, complexity and sequencing, actual milestones may be different than the current forecast schedule being planned.	This could cause a variance in the project schedule (positive or negative, but most likely negative).	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Project Manager	Project Cost & Schedule
PPM-2	Accelerated Design Schedule	An accelerated schedule can result in inadequate studies, shortcuts in plans, change in contract acquisition strategy, failure to capture full scope, miss-steps, etc. There is the potential of moving forward with limited information.	An accelerated design schedule could impact the whole project design if there is not enough time to fully plan. This could impact both cost and schedule.	Likely	Significant	High		Likely	Significant	High		Triangular		District Management	Project Cost & Schedule
PM-3	Accelerated Construction Schedule	The need for physical progress on the ground supports construction acceleration as much as practical. Acceleration comes in the form of concurrent construction activities, added overtime costs, perdiem costs, possible contractor conflicts, congested work areas, poorly developed contracts resulting in more modifications and claims.	This could impact cost and schedule	Likely	Marginal	Moderate		Likely	Significant	High		Triangular		District Management	Project Cost & Schedule
PPM-4	Local Agency/Regulator Issues	The acceleration of the planning schedule has forced reviews and collaboration without much time given to local agencies and regulators	This could impact cost and schedule. There is however about two years before construction starts to resolve issues.	Unlikely	Negligible	Low		Unlikely	Marginal	Low		Yes-No		Project Manager	Project Cost & Schedule
PPM-7	Conflicting Priorities	The District's workload and competing priorities may impede progress on this project related to staff availability and experience, related to design, investigations, contract procurements, construction management.	Since the identity of this concern, the F-M project has been identified as a high priority regional project, and barring a major national disaster the F-M project will have all the resources it should need. Unlikely to cause cause any variance in the cost or schedule.	Unlikely	Negligible	Low		Unlikely	Negligible	Low		Uniform		District Management	Project Schedule
PPM-8	Scope Changes	The many competing interests & priorities, coupled with an accelerated schedule could result in scope changes currently unacptured or unanticipated. These scope changes would require additional coordination, cause further design and investigation and potentially impact the real estate acquisitions.	While minor alterations to the final alignment may occur, there should not be any major changes.	Likely	Marginal	Moderate		Likely	Significant	High		Yes-No		Project Manager	Project Cost & Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	CONTRACT ACQUISITION RISKS														
CA-1	Undefined Acquisition Strategy	The overall acquisition strategy for both design and construction has not been defined. Acquisition strategy could affect/impact bid competition and bid costs. It can also move risk onto the Government, causing need for greater contingencies. Clarification should be made related to number of contracts, contract types, etc authority for this procurement.	Acquisition strategy needs to be defined and could impact the cost and schedule.	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		TASD	Contract Cost & Project Schedule
CA-2	Preference to Small Business	Most of the larger requirements are so large that they would not be suitable for small business. However, there is potential for some of the restoration, seeding, and mitigation may be suitable for small business. There is a requirement for review by the PARC if the requirements were less than $50 Million	The project is so large, it is likely that even separable requirements would not be suitable for small business. Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost & Project Schedule
CA-3	Numerous Separate Contracts	There is potential to have numerous separate contracts, especially if the continuing contracts authority is not granted. Funding stream issues could also have an impact on the number of contracts. Lack of planning or foresight could result in change of plans, scope and reactive acquisition.	The best case would be 6 contracts. The worst case would be in excess of 10 contracts. More contracts could increase bidding competition. This could have a significant effect on cost and schedule (either positive or negative)	Very Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost
CA-4	Potential Bid Protests	The larger size of the project increase contractor interests in bidding, but also increases potential risk for protests due to hungry economy and interest in obtaining project dollars.	This could impact cost and schedule.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Yes-No		District Management	Project Cost & Schedule
CA-5	Contracting Staff shortages	Contracting is experiencing a lack of staffing, causing challenges in obtaining resources on a timely basis for all procurements.	Could cause a variance in the schedule, though by the time procurements are needed for construction, staffing issues could be resolved	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Uniform		District Management	Project Schedule
	TECHNICAL RISKS														
TL-1	Uncertainty with Geotechnical Conditions	There is uncertainty with geotechnical conditions but the Phase 3 estimate uses recent borings from 2010 to help define the the soil parameters for excavation and how that will impact the construction productivity. The material is all clay and silt	The current working estimate is fairly conservative. However, variation in the ultimate characterization of material could cause significant variance in productivity. Could impact cost and schedule (positive or negative).	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Geotechnical/Civil Design	Contract Cost & Project Schedule
TL-2	Survey Data Incomplete	The PDT currently has incomplete or outdated survey data (for bathymetry for the Red River and Tributaries)	If the survey data uncovers data that differs greatly from current conceptual design, it could lead to variance in cost (due to issues such as configuration and details for structures).	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
TL-3	Hazardous Waste/HTRW Concerns	Due to the project footprint involving BNSF's rail yard, there is the possibility that HTRW or hazardous substances may be encountered.	There is the potential for contaminated and or petroleum based contamination, as well as other deleterious substances. This would only impact schedule, as HTRW cleanup is not part of the project cost.	Very Unlikely	Negligible	Low		Likely	Significant	High		Yes-No		Geotechnical/Civil Design	Contract Cost & Project Schedule
TL-4	Variation in Estimated Quantities	There is potential for variation of estimated quantities in the excavation and earthwork features.	This could impact cost and schedule.	Likely	Significant	High		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Contract Cost
TL-5	Flowrate Capacity	If during detailed design the hydraulics change, it could affect the amount of flow required for the diversion channel to handle. This would affect channel width, bridge lengths and major hydraulic structure sizes.	This could impact Schedule	Unlikely	Marginal	Low		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Contract Cost & Project Schedule
TL-6	Relocations - Utilities	Quality of design at budget level	Most costs were obtained from affected utilities for the major lines that are impacted.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-7	Relocations - Bridges	Bridge costs will change depending on final diversion channel width	Bridge costs from historical DOT costs are fairly reliable.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-8	Mitigation	fish, wetlands, forest, adaptive management issues	Resource agencies have not agreed to any particular features yet so there is the potential for additional mitigation beyond what is proposed, though the Corps has laid out a well planned approach to mitigating the issues.	Likely	Significant	High		Likely	Negligible	Low		Uniform		Environmental Compliance	Contract Cost
TL-9	Diversions Excavations & Productivity	Excavations could be impacted by diversion alignment changes and/or model results	Impacts should only affect quantities of different soil layers.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Technical Lead	Contract Cost
TL-10	Hydraulic Structures	Hydraulic structures will need to be modeled	Model results could change design concepts	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Technical Lead	Contract Cost & Project Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
TL-11	Levees	Levee heights and lengths could change depending on if upstream staging is incorporated	The F-CP MN alternative is not likely to change to incorporate upstream staging	Unlikely	Significant	Moderate		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost
TL-12	Non-Structural Floodproofing	Costs for downstream impacts could change when the effects of have been fully developed	This is dependent on the takings analysis which so far has indicated that there is not a taking.	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost
TL-13	Recreational Facilities	Feasibility at conceptual design	Final designs could look different than Feasibility but overall concepts should be similar	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Cost Engineering	Contract Cost
TL-14	Fuel Cost Concerns	Volatility in the price of fuel	Recent spikes in fuel could increase the cost of fule for the project. Conversely, if the world markets calm down, fuel could return to a price lower that currently estimated in the project.	Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Cost Engineering	Contract Cost
	LANDS AND DAMAGES RISKS														
LD-1	Concerns with the Rail yard	The alignment currently goes through a BNSF rail yard. Due to the complication of working in an active rail yard, with the requirement of bridge construction/relocation/or reconfiguration could present significant challenges	The real risk is obtaining agreement from the railroad on the exact configuration of the rail yard crossing. Cost estimate from RR at feasibility level. Could impact cost or schedule.	Likely	Crisis	High		Unlikely	Critical	Moderate		Yes-No		Project Manager	Project Cost & Schedule
LD-2	Mitigation Needs Identified for Downstream Impacts	The effects of the project on areas downstream may require mitigation. footprint that has not been finalized. The impacts are not fully captured, and a determination has to be made as to whether a "taking" will be required.	The PDT feels that a "taking" is unlikely. This could significantly impact costs if there is a taking, and it could significantly impact schedule.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate		Yes-No		Real Estate	Project Cost & Schedule
LD-3	Potential Savings for Eliminating RR Bridge 1	Currently, the BNSF RR has limited use of this line and indicated that abandonment is possible	This could save the cost of bridge and track raise	Unlikely	Significant	Moderate		Very Unlikely	Negligible	Low		Yes-No		Project Manager	Project Cost & Schedule
LD-4	Appraisal	Appraisals carry certain assumptions based on technical information. If the technical information has the potential to change, the appraisals could be impacted.	Appraisals are using an average value	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
LD-5	Non-Appraisal	Real Estate office is responsible for establishing contingencies. There could be risks outside their domain that can still impact the costs.	Real Estate office will be using the CSRA contingencies	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
LD-6	Labor to Process RE	The estimated labor to manage and process the real estate needs may not be properly estimated.	Real Estate office has accounted for RE admin. in the estimate	Unlikely	Marginal	Low		Very Unlikely	Negligible	Low		Triangular		Real Estate	Project Cost
	REGULATORY AND ENVIRONMENTAL RISKS														
RE-1	Environmental Mitigation Feature Concerns	The PDT has estimated mitigation features for Phase 4 based on the expected impacts (to include construction and real estate).	This could impact the costs either positively or negatively. This item is more likely to vary on the low side.	Likely	Marginal	Moderate		Very Unlikely	Negligible	Low		Triangular		Environmental Compliance	Project Cost
RE-2	Historical Cultural Resource Issues	There is potential to find cultural resources, particularly on the riverbanks. No cultural resource survey has been completed to date. Mitigation will probably be necessary	Could impact cost	Very Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Environmental Compliance	Project Cost
RE-3	Fish Passage Issues	There will be fish passage requirement in the project, but the actual configuration has not been finalized/agreed upon by the local agencies.	Could impact cost, however fish passage has been designed into the hydraulic structures so only minor design refinements should be required.	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Project Cost
RE-4	Pressure to Compress Permitting Activities	The local agencies perceive that they are being pressured through the project permitting process.	PDT has programmed this into the schedule, and the agencies are not constricted more than normal review times.	Very Unlikely	Negligible	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule
RE-5	HTRW Issues	There is some potential for discovery of HTRW in the project alignment. Most of the alignment is through farmland.	Could impact cost and schedule. Since most of the project is through farmland there likely should not be any major issues	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	CONSTRUCTION RISKS														
CON-1	Unknown Residential Utility Conflicts	There is potential for the need to abandon some small residential utilities.	This could impact cost and schedule, but it would be negligible.	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
CON-2	Control and Diversion of Water	Methodology of controlling water could be impacted by the sequencing and timing of relocation, the characterization of materials, or other unknown impacts.	Could impact cost and schedule. This is more likely to affect cost from using larger pumping equipment or for increased handling of water.	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost
CON-3	Conflicts between Contractors	There is potential for conflicts between multiple contractors working in the same footprint at the same time.	Could impact cost. However, careful planning of the construction scheduling and sequencing should be able to avoid any major conflicts.	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule
CON-4	Sufficient QA Staff	to manage numerous contracts, mods and claims	EDC is well aware of QA staffing issues and is planning accordingly	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule
CON-5	Project Sequencing	conflicts between contractors and schedule impacts (one contractor waiting on another)	Conflicts may develop at reaches/ interface, building of bridges or hydraulic structures	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Construction	Contract Cost & Project Schedule
CON-6	Contract Mods	Contract mods and claims resulting from unforeseen site conditions, weather impacts, political and lawsuit impacts are a concern and can impact both cost and schedule.	Many of these concerns may be valid and impact the project	Likely	Significant	High		Likely	Negligible	Low		Triangular		Construction	Contract Cost
	ESTIMATE AND SCHEDULE RISKS														
EST-1	Potential Fluctuation in Labor Costs	There is concern that the labor force required for this work could be a challenge, requiring off-site labor, per diem and premium pay, as well as unique markups and multipliers for workers compensation and other factors.	Estimate currently has National Wage rates, which are higher than the local Davis-Bacon Wage Determination. The Estimate also includes $75/day for per diem. There is potential for savings, as the labor wage rate for North Dakota is cheaper than Minnesota. This could impact costs either positively or negatively.	Likely	Significant	High		Very Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
EST-2	WBS Elements - Estimate confidence	Certain WBS elements are better developed in scope and estimate than other scope areas. Some WBS elements may be more or less conservative. Some elements have greater risk and resulting need for greater contingencies.	The major cost elements for the diversion excavation, hydraulic structures and bridges have been highly developed for feasibility since they make up the bulk of the cost items. Environmental mitigation features are less develop and more conceptual and likely will change. Real Estate may be another area of risk confidence	Likely	Marginal	Moderate		Likely	Negligible	Low		Triangular		Cost Engineering	Project Cost & Schedule
EST-3	Estimate assumptions	The estimate assumptions may be flawed in certain cost areas related to scope, crews, productivity, material cost, markups, contingencies etc. This could result in a flawed budget development.	The estimate has been in development for enough time that scope, crews, productivity, material costs and markups are fairly well developed. Contingencies are from the CSRA	Unlikely	Marginal	Low		Likely	Negligible	Low		Triangular		Cost Engineering	Project Cost & Schedule
EST-4	PED & CM	The estimate currently uses 15% PED and 7% CM of the construction cost	With the high construction cost of this project and the amount of design required for excavation, these percentages may be too nigh, based on about 16% for the $410M Grand Forks/East Grand Forks Flood project which was more urban levees & floodwalls	Likely	Significant	High		Unlikely	Negligible	Low		Triangular		Cost Engineering	Project Cost

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Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)															
PR-1	Uncertainty with Funding Stream	There is a window of opportunity during the next couple years of obtaining the necessary increments on a timely basis. However, historically this has been a challenge in obtaining the increments necessary to complete on schedule, and there have been challenges in obtaining them on a timely basis.	This could impact both cost and schedule.	Very Likely	Significant	High		Very Likely	Significant	High		Uniform		Project Manager	Project Cost & Schedule
PR-2	Unusually Wet Season	If a given construction season is unusually higher than an average year, it could have significant impact on the productivity of the work.	If this it occurs, it reduce productivity and create substantial delays.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Binomial		N/A	Project Cost & Schedule
PR-3	Flooding Event	There is a chance of a flooding event during construction that could cause damage to constructed work features.	This could impact both cost and schedule. The contractors must prepare/construct for potential and possible remobilizations.	Very Unlikely	Negligible	Low		Very Unlikely	Negligible	Low		Binomial		N/A	Project Cost & Schedule
PR-4	Lawsuit Potentials	The City of Dilworth has voiced objection over the route of the current project alignment, as they perceive too few benefits from the project	PDT feels that this risk could be mitigated and managed Could impact cost and schedule	Unlikely	Marginal	Low		Unlikely	Significant	Moderate		Yes-No		Project Manager	Project Schedule
PR-5	Political factors change at state, local, or federal level	Political factors at the local or state levels may change, impacting project support. Senator Dorgan has retired. He was very influential and favorable to the project interests. Since the authorization was not obtained prior to his departure, there is concern that the project would not be authorized or funded on a timely basis.	There is more chance of local or state political opposition on the Minnesota plan because of impacts to Dilworth, MN and the downstream communities that may be impacted. Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Crisis	High		Yes-No		Project Manager	Project Schedule
PR-7	Lawsuit Risk from NGOs and Downstream Interests	There may be perceived damages from downstream concerns - this will be less on the MN side	Could impact cost and schedule.	Likely	Marginal	Moderate		Likely	Significant	High		Uniform		Project Manager	Project Schedule

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely, Unlikely, Moderately Likely, Likely, Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible, Marginal, Significant, Critical**, or **Crisis**. Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low, Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

Contingency on Base Estimate	80% Confidence Project Cost
Baseline Estimate Cost (Most Likely) ->	$948,530,215
Baseline Estimate Cost Contingency Amount ->	$180,687,057
Baseline Estimate Construction Cost (80% Confidence) ->	$1,129,217,272

Contingency on Schedule	80% Confidence Project Schedule
Project Schedule Duration (Most Likely) ->	95.5 Months
Schedule Contingency Duration ->	104.8 Months
Project Schedule Duration (80% Confidence) ->	200.3 Months
Project Schedule Contingency Amount (80% Confidence) ->	$64,715,585

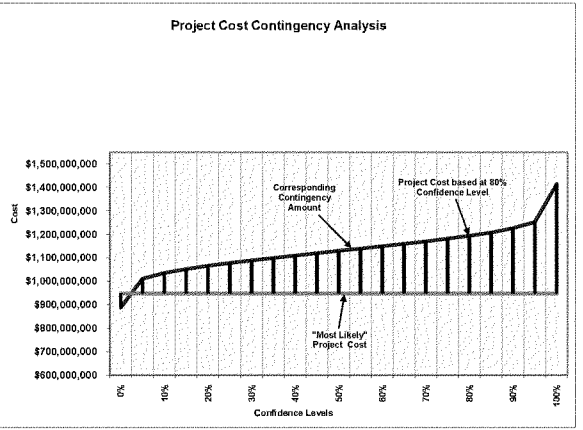
Project Contingency	80% Confidence Project Cost
Project Contingency Amount (80% Confidence) ->	$245,402,622
Project Contingency Percentage (80% Confidence) ->	26%

Project Cost (80% Confidence) ->	$1,193,932,836

- PROJECT CONTINGENCY DEVELOPMENT -

Contingency Analysis

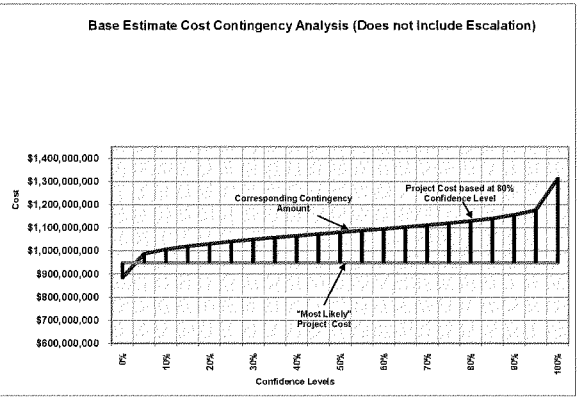
Most Likely Cost Estimate	$948,530,215		
Confidence Level	Project Cost	Contingency	Contingency %
0%	$887,943,310	($60,586,904)	-6.39%
5%	$1,011,329,628	$62,799,413	6.62%
10%	$1,035,273,666	$86,743,451	9.15%
15%	$1,051,942,210	$103,411,995	10.90%
20%	$1,065,481,512	$116,951,298	12.33%
25%	$1,078,099,735	$129,569,521	13.66%
30%	$1,089,103,081	$140,572,866	14.82%
35%	$1,099,626,512	$151,096,297	15.93%
40%	$1,109,631,700	$161,101,485	16.98%
45%	$1,119,542,602	$171,012,387	18.03%
50%	$1,129,751,928	$181,221,713	19.11%
55%	$1,139,446,444	$190,916,230	20.13%
60%	$1,149,883,372	$201,353,157	21.23%
65%	$1,159,801,199	$211,270,984	22.27%
70%	$1,170,131,865	$221,601,651	23.36%
75%	$1,181,672,791	$233,142,576	24.58%
80%	$1,193,932,836	$245,402,622	25.87%
85%	$1,207,714,410	$259,184,195	27.32%
90%	$1,226,509,041	$277,978,826	29.31%
95%	$1,252,332,843	$303,802,628	32.03%
100%	$1,414,017,542	$465,487,327	49.07%



- BASE CONTINGENCY DEVELOPMENT -

Contingency Analysis

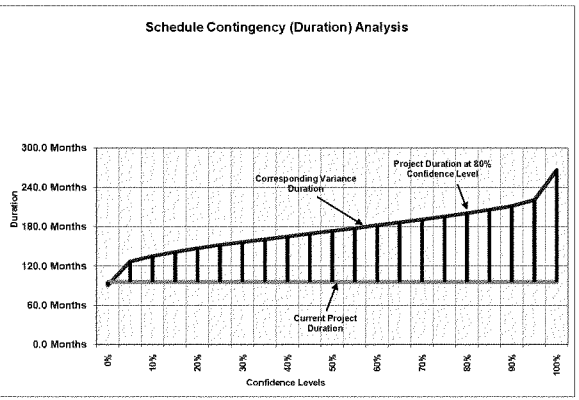
Most Likely Cost Estimate	$948,530,215		
Confidence Level	Value		Contingency
0%	$884,594,262	($63,935,953)	-6.74%
5%	$987,789,920	$39,259,706	4.14%
10%	$1,007,075,412	$58,545,197	6.17%
15%	$1,020,291,286	$71,761,071	7.57%
20%	$1,030,718,995	$82,188,780	8.66%
25%	$1,040,497,920	$91,967,706	9.70%
30%	$1,049,053,519	$100,523,304	10.60%
35%	$1,057,131,010	$108,600,795	11.45%
40%	$1,064,672,740	$116,142,526	12.24%
45%	$1,072,188,740	$123,658,525	13.04%
50%	$1,079,996,514	$131,466,299	13.86%
55%	$1,087,416,074	$138,885,859	14.64%
60%	$1,095,385,159	$146,854,944	15.48%
65%	$1,102,919,106	$154,388,891	16.28%
70%	$1,110,801,734	$162,271,519	17.11%
75%	$1,119,700,924	$171,170,710	18.05%
80%	$1,129,217,272	$180,687,057	19.05%
85%	$1,140,066,664	$191,536,449	20.19%
90%	$1,155,521,288	$206,991,073	21.82%
95%	$1,176,284,791	$227,754,576	24.01%
100%	$1,312,911,414	$363,981,200	38.37%



- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

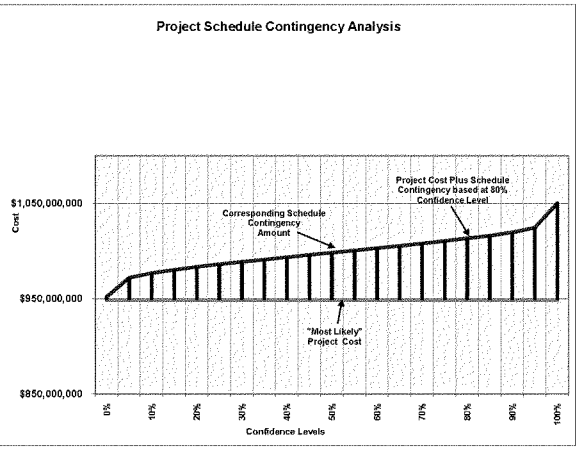
Most Likely Schedule	95.5 Months		
Confidence Level	Project Duration	Contingency	Contingency %
0%	90.7 Months	-4.8 Months	-5.03%
5%	126.7 Months	31.3 Months	32.75%
10%	135.0 Months	39.6 Months	41.46%
15%	141.2 Months	45.7 Months	47.92%
20%	146.8 Months	51.3 Months	53.74%
25%	151.8 Months	56.4 Months	59.06%
30%	156.2 Months	60.7 Months	63.64%
35%	160.6 Months	65.1 Months	68.21%
40%	165.0 Months	69.5 Months	72.82%
45%	169.3 Months	73.8 Months	77.30%
50%	173.5 Months	78.1 Months	81.79%
55%	177.6 Months	82.1 Months	86.05%
60%	182.0 Months	86.6 Months	90.67%
65%	186.3 Months	90.8 Months	95.13%
70%	190.6 Months	95.2 Months	99.71%
75%	195.4 Months	99.9 Months	104.65%
80%	200.3 Months	104.8 Months	109.78%
85%	205.5 Months	110.0 Months	115.27%
90%	211.5 Months	116.0 Months	121.52%
95%	220.5 Months	125.0 Months	130.99%
100%	266.0 Months	170.5 Months	178.61%



- SCHEDULE CONTINGENCY (AMOUNT) DEVELOPMENT -

Contingency Analysis

Most Likely Cost Estimate	$948,530,215		
Confidence Level	Value		Contingency
0%	$951,879,263	$3,349,049	0.35%
5%	$972,069,922	$23,539,708	2.48%
10%	$976,728,469	$28,198,254	2.97%
15%	$980,181,139	$31,650,924	3.34%
20%	$983,292,732	$34,762,517	3.66%
25%	$986,132,030	$37,601,815	3.96%
30%	$988,579,776	$40,049,562	4.22%
35%	$991,025,717	$42,495,502	4.48%
40%	$993,489,174	$44,958,959	4.74%
45%	$995,884,077	$47,353,862	4.99%
50%	$998,285,629	$49,755,414	5.25%
55%	$1,000,560,585	$52,030,370	5.49%
60%	$1,003,028,428	$54,498,213	5.75%
65%	$1,005,412,308	$56,882,093	6.00%
70%	$1,007,860,346	$59,330,131	6.25%
75%	$1,010,502,081	$61,971,867	6.53%
80%	$1,013,245,780	$64,715,565	6.82%
85%	$1,016,177,961	$67,647,746	7.13%
90%	$1,019,517,967	$70,987,753	7.48%
95%	$1,024,578,266	$76,048,052	8.02%
100%	$1,050,036,342	$101,506,127	10.70%



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MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Cost Risk Analysis Model

Risk No.	Risk/Opportunity Event	Project Cost: Likelihood*	Project Cost: Impact*	Project Cost: Risk Level*	Variance Distribution	Correlation to Other(s)	Crystal Ball Simulation Expected Values ($$): Low	Most Likely	High		Crystal Ball Simulation Expected Values (%s): Low	Most Likely	High	
Internal Risks (Internal Risk items are those that are generated, caused, or controlled within the PDT's sphere of influence.)														
PROJECT & PROGRAM MGMT														
PPM-1	Project Schedule in Question	Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	*Removed From Cost Risk Study as this is captured by the Schedule Risk Analysis*	N/A	N/A	N/A	
PPM-2	Accelerated Design Schedule	Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	*Removed From Cost Risk Study as this is captured in Technical Risks*	N/A	N/A	N/A	
PM-3	Accelerated Construction Schedule	Likely	Marginal	Moderate	N/A	N/A	N/A	N/A	N/A	*Removed From Cost Risk Study as this is captured in Technical Risks*	N/A	N/A	N/A	
PPM-6	Scope Changes	Likely	Significant	High	Triangular		($47,415,140)	$0	$94,830,280		-5.00%	0.00%	10.00%	100%
CONTRACT ACQUISITION RISKS														
CA-1	Undefined Acquisition Strategy	Likely	Marginal	Moderate	Triangular		($18,309,635)	$0	$73,239,350		-1.93%	0.00%	7.72%	100%
CA-3	Numerous Separate Contracts	Very Likely	Significant	High	Triangular		$0	$0	$8,056,350		0.00%	0.00%	0.85%	100%
CA-4	Potential Bid Protests	Likely	Marginal	Moderate	Yes-No/Uniform		$0	$0	$36,619,675		0.00%	0.00%	3.86%	66%
TECHNICAL RISKS														
TL-1	Uncertainty with Geotechnical Conditions	Likely	Marginal	Moderate	Triangular		($713,980)	$0	$356,990		-0.08%	0.00%	0.04%	100%
TL-4	Variation in Estimated Quantities	Likely	Significant	High	Yes-No/Uniform		($13,720,690)	$0	$13,720,690		-1.45%	0.00%	1.45%	66%
TL-6	Relocations - Utilities	Likely	Marginal	Moderate	Triangular		($251,280)	$0	$1,567,680		-0.03%	0.00%	0.17%	100%
TL-7	Relocations - Bridges	Likely	Marginal	Moderate	Triangular		($3,969,530)	$0	$7,973,060		-0.42%	0.00%	0.84%	100%
TL-8	Mitigation	Likely	Significant	High	Uniform		($578,295)	$0	$2,891,475		-0.06%	0.00%	0.30%	100%
TL-9	Diversions Excavations & Productivity	Likely	Marginal	Moderate	Triangular		($19,291,395)	$0	$57,874,185		-2.03%	0.00%	6.10%	100%
TL-10	Hydraulic Structures	Likely	Significant	High	Triangular		($4,155,625)	$0	$16,622,500		-0.44%	0.00%	1.75%	100%
TL-11	Levees	Unlikely	Significant	Moderate	Triangular		($705,710)	$0	$3,528,550		-0.07%	0.00%	0.37%	100%
TL-12	Non-Structural Floodproofing	Likely	Marginal	Moderate	Triangular		($549,090)	$0	$2,745,450		-0.06%	0.00%	0.29%	100%
TL-13	Recreational Facilities	Likely	Marginal	Moderate	Triangular		($998,470)	$0	$4,992,350		-0.11%	0.00%	0.53%	100%
TL-14	Fuel Cost Concerns	Likely	Significant	High	Triangular		($8,110,020)	$0	$8,110,020		-0.86%	0.00%	0.86%	100%
LANDS AND DAMAGES RISKS														
LD-1	Concerns with the Rail yard	Likely	Crisis	High	Yes-No/Uniform		($6,364,720)	$0	$44,553,040		-0.67%	0.00%	4.70%	66%
LD-2	Mitigation Needs Identified for Downstream Impacts	Unlikely	Significant	Moderate	Yes-No/Uniform	RE-1	$0	$0	$50,000,000		0.00%	0.00%	5.27%	25%
LD-3	Potential Savings for Eliminating RR Bridge 1	Unlikely	Significant	Moderate	Yes-No/Custom		($16,765,552)	$0	$0		-1.98%	0.00%	0.00%	25%
LD-4	Appraisal	Likely	Significant	High	Triangular		($2,739,115)	$0	$16,434,690		-0.29%	0.00%	1.73%	100%
LD-5	Non-Appraisal	Likely	Marginal	Moderate	Triangular		($2,739,115)	$0	$5,478,230		-0.29%	0.00%	0.58%	100%

Percentages are calculated as the variance from the assumption value to facilitate iteration of the model should the cost values change throughout the project phases. Uniform distribution percentages reflect variation from the total project cost.

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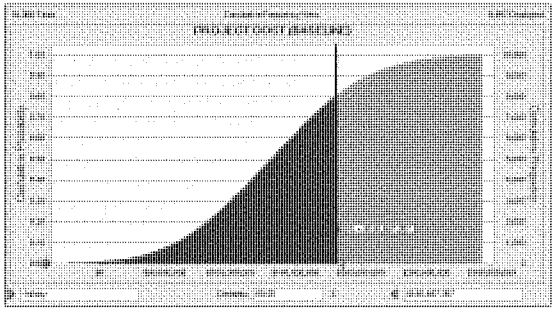
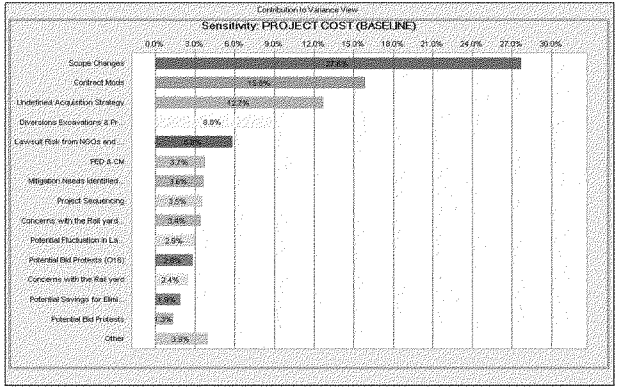
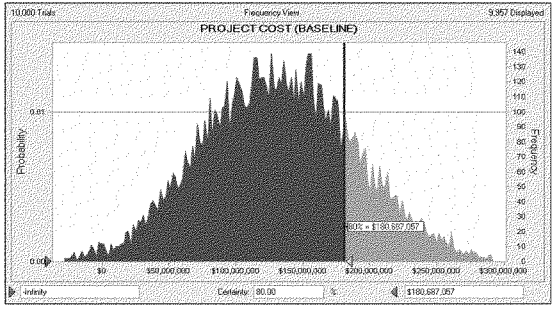
REGULATORY AND ENVIRONMENTAL RISKS														
RE-1	Environmental Mitigation Feature Concerns	Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	*Removed From Cost Risk Study as this is captured by TL-8*	N/A	N/A	N/A	
RE-2	Historical Cultural Resource Issues	Very Likely	Marginal	Moderate	Triangular		($500,000)	$0	$1,000,000		-0.05%	0.00%	0.11%	100%
CONSTRUCTION RISKS														
CON-2	Control and Diversion of Water	Likely	Marginal	Moderate	Triangular		($4,502,900)	$0	$4,502,900		-0.47%	0.00%	0.47%	100%
CON-5	Project Sequencing	Likely	Significant	High	Uniform		($6,767,933)	$0	$33,839,665		-0.71%	0.00%	3.57%	100%
CON-6	Contract Mods	Likely	Significant	High	Triangular		($36,358,395)	$0	$72,716,790		-3.83%	0.00%	7.67%	100%
ESTIMATE AND SCHEDULE RISKS														
EST-1	Potential Fluctuation in Labor Costs	Likely	Significant	High	Triangular		($16,384,590)	$0	$32,768,180		-1.73%	0.00%	3.45%	100%
EST-2	WBS Elements - Estimate confidence	Likely	Marginal	Moderate	N/A	N/A	N/A	N/A	N/A	*Removed From Cost Risk Study as this is captured by LD-4 and TL-6*	N/A	N/A	N/A	
EST-4	PED & CM	Likely	Significant	High	Triangular		($43,504,290)	$0	$0		-4.59%	0.00%	0.00%	100%
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)														
PR-1	Uncertainty with Funding Stream	Very Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	*Removed From Cost Risk Study as this is captured by the Schedule Risk Analysis*	N/A	N/A	N/A	
PR-7	Lawsuit Risk from NGOs and Downstream Interest	Very Likely	Marginal	Moderate	Uniform		$0	$0	$47,415,140		0.00%	0.00%	5.00%	100%
										Not Part of Study - Placeholder for Project Summation Purposes Only				
								$0						

	Percentile	Baseline TPC	Contingency Amount	Baseline w/ Contingency	Contingency %
PROJECT COST (BASELINE)	0%	$948,530,215	($63,935,953)	**$884,594,262**	**-6.74%**
	5%	$948,530,215	**$39,259,706**	**$987,789,920**	**4.14%**
	10%	$948,530,215	**$58,545,197**	**$1,007,075,412**	**6.17%**
	15%	$948,530,215	**$71,761,071**	**$1,020,291,286**	**7.57%**
	20%	$948,530,215	**$82,188,780**	**$1,030,718,995**	**8.66%**
	25%	$948,530,215	**$91,967,706**	**$1,040,497,920**	**9.70%**
	30%	$948,530,215	**$100,523,304**	**$1,049,053,519**	**10.60%**
	35%	$948,530,215	**$108,600,795**	**$1,057,131,010**	**11.45%**
	40%	$948,530,215	**$116,142,526**	**$1,064,672,740**	**12.24%**
	45%	$948,530,215	**$123,658,525**	**$1,072,188,740**	**13.04%**
	50%	$948,530,215	**$131,466,299**	**$1,079,996,514**	**13.86%**
	55%	$948,530,215	**$138,885,859**	**$1,087,416,074**	**14.64%**
	60%	$948,530,215	**$146,854,944**	**$1,095,385,159**	**15.48%**
	65%	$948,530,215	**$154,388,891**	**$1,102,919,106**	**16.28%**
	70%	$948,530,215	**$162,271,519**	**$1,110,801,734**	**17.11%**
	75%	$948,530,215	**$171,170,710**	**$1,119,700,924**	**18.05%**
	80%	$948,530,215	**$180,687,057**	**$1,129,217,272**	**19.05%**
	85%	$948,530,215	**$191,536,449**	**$1,140,066,664**	**20.19%**
	90%	$948,530,215	**$206,991,073**	**$1,155,521,288**	**21.82%**
	95%	$948,530,215	**$227,754,576**	**$1,176,284,791**	**24.01%**
	100%	$948,530,215	**$363,981,200**	**$1,312,511,414**	**38.37%**







MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Cost Risk Analysis Model

Risk Refer No.	Risk Event	Low	Most Likely	High	
PPM-1	Project Schedule in Question	[redacted]	[redacted]	[redacted]	*Removed From Cost Risk Study as this is captured by the Schedule Risk Analysis*

Risk Refer No.	Risk Event	Low	Most Likely	High	
PPM-2	Accelerated Design Schedule	$0	$0	$0	*Removed From Cost Risk Study as this is captured in Technical Risks*

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% less than project costs

High Assumes 20% greater than Project Costs

Most Likely	
$947,302,800	Project Cost Total from TPCS
$947,302,800	

MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Cost Risk Analysis Model

Risk Refer No.	Risk Event	Low	Most Likely	High	
PPM-3	Accelerated Construction Schedule	$0	$0	$0	*Removed From Cost Risk Study as this is captured in Technical Risks*

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that acceleration changes decrease construction cost by 5%

High Assumes that acceleration changes add costs of 15% to the construction cost.

Most Likely	
$84,956,200	02 Relocations
$11,565,900	06 Fish & Wildlife Facilities - Mitigation
$127,294,300	08 Roads & Railroads
$469,768,400	09 Channels & Canals
$19,605,100	11 Levees, Floodwall & Floodproofing
$19,203,600	14 Recreation Facilities
$732,393,500	

Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-8	Scope Changes	($47,415,140)	$0	$94,830,280

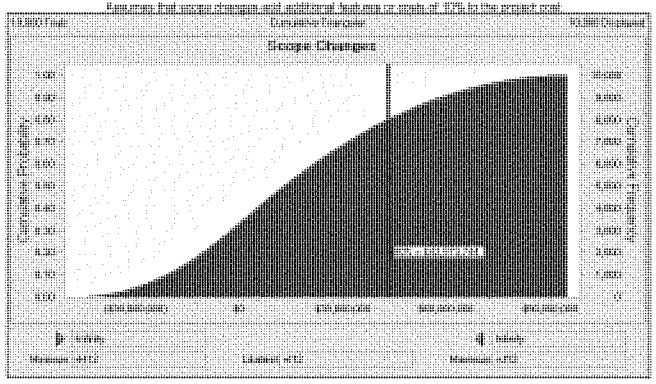
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that scope changes decrease the project cost by 5%

High Assumes that scope changes add additional back-end or scope of 10% to the project cost.

Most Likely
$948,302,800 Project Cost Total from TPCS
$948,302,800



Assumption: Scope Changes

Percentile	Assumption values
0%	($46,596,748)
10%	($20,767,930)
20%	($10,611,839)
30%	($2,399,324)
40%	$4,996,346
50%	$12,695,296
60%	$21,726,585
70%	$31,615,485
80%	$42,873,744
90%	$58,294,031
100%	$94,134,828

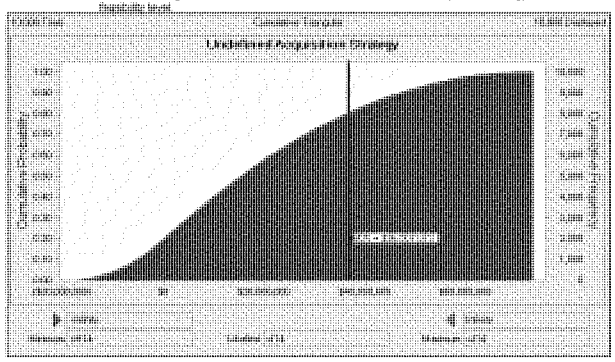
Risk Refer No.	Risk Event	Low	Most Likely	High
CA-1	Undefined Acquisition Strategy	($18,309,838)	$0	$73,239,350

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 2.5% **less** of construction costs because of favorable acquisitions implementation.

High Assumes 10% **greater** construction costs because of the undefined acquisition strategy at the



Assumption: Undefined Acquisition Strategy

Percentile	Assumption values
0%	($17,917,576)
10%	($5,223,520)
20%	$183,563
30%	$4,901,045
40%	$9,905,955
50%	$15,376,541
60%	$21,235,419
70%	$28,074,984
80%	$36,507,073
90%	$47,036,044
100%	$72,544,235

Most Likely	
$84,956,200	02 Relocations
$11,565,900	06 Fish & Wildlife Facilities - Mitigation
$127,294,300	08 Roads & Railroads
$469,768,400	09 Channels & Canals
$19,605,100	11 Levees, Floodwall & Floodproofing
$19,203,600	14 Recreation Facilities
$732,393,500	

Risk Refer No.	Risk Event	Low	Most Likely	High
CA-3	Numerous Separate Contracts	$0	$0	$8,056,350

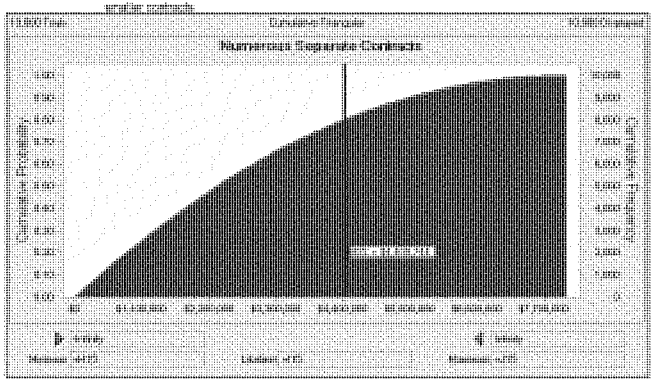
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 0% less PED and CM costs if contracting issues do not cause delays

High Assumes 5% greater PED and CM costs if contracting issues cause delays by using several smaller contracts

Most Likely
$109,859,000 PED (from TPCS)
$51,268,000 CM (from TPCS)
$161,127,000 Total



Assumption: Numerous Separate Contracts

Percentile	Assumption values
0%	$219
10%	$426,743
20%	$844,140
30%	$1,311,085
40%	$1,811,230
50%	$2,333,909
60%	$2,933,633
70%	$3,609,861
80%	$4,409,744
90%	$5,463,622
100%	$8,010,934

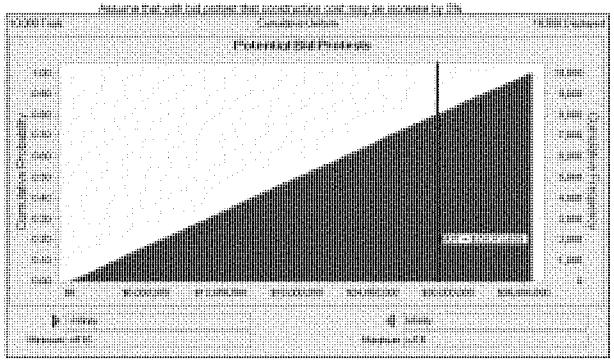
Risk Refer No.	Risk Event	Low	Most Likely	High
CA-4	Potential Bid Protests	$0	$0	$36,619,675

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that without bid protests that costs would not decrease.

High



Assumption: Potential Bid Protests

Percentile	Assumption values
0%	$9,495
10%	$3,600,326
20%	$7,202,785
30%	$10,881,978
40%	$14,379,011
50%	$18,120,955
60%	$21,806,092
70%	$25,289,267
80%	$29,073,609
90%	$32,824,938
100%	$36,616,689

Most Likely	
$84,956,200	02 Relocations
$11,565,900	06 Fish & Wildlife Facilities - Mitigation
$127,294,300	08 Roads & Railroads
$469,768,400	09 Channels & Canals
$19,605,100	11 Levees, Floodwall & Floodproofing
$19,203,600	14 Recreation Facilities
$732,393,500	

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-1	Uncertainty with Geotechnical Conditions	($713,980)	$0	$356,990

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

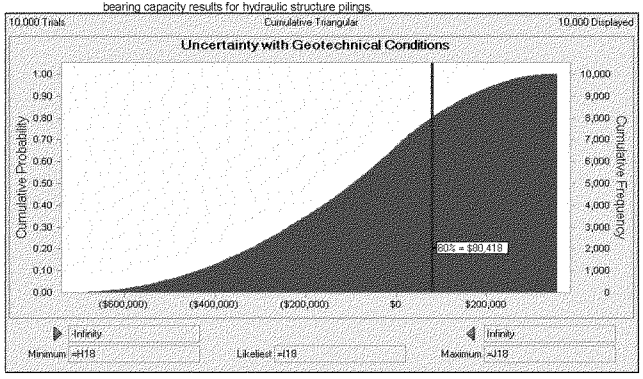
Likely Likely assumes no change from the baseline estimate.

Low Assumes 20% **less** costs for the piling for the hydraulic structures due to changes in the bearing capacity results for hydraulic structure pilings.

High Assumes 10% **greater** costs for the piling for the hydraulic structures due to changes in the bearing capacity results for hydraulic structure pilings.

Most Likely

$945,400 RRN Inlet Piling for Gated structure
$2,624,500 RRN Inlet Piling for Walls
$3,569,900 **Total**



Assumption: **Uncertainty with Geotechnical Conditions**

Percentile	Assumption values
0%	($706,640)
10%	($436,456)
20%	($323,535)
30%	($237,124)
40%	($160,652)
50%	($91,739)
60%	($35,319)
70%	$17,687
80%	$80,418
90%	$165,012
100%	$345,518

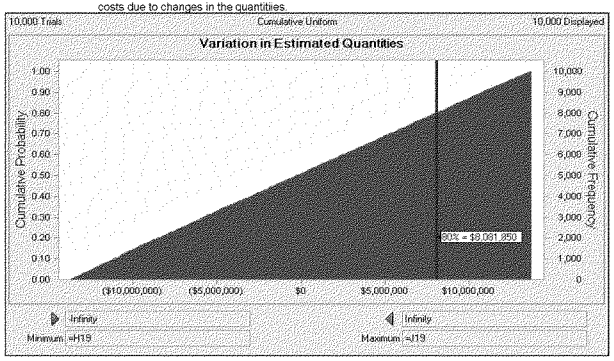
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-4	Variation in Estimated Quantities	($13,720,690)	$0	$13,720,690

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% **less** costs for diversion channel excavation for Reaches 1-6 + tie-back levee cost due to changes in the quantities.

High Assumes 5% **greater** costs for diversion channel excavation for Reaches 1-6 + tie-back levee costs due to changes in the quantities.



Assumption: Variation in Estimated Quantities

Percentile	Assumption values
0%	($13,720,600)
10%	($11,073,667)
20%	($8,451,304)
30%	($5,784,724)
40%	($2,968,908)
50%	($192,207)
60%	$2,505,639
70%	$5,273,557
80%	$8,081,850
90%	$10,868,260
100%	$13,718,930

Most Likely

$3,881,200 Reach 1 Excavation
$16,421,100 Reach 2 Excavation
$66,475,800 Reach 3 Excavation
$51,440,600 Reach 4 Excavation
$26,812,200 Reach 5 Excavation
$89,413,500 Reach 6 Excavation

$10,095,000 (9020109) RRN Control Structure Excavation
$9,874,400 (110103) Tie-back Levee Excavation

$274,413,800

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-6	Relocations - Utilitites	($261,280)	$0	$1,567,680

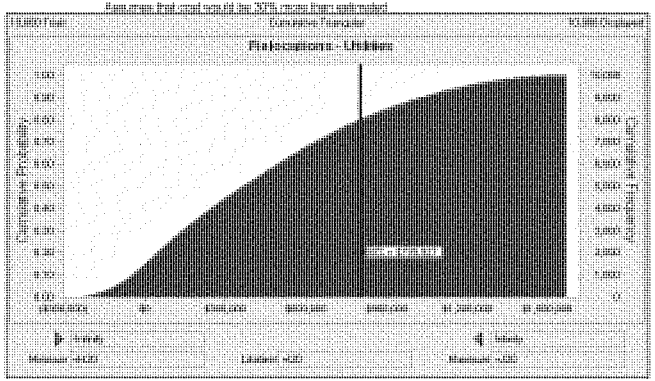
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated

High

Most Likely
$5,225,600 Utilities Cost
$5,225,600



Assumption: Relocations - Utilitites

Percentile	Assumption values
0%	($257,393)
10%	($43,361)
20%	$48,715
30%	$142,067
40%	$248,462
50%	$367,812
60%	$497,533
70%	$633,641
80%	$799,927
90%	$1,027,721
100%	$1,554,957

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-7	Relocations - Bridges	($3,966,930)	$0	$7,973,060

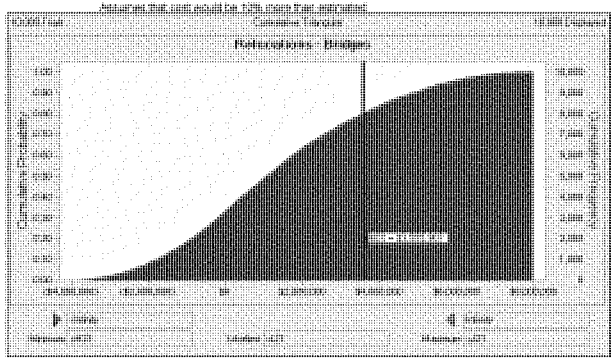
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated

High

Most Likely
$79,730,600 Cost of Relocations for bridges & highways
$79,730,600



Assumption: Relocations - Bridges

Percentile	Assumption values
0%	($3,935,003)
10%	($1,769,063)
20%	($871,584)
30%	($185,590)
40%	$416,836
50%	$1,073,155
60%	$1,749,662
70%	$2,567,311
80%	$3,555,907
90%	$4,880,091
100%	$7,883,256

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-8	Mitigation	($578,206)	$0	$2,891,475

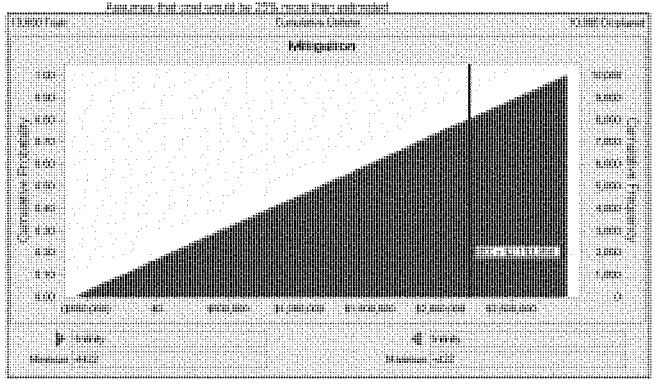
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated

High Assumes that cost would be 10% more than estimated

Most Likely
$11,565,900 06 01 Environmental Mitigation Costs
$11,565,900



Assumption: Mitigation

Percentile	Assumption values
0%	($578,206)
10%	($244,219)
20%	$99,081
30%	$445,640
40%	$799,861
50%	$1,155,587
60%	$1,504,941
70%	$1,842,125
80%	$2,193,958
90%	$2,543,857
100%	$2,891,446

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-9	Diversions Excavations & Productivity	($19,291,395)	$0	$57,874,185

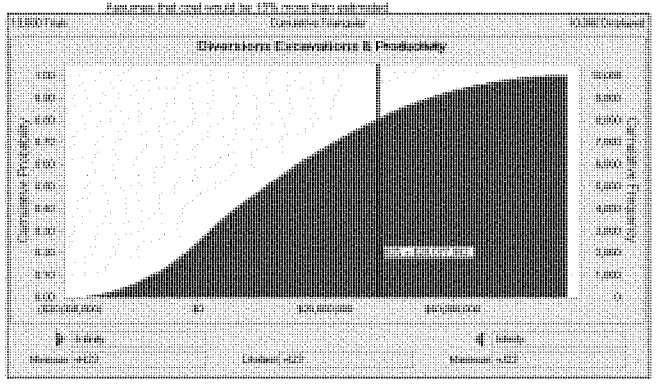
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated

High

Most Likely
$365,827,900 Diversion Channel Costs
$365,827,900



Assumption: Diversions Excavations & Productivity

Percentile	Assumption values
0%	($19,154,175)
10%	($7,321,816)
20%	($2,003,774)
30%	$1,807,757
40%	$5,815,510
50%	$10,543,327
60%	$15,564,941
70%	$21,345,168
80%	$28,077,992
90%	$36,402,644
100%	$57,408,565

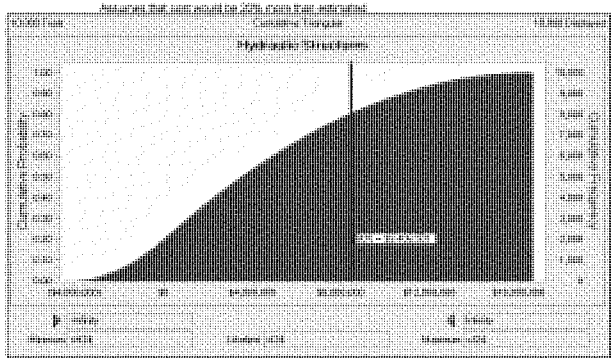
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-10	Hydraulic Structures	($4,155,625)	$0	$16,622,500

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated

High



Assumption: Hydraulic Structures

Percentile	Assumption values
0%	($4,107,727)
10%	($1,215,979)
20%	$22,197
30%	$1,093,499
40%	$2,291,158
50%	$3,549,919
60%	$5,001,206
70%	$6,534,324
80%	$8,406,501
90%	$10,870,661
100%	$16,554,678

Most Likely

$64,174,100 Hydraulic Structure - RRN Inlet
$781,200 Hydraulic Structure - Small Drains
$3,170,300 Hydraulic Structure - Side Channel Inlets
$9,060,700 Hydraulic Structure - Twin Side Channel Inlets
$1,613,900 Hydraulic Structure - RRN Outlet
$4,312,300 Hydraulic Structure - Diversion Channel Drop Structure

$83,112,500

Risk Refer No	Risk Event	Low	Most Likely	High
TL-11	Levees	($705,710)	$0	$3,528,550

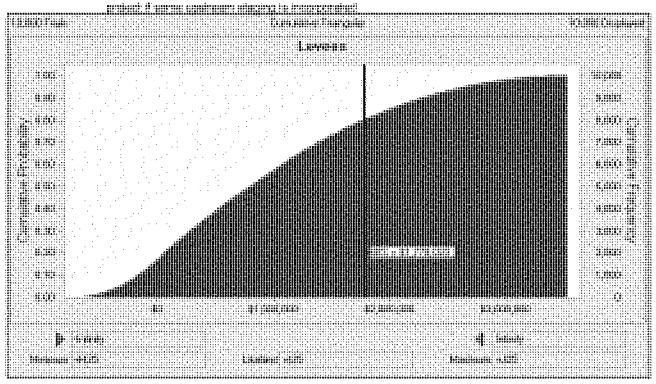
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated due to levee design becoming lower

High Assumes that cost would be 25% more than estimated due to additional levees required for the

Most Likely
$14,114,200 Tie-back Levees
$14,114,200



Assumption: **Levees**

Percentile	Assumption values
0%	($555,071)
10%	($168,675)
20%	$59,663
30%	$282,950
40%	$528,680
50%	$801,090
60%	$1,076,012
70%	$1,390,490
80%	$1,778,020
90%	$2,279,988
100%	$3,508,802

Risk Refer No	Risk Event	Low	Most Likely	High
TL-12	Non-structural	($549,090)	$0	$2,745,450

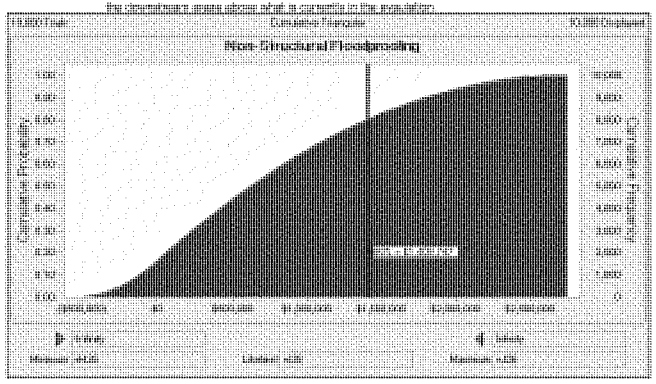
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 10% less than estimated

High Assumes that cost would be 50% more than estimate due to additional measures being taken for the construction areas above what is currently in the evaluation

Most Likely
$5,490,900 Non-structural floodproofing
$5,490,900



Assumption: Non-structural

Percentile	Assumption values
0%	($534,213)
10%	($121,777)
20%	$58,577
30%	$231,658
40%	$427,484
50%	$626,699
60%	$848,353
70%	$1,096,887
80%	$1,408,747
90%	$1,797,571
100%	$2,706,609

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-13	Recreation	($968,470)	$0	$4,992,350

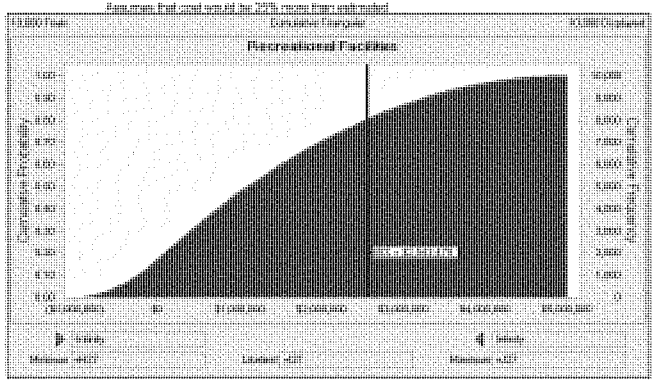
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated

High

Most Likely
$19,969,400 Recreational Facilities
$19,969,400



Assumption: **Recreation**

Percentile	Assumption values
0%	($999,468)
10%	($233,736)
20%	$90,763
30%	$407,533
40%	$737,173
50%	$1,103,586
60%	$1,508,846
70%	$1,974,999
80%	$2,543,479
90%	$3,264,514
100%	$4,970,701

Risk Refer No	Risk Event	Low	Most Likely	High
TL-14	Fuel Cost Concerns	($8,110,020)	$0	$8,110,020

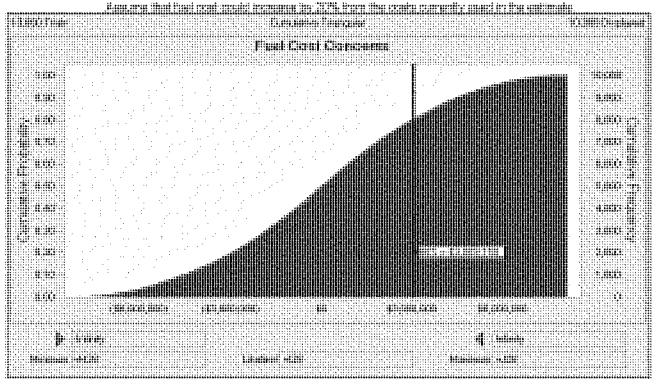
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that fuel cost could decrease by 20% from what is currently used in the estimate

High

Most Likely
$40,550,100 Fuel Costs



$40,550,100

Assumption: Fuel Cost Concerns

Percentile	Assumption values
0%	($7,965,304)
10%	($4,548,344)
20%	($2,925,038)
30%	($1,627,794)
40%	($822,407)
50%	$18,552
60%	$898,617
70%	$1,856,014
80%	$3,009,150
90%	$4,470,053
100%	$8,027,985

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-1	Concerns with the Rail yard	($6,364,720)	$0	$44,553,040

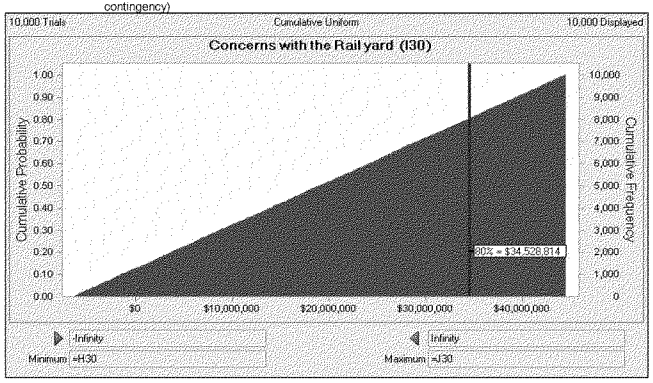
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% less cost than baseline cost of the RR bridges

High Assumes 35% greater cost than baseline cost of the RR bridges (based on RR estimate contingency)

Most Likely
$127,294,400 06 RR Bridge Cost
$127,294,400 Total



Assumption: Concerns with the Rail yard

Percentile	Assumption values
0%	($6,364,680)
10%	($1,435,555)
20%	$3,707,353
30%	$8,798,378
40%	$14,069,122
50%	$19,067,645
60%	$24,330,473
70%	$29,208,387
80%	$34,528,814
90%	$39,481,059
100%	$44,549,706

Risk Refer No	Risk Event	Low	Most Likely	High
LD-2	Mitigation Needs Identified for Downstream Impacts	$0	$0	$50,000,000

Notes:

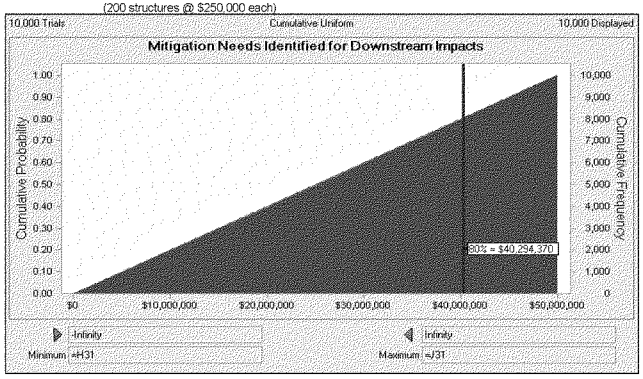
This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Baseline has no cost currently so cost would not decrease from zero

High Baseline has no cost currently so impacts to downstream interest could add to projects cost (200 structures @ $250,000 each)

Most Likely
$50,000,000 Potential DS impacts
$50,000,000 Total



Assumption: Mitigation Needs Identified for Downstream Impacts

Percentile	Assumption values
0%	$5,918
10%	$5,185,248
20%	$10,280,750
30%	$15,334,095
40%	$20,438,075
50%	$25,582,239
60%	$30,422,004
70%	$35,307,738
80%	$40,294,370
90%	$45,190,476
100%	$49,994,696

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-3	Potential Savings for Eliminating RR Bridge 1 (P-line) if BSNF abandones line	($18,765,552)	$0	$0

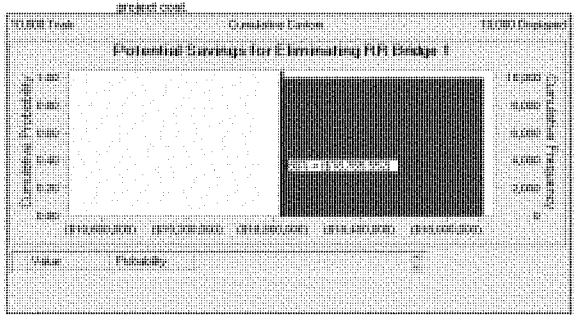
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low If RR abondones P-Line route this bridge would not be required. Saves cost of bridge + 15% PED and 7% CM

High Cost for bridge already included in baseline and eliminating bridge would not add to

Most Likely	
$15,381,600	RR Bridge 1 - BNSF P-Line
$2,307,240	RR Bridge 1 - PED
$1,076,712	RR Bridge 1 - CM
$18,765,552	Total



Assumption: Potential Savings for Eliminating RR Bridge 1 (P-line) if BSNF abandones line

Percentile	Assumption values
0%	($18,765,552)
10%	($18,765,552)
20%	($18,765,552)
30%	($18,765,552)
40%	($18,765,552)
50%	($18,765,552)
60%	($18,765,552)
70%	($18,765,552)
80%	($18,765,552)
90%	($18,765,552)
100%	($18,765,552)

Risk Refer No	Risk Event	Low	Most Likely	High
LD-4	Appraisal	($2,739,115)	$0	$16,434,690

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

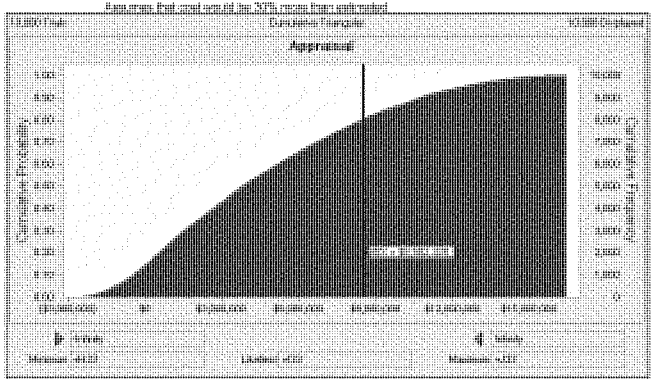
Low Assumes that cost would be 5% less than estimated

High

Most Likely

$54,782,300 Real estate appraisal

$54,782,300



Assumption: **Appraisal**

Percentile	Assumption values
0%	($2,709,361)
10%	($443,814)
20%	$561,718
30%	$1,552,332
40%	$2,679,803
50%	$3,808,121
60%	$5,222,674
70%	$6,713,749
80%	$8,502,328
90%	$10,758,807
100%	$16,282,863

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-5	Non-Appraisal	($2,739,115)	$0	$5,478,230

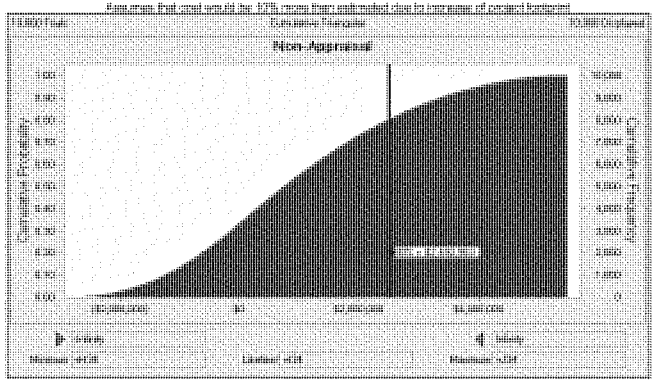
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated due to project footprint being less than currently estimated

High

Most Likely
$54,782,300 Lands & Damages
$54,782,300



Assumption: Non-Appraisal

Percentile	Assumption values
0%	($2,857,594)
10%	($1,235,453)
20%	($633,055)
30%	($130,936)
40%	$298,006
50%	$757,334
60%	$1,270,533
70%	$1,820,649
80%	$2,492,963
90%	$3,373,360
100%	$5,445,327

Risk Refer No.	Risk Event	Low	Most Likely	High	
RE-1	Environmental Mitigation Feature Concerns	$0	$0	$0	*Removed From Cost Risk Study as this is captured by TL-8*

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assume 20% less costs from baseline

High Assumes 30% greater cost than baseline

Most Likely	
$11,565,900	06 01 Environmental Mitigation Costs
$11,565,900	Total

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Risk Refer No.	Risk Event	Low	Most Likely	High
RE-2	Historical Cultural Resource Issues	($500,000)	$0	$1,000,000

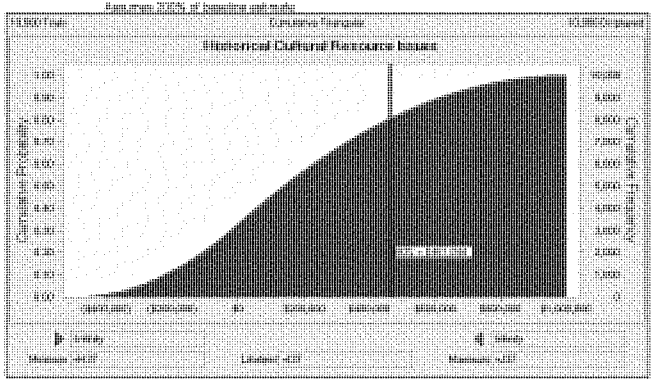
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 50% of baseline estimate

High

Most Likely
$1,000,000 Assume for baseline
$1,000,000



Assumption: Historical Cultural Resource Issues

Percentile	Assumption values
0%	($497,694)
10%	($226,017)
20%	($110,329)
30%	($22,520)
40%	$54,000
50%	$138,842
60%	$234,363
70%	$335,528
80%	$461,044
90%	$619,834
100%	$984,385

Risk Refer No.	Risk Event	Low	Most Likely	High
CON-2	Control and Diversion of Water	($4,502,900)	$0	$4,502,900

Notes:

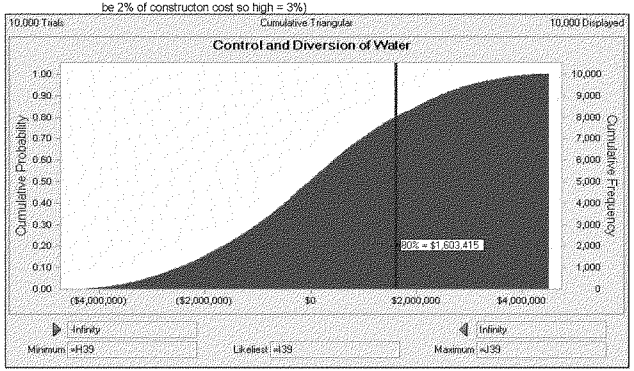
This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 50% less costs of baseline for dewatering items

High Assumes 50% greater costs of baseline for dewatering items. (Baseline is estimated to be 2% of construcion cost so high = 3%)

Most Likely	
$500,700	Reach 1 Dewatering & Control of Water
$609,100	Reach 2 Dewatering & Control of Water
$1,941,200	Reach 3 Dewatering & Control of Water
$1,429,700	Reach 4 Dewatering & Control of Water
$769,600	Reach 5 Dewatering & Control of Water
$2,423,800	Reach 6 Dewatering & Control of Water
$1,331,700	9020110 RRN Inlet Control Structure Dewatering
$9,005,800	



Assumption: Control and Diversion of Water

Percentile	Assumption values
0%	($4,453,043)
10%	($2,474,501)
20%	($1,648,980)
30%	($1,002,567)
40%	($468,829)
50%	($12,678)
60%	$448,583
70%	$980,162
80%	$1,603,415
90%	$2,453,108
100%	$4,453,183

Risk Refer No	Risk Event	Low	Most Likely	High
CON-5	Project Sequencing	(56,767,933)	$0	$33,839,665

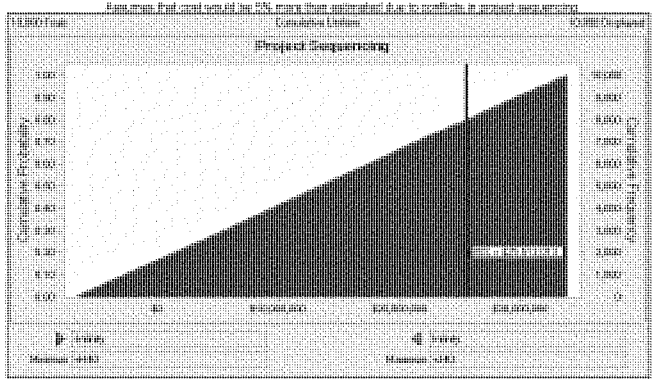
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 1% less than estimated due to sequencing actually saving money

High Assumes that cost would be 5% more than estimated due to conflicts in project sequencing

Most Likely
$79,730,600 Roads & Bridges
$127,294,300 Railroad Bridges
$469,768,400 Channels & Canals
$676,793,300



Assumption: Project Sequencing

Percentile	Assumption values
0%	($6,763,280)
10%	($2,765,490)
20%	$1,338,005
30%	$5,469,569
40%	$9,450,896
50%	$13,395,047
60%	$17,405,158
70%	$21,316,384
80%	$25,513,013
90%	$29,582,606
100%	$33,839,103

Risk Refer No.	Risk Event	Low	Most Likely	High
CON-6	Contract Mods	($36,358,395)	$0	$72,716,790

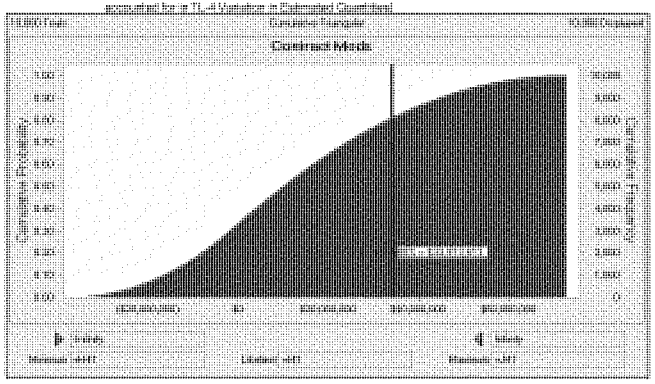
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated due to contract mods that save money (i.e., by contractor VE proposals)

High Assumes that cost would be 10% more than estimated due to contract mods (5% already

Most Likely	
$79,730,600	Roads & Bridges
$11,565,900	Environmental mitigation
$127,294,300	Railroad Bridges
$469,768,400	Channels & Canals
$19,605,100	Levees & Floodproofing
$19,203,600	Recreation Features
$727,167,900	



Assumption: Contract Mods

Percentile	Assumption values
0%	($35,835,021)
10%	($16,396,074)
20%	($8,065,684)
30%	($1,807,315)
40%	$3,824,018
50%	$10,321,344
60%	$16,799,321
70%	$24,287,532
80%	$33,913,613
90%	$45,216,783
100%	$71,714,760

Risk Refer No	Risk Event	Low	Most Likely	High
EST-1	Potential Fluctuation in Labor Costs	($16,384,590)	$0	$32,769,180

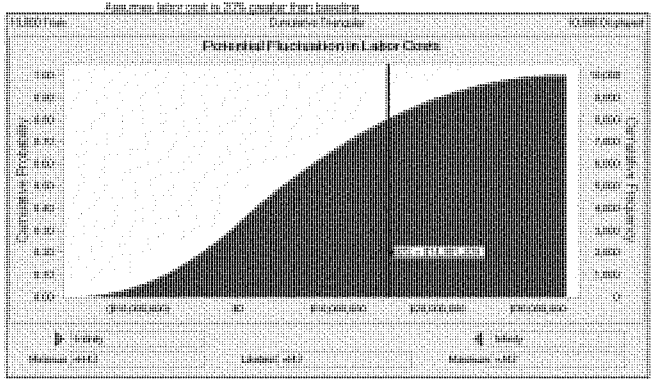
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes labor cost is 10% less

High

Most Likely
$163,845,900 Labor Costs from MII
$163,845,900 Total



Assumption: Potential Fluctuation in Labor Costs

Percentile	Assumption values
0%	($16,101,197)
10%	($7,218,021)
20%	($3,588,150)
30%	($899,109)
40%	$1,699,362
50%	$4,437,111
60%	$7,553,137
70%	$10,966,864
80%	$14,901,209
90%	$20,152,845
100%	$32,429,939

Risk Refer No.	Risk Event	Low	Most Likely	High
EST-2	WBS Elements - Estimate confidence	$0	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 10% less than estimated for L&D and Mitigation

High Assumes that cost would be 30% more than estimated for L&D and Mitigation. These are the two WBS elements with the least confidence or lack of design.

Most Likely	
$54,782,300	Lands & Damages
$11,565,900	Environmental Mitigation
$66,348,200	

Risk Refer No.	Risk Event	Low	Most Likely	High
EST-4	PED & CM	($43,504,290)	$0	$0

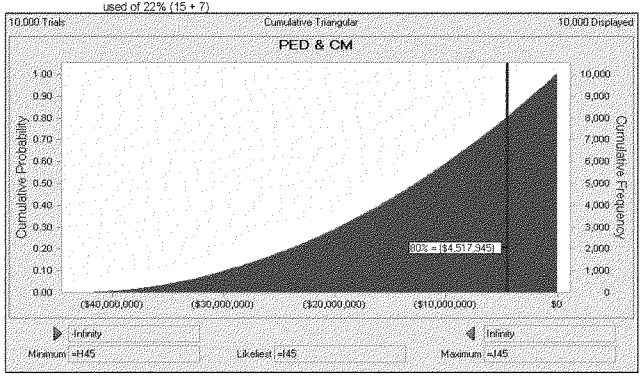
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that PED & CM cost would be a total of 16% of the project cost rather than the currently used 22% (15 + 7). The 16% is based on the $410M Grand Forks/East Grand Forks Flood control project which was more urban levees & floodwalls. (16/22 = 0.727)

High Assumes that PED & CM cost would be the percent of the currently estimated construction cost used of 22% (15 + 7)

Most Likely
$109,859,000 PED
$51,268,000 CM
$161,127,000



Assumption: **PED & CM**

Percentile	Assumption values
0%	($42,751,215)
10%	($29,846,868)
20%	($23,977,806)
30%	($19,481,652)
40%	($15,633,372)
50%	($12,552,343)
60%	($9,730,793)
70%	($7,003,396)
80%	($4,517,945)
90%	($2,261,569)
100%	($1,510)

MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Cost Risk Analysis Model

Risk Refer No	Risk Event	Low	Most Likely	High	*Removed From Cost Risk Study as this is captured by the Schedule Risk Analysis*
PR-1	Uncertainty with Funding Streamn	$0	$0	$0	

		Most Likely	
Notes:	This item captures the risk that will cause a variance from the current working estimate for the project.		
Likely	Likely assumes no change from the baseline estimate.	$948,302,800	Project cost
Low	Assumes 5% less of construction cost if funding is excelerated from projections		
High	Assumes 20% greater cost of construction if funding is delayed from projections		
		$948,302,800	

Risk Refer No.	Risk Event	Low	Most Likely	High
PR-7	Lawsuit Risk from NGOs and Downstream Interests	$0	$0	$47,415,140

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

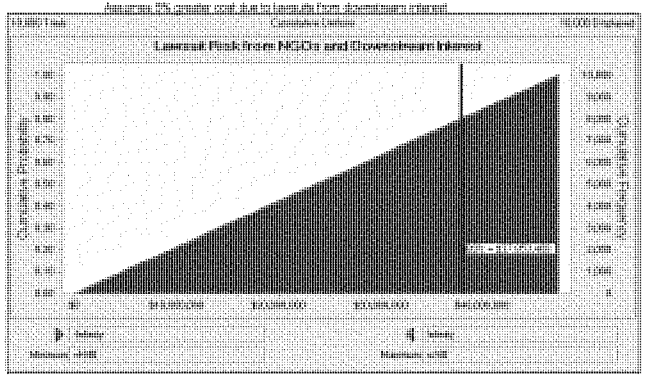
Likely Likely assumes no change from the baseline estimate.

Low Assumes cost to remain at baseline if there are no lawsuits from downstream interest

High

Most Likely
$948,302,800 Project Costs

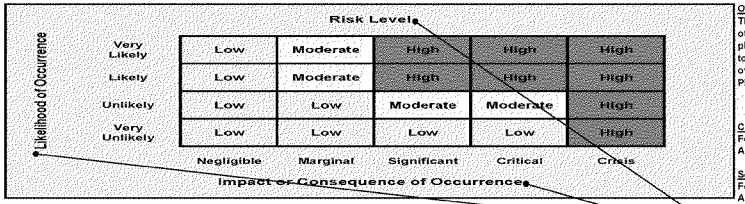
$948,302,800



Assumption: Lawsuit Risk from NGOs and Downstream Interests

Percentile	Assumption values
0%	$1,552
10%	$4,641,110
20%	$9,488,293
30%	$14,070,823
40%	$18,876,479
50%	$23,625,145
60%	$28,565,189
70%	$33,091,429
80%	$37,853,408
90%	$42,713,613
100%	$47,403,774

MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - PDT Risk Register (Draft)



Overall Project Scope
The Fargo-Moorhead Feasibility Study purpose is to identify measures and develop a regional system to reduce flood risk along the Red River of the North for the entire F-M metroplitan area. The study PDT collected, evaluated and screened an array of possible flood risk management plans to define the costs, benefits and impacts to the project area. The plans resulted in a diversion channel alternative as the best measures to reduce the flood risk. A diversion through Minnesota around the city of Moorhead offered the plan with the lowest cost having a B/C ratio over one. The local sponsors preferred a diversion alternative through North Dakota around the city of Fargo as a locally preferred plan. The PDT has developed plans and estimates for both the MN Plan and the LPP ND plan.

Cost Impacts
For the Fargo/Moorhead Project, any cost impact of $10 Million or higher should be considered at least "Significant."
Anything over $5 Million should be considered at least "Marginal."

Schedule Impacts
For the Fargo/Moorhead Project, any schedule impact of 12 months or greater should be considered at least "Significant."
Anything over 6 months should be considered at least "Marginal."

				Project Cost				Project Schedule							
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)															
	PROJECT & PROGRAM MGMT														
PPM-1	Project Schedule in Question	Due to the size and magnitude of the project, as well as the complexity of the structures and sequencing, there is inherent concern regarding the actual project schedule.	This could cause a variance in the project schedule (positive or negative, but most likely negative).	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Project Manager	Project Cost & Schedule
PPM-2	Accelerated Design Schedule	An accelerated schedule can result in inadequate studies, shortcuts in plans, change in contract acquisition strategy, failure to capture full scope, mis-steps, etc. There is the potential of moving forward with limited information.	An accelerated design schedule could impact the whole project design if there is not enough time to fully plan. This could impact both cost and schedule.	Likely	Significant	High		Likely	Significant	High		Triangular		District Management	Project Cost & Schedule
PPM-3	Accelerated Construction Schedule	The need for physical progress on the ground supports construction acceleration as much as practical. Acceleration comes in the form of concurrent construction activities, added overtime costs, perdiem costs, possible contractor conflicts, congested work areas, poorly developed contracts resulting in more modifications and claims.	Most of these subfeatures are already captured in the design and estimate, but the configuration may change.	Likely	Marginal	Moderate		Likely	Significant	High		Triangular		District Management	Project Cost & Schedule
PPM-4	Local Agency/Regulator Issues	The acceleration of the planning schedule has forced reviews and collaboration without much time given to local agencies and regulators. Although there has been communication between the Government and the local agencies, these agencies have not responded with definitive decisions. This could present potential impacts.	This could impact cost and schedule. There is however about two years before construction starts to resolve issues.	Unlikely	Negligible	Low		Unlikely	Marginal	Low		Yes-No		Project Manager	Project Cost & Schedule
PPM-7	Conflicting Priorities	The District's workload and competing priorities may impede progress on this project related to staff availability and experience, related to design, investigations, contract procurements, construction management.	Could cause a variance in the schedule.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Uniform		District Management	Project Schedule
PPM-8	Scope Changes	The many competing interests & priorities, coupled with an accelerated schedule could result in scope changes currently uncaptured or unanticipated. These scope changes would require additional coordination, cause further design and investigation and potentially impact the real estate acquisitions.	While minor alterations to the final alignment may occur, there should not be any major changes.	Likely	Marginal	Moderate		Likely	Significant	High		Yes-No		Project Manager	Project Cost & Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	CONTRACT ACQUISITION RISKS														
CA-1	Undefined Acquisition Strategy	The overall acquisition strategy for both design and construction has not been defined. Acquisition strategy could affect/impact bid competition and bid costs. It can also move risk onto the Government, causing need for greater contingencies. Clarification should be made related to number of contracts, contract types, etc. authority for this procurement.	Acquisition strategy needs to be defined and could impact the cost and schedule.	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		TASB	Contract Cost & Project Schedule
CA-2	Preference to Small Business	Most of the larger requirements are so large that they would not be suitable for small business. However, there is potential for some of the restoration, seeding, and mitigation may be suitable for small business. There is a requirement for review by the PARC if the requirements were less than $50 Million.	The project is so large, it is likely that even separable requirements would not be suitable for small business. Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost & Project Schedule
CA-3	Numerous Separate Contracts	There is potential to have numerous separate contracts, especially if the continuing contracts authority is not granted. Funding stream issues could also have an impact on the number of contracts.	The best case would be 6 contracts. The worst case would be in excess of 10 contracts. More contracts could increase bidding competition. This could have a significant effect on cost and schedule (either positive or negative).	Very Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost
CA-4	Potential Bid Protests	The larger size of the project increase contractor interests in bidding, but also increases potrtial risk for protets due to hungry economy and interest in obtaining project dollars.	This could impact cost and schedule.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Yes-No		District Management	Project Cost & Schedule
CA-5	Contracting Staff shortages	Contracting is experiencing a lack of staffing, causing challenges in obtaining resources on a timely basis for all procurements.	Could cause a variance in the schedule, though by the time procurements are needed for construction, staffing issues could be resolved	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Uniform		District Management	Project Schedule
	TECHNICAL RISKS														
TL-1	Uncertainty with Geotechnical Conditions	There is uncertainty with geotechnical conditions for excavation regarding characterization and wet material, specifically on how that will impact the construction productivity. The material is all clay and silt.	The current working estimate is fairly conservative. However, variation in the ultimate characterization of material could cause significant variance in productivity. Could impact cost and schedule (positive or negative).	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Geotechnical/Civil Design	Contract Cost & Project Schedule
TL-2	Survey Data Incomplete	The PDT currently has incomplete or outdated survey data (for bathymetry for the Red River and Tributaries).	If the survey data uncovers data that differs greatly from current conceptual design, it could lead to variance in cost (due to issues such as configuration and details for structures).	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
TL-3	Hazardous Waste/HTRW Concerns	Due to the project footprint involving BNSF's rail yard, there is the possibility that HTRW or hazardous substances may be encountered.	There is the potential for contaminated and or petroleum based contamination, as well as other deleterious substances. This would only impact schedule, as HTRW cleanup is not part of the project cost.	Very Unlikely	Negligible	Low		Likely	Significant	High		Yes-No		Geotechnical/Civil Design	Contract Cost & Project Schedule
TL-4	Variation in Estimated Quantities	There is potential for variation of estimated quantities in the excavation and earthwork features.	This could impact cost and schedule	Likely	Significant	High		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Contract Cost
TL-5	Flowrate Capacity	affect the amount of flow required for the diversion channel to handle. This would affect channel width, bridge lengths and major hydraulic structure sizes	This could impact cost	Unlikely	Marginal	Low		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Contract Cost & Project Schedule
TL-6	Relocations - Utilities	Quality of design at budget level	Most costs were obtained from affected utilities for the major lines that are impacted.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-7	Relocations - Bridges	Bridge costs will change depending on final diversion channel width	Bridge costs from historical DOT costs are fairly reliable.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-8	Mitigation	fish, wetlands, forest, adaptive management	Resource agencies have not agreed to any particular features yet so there is the potential for additional mitigation beyond what is proposed.	Very Likely	Significant	High		Likely	Negligible	Low		Uniform		Environmental Compliance	Contract Cost
TL-9	Diversions Excavations & Productivity	Excavations could be impacted by diversion alignment changes and/or model results	Impacts should only affect quantities of different soil layers	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Technical Lead	Contract Cost
TL-10	Hydraulic Structures	Hydraulic structures will need to be modeled.	Model results could change design concepts	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Technical Lead	Contract Cost & Project Schedule
TL-11	Levees	Levee heights and lengths could change depending on if upstream staging is incorporated	The FCP MN alternative is not likely to change to incorporate upstream staging	Unlikely	Significant	Moderate		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
TL-12	Non-Structural Floodproofing	Costs for downstream impacts could change when the effects of have been fully developed	This is dependent on the takings analysis which so far has indicated there is not a taking.	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost
TL-13	Recreational Facilities	Feasibility is at conceptual design	Final designs could look different than Feasibility but overall concepts should be similar	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Cost Engineering	Contract Cost

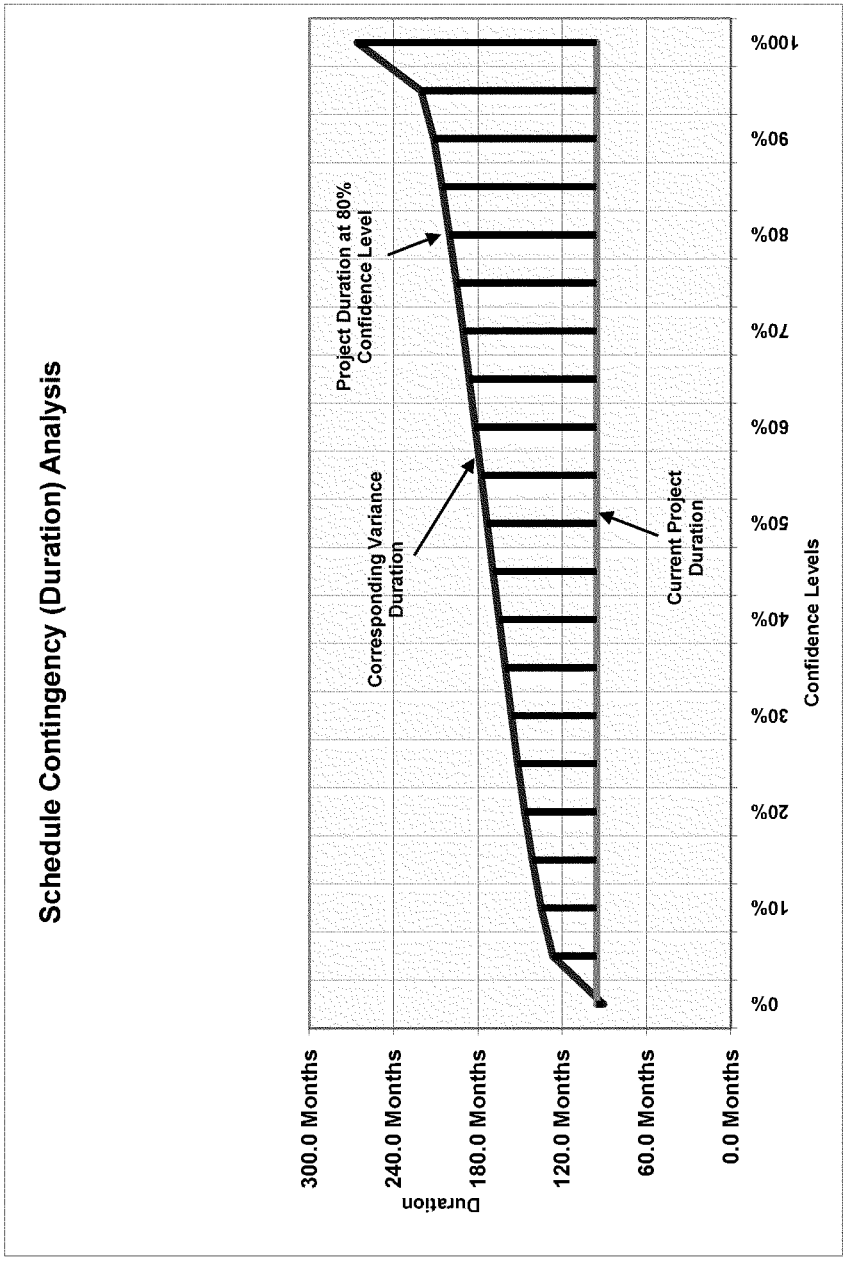
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	LANDS AND DAMAGES RISKS														
LD-1	Concerns with the Rail yard	The alignment currently goes through a BNSF rail yard. Due to the complication of working in an active rail yard, with the requirement of bridge construction/relocation/or reconfiguration could present significant challenges.	The real risk is obtaining agreement from the railroad on the exact configuration of the rail yard crossing. Could impact cost or schedule.	Unlikely	Crisis	High		Unlikely	Critical	Moderate		Yes-No		Project Manager	Project Cost & Schedule
LD-2	Mitigation Needs Identified for Downstream Impacts	The effects of the project on areas downstream may require mitigation footprint that has not been finalized. The impacts are not fully captured, and a determination has to be made as to whether a "taking" will be required.	The PDT feels that a "taking" is unlikely. This could significantly impact costs if there is a taking, and it could significantly impact schedule.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate		Yes-No		Real Estate	Project Cost & Schedule
LD-3	Potential Savings for Eliminating RR Bridge 1	Currently, the BNSF RR has limited use of this line and indicated that abandonement is possible	This could save the cost of bridge and track raise	Unlikely	Significant	Moderate		Very Unlikely	Negligible	Low		Yes-No		Project Manager	Project Cost & Schedule
LD-4	Appraisal	Appraisals carry certain assumptions based on technical information. If the technical information has the potential to change, the appraisals could be impacted.	Appraisals are using an average value	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
LD-5	Non-Appraisal	Real Estate office is responsible for establishing contingencies. There could be risks outside their domain that can still impact the costs.	Real Estate office will be using the CSRA contingencies	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
LD-6	Labor to Process RE	The estimated labor to manage and process the real estate needs may not be properly estimated.	Real Estate office has accounted for RE admin in the estimate	Unlikely	Marginal	Low		Very Unlikely	Negligible	Low		Triangular		Real Estate	Project Cost
	REGULATORY AND ENVIRONMENTAL RISKS														
RE-1	Environmental Mitigation Feature Concerns	The PDT is going to add a lump sum for separable environmental mitigation (to include construction and real estate). This has not been well defined or finalized.	This could impact the costs either positively or negatively. This item is more likely to vary on the low side.	Likely	Significant	Moderate		Very Unlikely	Negligible	Low		Triangular		Environmental Compliance	Project Cost
RE-2	Historical Cultural Resource Issues	There is potential to find cultural resources, particularly on the riverbanks. No cultural resource survey has been completed to date. Mitigation will probably be necessary.	Could impact cost	Very Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Environmental Compliance	Project Cost
RE-3	Fish Passage Issues	There will be fish passage requirement in the project, but the actual configuration has not been finalized/agreed upon by the local agencies.	Could impact cost, however fish passage has been designed into the hydraulic structures so only minor design refinements should be required.	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Project Cost
RE-4	Pressure to Compress Permitting Activities	The local agencies perceive that they are being pressured through the project permitting process.	PDT has programmed this into the schedule, and the agencies are not constricted more than normal review times.	Very Unlikely	Negligible	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule
RE-5	HTRW Issues	There is some potential for discovery of HTRW in the project alignment. Most of the alignment is through farmland.	Could impact cost and schedule. Since most of the project is through farmland there likely should not be any major issues.	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule
	CONSTRUCTION RISKS														
CON-1	Unknown Residential Utility Conflicts	There is potential for the need to abandon some small residential utilities.	This could impact cost and schedule, but it would be negligible.	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
CON-2	Control and Diversion of Water	Methodology of controlling water could be impacted by the sequencing and timing of relocation, the characterization of materials, or other unknown impacts.	Could impact cost and schedule. This is more likely to affect cost from using larger pumping equipment or for increased handling of water.	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost
CON-3	Conflicts between Contractors	There is potential for conflicts between multiple contractors working in the same footprint at the same time.	Could impact cost. However, careful planning of the construction scheduling and sequencing should be able to avoid any major conflicts.	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule
CON-4	Sufficient QA Staff	to manage numerous contracts, mods and claims	SDC is well aware of QA staffing issues and is planning accordingly.	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule
CON-5	Project Sequencing	conflicts between contractors and schedule impacts (one contractor waiting on another)	Conflicts may develop at reaches interface, building of bridges or hydraulic structures	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Construction	Contract Cost & Project Schedule
CON-6	Contract Mods	Contract mods and claims resulting from unforeseen site conditions, weather impacts, political and lawsuit impacts are a concern and can impact both cost and schedule.	Many of these concerns may be valid and impact the project	Likely	Significant	High		Likely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	ESTIMATE AND SCHEDULE RISKS														
EST-1	Potential Fluctuation in Labor Costs	There is concern that the labor force required for this work could be a challenge, requiring off-site labor, per diem and premium pay, as well as unique markups and multipliers for workers compensation and other factors.	Estimate currently has National Wage rates, which are higher than the local Davis-Bacon Wage Determination The Estimate also includes $75/day for per diem. There is potential for savings, as the labor wage rate for North Dakota is cheaper than Minnesota. This could impact costs either positively or negatively.	Likely	Significant	High		Very Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
EST-2	WBS Elements - Estimate confidence	Certain WBS elements are better developed in scope and estimate than other scope areas. Some WBS elements may be more or less conservative. Some elements have greater risk and resulting need for greater contingencies.	The major cost elements for the diversion excavation, hydraulic structures and bridges have been highly developed for feasibility since they make up the bulk of the cost items. Environmental mitigation features are less develop and more conceptual and likely will change. Real Estate may be another area of risk confidence.	Likely	Marginal	Moderate		Likely	Negligible	Low		Triangular		Cost Engineering	Project Cost & Schedule
EST-3	Estimate assumptions	The estimate assumptions may be flawed in certain cost areas related to scope, crews, productivity, material cost, markups, contingencies, etc. This could result in a flawed budget development.	The estimate has been in development for enough time that scope, crews, productivity, material costs and markups are fairly well developed. Contingencies are from the CSRA	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Cost Engineering	Project Cost & Schedule
EST-4	PED & CM	The estimate currently uses 15% PED and 7% CM of the construction cost.	With the high construction cost of this project and the amount of design required for excavation, these percentages may be too high, based on about 16% for the $410M Grand Forks/East Grand Forks Flood project which was more urban levees & floodwalls.	Likely	Significant	High		Likely	Negligible	Low		Triangular		Cost Engineering	Project Cost
	Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)														
PR-1	Uncertainty with Funding Stream	There is a window of opportunity during the next couple years of obtaining the necessary increments on a timely basis. However, historically this has been a challenge in obtaining the increments necessary to complete on schedule, and there have been challenges in obtaining them on a timely basis.	This could impact both cost and schedule.	Very Likely	Significant	High		Very Likely	Significant	High		Uniform		Project Manager	Project Cost & Schedule
PR-2	Unusually Wet Season	If a given construction season is unusually higher than an average year, it could have significant impact on the productivity of the work.	If this it occurs, it reduces productivity and could create substantial delays.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Binomial		N/A	Project Cost & Schedule
PR-3	Flooding Event	There is a chance of a flooding event during construction that could cause damage to constructed work features.	This could impact both cost and schedule. The RRN usually has several days before major flood stage is reached, thus contractor should have sufficient time to protect any work.	Very Unlikely	Negligible	Low		Very Unlikely	Negligible	Low		Binomial		N/A	Project Cost & Schedule
PR-4	Lawsuit Risk	The City of Dilworth has voiced objection over the route of the current project alignment, as they perceive too few benefits from the project.	PDT feels that this risk could be mitigated and managed. Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Significant	Moderate		Yes-No		Project Manager	Project Schedule
PR-5	Political factors change at state, local, or federal level	Political factors at the local or state levels may change, impacting project support. Senator Dorgan has retired. He was very influential and favorable to the project interests. Since the authorization was not obtained prior to his departure, there is concern that the project will not be authorized or funded on a timely basis.	There is more chance of local or state political opposition on the Minnesota plan because of impacts to Dilworth, MN and the downstream communities that may be impacted. Could impact cost and schedule.	Unlikely	Marginal	Low		Likely	Critical	High		Yes-No		Project Manager	Project Schedule
PR-7	Lawsuit Risk from NGOs and Downstream Interests	There may be perceived damages from downstream concerns - this may be more on the MN side	Could impact cost and schedule.	Likely	Marginal	Moderate		Very Likely	Significant	High		Uniform		Project Manager	Project Schedule

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the events effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High.** Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule [i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				



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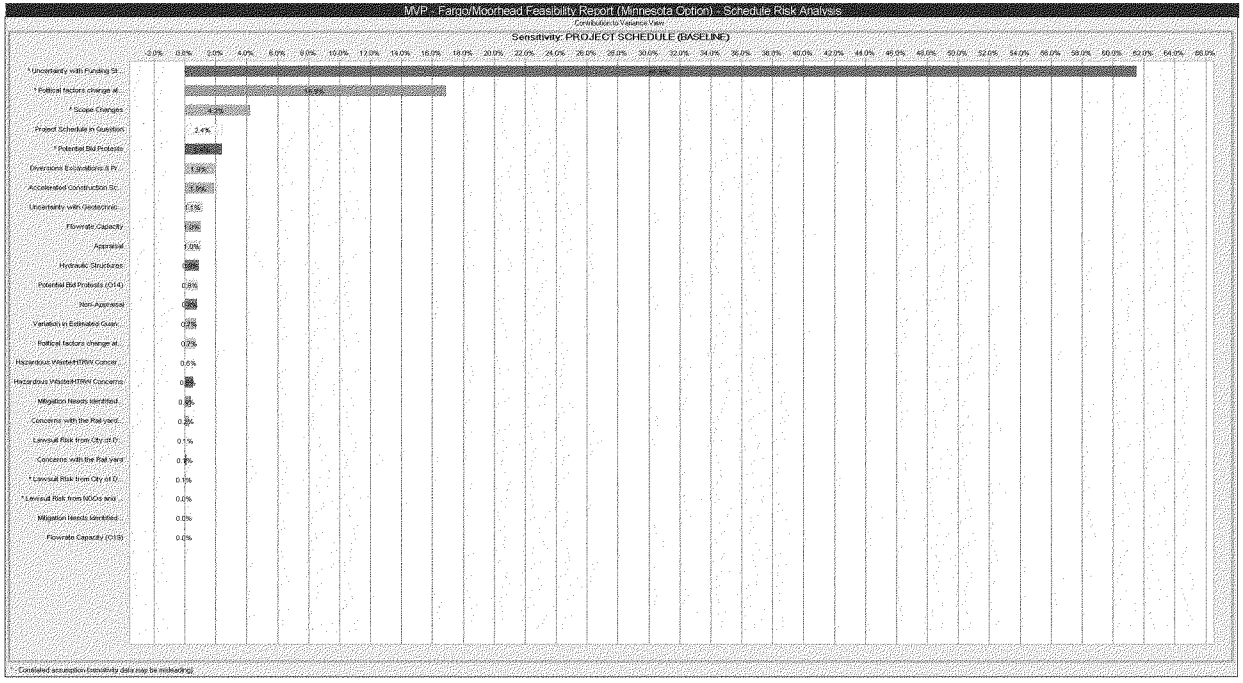
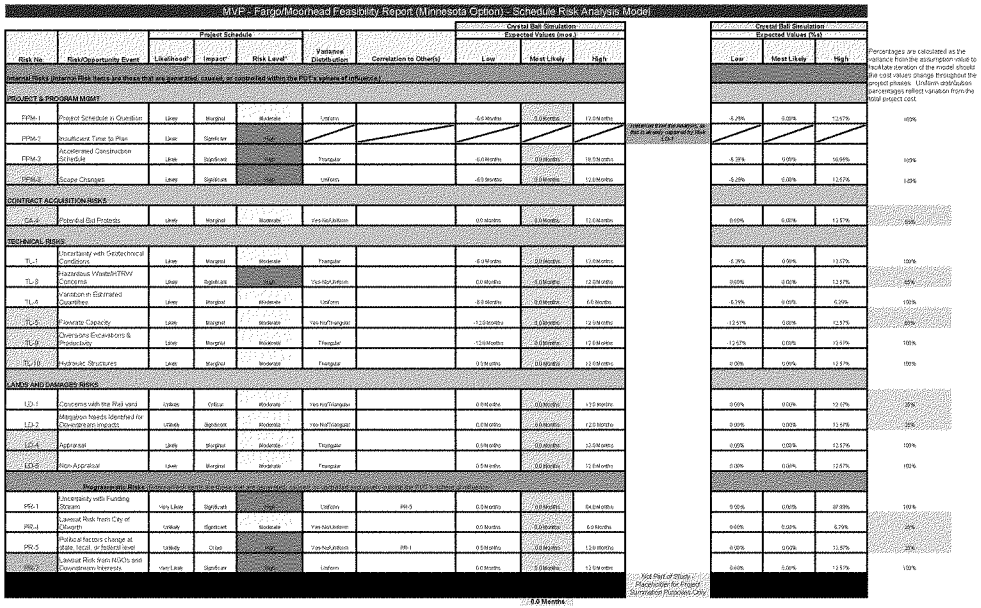

MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Schedule Risk Analysis
Contribution to Variance View
Sensitivity: PROJECT SCHEDULE (BASELINE)
* Uncertainty with Funding St...
* Political factors change at...
* Scope Changes
Project Schedule in Question
* Potential Bid Protests
Diversions Excavations & Pr...
Accelerated Construction Sc...
Uncertainty with Geotechnic...
Flowrate Capacity
Appraisal
Hydraulic Structures
Potential Bid Protests (O14)
Non-Appraisal
Variation in Estimated Quan...
Political factors change at...
Hazardous Waste/HTRW Concer...
Hazardous Waste/HTRW Concerns
Mitigation Needs Identified
Concerns with the Rail yard...
Lawsuit Risk from City of D...
Concerns with the Rail yard
* Lawsuit Risk from City of D...
* Lawsuit Risk from NGOs and...
Mitigation Needs Identified
Flowrate Capacity (O19)
* Correlated assumption (sensitivity data may be misleading)



MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Schedule Risk Analysis Model

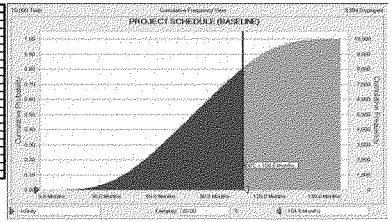
Risk No	Risk/Opportunity Event	Project Schedule: Likelihood[1]	Project Schedule: Impact[2]	Project Schedule: Risk Level[3]	Variance Distribution	Correlation to Other(s)	Crystal Ball Simulation: Expected Values (mos.): Low	Crystal Ball Simulation: Expected Values (mos.): Most Likely	Crystal Ball Simulation: Expected Values (mos.): High	Crystal Ball Simulation: Expected Values (%): Low	Crystal Ball Simulation: Expected Values (%): Most Likely	Crystal Ball Simulation: Expected Values (%): High
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)												
PROJECT & PROGRAM MGMT												
PPM-1	Project Schedule is Overdriven	Likely	Marginal	Moderate	Uniform		6.0 Months	0.0 Months	12.0 Months	-6.25%	0.00%	12.57%
PPM-2	Insufficient Time to Plan	Likely	Significant	High								
PPM-3	Accelerated Construction Schedule	Likely	Significant	High	Triangular		6.0 Months	0.0 Months	18.0 Months	-6.25%	0.00%	18.85%
PPM-4	Scope Changes	Likely	Significant	High	Uniform		-6.0 Months	0.0 Months	12.0 Months	-6.25%	0.00%	12.57%
CONTRACT ACQUISITION RISKS												
CA-1	Potential Bid Protests	Likely	Marginal	Moderate	Yes-NotUniform		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
TECHNICAL RISKS												
TL-1	Uncertainty with Geotechnical Conditions	Likely	Marginal	Moderate	Triangular		-6.0 Months	0.0 Months	12.0 Months	-6.25%	0.00%	12.57%
TL-3	Hazardous Waste/HTRW Concerns	Likely	Significant	High	Yes-NotUniform		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
TL-4	Variation in Estimated Quantities	Likely	Marginal	Moderate	Uniform		-6.0 Months	0.0 Months	6.0 Months	-6.25%	0.00%	6.29%
TL-5	Flowrate Capacity	Likely	Marginal	Moderate	Yes-NotTriangular		-12.0 Months	0.0 Months	12.0 Months	-12.57%	0.00%	12.57%
TL-9	Overseepage Excavations & Protection	Likely	Marginal	Moderate	Triangular		-12.0 Months	0.0 Months	12.0 Months	-12.57%	0.00%	12.57%
TL-10	Hydraulic Structures	Likely	Marginal	Moderate	Triangular		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
LANDS AND DAMAGES RISKS												
LD-1	Concerns with the Real Estate	Unlikely	Critical	Moderate	Yes-NotTriangular		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
LD-2	Mitigation Needs Identified for Diversion Impacts	Unlikely	Significant	Moderate	Yes-NotTriangular		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
LD-4	Appraisal	Likely	Marginal	Moderate	Triangular		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
LD-5	Non-Appraisal	Likely	Marginal	Moderate	Triangular		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
Programmatic Risks (Programmatic Risk Items are those that are generated, caused, or controlled outside the PDT's sphere of influence.)												
PR-1	Uncertainty with Funding Stream	Very Likely	Significant	High	Uniform	PR-3	6.0 Months	0.0 Months	84.0 Months	6.25%	0.00%	87.89%
PR-4	Lawsuit Risk from City of Dilworth	Unlikely	Significant	Moderate	Yes-NotUniform		0.0 Months	0.0 Months	6.0 Months	0.00%	0.00%	6.29%
PR-5	Political factors change at state, local, or federal level	Unlikely	Critical	High	Yes-NotUniform	PR-1	0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
PR-7	Lawsuit Risk from NGOs and Downstream Interests	Very Likely	Significant	High	Uniform		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	12.57%
							0.0 Months					

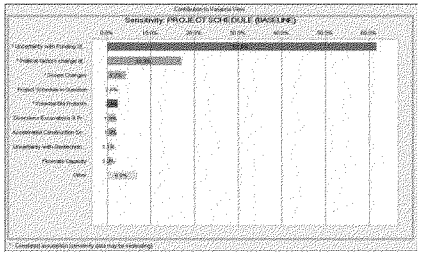
Uniform distribution, as that is already captured by Risk LD-1

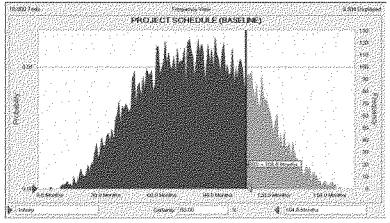
Not Part of Study - Placeholder for Project Formulation Process Only

Percentages are calculated as the variance from the assumption value to facilitate iteration of the model should the cost values change throughout the project phases. Uniform distribution percentages reflect variation from the total project cost.

PROJECT SCHEDULE (BASELINE)	Percentile	Baseline Schedule Duration	Contingency	Baseline w/ Contingency	Contingency %
	5%	83.5 Months	4.9 Months	90.7 Months	6.07%
	7%	83.5 Months	31.3 Months	126.7 Months	32.75%
	10%	83.5 Months	38.6 Months	135.6 Months	41.48%
	13%	83.5 Months	45.7 Months	141.2 Months	47.92%
	15%	83.5 Months	51.3 Months	148.8 Months	53.74%
	20%	83.5 Months	58.4 Months	151.9 Months	59.98%
	25%	83.5 Months	58.7 Months	156.1 Months	63.54%
	30%	83.5 Months	65.1 Months	160.6 Months	68.21%
	35%	83.5 Months	69.5 Months	165.0 Months	72.52%
	40%	83.5 Months	73.0 Months	169.3 Months	77.36%
	45%	83.5 Months	78.1 Months	173.5 Months	81.79%
	50%	83.5 Months	82.1 Months	177.6 Months	86.08%
	55%	83.5 Months	86.6 Months	183.0 Months	90.92%
	60%	83.5 Months	90.8 Months	186.3 Months	95.13%
	65%	83.5 Months	95.2 Months	190.8 Months	99.71%
	70%	83.5 Months	99.8 Months	195.4 Months	104.66%
	80%	83.5 Months	104.8 Months	200.3 Months	109.79%
	90%	83.5 Months	110.0 Months	206.6 Months	115.27%
	95%	83.5 Months	116.2 Months	211.8 Months	121.52%
	98%	83.5 Months	125.6 Months	220.5 Months	130.96%
	100%	83.5 Months	179.9 Months	268.6 Months	179.91%







MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Schedule Risk Analysis Model	
Estimated Total Project Cost (Price Level)	$948,530,215
Max. Anticipated Annual Amount	$119,301,192
Enter Current OMB Escalation Rate	1.80%
Enter Current Project Location Escalation Rate	1.88%
Enter Assumed Monthly Recurring Cost Rate	5.00%

Enter Current Project Year	23-Jan-20			
Enter Assumed Project Completion	11-Jan-35			
Project Completion at 10% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 15% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 20% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 25% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 30% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 35% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 40% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 45% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 50% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 55% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 60% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 65% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 70% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 75% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 80% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 85% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 90% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00
Project Completion at 95% Confidence	1-Oct-30	$1,000,000.00	$1,000,000.00	$1,000,000.00

Entry Required
Do Not Overwrite
Summary Data -- Do Not Overwrite

Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-1	Project Schedule in Question	-6.0 Months	0.0 Months	12.0 Months

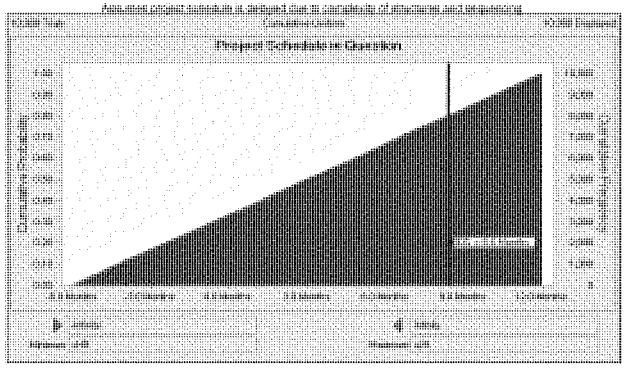
Assumes project completion is November 2019. From March 2011 this is = 105 months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes schedule concerns are conservative and actual project schedule can be exceeded

High



Assumption: Project Schedule in Question

Percentile	Assumption values
0%	-6.0 Months
10%	-4.3 Months
20%	-2.4 Months
30%	-0.6 Months
40%	1.2 Months
50%	2.9 Months
60%	4.8 Months
70%	6.5 Months
80%	8.4 Months
90%	10.2 Months
100%	12.0 Months

MVP - Fargo/Moorhead Feasibility Report (Minnesota Option) - Schedule Risk Analysis Model

Risk Refer No.	Risk Event	Low	Most Likely	High	
PPM-2	Accelerated Design Schedule				*Removed from the Analysis, as this is already captured by Risk LD-1*

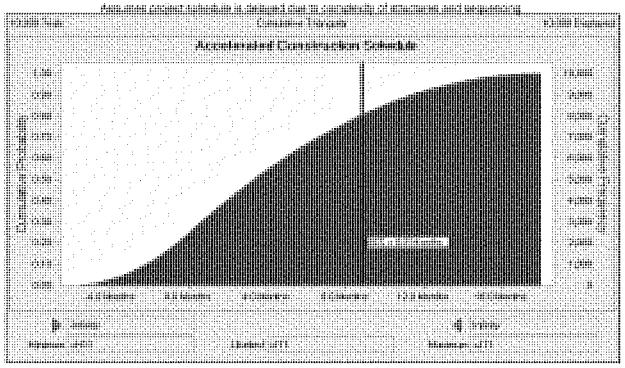
Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-3	Accelerated Construction Schedule	-6.0 Months	0.0 Months	18.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes schedule concerns are conservative and actual project schedule can be exceeded

High



Assumption: Accelerated Construction Schedule

Percentile	Assumption values
0%	-5.9 Months
10%	-2.1 Months
20%	-0.6 Months
30%	0.6 Months
40%	2.0 Months
50%	3.4 Months
60%	4.9 Months
70%	6.7 Months
80%	8.8 Months
90%	11.4 Months
100%	17.8 Months

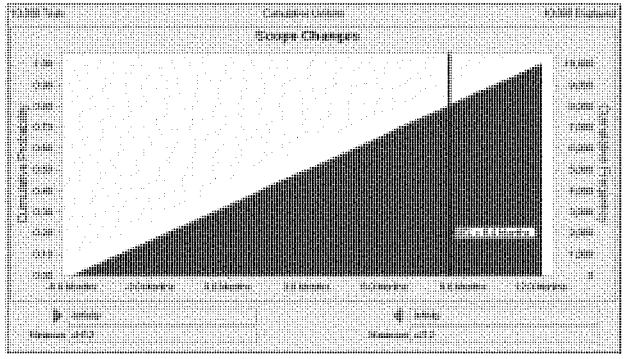
Risk Refer No	Risk Event	Low	Most Likely	High
PPM-8	Scope Changes	-6.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes scope changes decrease project features and schedule.

High Assumes scope changes increase project features, footprint and schedule.



Assumption: Scope Changes

Percentile	Assumption values
0%	-6.0 Months
10%	-4.2 Months
20%	-2.4 Months
30%	-0.5 Months
40%	1.2 Months
50%	3.0 Months
60%	4.9 Months
70%	6.6 Months
80%	8.4 Months
90%	10.2 Months
100%	12.0 Months

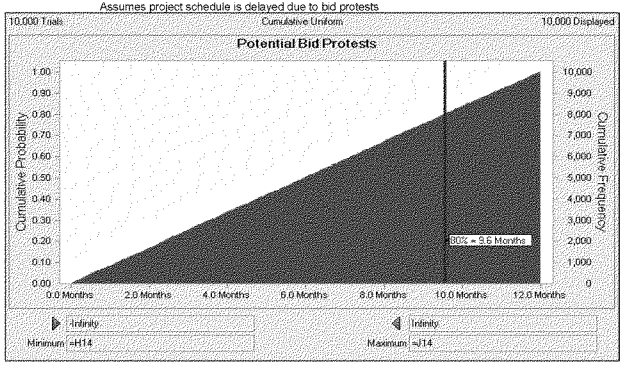
Risk Refer No	Risk Event	Low	Most Likely	High
CA-4	Potential Bid Protests	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project

Likely Likely assumes no change from the baseline schedule.

Low Assumes that there are not any bid protest so no changes from baseline schedule

High Assumes project schedule is delayed due to bid protests



Assumption: Potential Bid Protests

Percentile	Assumption values
0%	0.0 Months
10%	1.2 Months
20%	2.4 Months
30%	3.5 Months
40%	4.8 Months
50%	6.0 Months
60%	7.2 Months
70%	8.3 Months
80%	9.6 Months
90%	10.8 Months
100%	12.0 Months

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-1	Uncertainty with Geotechnical Conditions	-6.0 Months	0.0 Months	12.0 Months

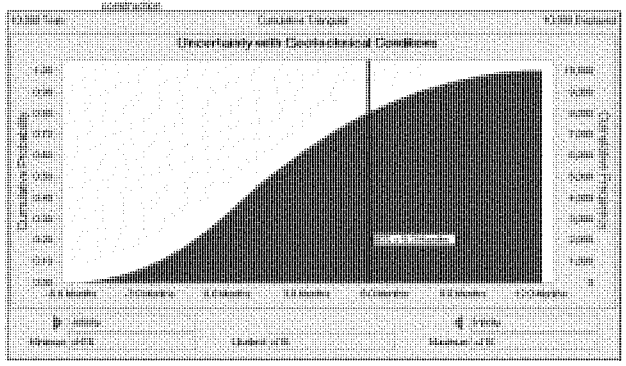
Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes that best case geotechnical conditions allow construction to advance by 6 months

High

Assumes that uncertainty with geotechnical condtions causes 12 month delay in construction.



Assumption:	Uncertainty with Geotechnical Conditions
Percentile	Assumption values
0%	-5.8 Months
10%	-2.6 Months
20%	-1.3 Months
30%	-0.3 Months
40%	0.6 Months
50%	1.6 Months
60%	2.7 Months
70%	3.9 Months
80%	5.3 Months
90%	7.3 Months
100%	11.8 Months

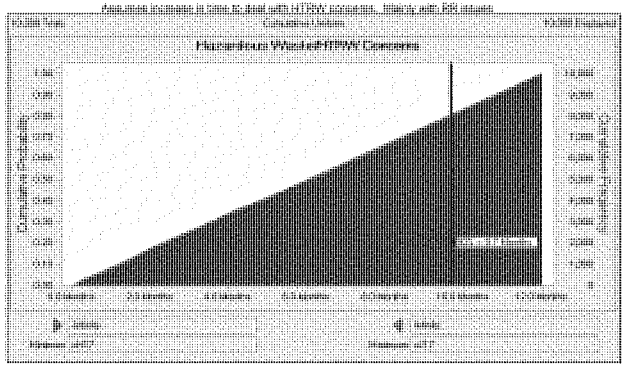
Risk Refer No.	Risk Event	Low	Most Likely	High
1L-3	Hazardous Waste/HTRW Concerns	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes no change from the baseline since baseline assumes not finding any HTRW concerns

High

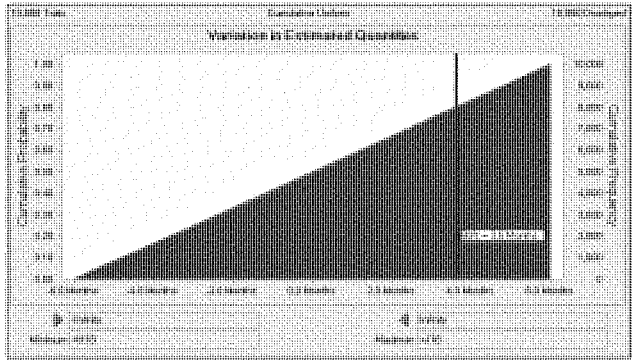


Assumption: Hazardous Waste/HTRW Concerns

Percentile	Assumption values
0%	0.0 Months
10%	1.2 Months
20%	2.3 Months
30%	3.5 Months
40%	4.8 Months
50%	6.1 Months
60%	7.3 Months
70%	8.5 Months
80%	9.7 Months
90%	10.8 Months
100%	12.0 Months

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-4	Variation in Estimated Quantities	-6.0 Months	0.0 Months	6.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.
Likely Likely assumes no change from the baseline schedule.
Low Assumes quantities are less than baseline
High Assume quantities are greater than baseline



Assumption: Variation in Estimated Quantities

Percentile	Assumption values
0%	-6.0 Months
10%	-4.8 Months
20%	-3.5 Months
30%	-2.3 Months
40%	-1.1 Months
50%	0.1 Months
60%	1.3 Months
70%	2.4 Months
80%	3.6 Months
90%	4.8 Months
100%	6.0 Months

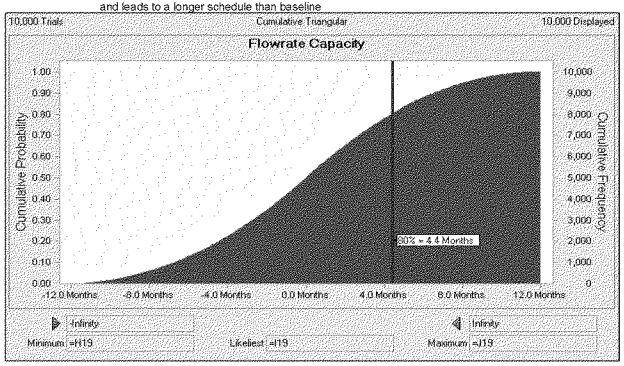
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-5	Flowrate Capacity	-12.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes required flowrates are less which decreases project footprint and quantities and leads to a shorter schedule than baseline

High Assumes required flowrates are greater which increases project footprint and quantities and leads to a longer schedule than baseline



Assumption: Flowrate Capacity

Percentile	Assumption values
0%	'-11.9 Months
10%	'-6.7 Months
20%	'-4.4 Months
30%	'-2.7 Months
40%	'-1.2 Months
50%	0.0 Months
60%	1.3 Months
70%	2.7 Months
80%	4.4 Months
90%	6.6 Months
100%	11.9 Months

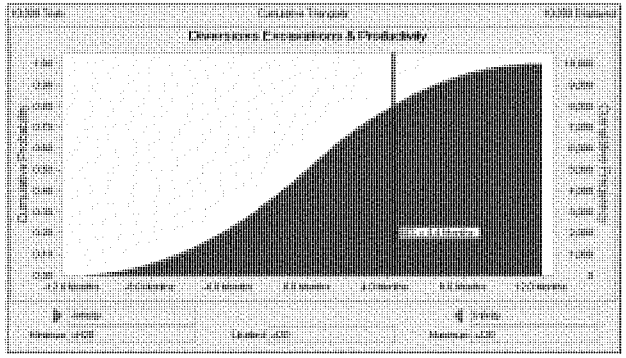
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-9	Diversions Excavations & Productivity	-12.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes diverson alignment changes decrease footprint and quantities making for a shorter schedule than the baseline

High Assumes diverson alignment changes increase footprint and quantities making for a longer schedule than the baseline



Assumption: Diversions Excavations & Productivity

Percentile	Assumption values
0%	-11.8 Months
10%	-6.5 Months
20%	-4.3 Months
30%	-2.7 Months
40%	-1.3 Months
50%	0.0 Months
60%	1.2 Months
70%	2.7 Months
80%	4.4 Months
90%	6.6 Months
100%	11.7 Months

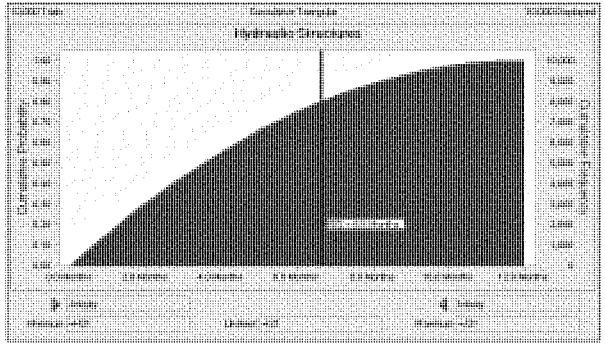
Risk Refer No	Risk Event	Low	Most Likely	High
TL-10	Hydraulic Structures	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes model studies of hydraulic structures shows that cuurent design is adequate or that structures can be smaller. However smaller structures would probably not reduce the project schedule from the baseline since channel excavation would most likely be controlling

High Assumes model studies of hydraulic structures shows that cuurent design is not adequate and that structures should be larger. Additional design and construction time may result



Assumption: Hydraulic Structures

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.3 Months
30%	2.0 Months
40%	2.7 Months
50%	3.6 Months
60%	4.4 Months
70%	5.4 Months
80%	6.6 Months
90%	8.2 Months
100%	11.9 Months

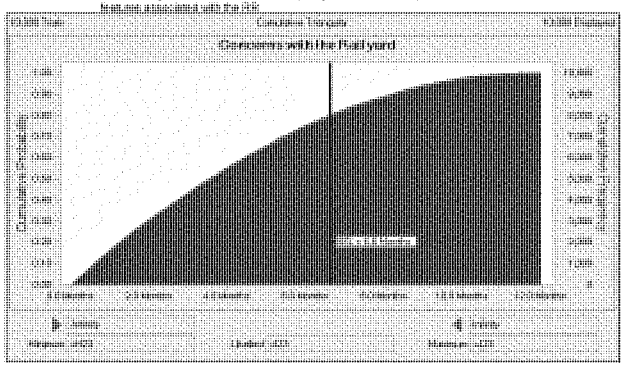
Risk Refer No.	Risk Event	Low	Most Likely	High
LD-1	Concerns with the Rail yard	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project

Likely Likely assumes no change from the baseline schedule.

Low Assumes agreements can be reached successfully and quickly with RR but that this most likely would not decrease the schedule from the baseline

High Assumes agreements are not reached quickly with RR and delays the construction of



Assumption: Concerns with the Rail yard

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.2 Months
30%	1.9 Months
40%	2.7 Months
50%	3.5 Months
60%	4.4 Months
70%	5.4 Months
80%	6.6 Months
90%	8.2 Months
100%	12.0 Months

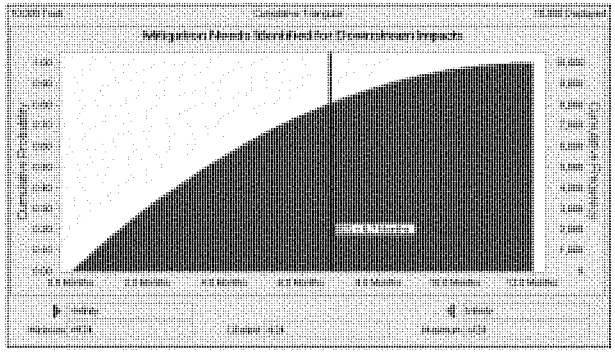
Risk Refer No.	Risk Event	Low	Most Likely	High
LD-2	Mitigation Needs Identified for Downstream Impacts	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes no change from baseline since baseline does not currently have any downstream mitigation for impacts for the project

High Assumes delay in project to mitigate impacts to areas downstream.



Assumption: Mitigation Needs Identified for Downstream Impacts

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.3 Months
30%	1.9 Months
40%	2.7 Months
50%	3.5 Months
60%	4.4 Months
70%	5.4 Months
80%	6.7 Months
90%	8.3 Months
100%	11.9 Months

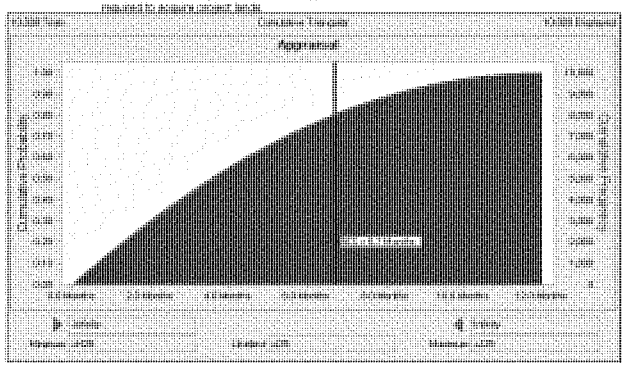
Risk Refer No.	Risk Event	Low	Most Likely	High
LD-4	Appraisal	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes no change from baseline since project schedule would be controled by construction schedule

High Assumes delay in project schedule from appraisals that are to low and condemnation is



Assumption: Appraisal

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.3 Months
30%	2.1 Months
40%	2.8 Months
50%	3.6 Months
60%	4.5 Months
70%	5.5 Months
80%	6.7 Months
90%	8.2 Months
100%	11.9 Months

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-5	Non-Appraisal	0.0 Months	0.0 Months	12.0 Months

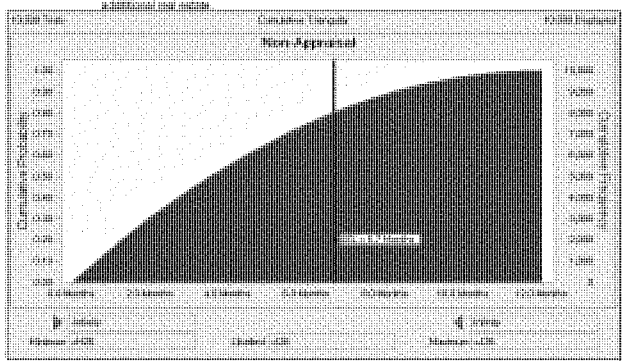
Notes: This item captures the risk that will cause a variance from the baseline schedule for the project

Likely Likely assumes no change from the baseline schedule.

Low Assumes no change from baseline since project schedule would be controled by construction schedule

High

Assumes delay in project schedule from project footprint increasing and requiring additional real estate



Assumption: **Non-Appraisal**

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.2 Months
30%	1.9 Months
40%	2.7 Months
50%	3.5 Months
60%	4.5 Months
70%	5.5 Months
80%	6.7 Months
90%	8.2 Months
100%	11.9 Months

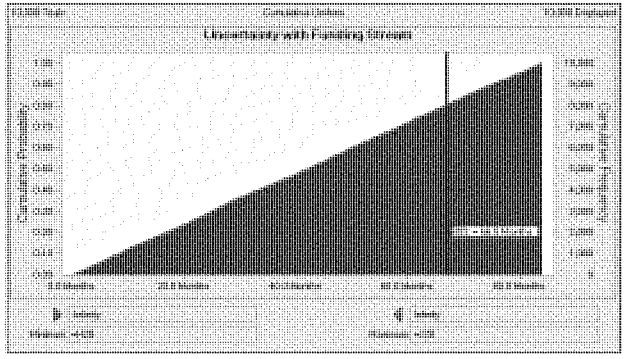
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-1	Uncertainty with Funding Stream	0.0 Months	0.0 Months	84.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project

Likely Likely assumes no change from the baseline schedule.

Low Assumes that funding will not be higher than the proposed project schedule

High Assumes that funding will be at the alternate funding of schedule of $80M/year which may take an additional 7 years.



Assumption: **Uncertainty with Funding Stream**

Percentile	Assumption values
0%	0.0 Months
10%	8.2 Months
20%	16.8 Months
30%	25.0 Months
40%	33.1 Months
50%	42.0 Months
60%	50.0 Months
70%	58.4 Months
80%	66.8 Months
90%	75.2 Months
100%	84.0 Months

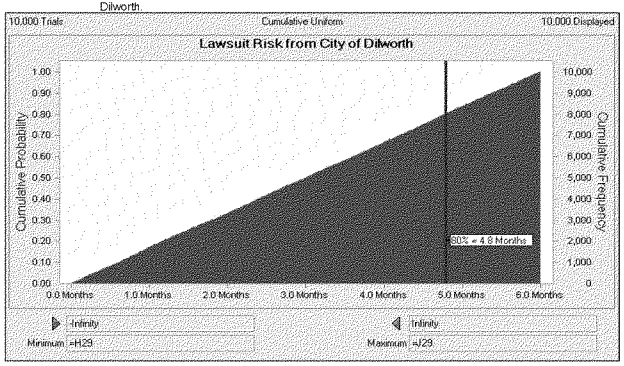
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-4	Lawsuit Risk	0.0 Months	0.0 Months	6.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes that project schedule will still be the baseline if there is not a lawsuit from Dilworth

High Assumes that there will be a delay in the project schedule if there is a lawsuit from Dilworth.



Assumption: **Lawsuit Risk**

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.2 Months
30%	1.8 Months
40%	2.4 Months
50%	3.0 Months
60%	3.6 Months
70%	4.2 Months
80%	4.8 Months
90%	5.4 Months
100%	6.0 Months

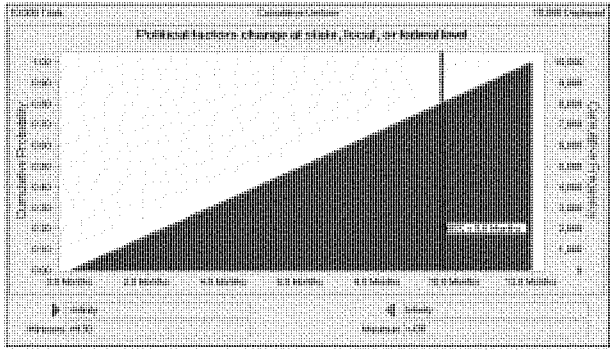
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-5	Political factors change at state, local, or federal level	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes the baseline schedule even if there are more favorable political changes and not any oppisition

High Assumes the political factors cause an increase from the baseline project schedule

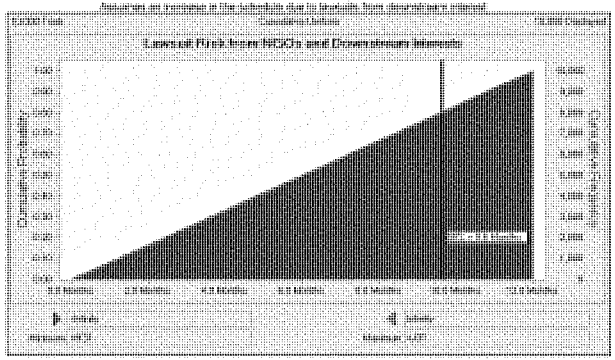


Assumption: **Political factors change at state, local, or federal level**

Percentile	Assumption values
0%	0.0 Months
10%	1.2 Months
20%	2.4 Months
30%	3.6 Months
40%	4.8 Months
50%	6.0 Months
60%	7.2 Months
70%	8.4 Months
80%	9.6 Months
90%	10.8 Months
100%	12.0 Months

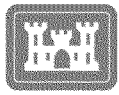
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-7	Lawsuit Risk from NGOs and Downstream Interests	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.
Likely Likely assumes no change from the baseline schedule.
Low Assumes the baseline schedule when there are not any lawsuits from Downstream interest
High



Assumption: Lawsuit Risk from NGOs and Downstream Interests

Percentile	Assumption values
0%	0.0 Months
10%	1.2 Months
20%	2.5 Months
30%	3.7 Months
40%	4.8 Months
50%	6.0 Months
60%	7.2 Months
70%	8.4 Months
80%	9.6 Months
90%	10.8 Months
100%	12.0 Months



US Army Corps
of Engineers®

Fargo-Moorhead Metro Flood Risk Management Project, Feasibility Study, Phase 4

Locally Preferred Plan (LPP) – North Dakota Option

Project Cost and Schedule Risk Analysis Report

Prepared for:

U.S. Army Corps of Engineers,
St. Paul District

Prepared by:

U.S. Army Corps of Engineers
Cost Engineering Directory of Expertise, Walla Walla

May 2, 2011

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EXECUTIVE SUMMARY

Under the auspices of the US Army Corps of Engineers (USACE), St. Paul District, this report presents a recommendation for the project cost and schedule contingencies for the Fargo-Moorhead Metro Flood Risk Management Project, Feasibility Study, Phase 4 Locally Preferred Plan (LPP) – North Dakota Option (Fargo-Moorhead FRM LPP). In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis study was conducted for the development of contingency on the project cost. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated project cost.

Specific to the Fargo-Moorhead LPP Project, the most likely project cost (at price level) is estimated at approximately $1.387 Billion. Based on the results of the analysis, the Cost Engineering Directory of Expertise for Civil Works (Walla Walla District) recommends a contingency value of $367 Million, or 26%. This contingency includes $279 Million (20%) for cost growth potential due to risk analyzed in the base cost estimate and $88 Million (6%) for cost growth potential due to risk analyzed in the baseline schedule.

Walla Walla Cost Dx performed risk analysis using the *Monte Carlo* technique, producing the aforementioned contingencies and identifying key risk drivers.

The following table ES-1 portrays the development of contingencies (26%). The contingency is based on an 80% confidence level, as per USACE Civil Works guidance.

Table ES-1. Contingency Analysis Table

Most Likely Cost Estimate	**$1,387,078,819**	
Confidence Level	**Value ($$)**	**Contingency (%)**
5%	$1,505,513,807	8.54%
50%	$1,660,870,979	19.74%
80%	**$1,754,275,887**	**26.47%**
95%	$1,840,932,008	32.72%

The following table ES-2 portrays the full costs of the recommended alternative based on the anticipated contracts. The costs are intended to address the congressional request of estimates to implement the project. The contingency is based on an 80% confidence level, as per accepted USACE Civil Works guidance.

Table ES-2. Cost Summary

	FARGO-MOORHEAD LPP	COST ($1,000)	CNTG ($1,000)	TOTAL ($1,000)
01	LANDS AND DAMAGES	214,845	56,875	271,720
02	RELOCATIONS	119,480	31,630	151,110
06	FISH AND WILDLIFE FACILITIES	51,113	13,531	64,644
08	ROADS, RAILROADS, AND BRIDGES	46,497	12,309	58,807
09	CHANNELS AND CANALS	609,705	161,405	771,110
11	LEVEES AND FLOODWALLS	111,190	29,435	140,624
14	RECREATION FACILITIES	23,027	6,096	29,123
30	PLANNING, ENGINEERING AND DESIGN	144,015	38,125	182,140
31	CONSTRUCTION MANAGEMENT	67,207	17,792	84,999
	TOTAL PROJECT COSTS	**1,387,079**	**367,197**	**1,754,276**
	Schedule Completion with Contingency	**2 Apr 2020**	**117 months**	**17 Dec 2029**

Notes:
1) Costs include the recommended contingency of 26%.
2) Costs exclude O&M and Life Cycle Cost estimates.

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The key cost risk drivers identified through sensitivity analysis were Risks PR-6 (Lawsuit Risk from NGOs and Upstream Interests), PPM-8 (Scope Changes) and CON-6 (Contract Modifications), which together contribute 65 percent of the statistical cost variance. PR-6 captures the risk that there may be perceived damages by upstream interests and non-sponsor communities. PPM-8 captures the risk that changes to scope, as required by stakeholders, may increase the cost of the project. CON-6 captures the risk that there may be cost growth due to post-award modifications to the contracts due to differing site conditions, engineering changes, and/or claims.

The key schedule risk driver identified through sensitivity analysis was Risk PR-1 (Uncertainty with Funding Stream), which contributes 82 percent of the statistical schedule variance. PR-1 covers the risk that delay in obtaining necessary funding increments my significantly delay the project.

Recommendations, as detailed within the main report, include the implementation of cost and schedule contingencies, further iterative study of risks throughout the project life-cycle, potential mitigation throughout the PED phase, and proactive monitoring and control of risk identified in this study.

MAIN REPORT

1.0 PURPOSE

Under the auspices of the US Army Corps of Engineers (USACE), St. Paul District, this report presents a recommendation for the project cost and schedule contingencies for the Fargo-Moorhead Metro Flood Risk Management Project, Feasibility Study, Phase 4 Locally Preferred Plan (LPP) – North Dakota Option (Fargo-Moorhead FRM LPP).

2.0 BACKGROUND

The purpose of the Fargo-Moorhead Feasibility Study is to identify measures and develop a regional system to reduce flood risk along the Red River of the North for the entire Fargo-Moorhead metropolitan area. The study PDT collected, evaluated and screened an array of possible flood risk management plans to define the costs, benefits and impacts to the project area. The plans resulted in a diversion channel alternative as the best measures to reduce the flood risk. A diversion through Minnesota around the city of Moorhead offered the plan with the lowest cost having a B/C ratio over one. The local sponsors preferred a diversion alternative through North Dakota around the city of Fargo as a locally preferred plan. The PDT has developed plans and estimates for both the National Economic Development (NED) - Minnesota Plan and the LPP – North Dakota plan.

St. Paul District is preparing a Feasibility Report. As a part of this effort, St. Paul District requested that the USACE Cost Engineering Directory of Expertise for Civil Works (Cost Engineering Dx) provide an agency technical review (ATR) of the cost estimate and schedule for LRR. That tasking also included providing a risk analysis study to establish the resulting contingencies.

3.0 REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for all project features. The study and presentation does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the most likely Micro Computer Aided Cost Estimating System (MCACES) cost estimate, schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the St. Paul District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of problems, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Dx. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering Dx.

- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008.

- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

4.0 METHODOLOGY / PROCESS

The Cost Engineering Dx assembled a team, also relying on local St. Paul District staff to further augment labor, expertise and information gathering. The Cost Engineering Dx team consisted of one senior civil cost engineer.

The Cost Engineering Dx cost engineer facilitated a risk identification meeting on site with the St. Paul PDT on January 7, 2010. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the framework for the risk analysis. The cost and schedule risk models were completed and results reported on January 29, 2010. Several subsequent revisions to the estimates and risk analyses took place between January 29, 2010 and April 17, 2011. The final results were reported on April 17, 2011.

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence.

In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Dx guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk averse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Formal PDT meetings were held for the purposes of identifying and assessing risk factors. The formal meeting conducted on January 7, 2010 included representatives from plan formulation, project management, geotechnical and hydraulic design, cost engineering, construction, environmental compliance, real estate, and the project sponsors.

The initial formal meetings focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Subsequent meetings focused primarily on risk factor assessment and quantification.

Additionally, numerous conference calls and informal meetings were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were quantified using probability distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the Fargo-Moorhead LPP project.

a. The St. Paul District provided MII MCACES (Micro-Computer Aided Cost Estimating Software) files via email. The file title, "MVP LPP_ND_Diversion_Phase_4 with 2009 Equip Rate.mlp" was the basis for the cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level.

c. Schedules are analyzed for impact to the project cost in terms of both uncaptured escalation (variance from OMB factors and the local market) and unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay.

d. Per the CWCCIS Historical State Adjustment Factors in EM 1110-2-1304, State Adjustment Factors for Minnesota and North Dakota are 1.15 and 0.92, respectively. Taking this into account along with the historical RS Means labor inflation rate and Consumer Price Index (CPI) factor for Minnesota, the average suggests that true inflation is approximately 4.55% higher for the Fargo Metro area than for the national average. This rate was used to calculate the differential between the local market and OMB inflation factors for future construction. For the P80 schedule, this is approximately 1.59% of the contingency.

e. Per the data in the estimate, the Job Office Overhead (JOOH) amount comprises approximately 5% of the Project Cost at Baseline. Thus, the assumed residual fixed cost rate for this project is 5%. For the P80 schedule, this comprises approximately 4.77% of the total contingency due to the accrual of residual fixed costs associated with delay.

f. The Cost Dx guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

g. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk "watch list".

6.0 RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Contingency and Sensitivity Analysis

Table 1 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes only.

Contingency was quantified as approximately $367 Million at the P80 confidence level (26% of the baseline cost estimate). For comparison, the cost contingency at the P50 and P100 confidence levels was quantified as 20% and 47% of the baseline cost estimate, respectively.

Table 1. Project Cost Contingency Summary

Risk Analysis Forecast	Baseline Estimate	Total Contingency[1,2] ($)	Total Contingency (%)
50% Confidence Level			
Project Cost	$1,660,870,979	$273,792,160	19.74%
80% Confidence Level			
Project Cost	$1,754,275,887	$367,197,067	26.47%
100% Confidence Level			
Project Cost	$2,040,970,710	$653,891,891	47.14%

Notes:
1) These figures combine uncertainty in the baseline cost estimates and schedule.
2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of "unknown unknowns") makes 100% confidence a theoretical impossibility.

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high level schedule risks identified in the risk register.

6.3 Schedule and Contingency Risk Analysis

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 117 months based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were calculated by applying the high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs.

Table 2. Schedule Duration Contingency Summary

Risk Analysis Forecast	Baseline Schedule Duration (months)	Contingency[1] (months)
50% Confidence Level		
Project Duration	122	74
80% Confidence Level		
Project Duration	122	95
100% Confidence Level		
Project Duration	122	176

Notes:
1) The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented in Table 2.
2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of "unknown unknowns") makes 100% confidence a theoretical impossibility.

Figure 1. Cost Sensitivity Analysis

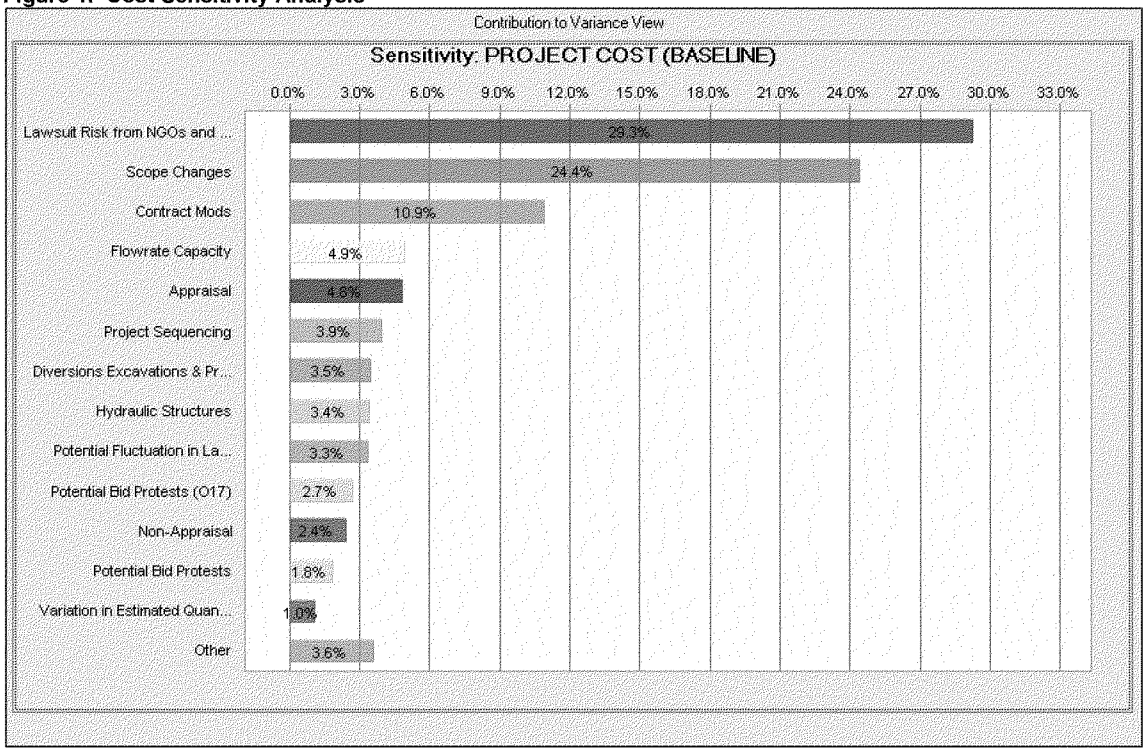
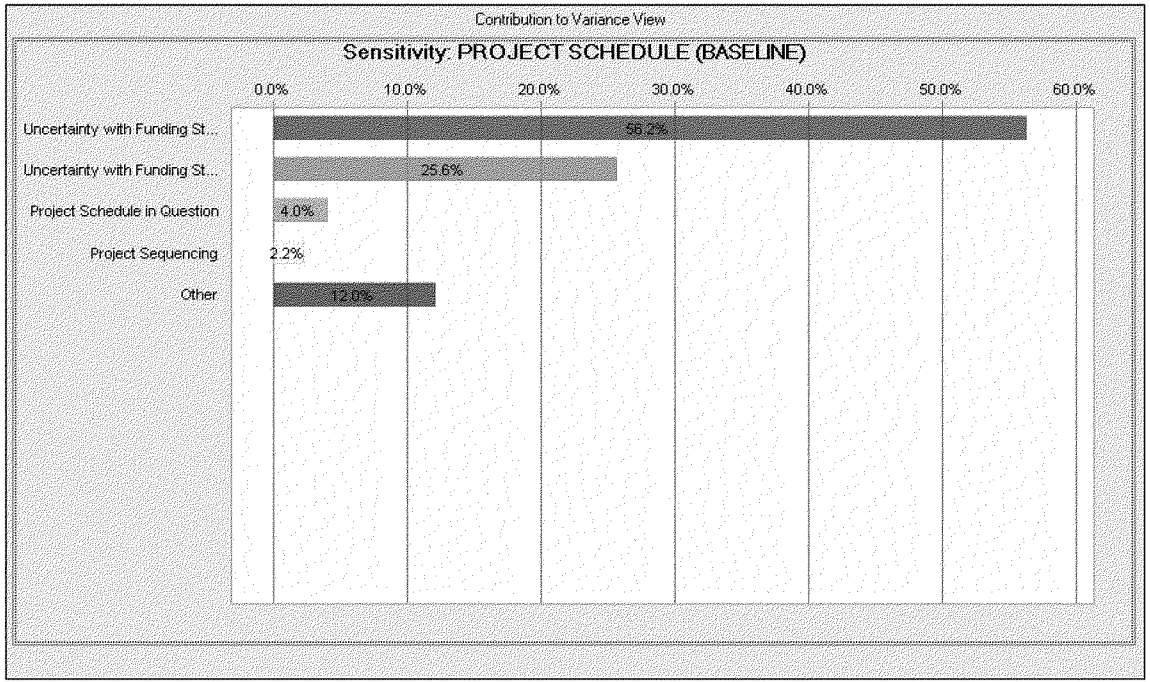


Figure 2. Schedule Sensitivity Analysis



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Project cost comparison summaries are provided in Table 3 and Figure 3. Additional major findings and observations of the risk analysis are listed below.

1. The key cost risk drivers identified through sensitivity analysis were Risks PR-6 (Lawsuit Risk from NGOs and Upstream Interests), PPM-8 (Scope Changes) and CON-6 (Contract Modifications), which together contribute 65 percent of the statistical cost variance.

2. The key schedule risk driver identified through sensitivity analysis was Risk PR-1 (Uncertainty with Funding Stream), which contributes 82 percent of the statistical schedule variance.

3. Operation and maintenance activities were not included in the cost estimate or schedules. Therefore, a full lifecycle risk analysis could not be performed. Risk analysis results or conclusions could be significantly different if the necessary operation and maintenance activities were included.

Table 3. Project Cost Comparison Summary

Confidence Level	Project Cost ($)	Contingency (%)
P0	**$1,339,855,676**	**-3.40%**
P5	**$1,505,513,807**	**8.54%**
P10	**$1,538,269,944**	**10.90%**
P15	**$1,560,810,805**	**12.53%**
P20	**$1,577,802,468**	**13.75%**
P25	**$1,593,278,637**	**14.87%**
P30	**$1,607,580,440**	**15.90%**
P35	**$1,621,111,138**	**16.87%**
P40	**$1,634,694,783**	**17.85%**
P45	**$1,647,129,777**	**18.75%**
P50	**$1,660,870,979**	**19.74%**
P55	**$1,674,604,577**	**20.73%**
P60	**$1,688,826,432**	**21.75%**
P65	**$1,703,289,774**	**22.80%**
P70	**$1,719,421,608**	**23.96%**
P75	**$1,735,440,729**	**25.11%**
P80	**$1,754,275,887**	**26.47%**
P85	**$1,775,988,250**	**28.04%**
P90	**$1,802,415,619**	**29.94%**
P95	**$1,840,932,008**	**32.72%**
P100	**$2,040,970,710**	**47.14%**

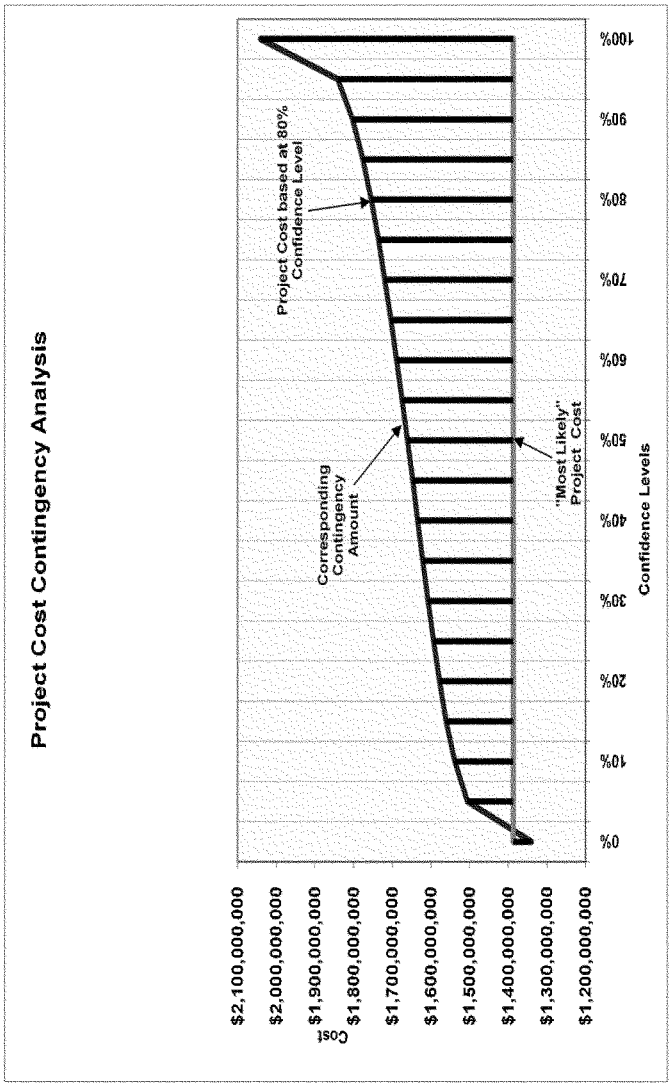
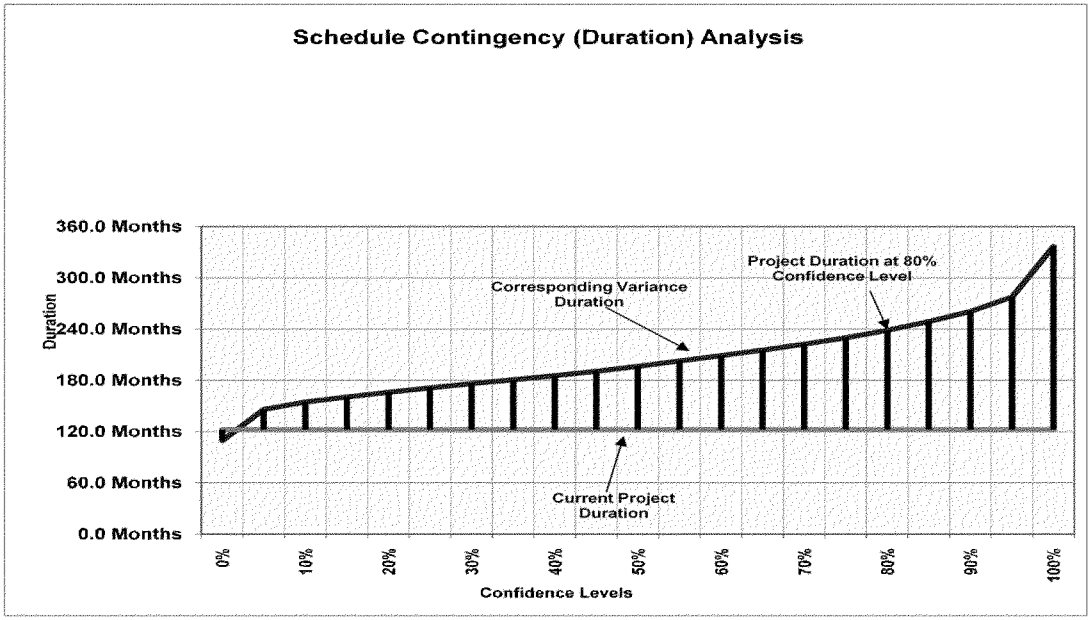


Figure 3. Project Cost Summary

Figure 4. Project Duration Summary



7.2 Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 4th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The Cost and Schedule Risk Analysis (CSRA) produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

1. Key Cost Risk Drivers: The key cost risk drivers identified through sensitivity analysis were Risks PR-6 (Lawsuit Risk from NGOs and Upstream Interests), PPM-8 (Scope Changes) and CON-6 (Contract Modifications), which together contribute 65 percent of the statistical cost variance.

a) Lawsuit Risk from NGOs and Upstream Interests: Project leadership should take proactive measures to obtain decisions as well as collect information regarding upstream interests. Project leadership should also communicate to management regarding the impact of these issues on cost performance. Ultimately, this is an external risk, and its impacts must be communicated to management, and funds should be maintained in project reserve for treatment of this risk.

b) Scope Changes: Project leadership should attempt to capture and finalize the scope of the project to the maximum extent possible. It is imperative to identify all features of work and probable methodologies, along with the accompanying risks associated with implementation. Iterative quantification (risk analysis) may be necessary to further develop and pinpoint sources of risk to identify needs for risk treatment in the risk response and management plan.

c) Contract Modifications: Project leadership should attempt to capture and finalize the scope of the project to the maximum extent possible. It is imperative to identify all features of work and probable methodologies, along with the accompanying risks associated with implementation. Iterative quantification (risk

analysis) may be necessary to further develop and pinpoint sources of risk to identify needs for risk treatment in the risk response and management plan. Additionally, project leadership should determine acquisition strategy and make decisions early to impact the completion of contract documents as to minimize risk of engineering changes and potential claims.

2. Key Schedule Risk Drivers: The key schedule risk driver identified through sensitivity analysis was Risk PR-1 (Uncertainty with Funding Stream), which contributes 82 percent of the statistical schedule variance.

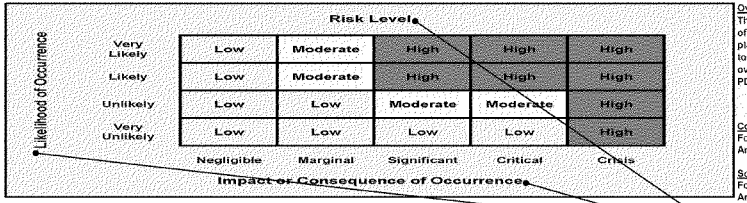
a) Uncertainty with Funding Stream: Project leadership should project leadership proactively develop accurate funding profile projections to capture probable funding requirements. Ultimately, this is an external risk, and its impacts must be communicated to management.

3. Risk Management: Project leadership should use of the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

4. Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

APPENDIX A

MVP - Fargo/Moorhead Feasibility Report (LPP - North Dakota Option) - PDT Risk Register



Overall Project Scope
The Fargo-Moorhead Feasibility Study purpose is to identify measures and develop a regional system to reduce flood risk along the Red River of the North for the entire F-M metropliotan area. The study PDT collected, evaluated and screened an array of possible flood risk management plans to define the costs, benefits and impacts to the project area. The plans resulted in a diversion channel alternative as the best measures to reduce the flood risk. A diversion through Minnesota around the city of Moorhead offered the plan with the lowest cost having a B/C ratio over one. The local sponsors preferred a diversion alternative through North Dakota around the city of Fargo as a locally preferred plan. The PDT has developed plans and estimates for both the MN Plan and the LPP ND plan.

Cost Impacts
For the Fargo/Moorhead Project, any cost impact of $10 Million or higher should be considered at least "Significant."
Anything over $5 Million should be considered at least "Marginal."

Schedule Impacts
For the Fargo/Moorhead Project, any schedule impact of 12 months or greater should be considered at least "Significant."
Anything over 6 months should be considered at least "Marginal."

				Project Cost				Project Schedule							
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)															
	PROJECT & PROGRAM MGMT														
PPM-1	Project Schedule in Question	Due to the size and magnitude of the project, as well as the complexity of the structures and sequencing, there is inherent concern regarding the actual project schedule	This could cause a variance in the project schedule (positive or negative, but most likely negative).	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Project Manager	Project Cost & Schedule
PPM-2	Accelerated Design Schedule	An accelerated schedule can result in inadequate studies, shortcuts in plans, change in contract acquisition strategy, failure to capture full scope, miss-steps, etc. There is the potential of moving forward with limited information	The issue is covered in other risk events.	Likely	Significant	High		Likely	Significant	High		Triangular		District Management	Project Cost & Schedule
PPM-3	Unplanned Work that Must be Accommodated	Due to the preliminary stage of project development, there is potential that there may be features or subfeatures of work that must be added to construction. Ice handling and sediment transport are the two most likely issues that must be accommodated. There may also be mitigation requirements.	Most of these subfeatures are already captured in the design and estimate, but the configuration may change	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Yes-No		Project Manager	Project Cost & Schedule
PPM-4	Local Agency/Regulator Issues	The acceleration of the planning schedule has forced reviews and collaboration without much time given to local agencies and regulators. Although there has been communication between the Government and the local agencies, these agencies have not responded with definitive decisions. This could present potential impacts	Each of the agencies have provided formal comments and identified areas of concern. The design has been modified from when this concern was initially identified to increase the flows into the protected areas as coordinated with the agencies. This could impact cost and schedule.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Yes-No		Project Manager	Project Cost & Schedule
PPM-7	Conflicting Priorities	The District's workload and competing priorities may impede progress on this project related to staff availability and experience, related to design investigations, contract procurements, construction management	Since the identity of this concern, the F-M project has been identified as a high priority regional project, and barring a major national disater the F-M project will have all the resources it should need. Unlikely to cause cause any variance in the cost or schedule	Unlikely	Negligible	Low		Unlikely	Negligible	Low		Uniform		District Management	Project Schedule
PPM-8	Scope Changes	The many competing interests & priorities, coupled with an accelerated schedule could result in scope changes currently uncaptured or unanticipated. These scope changes would require additional coordination, cause further design and investigation and potentially impact the real estate acquisitions.	While minor alterations to the final alignment may occur, there should not be any major changes.	Likely	Marginal	Moderate		Likely	Significant	High		Yes-No		Project Manager	Project Cost & Schedule
	CONTRACT ACQUISITION RISKS														

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
CA-1	Undefined Acquisition Strategy	The overall acquisition strategy for both design and construction has not been defined. Acquisition strategy could affect/impact bid competition and bid costs. It can also move risk onto the Government, causing need for greater contingencies. Clarification should be made related to number of contracts, contract types, etc. authority for this procurement.	Acquisition strategy needs to be defined and could impact the cost and schedule	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		TASB	Contract Cost & Project Schedule
CA-2	Preference to Small Business	Most of the larger requirements are so large that they would not be suitable for small business. However, there is potential for some of the restoration, seeding and mitigation may be suitable for small business. There is a requirement for review by the PARC if the requirements were less than $50 Million.	The project is so large, it is likely that even separable requirements would not be suitable for small business. Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost & Project Schedule
CA-3	Numerous Separate Contracts	There is potential to have numerous separate contracts, especially if the continuing contracts authority is not granted. Funding stream issues could also have an impact on the number of contracts.	The best case would be 8 contracts. The worst case would be in excess of 12 contracts. More contracts could increase bidding competition. This could have a significant effect on cost and schedule (either positive or negative).	Very Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost
CA-4	Potential Bid Protests	The larger size of the project increase contractor interests in bidding, but also increases potrtial risk for protets due to hungry economy and interest in obtaining project dollars.	This could impact cost and schedule.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Yes-No		Contracting	Contract Cost
	TECHNICAL RISKS														
TL-1	Uncertainty with Geotechnical Conditions	There is uncertainty with geotechnical conditions, but the Phase 4 estimate uses recent borings from 2010 to help define the the soil parameters for excavation and bearing capacity and how that will impact the construction productivity. The material is all clay and silt	The current working estimate is fairly conservative. However, variation in the ultimate characterization of material could cause significant variance in productivity. Could impact cost and schedule (more likely positive than negative)	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Geotechnical/Civil Design	Contract Cost & Project Schedule
TL-2	Survey Data Incomplete	The PDT currently has incomplete or outdated survey data (for bathymetry for the Red River and Tributaries).	If the survey data uncovers data that differs greatly from current conceptual design, it could lead to variance in cost (due to issues such as configuration and details for structures). More likely on ND side.	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
TL-3	Maple Diversion Structure Concerns	Under very high flood events, water flows over and under the diversion structure. This could present issues, as this an unusual technical approach	With the revised Phase 4 flow, this structure does not submerge anymore and is not as much of a concern.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Yes-No		Hydrology/Hydraulic Design	Contract Cost & Project Schedule
TL-4	Sedimentation Modeling	The sedimentation modeling could show that higher flow accommodation may be necessary in the tributary structures.	This issue is more likely on Wild Rice, but not as likely on the Sheyenne or the Maple. This could impact cost and schedule.	Unlikely	Significant	Moderate		Unlikely	Negligible	Low		Yes-No		Hydrology/Hydraulic Design	Contract Cost
TL-5	Variation in Estimated Quantities	There is potential for variation of estimated quantities in the excavation and earthwork features.	This could impact cost and schedule.	Likely	Significant	High		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Contract Cost
TL-6	Flowrate Capacity	If during detailed design the hydraulics change, it could affect the amount of flow required for the diversion channel to handle. This would affect channel width, bridge lengths and major hydraulic structure sizes	This could impact cost and schedule.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Project Cost & Schedule
TL-7	Relocations - Utilities	Quality of design at budget level	Most costs were obtained from affected utilities for the major lines that are impacted.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-8	Relocations - Bridges	Bridge costs will change depending on final diversion channel width	Bridge costs from historical DOT costs are fairly reliable.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-9	Mitigation	fish, wetlands, forest, adaptive management issues	Resource agencies have not agreed to any particular features yet so there is the potential for additional mitigation beyond what is proposed, though the Corps has laid out a well planned approach to mitigating the issues.	Likely	Significant	High		Likely	Negligible	Low		Uniform		Environmental Compliance	Project Cost
TL-10	Railroad Bridges	RR Bridge sizes have changed since the initial RR bridge estimates and the costs have been scaled.	Bridge costs from BNSF's consulting engineer are at conceptual design and cost could have significant changes	Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Structural Design	Project Cost
TL-11	Diversions Excavations & Productivity	Excavations could be impacted by diversion alignment changes, productivity and/or model results	Impacts should only affect quantities of different soil layers	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Technical Lead	Contract Cost
TL-12	Hydraulic Structures	Hydraulic structures will need to be modeled	Model results could change design concepts	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Hydrology/Hydraulic Design	Contract Cost & Project Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
TL-13	Levees	Levee heights and lengths could change depending on if upstream staging is incorporated	Levees for upstream staging may depend on model studies and landowner opposition	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Hydrology/Hydraulic Design	Contract Cost & Project Schedule
TL-14	Non-Structural Floodproofing	Costs for downstream impacts could change when the effects of have been fully developed	With Phase 4 LPP design with the upstream staging, there should not be any downstream impacts	Unlikely	Negligible	Low		Unlikely	Marginal	Low		Triangular		Technical Lead	Project Cost
TL-15	Recreational Facilities	Feasibility is at conceptual design	Final designs could look different than Feasibility but overall concepts should be similar	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Cost Engineering	Contract Cost
TL-16	Fuel Cost Concerns	Volatility in the price of fuel	Recent spikes in fuel could increase the cost of fule for the project. Conversely, if the world markets calm down, fuel could return to a price lower that currently estimated in the project.	Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Cost Engineering	Contract Cost
	LANDS AND DAMAGES RISKS														
LD-1	Mitigation Needs Identified for Upstream Impacts due to staging	The effects of the project on areas upstream may require mitigation footprint that has not been finalized. The impacts may not be fully captured.	This could significantly impact costs depending on final staging area configuration. It could significantly impact schedule.	Likely	Significant	High		Likely	Significant	High		Yes-No		Real Estate	Project Cost & Schedule
LD-2	Potential Savings for Eliminating RR Bridge 4	Currently, the RRVW RR has limited use of this line and indicated that abandonment is possible	This could save the cost of bridge and track raise	Likely	Significant	High		Very Unlikely	Negligible	Low		Yes-No		Project Manager	Project Cost & Schedule
LD-4	Appraisal	Appraisals carry certain assumptions based on technical information. If the technical information has the potential to change, the appraisals could be impacted.	Appraisals are using an average value	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
LD-5	Non-Appraisal	Real Estate office is responsible for establishing contingencies. There could be risks outside their domain that can still impact the costs.	Real Estate has identified $29M in acquisition cost that the sponsor could recoup on the Lands & Damages estimate. Real Estate office will be using the CSRA contingencies	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
	REGULATORY AND ENVIRONMENTAL RISKS														
RE-1	Environmental Mitigation Feature Concerns	The PDT has estimated mitigation features for Phase 4 based on the expected impacts (to include construction and real estate).	This could impact the costs either positively or negatively.	Likely	Marginal	Moderate		Very Unlikely	Negligible	Low		Triangular		Environmental Compliance	Project Cost
RE-2	Historical Cultural Resource Issues	There is potential to find cultural resources, particulary on the riverbanks. No cultural resource survey has been completed to date. Mitigation will probably be necessary	Could impact cost.	Very Likely	Negligible	Low		Unlikely	Marginal	Low		Triangular		Environmental Compliance	Project Cost
RE-3	HTRW Issues	There is some potential for discovery of HTRW in the project alignment. Most of the alignment is through farmland.	Any HTRW issues likely to be minor associated with farm chemicals	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule
RE-4	Fish Passage Issues	There will be fish passage requirement in the project, but the actual configuration has not been finalized/agreed upon by the local agencies.	Could impact cost of fish passage structures at associated structures	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Technical Lead	Project Cost
RE-5	Pressure to Compress Permitting Activities	The local agencies perceive that they are being pressured through the project permeting process.	PDT has programmed this into the schedule, and the agencies are not constricted more than normal review times.	Very Unlikely	Negligible	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	CONSTRUCTION RISKS														
CON-1	Unknown Residential Utility Conflicts	There is potential for the need to abandon some small residential utilities.	This could impact cost and schedule, but it would be negligible.	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
CON-2	Control and Diversion of Water	Methodology of controlling water could be impacted by the sequencing and timing of relocation, the characterization of materials, or other unknown impacts.	Could impact cost and schedule.	Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost
CON-3	Conflicts between Contractors	There is potential for conflicts between multiple contractors working in the same footprint at the same time.	Could impact cost. However, careful planning of the construction scheduling and sequencing should be able to avoid any major conflicts	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule
CON-4	Sufficient QA Staff	to manage numerous contracts, mods and claims	ED-C is well aware of QA staffing issues and is planning accordingly	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule
CON-5	Project Sequencing	conflicts between contractors and schedule impacts (one contractor waiting on another)	Conflicts may develop at reaches interface, building of bridges or hydraulic structures	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Construction	Project Cost & Schedule
CON-6	Contract Mods	Contract mods and claims resulting from unforeseen site conditions, weather impacts, political and lawsuit impacts are a concern and can impact both cost and schedule.	Many of these concerns may be valid and impact the project	Likely	Significant	High		Likely	Negligible	Low		Triangular		Construction	Contract Cost
	ESTIMATE AND SCHEDULE RISKS														
EST-1	Potential Fluctuation in Labor Costs	There is concern that the labor force required for this work could be a challenge, requiring off-site labor, per diem and premium pay, as well as unique markups and multipliers for workers compensation and other factors.	Estimate currently has National Wage rates, which are higher than the local Davis-Bacon Wage Determination. The Estimate also includes $75/day for per diem. There is potential for savings, as the labor wage rate for North Dakota is cheaper than Minnesota. This could impact costs either positively or negatively.	Likely	Significant	High		Very Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
EST-2	WBS Elements - Estimate confidence	Certain WBS elements are better developed in scope and estimate than other scope areas. Some WBS elements may be more or less conservative. Some elements have greater risk and resulting need for greater contingencies.	The major cost elements for the diversion excavation, hydraulic structures and bridges have been highly developed for feasibility since they make up the bulk of the cost items. Environmental mitigation features are less develop and more conceptual and likely will change. Real Estate may be another area of risk confidence	Likely	Marginal	Moderate		Likely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
EST-3	Estimate assumptions	The estimate assumptions may be flawed in certain cost areas related to scope, crews, productivity, material cost, markups, contingencies, etc. This could result in a flawed budget development.	The estimate has been in development for enough time that scope, crews, productivity, material costs and markups are fairly well developed. Contingencies are from the CSRA	Unlikely	Marginal	Low		Likely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
EST-4	PED & CM	The estiamte currently uses 15% PED and 7% CM of the construction cost	With the high construction cost of this project and the amount of design required for excavation, those percentages may be too high, based on about 10% for the $410M Grand Forks/East Grand Forks Flood project which was more urban levees & floodwalls	Likely	Significant	High		Unlikely	Negligible	Low		Triangular		Cost Engineering	Project Cost

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)															
PR-1	Uncertainty with Funding Stream	There is a window of opportunity during the next couple years of obtaining the necessary increments on a timely basis. However, historically this has been a challenge in obtaining the increments necessary to complete on schedule, and there have been challenges in obtaining them on a timely basis.	This could impact both cost and schedule.	Very Likely	Significant	High		Very Likely	Significant	High		Uniform		Project Manager	Project Cost & Schedule
PR-2	Unusually Wet Season	If a given construction season is unusually higher than an average year, it could have significant impact on the productivity of the work.	If this it occurs, it reduces productivity and creates substantial delays.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Binomial		N/A	Project Cost & Schedule
PR-3	Flooding Event	There is a chance of a flooding event during construction that could cause damage to constructed work features.	Could be minor impacts to cost and schedule.	Very Unlikely	Negligible	Low		Very Unlikely	Negligible	Low		Binomial		N/A	Project Cost & Schedule
PR-4	Political factors change at state, local, or federal level	Senator Dorgan has retired. He was very influential and favorable to the project interests. Since the authorization was not obtained prior to his departure, there is concern that the project would not be authorized or funded on a timely basis.	Could be minor impacts to cost and schedule.	Unlikely	Marginal	Low		Unlikely	Crisis	High		Yes-No		Project Manager	Project Schedule
PR-5	Political opposition	There could be opposition from Federal Agencies (FEMA, FWS, and EPA).	Could be minor impacts to cost and schedule.	Unlikely	Marginal	Low		Likely	Marginal	Moderate		Uniform		Project Manager	Project Cost & Schedule
PR-6	Lawsuit Risk from NGOs and Upstream Interests	There may be perceived damages from upstream concerns or non-sponsor cities that are affected.	Could impact cost and schedule.	Likely	Significant	High		Unlikely	Significant	Moderate		Uniform		Project Manager	Project Schedule

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely, Unlikely, Moderately Likely, Likely, Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible, Marginal, Significant, Critical,** or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low, Moderate,** or **High.** Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

Contingency on Base Estimate	80% Confidence Project Cost
Baseline Estimate Cost (Most Likely) ->	$1,387,078,819
Baseline Estimate Cost Contingency Amount ->	$278,937,013
Baseline Estimate Construction Cost (80% Confidence) ->	$1,666,015,833

Contingency on Schedule	80% Confidence Project Schedule
Project Schedule Duration (Most Likely) ->	122.2 Months
Schedule Contingency Duration ->	116.8 Months
Project Schedule Duration (80% Confidence) ->	236.7 Months
Project Schedule Contingency Amount (80% Confidence) ->	$99,260,054

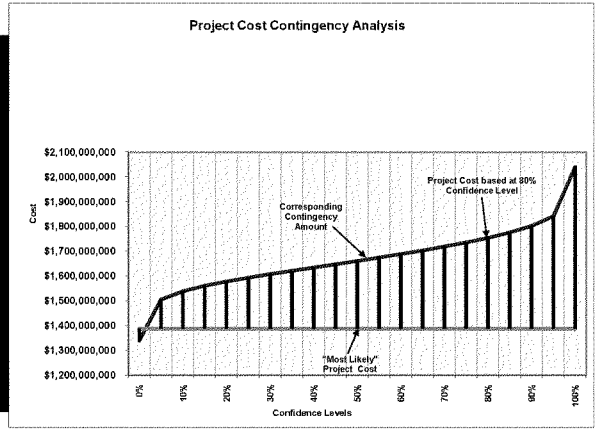
Project Contingency	80% Confidence Project Cost
Project Contingency Amount (80% Confidence) ->	$367,197,067
Project Contingency Percentage (80% Confidence) ->	26%

Project Cost (80% Confidence) ->	$1,754,275,887

- PROJECT CONTINGENCY DEVELOPMENT -

Contingency Analysis

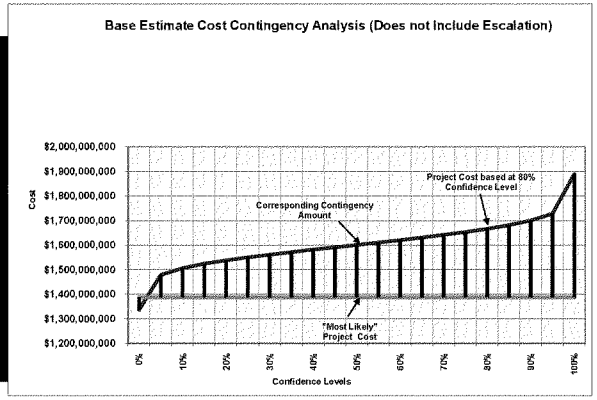
Most Likely Cost Estimate	$1,387,078,819		
Confidence Level	Project Cost	Contingency	Contingency %
0%	$1,339,855,676	($47,223,143)	-3.40%
5%	$1,505,513,807	$118,434,988	8.54%
10%	$1,538,269,944	$151,191,124	10.90%
15%	$1,560,810,805	$173,731,985	12.53%
20%	$1,577,802,468	$190,723,649	13.75%
25%	$1,593,278,637	$206,199,818	14.87%
30%	$1,607,580,440	$220,501,621	15.90%
35%	$1,621,111,138	$234,032,319	16.87%
40%	$1,634,694,783	$247,615,964	17.85%
45%	$1,647,129,777	$260,050,958	18.75%
50%	$1,660,870,979	$273,792,160	19.74%
55%	$1,674,604,577	$287,525,758	20.73%
60%	$1,688,826,432	$301,747,612	21.75%
65%	$1,703,289,774	$316,210,955	22.80%
70%	$1,719,421,608	$332,342,789	23.96%
75%	$1,735,440,729	$348,361,910	25.11%
80%	$1,754,275,887	$367,197,067	26.47%
85%	$1,775,988,250	$388,909,431	28.04%
90%	$1,802,415,619	$415,336,800	29.94%
95%	$1,840,932,008	$453,853,189	32.72%
100%	$2,040,970,710	$653,891,891	47.14%



- BASE CONTINGENCY DEVELOPMENT -

Contingency Analysis

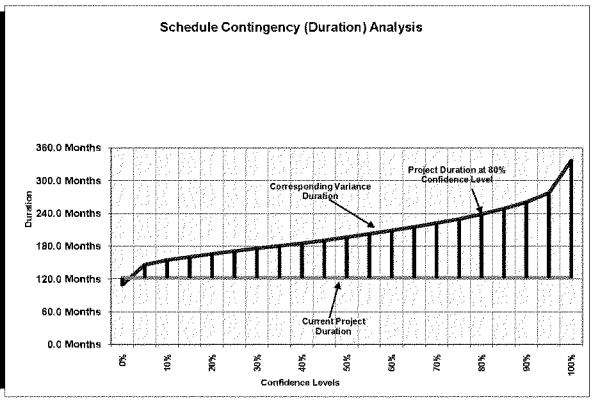
Most Likely Cost Estimate	$1,387,078,819		
Confidence Level	Project Cost	Contingency	Contingency %
0%	$1,336,855,935	($50,222,884)	-3.62%
5%	$1,478,536,519	$91,457,700	6.59%
10%	$1,505,453,347	$118,374,528	8.53%
15%	$1,524,147,605	$137,068,786	9.88%
20%	$1,537,481,951	$150,403,131	10.84%
25%	$1,549,681,209	$162,602,390	11.72%
30%	$1,560,624,812	$173,545,992	12.51%
35%	$1,571,117,586	$184,038,767	13.27%
40%	$1,581,539,408	$194,460,589	14.02%
45%	$1,590,558,739	$203,479,920	14.67%
50%	$1,600,501,068	$213,422,249	15.39%
55%	$1,610,094,229	$223,015,410	16.08%
60%	$1,620,246,516	$233,167,697	16.81%
65%	$1,630,424,107	$243,345,287	17.54%
70%	$1,641,958,964	$254,880,145	18.38%
75%	$1,653,035,337	$265,956,518	19.17%
80%	$1,666,015,833	$278,937,013	20.11%
85%	$1,681,112,745	$294,033,926	21.20%
90%	$1,699,645,557	$312,566,738	22.53%
95%	$1,727,019,327	$339,940,507	24.51%
100%	$1,888,078,395	$500,999,575	36.12%



- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

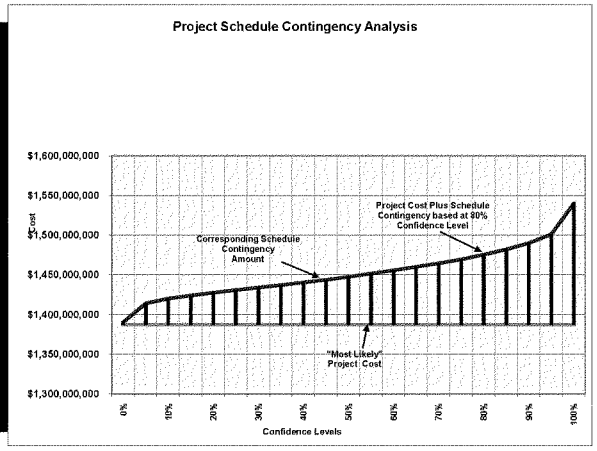
Most Likely Schedule	122.2 Months		
Confidence Level	Project Duration	Contingency	Contingency %
0%	109.6 Months	-12.6 Months	-10.29%
5%	145.9 Months	23.7 Months	19.44%
10%	154.8 Months	32.6 Months	26.68%
15%	160.6 Months	38.4 Months	31.45%
20%	166.1 Months	44.0 Months	35.99%
25%	171.1 Months	48.9 Months	40.05%
30%	176.2 Months	54.0 Months	44.21%
35%	180.8 Months	58.6 Months	47.98%
40%	185.6 Months	63.4 Months	51.90%
45%	190.7 Months	68.6 Months	56.14%
50%	196.5 Months	74.3 Months	60.85%
55%	202.8 Months	80.6 Months	65.98%
60%	208.9 Months	86.8 Months	71.03%
65%	215.4 Months	93.3 Months	76.34%
70%	222.4 Months	100.2 Months	82.04%
75%	229.9 Months	107.7 Months	88.17%
80%	238.7 Months	116.6 Months	95.43%
85%	248.7 Months	126.6 Months	103.63%
90%	260.7 Months	138.5 Months	113.42%
95%	277.6 Months	155.4 Months	127.23%
100%	336.6 Months	214.5 Months	175.56%



- SCHEDULE CONTINGENCY (AMOUNT) DEVELOPMENT -

Contingency Analysis

Most Likely Cost Estimate	$1,387,078,819		
Confidence Level	Project Cost	Contingency	Contingency %
0%	$1,390,078,560	$2,999,741	0.22%
5%	$1,414,056,107	$26,977,288	1.94%
10%	$1,419,895,416	$32,816,596	2.37%
15%	$1,423,742,019	$36,663,200	2.64%
20%	$1,427,399,336	$40,320,517	2.91%
25%	$1,430,676,248	$43,597,428	3.14%
30%	$1,434,034,448	$46,955,629	3.39%
35%	$1,437,072,372	$49,993,552	3.60%
40%	$1,440,234,194	$53,155,375	3.83%
45%	$1,443,649,857	$56,571,038	4.08%
50%	$1,447,448,730	$60,369,911	4.35%
55%	$1,451,589,167	$64,510,348	4.65%
60%	$1,455,658,735	$68,579,915	4.94%
65%	$1,459,944,487	$72,865,667	5.25%
70%	$1,464,541,463	$77,462,644	5.58%
75%	$1,469,484,212	$82,405,392	5.94%
80%	$1,475,338,873	$88,260,054	6.36%
85%	$1,481,954,325	$94,875,505	6.84%
90%	$1,489,848,881	$102,770,062	7.41%
95%	$1,500,991,501	$113,912,681	8.21%
100%	$1,539,971,135	$152,892,316	11.02%



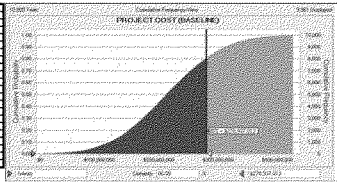
USACE-MVP-0000087977

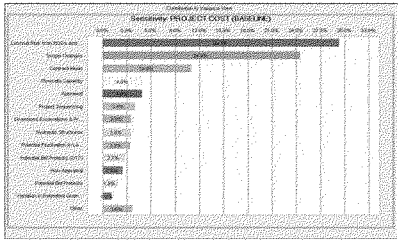
MVP - Fargo/Moorhead Feasibility Report (North Dakota Option) - Cost Risk Analysis Model

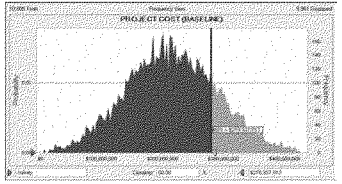
Risk No.	Risk/Opportunity Event	Project Cost: Likelihood*	Project Cost: Impact*	Project Cost: Risk Level*	Variance Distribution	Correlation to Other(s)	Crystal Ball Simulation: Expected Values ($$$): Low	Expected Values ($$$): Most Likely	Expected Values ($$$): High		Crystal Ball Simulation: Expected Values (% s): Low	Expected Values (% s): Most Likely	Expected Values (% s): High	
														Percentages are calculated as the variance from the assumption value to indicate iterations of the model versus the cost values change throughout the project process. Uniform distribution percentages reflect variation from the total project cost
Internal Risks (Internal Risk items are those that are guaranteed, caused, or controlled within the PDT's sphere of influence.)														
PROJECT & PROGRAM MGMT														
PPM-1	Project Schedule in Question	Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	Removed From Cost Risk Study - Captured in the 7 Month Risk Analysis	N/A	N/A	N/A	
PPM-2	Accelerated Design Schedule	Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	Removed From Cost Risk Study - Captured by Schedule of Work	N/A	N/A	N/A	
PPM-3	Unplanned Work that Must be Accomplished	Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	Removed From Cost Risk Study - Captured in the Schedule of Work	N/A	N/A	N/A	
PPM-4	Local Agency/Requestor Changes	Likely	Significant	High	N/A	N/A	N/A	N/A	N/A	Removed From Cost Risk Study - Captured by the Schedule of Work	N/A	N/A	N/A	
PPM-5	Scope Changes	Likely	Marginal	Moderate	Triangular		($1,473,000)	$0	$138,797,000		-2.50%	0.00%	10.00%	100%
CONTRACT ACQUISITION RISKS														
CA-1	Undefined Acquisition Strategy	Likely	Marginal	Moderate	Triangular	N/A	($2,250,000)	$0	$16,870,132		-4.73%	0.00%	6.62%	
CA-3	Numerous Separate Contracts	Very Likely	Significant	High	Triangular		$0	$0	$10,941,000		0.00%	0.00%	0.75%	100%
CA-4	Potential Bid Protests	Likely	Marginal	Moderate	Yes-Mid/Triangular		$0	$0	$10,000,000		0.00%	0.00%	0.45%	100%
TECHNICAL RISKS														
TL-1	Uncertainty with Geotechnical Conditions	Likely	Critical	High	Triangular		($5,434,000)	$0	$1,736,000		0.00%	0.00%	0.12%	100%
TL-4	Sedimentation Modeling	Unlikely	Significant	Moderate	Yes-Mid/Triangular	TL-5	$0	$0	$3,900,000		0.00%	0.00%	0.27%	20%
TL-5	Variation in Estimated Quantities	Likely	Significant	High	Uniform	T_{CV}-4	($37,342,000)	$0	$16,242,000		-1.17%	0.00%	1.17%	100%
TL-6	Riverside Capacity	Likely	Marginal	Moderate	Triangular		($31,564,000)	$0	$50,004,000		-1.14%	0.00%	2.14%	100%
TL-7	Relocations - Utilities	Likely	Marginal	Moderate	Triangular		($791,000)	$0	$4,750,000		-0.06%	0.00%	0.34%	100%
TL-8	Relocations - Bridges	Likely	Marginal	Moderate	Triangular		($5,746,000)	$0	$10,301,000		-0.57%	0.00%	0.75%	100%
TL-9	Mitigation	Very Likely	Significant	High	Uniform		($2,000,000)	$0	$12,780,000		-0.14%	0.00%	0.90%	100%
TL-10	Railroad Bridges	Likely	Significant	High	Triangular		($15,000,000)	$0	$16,374,000		-0.17%	0.00%	1.17%	100%
TL-11	Diversions, Excavations & Productivity	Likely	Marginal	Moderate	Triangular		($24,000,000)	$0	$50,000,000		-1.72%	0.00%	3.60%	100%
TL-12	Hydraulic Structures	Likely	Significant	High	Triangular		($41,000,000)	$0	$58,944,000		-1.91%	0.00%	4.69%	100%
TL-13	Levees	Likely	Marginal	Moderate	Triangular		($12,000,000)	$0	$16,670,000		-1.38%	0.00%	1.20%	100%
TL-14	Recreational Facilities	Likely	Marginal	Moderate	Triangular		($1,500,000)	$0	$1,700,000		0.00%	0.00%	0.01%	100%
TL-16	Fuel Cost Concerns	Likely	Significant	High	Triangular		($3,000,000)	$0	$12,129,000		0.00%	0.00%	0.00%	100%
LANDS AND DAMAGES RISKS														
LD-1	Mitigation Needs Identified for Downstream Impacts	Unlikely	Significant	Moderate	Yes-No/Triangular		($500,000)	$0	$0		0.00%	0.00%	0.00%	20%
LD-2	Potential Savings for Eliminating RR Bridge 3	Likely	Significant	High	Yes-No/Custom		($2,700,000)	$0	$0		0.00%	0.00%	0.00%	50%
LD-4	Appraisal	Likely	Significant	High	Triangular		($20,000,000)	$0	$64,453,000		-2.77%	0.00%	4.99%	100%
LD-5	High Appraisal	Likely	Marginal	Moderate	Triangular		($20,000,000)	$0	$21,484,000		-2.87%	0.00%	1.66%	100%
REGULATORY AND ENVIRONMENTAL RISKS														
RE-1	Environmental Mitigation Feature Concerns	Likely	Marginal	Moderate	N/A	N/A	N/A	N/A	N/A	Removed From Cost Risk Study as this is captured by Risk R-4	N/A	N/A	N/A	
RE-4	Fish Passage Issues	Likely	Marginal	Moderate	N/A	N/A	N/A	N/A	N/A	Removed From Cost Risk Study as this is captured by Risk R-14	N/A	N/A	N/A	
CONSTRUCTION RISKS														
CON-2	Control and Diversion of Water	Likely	Marginal	Moderate	Triangular		($4,445,000)	$0	$6,695,000		-0.32%	0.00%	0.32%	100%
CON-5	Project Sequencing	Likely	Significant	High	Uniform		($5,736,000)	$0	$43,894,000		-0.23%	0.00%	3.14%	100%
CON-6	Contract Mods	Likely	Significant	High	Triangular		($20,000,000)	$0	$85,000,000		-1.27%	0.00%	6.02%	100%
ESTIMATE AND SCHEDULE RISKS														
EST-1	Potential Fluctuation in Labor Costs	Likely	Significant	High	Triangular		($21,000,000)	$0	$60,675,000		-2.54%	0.00%	3.00%	100%
EST-3	WBS Elements - Estimate Confidence	Likely	Marginal	Moderate	N/A	N/A	N/A	N/A	N/A	Removed From Cost Risk Study as this is captured by Risks UT-1 & R-4	N/A	N/A	N/A	
EST-4	PED & CM	Likely	Significant	High	Triangular		($7,000,000)	$0	$0		-4.11%	0.00%	0.00%	100%

Programmatic Risks (Estimate risks and opportunities that are programmatic in nature and not specific to a single project or contract)													
PR-1	Uncertainty with Funding Streams	Likely	Marginal	Moderate	N/A	N/A	N/A	$0A	N/A	Risk Part of Study / Placeholder for Project Execution Program Cost	N/A	N/A	N/A
PR-2	Lawsuit Risk from NGOs and upstream interests	Likely	Significant	High	Unitam		30	$5	$150,000,000		0.95%	0.95%	0.99%
										$0			

PROJECT COST (BASELINE)	Percentile	Baseline TPC	Contingency Amount	Baseline w/ Contingency	Contingency %
	0%	$1,397,079,819	$61,457,706	$1,458,537,525	4.40%
	5%	$1,397,079,819	$81,457,706	$1,478,536,515	5.83%
	10%	$1,397,079,819	$118,374,628	$1,515,453,047	8.83%
	15%	$1,397,079,819	$137,088,786	$1,534,167,605	9.88%
	20%	$1,397,079,819	$150,402,131	$1,547,481,951	10.94%
	25%	$1,397,079,819	$162,402,780	$1,559,481,599	11.72%
	30%	$1,397,079,819	$173,246,592	$1,570,326,412	12.51%
	35%	$1,397,079,819	$184,636,747	$1,581,716,566	13.02%
	40%	$1,397,079,819	$184,460,885	$1,581,539,466	14.06%
	45%	$1,397,079,819	$203,478,920	$1,600,558,739	14.87%
	50%	$1,397,079,819	$213,422,248	$1,610,501,068	15.29%
	55%	$1,397,079,819	$223,013,410	$1,620,093,229	15.96%
	60%	$1,397,079,819	$223,187,497	$1,620,246,816	16.81%
	65%	$1,397,079,819	$243,345,497	$1,640,424,197	17.44%
	70%	$1,397,079,819	$244,880,146	$1,641,959,965	19.58%
	75%	$1,397,079,819	$266,906,818	$1,663,986,637	19.17%
	80%	$1,397,079,819	$278,937,813	$1,676,015,633	20.11%
	85%	$1,397,079,819	$294,033,926	$1,691,113,745	21.29%
	90%	$1,397,079,819	$311,566,726	$1,708,646,457	22.93%
	95%	$1,397,079,819	$329,949,997	$1,727,029,322	24.61%
	100%	$1,397,079,819	$509,993,576	$1,906,973,395	36.12%







310

Risk Refer No.	Risk Event	Low	Most Likely	High	
PPM-1	Project Schedule in Question				*Removed From Cost Risk Study as this is captured by the Schedule Risk Analysis*

Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-2	Accelerated Design Schedule	$0	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assume cost of project decreases 10% less than baseline

High Assume cost of project increases 20% more the baseline

Most Likely
$1,387,078,800 Project cost
$1,387,078,800 Total

Assumption: **Accelerated Design Schedule**

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-3	Unplanned Work that Must be Accommodated	$0	$0	$0

Notes:

This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assume if there is not any unplanned work that it will = baseline

High Assume that unplanned work will increase construction cost by 10%

Most Likely	
$119,479,700	02 Relocations
$51,120,300	06 Fish & Wildlife - Mitigation
$46,497,500	08 Railroads
$608,789,400	09 Channels
$111,190,600	11 Levees, Floodwalls & Floodproofing
$23,024,400	14 Recreational Facilities
$960,101,900	Sub-total Construction Features
$144,015,000	30 PED
$67,207,000	31 CM
$1,171,323,900	Total

Assumption: Unplanned Work that Must be Accommodated

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-4	Local Agency/Regulator Issues	$0	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 10% less cost of mitigation

High Assumes 10% greater cost of mitigation

Most Likely	
$51,120,300	06 Mitigation
$7,668,000	30 PED for Mitigation
$3,578,000	31 CM for Mitigation
$62,366,300	Total

Assumption: Local Agency/Regulator Issues

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-8	Scope Changes	($34,676,970)	$0	$138,707,880

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

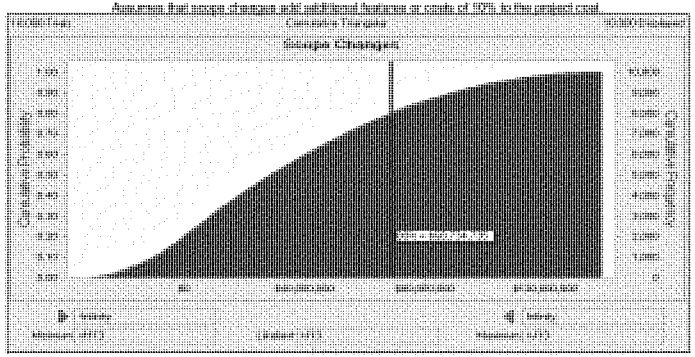
Low Assumes that scope changes decrease the project cost by 2.5%

High

Most Likely

$1,387,078,800 Project Costs

$1,387,078,800 Total



Assumption: Scope Changes

Percentile	Assumption values
0%	($33,839,187)
10%	($10,245,884)
20%	($112,405)
30%	$8,689,150
40%	$18,145,424
50%	$28,617,957
60%	$40,273,631
70%	$53,417,888
80%	$68,734,735
90%	$89,334,596
100%	$136,773,842

Risk Refer No.	Risk Event	Low	Most Likely	High
CA-1	Undefined Acquisition Strategy	($24,002,548)	$0	$96,010,190

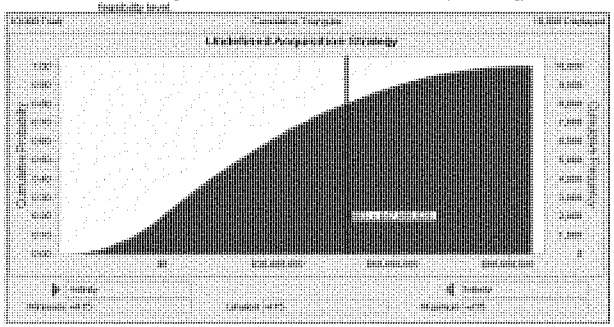
############

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 2.5% **less** of construction costs because of favorable acquisitions implementation.

High Assumes 10% **greater** construction costs because of the undefined acquisition strategy at the



Assumption: Undefined Acquisition Strategy

Percentile	Assumption values
0%	($23,954,882)
10%	($8,962,741)
20%	($36,595)
30%	$6,176,806
40%	$12,562,077
50%	$19,959,441
60%	$27,804,114
70%	$36,872,810
80%	$47,680,628
90%	$61,824,001
100%	$95,260,971

Most Likely

$119,479,700	02 Relocations
$51,120,300	06 Fish & Wildlife - Mitigation
$46,497,500	08 Railroads
$608,789,400	09 Channels
$111,190,600	11 Levees, Floodwalls & Floodproofing
$23,024,400	14 Recreational Facilities
$960,101,900	Sub-total Construction Features
$960,101,900	Total

Risk Refer No.	Risk Event	Low	Most Likely	High
CA-3	Numerous Separate Contracts	$0	$0	$10,561,100

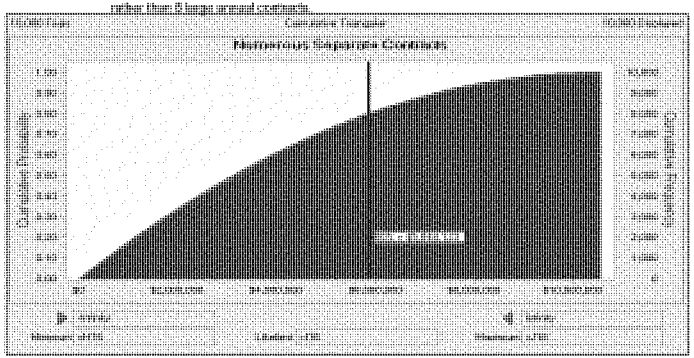
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes no cost decrease for PED and CM costs if contracting does not have numerous separate constracts

High Assumes 5% greater PED and CM costs if contracting issues numerous separate contracts rather than 5 large annual contracts.

Most Likely	
$144,015,000	30 PED
$67,207,000	31 CM
$211,222,000	Total.



Assumption: Numerous Separate Contracts

Percentile	Assumption values
0%	$296
10%	$566,248
20%	$1,133,206
30%	$1,778,804
40%	$2,471,469
50%	$3,216,676
60%	$3,953,100
70%	$4,805,305
80%	$5,848,123
90%	$7,236,639
100%	$10,478,648

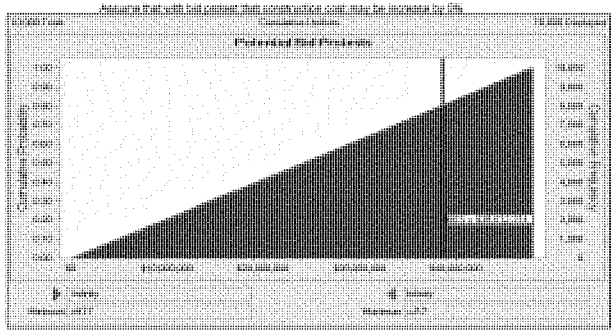
Risk Refer No	Risk Event	Low	Most Likely	High
CA-4	Potential Bid Protests	$0	$0	$48,005,095

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that without bid protests that costs would not decrease.

High



Assumption: Potential Bid Protests

Percentile	Assumption values
0%	$6,112
10%	$4,880,223
20%	$9,788,768
30%	$14,366,170
40%	$19,363,807
50%	$24,406,865
60%	$29,037,393
70%	$33,797,707
80%	$38,612,314
90%	$43,171,752
100%	$48,002,586

Most Likely

$119,479,700 02 Relocations
$51,120,300 06 Fish & Wildlife - Mitigation
$46,497,500 08 Railroads
$608,789,400 09 Channels
$111,190,600 11 Levees, Floodwalls & Floodproofing
$23,024,400 14 Recreational Facilities

$960,101,900 Sub-total Construction Features

(PED & CM covered in CA-3)

$960,101,900 Total

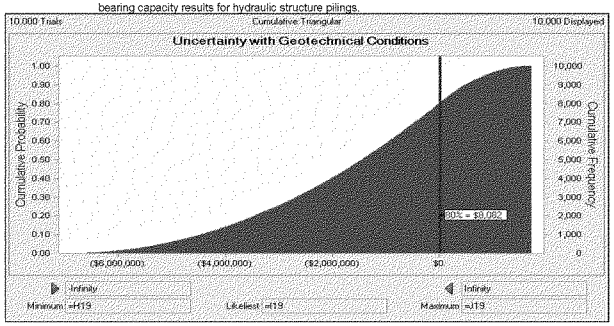
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-1	Uncertainty with Geotechnical Conditions	($6,900,280)	$0	$1,725,065

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 20% less costs for the piling of the hydraulic structures due to changes in the bearing capacity results for hydraulic structure pilings.

High Assumes 5% greater costs for the piling of the hydraulic structures due to changes in the bearing capacity results for hydraulic structure pilings.



Assumption: Uncertainty with Geotechnical Conditions

Percentile	Assumption values
0%	($6,542,630)
10%	($4,439,372)
20%	($3,449,559)
30%	($2,645,485)
40%	($1,988,056)
50%	($1,423,583)
60%	($915,920)
70%	($447,834)
80%	$8,082
90%	$510,233
100%	$1,692,320

Most Likely

$785,000	(902020201) Piling for RRN Inlet Gated Structure
$2,430,700	(902020301) Piling for RRN Inlet Structure Walls
$829,000	(903020201) Piling for Wolverton Creek Structure
$395,300	(904020201) Piling for WRR Inlet Gated Structure
$1,158,800	(904020301) Piling for WRR Inlet Structure Walls
$580,600	(906020101) Piling for Inlet Weir Structure
$761,300	(906020201) Piling for Inlet Weir Structure Walls
$4,271,500	(907020201) Piling for Sheyenne River Aqueduct Structure & Wingwalls
$3,815,600	(90803) Piling for Drain 14 Structure
$5,318,000	(909020201) Piling for Maple River Aqueduct Structure & Wingwalls
$3,917,000	(910020201) Piling for Lower Rush River Drop Structure & Wingwalls
$3,816,300	(911020201) Piling for Rush River Drop Structure & Wingwalls
$2,299,500	(916020201) Piling for RRN Outlet Rollway Structure
$2,285,300	(918020301) Piling for RRN Outlet Structure Walls
$918,700	(110503020201) Piling for Storage Area 1 North Structure & Walls
$918,700	(110504020201) Piling for Storage Area 1 East Structure & Walls
$34,501,300	Total

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-4	Sedimentation Modeling	$0	$0	$2,963,030

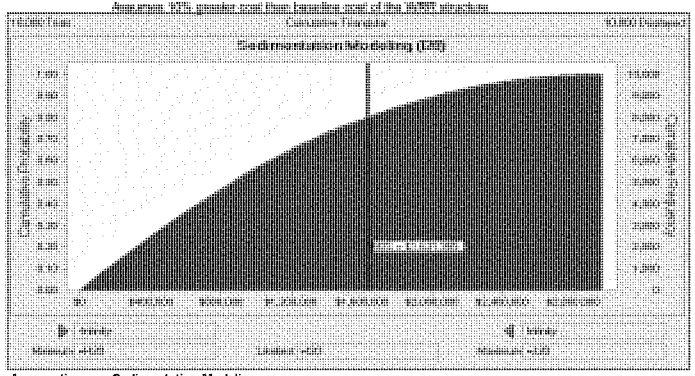
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 0% less cost than baseline cost of WRR structure

High

Most Likely
$29,630,300 WWR Control Structure



Assumption: **Sedimentation Modeling**

Percentile	Assumption values
0%	$137
10%	$153,486
20%	$320,692
30%	$488,341
40%	$670,465
50%	$865,697
60%	$1,077,384
70%	$1,321,764
80%	$1,631,985
90%	$2,018,198
100%	$2,931,466

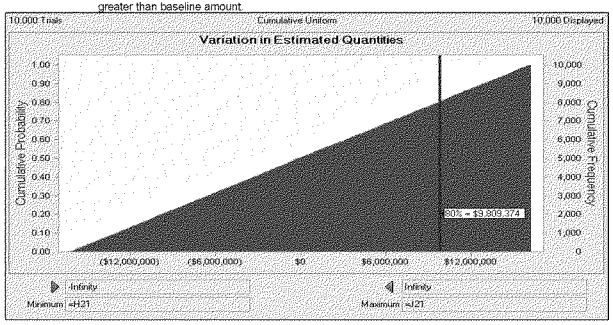
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-5	Variation in Estimated Quantities	($16,245,040)	$0	$16,245,040

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes quantities for excavation of diversion channel, control structures and levees costs 5% less than baseline amount.

High Assumes quantities for excavation of diversion channel, control structures and levees costs 5% greater than baseline amount.



Assumption: Variation in Estimated Quantities

Percentile	Assumption values
0%	($16,235,714)
10%	($12,837,350)
20%	($8,751,788)
30%	($6,460,994)
40%	($3,235,105)
50%	($101,903)
60%	$3,260,804
70%	$6,491,594
80%	$9,909,374
90%	$12,994,490
100%	$16,233,593

Most Likely

$378,100	Reach 1 Excavation
$2,313,100	Reach 2 Excavation
$17,405,500	Reach 3 Excavation
$55,596,500	Reach 4 Excavation
$11,279,200	Reach 5 Excavation
$109,037,200	Reach 6 Excavation
$4,275,000	Reach 7 Excavation
$1,139,900	Reach 8 Excavation
$11,685,400	(9020108) RRN Inlet Control Structure Excavation
$3,804,900	(9040108) WRR Control Structure Excavation
$707,200	(9060109) Inlet Weir Excavation
$11,443,400	(9070109) Sheyenne River Control Structure Excavation
$6,937,000	(9090108) Maple River Control Structure Excavation
$3,713,700	(9100107) Lower Rush River Control Structure Excavation
$3,577,200	(9110107) Rush River Control Structure Excavation
$2,866,800	(9160107) RRN Outlet Structure Excavation
$14,630,200	(110103) TBL East 2B Levee Excavation & Embankment
$5,566,700	(110203) TBL Cass 17 Levee Excavation & Embankment
$1,669,300	(110301) Connecting Channel 2018 Levee Excavation & Embankment
$6,911,300	(110401 + 110402) Connecting Channel 2019 Levee Excavation & Embankment
$49,963,200	(11050105) Storage Area 1 Excavation & Embankment
$324,900,800	Total

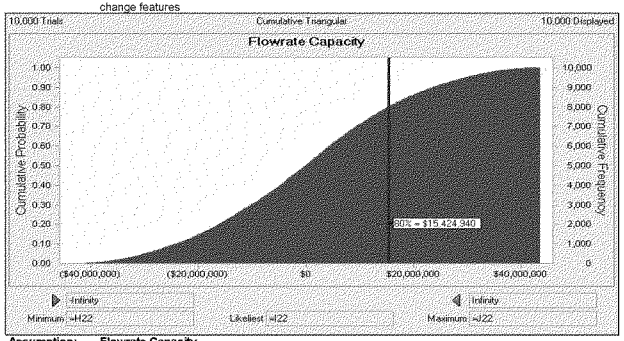
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-6	Flowrate Capacity	($43,504,465)	$0	$43,504,465

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% less cost than selected baseline cost for changes to the flowrate capcity that change features

High Assumes 5% greater cost than selected baseline cost for changes to the flowrate capcity that change features



Assumption: Flowrate Capacity

Percentile	Assumption values
0%	($42,755,438)
10%	($24,098,505)
20%	($16,017,924)
30%	($9,994,294)
40%	($4,579,017)
50%	$86,441
60%	$4,522,569
70%	$9,496,176
80%	$15,424,940
90%	$23,666,675
100%	$43,275,554

Most Likely	
$103,611,800	02 Relocations - Roadway Bridges
$46,497,500	08 Railroads
$608,789,400	09 Channels
$111,190,600	11 Levees, Floodwalls & Floodproofing
$870,089,300	Sub-total
$870,089,300	Total

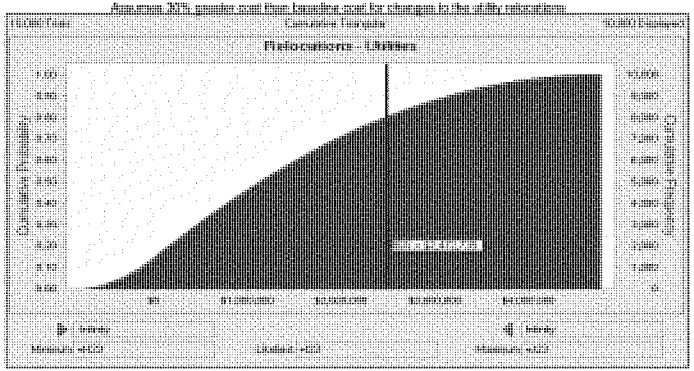
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-7	Relocations - Utilities	($793,395)	$0	$4,760,370

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% less cost than baseline cost for changes to the utility relocations

High



Assumption: Relocations - Utilities

Percentile	Assumption values
0%	($777,429)
10%	($133,506)
20%	$166,001
30%	$474,028
40%	$793,740
50%	$1,144,590
60%	$1,523,429
70%	$1,950,533
80%	$2,472,735
90%	$3,152,167
100%	$4,729,275

Most Likely

$15,867,900 02 Relocations - Utilities

$15,867,900 total

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-8	Relocations - Roadway Bridges	($5,180,590)	$0	$10,361,180

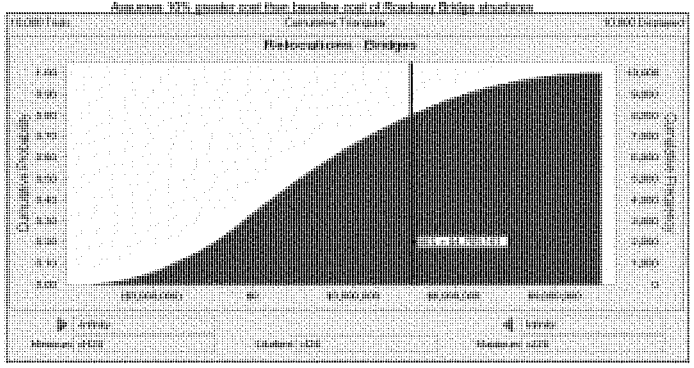
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low

Assumes 5% less cost than baseline cost of Roadway Bridge structures

High



Assumption: **Relocations - Roadway Bridges**

Percentile	Assumption values
0%	($5,091,172)
10%	($2,366,265)
20%	($1,118,016)
30%	($280,254)
40%	$527,976
50%	$1,396,512
60%	$2,367,863
70%	$3,430,870
80%	$4,705,161
90%	$6,330,013
100%	$10,114,164

Most Likely
$103,611,800 02 Relocations - Roadway Bridges

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-9	Mitigation	($2,556,015)	$0	$12,780,075

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

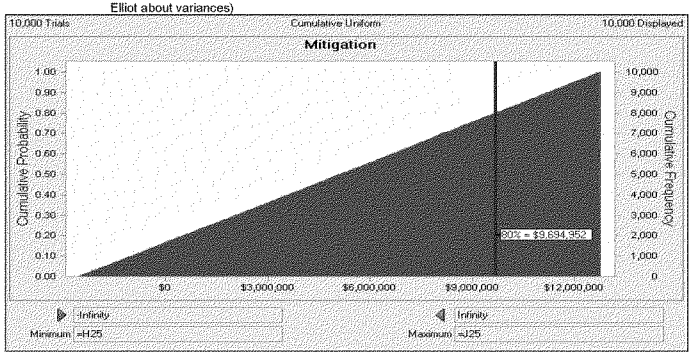
Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated for mitigation

High Assumes that cost would be 25% more than estimated for mitigation. (Talked with Jon & Elliot about variances)

Most Likely

$51,120,300 06 Mitigation



Assumption: Mitigation

Percentile	Assumption values
0%	($2,552,682)
10%	($1,007,328)
20%	$528,892
30%	$2,124,546
40%	$3,626,552
50%	$5,119,373
60%	$6,690,477
70%	$8,137,876
80%	$9,694,952
90%	$11,247,582
100%	$12,779,031

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-10	Railroad Bridges	($2,324,875)	$0	$16,274,125

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

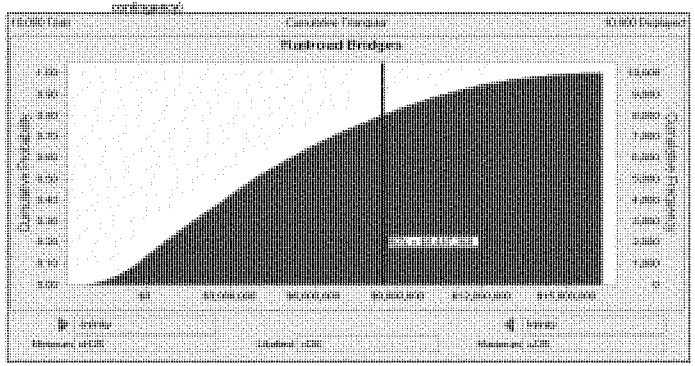
Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% less cost than baseline cost of the RR bridges

High Assumes 35% greater cost than baseline cost of the RR bridges (based on RR estimate contingency)

Most Likely

$46,497,500 Railroad Bridges



Assumption: Railroad Bridges

Percentile	Assumption values
0%	($2,312,972)
10%	($272,172)
20%	$690,752
30%	$1,712,155
40%	$2,800,395
50%	$3,886,127
60%	$5,202,636
70%	$6,686,942
80%	$8,447,360
90%	$10,696,869
100%	$16,210,634

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-11	Diversions Excavations & Productivity	($16,865,120)	$0	$50,595,360

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

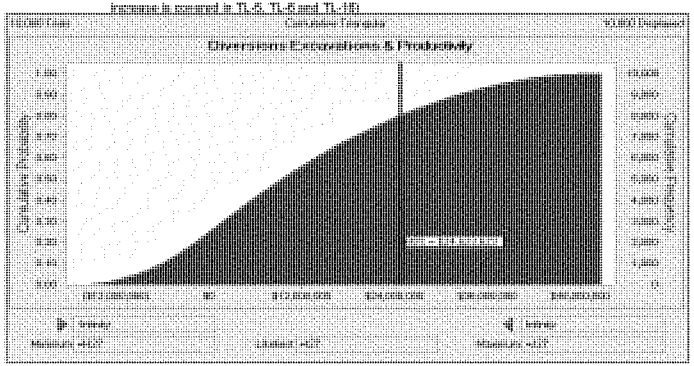
Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated (assumes that some of cost decrease is covered in TL-5, TL-6 and TL-16)

High Assumes that cost would be 15% more than estimated (assumes that some of cost increase is covered in TL-5, TL-6 and TL-16)

Most Likely

$337,302,400 Diversion Channel Costs



Assumption: Diversions Excavations & Productivity

Percentile	Assumption values
0%	($16,584,792)
10%	($6,032,992)
20%	($1,809,367)
30%	$1,802,432
40%	$5,445,506
50%	$9,380,192
60%	$13,737,392
70%	$18,670,523
80%	$24,623,623
90%	$32,269,011
100%	$50,335,749

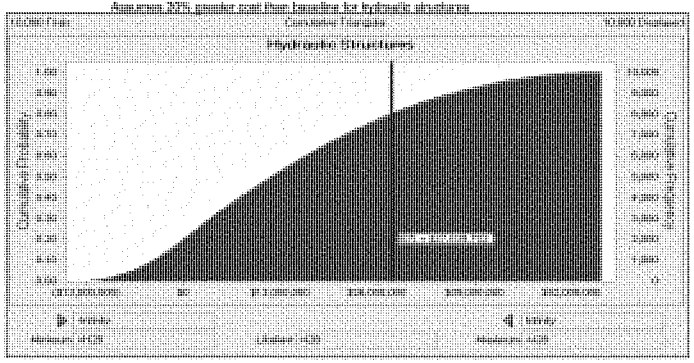
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-12	Hydraulic Structures	($13,988,520)	$0	$55,954,080

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% less cost than baseline for hydraulic structures

High



Assumption: Hydraulic Structures

Percentile	Assumption values
0%	($13,620,969)
10%	($3,943,240)
20%	$58,546
30%	$3,576,097
40%	$7,580,684
50%	$11,757,077
60%	$16,394,033
70%	$21,626,099
80%	$27,839,703
90%	$36,129,935
100%	$55,518,203

Most Likely

$48,276,200	RRN Inlet Control Structure
$29,630,300	WRR Control Structure
$50,805,800	Sheyenne River Control Structure
$45,799,500	Maple River Control Structure
$17,743,600	Lower Rush River Control Structure
$17,709,700	Rush River Control Structure
$22,704,300	RRN Outlet Structure
$4,366,300	Wolverton Creek Control Structure
$215,700	East Weir
$9,942,200	Inlet Weir
$8,378,200	Drain 14
$447,400	Large Drains
$254,400	Small Drains
$8,453,100	Side Channel Inlets
$5,662,300	Twin Side Channel Inlets
$4,690,700	Storage Area 1 North Structure
$4,690,700	Storage Area 1 East Structure
$279,770,400	Total

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-13	Levees	($16,678,590)	$0	$16,678,590

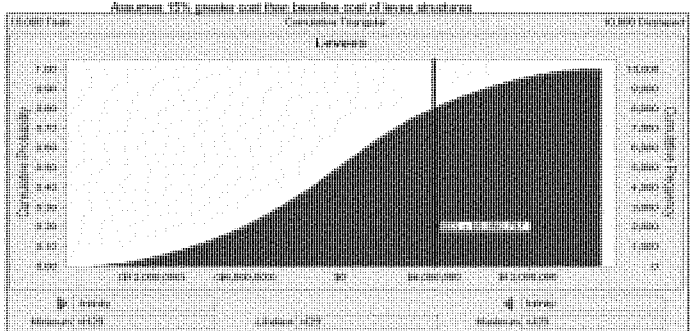
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 15% less cost than baseline cost of Levee structures since there is a possibility that additional flow may be able to be passed through town which could reduce the size of the storage area levees

High

Most Likely	
$111,190,600	11 Levees



Assumption: Levees

Percentile	Assumption values
0%	($16,234,733)
10%	($9,503,340)
20%	($6,192,268)
30%	($3,842,499)
40%	($1,840,584)
50%	($132,602)
60%	$1,602,573
70%	$3,561,283
80%	$5,950,797
90%	$9,318,428
100%	$16,585,217

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-15	Recreational Facilities	($1,151,220)	$0	$5,756,100

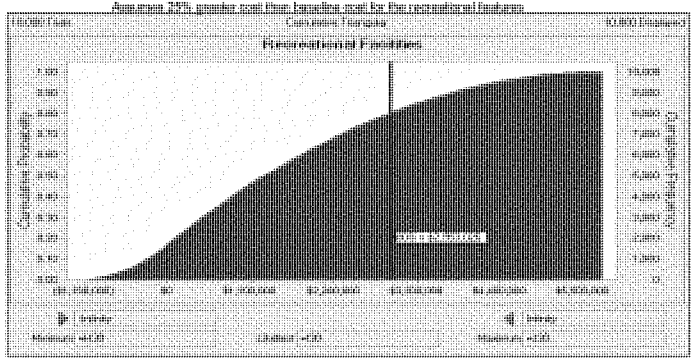
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 5% less cost than baseline cost for the recreational features

High

Most Likely
$23,024,400 14 Recreational Facilitites



Assumption: **Recreational Facilities**

Percentile	Assumption values
0%	($1,130,103)
10%	($254,454)
20%	$110,464
30%	$464,283
40%	$855,527
50%	$1,276,537
60%	$1,773,445
70%	$2,301,326
80%	$2,953,026
90%	$3,764,057
100%	$5,674,666

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-16	Fuel Cost Concerns	($4,851,910)	$0	$12,129,775

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

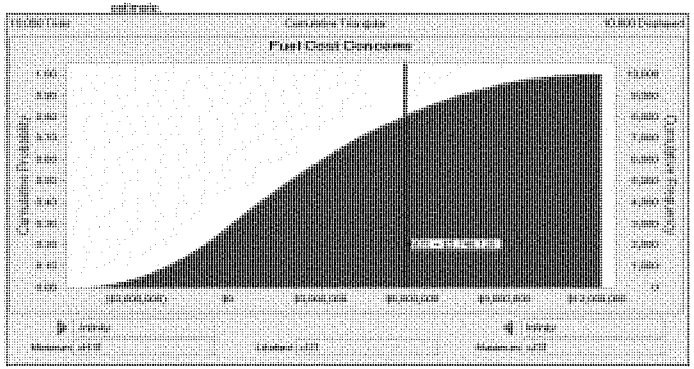
Likely Likely assumes no change from the baseline estimate.

Low Assumes that fuel cost could decrease by 10% from what is currently used in the estimate

High Assume that fuel cost could increase by 25% from the costs currently used in the estimate

Most Likely

$48,519,100 Fuel Costs



Assumption: Fuel Cost Concerns

Percentile	Assumption values
0%	($4,805,121)
10%	($1,971,961)
20%	($736,105)
30%	$181,128
40%	$1,097,886
50%	$2,027,409
60%	$3,092,071
70%	$4,231,155
80%	$5,748,128
90%	$7,520,320
100%	$11,922,138

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-1	Mitigation Needs Identified for Upstream Impacts due to staging	($50,000,000)	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

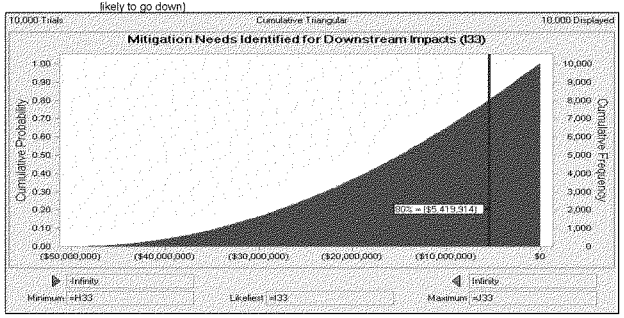
Likely Likely assumes no change from the baseline estimate.

Low There is a possibility that fewer structures may be impacted than is currently estimated based on the type of model used. Assume 200 fewer structures impacted x $250,000 each.

High Assumes that an there are not any additional structures that are affected. (The way the hydraulic model has been set up maximized the area affected so number of structures is likely to go down)

Most Likely

$250,000 Average Structure Cost $250,000 each



Assumption: Mitigation Needs Identified for Upstream Impacts due to staging

Percentile	Assumption values
0%	($49,822,175)
10%	($34,305,842)
20%	($27,912,793)
30%	($22,837,028)
40%	($18,627,857)
50%	($14,919,695)
60%	($11,611,177)
70%	($8,423,651)
80%	($5,419,914)
90%	($2,694,460)
100%	($2,724)

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-2	Potential Savings for Eliminating RR Bridge 4 (RRVW 4th Sub)	($7,709,058)	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

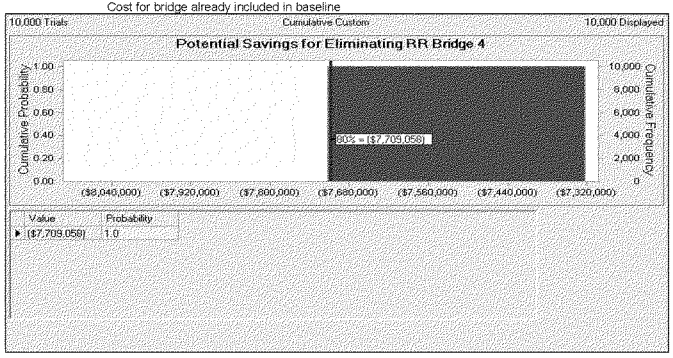
Likely Likely assumes no change from the baseline estimate.

Low If RR abondones RRVW 4th Sub line route this bridge would not be required. Saves cost of bridge + 15% PED and 7% CM

High Cost for bridge already included in baseline

Most Likely

$6,318,900 RR Bridge 4 + track work



Assumption: Potential Savings for Eliminating RR Bridge 4 (RRVW 4th Sub)

Percentile	Assumption values
0%	($7,709,058)
10%	($7,709,058)
20%	($7,709,058)
30%	($7,709,058)
40%	($7,709,058)
50%	($7,709,058)
60%	($7,709,058)
70%	($7,709,058)
80%	($7,709,058)
90%	($7,709,058)
100%	($7,709,058)

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-4	Appraisal	($10,742,245)	$0	$64,453,470

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

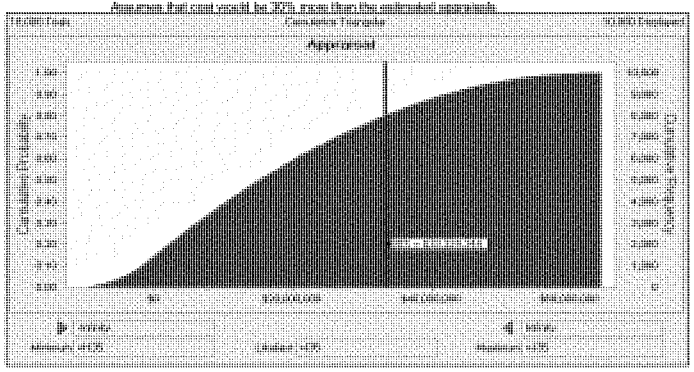
Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than the estimated aprraisals

High

Most Likely

$214,844,900 Lands & Damages



Assumption: Appraisal

Percentile	Assumption values
0%	($10,368,641)
10%	($1,549,940)
20%	$2,305,759
30%	$6,292,704
40%	$10,623,902
50%	$15,268,652
60%	$20,437,725
70%	$26,389,692
80%	$33,324,344
90%	$42,315,936
100%	$63,662,546

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-5	Non-Appraisal	($39,777,160)	$0	$21,484,490

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

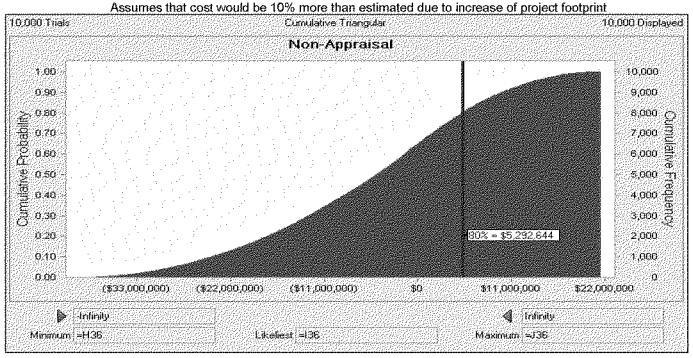
Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 5% less than estimated due to project footprint being less than currently estimated plus $29M recapture cost as identified and estimated by Real Estate Office

High Assumes that cost would be 10% more than estimated due to increase of project footprint

Most Likely

$214,844,900 Lands & Damages



Assumption: Non-Appraisal

Percentile	Assumption values
0%	($39,494,711)
10%	($24,213,339)
20%	($17,494,867)
30%	($12,808,916)
40%	($8,588,155)
50%	($4,659,356)
60%	($1,464,141)
70%	$1,710,913
80%	$5,292,644
90%	$9,929,246
100%	$21,267,254

Risk Refer No.	Risk Event	Low	Most Likely	High
RE-1	Environmental Mitigation Feature Concerns	$0	$0	$0

Notes:

Likely Likely assumes no change from the baseline estimate.

Low Assumes Mitigation work to be 20% less than the baseline

High Assumes Mitigation work to be 20% more than the baseline

Most Likely

$51,120,300 Environmental Mitigation Cost

Assumption: Environmental Mitigation Feature Concerns

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

Risk Refer No	Risk Event	Low	Most Likely	High
RE-2	Historical Cultural Resource Issues	$0	$0	$0

Notes:

This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate = Review and testing + 1 mitigation site per river crossing = $300,000 + (8 x $150,000) = $1,500,000

Low ~~Assumes that no mitigation is required and only cost is the review and testing = $300,000~~ REMOVED FROM MODEL

High ~~Assumes there are two sites per river crossing (one each side of waterway) for mitigation + review & testing = (16 x $150,000) + $300,000 = $2,700,000~~ REMOVED FROM MODEL

Most Likely
$1,500,000 Cultural baseline estimate

Assumption: Historical Cultural Resource Issues

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

Risk Refer No.	Risk Event	Low	Most Likely	High
RE-4	Fish Passage Issues	$0	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that baseline fish passage design is overdesigned and cost savings of 10% can be achieved

High Assumes that baseline fish passage design required additional design and cost increases by 20%

deleted from model, considered in TL-12

Most Likely	
$5,950,300	RRN Inlet fish passage
$4,550,300	WRR Structure fish passage
$1,826,800	Lower Rush River Structure fish passage
$1,247,200	Rush River Structure fish passage
$1,260,300	RRN Outlet fish passage
$14,834,900	Total

Assumption: Fish Passage Issues

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

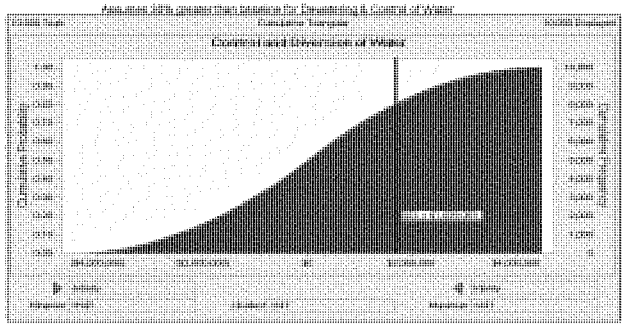
Risk Refer No.	Risk Event	Low	Most Likely	High
CON-2	Control and Diversion of Water	($4,486,110)	$0	$4,486,110

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes 30% of baseline for Dewatering & Control of Water (Reduced from 50% --> 5% already in TL-6 and 15% already in TL12)

High



Assumption: Control and Diversion of Water

Percentile	Assumption values
0%	($4,377,189)
10%	($2,530,566)
20%	($1,984,013)
30%	($1,031,560)
40%	($437,215)
50%	$35,804
60%	$525,177
70%	$1,052,176
80%	$1,689,069
90%	$2,500,361
100%	$4,427,802

Most Likely

$503,800	Reach 1 Dewatering & Control of Water
$145,700	Reach 2 Dewatering & Control of Water
$744,300	Reach 3 Dewatering & Control of Water
$2,656,300	Reach 4 Dewatering & Control of Water
$666,300	Reach 5 Dewatering & Control of Water
$4,102,600	Reach 6 Dewatering & Control of Water
$306,200	Reach 7 Dewatering & Control of Water
$194,300	Reach 8 Dewatering & Control of Water
$1,091,500	RRN Inlet Structure Dewatering
$1,060,800	WRR Structure Dewatering
$1,060,800	Sheyenne River Structure Dewatering
$1,060,800	Maple River Structure Dewatering
$285,000	Lower Rush River Structure Dewatering
$285,000	Rush River Structure Dewatering
$50,400	Wolverton Creek Dewatering
$147,100	Inlet Weir Dewatering
$25,200	Drain 14 Dewatering
$63,500	RRN Inlet Temporary Levees
$114,400	WRR Temporary Levees
$31,800	Inlet Weir Temporary Levees
$200,200	Sheyenne River Structure Temp Levees
$69,300	Maple River Structure Temp Levees
$44,200	Lower Rush River Structure Temp Levees
$44,200	Rush River Structure Temp Levees
$14,953,700	Total

Risk Rater No.	Risk Event	Low	Most Likely	High
CON-5	Project Sequencing	($8,700,682)	$0	$43,504,410

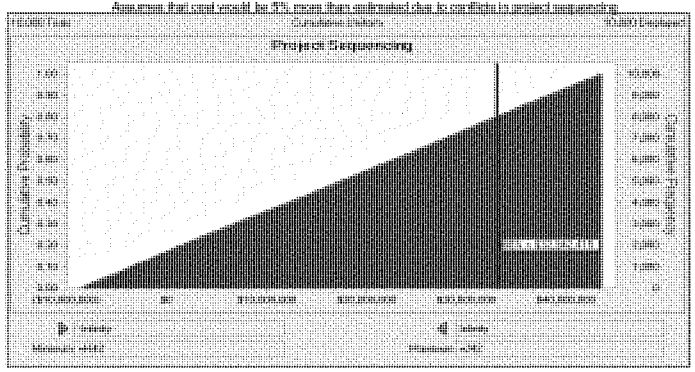
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 1% less than estimated due to sequencing actually saving money

High

Most Likely	
$103,611,800	Roads & Bridges
$46,497,500	Railroad Bridges
$608,789,400	Channels & Canals
$111,189,500	Levees
$870,088,200	



Assumption: Project Sequencing

Percentile	Assumption values
0%	($8,697,537)
10%	($3,686,013)
20%	$1,371,805
30%	$6,644,653
40%	$12,095,011
50%	$17,364,637
60%	$22,700,526
70%	$27,845,098
80%	$32,942,415
90%	$38,137,381
100%	$43,497,226

Risk Refer No.	Risk Event	Low	Most Likely	High
CON-6	Contract Mods	($24,002,548)	$0	$96,010,190

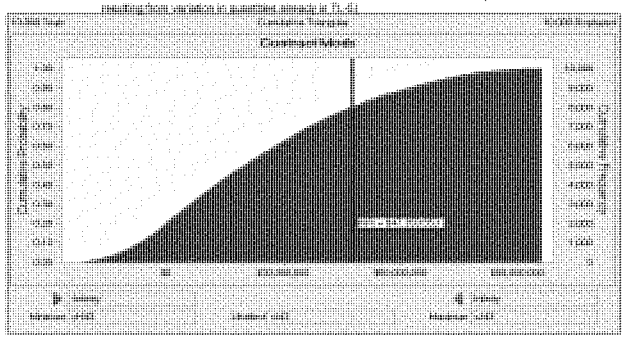
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 2.5% less than estimated due to contract mods that save money (i.e., by contractor VE proposals)

High Assumes that cost would be 10% more than estimated due to contract mods (mods

Most Likely	
$119,479,700	02 Relocations
$51,120,300	06 Fish & Wildlife - Mitigation
$46,497,500	08 Railroads
$608,789,400	09 Channels
$111,190,600	11 Levees, Floodwalls & Floodproofing
$23,024,400	14 Recreational Facilities
$960,101,900	Total



Assumption: Contract Mods

Percentile	Assumption values
0%	($23,641,627)
10%	($6,763,507)
20%	($123,118)
30%	$6,190,901
40%	$12,618,928
50%	$20,036,331
60%	$27,912,056
70%	$36,500,594
80%	$47,359,553
90%	$62,372,258
100%	$95,089,397

Risk Refer No.	Risk Event	Low	Most Likely	High
EST-1	Potential Fluctuation in Labor Costs	($21,337,805)	$0	$42,675,610

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

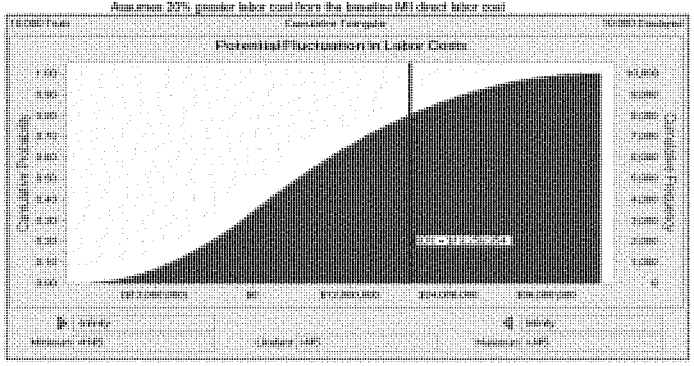
Likely Likely assumes no change from the baseline estimate.

Low Assumes 10% less labor cost from the baseline MII direct labor cost

High

Most Likely

$213,378,052 Labor from MII



Assumption: **Potential Fluctuation in Labor Costs**

Percentile	Assumption values
0%	($21,048,453)
10%	($9,990,599)
20%	($5,155,268)
30%	($1,287,958)
40%	$1,954,277
50%	$5,531,164
60%	$9,458,775
70%	$13,769,589
80%	$19,258,954
90%	$26,023,648
100%	$42,203,668

Risk Refer No.	Risk Event	Low	Most Likely	High
EST-2	WBS Elements - Estimate confidence	$0	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that cost would be 10% less than estimated for L&D and Mitigation

High Assumes that cost would be 20% more than estimated for L&D and Mitigation

Most Likely	
$257,702,600	Lands & Damages
$51,120,300	Environmental Mitigation
$308,822,900	

Assumption: WBS Elements - Estimate confidence

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

Risk Refer No.	Risk Event	Low	Most Likely	High
EST-4	PED & CM	($57,029,940)	$0	$0

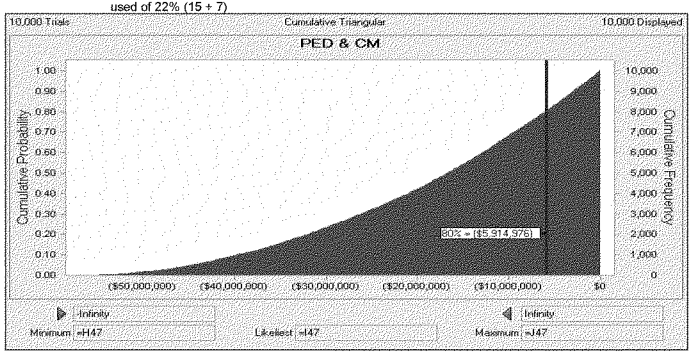
Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes that PED & CM cost would be a total of 16% of the project cost rather than the currently used 22% (15 + 7). The 16% is based on the $410M Grand Forks/East Grand Forks Flood control project which was more urban levees & floodwalls. (16/22 = 0.727)

High Assumes that PED & CM cost would be the percent of the currently estimated construction cost used of 22% (15 + 7)

Most Likely	
$144,015,000	Lands & Damages
$67,207,000	Environmental Mitigation
$211,222,000	



Assumption: PED & CM

Percentile	Assumption values
0%	($56,470,612)
10%	($39,661,854)
20%	($31,915,392)
30%	($26,143,891)
40%	($20,875,317)
50%	($16,574,122)
60%	($12,797,376)
70%	($9,350,377)
80%	($5,914,976)
90%	($2,900,895)
100%	($9,808)

Risk Refer No.	Risk Event	Low	Most Likely	High
PR-1	Uncertainty with Funding Stream	$0	$0	$0

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate,

Low Assumes 10% less than baseline project cost estimate

High Assumes 20% more than baseline project cost estimate

Most Likely	
$214,844,900	01 Lands & Damages
$119,479,700	02 Relocations
$51,120,300	06 Environmental Mitigation
$46,497,500	08 RR Bridges
$608,789,400	09 Diversion Channel
$111,190,600	11 Levees & Floodwalls
$23,024,400	14 Recreational Features
$144,015,000	30 PED
$67,207,000	31 CM
$1,386,168,800	Total

Assumption: **Uncertainty with Funding Stream**

Percentile	Assumption values
0%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
90%	
100%	

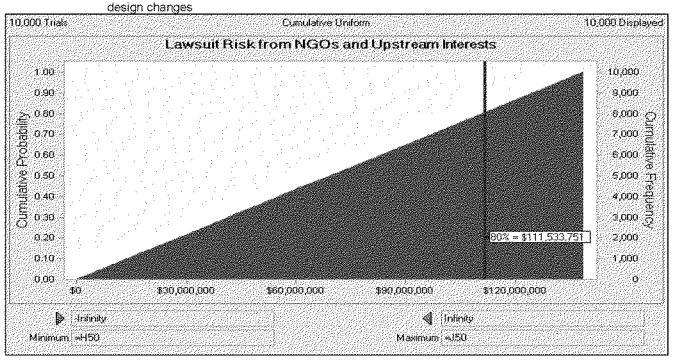
Risk Refer No	Risk Event	Low	Most Likely	High
PR-6	Lawsuit Risk from NGOs and Upstream Interests	$0	$0	$138,616,880

Notes: This item captures the risk that will cause a variance from the current working estimate for the project.

Likely Likely assumes no change from the baseline estimate.

Low Assumes cost to remain at baseline if there are no lawsuits from upstream interest

High Assumes 10% greater cost due to lawsuits from upstream interests that cause project delays or design changes



Assumption: **Lawsuit Risk from NGOs and Upstream Interests**

Percentile	Assumption values
0%	$19,731
10%	$13,897,349
20%	$28,195,987
30%	$41,695,174
40%	$55,147,314
50%	$69,567,899
60%	$83,788,954
70%	$97,483,674
80%	$111,533,751
90%	$125,336,460
100%	$138,614,006

Most Likely	
$214,644,900	01 Lands & Damages
$119,479,700	02 Relocations
$51,120,300	05 Environmental Mitigation
$46,497,500	08 RR Bridges
$608,789,400	09 Diversion Channel
$111,190,600	11 Levees & Floodwalls
$23,024,400	14 Recreational Features
$144,015,000	30 PED
$67,207,000	31 CM
$1,386,168,800	Total

MVP - Fargo/Moorhead Feasibility Report (LPP - North Dakota Option) - PDT Risk Register

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)															
	PROJECT & PROGRAM MGMT														
PPM-1	Project Schedule in Question	Due to the size and magnitude of the project, as well as the complexity of the structures and sequencing, there is inherent concern regarding the actual project schedule.	This could cause a variance in the project schedule (positive or negative, but most likely negative).	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Project Manager	Project Cost & Schedule
PPM-2	Accelerated Design Schedule	An accelerated schedule can result in inadequate studies, shortcuts in plans, change in contract acquisition strategy, failure to capture full scope, miss-steps, etc. There is the potential of moving forward with limited information.	This issue is covered in other risk events.	Likely	Significant	High		Likely	Significant	High		Triangular		District Management	Project Cost & Schedule
PPM-3	Unplanned Work that Must be Accommodated	Due to the preliminary stage of project development, there is potential that there may be features or subfeatures of work that must be added to construction. Ice handling and sediment transport are the two most likely issues that must be accommodated. There may also be mitigation requirements.	Most of these subfeatures are already captured in the design and estimate, but the configuration may change.	Likely	Significant	High		Likely	Marginal	Moderate		Yes-No		Project Manager	Project Cost & Schedule
PPM-4	Local Agency/Regulator Issues	The acceleration of the planning schedule has forced reviews and collaboration without much time given to local agencies and regulators. Although there has been communication between the Government and the local agencies, these agencies have not responded with definitive decisions. This could present potential impacts.	There has been some discussion and pushback from agencies to entertain altering the level of flows allowed in the protected area from a 2-year as designed to a 5-year. Specifically, agencies may require that lower flows must be accommodated. This could impact cost and schedule.	Likely	Significant	High		Likely	Marginal	Moderate		Yes-No		Project Manager	Project Cost & Schedule
PPM-7	Contracting Staffing	Contracting is experiencing a lack of staffing, causing challenges in obtaining resources on a timely basis for all procurements.	Could cause a variance in the schedule.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Uniform		District Management	Project Schedule
PPM-8	Scope Changes	The many competing interests & priorities, coupled with an accelerated schedule could result in scope changes currently uncaptured or unanticipated. These scope changes would require additional coordination, cause further design and investigation and potentially impact the real estate acquisitions.	While minor alterations to the final alignment may occur, there should not be any major changes.	Likely	Marginal	Moderate		Likely	Significant	High		Yes-No		Project Manager	Project Cost & Schedule
	CONTRACT ACQUISITION RISKS														
CA-1	Undefined Acquisition Strategy	The overall acquisition strategy for both design and construction has not been defined. Acquisition strategy could affect/impact bid competition and bid costs. It can also move risk onto the Government, causing need for greater contingencies. Clarification should be made related to number of contracts, contract types, etc. authority for this procurement.	Acquisition strategy needs to be defined and could impact the cost and schedule.	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		TASB	Contract Cost & Project Schedule
CA-2	Preference to Small Business	Most of the larger requirements are so large that they would not be suitable for small business. However, there is potential for some of the restoration, seeding, and mitigation may be suitable for small business. There is a requirement for review by the PARC if the requirements were less than $50 Million.	The project is so large, it is likely that even separable requirements would not be suitable for small business. Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost & Project Schedule
CA-3	Numerous Separate Contracts	There is potential to have numerous separate contracts, especially if the continuing contracts authority is not granted. Funding stream issues could also have an impact on the number of contracts.	The best case would be 8 contracts. The worst case would be in excess of 12 contracts. More contracts could increase bidding competition. This could have a significant effect on cost and schedule (either positive or negative).	Very Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Contracting	Contract Cost
CA-4	Potential Bid Protests	The larger size of the project increase contractor interests in bidding, but also increases potential risk for protests due to hungry economy and interest in obtaining project dollars.	This could impact cost and schedule.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Yes-No		Contracting	Contract Cost
	TECHNICAL RISKS														
TL-1	Uncertainty with Geotechnical Conditions	There is uncertainty with geotechnical conditions but the Phase 3 estimate uses recent borings from 2010 to help define the the soil parameters for excavation and how that will impact the construction productivity. The material is all clay and silt.	The current working estimate is fairly conservative. However, variation in the ultimate characterization of material could cause significant variance in productivity. Could impact cost and schedule (positive or negative).	Likely	Critical	High		Likely	Marginal	Moderate		Triangular		Geotechnical/Civil Design	Contract Cost & Project Schedule

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
TL-2	Survey Data Incomplete	The PDT currently has incomplete or outdated survey data (for bathymetry for the Red River and Tributaries)	If the survey data uncovers data that differs greatly from current conceptual design, it could lead to variance in cost (due to issues such as configuration and details for structures). More likely on ND side.	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
TL-3	Maple Diversion Structure Concerns	Under very high flood events, water flows over and under the diversion structure. This could present issues, as this an unusual technical approach.	This could impact cost negatively. Could impact the schedule one year.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Yes-No		Hydrology/Hydraulic Design	Contract Cost & Project Schedule
TL-4	Sedimentation Modeling	The sedimentation modeling could show that higher flow accommodation may be necessary in the tributary structures.	This issue is more likely on Wild Rice, but not as likely on the Sheyenne or the Maple. This could impact cost and schedule.	Unlikely	Significant	Moderate		Unlikely	Negligible	Low		Yes-No		Hydrology/Hydraulic Design	Contract Cost
TL-5	Variation in Estimated Quantities	There is potential for variation of estimated quantities in the excavation and earthwork features.	This could impact cost and schedule.	Likely	Significant	High		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Contract Cost
TL-6	Flowrate Capacity	effect the amount of flow required for the diversion channel to handle. This would affect channel width, bridge lengths and major hydraulic structure sizes	This could impact cost and schedule.	Likely	Significant	High		Likely	Marginal	Moderate		Yes-No		Hydrology/Hydraulic Design	Project Cost & Schedule
TL-7	Relocations - Utilities	Quality of design at budget level	Most costs were obtained from affected utilities for the major lines that are impacted.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-8	Relocations - Bridges	Bridge costs will change depending on final diversion channel width.	Bridge costs from historical DOT costs are fairly reliable.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
TL-9	Mitigation	fish, wetlands, invest. adaptive management	Resource agencies have not agreed to any particular features yet as there is the potential for additional mitigation beyond what is proposed.	Very Likely	Significant	High		Likely	Negligible	Low		Uniform		Environmental Compliance	Project Cost
TL-10	Railroad Bridges	RR Bridge sizes have changed since the initial RR bridge estimates and the costs have been scaled	Bridge costs from BNSF's consulting engineer are at conceptual design and cost could have significant changes	Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Structural Design	Contract Cost
TL-11	Diversions Excavations & Productivity	Excavations could be impacted by diversion alignment changes and/or model results	Impacts should only affect quantities of different soil layers	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Geotechnical/Civil Design	Contract Cost
TL-12	Hydraulic Structures	Hydraulic structures will need to be modeled	Model results could change design concepts	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Hydrology/Hydraulic Design	Contract Cost & Project Schedule
TL-13	Levees	Levee heights and lengths could change depending on if upstream staging is incorporated	Levees for upstream staging may depend on model studies and landowner opposition	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Hydrology/Hydraulic Design	Contract Cost & Project Schedule
TL-14	Non-Structural Floodproofing	Costs for downstream impacts could change when the effects of have been fully developed	With Phase 4 LPP design with the upstream staging, there should not be any downstream impacts.	Unlikely	Negligible	Low		Unlikely	Marginal	Low		Triangular		Technical Lead	Project Cost
TL-15	Recreational Facilities	Feasibility is at conceptual design	Final designs could look different than Feasibility but overall concepts should be similar	Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Cost Engineering	Contract Cost
TL-16	Fuel Cost Concerns	Volatility in the price of fuel	project. Conversely, if the world markets calm down, fuel could return to a price lower that currently estimated in the project.	Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Cost Engineering	Contract Cost
	LANDS AND DAMAGES RISKS														
LD-1	Mitigation Needs Identified for Upstream Impacts due to staging	The effects of the project on areas upstream may require mitigation footprint that has not been finalized. The impacts may not be fully captured	This could significantly impact costs depending on final staging area configuration. It could significantly impact schedule	Likely	Significant	High		Likely	Significant	High		Yes-No		Real Estate	Project Cost & Schedule
LD-2	Potential Savings for Eliminating RR Bridge 4	Currently, the RRVW RR has limited use of this line and indicated that abandonement is possible	This could save the cost of bridge and track raise	Likely	Significant	High		Very Unlikely	Negligible	Low		Yes-No		Project Manager	Project Cost & Schedule
LD-4	Appraisal	Appraisals carry certain assumptions based on technical information. If the technical information has the potential to change, the appraisals could be impacted.	Appraisals are using an average value	Likely	Significant	High		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
LD-5	Non-Appraisal	Real Estate office is responsible for establishing contingencies. There could be risks outside their domain that can still impact the costs.	Real Estate office will be using the CSRA contingencies	Likely	Marginal	Moderate		Likely	Marginal	Moderate		Triangular		Real Estate	Project Cost
	REGULATORY AND ENVIRONMENTAL RISKS														

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
RE-1	Environmental Mitigation Feature Concerns	The PDT is going to add a lump sum for separable environmental mitigation (to include construction and real estate). This has not been well defined or finalized.	This could impact the costs either positively or negatively.	Likely	Significant	High		Very Unlikely	Negligible	Low		Triangular		Environmental Compliance	Project Cost
RE-2	Historical Cultural Resource Issues	There is potential to find cultural resources particularly on the riverbanks. No cultural resource survey has been completed to date. Mitigation will probably be necessary.	Could impact cost	Very Likely	Marginal	Moderate		Unlikely	Marginal	Low		Triangular		Environmental Compliance	Project Cost
RE-3	HTRW Issues	There is some potential for discovery of HTRW in the project alignment. Most of the alignment is through farmland.	Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule
RE-4	Fish Passage Issues	There will be fish passage requirement in the project, but the actual configuration has not been finalized/agreed upon by the local agencies.	Could impact cost.	Likely	Marginal	Moderate		Unlikely	Negligible	Low		Triangular		Technical Lead	Project Cost
RE-5	Pressure to Compress Permitting Activities	The local agencies perceive that they are being pressured through the project permitting process.	PDT has programmed this into the schedule, and the agencies are not constricted more than normal review times.	Very Unlikely	Negligible	Low		Unlikely	Negligible	Low		Uniform		Environmental Compliance	Project Cost & Schedule
	CONSTRUCTION RISKS														
CON-1	Unknown Residential Utility Conflicts	There is potential for the need to abandon some small residential utilities.	This could impact cost and schedule, but it would be negligible.	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Technical Lead	Contract Cost & Project Schedule
CON-2	Control and Diversion of Water	Methodology of controlling water could be impacted by the sequencing and timing of relocation, the characterization of materials, or other unknown impacts.	Could impact cost and schedule.	Likely	Significant	High		Unlikely	Marginal	Low		Triangular		Technical Lead	Contract Cost
CON-3	Conflicts between Contractors	There is potential for conflicts between multiple contractors working in the same footprint at the same time.	Could impact cost	Likely	Negligible	Low		Unlikely	Negligible	Low		Triangular		Construction	Contract Cost & Project Schedule
CON-4	Sufficient QA Staff	to manage numerous contracts, mods and claims	ED-C is well aware of QA staffing issues and is planning accordingly	Unlikely	Marginal	Low		Unlikely	Negligible	Low		Triangular		Contracting	Contract Cost & Project Schedule
CON-5	Project Sequencing	conflicts between contractors and schedule impacts (one contractor waiting on another)	Conflicts may develop at reaches interface, building of bridges or hydraulic structures.	Likely	Significant	High		Likely	Marginal	Moderate		Uniform		Construction	Project Cost & Schedule
CON-6	Contract Mods	Contract mods and claims resulting from unforeseen site conditions, weather impacts, political and lawsuit impacts are a concern and can impact both cost and schedule.	Many of these concerns may be valid and impact the project.	Likely	Significant	High		Likely	Negligible	Low		Triangular		Construction	Contract Cost
	ESTIMATE AND SCHEDULE RISKS														
EST-1	Potential Fluctuation in Labor Costs	There is concern that the labor force required for this work could be a challenge, requiring off-site labor, per diem and premium pay, as well as unique markups and multipliers for workers compensation and other factors.	Estimate currently has National Wage rates, which are higher than the local Davis-Bacon Wage Determination. The Estimate also includes $75/day for per diem. There is potential for savings, as the labor wage rate for North Dakota is cheaper than Minnesota. This could impact costs either positively or negatively	Likely	Significant	High		Very Unlikely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
EST-2	WBS Elements - Estimate confidence	Certain WBS elements are better developed in scope and estimate than other scope areas. Some WBS elements may be more or less conservative. Some elements have greater risk and resulting need for greater contingencies.	The major cost elements for the diversion excavation, hydraulic structures and bridges have been highly developed for feasibility since they make up the bulk of the cost items. Env/ornmental mitigation features are less develop and more conceptual and likely will change. Real Estate may be another area of risk confidence	Likely	Marginal	Moderate		Likely	Marginal	Low		Triangular		Cost Engineering	Contract Cost
EST-3	Estimate assumptions	The estimate assumptions may be flawed in certain cost areas related to scope, crews, productivity, material cost, markups, contingencies, etc. This could result in a flawed budget development.	The estimate has been in development for enough time that scope, crews, productivity, material costs and markups are fairly well developed. Contingencies are from the CSRA.	Unlikely	Marginal	Low		Likely	Negligible	Low		Triangular		Cost Engineering	Contract Cost
EST-4	PED & CM	The estiamte currently uses 15% PED and 7% CM of the construction cost.	With the high construction cost of this project and the amount of design required for excavation, these percentages may be too high, based on about 16% for the $410M Grand Forks/East Grand Forks Flood project which was more urban levees & floodwalls.	Likely	Significant	High		Unlikely	Negligible	Low		Triangular		Cost Engineering	Project Cost

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)															
PR-1	Uncertainty with Funding Stream	There is a window of opportunity during the next couple years of obtaining the necessary increments on a timely basis. However, historically this has been a challenge in obtaining the increments necessary to complete on schedule, and there have been challenges in obtaining them on a timely basis.	This could impact both cost and schedule.	Very Likely	Significant	High		Very Likely	Significant	High		Uniform		Project Manager	Project Cost & Schedule
PR-2	Unusually Wet Season	If a given construction season is unusually higher than an average year, it could have significant impact on the productivity of the work.	If this it occurs, it reduce productivity and create substantial delays.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		Binomial		N/A	Project Cost & Schedule
PR-3	Flooding Event	There is a chance of a flooding event during construction that could cause damage to constructed work features.	This could impact both cost and schedule.	Very Unlikely	Negligible	Low		Very Unlikely	Negligible	Low		Binomial		N/A	Project Cost & Schedule
PR-4	Political factors change at state, local, or federal level	Senator Dorgan has retired. He was very influential and favorable to the project interests. Since the authorization was not obtained prior to his departure, there is concern that the project would not be authorized or funded on a timely basis.	Could impact cost and schedule.	Unlikely	Marginal	Low		Unlikely	Crisis	High		Yes-No		Project Manager	Project Schedule
PR-5	Political opposition	There could be opposition from Federal Agencies (FEMA, FWS, and EPA).	Could impact cost and schedule.	Likely	Marginal	Low		Likely	Marginal	Moderate		Uniform		Project Manager	Project Cost & Schedule
PR-6	Lawsuit Risk from NGOs and Upstream Interests	There may be perceived damages from upstream concerns or non-sponsor cities that are affected.	Could impact cost and schedule.	Likely	Significant	High		Unlikely	Significant	Moderate		Uniform		Project Manager	Project Schedule

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

Contingency on Base Estimate	80% Confidence Project Cost
Baseline Estimate Cost (Most Likely) ->	$1,387,078,819
Baseline Estimate Cost Contingency Amount ->	$278,937,013
Baseline Estimate Construction Cost (80% Confidence) ->	$1,666,015,833

Contingency on Schedule	80% Confidence Project Schedule
Project Schedule Duration (Most Likely) ->	122.2 Months
Schedule Contingency Duration ->	116.5 Months
Project Schedule Duration (80% Confidence) ->	238.7 Months
Project Schedule Contingency Amount (80% Confidence) ->	$86,260,054

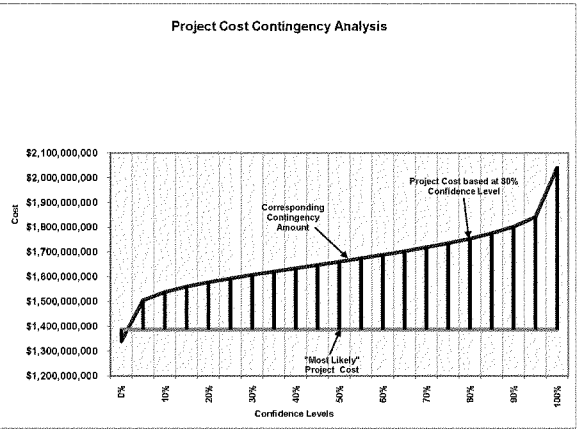
Project Contingency	80% Confidence Project Cost
Project Contingency Amount (80% Confidence) ->	$367,197,067
Project Contingency Percentage (80% Confidence) ->	26%

Project Cost (80% Confidence) ->	$1,754,275,887

- PROJECT CONTINGENCY DEVELOPMENT -

Contingency Analysis

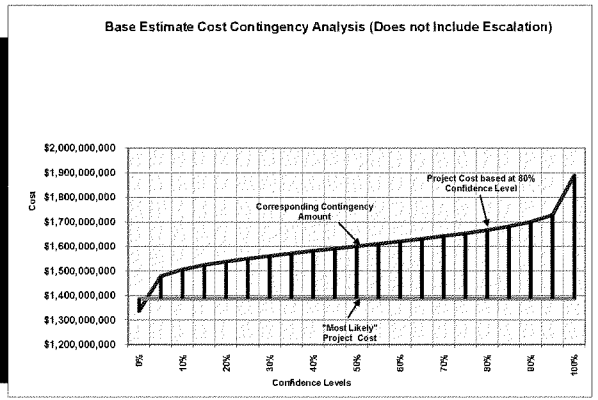
Most Likely Cost Estimate	$1,387,078,819		
Confidence Level	Project Cost	Contingency	Contingency %
0%	$1,339,855,676	($47,223,143)	-3.40%
5%	$1,505,513,807	$118,434,988	8.54%
10%	$1,538,269,944	$151,191,124	10.90%
15%	$1,560,810,805	$173,731,985	12.53%
20%	$1,577,802,468	$190,723,649	13.75%
25%	$1,593,278,637	$206,199,818	14.87%
30%	$1,607,580,440	$220,501,621	15.90%
35%	$1,621,111,138	$234,032,319	16.87%
40%	$1,634,694,783	$247,615,964	17.85%
45%	$1,647,129,777	$260,050,958	18.75%
50%	$1,660,870,979	$273,792,160	19.74%
55%	$1,674,604,577	$287,525,758	20.73%
60%	$1,688,826,432	$301,747,612	21.75%
65%	$1,703,289,774	$316,210,955	22.80%
70%	$1,719,421,608	$332,342,789	23.96%
75%	$1,735,440,729	$348,361,910	25.11%
80%	$1,754,275,887	$367,197,067	26.47%
85%	$1,775,988,250	$388,909,431	28.04%
90%	$1,802,415,619	$415,336,800	29.94%
95%	$1,840,932,008	$453,853,189	32.72%
100%	$2,040,970,710	$653,891,891	47.14%



- BASE CONTINGENCY DEVELOPMENT -

Contingency Analysis

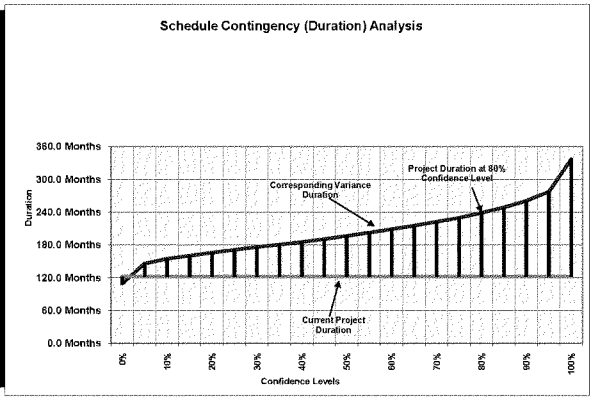
Most Likely Cost Estimate	$1,387,078,819		
Confidence Level	Project Cost	Contingency	Contingency %
0%	$1,336,855,935	($50,222,884)	-3.62%
5%	$1,478,536,519	$91,457,700	6.59%
10%	$1,505,453,347	$118,374,528	8.53%
15%	$1,524,147,605	$137,068,786	9.88%
20%	$1,537,481,951	$150,403,131	10.84%
25%	$1,549,681,209	$162,602,390	11.72%
30%	$1,560,624,812	$173,545,992	12.51%
35%	$1,571,117,586	$184,038,767	13.27%
40%	$1,581,539,408	$194,460,589	14.02%
45%	$1,590,558,739	$203,479,920	14.67%
50%	$1,600,501,068	$213,422,249	15.39%
55%	$1,610,094,229	$223,015,410	16.08%
60%	$1,620,246,516	$233,167,697	16.81%
65%	$1,630,424,107	$243,345,287	17.54%
70%	$1,641,958,964	$254,880,145	18.38%
75%	$1,653,035,337	$265,956,518	19.17%
80%	$1,666,015,833	$278,937,013	20.11%
85%	$1,681,112,745	$294,033,926	21.20%
90%	$1,699,645,557	$312,566,738	22.53%
95%	$1,727,019,327	$339,940,507	24.51%
100%	$1,888,078,395	$500,999,575	36.12%



- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

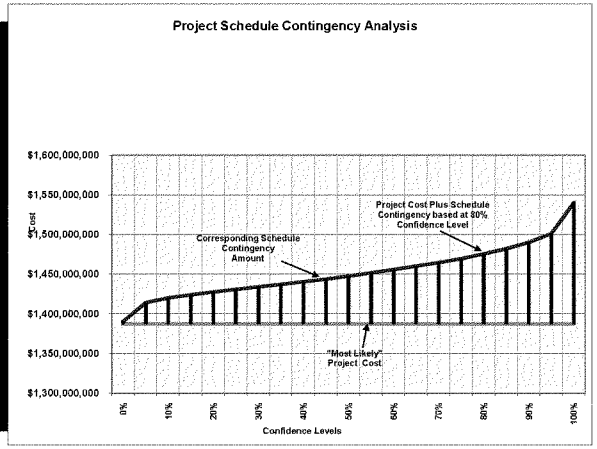
Most Likely Schedule	122.2 Months		
Confidence Level	Project Duration	Contingency	Contingency %
0%	109.6 Months	-12.6 Months	-10.29%
5%	145.9 Months	23.7 Months	19.44%
10%	154.8 Months	32.6 Months	26.68%
15%	160.6 Months	38.4 Months	31.45%
20%	166.1 Months	44.0 Months	35.99%
25%	171.1 Months	48.9 Months	40.05%
30%	176.2 Months	54.0 Months	44.21%
35%	180.8 Months	58.6 Months	47.98%
40%	185.6 Months	63.4 Months	51.90%
45%	190.7 Months	68.6 Months	56.14%
50%	196.5 Months	74.3 Months	60.85%
55%	202.8 Months	80.6 Months	65.98%
60%	208.9 Months	86.8 Months	71.03%
65%	215.4 Months	93.3 Months	76.34%
70%	222.4 Months	100.2 Months	82.04%
75%	229.9 Months	107.7 Months	88.17%
80%	238.7 Months	116.6 Months	95.43%
85%	248.7 Months	126.6 Months	103.63%
90%	260.7 Months	138.5 Months	113.42%
95%	277.6 Months	155.4 Months	127.23%
100%	336.6 Months	214.5 Months	175.56%

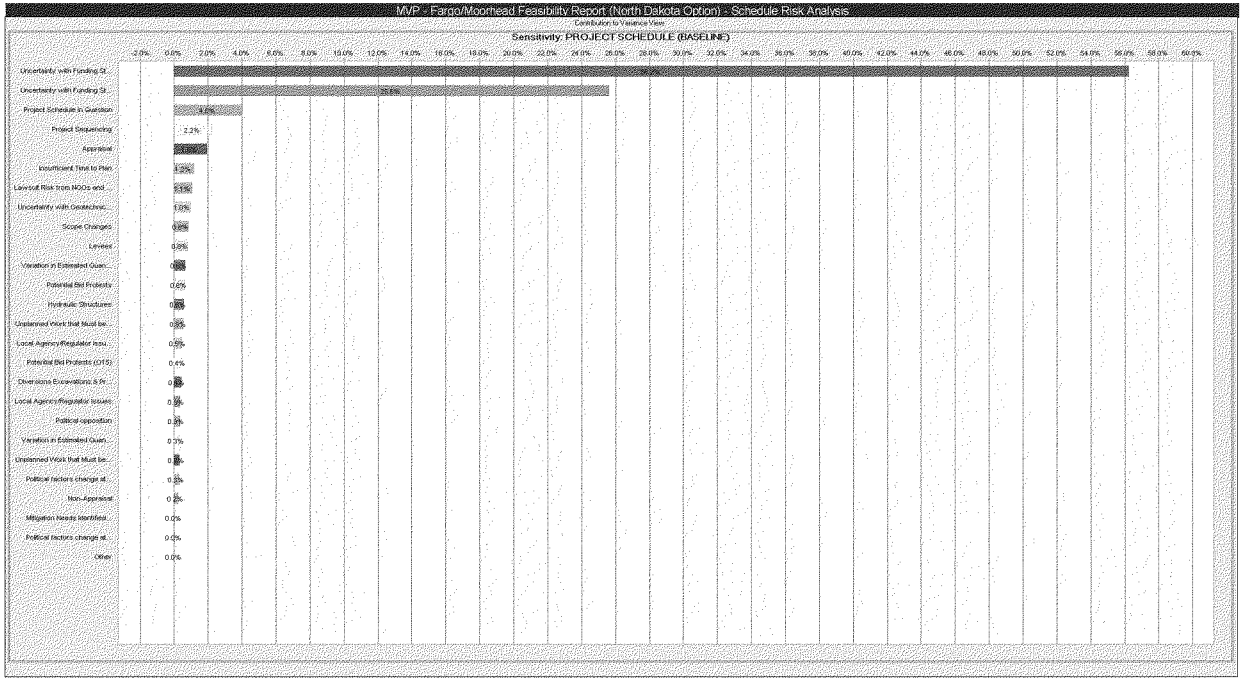


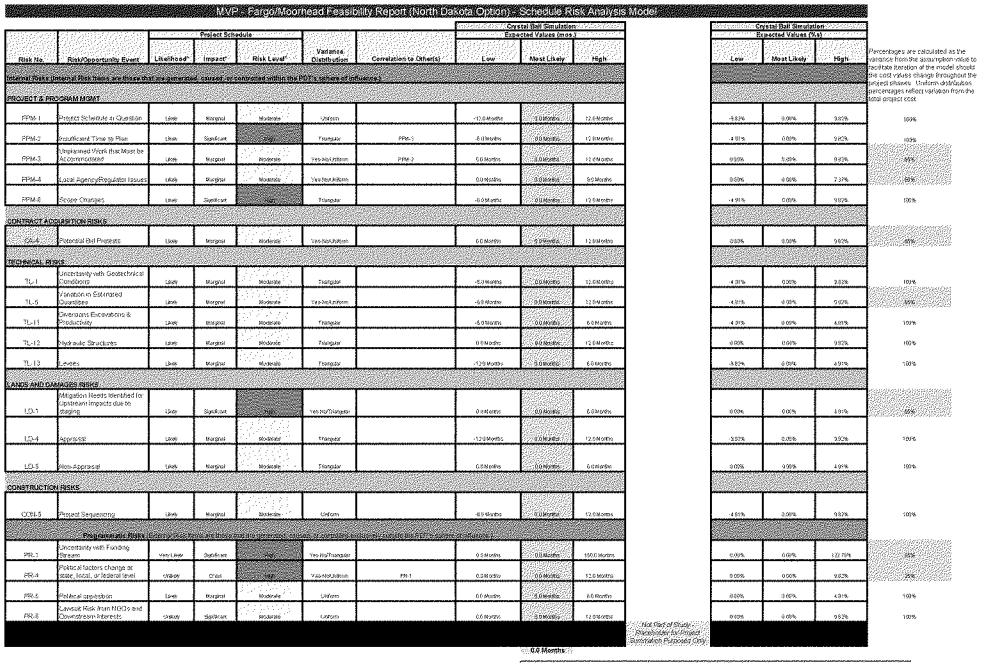
- SCHEDULE CONTINGENCY (AMOUNT) DEVELOPMENT -

Contingency Analysis

Most Likely Cost Estimate	$1,387,078,819		
Confidence Level	Project Cost	Contingency	Contingency %
0%	$1,390,078,560	$2,999,741	0.22%
5%	$1,414,056,107	$26,977,288	1.94%
10%	$1,419,895,416	$32,816,596	2.37%
15%	$1,423,742,019	$36,663,200	2.64%
20%	$1,427,399,336	$40,320,517	2.91%
25%	$1,430,676,248	$43,597,428	3.14%
30%	$1,434,034,448	$46,955,629	3.39%
35%	$1,437,072,372	$49,993,552	3.60%
40%	$1,440,234,194	$53,155,375	3.83%
45%	$1,443,649,857	$56,571,038	4.08%
50%	$1,447,448,730	$60,369,911	4.35%
55%	$1,451,589,167	$64,510,348	4.65%
60%	$1,455,658,735	$68,579,915	4.94%
65%	$1,459,944,487	$72,865,667	5.25%
70%	$1,464,541,463	$77,462,644	5.58%
75%	$1,469,484,212	$82,405,392	5.94%
80%	$1,475,338,873	$88,260,054	6.36%
85%	$1,481,954,325	$94,875,505	6.84%
90%	$1,489,848,881	$102,770,062	7.41%
95%	$1,500,991,501	$113,912,681	8.21%
100%	$1,539,971,135	$152,892,316	11.02%




MVP - Fargo/Moorhead Feasibility Report (North Dakota Option) - Schedule Risk Analysis
Contribution to Variance View
Sensitivity: PROJECT SCHEDULE (BASELINE)
Uncertainty with Funding St...
Uncertainty with Funding St...
Project Schedule in Question
Project Sequencing
Appraisal
Insufficient Time to Plan
Lawsuit Risk from NGOs and...
Uncertainty with Geotechnic...
Scope Changes
Levees
Variation in Estimated Quan...
Potential Bid Protests
Hydraulic Structures
Unplanned Work that Must be...
Local Agency/Regulator Issu...
Potential Bid Protests (OTS)
Diversions Excavations & Fi...
Local Agency/Regulator Issues
Political opposition
Variation in Estimated Quan...
Unplanned Work that Must be...
Political factors change at...
Non-Appraisal
Mitigation Needs Identified...
Political factors change at...
Other



MVP - Fargo/Moorhead Feasibility Report (North Dakota Option) - Schedule Risk Analysis Model

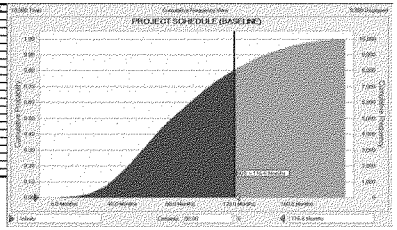
Risk No.	Risk/Opportunity Event	Project Schedule: Likelihood[a]	Impact[a]	Risk Level[a]	Variance Distribution	Correlation to Other(s)	Crystal Ball Simulation: Expected Values (mos.): Low	Most Likely	High	Crystal Ball Simulation: Expected Values (%): Low	Most Likely	High	
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence)													
PROJECT & PROGRAM MGMT													
PPM-1	Project Schedule at Question	Likely	Marginal	Moderate	Uniform		-12.0 Months	0.0 Months	12.0 Months	-8.82%	0.00%	9.80%	100%
PPM-2	Insufficient Time to Plan	Likely	Significant	High	Triangular	PPM-1	-6.0 Months	0.0 Months	12.0 Months	-4.91%	0.00%	9.82%	100%
PPM-3	Unplanned Work that Must be Accommodated	Likely	Marginal	Moderate	Two-Sided Uniform	PPM-2	-6.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	9.82%	100%
PPM-4	Local Agency/Regulator Issues	Likely	Marginal	Moderate	Two-Sided Uniform		-9.0 Months	0.0 Months	9.0 Months	0.00%	0.00%	7.37%	100%
PPM-5	Scope Changes	Likely	Significant	High	Triangular		-6.0 Months	0.0 Months	12.0 Months	-4.91%	0.00%	9.82%	100%
CONTRACT ACQUISITION RISKS													
CAQ-4	Potential Bid Protests	Likely	Marginal	Moderate	Two-Sided Uniform		-6.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	9.82%	100%
TECHNICAL RISKS													
TL-1	Uncertainty with Geotechnical Conditions	Likely	Marginal	Moderate	Triangular		-6.0 Months	0.0 Months	12.0 Months	-4.91%	0.00%	9.82%	100%
TL-5	Variation in Estimated Quantities	Likely	Marginal	Moderate	Two-Sided Uniform		-6.0 Months	0.0 Months	12.0 Months	-4.91%	0.00%	9.82%	100%
TL-11	Dewatering Excavations & Productivity	Likely	Marginal	Moderate	Triangular		-6.0 Months	0.0 Months	6.0 Months	-4.91%	0.00%	4.91%	100%
TL-12	Hydraulic Structures	Likely	Marginal	Moderate	Triangular		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	9.82%	100%
TL-13	Levees	Likely	Marginal	Moderate	Triangular		-12.0 Months	0.0 Months	6.0 Months	-9.82%	0.00%	4.91%	100%
LANDS AND DAMAGES RISKS													
LD-1	Mitigation Needs Identified for Upstream Impacts due to Staging	Likely	Significant	High	Two-Sided Triangular		0.0 Months	0.0 Months	6.0 Months	0.00%	0.00%	4.91%	49%
LD-4	Appraisal	Likely	Marginal	Moderate	Triangular		-12.0 Months	0.0 Months	12.0 Months	-9.82%	0.00%	9.82%	100%
LD-5	Non-Appraisal	Likely	Marginal	Moderate	Triangular		-6.0 Months	0.0 Months	6.0 Months	0.00%	0.00%	4.91%	100%
CONSTRUCTION RISKS													
CONS-5	Project Sequencing	Likely	Marginal	Moderate	Uniform		-6.0 Months	0.0 Months	12.0 Months	-4.91%	0.00%	9.82%	100%
Programmatic Risks (Programmatic Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence)													
PR-1	Uncertainty with Funding Stream	Very Likely	Significant	High	Two-Sided Triangular		0.0 Months	0.0 Months	150.0 Months	0.00%	0.00%	122.79%	25%
PR-4	Political factors change at state, local, or federal level	Unlikely	Great	High	Two-Sided Uniform	PR-1	0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	9.82%	2%
PR-5	Political opposition	Likely	Marginal	Moderate	Uniform		0.0 Months	0.0 Months	6.0 Months	0.00%	0.00%	4.91%	100%
PR-6	Lawsuit Risk from NDDs and Downstream Interests	Unlikely	Significant	Moderate	Uniform		0.0 Months	0.0 Months	12.0 Months	0.00%	0.00%	9.82%	100%

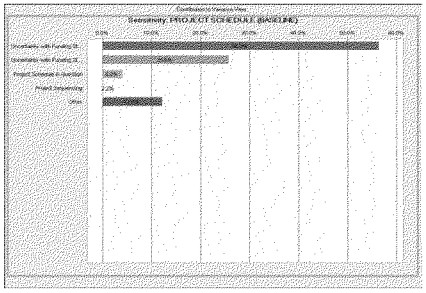
Not Part of Study. Placeholder for Project Summation Purposes Only.

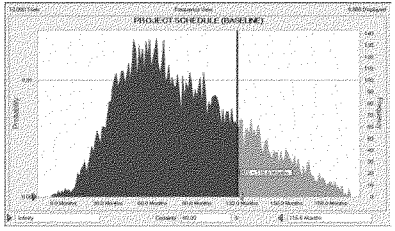
0.0 Months

Percentages are calculated as the variance from the assumption value to facilitate iteration of the model should the cost values change throughout the project phases. Uniform distribution percentages reflect variation from the total project cost.

	Percentile	Baseline Schedule Duration	Contingency	Baseline w/ Contingency	Contingency %
PROJECT SCHEDULE (BASELINE)	0%	122.2 Months	37.8 Months	160.0 Months	23.59%
	5%	122.2 Months	23.7 Months	145.8 Months	19.46%
	10%	122.2 Months	32.6 Months	154.9 Months	26.69%
	15%	122.2 Months	39.4 Months	161.6 Months	31.46%
	20%	122.2 Months	44.0 Months	166.1 Months	35.99%
	25%	122.2 Months	48.8 Months	171.1 Months	40.05%
	30%	122.2 Months	54.9 Months	176.2 Months	44.21%
	35%	122.2 Months	60.8 Months	183.0 Months	47.38%
	40%	122.2 Months	63.4 Months	185.8 Months	51.90%
	45%	122.2 Months	69.6 Months	193.7 Months	56.14%
	50%	122.2 Months	74.3 Months	196.5 Months	60.80%
	55%	122.2 Months	80.8 Months	202.8 Months	66.18%
	60%	122.2 Months	85.8 Months	208.8 Months	71.03%
	65%	122.2 Months	93.3 Months	215.4 Months	76.34%
	70%	122.2 Months	100.2 Months	222.4 Months	82.04%
	75%	122.2 Months	107.7 Months	229.9 Months	88.17%
	80%	122.2 Months	116.5 Months	238.7 Months	95.43%
	85%	122.2 Months	126.6 Months	248.7 Months	103.62%
	90%	122.2 Months	139.5 Months	260.7 Months	113.42%
	95%	122.2 Months	155.4 Months	277.6 Months	127.22%
	100%	122.2 Months	274.6 Months	396.8 Months	175.36%







MVP - Fargo/Moorhead Feasibility Report (North Dakota Option) - Schedule Risk Analysis Model	
Estimated Total Project Cost (Price Level)	$1,387,078,819
Max. Anticipated Annual Amount	$136,337,605
Enter Current OMB Escalation Rate	1.80%
Enter Current Project Location Escalation Rate	1.88%
Enter Assumed Hotel Rate	5.00%

	Date	Cumulative Costs Amount	Risk Amount	Total Estimated Contingency
Enter Current Project Date	28-Apr-23			
Latest Scheduled Project Completion	2-Apr-29	$1,[illegible]	[illegible]	$[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[

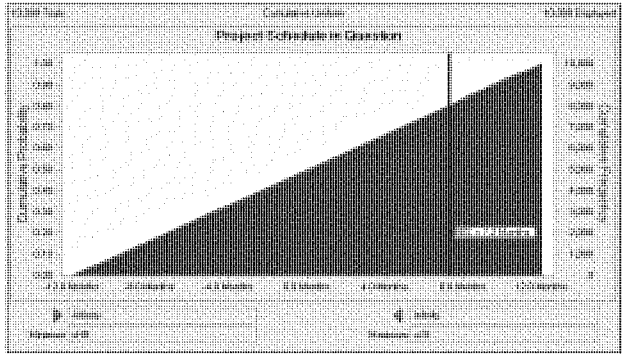
Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-1	Project Schedule in Question	-12.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes schedule concerns are conservative and actual project schedule can be exceeded

High Assumes project schedule is delayed due to complexity of structures and sequencing



Assumption: Project Schedule in Question

Percentile	Assumption values
0%	-12.0 Months
10%	-9.5 Months
20%	-7.1 Months
30%	-4.8 Months
40%	-2.2 Months
50%	0.1 Months
60%	2.5 Months
70%	4.8 Months
80%	7.2 Months
90%	9.5 Months
100%	12.0 Months

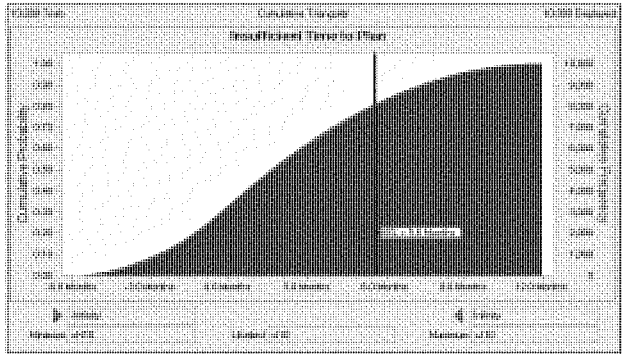
Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-2	Accelerated Design Schedule	-6.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes that best case diversion structure design allow construction to advance by 6 months

High Assumes that uncertainty with the diversion structure design and/or model results causes a 12 month delay in construction



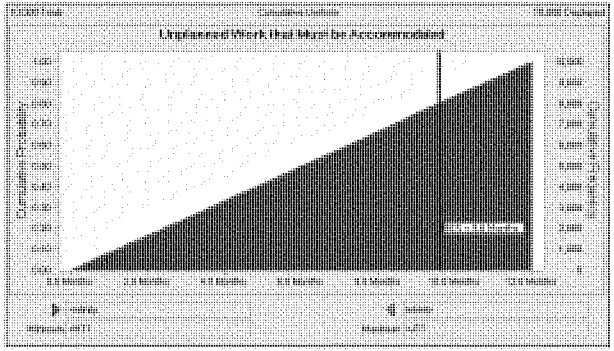
Assumption: Accelerated Design Schedule

Percentile	Assumption values
0%	-6.0 Months
10%	-2.7 Months
20%	-1.3 Months
30%	-0.3 Months
40%	0.7 Months
50%	1.7 Months
60%	2.8 Months
70%	4.1 Months
80%	5.6 Months
90%	7.4 Months
100%	11.9 Months

Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-3	Unplanned Work that Must be Accommodated	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.
Likely Likely assumes no change from the baseline schedule.
Low Assumes no time savings from baseline if there is not any unplanned work

High Assumes 12 month delay from baseline due to unplanned work



Assumption: Unplanned Work that Must be Accommodated

Percentile	Assumption values
0%	0.0 Months
10%	1.2 Months
20%	2.4 Months
30%	3.6 Months
40%	4.8 Months
50%	6.0 Months
60%	7.2 Months
70%	8.4 Months
80%	9.6 Months
90%	10.8 Months
100%	12.0 Months

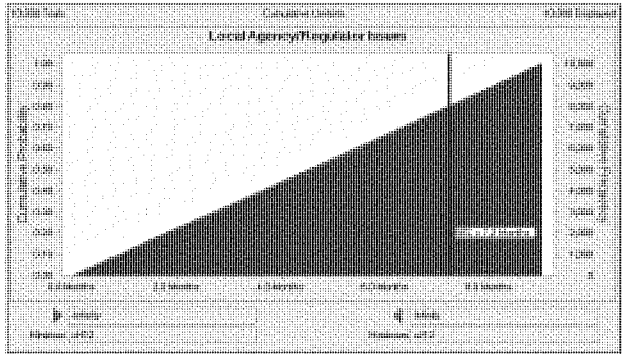
Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-4	Local Agency/Regulator Issues	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes no time savings from baseline if the resource agencies accept the project as currently designed and do not require changes to the design flows

High Assumes 12 month delay from baseline due to agency / regulator issues requiring changes to the design flow rates



Assumption: Local Agency/Regulator Issues

Percentile	Assumption values
0%	0.0 Months
10%	0.9 Months
20%	1.8 Months
30%	2.7 Months
40%	3.7 Months
50%	4.6 Months
60%	5.5 Months
70%	6.4 Months
80%	7.2 Months
90%	8.1 Months
100%	9.0 Months

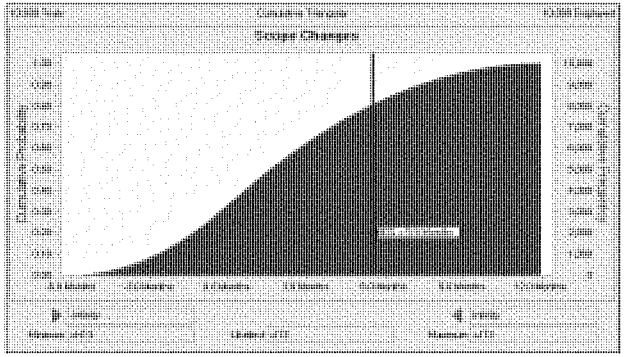
Risk Refer No.	Risk Event	Low	Most Likely	High
PPM-8	Scope changes	-6.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes scope changes decrease project features and schedule.

High Assumes scope changes increase project features, footprint and schedule.



Assumption: Scope changes

Percentile	Assumption values
0%	-5.9 Months
10%	-2.7 Months
20%	-1.3 Months
30%	-0.3 Months
40%	0.7 Months
50%	1.6 Months
60%	2.7 Months
70%	4.0 Months
80%	5.5 Months
90%	7.5 Months
100%	11.8 Months

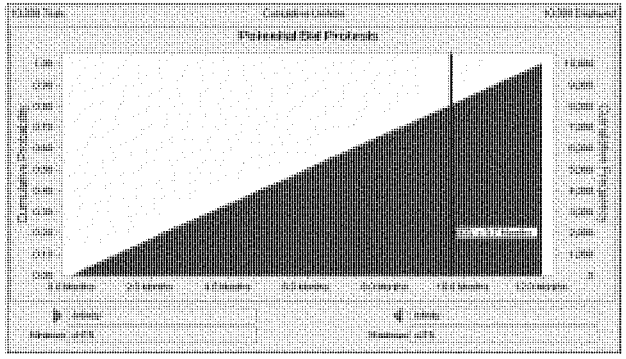
Risk Refer No	Risk Event	Low	Most Likely	High
CA-4	Potential Bid Protests	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes no time savings from baseline if there are not any bid protests

High Assumes 12 month delay from baseline due to bid protests delaying work



Assumption: Potential Bid Protests

Percentile	Assumption values
0%	0.0 Months
10%	1.1 Months
20%	2.3 Months
30%	3.6 Months
40%	4.7 Months
50%	6.0 Months
60%	7.2 Months
70%	8.4 Months
80%	9.7 Months
90%	10.8 Months
100%	12.0 Months

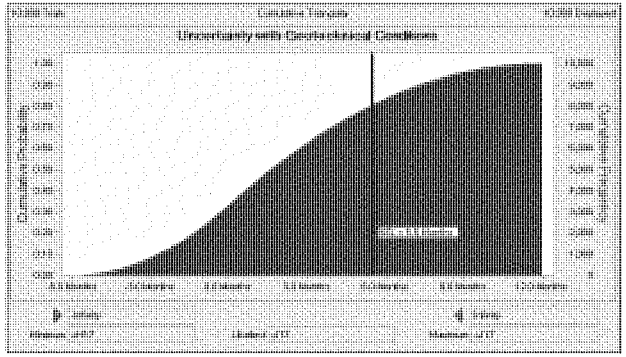
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-1	Uncertainty with Geotechnical Conditions	-6.0 Months	0.0 Months	6.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes that best case geotechnical conditions allow construction to advance by 6 months

High Assumes that uncertainty with geotechnical condtions causes 6 month delay in construction

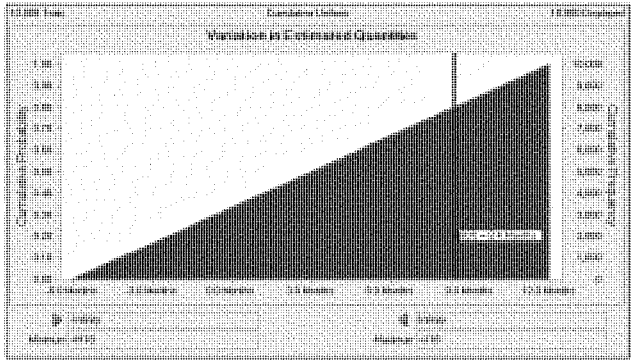


Assumption: Uncertainty with Geotechnical Conditions

Percentile	Assumption values
0%	-5.9 Months
10%	-2.7 Months
20%	-1.3 Months
30%	-0.3 Months
40%	0.6 Months
50%	1.6 Months
60%	2.8 Months
70%	4.0 Months
80%	5.5 Months
90%	7.4 Months
100%	11.9 Months

Risk Refer No.	Risk Event	Low	Most Likely	High
TL-5	Variation in Estimated Quantities	-6.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.
Likely Likely assumes no change from the baseline schedule.
Low Assumes quantities are less than baseline and schedule is shortened
High Assumes quantities are greater than baseline and causes an increase in the schedule



Assumption: Variation in Estimated Quantities

Percentile	Assumption values
0%	-6.0 Months
10%	-4.2 Months
20%	-2.4 Months
30%	-0.6 Months
40%	1.2 Months
50%	3.0 Months
60%	4.8 Months
70%	6.6 Months
80%	8.4 Months
90%	10.2 Months
100%	12.0 Months

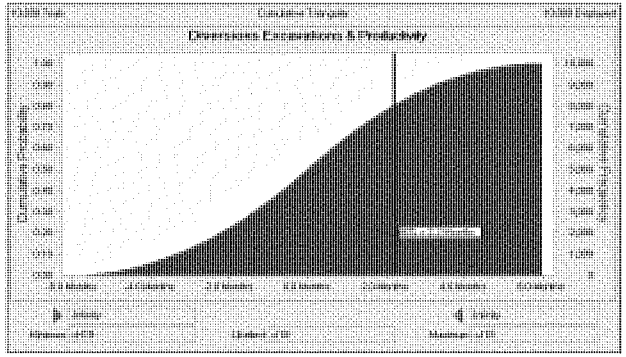
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-11	Diversions	-6.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes diverson alignment changes decrease footprint and quantities making for a shorter schedule than the baseline

High Assumes diverson alignment changes increase footprint and quantities making for a longer schedule than the baseline



Assumption: Diversions

Percentile	Assumption values
0%	-5.9 Months
10%	-3.4 Months
20%	-2.2 Months
30%	-1.4 Months
40%	-0.6 Months
50%	0.0 Months
60%	0.6 Months
70%	1.4 Months
80%	2.2 Months
90%	3.3 Months
100%	5.9 Months

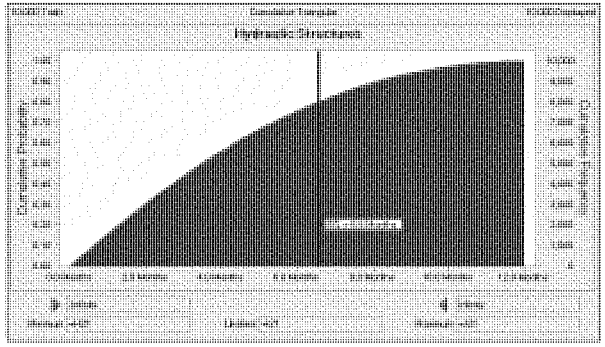
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-12	Hydraulic Structures	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes model studies of hydraulic structures shows that cuurent design is adequate or that structures can be smaller. However smaller structures would probably not reduce the project schedule from the baseline since channel excavation would most likely be controlling

High Assumes model studies of hydraulic structures shows that cuurent design is not adequate and that structures should be larger. Additional design and construction time may result



Assumption: Hydraulic Structures

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.3 Months
30%	2.0 Months
40%	2.7 Months
50%	3.5 Months
60%	4.3 Months
70%	5.4 Months
80%	6.6 Months
90%	8.1 Months
100%	11.9 Months

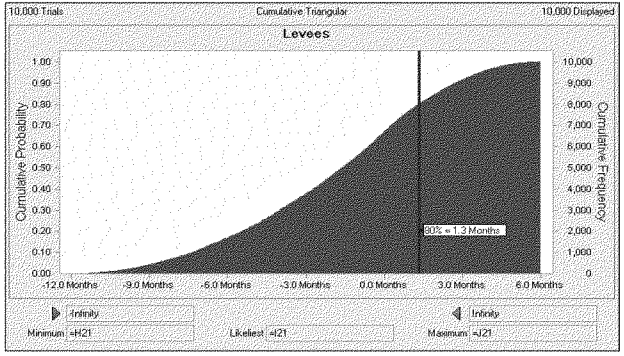
Risk Refer No.	Risk Event	Low	Most Likely	High
TL-13	Levees	-12.0 Months	0.0 Months	0.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes required staging areas are less which decreases project footprint and quantities and leads to a less and smaller levees and a shorter schedule than baseline

High Assumes required staging areas will not be greater footprint than currently modeled



Assumption: Levees

Percentile	Assumption values
0%	'-11.9 Months
10%	'-7.4 Months
20%	'-5.4 Months
30%	'-4.0 Months
40%	'-2.7 Months
50%	'-1.6 Months
60%	'-0.6 Months
70%	0.3 Months
80%	1.3 Months
90%	2.8 Months
100%	5.9 Months

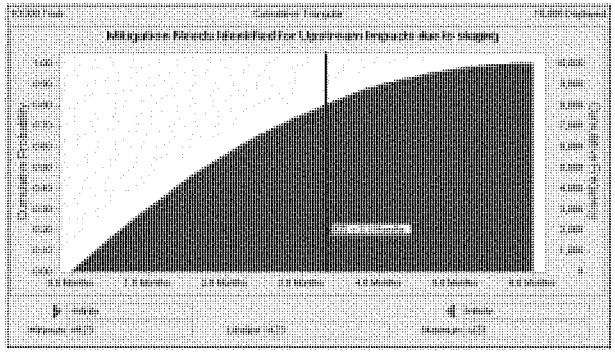
Risk Refer No.	Risk Event	Low	Most Likely	High
LD-1	Mitigation Needs Identified for Upstream Impacts due to staging	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes no change from baseline if additional upstream mitigation is not required from the baseline project plan

High Assumes delay in project to mitigate impacts to areas upstream.



Assumption: Mitigation Needs Identified for Upstream Impacts due to staging

Percentile	Assumption values
0%	0.0 Months
10%	0.3 Months
20%	0.6 Months
30%	1.0 Months
40%	1.3 Months
50%	1.7 Months
60%	2.2 Months
70%	2.7 Months
80%	3.3 Months
90%	4.0 Months
100%	6.0 Months

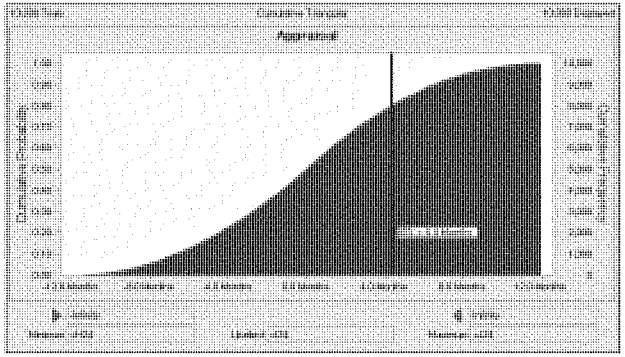
Risk Refer No.	Risk Event	Low	Most Likely	High
LD-4	Appraisal	-12.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes that project schedule can decrease if appraisals go smoothly

High Assumes that project schedule can increases if appraisals go take longer

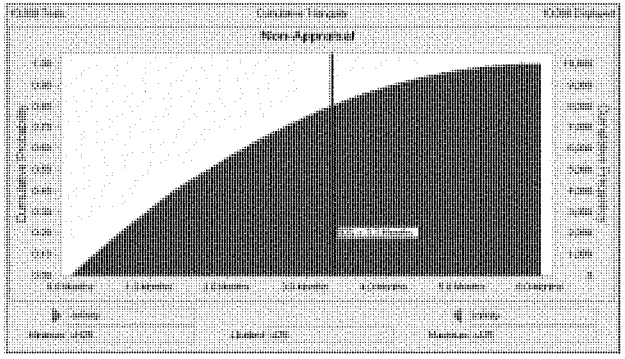


Assumption: Appraisal

Percentile	Assumption values
0%	-11.9 Months
10%	-6.7 Months
20%	-4.5 Months
30%	-2.8 Months
40%	-1.3 Months
50%	0.0 Months
60%	1.2 Months
70%	2.7 Months
80%	4.4 Months
90%	6.5 Months
100%	11.9 Months

Risk Refer No.	Risk Event	Low	Most Likely	High
LD-5	Non-Appraisal	0.0 Months	0.0 Months	6.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.
Likely Likely assumes no change from the baseline schedule.
Low Assumes that project schedule can will not change if there are not any non-appraisals issues
High Assumes that project schedule can increase if non-appraisal issues delay project



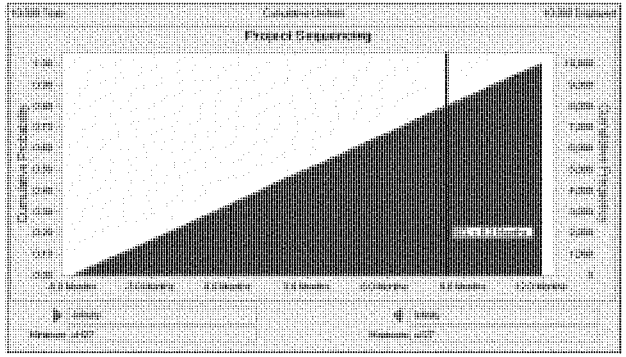
Assumption: Non-Appraisal

Percentile	Assumption values
0%	0.0 Months
10%	0.3 Months
20%	0.6 Months
30%	1.0 Months
40%	1.3 Months
50%	1.8 Months
60%	2.2 Months
70%	2.7 Months
80%	3.3 Months
90%	4.1 Months
100%	6.0 Months

Risk Refer No.	Risk Event	Low	Most Likely	High
CON-5	Project Sequencing	-6.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.
Likely Likely assumes no change from the baseline schedule.
Low Assumes project sequencing save time for schedule

High Assumes delay in project schedule if conflicts develop between contractors



Assumption: Project Sequencing

Percentile	Assumption values
0%	-6.0 Months
10%	-4.2 Months
20%	-2.3 Months
30%	-0.6 Months
40%	1.2 Months
50%	2.9 Months
60%	4.8 Months
70%	6.6 Months
80%	8.3 Months
90%	10.1 Months
100%	12.0 Months

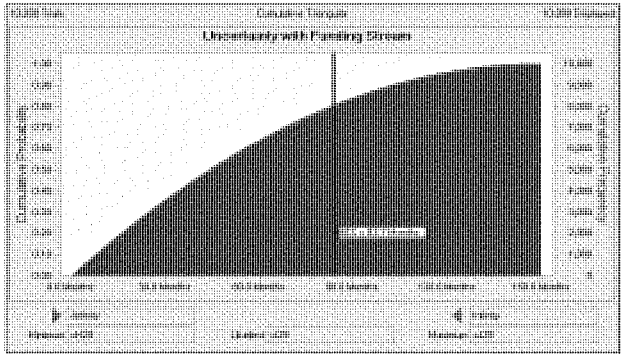
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-1	Uncertainty with Funding Stream	0.0 Months	0.0 Months	150.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project

Likely Likely assumes no change from the baseline schedule.

Low Assumes that funding will not be higher than the proposed project schedule

High Assumes that funding will be at the alternate funding of schedule of approximately $80M/year which may take an additional 12-13 years to complete the project



Assumption: Uncertainty with Funding Stream

Percentile	Assumption values
0%	0.0 Months
10%	8.1 Months
20%	16.2 Months
30%	25.1 Months
40%	34.6 Months
50%	44.7 Months
60%	55.4 Months
70%	68.2 Months
80%	83.7 Months
90%	102.9 Months
100%	148.3 Months

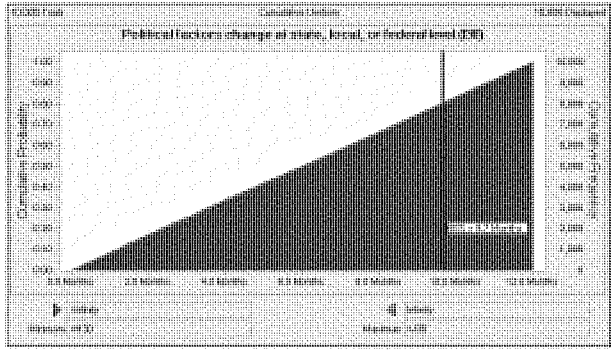
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-4	Political factors change at state, local, or federal level	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes the baseline schedule when there is not any political oppisition

High Assumes the political factors cause an increase from the baseline project schedule



Assumption: **Political factors change at state, local, or federal level**

Percentile	Assumption values
0%	0.0 Months
10%	1.2 Months
20%	2.3 Months
30%	3.5 Months
40%	4.8 Months
50%	6.1 Months
60%	7.3 Months
70%	8.5 Months
80%	9.7 Months
90%	10.8 Months
100%	12.0 Months

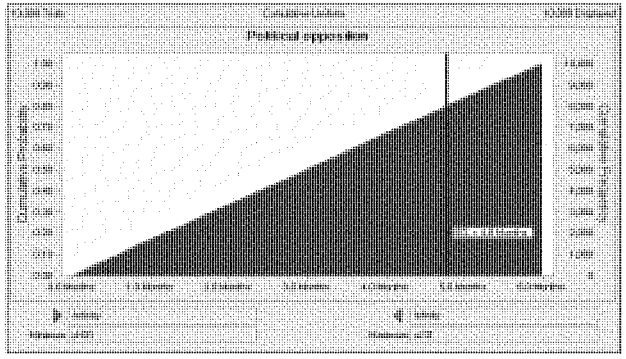
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-5	Political opposition	0.0 Months	0.0 Months	6.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project

Likely Likely assumes no change from the baseline schedule.

Low Assumes the baseline schedule when there is not any political oppisition from Federal agencies.

High Assume an increase in the schedule due to political oppisition from Federal agencies



Assumption: **Political opposition**

Percentile	Assumption values
0%	0.0 Months
10%	0.6 Months
20%	1.2 Months
30%	1.8 Months
40%	2.4 Months
50%	3.0 Months
60%	3.6 Months
70%	4.2 Months
80%	4.8 Months
90%	5.4 Months
100%	6.0 Months

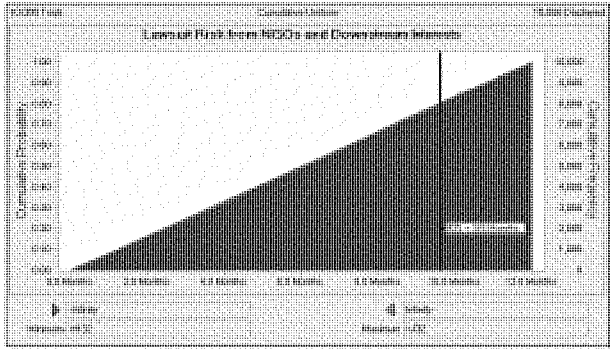
Risk Refer No.	Risk Event	Low	Most Likely	High
PR-6	Lawsuit Risk from NGOs and Downstream Interests	0.0 Months	0.0 Months	12.0 Months

Notes: This item captures the risk that will cause a variance from the baseline schedule for the project.

Likely Likely assumes no change from the baseline schedule.

Low Assumes the baseline schedule when there are not any lawsuits from upstream interest

High Assumes an increase in the schedule due to lawsuits from upstream interest that delay the project



Assumption: Lawsuit Risk from NGOs and Downstream Interests

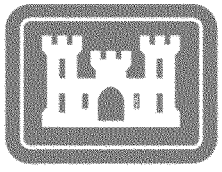
Percentile	Assumption values
0%	0.0 Months
10%	1.3 Months
20%	2.5 Months
30%	3.7 Months
40%	4.9 Months
50%	6.1 Months
60%	7.3 Months
70%	8.4 Months
80%	9.6 Months
90%	10.8 Months
100%	12.0 Months

Appendix O
Plan Formulation

Fargo-Moorhead Metropolitan Area Flood Risk Management

Final Feasibility Report and Environmental Impact Statement

July 2011



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3. Alternative Formulation Briefing Project Guidance Memorandum
4. Alternatives Screening Document
5. Value Engineering Study Report
6. ASA(CW) Approvals to tentatively recommend the Locally Preferred Plan
7. Red River Diversion – Alternative Scenario Analysis

1.0 INTRODUCTION

Appendix O describes the planning process used during the Fargo-Moorhead Metropolitan Area Flood Risk Management Feasibility Study. It documents the major activities performed, assumptions made and conclusions drawn during the various phases of the study.

1.1 TEAM DEFINITIONS

1.1.1 Project delivery team (PDT): the team directly responsible for conducting the study and preparing the feasibility report and environmental impact statement. The PDT includes staff from the St. Paul District Corps of Engineers, the non-federal sponsors, and the Corps Non-structural Flood-Proofing Committee as well as private-sector contractors hired to assist with the project.

1.1.2 Vertical team: the Corps staff at the Mississippi Valley Division office and Headquarters who are responsible for oversight and policy review.

1.1.3 Agency Technical Review (ATR) team: an independent team responsible for conducting technical review of the study products. The ATR team includes Corps staff primarily from Omaha District and the Corps Cost Engineering Directory of Expertise who were not directly involved in preparation of the study products.

1.1.4 Independent External Peer Review (IEPR) panel: a panel of technical experts independent of the Corps of Engineers who are responsible for conducting an independent external peer review as required by Section 2034 of the Water Resources Development Act of 2007.

1.1.5 Metropolitan Flood Management Committee: the combined elected bodies for Fargo and Cass County, North Dakota and Moorhead and Clay County, Minnesota.

1.1.6 Metro Flood Study Work Group (MFSWG): a work group formed to advise the Metropolitan Flood Management Committee regarding flood-related issues. The MFSWG consisted of two representatives from each of the elected bodies for Fargo and Cass County, North Dakota and Moorhead and Clay County, Minnesota plus one representative from the Buffalo-Red River Watershed District in Minnesota and one from the Cass County Water Resource District in North Dakota.

1.2 PLANNING POLICY

The U.S. Army Corps of Engineers conducts planning efforts in accordance with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the Water Resources Council in 1983. These principles and guidelines, referred to as the "P&G," establish federal water resource planning policy for the Corps, Bureau of Reclamation, Tennessee Valley Authority, and the Natural Resources Conservation Service (formerly Soil Conservation Service).

Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, defines the specific planning policies of the Corps of Engineers based upon the P&G. The Corps has published several other ERs, guidance letters and engineering circulars pertinent to specific aspects of planning and project implementation.

Federal planning efforts must comply with federal laws including the National Environmental Policy Act (NEPA) and the Clean Water Act. The Corps must also comply with applicable executive orders such as EO 11988, Floodplain Management.

1.3 PLANNING PROCESS

The Corps' planning process consists of six major steps:

(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
(6) Selection of the recommended plan based upon the comparison of the alternative plans

The six steps are presented in a linear fashion, but the actual planning process is not linear. In fact, the six steps are applied in several iterations over time as more information is developed to inform the process. Early iterations focus on defining the problems and assessing the existing conditions while also exploring possible solutions. Later iterations focus on formulation, evaluation and comparison of alternative actions, but they still seek to clarify the problems and expected future conditions.

This appendix explains how the planning process was applied in the Fargo-Moorhead Metro feasibility study.

1.4 STUDY GOALS

The Project Delivery Team along with the non-federal sponsors developed the following study goals:

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 reduction 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 U.S. Congress.

1.5 NATIONAL PLANNING 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.

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.

1.6 PUBLIC CONCERNS

A number of public concerns were 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. 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

1.7 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 without project conditions that are described in Chapter 3, Alternatives in the main report.

1.7.1 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.

1.7.2 Opportunities

There are opportunities to increase and improve wildlife habitat in conjunction with measures 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 reduction measures that involve land use changes could provide opportunities to increase recreation in conjunction with reducing flood risk.

1.8 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 must be 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.

1.9 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

1.10 STUDY PRODUCT

The product of the study is a decision document in the form of an integrated feasibility report and environmental impact statement. The report documents the information generated during the study and the recommendations of the Corps of Engineers. To be implementable as a federal project, a project must have the support of the non-federal sponsor(s) and a demonstrated federal interest in implementing the plan. To obtain federal authorization for a flood risk management project, the plan formulation process must adhere to laws, policies, and regulations that define the planning process.

1.11 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," establishes the baseline for federal cost sharing during implementation. A different plan that is more acceptable to the non-federal sponsor 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)). The non-federal sponsor would be responsible for all locally preferred plan implementation costs in excess of the federal share of the NED plan implementation costs.

2.0 PLANNING TIMELINE SUMMARY

This study was conducted in several phases beginning in June 2006. The major phases were as follows:

- Reconnaissance (June 2006-September 2008)
- Feasibility Phase 1 (September 2008-May 2009)
- Feasibility Phase 2
  - Screening #1 (May 2009-November 2009)
  - Screening #2 (November 2009-March 2010)
- Feasibility Phase 3 (March 2010-September 2010)
- Feasibility Phase 4 (September 2010-July 2011)

3.0 RECONNAISSANCE (Jun 2006 - Sep 2008)

Reconnaissance study efforts for the Fargo-Moorhead area were initiated at the request of the City of Fargo in a letter dated June 16, 2006. The letter requested that the Corps "conduct studies to determine the feasibility of developing a flood control project along 2nd Street from 5th Avenue North to 2nd Avenue South, and along 4th Street from 2nd to 10th Avenues South, under the authority provided by Section 205 of the 1948 Flood Control Act, as amended."

In discussions with staff of the cities of Fargo, North Dakota and Moorhead, Minnesota, it was agreed that the study should be expanded to include the entire metropolitan area and the surrounding region. Because of the increased scope, the study team opted to conduct the study as a specifically authorized study instead of using the Section 205

Continuing Authority, as requested. The Red River of the North Reconnaissance Study approved in September 2002 and conducted under the authority of a September 30, 1974 resolution of the Senate Committee on Public Works allowed for supplemental 905(b) analyses to be prepared as needs arose in the basin. This was the authority selected for the Fargo-Moorhead reconnaissance effort.

The reconnaissance study received funding in April 2007 and was conducted between June 2007 and April 2008. The primary problem identified in the study area was flooding. The reconnaissance study evaluated relatively short segments of levee/floodwall in both Fargo and Moorhead. The study determined that at least one reach of levee could be economically justified, so there was federal interest in conducting a cost-shared feasibility study. The study also recommended that the feasibility study consider larger potential solutions that could benefit the entire region.

4.0 FEASIBILITY PHASE 1 (Sep 2008 – May 2009)

4.1 PHASE 1 ACTIVITIES

The feasibility study began on September 22, 2008 with the execution of a feasibility cost share agreement between the Corps of Engineers and the cities of Fargo, North Dakota and Moorhead, Minnesota. Public meetings were held in November 2008 to make the public aware of the study and to solicit information about the problems, opportunities, and range of potential solutions developed during the reconnaissance study. The first phase of study was scoped to be a low-detail assessment of the future without project condition and two primary regional flood risk management concepts: a levee/floodwall system and a diversion channel system. The intent was to assess the potential viability of these two concepts before investing substantial resources in a full feasibility level of detail for the full array of measures identified in the reconnaissance phase. The work of this phase was dominated by hydrologic, hydraulic and economic analyses, although geotechnical investigations and consideration of non-structural measures were also begun. The record-setting flood of 2009 occurred near the end of this phase of study, which keenly increased public and political interest in the results. A feasibility scoping meeting (FSM) was held on May 19, 2009 with Corps Mississippi Valley Division and Headquarters staff. Public meetings were held on May 19-20, 2009 to share the initial findings and request public input on the range of potential alternatives and impacts.

4.2 PHASE 1 REVIEW AND COORDINATION

4.2.1 Agency Technical Review

Prior to the Feasibility Scoping Meeting (FSM) documentation was sent to the Agency Technical Review (ATR) team which consisted of Corps staff primarily from the Omaha District. The documents, which included: the main report, hydraulics appendix and preliminary HEC-RAS model, hydrology appendix, geotechnical appendix for credit to existing levees, and the economic appendix and preliminary HEC-FDA model; were provided to the ATR team on March 16, 2009. The review resulted in 106 comments. The PDT responded to most of the comments, but a number of the comments were left

open, and the plan was to backcheck them upon review of the next draft report to be prepared for Alternative Formulation Briefing documentation.

4.2.2 Feasibility Scoping Meeting (FSM)
The Feasibility Scoping Meeting was held on May 19, 2009. The PDT and the Vertical Team discussed the preliminary planning efforts, the range of alternatives, and the proposed planning activities needed to complete the study. The results of the meeting were documented in a memorandum (See Attachment 1 - FSM Memo).

4.3 PHASE 1 KEY ASSUMPTIONS

4.3.1 Future without project assumptions
The future without project assumptions were key to the analysis and were discussed in the FSM documentation submitted to the ATR team and the vertical team. Comments from both the ATR and vertical teams addressed these assumptions. The key assumptions for this phase were:

- The city of Fargo's potential "Southside Flood Control Project" was assumed to not be in place as part of 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."
- No credit was given to flood fights and emergency measures. The vertical team requested that a sensitivity analysis be completed in the future to provide the decision makers with this information.
- Climate change was not included in the Phase 1 analyses, although there appeared to be an increasing trend in both peak flows and flood frequency in recent decades. The vertical team agreed that it would be appropriate to use an expert opinion elicitation process to obtain recommendations on this topic and to use those recommendations.
- Loss of life was not considered as part of the initial economic analysis. The vertical team requested that a loss of life analysis be completed to supplement the Other Social Effects (OSE) account, but no dollar value was to be placed on the loss of life.

4.3.2 Hydrology
The hydrologic information used in Phase 1 was the best available data when the work began in 2008. It was based on earlier work done by the Corps after the 1997 flood. The Corps hydrology was different from the data used by the Federal Emergency Management Agency (FEMA) in updating flood insurance maps, because FEMA's flows were based upon an earlier administrative determination. Phase 1 hydrology did not include the 2009 flood, the flood of record at the Fargo gage, because it did not occur until after the initial analyses were under way

4.3.3 Hydraulic Modeling
Phase 1 hydraulic modeling was primarily steady-state HEC-RAS based on the most recent FEMA flood insurance study completed at the time.

4.4 PHASE 1 CONCLUSIONS

The preliminary study found that a levee system would cost approximately $625 million and have a benefit/cost ratio (BCR) of 1.0. The preliminary diversion concept without a control structure was estimated to cost $909 million and have a BCR of 0.65. The preliminary economic analyses estimated expected average annual flood damages at more than $64 million, with single event damages ranging from $2.1 billion for a 1-percent chance event to $6.6 billion for a 0.2-percent chance event. On the basis of the preliminary findings, the non-federal sponsors elected to continue the feasibility study.

5.0 FEASIBILITY PHASE 2, SCREENING #1 (May 2009 – Nov 2009)

5.1 PHASE 2, SCREENING #1 ACTIVITIES

5.1.1 General
Phase 2 considered the full array of potential measures to address flood risk in the study area. Coordination began in earnest with federal and state natural resource agencies regarding issues and concerns and potential ways to cooperate on the study. A notice of intent to prepare a draft environmental impact statement (EIS) was published in the Federal Register on May 5, 2009. The study team held public and agency meetings to solicit input on problems and opportunities, project scoping, affected resources and potential effects. A scoping document dated September 14, 2009 was prepared to summarize the potential alternatives and impacts to be considered during the remainder of the study.

In June and July 2009, the Fargo City Commission and Moorhead City Council coordinated with the boards of Cass County, North Dakota and Clay County, Minnesota, to form a Metropolitan Flood Management Committee consisting of their four elected governing bodies plus one member from the Southeast Cass Water Resource Management District and one from the Buffalo-Red River Watershed District. Each of the boards appointed representatives to serve on a smaller Metropolitan Flood Study Work Group (MFSWG) whose purpose was to oversee study activities and make recommendations to the larger elected bodies. The MFSWG first met on August 26, 2009.

During this Phase a cursory technical analysis of all proposed measures was conducted. Screening criteria were developed in partnership with the non-federal sponsors. These criteria were then used to screen the proposed measures and to select those that warranted additional analysis. Using the preliminary technical information, professional judgment was used to assess the measures against the screening criteria. Those measures that appeared to be most viable, either alone or in combination with other measures, were refined and further

developed so that accurate costs and economic benefits could be determined. Using all of the information developed, the PDT compared the alternative measures and plans to each other to screen out inferior plans and identify the optimal plans. Initial screening results were presented at public meetings in October 2009.

An in-progress review (IPR) was held in November with the vertical team (Corps Mississippi Valley Division and Headquarters staff).

Following the public meetings, IPR and further coordination with the sponsors and the MFSWG, an "Alternatives Screening Document" was prepared and distributed to the public to document the team's alternative screening process.

5.1.2 Array of Measures and Alternatives

Several measures were identified for consideration in evaluating future possible actions in the Fargo-Moorhead metropolitan area. Input provided at public meetings and directly from stakeholders provided a wide array of initial measures that were considered. Some of the measures constituted complete alternative plans, while others could be combined to make complete alternatives. The measures identified initially for evaluation were:

- No Action: Continue emergency measures

- Nonstructural measures
    - Buy and relocate flood-prone structures
    - Flood proofing
    - Elevate structures
    - Flood warning systems
    - Flood insurance
    - Wetlands
    - Grasslands

- 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 riverbank
    - 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
  - Pay landowners for water retention

Details of the various measures and alternatives are described in the Alternatives Screening Document dated December 2009 (see Attachment 4).

5.1.3 Detailed Alternatives Developed

5.1.3.1 In addition to a cursory review of all proposed measures, the study team developed more detailed conceptual plans involving non-structural measures, diversion channels and flood barriers. Three scales of non-structural plans (1-percent, 0.5-percent, and 0.2-percent chance) including the non-structural measures listed above, as well as other potential non-structural measures . Eleven different structural plans were analyzed based on 5 alignments: 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).

5.1.3.2 Diversion channel alignments and cross sections took several considerations into account. The Phase 1 diversion was located in Minnesota, because a Minnesota diversion would be shorter and was likely to be less expensive than a longer alignment in North Dakota. The six primary constraints on the initial diversion channel alignment were the Buffalo River, the Buffalo Aquifer, the City of Dilworth, Minnesota, the Burlington Northern and Santa Fe rail yard at Dilworth, the southern extent of development along the Red River, and the Wild Rice River. The channel's downstream outlet was located upstream of the confluence of the Red and Buffalo rivers so that the diversion would not cross the Buffalo River. The City of Dilworth is located east of Moorhead, Minnesota and west of the Buffalo Aquifer; the diversion was located as far east as possible in order to avoid Dilworth without impacting the Buffalo Aquifer and to minimize impacts to the rail yard. The southern end of the channel was located far enough south to benefit the majority of developed areas south of Fargo while staying downstream (north) of the confluence of the Red and Wild Rice rivers.

In Phase 2, the nine separate diversion alternatives analyzed included a total of four separate alignments, two in Minnesota and two in North Dakota. The alignments studied in Minnesota were roughly based on the alignment used during Phase 1. These basic alignments were modified based on the following considerations:

- Alignments were shortened where reasonable to reduce footprint and cost.
- Alignments were moved to relatively lower ground to minimize the excavation required.
- Alignments cross roads and railroads at or as close to 90 degrees as possible to minimize bridge lengths.
- Alignments avoid populated areas to minimize buyouts where possible.
- Inlet and outlet locations were selected at river bends with favorable hydraulic orientations to direct flow into or out of the diversion.
- Alignments were adjusted to avoid FEMA deed-restricted properties

The North Dakota West diversion alignment was based roughly on an alignment that was originally developed as part of the Southside Flood Control project. This alignment was also modified from its original location, based mainly on the total diversion length and ground elevations. The North Dakota East alignment, while similar to the North Dakota West alignment through much of its length, followed a portion of the existing Horace to West Fargo Sheyenne River Diversion alignment. Both North Dakota alignments cross the Sheyenne, Maple, Lower Rush and Rush rivers at or as close to 90 degrees as possible to minimize hydraulic structure size and cost. The diversion outlet was located downstream of the Red River-Sheyenne River confluence to avoid crossing the Sheyenne River twice.

The North Dakota diversion alignments and the Minnesota diversion tie-back levee between the Red River and the Sheyenne River south of Fargo, North Dakota were located to keep flood water out of the Rose Creek watershed, which flows north into the southern portion of Fargo.

5.1.3.3 The initial levee alignments in both Fargo and Moorhead were located as close to the river as geotechnical considerations would allow in order to minimize impacts to existing development. Floodwalls were not included in the preliminary designs.

5.1.3.4 Non-structural plans were developed for the entire study area. The details of the non-structural plans are described in Appendix P Non-Structural.

5.1.4 Climate and Hydrologic Uncertainty

To address the climate and hydrologic uncertainty that was identified in Phase 1, an Expert Opinion Elicitation (EOE) panel was convened in September 2009. The panel consisted of six panel members and five invited observers with expertise related to hydrology or climatology. The panel concluded that there were two distinct hydrologic periods in the Red River Valley: wet and dry. They recommended that this be addressed by developing separate wet and dry discharge-frequency curves and then using a probability to combine them over time. The study area experienced a wet cycle beginning in the early 1940's and continuing to the present, and the panel concluded that continued wet conditions were more likely than a return to a drier period within the Corps' 50-year period of analysis. The panel thought that traditional hydrologic analyses using the entire period of record (including both

dry and wet times) would underestimate flood flows expected over the period of analysis. Upon completion of the EOE process, Saint Paul District began coordination with the Corps Hydrologic Engineering Center to implement the EOE panel's recommendations. Information on the EOE panel can be found in Appendix A, Hydrology.

5.2 PHASE 2, SCREENING #1 REVIEW AND COORDINATION

5.2.1 In Progress Review (November 5, 2009)

An in Progress Review (IPR) was held with the Corps vertical team on November 5, 2009 in Fargo, North Dakota to discuss study progress and to verify the decisions that had been made up to that point in the project. This included the elimination of levee plans from further consideration. See the Attachment 2 Memorandum for Record of the IPR.

5.3 PHASE 2, SCREENING #1 KEY ASSUMPTIONS

5.3.1 Future without project assumptions

The assumptions in Phase 2 regarding future without project conditions generally followed the assumptions in Phase 1. Those being:

- The Southside project was not be included, as FEMA withdrew its funding and support for the project.
- No credit was given to emergency flood fights.
- Benefits were accounted based on future growth assumptions, as a cost avoidance benefit.

5.3.2 Hydrology and Hydraulic Modeling

Design and screening of levee and diversion channel alternatives along with economic analyses were based on Phase 1 hydrology (without the 2009 flood event) and steady-state hydraulic modeling.

5.4 PHASE 2, SCREENING #1 PROCESS

5.4.1 Alternative Screening Criteria

Key study team members and representatives of the non-federal sponsors met to develop screening criteria to focus evaluation and design efforts on the most implementable conceptual stand-alone alternatives. 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 to identify those alternatives 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 changed environmental conditions resulting from the construction or operation of the project. This criterion 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 considered 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 was not used to eliminate any alternatives, but was 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 considered the potential need for mitigation resulting from the project's implementation to address environmental, hydraulic or other impacts. Is mitigation possible, what does it cost, and how does it impact the project cost? This criterion is related to all four of the P&G criteria.

Cost Effectiveness: This criterion was 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.

5.4.2 Preliminary Conceptual Alternative Screening

Key study team members and representatives of the non-federal sponsors met to discuss how the various measures could be combined into alternative plans and how these measures and conceptual alternatives rated against the criteria. The process was

subjective and based on the collective professional judgment of those present. At this point in the planning process, the evaluation was mainly qualitative, because very little quantitative data was available. The results of the preliminary alternative screening were reported in the Alternatives Screening Document dated December 2009, (Attachment 4). The Alternatives Screening Summary Matrix from that report is reproduced as Table 1.

Table 1: Alternatives Screening Summary Matrix

Resource Category	Alternative: Future Without Project Conditions	Flood Barriers	Diversion Channels	Non-Structural Measures
Alternative Description	Emergency measures currently being pursued in the project area will continue to be implemented as necessary due to flooding. These include raising levees, constructing temporary levees and floodwalls in various areas, and sandbagging.	This alternative includes the use of permanent flood barrier systems including levees, floodwalls, invisible floodwalls, gate closures, and pump stations. Two different top profiles to reliably contain the 2% chance flood and the 1% chance flood. Initial analyses were based on constructing levees in both Fargo and Moorhead to the design levels and assessing the costs and economic benefits of the plans.	Route flood flows around the metropolitan area. Several potential alignments will be considered, including alignments in both Minnesota and North Dakota and incorporating the existing Sheyenne Diversion from Horace to West Fargo.	Relocation of structures, buyout and demolition of structures, elevation of structures, removal of basement, dry flood proofing, wet flood proofing, land acquisition, flood management plans, vertical construction for residential occupancy. Additionally flood warning, preparedness, evacuation plans and pertinent equipment installation, and nonstructural berms, levees, and floodwalls are considered.
Effectiveness	(Low) Not expected to provide consistent/reliable long-term risk reduction. Emergency measures are temporary, demand high number of workers in extreme weather, are a risk to human health.	(Moderate) Levees and other properly designed and constructed flood barriers can prevent damages from most flood events that do not exceed their maximum design event.	(High) Effectively eliminate flooding for small events, but require flood fighting for large events. Diversions generally provide robust risk reduction.	(High) Effectively reduces risk to structures and their contents up to the design event. Floods would still have potentially large impacts on infrastructure, evacuation routes, and daily life and business activities.
Environmental Effects - Natural Resources	(Negative) Emergency levees are susceptible to erosion, feeding sediment into the river. They adversely impact terrestrial vegetation, and borrow sites.	(Neutral) Resources affected along embankment alignment. Wetland mitigation may be required. Open space between barrier and river will provide benefits. Larger riparian areas.	(Neutral) Issues such as fish passage and sedimentation arise. Also, wetlands and ground water may be impacted. The channel would be designed to include wetland and/or prairie swale type habitat within the diversion channels which could lead to increased habitat quantity and value from the existing conditions.	(Positive) Removal/relocation of homes allows to develop riparian habitat, restoration of wetlands, greenway area for recreational and ecosystem benefits.
Environmental Effects - Cultural Resources	(Negative) Excavating borrow material, building temporary levees/floodwalls, removing temporary levees/floodwalls all have the potential to have adverse effects on cultural resources. Failure of the temporary levees/floodwalls would also have adverse impacts to cultural properties/resources.	(Negative) There are a number of historical structures that would be directly or indirectly impacted by the construction of the in-town levees, and mitigation would be required for the adverse impacts. Potential for adverse impacts on deeply buried archeological sites, and historical structures and requires mitigation.	(Negative) High potential for impact to archeological sites within the area, particularly buried sites where channels leave, enter, or cross rivers. Historical structures may be directly or indirectly impacted.	(Neutral) A number of historical structures would be directly or indirectly impacted. Potential adverse impact to archeological sites. The alternative would also minimize the chance of flooding to historical structures.
Social Effects	(High Negative) Negative effect on businesses, transportation, recreational facilities, and public services. Emergency measures failure may result in loss of community, community cohesion, public safety, and potential loss of life.	(Moderate Positive) Positive: improved public safety during flood events, regional business growth, less frequent emergency actions, addition of recreational components. Negative: 1000 structures removed, road closures during floods. Failure would result in significant threat to public safety.	(High Positive) A large amount of agricultural land would be necessary. Regional growth, public safety, employment, and recreation would all benefit from the project.	(High Negative) Required evacuation during floods would adversely effect transportation, business, regional growth. Large percentage of structures would be impacted by the required modifications.
Acceptability	(Low) Not acceptable as a long term solution. Eventually flood fighting will adversely effect the local community and region.	(Moderate) Alternative will disrupt community cohesion by removal of approximately 1000 structures, railroad lines, increased flood stages upstream, and will not meet sponsors desired level of protection.	(Moderate) This plan is acceptable but will impact a number of agricultural properties. There could also be actual or perceived downstream impacts due to increased flood stages that may need to be addressed. Controversy will be more of an issue depending on which diversion is selected.	(Low) Necessary modifications to individual structures would be extremely controversial and have little support from local sponsors.
Implementability	(Moderate) Legal and technical issues complicate implementation of emergency measures. Obtaining rights of access on short notice is difficult and controversial. Maximum level of protection limited by natural ground..	(Moderate) Difficulty in timely implementation. Feasible protection can be constructed up to a maximum of 1% chance level.	(High) There are some technical issues to implementing this plan, the largest concern would be with the Red River control structure and the tributary structures. Diversions have been successfully used in other projects in the Red River Valley.	(Low) Difficult implementing due to enormous number of affected properties.
Cost	(Extremely High) Extremely high costs ($74 million / year). 500yr event may exceed $6 billion.	(High) 2% chance flood protection estimated at $840 million, and $902 million for 1% chance level of protection. The 1% levee plan would leave the community susceptible to residual damages averaging more than $20 million annually.	(Medium) Costs for the nine diversion alternatives investigated range from $962 million to $1.46 billion. The plans all reduce the residual risk to the communities to less than $1.4 million annually and would allow for emergency flood fighting if necessary.	(Extremely High) 1% and 0.2% chance floods estimated to cost $1.6 billion and $4.7 billion respectively. Even if the 1% or the 0.2% plans were developed the community would still be at risk of flooding and there would be residual damages to local infrastructure.
Risk*	(Extremely low) Extremely low level of risk reduction and there would be a high risk of future flooding. Reliability of emergency measures is poor. Mobilizing man power is difficult and unreliable, and those people are placed at risk. Unreliable protection as a result of construction measures.	(Moderate) This plan will provide risk reduction up to the design event; once that event is exceeded catastrophic damages will occur. This plan may also induce additional growth between the 1% chance and 0.2% chance flood plains resulting in greater risk to the community over time.	(High) Flood stages are no higher than they would have been without the project in place. They are not fool-proof and significant residual risk often remains from flood events larger than design event, and there is potential for channel blockage from debris and ice.	(Moderate) High risk to public infrastructure, looting and property damage, evacuation routes. Population relocation may be required.
Separable Mitigation	(High) Repair of damaged properties following flood event is necessary resulting in large costs for removal and repair.	(Moderate) The plan may result in quantifiable damages resulting from increased flood stages up and downstream and would require mitigation with option such as upstream storage, ring levees, and non-structural solutions.	(Moderate to High) If project causes increased flood damages downstream, mitigation would be required such as ring levees, buyouts, and relocations. Aquatic resource mitigation may be required and would be more likely with the tributary structures.	(Low) None is anticipated.
Cost Effectiveness	(Moderate) Emergency measures are cost effective, because they prevent damages far in excess of their cost.	(Moderate) From the investigated levee plans only 1% chance levee was determined cost effective.	(Low-High) Smaller diversions were found to provide better cost effectiveness, and all of the Minnesota short diversions were cost effective	(Low) Not cost effective with BCRs of less than 0.35.
Recommendation	The future without project (no action) alternative should be retained as the base condition for comparison with all other alternatives.	Levee plans should no longer be considered as a stand-alone alternative. The levee plans would provide a limited level of risk reduction, have large short term social impacts, high costs, and relies on emergency measures for larger flood events.	Diversion concept should be retained for further refinement. Preliminary analysis shows that the Minnesota Short Diversion appears implementable, effective, and cost effective.	Non-structural measures should no longer be considered as stand-alone alternatives

* Risk is measured based on the risk reduction, therefore a plan with a rating of high would have a high level of risk reduction, meaning the community would be less susceptible to flooding.

Table 1: Alternatives Screening Summary Matrix

Resource Category	Alternative: Flood Storage	Tunneling	Bridge Replacement or Modification	Interstate 29 Viaduct
Alternative Description	Preserve natural floodplain areas, restore wetalnds, build dams and other water retention facilities to hold water during flood events. Impoundments may be designed to remain dry until a flood event or to retain a pool during nonflood times for conservation or water supply purposes.	A series of tunnels underneath the city to convey the water and reduce the water levels in the river.	Bridges can restrict the flow during flood events. Raising or modifying bridges can increase conveyance in the channel and reduce flood stages.	Reconstructing the Interstate 29 corridor to serve as an open viaduct during floods was proposed. The reconstructed corridor would function as an interstate highway during non-flood times.
Effectiveness	(Low) Very difficult to ensure that the system would be reliable and effective. A model of system of impoundments with 400,000 acre feet of storage indicated that it could reduce the 1% chance flood stage in Fargo-Moorhead by less than 1.6 feet.	(High) Tunneling, would be effective in reducing flood risk, eliminating emergency measures during smaller floods. Large floods would also see a reduction in flood risk. Overall flood risk reduction is dependent on tunnel capacity.	(Low) Not an effective stand alone measure. Removing the bridges entirely has only minor effects.	(High) Would effectively provide flood risk management, reducing flood risk for small and large events.
Environmental Effects - Natural Resources	(Positive) May be both beneficial and detrimental, with dams causing adverse effects, and off-channel storage can be beneficial. Off-channel storage located on poorly-drained agricultural sites, former wetlands, or drained lakes can be environmentally beneficial if designed and managed properly.	(Negative) There are adverse effects on aquatic habitat due to loss of fish passage and potential sedimentation. Potential adverse effects on areas where spoil material would be placed.	(Neutral) No appreciable adverse effects.	(Negative) Issues such as fish passage and sedimentation arise. There would be little opportunity to provide any environmental enhancements to the project as it would also function as an interstate highway.
Environmental Effects - Cultural Resources	(Negative) Flood storage project may cover cultural resources and impact archeological resources.	(Neutral) Possible adverse impact to archeological resources near tunnel inlet/outlet and location of spoil material placement are possible. Cultural resources in the existing floodplain in the Fargo-Moorhead area would receive benefits from tunneling and would not be as prone to flooding.	(Negative) Potential for impact to archeological sites near bridge abutments and piers. Potential to adversely affect National Register eligible or listed bridges.	(Positive) Minimal impacts could occur at the inlet and outlet of the corridor. Historic structures would be less likely to flood and would benefit from this alternative.
Social Effects	(Moderate Positive) Large amounts of agricultural land would be necessary for acquisition or may be impacted. Depending on the depth of the storage areas and timing of storage, there could be a potential for recreational opportunities such as boating, fishing, or hunting.	(High Positive) Alternative requires a substantial amount of agricultural land. Regional growth, public safety, employment, and recreation would all benefit from the project.	(Low Positive) There would be minimal impact to transportation during construction, and emergency evacuation routes would be able to stay open during flood events.	(Moderate Positive) There would be major negative impacts to the transportation and evacuation route during flood events. Positive effects that may be seen are regional growth, public safety, and employment.
Acceptability	(Low) Very difficult to implement in reasonable amount of time. Issues with land acquisition such as legal processes and scarcity in economical storage.	(Moderate) There could be actual or perceived downstream impact that will need to be addressed. There would also be an adverse impact to the aquatic habitat.	(Low) Because of minimal levels of risk reduction this plan is not acceptable.	(High) The resulting impact to the transportation would not be acceptable. Elevation of the interstate would bring the project to the acceptability of the diversion.
Implementability	(Low) It is likely that additional flood storage will be built upstream of the study area, but that storage alone is not likely to adequately reduce flood risk to the study area over the next 50 years.	(Moderate) There are technical issues such as sedimentation and maintenance for an underground project to make sure the functionality of the alternative over a long-term.	(High) Alternative is implementable with no major issues.	(Low) Significant technical issues raising or lowering the road which involve demolition and reconstruction.
Cost	(Extremely High) Cost range from $160-$543 million depending on level of protection and type of plan. The communities would still face a large residual flood costs.	(Extremely High) Typical costs range from $100 - $350 million per mile.	(Extremely High) No estimates were prepared. Alternative would not reduce the residual flood risk. If this alternative were constructed the community would still have a residual flood risk of nearly $74 million annually.	(High) Estimated cost of $1.4 - 4.0 billion, with large operation and maintenance cost.
Risk*	(Moderate) Able to help with small events, but the estimated stage reduction for large events is not significant.	(High) Large flood risk reduction is achieved with this alternative. There is minimal risk of sudden or catastrophic failure. Residual risk often remains from flood events larger than the design event, and emergency flood fighting would still be required for those extremely rare events which could lead to risks similar to the without project condition.	(Extremely Low) Community would continue to be at risk of flooding.	(Moderate) Risks include ice jams, access to evacuation routes during floods, maintenance of the structure, backwater during minor floods. The risk of floods would decrease significantly, similar to the diversion channels.
Separable Mitigation	(Moderate) Mitigation depends on the project location, and is likely that it would not be possible to adequately mitigate environmental impacts.	(Moderate) If alternative results in increased flood damage downstream, mitigation would be required.	(Low) None is anticipated.	(Moderate) If project causes increased flood damages downstream, mitigation would be required such as ring levees, buyouts, and relocations. Aquatic resource mitigation may be required.
Cost Effectiveness	(Low) Unlikely to be economically justifiable for large systems, but may be considered for small areas.	(Low) Alternative is much more expensive than diversion with similar benefits.	(Low) Unlikely to be cost effective.	(Low) Cost similar to diversion alternative plus additional to demolish and reconstruct the roadway, with similar benefits to the diversions.
Recommendation	Flood storage should no longer be considered as a stand-alone alternative for the Fargo-Moorhead area as part of this project. Local communities should continue to seek opportunities for storage in the basin.	There would be a number of positive aspects to a tunnel alternative, however due to the cost of this alternative being substantially greater than any of the diversion channels while providing similar benefits, and other uncertainties with long term maintenance and repair, it is recommended that no additional study of tunnels be conducted.	Bridge replacement/modification should not be considered further as a stand-alone plan, but should be retained for possible inclusion in an overall plan if it can be incrementally justified.	The I-29 viaduct concept should no longer be considered for further analysis.

* Risk is measured based on the risk reduction, therefore a plan with a rating of high would have a high level of risk reduction, meaning the community would be less susceptible to flooding.

Table 1: Alternatives Screening Summary Matrix

Resource Category	Alternative: Dredging and Widening the River	Alternative: Wetland and Grassland Restoration	Alternative: Cut-off Channels
Alternative Description	Digging the Red River channel deeper and wider to allow for more flow to pass through the Fargo-Moorhead Metropolitan Area was proposed. This alternative could also be looked at underneath existing bridges to prevent the damming effect the bridges can create.	Restoration of grassland and wetlands to reduce peak runoff and serve as water storage during flooding events was proposed.	Building cut-off channels across meanders in the cities was proposed. It would provide the water a straighter path through the city and potentially reduce peak stages.
Effectiveness	(Low) Very limited hydraulic effectiveness and would likely negatively affect the stability of the river banks. Sedimentation following project implementation would be a concern and if maintenance was not completed properly any benefits of the project would be lost.	(Low) Effects are localized with no likely major benefit for Fargo-Moorhead Metropolitan Area. The effectiveness would be expected to be less than that of flood storage.	(Low) Alternative is not effective as a stand-alone.
Environmental Effects - Natural Resources	(Negative) There would be increased sedimentation, displacement of mussels, erosion issues, riparian forest habitat loss, aquatic habitat impacted, and wildlife mortality issues during dredging.	(Positive) Wetland and grassland habitat would greatly be enhanced and provide associated benefits to the water quality downstream.	(Negative) Alternative would impact riparian habitat, geomorphology of the stream, and fishery resource when flow exceeds design event.
Environmental Effects - Cultural Resources	(Negative) High potential for impact to archeological resources located on river banks.	(Neutral) There are a number of cultural sites within the study area so there is potential for adverse impacts to archeological sites.	(Negative) Alternative has potential to affect historical structures, and high potential to affect archeological sites.
Social Effects	(High Negative) Alternative would change appearance and function of the river. Properties along the river would need to be acquired due to slope stability issues which would require that the banks be cut back to allow for a deeper channel.	(Moderate Positive) Large amounts of land acquisition is required impacting agriculture and urban areas, and potentially transportation. Benefits are recreational opportunities such as hunting.	(High Negative) Social effects similar to existing condition with a similar risk of flooding.
Acceptability	(Low) Not an acceptable alternative and violates many local and national policies.	(Moderate) Alternative impacts a large number of landowners, and does not provide a lot of flood risk reduction.	(Low) Alternative is unacceptable to the resource agencies and potentially violates state and federal policies.
Implementability	(Low) Not Implementable.	(Low) The project is difficult implementing due to large amount of impacted land, and legal issues.	(Low) Not implementable as a stand-alone.
Cost	(High) Excessive – operations and maintenance costs would be large and long term. Environmental mitigation costs would be extreme. The communities would face large residual risks and if continued dredging was not maintained any benefits of the project would be lost.	(Extremely High) Cost is expected to be large, exceeding that of the storage alternative.	(Extremely High) No estimates were prepared. Cost of residual damage is assumed to be similar to the existing condition.
Risk*	(Low) There would be risk of project failure due to sedimentation. The community would still be at risk of flooding.	(Low) The impact of implementation of this alternative would not provide sufficient flood risk reduction leaving the areas at high risk of future flooding.	(High) There would possibly be large environmental impacts and community will continue to be at high flood risk.
Separable Mitigation	(Extremely High) Not possible to mitigate environmental impacts.	(Low) None is anticipated.	(Low) Besides replacement of trees, none is anticipated.
Cost Effectiveness	(Low) Not determined, but it is likely that the costs will outweigh the benefits.	(Low) Unlikely to be cost effective for flood damage reduction.	(Low to moderate) Cost effectiveness would be site specific.
Recommendation	Dredging and widening the river should no longer be considered.	Restoring wetlands and grasslands should no longer be considered as a stand-alone alternative, but may be considered for inclusion to mitigate for other adverse project effects where it can be incrementally justified.	Cut-off channels should not be considered as stand-alone alternatives but should be retained for possible inclusion in an overall plan where they could be incrementally justified.

* Risk is measured based on the risk reduction, therefore a plan with a rating of high would have a high level of risk reduction, meaning the community would be less susceptible to flooding.

5.4.3 Detailed screening

The analyses completed in the first part of Phase 2 allowed for significant screening of the stand-alone alternatives. Five of the six diversions located in Minnesota and the larger of two levee/floodwall plans were found to be cost-effective, with benefit/cost ratios (BCR) ranging from 1.0 to 1.22. Two of the diversions located in North Dakota had BCRs above 0.9 but less than 1.0. The non-structural plans were not cost effective, with BCRs less than 0.4.

Table 2 presents the results of the initial cost-effectiveness analyses of the levee and diversion alternatives. Table 3 presents the expected flood stages with various capacities of diversion channel.

Table 2 - Initial 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 are $73.7 million.

Table 3 -Estimated flood stages assuming various diversion capacities

	STAGE at the FARGO GAGE		
	2% Chance	1% Chance	0.2% Chance
	(50-year)	(100-year)	(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

5.4.4 National Economic Development (NED) plan
The first screening analyses indicated that the NED plan would most likely be a diversion located in Minnesota, but additional study was needed to determine the optimal channel capacity. Of the plans analyzed, the smallest capacity diversion had the highest net benefits, so an even smaller plan would need to be studied to be sure the optimal capacity was identified.

5.4.5 Tolerable level of risk
5.4.5.1 Diversion alternatives
The non-federal sponsors indicated a desire for a project that would minimize the need for most flood fighting activities up to the 0.2-percent chance event. A project that would produce a flood stage of approximately 36 feet on the Fargo gage during a 0.2-percent chance event would meet that objective and result in a tolerable level of risk for the communities. The first Phase 2 screening results indicated that a diversion capacity of approximately 30,000 to 35,000 cfs could reduce stages to the desired level, but it was likely that the NED plan would be smaller. Therefore, further development of diversion plans larger than the potential NED plan would be necessary to meet the study goals.

5.4.5.2 Levee alternatives
The largest levee plan considered would only reliably contain the 1-percent chance event. Higher levee plans would not be feasible because there is no higher natural ground available at which to begin and end the line of protection. Therefore, the sponsors did not request further work to refine levee plans as a potential locally preferred alternative. Since the levee plans were both outperformed by the diversion plans, the levee concept was dropped from consideration.

5.4.6 Locally preferred diversion alignment
The non-federal sponsors indicated that a North Dakota diversion alignment was locally preferable to a Minnesota alignment for a variety of reasons. Federal policy would not allow implementation of a plan that was not cost-effective. Although the first Phase 2 screening found that the North Dakota plans had BCRs less than 1.0, they were close enough to warrant further refinement to reduce project cost and increase benefits.

5.4.7 Other undetermined impacts
Additional study was also needed to assess potential environmental impacts, downstream stage impacts, and additional benefit categories that were not yet fully analyzed. These benefit categories included transportation benefits and benefits attributable to reductions in tributary flooding afforded only by the North Dakota diversion alternatives.

5.5 PHASE 2, SCREENING #1 CONCLUSIONS

The combined conclusions of both the preliminary conceptual alternative screening (using the screening criteria) and the detailed screening (using the economic analyses) are presented in this section.

5.5.1 Preliminary plans eliminated from further consideration as stand-alone alternatives
The following alternatives were not recommended for further evaluation as stand-alone alternatives for this project:

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

5.5.1.1 Flood barriers and associated measures were eliminated as conceptual alternatives 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 in excess of $20 million annually (based on the preliminary screening analysis). The levee plans that were evaluated would also have had large short term social impacts, due to the need to remove over 1,000 structures in the urban flood plain.

Professional judgment was applied in comparing the diversion concept to the levee concept at this stage of the screening. It was recognized that several cost and benefit categories had not been assessed, but the overall potential for levees to overtake diversions as the NED plan appeared to be low. The following uncertainties would likely increase the overall cost of the levee plans, reducing their net benefits relative to the diversion plans:

- Levees would increase stages upstream and possibly cause damages that were not included in the economic analysis
- The levee plans were based only on earthen levees; use of floodwalls would likely increase levee costs.
- Impacts to historical properties were not fully assessed, but costs were likely greater for the levee plans than for diversion plans.

Floodproofing cost savings and transportation benefits were not included in the preliminary analyses for the diversion or levee plans, but these benefits would likely be greater for the diversion plans, thus further reducing the chance that levees would be the NED plan if additional factors were considered.

5.5.1.2 Tunneling was eliminated due to cost-effectiveness. Large tunnels could be used to divert flows under the communities and provide benefits similar to a diversion channel. 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. Real estate interests would be required to tunnel under private property, and real estate would also be required to dispose of the 10,370,000 cubic yards of excavated material. Sedimentation and maintenance issues with an underground project would result in high operation and maintenance costs. Research on other tunneling projects found that costs for a single bore tunnel varied from approximately $37 million per mile for the San Antonio, Texas River Tunnel to $677 million per mile for a proposed Port of Miami project, but typical costs range from $100 million to $350 million per mile. Assuming $50 million per mile, the three tunnels proposed for the Fargo-Moorhead project would cost $3.75 billion.

5.5.1.3 Reconstructing the Interstate 29 (I-29) corridor to serve as an open viaduct during floods was eliminated due to cost-effectiveness and operability concerns. The viaduct 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. Operation and maintenance costs of the corridor and the roadway would be high, and flooding would interfere with use of the Interstate for transportation. Residual damages would be similar to the diversion channels. 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 a highway located at the bottom of the channel. Excavation volumes per mile for this alternative would be similar to those of a comparable diversion plan, although the total length could be shorter. Demolition and reconstruction of the existing interstate would cost at least $400 million. Real estate would be required to dispose of the excavated material. Total cost of this alternative would likely be $1.4 billion to $4.0 billion. The costs would likely exceed any diversion alternative considered. Because the concept would provide benefits similar to a diversion channel at greater cost, it did not appear to be cost effective.

5.5.1.4 Digging the Red River channel deeper and wider to allow for more flow to pass through the Fargo-Moorhead metropolitan area was considered, as well as increasing conveyance in Oakport Coulee. Excavation to widen the river channel could also be considered beneath existing bridges to prevent the damming effect the bridge constriction can create. These alternatives were eliminated for several reasons, including environmental impacts and cost effectiveness. These alternatives, if implemented on a hydraulically effective scale, would be highly detrimental to the riverine and riparian ecosystems and would likely not be permittable. They would also not be consistent with the planning objectives to restore and improve these aquatic ecosystems. Operations and maintenance costs would be high and long-term. Environmental mitigation costs would be extreme, assuming mitigation would be possible. The communities would still face large residual risks, and if continued dredging was not maintained, any benefits of the project would be lost.

5.5.2 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

5.5.2.1 Non-structural measures were eliminated as stand-alone plans because they were not found to be cost effective. Additionally, non-structural measures would not address the large disruptions to transportation and businesses that could last more than a month during extended flood events. 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.

5.5.2.2 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 also 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 distributed throughout that area. Distributed storage could require many small structures that could take a long time to construct and would potentially be difficult to operate. The potentially large number of structures such as suggested in the "waffle plan" would require hundreds of gates to be closed at the proper time by individuals in the field, making implementation difficult and reducing the long term reliability of the plan. 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 flood event. Stage

reductions during larger floods would be even smaller. 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.

5.5.2.3 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.

5.5.2.4 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.

5.5.2.5 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.

5.5.3 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

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

5.5.3.2 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. The final array of plans must bracket the National Economic Development (NED) plan which maximizes the net NED benefits.

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. 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.

5.5.3.3 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.

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 diversions lacking a control structure were carried forward.

The Minnesota Short alignment outperformed the Minnesota Long alignment, and 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.

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

5.5.4 Additional Alternative Development

The surviving diversion alternatives were differentiated by 1) their location in either Minnesota or North Dakota, and 2) their capacity. Nonstructural 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.

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

- Preliminary screening 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 would impact an existing rail yard 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 floodplain than the Minnesota alignment. (The North Dakota and Minnesota diversions remove 80 and 30 square miles, respectively, from the 1-percent chance floodplain.)
- The sponsors and a majority of stakeholders preferred a North Dakota alignment.

5.5.4.2 Channel capacity is directly related to the project's effectiveness in reducing flood stages. On the basis of the initial design data (presented in Table 3, above), the sponsors indicated that a capacity of approximately 30,000-35,000 cfs would 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. The initial screening analysis indicated that a smaller capacity would likely optimize the net economic benefits.

5.5.5 Array of remaining alternatives

An array of remaining alternatives was formulated using those management measures or plans that survived the screening described above. The following plans were included in the array of alternatives for further consideration:

- 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 nonstructural measures

6.0 FEASIBILITY PHASE 2, SCREENING #2 (Nov 2009 – Mar 2010)

6.1 PHASE 2, SCREENING #2 ACTIVITIES

6.1.1 General

Between November 2009 and February 2010 the 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 Red River control structure and diversion inlet works were redesigned to substantially improve fish passage. The tributary structures in the North Dakota alternative were all redesigned to reduce cost and address potential environmental impacts to fish passage and geomorphology. The North Dakota channel dimensions were optimized to reduce cost and improve hydraulic efficiency. A shorter diversion was considered northwest of Fargo to intercept the Maple, Lower Rush and Rush rivers as an

additional measure to be implemented with a Minnesota diversion alternative. Coordination with natural resource agencies continued with greater focus on the potential adverse impacts of the diversion plans and measures to avoid, minimize and mitigate for those impacts. The economic analysis was expanded to assess transportation benefits, future development cost avoidance, and flood damage reduction benefits on the Sheyenne River and its tributaries. A sensitivity analysis providing various levels of economic credit to emergency levees was completed. Non-structural alternatives were evaluated for areas upstream and downstream of the diversion features. A value engineering study was completed (see Attachment 4). An unsteady HEC-RAS hydraulic model was developed to assess downstream stage increases caused by the various diversion alternatives. A loss of life analysis was completed for the future without project condition. A cost and schedule risk analysis was completed. Results of the second screening were presented at public meetings on February 1-3, 2010.

The Metro Flood Study Work Group met several times between December 2009 and March 2010 to discuss issues of plan selection, cost-sharing and sponsorship for project construction, operation and maintenance. On March 18, 2010, the work group voted to recommend the North Dakota 35,000 cfs channel as its locally preferred alternative.

6.2 PHASE 2, SCREENING #2 REVIEW AND COORDINATION

6.2.1 Agency Technical Review (ATR)

The information developed throughout the feasibility study was presented to the ATR team in the form of a draft report on February 16, 2010. The documents provided to the ATR team included:

- Draft Feasibility Report with associated EIS
- Appendix A Hydrology
- Appendix B Hydraulic appendix and HEC-RAS models
- Appendix C Economics, Social and HEC-FDA model
- Appendix D Not Used
- Appendix E Cultural Resources
- Appendix F Environmental – EIS is part of main report
- Appendix G Real Estate
- Appendix H Geotechnical – Credit to existing Levees
- Appendix I Geotechnical Analysis
- Appendix J Structural
- Appendix K Civil Design
- Appendix L Cost Engineering and Cost and Schedule Risk Assessment model
- Appendix M Recreation and Aesthetics
- Appendix N Not Used
- Appendix O Plan Formulation
- Appendix P Non-Structural
- Appendix Q Public Involvement and Comments

The review resulted in 136 comments, of which 28 were critical comments. The PDT responded to the comments and the ATR team backchecked the responses prior to the Alternative Formulation Briefing. The ATR documentation was provided to both the vertical team and the Independent External Peer Review (IEPR) team for the first of two IEPRs.

6.3 PHASE 2, SCREENING #2 KEY ASSUMPTIONS

6.3.1 Future without project assumptions

The future without project assumptions remained the same as in Screening #1. (See paragraph 5.3.1)

6.3.2 Hydrology

"Phase 2" hydrology was developed during the first Phase 2 screening step and used during the second screening analyses. Phase 2 hydrology incorporated the 2009 flood event into the entire period of record. Phase 2 flows were higher than Phase 1 for more frequent events but lower for the larger, less frequent events. 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.

From October 2009 through March 2010, the Corps Hydrologic Engineering Center (HEC) in Davis, California worked with St. Paul District on revised flow frequency curves. These efforts affected both the traditional "full period of record" analyses and those based on the climate change expert panel recommendations. HEC's revised curves were not available for use during Phase 2.

6.3.3 Hydraulic Modeling

The team used a steady-state HEC-RAS model calibrated to the 2006 event for all Phase 2 economic analyses and comparisons of stage reduction in town. An unsteady HEC-RAS model was built to assess downstream impacts.

During the latter part of the second screening in Phase 2, the team calibrated the existing conditions steady-state model to the 2009 event but did not use it for the screening analyses; the recalibrated model was not available until the end of Phase 2, and it showed approximately 1 foot higher stages than the 2006 calibrated model but matched better with the unsteady model.

6.4 PHASE 2, SCREENING #2 PROCESS

6.4.1 Second Phase 2 Screening

The array of alternatives that remained after the first screening was optimized with a focus on reducing the costs and increasing the benefits for the alternatives. This analysis focused on identifying more cost effective solutions for the river structures, the addition of fish passage and further optimizing the channel excavation to reduce costs. Additional benefits were calculated for transportation and flood proofing cost savings.

During this phase a cost and schedule risk assessment was completed on both the Minnesota and North Dakota alternatives. The assessment was in compliance with ECB No. 2007-17, dated September 2007 and was completed using the "Cost and Schedule Risk Analysis Guidance" dated 17 May 2009 and developed by the Directory of Expertise for Civil Works Cost Engineering (Walla Walla District). Staff of the Directory of Expertise assisted in completing the cost and schedule risk assessment. The assessment resulted in the overall project contingencies for the Minnesota alternatives increasing from 25 percent to 34 percent and from 24 percent to 36 percent on the North Dakota alternatives. The contingencies developed from this assessment are included in the costs in Table 4.

Table 4 – Screening #2 Alternatives with Cost and Schedule Risk Assessment

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.

The analyses completed during the second screening showed that the MN20K plan had the largest net benefits of the plans analyzed, so therefore it was the apparent NED plan. The MN20K plan was the smallest of the plans considered in the array at the beginning of the second screening. In order to bracket the NED plan, MN15K and MN10K plans were analyzed to ensure that they were not the NED plan. The analysis included development of actual benefits for the smaller plans and a linear extrapolation of costs.

All of the plans considered had a BCR greater than 1.0, meaning that any plan could be selected by the non-federal sponsors as a locally preferred plan.

Table 5 presents the expected flood stages with various capacities of diversion channel as calculated in Phase 2.

Table 5 – Stage at Fargo Gage with Diversion Channels (Phase 2)

	Stage at Fargo Gage (ft)		
	2-percent Chance (50-year)	1-percent Chance (100-year)	0.2-percent Chance (500- year)
Existing Condition	37.8	39.5	43.9
MN Alignment			
20K	30.8	32.8	40.6
25K	29.8	31.4	38.9
30K	29.8	31.1	36.9
35K	29.8	30.3	34.9
ND Alignment			
30K	29.3	29.4	37.0
35K	28.8	29.3	34.9

It should be noted that the apparent differences in performance shown in Table 5 between the larger Minnesota and North Dakota plans were due to better refinement of the models for the North Dakota plans. No actual differences in performance were expected for comparable capacity regardless of the alignment. As a result, the economic analyses presented in Table 4 would be expected to underestimate the net benefits for the Minnesota plans relative to the North Dakota plans.

The following information is intended to provide context for the stages shown in Table 5. Flood stages lower than 30.0 on the Fargo gage present only minor flood impacts to low-lying roads. Above the stage of 30.0, more extensive emergency actions are required, including temporary levees along Second Street in downtown Fargo and other locations. The major threat to homes begins at about a stage of 33.0, and significant emergency actions are required up to a stage of 40.0. Above a stage of 40.0, emergency actions are extreme. Lines of protection must extend many miles, and several portions of emergency levees exceed normally recommended heights for sandbag construction. During the 2009 flood of record, more than 80 miles of emergency measures were required to attain a line of protection equal to a stage of approximately 42.0. The actual 2009 peak flood stage was 40.82 on the Fargo gage.

6.4.2 Non-structural measures

Non-structural measures were assessed both upstream of the diversion alignments and in areas near the downstream end of the project that receive little or no stage reduction from the project. It was determined that no additional non-structural measures could be economically justified in addition to a North Dakota diversion. No non-structural measures were economically justified upstream of the diversions. However, non-structural measures downstream were incrementally justified in conjunction with all of the Minnesota diversions. 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. (Appendix P) These additional costs and benefits are not included in Table 4 above.

The nonstructural mitigation measures proposed near the downstream end of the Minnesota diversions consisted of buyouts, elevation, and construction of flood walls in the vicinity of Harwood, North Dakota. For the MN20K plan there were 57 residential structures, 1 commercial structure, and 1 critical facility (ID 400802 public school) included. For the larger Minnesota plans there are 51 residential structures and 1 critical facility (ID 400802 public school) included.

The non-structural measures in combination with all of the Minnesota alternatives being considered had net benefits greater than 1. Therefore with the selection of any Minnesota diversion alternative the non-structural plan would be added as a justified increment to that plan and would become part of the NED plan.

6.4.3. Downstream impacts to flood stages

An unsteady HEC-RAS model was created to determine how the various diversion plans would affect flood stages downstream. Preliminary modeling indicated that operating a 35,000 cfs diversion could increase flood stages downstream up to approximately 10 inches during a 1-percent chance event. The model showed that the flood duration would not be affected, but the higher stage would likely arrive about 1 day earlier. Smaller more frequent events were also analyzed, and a preliminary takings analysis was prepared. It was determined that the project did not affect the magnitude, duration or frequency of flooding downstream enough to rise to the level of a taking for any of the Minnesota alternatives. The predicted induced impacts of the project under the North Dakota alignment were sufficient to raise takings concerns. Agricultural damages were expected to be minimal, because the large Red River floods occur in the months of March and April when there is still frost in the ground and no crops are planted. Most of the structures in the floodplain downstream were either already affected by a 1-percent chance event, or they were in communities that were planning to build significant levees in the future. Both of these factors affect the takings determination. If the threshold for a taking is not met, the project could not compensate or mitigate for the incremental flood damages that may be caused by the project.

6.4.4 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 study team evaluated a shorter diversion northwest of Fargo to intercept only the Maple, Lower Rush and Rush rivers as an additional measure to be implemented with a Minnesota diversion alternative. The northwest diversion was not cost-effective as an incremental measure, so it was dropped from further consideration. Additional information about incremental measures and how they were eliminated from further consideration can be found in section 8.4.2.

6.5 STUDY DEVELOPMENTS AT THE END OF PHASE 2

6.5.1 Effects of the Recalibrated Hydraulic Model

As described in paragraph 6.3.3, the steady-state hydraulic model was recalibrated to the 2009 event late in the second screening in Phase 2. The new model showed approximately 1 foot higher stages than the 2006 calibrated model but matched better with the unsteady model being used to determine downstream impacts. In order to verify the NED evaluation, the MN20K and MN35K plans were evaluated with the recalibrated model, and economic benefits were recalculated. Using the recalibrated model resulted in significantly greater damages in the without-project condition ($104 million average annual damages compared to $77 million with the earlier model). Net benefits of each plan were substantially increased, and the MN35K plan saw greater increases in net benefits than the MN20K plan. Based upon the new model results, the net benefits for these two plans differed by approximately 5 percent. From this information, it became clear that the NED plan could be larger than the MN20K plan if all plans were reevaluated.

6.5.2 Hydrologic assumptions

As described in paragraph 6.3.2, efforts were taken from October 2009 through March 2010 to develop revised hydrologic data based upon the recommendations of the climate change expert opinion elicitation panel. Saint Paul District worked with the Corps Hydrologic Engineering Center to refine the traditional hydrologic analysis and to implement the non-traditional approach recommended by the EOE panel. After the draft report went to the Agency Technical Review team for review in February 2010, these hydrologic data were finalized. Both the revised traditional analysis and the non-traditional EOE analysis resulted in higher flows for all frequencies than what had been used in the economic analyses in Phase 2. After considering both sets of data, it was determined that using the non-traditional approach recommended by the EOE panel for all future economic analyses would better represent the actual conditions being seen in the Red River Basin and provide a more likely estimate of expected future conditions.

6.5.3 Implications for the final screening

The combination of the revised hydraulic and hydrologic data had two primary implications for plan formulation. First, the data validated the earlier screening of major conceptual alternatives. Second, it showed that additional work was needed to determine the NED plan.

Both the revised hydraulics and hydrology resulted in higher stages for any given frequency of event. All of the other conceptual alternatives—levee/floodwalls, upstream storage, and non-structural measures—would perform far less efficiently than diversions with a larger flow regime than what was assumed during screening. Therefore, this data confirmed that the diversion concept was superior and that the NED plan would be a diversion.

Because the increased stage from the hydraulic change alone increased net benefits disproportionately for the largest and smallest plans, it was not known how additional stage increases resulting from changing the hydrologic assumptions would affect the NED calculations. For that reason, all of the Minnesota diversion capacities would need to be evaluated using the recalibrated model and higher flows in order to identify the NED plan. There was also a possibility that the NED plan could be one of the North Dakota plans.

7.0 FEASIBILITY PHASE 3 (Mar 2010 – Sep 2010)

7.1 PHASE 3 ACTIVITIES

Plan formulation activities early in Phase 3 focused on using the non-traditional hydrology and re-calibrated hydraulic models to identify the NED plan. The hydraulic models used to determine downstream impacts were refined and updated using the new hydrology. Coordination with the railroads was conducted to identify and address impacts to the railyard near Dilworth, Minnesota and to refine cost estimates for railway bridges in both the Minnesota and North Dakota plans. The diversion channel alignments, cross sections, and the locations of the hydraulic structures were refined to address geotechnical concerns and to reduce the risk to the Buffalo Aquifer in Minnesota. Coordination with the non-federal sponsors and the Corps vertical team continued throughout Phase 3; the sponsors requested a locally preferred plan and in April 2010 the ASA(CW) approved the request to tentatively recommend a locally preferred plan. A draft feasibility report and environmental impact statement (DEIS) was published for public review and comment in May 2010. Concurrent with public review, the study team conducted field surveys for HTRW, cultural resources, wetland delineation and additional geotechnical investigations. Hydraulic modeling of downstream impacts also continued during the public review period. Phase 3 concluded with a decision to extend the study schedule to allow for additional hydraulic modeling of downstream impacts and investigation of measures to minimize those impacts.

7.2 PHASE 3 REVIEW AND COORDINATION

7.2.1 Alternative Formulation Briefing (AFB)

An AFB was held in the St. Paul District Office on April 26, 2010. The PDT, vertical team and staff from the Assistant Secretary of the Army for Civil Works (ASA(CW)) attended. The draft report and associated review documents were submitted to the vertical team on March 26, 2010. The report addressed as many ATR comments as possible, and acknowledged outstanding issues needing further attention. A Project Guidance Memorandum dated May 24, 2010 identified changes required prior to release

of the draft report and environmental impact statement for public review in accordance with the National Environmental Policy Act (NEPA). (Attachment 3)

7.2.2 Approval to tentatively recommend a Locally Preferred Plan (LPP)
U.S. Army Corps of Engineers policy requires the Corps to recommend the NED plan unless an exception from policy is obtained from the ASA(CW). Meetings were held with the Metropolitan Flood Management Committee on February 1, 2010 and with the Metro Flood Study Work Group (MFSWG) on February 4, 2010 to present the results of Phase 2 screenings. These groups were asked if they were still interested in a LPP and a deadline of April 15, 2010 was set to receive a formal request. After February 4, the MFSWG met weekly to discuss the project. On March 18, 2010, the work group voted to recommend the North Dakota 35,000 cfs channel as its locally preferred alternative. In its motion to select the ND35K plan, the work group noted that this plan provided "500-year flood protection to the FM metro area for the Red, Wild Rice, Sheyenne, Maple, Rush and Lower Rush Rivers" and "protection for the greatest amount of land and for the greatest number of citizens." The non-federal sponsors provided a letter dated March 29, 2010 that formally identified the North Dakota 35,000 cfs diversion as the LPP. St. Paul District forwarded the non-federal sponsors' request for a LPP to the vertical team on April 8, 2010 for coordination with the Office of the ASA(CW). The ASA(CW) visited the study area on April 25, 2010 and approved the necessary exception from policy on April 28, 2010. The exception allowed St. Paul District to prepare the draft feasibility report and environmental impact statement tentatively recommending the ND35K plan as a LPP.

7.2.3 Public Review
7.2.3.1 The draft feasibility report and environmental impact statement (DEIS) was released for public review in May 2010. The public review period ended on August 9, 2010. Comments were received from individuals and representatives of local, state and federal governmental agencies as well as non-profit organizations.

7.2.3.2 Public meetings, landowner meetings, and downstream stakeholder meetings were held in June 2010, information on these meetings can be found in Appendix Q.

7.2.4 Independent External Peer Review (IEPR)
The same document submitted to the vertical team for the AFB was also submitted to the independent external peer review panel. An initial IEPR meeting was held on April 2, 2010. IEPR of the draft report was completed on July 6, 2010.

7.3 PHASE 3 KEY ASSUMPTIONS
7.3.1 Hydrology and Hydraulics
"Phase 3" hydrology and hydraulics were used to complete the final screening and to determine the NED plan. The Phase 3 hydrology was based on the results of the EOE panel which divided the Red River's historic hydrologic record into "wet" and "dry" periods and recommended assuming continued wet conditions in project year zero

changing progressively to drier conditions in years 25 and 50. Late in Phase 3, the hydrology of the Sheyenne River was refined to better reflect recent flood events.

Phase 3 hydrology included the following flows:

	Year 0	Year 25	Year50
2-percent chance exceedance (cfs):	29,300	27,441	25,764
1-percent chance exceedance (cfs):	34,700	32,921	31,304
0.2 percent chance exceedance (cfs):	61,700	57,641	54,034

Phase 3 hydraulics used a steady-state HEC-RAS model calibrated to the 2009 flood event for diversion channel design. The expected 1-percent chance stage at the Fargo gage was 42.4 feet at Year 0.

An unsteady HEC-RAS model was used to assess upstream and downstream impacts.

7.4 PHASE 3 PROCESS

7.4.1 Phase 3 Screening

Early in Phase 3 all of the Minnesota diversion capacities were evaluated using the recalibrated model and higher flows in order to identify the NED plan. The ND35K diversion was also evaluated at this time to verify that the NED plan was not a North Dakota diversion and to ensure adequate analysis was completed on the LPP. The cost estimates were updated to include detailed analysis of the railroad crossings and recent geotechnical analysis.

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 maximized net economic benefits, so therefore it was the apparent NED plan. The MN35K plan was the largest of the plans considered in the array at the beginning of Phase 3. In order to bracket the NED plan, MN40K and MN45K plans were analyzed to ensure that they were not 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.

Costs for the MN40K and MN45K plans were estimated based upon linear extrapolation from the detailed estimates of the smaller Minnesota alternatives. Figure 1 illustrates the linear nature of the cost curve for these alternatives and supports the methodology used. 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 6.

Figure 1 - Linear Extrapolation of Costs for the MN40K and MN45K Alternatives

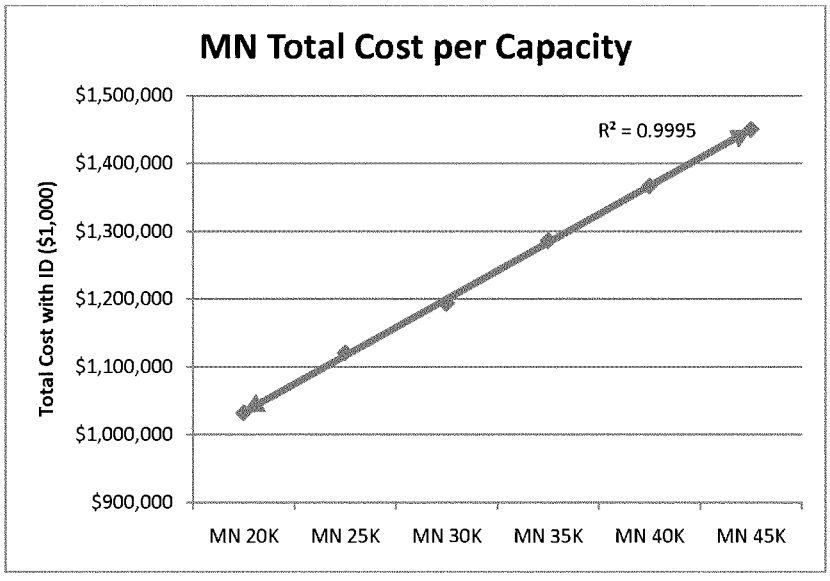


Table 6 – Phase 3 screening with updated hydrology and hydraulics

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 7 presents the expected flood stages with various capacities of the diversion channel as calculated in Phase 3.

Table 7 - 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

The Metro Flood Study Work Group (MFSWG) was provided with the economic analysis of the Minnesota diversion plans and the expected flood stages with the diversion channels on May 13, 2010. Using the revised hydrology and re-calibrated hydraulic model, the study team found that the 35K diversion channels would no longer meet the non-federal sponsors' earlier goal, a stage of 36 at the Fargo gage during a 0.2-percent chance event. The work group requested that information be developed to determine what size diversion could meet their goals, and this is also included in Table 7. It was determined that a 45K diversion would be the smallest diversion that would meet the non-federal sponsors' earlier goal.

7.4.2 Reconsideration of the Locally Preferred Plan (LPP)

On April 28, 2010, the Assistant Secretary of the Army for Civil Works authorized the Corps to tentatively recommend the ND35K plan as a LPP (See Attachment 6 - approval letter). After considering the Phase 3 results, the non-federal sponsors reaffirmed their preference for the ND35K plan as the LPP. It was noted that the revised hydrology and hydraulics affected the nominal performance of the LPP, and the ND35K plan would no longer produce the locally desired stage of 36.0 on the Fargo gage for a 0.2-percent chance event.

7.4.3 Dismissal 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 LPP could not be based on the NED

plan, because the LPP 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 LPP. Table 6 shows that the MN35K plan and the LPP 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 LPP for cost-sharing purposes. The MN35K plan was therefore identified as the Federally Comparable Plan (FCP).

7.4.4 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 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 feasibility Phase 3 confirmed that the diversion channel concept was the only concept that could achieve a high level of flood risk reduction in the study area.

7.4.5 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.

7.4.5.1 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.

7.4.5.2 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.

7.5 PHASE 3 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 information in section 7.5 of this appendix was presented in the May 2010 Draft report, and is presented here for historical documentation of the planning process. Section 8 of this appendix includes similar information for the final screening completed in Phase 4.

7.5.1 Comparison of Plan Features

Features of the alternative plans are displayed in a comparative format in Table 8. The costs of these features are included in Table 9, also in a comparative format.

Table 8 – Comparison of Alternative Plan Features

CHANNEL ALIGNMENT PARAMETERS	Minnesota Short Alignment				ND East Alignment
	20K	25K	30K	35K	35K
Top Width (feet)					
Red River to Wild Rice	1880	2020	2000	2150	2450
Wild Rice to Sheyenne					2320
Sheyenne to Outfall					2300
Bottom Width (feet)					
Red River to Wild Rice	175	240	300	360	300
Wild Rice to Sheyenne					100
Sheyenne to Outfall					125
Depth (max. excavation feet)	30	30	30	30	29
Excavation quantities (million yd^3)	36	42	49	55	67
Low flow channel required: Depth 3 ft Bottom Width 10 ft	√	√	√	√	√
Length of Alignment (miles)	25	25	25	25	36
Channel extension needed	3.7	3.7	3.7	3.7	
Length of tie back levee (miles)	9.9	9.9	9.9	9.9	3.3
Height of Levee (feet)	8	8	8	8	8
Hydraulic Structures					
Drop Structures	1	1	1	1	3
River Crossings	0	0	0	0	5
Highway Bridges	20	20	20	20	18
Rail Road Bridges	4	4	4	4	4
Number of Houses Impacted	5	5	5	5	6
Number of Acres Impacted	4,485	5,455	5,965	6,415	6,560
Acres of Wetlands Impacted - worst case					
Directly	13				33
Indirectly (due to lowering of groundwater)	85				193
Stage @ Fargo Gage					
0.2 % Event (500yr) (ft)	43.7	42.4	41.9	39.6	40
1% Event (100yr) (ft)	36.9	34.8	33.6	31.9	30.6
Max. Downstream Stage Increase (inches) 1% Event	TBD			9.4	10.4
Land removed from 1% floodplain ($miles^2$)	30				80

Table 9 – Comparison of Alternative Plan Costs including Recreation (December 2009Unit Pricing)

		Minnesota Short Alignment				ND East Alignment
Account	Item	20K	25K	30K	35K	35K
01	Lands & Damages	36,954	41,108	45,195	49,282	60,593
02	Relocations	76,534	84,396	92,911	94,050	82,251
06	Fish and Wildlife Facilities	50,920	50,920	50,920	50,920	82,960
08	Roads, Relocations and Bridges	147,708	148,271	148,834	149,397	54,971
09	Channels & Canals	380,177	429,732	466,924	524,576	741,990
11	Levees, Floodwalls, & Floodproofing	16,101	14,922	14,922	14,922	2,386
14	Recreation Facilities	28,067	28,067	28,067	28,067	28,486
30	Planning, Engineering and Design	104,926	113,446	120,387	129,290	148,957
31	Construction Management	48,965	52,942	56,181	60,335	69,514
	Total First Costs	**$890,352**	**$963,804**	**$1,024,341**	**$1,100,839**	**$1,272,108**
	Annual OMRR&R Diversion Cost	$1,883	$2,057	$2,217	$2,375	$3,318
	Annual OMRR&R Recreation Cost	$47	$47	$47	$47	$47
	Toal Annual OMRR&R	$1,930	$2,104	$2,264	$2,422	$3,069
	All costs in thousands ($1,000)					

7.5.2 System of Accounts

7.5.2.1 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.

7.5.2.2 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 in Phase 3 using the NED account is shown on Table 10. 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. Table 6 indicates 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 was kept for comparison to the LPP for cost-sharing purposes.

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

Table 10 - National Economic Development (NED) Account (all dollar values in thousands)

	Minnesota Short				North Dakota
	20K	25K	30K	35K	East 35K
Total Diversion First Cost	$856,110	$929,562	$990,099	$1,066,597	$1,237,355
Interest During Construction and Discounting	$176,066	$191,183	$203,634	$219,368	$224,549
Present worth of Investment	$1,032,176	$1,120,745	$1,193,733	$1,285,965	$1,461,904
Annualized Investment Cost	$51,172	$55,563	$59,182	$63,754	$72,477
Annual OMRR&R Cost	$1,883	$2,057	$2,217	$2,375	$3,318
Average Annual Diversion Charges	$53,055	$57,620	$61,399	$66,129	$75,795
Total Recreation First Cost	$34,242	$34,242	$34,242	$34,242	$34,753
Interest During Construction and Discounting	$2,280	$2,280	$2,280	$2,280	$760
Present worth of Investment	$36,522	$36,522	$36,522	$36,522	$35,513
Annual Recreation First Cost	$1,811	$1,811	$1,811	$1,811	$1,761
Annual Recreation OMRR&R Cost	$47	$47	$47	$47	$47
Average Annual Recreation Charges	$1,858	$1,858	$1,858	$1,858	$1,808
Flood Damage Reduction Benefit	$132,629	$148,756	$155,438	$163,372	$160,197
Flood Proofing Cost Savings	$5,960	$6,240	$6,240	$6,240	$9,993
Flood Insurance Adminstrative Cost Saving	$1,000	$1,000	$1,000	$1,000	$958
Incremental Non-Structural Flood Risk Benefit	$430	$414	$414	$414	
Avg. Annual Diversion Benefit	$140,019	$156,410	$163,092	$171,026	$171,148
Avg. Annual Recreation Benefit	$5,355	$5,355	$5,355	$5,355	$5,130
Annual Net Diversion Benefit	**$86,964**	**$98,790**	**$101,693**	**$104,897**	**$95,353**
Annual Net Recreation Benefit	$3,497	$3,497	$3,497	$3,497	$3,322
Total Annual Net Benefit	$90,461	$102,287	$105,190	$108,394	$98,675
Diversion Benefit-Cost Ratio	**2.64**	**2.71**	**2.66**	**2.59**	**2.26**
Recreation Benefit-Cost Ratio	2.88	2.88	2.88	2.88	2.84
Benefit-Cost Ratio	**2.65**	**2.72**	**2.66**	**2.59**	**2.27**

1. Costs and Benefits are given in $1,000's
2. Assumes a 50 year period of analysis - 4 3/8% 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

7.5.2.3 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 Phase 3 alternatives may have on the EQ resources is shown in Table 11.

Table 11 – Environmental Quality (EQ) Account

Resources	No Action	MN Diversion 20K	MN Diversion 25K	MN Diversion 30K	MN Diversion 35K	ND Diversion 35K
Flooding	Expected Annual Flood Damage of $195.9 million	Expected Annual Flood Damage reduced by $140.0 million	Expected Annual Flood Damage reduced by $156.4 million	Expected Annual Flood Damage reduced by $163.1 million	Expected Annual Flood Damage reduced by $171.0 million	Expected Annual Flood Damage reduced by $171.1 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	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.	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	Less Erosion and Sedimentation During Flooding, possible geomorphologic issues on Red River.	Less Erosion and Sedimentation During Flooding, possible geomorphologic issues on Red River.	Less Erosion and Sedimentation During Flooding, possible geomorphologic issues on Red River.	Less Erosion and Sedimentation During Flooding, possible geomorphologic issues on Red River.	Less Erosion and Sedimentation During Flooding, possible geomorphologic issues on Red River and tributaries.
Water Quantity	No Effect	Downstream stage increase expected to be less than the MN35k diversion	Downstream stage increase expected to be less than the MN35k diversion	Downstream stage increase expected to be less than the MN35k diversion	Downstream stage increase 4.6-9.4 inches 1 percent event	Downstream stage increase 5.3-10.4 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	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	Small potential to influence aquifers	Small potential to influence aquifers
Aquatic Habitat	Improved due to ongoing efforts to improve fish passage	Loss of 10 acres of habitat with large closure structure at Red River. Less than 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 10 acres of habitat with large closure structure at Red River. Less than 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

Table 12 – Environmental Quality (EQ) Account (continued)

Resources	No Action	MN Diversion 20K	MN Diversion 25K	MN Diversion 30K	MN Diversion 35K	ND Diversion 35K
Riparian Habitat	No Effect	Increase in habitat value for approximately 1,200 acres in the form of grass sw ale near the bottom of the diversion. Loss of 74.5 acres at river connections	Increase in habitat value for approximately 1,600 acres in the form of grass sw ale near the bottom of the diversion. Loss of 74.5 acres at river connections	Increase in habitat value for approximately 1,800 acres in the form of grass sw ale near the bottom of the diversion. Loss of 74.5 acres at river connections	Increase in habitat value for approximately 2,000 acres in the form of grass sw ale near the bottom of the diversion. Loss of 74.5 acres at river connections	Increase in habitat value for approximately 1,000 acres in the form of grass sw ale near the bottom of the diversion. Loss of 137.75 acres at river connections
Wetlands	No Effect	Direct impact to 17 acres of w etlands by construction of project, Indirect impact to 85 acres from low ering of groundw ater elevation	Direct impact to 17 acres of w etlands by construction of project, Indirect impact to 85 acres from low ering of groundw ater elevation	Direct impact to 17 acres of w etlands by construction of project, Indirect impact to 85 acres from low ering of groundw ater elevation	Direct impact to 17 acres of w etlands by construction of project, Indirect impact to 85 acres from low ering of groundw ater elevation	Direct impact to 32.5 acres of w etlands by construction of project, Indirect impact to 192 acres from low ering of groundw ater elevation
Upland Habitat	No Effect	Potential for increased habitat benefit	Potential for increased habitat benefit	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	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	Not analyzed for the environmental quality account	81.7 sq miles remain in floodplain, 30.5 sq miles taken out during a 1-percent chance event	Not analyzed for the environmental quality account	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	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	Not analyzed	Approximately 5500 acres of prime and unique farmland w ill be removed	Not analyzed	Approximately 5700 acres of prime and unique farmland w ill be removed	Approximately 5400 acres of prime and unique farmland w ill 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.	Significant reduction in property damage and lost business.	Significant reduction in property damage and lost business.

7.5.2.4 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 13. 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 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 4 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 13 – 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 ^ %

7.5.2.5 Other Social Effects (OSE)
The other social effects (OSE) account typically includes long-term community impacts in the areas of public facilities and services, public safety, recreational opportunities, transportation and traffic and man-made and natural resources.

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 floods, 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.

A comparison of the effects that the Phase 3 alternatives would have on OSE resources is shown on Table 14. The diversion alternatives considered all provide a high level of flood risk management, which results in the OSE impacts being similar for all of the Phase 3 alternatives, with the larger diversions performing better than the smaller diversions.

Table 14 – Other Social Effects (OSE) Account

		Minnesota Short Alignment				ND East Alignment
	No Action	20K	25K	30K	35K	35K
Public Health and Safety	Emergency floodfight activities would still be required, posing high risk of injury and death.	Project would improve public safety by reducing flood risk and the need for emergency actions.	Project would improve public safety greater than the smaller plans by reducing flood risk and the need for emergency actions.	Project would improve public safety greater than the smaller plans by reducing flood risk and the need for emergency actions.	Project would improve public safety greater than the smaller plans by reducing flood risk and the need for emergency actions.	Project would improve public safety greater than the smaller plans by reducing flood risk and the need for emergency actions.
Public Facilities and Services	Public facilities and services would continue to be impacted from floods.	Project would reduce impacts to public facilities and services.	Project would reduce impacts to public facilities and services greater than the smaller plans.	Project would reduce impacts to public facilities and services greater than the smaller plans.	Project would reduce impacts to public facilities and services greater than the smaller plans.	Project would reduce impacts to public facilities and services greater than the smaller plans.
Recreation and Public Access	Recreation would continue to be part of the community as currently plan.	Recreational features would be added to the project to enhance existing services.	Recreational features would be added to the project to enhance existing services.	Recreational features would be added to the project to enhance existing services.	Recreational features would be added to the project to enhance existing services.	Recreational features would be added to the project to enhance existing services.
Traffic and Transportation	Traffic and transportation would continue to be largely disrupted during flood events.	Some local traffic patterns will change as part of the project, overall traffic and transportation will see large benefits.	Some local traffic patterns will change as part of the project, overall traffic and transportation will see large benefits.	Some local traffic patterns will change as part of the project, overall traffic and transportation will see large benefits.	Some local traffic patterns will change as part of the project, overall traffic and transportation will see large benefits.	Some local traffic patterns will change as part of the project, overall traffic and transportation will see large benefits.

7.5.3 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.

7.5.3.1 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 of the diversion channel alternatives have a high likelihood of significantly reducing flood damage and flood risk, but none of the plans will eliminate flood risk. Any of the Minnesota or North Dakota 30K and 35K 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. Diversions smaller than the 30K alternatives would need more extensive additional flood barriers in town more frequently than the larger diversions would.

The North Dakota diversions 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 diversions.

The diversion channel alternatives require relatively minimal operations. Operations are necessary at the control structure on the Red River for the Minnesota plan. The North Dakota plan will require operations at the Red River control structure, Wild Rice control structure, and the Maple River tributary structure. The operations and maintenance of these structures and all project features will be dictated in the Operations and Maintenance manual that will be provided to the non-federal sponsors upon transfer 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.

7.5.3.2 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 15. The objectives of this study as described in Section 2.5 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 15 – Effectiveness in meeting planning objectives.

	Minnesota Short Alignment				ND East Alignment
	20K	25K	30K	35K	35K
Reduce Flood Risk	Reduces flood damages by 71%.	Reduces flood damages by 80%.	Reduces flood damages by 83%.	Reduces flood damages by 87%.	Reduces flood damages by 87%.
Residual Damages*	$55,881	$39,490	$32,808	$24,874	$24,752
River system afforded flood risk benefits	Red and Wild Rice Rivers	Red and Wild Rice Rivers	Red and Wild Rice Rivers	Red and Wild Rice Rivers	Red, Wild Rice, Sheyenne, Maple, Rush and Lower Rush Rivers
Restore/ Improve Riverine and Riparian Habitat	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	No specific improvement to the Riverine or Riparian habitat	No specific improvement to the Riverine or Riparian habitat
Provide additional Wetland Habitat	Provides additional 530 acres of wetlands in the project area.	Provides additional 725 acres of wetlands in the project area.	Provides additional 910 acres of wetlands in the project area.	Provides additional 1090 acres of wetlands in the project area.	Provides additional 593 acres of wetlands in the project area.
Provide Recreational Opportunities.	Provides multiple recreational features including multi-purpose trails.	Provides multiple recreational features including multi-purpose trails.	Provides multiple recreational features including multi-purpose trails.	Provides multiple recreational features including multi-purpose trails.	Provides multiple recreational features including multi-purpose trails.
* In thousands					

7.5.3.3 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 of the diversion alternatives have net benefits greater than 1 and are considered to be efficient. A breakdown of the net benefits and residual damages associated with each of the diversion alternatives is provided in Table 16. The larger diversions also result in a lower frequency of emergency

flood fights, lower risk to lives and property and considerably better effectiveness during extreme flood events.

Table 16 – Efficiency of plans – Net Benefits (all dollar values are in thousands)

		Minnesota Short Alignment				ND East Alignment
	NO Action	20K	25K	30K	35K	35K
Net Benefits of Plan (NED)	$0	$86,964	$98,790	$101,693	$104,897	$95,353
Residual Damages	$195,900	$55,881	$39,490	$32,808	$24,874	$24,752

7.5.3.4 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. All of the plans in the final array are in accordance with federal law and policy. All of the alternatives are considered acceptable for implementation, however there are slight differences in the level of acceptability. This information is summarized in the sections below.

7.5.3.4.1 Alignment

There is a strong desire from the non-federal sponsors and the public to have the diversion plan constructed in North Dakota. The North Dakota alignment would be considered highly acceptable to the non-federal sponsors. The Minnesota alignments are 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 ND35K plan as a locally preferred plan.

7.5.3.4.2 Downstream Effects

Prior to release of the May 2010 Draft Report, the best available downstream hydraulic models ended at Halstad, Minnesota. The diversion plans would all have potential downstream effects, and public concerns were raised regarding those effects. All of the diversions in the final array could cause increased flood stages downstream of the project. Analysis was conducted only for the MN35K and ND35K alternatives to determine the maximum extent of downstream impacts. The assumption was that the smaller diversions would have smaller downstream impacts for events at which their capacity was exceeded.

Downstream of the MN35K plan, the increase to the peak stage during a 1-percent chance event, with no emergency protection in place, was estimated to be 6.8 inches or less, depending upon location. The 1-percent chance event peak was estimated to 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, was estimated to be 4.3 inches or less, depending upon location. The timing of the 10-percent chance event peak would be nearly unchanged.

Downstream of the ND35K plan, the increase to the peak stage during a 1-percent chance event, with no emergency protection in place, was estimated to be 7.9 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 24.7 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.

The North Dakota alignment ha greater downstream effects than the Minnesota alignments and would therefore be less acceptable to downstream interests.

7.5.3.4.3 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. The non-federal sponsors indicated that this level is tolerable because they are confident that they would be successful with flood fighting efforts up to the stage of 36.0. Lesser stage reductions would be undesirable. Larger plans reduce flood risk to a greater degree and are, therefore, more acceptable than smaller plans from the perspective of tolerable level of risk. The analysis completed in May 2010 shows 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 45,000 cfs alignments in both Minnesota and North Dakota would result in a 0.2-percent chance stage of 35.3. The 35,000 cfs alternatives result in a 0.2 percent chance stage of 40.0. The non-federal sponsors indicated that such a stage reduction would be acceptable.

7.5.3.4.4 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 Minnesota alternatives because they cross five tributary streams. However, the North Dakota alignment provides flood risk management benefits to a larger geographic area and for more people. See Chapter 5, Environmental Consequences, of this report for more detail.

7.5.3.4.5 Floodplain Impacts
Executive Order 11988 requires federal agencies to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. 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 North Dakota alignment significantly reduces flood frequency on

approximately 80 square miles currently located in the 1-percent chance event floodplain. The North Dakota alignment reduces flood risk from all of the rivers in the North Dakota portion of the study area. The Minnesota alignment significantly reduces flood frequency on approximately 30 square miles currently located in the 1-percent chance event floodplain, but it does not address the North Dakota tributaries to the Red River. Because of the different impacts on existing floodplain, the Minnesota plans are more acceptable than the North Dakota plans 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. The LPP would generally prohibit development in portions of the staging area that would have flood depths of 3 feet or greater at the 1-percent chance event, reducing impacts on the floodplain. Any floodplain impacts created by any of the alternatives have been minimized, and will continue to be minimized, during the design phase of the project. All of the Phase 3 alternatives are in compliance with Executive Order 11988 and are acceptable from that perspective.

7.5.4 Trade-off Analysis

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.

7.5.4.1 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.

7.5.4.2 Trade-Offs between Action Alternatives

The second level of trade-offs to consider is those between the action alternatives. Of the action alternatives considered, there are two key elements that result in trade-offs: the size of the alternative selected and the location of the alternative.

In comparing the size of the diversion channels it is apparent that the largest plans (35,000 cfs) meet the four criteria in the P&G better than any of the smaller plans. In each of the four accounts (completeness, effectiveness, efficiency and acceptability) the 35,000 cfs plans outperform the smaller plans. Based on the comparison of the four criteria the larger alternatives should be selected over the smaller alternatives.

In comparing the location of the diversion channels, the tradeoffs are not clear cut. The North Dakota plans meet the completeness, effectiveness, and local acceptability criteria better than the Minnesota plans. The Minnesota plans meet the criteria of efficiency

better than the North Dakota plans. The Minnesota plans are more acceptable regarding the natural resources and downstream impacts.

Both size and location affect the cost of the alternatives. The North Dakota alternatives are more expensive than their comparably-sized Minnesota alternatives. The larger capacity channels cost more than smaller channels regardless of location. Thus, 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 cost are primarily non-federal political considerations that cannot be resolved with a technical analysis.

7.6 PHASE 3 CONCLUSIONS

7.6.1 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.

7.6.2 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. This is discussed below in section 8.0.

7.6.3 Federally Comparable Plan (FCP)
The LPP provided fewer total average annual benefits than the NED plan. Therefore, as described in section 7.4.3, it was necessary to develop a plan smaller than the NED plan that could be compared to the LPP for cost-sharing purposes. Table 6 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.

8.0 FEASIBILITY PHASE 4 (Sep 2010 – Jul 2011)

8.1 PHASE 4 ACTIVITIES

8.1.1 General. Phase 4 was primarily conducted to consider physical and operational changes to the ND35K plan needed to minimize the downstream impacts. Efforts were also made to address issues raised during the formal NEPA review of the DEIS, which ended on August 9, 2010. During Phase 4, a revised locally preferred plan was developed that included a 20,000 cfs diversion channel combined with upstream staging and storage. The ASA(CW) approved identifying the revised LPP as the tentatively selected plan on April 28, 2011. A notice of availability of the Supplemental Draft Feasibility Report and Environmental Impact Statement (SDEIS) was published in the *Federal Register* on May 6, 2011. Public meetings and a formal hearing were held during the official NEPA comment period, which ended on June 20, 2011. Responses to

the comments were developed, and appropriate revisions of the report were made prior to its finalization in July 2011.

8.1.2 NED Plan. Plan formulation to determine the NED plan and the federally comparable plan were completed in Phase 3. No further analyses were conducted on the Minnesota diversion alternatives in Phase 4 except to fully define their downstream impacts and update cost estimates.

8.2 PHASE 4 REVIEW AND COORDINATION

8.2.1 ATR Review

The information developed as part of Phase 4 was presented to the ATR team in the form of a draft report on March 14, 2011. The review focused on the changes in the document from the previous review. The documents provided to the ATR team included:

- Draft Feasibility Report with associated EIS
- Appendix A Hydrology
- Appendix B Hydraulic appendix and HEC-RAS models
- Appendix C Economics, and HEC-FDA model
- Appendix D Other Social Effects
- Appendix F Environmental – EIS is part of main report
- Appendix J Structural
- Appendix L Cost Engineering and Cost and Schedule Risk Assessment model
- Appendix P Non-Structural

The review resulted in 307 comments. The PDT responded to the comments and the ATR team backchecked the responses prior to the public release of the Supplemental Draft Feasibility Report in April 2011.

8.2.2 IEPR Review

A second IEPR review began on April 21, 2011 to assess the SDEIS and supporting analyses. IEPR comments will be addressed after completion of the Final EIS in accordance with Corps review policy.

8.2.3 In-Progress Review, April 13, 2011

An In-Progress Review (IPR) was held with the Corps vertical team on April 13, 2011 to discuss study progress, discuss the project impacts, and to verify the decisions that had been made up to that point in the project. This resulted in concurrence to release the Supplemental Draft Report to the public.

8.2.4 In-Progress Review, June 9, 2011

An In-Progress Review (IPR) was held with the Corps vertical team on June 9, 2011 to discuss and resolve vertical team comments on the Supplemental Draft Report.

8.2.5 Metro Flood Work Group
Information developed as part of Phase 4 was presented to the Metro Flood Work Group on March 30, 2011. The non-federal sponsors and local partners provided a letter dated April 6, 2011 that reconfirmed their support for the LPP, which was identified as the North Dakota diversion with upstream staging and storage.

8.3 PHASE 4 KEY ASSUMPTIONS

8.3.1 Hydrology
Phase 4 used the "wet" hydrologic assumptions for year zero from Phase 3.1 hydrology for design of the North Dakota diversion channel and to determine upstream and downstream impacts for that plan and the FCP. The channel design for the North Dakota diversion channel was analyzed for the 10, 2, 1 and 0.2-percent chance design events and the 1997, 2006, 2009 and 2010 historic events.

8.3.2 Hydraulics
In order to develop a design that incorporated the benefits of upstream storage and staging of water, the designers were required to use unsteady HEC-RAS models in Phase 4. All channel design prior to Phase 4 was completed using steady-state HEC-RAS models that could not assess the effects of storage and staging. The unsteady models used in Phase 3 to assess upstream and downstream impacts became the primary models for final design of the North Dakota diversion.

8.3.3 The NED plan and FCP were defined in Phase 3, and no additional economic analyses were needed in Phase 4 except to reflect the upstream and/or downstream impacts of the final plans—no changes were made that affected the hydraulic performance of the diversions within the benefitted area.

8.4 PHASE 4 PROCESS

8.4.1 Phase 4 Process
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. These strategies 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.

8.4.2 Phase 4 Alternatives Formulation
A number of flood risk management measures were considered in detail in Phase 1. The Alternatives Screening Document (Attachment 4 of Appendix O) concluded that a number of these measures be carried forward based on their likelihood of meeting screening criteria. The measures selected to be carried forward were formulated into

different alternatives as stand-alone plans (stand-alone plans only involve implementing one measure), and combination plans (two or more measures implemented together). Different scales of each measure were also considered. Consideration is also given to dependency and combinability of measures. The following measures were carried forward in the Alternatives Screening Document to be considered as stand-alone and combination measures:

Future without project condition - No Action
Diversion Channels

The following measures were carried forward to be considered in combination only:

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

8.4.2.1 Additional Measures

After the Phase 1 screening a number of additional measures were considered. These measures include "staging" water upstream of the diversion channel, control structures, aqueducts, tie-back levees, and smaller levees in the metro. Some of these concepts were introduced in the Phase 2 and 3 of the formulation but are discussed here. Some of these measures were formulated in order to reduce the induced impacts downstream of the diversion channel alternatives identified in Phases 2 and 3. None of these measures are considered stand-alone measures as they do not address the significant flood risk problem in the study area. The Phase 3 screening and selection of diversions as the only stand-alone alternatives is considered to be still valid, however, these additional measures will be considered as incremental features to improve the performance of diversion channel alternatives (as measured by efficiency, or other screening criteria). The following additional measures are discussed below:

Staging
Control Structures
Aqueducts
Tie-Back Levees
Smaller Levees
Northern Inlet for the North Dakota Diversion
Increasing flows through tributary channels
Adjusting Tie-Back Levee location for Minnesota Diversion.

8.4.2.1.1 Staging

Staging is a measure intended to change the timing and volume of total flows passing around the communities, with the result of reducing downstream impacts. This measure requires gate operations at the control structures to backup flows upstream of the

diversion channel and tie-back levees. The result is a temporary pool upstream of the diversion which will impact several thousand acres during gate operations.

Staging requires acquisition of a large amount of land for retaining flows. Some of the land acquired can be used for improving wildlife habitat and restoring wetland and grasslands. For this reason, staging has synergistic effect when combined with wetland and grassland restoration.

8.4.2.1.2 Control Structures
Control structures (in some places referred to as hydraulic structures) are concrete structures that can be located on the rivers or at the inlet of the diversion channel. A control structure has the advantage of creating hydraulic head at the diversion inlet and forcing flows down the diversion channel while restricting flows down the main stem channel. Control structures can be gated or un-gated. Gates add the ability to regulate the passage of flows through the main channel and diversion channel. Conceptual images of control structures can be found in the main report and in Appendix F- Hydraulic Structures of Attachment 5 to the main report.

8.4.2.1.3 Aqueducts
Aqueducts (in some places referred to as hydraulic structures, crossing structures, or tributary structures) are needed at locations where diversions cross tributary streams. Any of the North Dakota diversions would require crossing structures at the Wild Rice, Sheyenne, and Maple Rivers. Crossing structures allow a minimum flow of the tributary stream to pass over the diversion channel in order to maintain connectivity between the portions of the tributary upstream and downstream of the diversion channel.

8.4.2.1.4 Tie-Back Levees
Tie-back levees are a necessary feature for any diversion channel alternative in order to prevent flows from bypassing the diversion channel. The size and scale of tie-back levees are determined by the scale of diversion channel and the operating plan of the control structure (if the alternative includes a control structure).

8.4.2.1.5 Smaller Levees
Smaller levees are considered for parts of the Fargo-Moorhead Metro where damages occur at relatively frequent flood events. Smaller levees differ from the levee plans developed in Phase 1 in that the Phase 1 levees were scaled large enough to serve as a stand-alone flood risk management plan. Smaller levees are not intended to serve as a stand-alone plan, but rather to augment the risk reduction afforded by diversions, and possibly make smaller diversions more efficient. Potential small levees would be placed in segments and at locations where damages occur frequently. Smaller levees are similar to existing projects in Fargo, such as the Ridgewood levee/VA floodwall and Dike West. Smaller levees could also be used to allow additional base flows through town, resulting in the diversion channel being operated less frequently.

8.4.2.1.6 Northern Inlet for North Dakota Diversion
This inlet for the North Dakota diversion was initially considered near river mile 479. Moving the inlet North near river mile 469 was considered as a measure to minimize downstream impacts. It was determined that this measure could result in reduced downstream impacts, however it could not eliminate them independently. It would also leave a number of existing developed properties outside the protected area.

8.4.2.1.7 Increasing Flows through Existing Tributary Channels (More Passivity) – North Dakota Diversions
Consideration was given to reducing the amount of flows diverted from tributaries (Sheyenne and Maple Rivers) into the North Dakota diversion. It was determined that this measure alone would not significantly reduce downstream impacts.

8.4.2.1.8 Adjusting Tie-Back Levee Northward for Minnesota Diversion
Shifting the tie-back levees for the Minnesota diversions northward was considered as a measure for reducing downstream impacts. It was determined that this measure alone would not significantly reduce impacts.

8.4.2.2 Phase 4 Array of Measures
The Alternatives Screening Document (Attachment 4 of this appendix) contains a discussion of measures. The following is a list of measures carried forward from the screening document as well as the additional measures from the previous section. This is the final list of measures to be considered in alternatives formulation:

Diversion Channels-Minnesota Side (dependent on tie-back levees, exclusive of North Dakota diversion channels)
Diversion Channels-North Dakota Side (dependent on tie-back levees and aqueducts, exclusive of Minnesota diversion channels)
Non-Structural Measures
Flood Storage
Bridge Replacement or Modification
Wetland and Grassland Restoration (synergistic with staging)
Cut-Off Channels
Tie-Back Levees (dependent on diversion channels)
Staging water (dependent on diversion channels, tie-back levees, and control structures, synergistic with wetland and grassland restoration)
Control Structures (dependent on diversion channels)
Aqueducts (dependent on North Dakota diversion channels)
Smaller levees

Based on the dependency and exclusivity of the additional measures and the measures carried forward, there are 384 possible combinations of measures that form alternative plans.

8.4.3 Phase 4 Preliminary Screening of Alternatives
The 384 combinations of measures are evaluated, compared, and screened in the following sections. Phase 4 screening criteria include effectiveness, environmental effects, social effects, acceptability, implementability, cost, risk, separable mitigation, and cost effectiveness (efficiency). These are the same criteria used in previous screenings and are discussed in detail in section 5.4.1 of this appendix.

The screening results from previous phases are still valid, meaning diversion channels are the only feasible stand-alone alternatives. Combination alternatives are evaluated on an incremental basis, with the goal of identifying measures that improve the performance of diversion alternatives (as measured by screening criteria). Although each alternative is evaluated based on all screening criteria, only the most critical criteria are discussed in detail.

8.4.3.1 Combinations of Diversions and Smaller Levees
Combinations with smaller levees are evaluated based on a cursory economic analysis of NED benefits. Smaller levees were considered for three reaches (Fargo North, Fargo South, and the Lindenwood area – see appendix C of the main report for figures displaying reaches) and for larger and smaller diversions. A fully detailed economic model for smaller levees was not developed. The analysis conducted is a sensitivity analysis with best-case assumptions in favor of the possible benefits that could be attained by the smaller levees.

Large diversions (MN40K) have low residual average annual damage within the target reaches, on the order of $9.6 million. Smaller levees could potentially reduce residual damages by 50% to $4.8 million, with average annual benefits of $4.8 million. It is unlikely that smaller levees could be formulated at an average annual cost of less than $4.8 million.

Smaller diversions (MN20K) have a larger residual average annual damage. For the three target reaches residual risk is approximately $5.4 million (Fargo North), $16 million (Fargo South), and $4.7 million (Lindenwood area). Making the generous assumption that three smaller levees in the target reaches could reduce residual damages by 50%, the total benefits for each would be $2.9 million, $8 million, and $2.35 million, a total of $13.3 million.

Assuming average annual costs of smaller levees in the three target reaches would be less than 1/3 of the incremental benefits, incremental net benefits sum to $9.3 million. The addition of $9.3 million in net benefits to the MN20K diversion would not yield net benefits higher than those of the MN40K diversion. Table 17 shows the resulting net benefits.

Table 17 – Incremental Levee Analysis

Plan	Net Benefits (millions)
MN20K	87.0
Incremental levees	9.3
MN20K with small levees	96.3
MN40K	105.6

Combinations with Minnesota diversions and smaller levees are not likely to result in an NED plan and are therefore screened from further consideration. This eliminates 96 of the 384 combinations. Following this preliminary screening, combinations of North Dakota diversions and smaller levees were retained for consideration as a possible locally preferred plan, although it is unlikely that they would be a cost effective increment. They could still be a component of a locally preferred plan if desired locally or for environmental mitigation.

8.4.3.2 Combinations of Diversions without Control Structures
Evaluation of net benefits shows that diversions without control structures are marginally feasible (net benefits close to zero) or unfeasible, and that adding control structures greatly improves the efficiency. Therefore, all combination alternatives involving diversions without control structures will not be carried forward. This eliminates 96 of the 288 remaining combinations.

8.4.3.3 Combinations of Minnesota Diversions and without Non-Structural Measures
It was found that increments of non-structural measures are feasible when added to combinations with Minnesota diversions (see section 3.5.5. Non-structural measures; and Appendix P-Non-Structural for more information). This eliminates Minnesota diversions without non-structural measures (32 of the remaining 192 combinations).

8.4.3.4 Combinations of Minnesota Diversions and Staging
The incremental benefits of staging measures are the avoided downstream damages. Preliminary economic analysis shows that induced downstream damages caused by Minnesota Diversions are between $200,000 and $500,000 annually (see Appendix C Economics). Staging measures also improve the effectiveness of smaller diversion channels. It is estimated that staging measures could save approximately $8.9 million in diversion channel excavation costs (average annual). This is because staging will result in

higher water levels upstream of the diversion which results in a smaller channel carrying greater flows; it also places water into storage which means less water will need to pass around the communities. The combination of these two items will allow for a smaller diversion which could provide the same or similar benefits to the community.

The incremental annual costs of staging measures are estimated to be between $10 million and $15 million (See Appendix C Economics) compared to the annual cost of $200,000 to $500,000 for the downstream impacts. Therefore, staging measures are not efficient increments for Minnesota Diversion combinations. This eliminates 16 of the remaining 160 combinations. Following this preliminary screening, staging measures were retained for North Dakota diversion combinations for possible inclusion in a locally preferred plan.

8.4.3.5 Combinations of Diversions and Flood Storage or Wetland-Grassland Restoration
Flood storage, including the "waffle" concept, combinations were considered based on the alternatives developed in the Fargo-Moorhead and Upstream Feasibility Study (FM Upstream). The most effective system of flood storage formulated in the FM Upstream study was a 400,000 acre-foot system. This would entail creating a number of small impoundments between 2,000 acre-feet and 20,000 acre feet distributed throughout the Red River Basin and sub-basins upstream of Fargo-Moorhead. The exact size and locations of the impoundments was not determined.

Such a system of flood storage would be effective in reducing flood damages basin-wide, and could reduce the peak 1-percent chance event flood stage at Fargo by 1.6 ft. The storage system would be more effective at more frequent events, and could potentially reduce the peak 5-percent chance event stage by over 7 ft. This system has the potential to reduce expected annual damages in the Fargo-Moorhead Metro by 21 percent.

As a last-in-place increment, flood storage is feasible because it provides benefits basin-wide; however its effectiveness in reducing damages in the Fargo-Moorhead Metro is greatly diminished with a diversion already in place. It would continue to be feasible to implement a diversion even after storage is in place due to the limited effectiveness of storage to benefit the Fargo-Moorhead Metro.

Wetland and grassland restoration measures are similar to flood storage in that they store water and reduce runoff; however restoration sites are operated to maximize environmental quality. Typical wetland restoration projects are designed to hold water level fluctuations to less than two feet in order to avoid environmental impacts in the wetland. Flood storage impoundments would be designed to fluctuate as much as the terrain or embankments would allow in order to maximize storage. Wetland and grassland restoration could be implemented on a similar geographic scale as flood storage, however it would be less effective in reducing peak flows.

Wetland/grassland restoration measures provide opportunities to improve environmental quality and wildlife habitat. Flood storage, if operated carefully, could provide environmental benefits of the same kind, though to a smaller degree.

The following conclusions are pivotal in the evaluation of flood storage and wetland/grassland restoration:

1. There are opportunities to implement flood storage and wetland/grassland restoration basin-wide. These measures could have substantial cumulative benefits basin-wide; however they are relatively ineffective in reducing the significant problem of flooding in the Fargo-Moorhead Metro area.

2. It would be difficult and time consuming to implement a 400,000 acre-foot storage system as a unique measure. The most cost effective and timely way to implement a storage system is in increments, creating small impoundments as opportunities arise.

3. A system of flood storage is likely unable to offset downstream impacts induced by diversion channels. However, it would be effective in changing the frequency of how often the diversion channel would operate, making it operate less often.

4. Although flood storage and wetland/grassland restoration measures may provide environmental quality benefits and additional wildlife habitat, they would not be justified as an increment to this project, nor would they have much ability to reduce flood damages in the project area.

5. There would be the potential for large impacts from implementing flood storage and wetland/grassland restoration measures. If 400,000 acre feet of storage was needed and the average depth was 10 feet, then 40,000 acres (62.5 square miles) of land would be necessary. It would also be necessary to construct structural features to contain the water. The depth of the flood storage in wetlands and grasslands would be lower than with storage areas; assuming an average depth of 2 feet, wetland/grassland restoration would require 200,000 acres (312.5 square miles) to store 400,000 acre feet. Impacting that amount of land from either storage or wetland/grassland restoration would likely have significant impacts to people, homes, agriculture, and the environment.

Flood storage and wetland/grassland restoration increments do not effectively address the problems and opportunities identified in this study. Although there are opportunities to implement these measures on a large scale as an effective basin-wide measure, the implementation would need to take place in increments over a long period of time and in many locations. Based on effectiveness and difficulty of implementation, increments of flood storage and wetland/grassland restoration are not carried forward for further consideration. Screening combinations with Minnesota diversions and flood storage or wetland/grassland restoration eliminates 12 of the remaining 144 combinations.

Following this preliminary screening, combinations with North Dakota diversions and flood storage or wetland/grassland restoration were retained for inclusion as a possible locally preferred plan, although it is unlikely that they would be a cost effective increment. They could still be a component of a locally preferred plan if desired locally.

8.4.3.6 Combinations of North Dakota Diversions and Staging without Non-Structural Measures
Staging measures result in significant stage increases upstream of the diversion channel. It is anticipated that due to these large stage increases non-structural measures will be justified based on the increase in damages to properties that would remain in the area upstream in the absence of mitigation. This will eliminate all combinations of a North Dakota diversion and staging measures, but without non-structural measures (32 out of the remaining 132 combinations).

8.4.3.7 Combinations with Bridge Modifications or Channel-Cutoffs
Bridge modifications are relatively costly and are unlikely to be feasible as last-in-place increments with a diversion. Diversions reduce stage-frequency relationships through the metro area and make bridge modifications less beneficial.

Channel cut-offs also tend to be ineffective as last-in-place increments with diversions, and carry relatively high costs due to their potential to have large environmental impacts.

Screening bridge modifications and channel cutoffs eliminates 75 of the remaining 100 combinations.

8.4.3.8 Phase 4 Final Array of Combinations
The remaining 25 combinations can be classified into three alternatives: a Minnesota diversion with no staging, a North Dakota diversion with no staging, and a North Dakota diversion with staging. There are eight combinations with a North Dakota diversion and staging, 16 with a North Dakota diversion without staging, and one Minnesota diversion without staging. Table 18 displays the three remaining alternatives and identifies the items that may or may not be included in a possible combination.

The Minnesota diversion is fully defined and there is only one combination plan that remains. The North Dakota diversions plans include 24 remaining combinations. These combinations include four measures that may or may not be included in those plans: Non-Structural Measures, Flood Storage, Wetland/Grassland Restoration, and smaller levees. This analysis has shown that, with the exception of non-structural, none of these measures could be economically justified with the Minnesota diversion and, unless specifically requested as part of a locally preferred plan, no additional consideration is warranted. This analysis has shown that non-structural measures as part of the North Dakota diversion could be found to be economically justified; however inclusion of those measures would only be considered if specifically requested as part of a locally preferred plan. The other measures would not be economically justified but could be considered as part of a locally preferred plan. However, the flood storage and wetland/grassland

restoration measures would be very difficult to implement on a large scale due to the number of sites required, the technical challenges to operate all of the sites, the large area that would be impacted, along with the social and environmental impacts of those sites.

Table 18 – Final Array of Combinations

*"y" indicates measures is in place in plan, "n" indicates measure is not in place, "?" indicates a variable that may or may not be included in a particular combination.

Diversion Channels-Minnesota Side	Diversion Channels-North Dakota Side	Non-Structural Measures	Flood Storage	Bridge Replacement or Modification	Wetland and Grassland Restoration	Cut-Off Channels	Staging water	Control Structures	Tie-Back Levees	Smaller levees	Aqueducts	Plan Name
n	y	?	?	n	?	n	n	y	y	?	y	North Dakota Diversion without Staging
n	y	y	?	n	?	n	y	y	y	?	y	North Dakota Diversion with Staging
y	n	y	n	n	n	n	n	y	y	n	n	Minnesota Diversion without Staging

The final selection of alternatives, as well as the size and scale of measures is discussed in section 8.4.4.

8.4.4 Phase 4 Final Alternatives

8.4.4.1 Phase 4 Alternatives Considered
The Phase 4 analysis focused on ways to minimize the overall project impacts. This resulted in three plans being considered: the FCP as defined in Phase 3, the ND35K as defined in Phase 3, and the LPP, which is the North Dakota diversion with upstream storage and staging. The non-federal sponsors did not request any further consideration be given to those combination plans considered in section 8.4.3 of this appendix, and all remaining combinations were dropped from further consideration.

8.4.4.2 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 of the Main Report for more details).

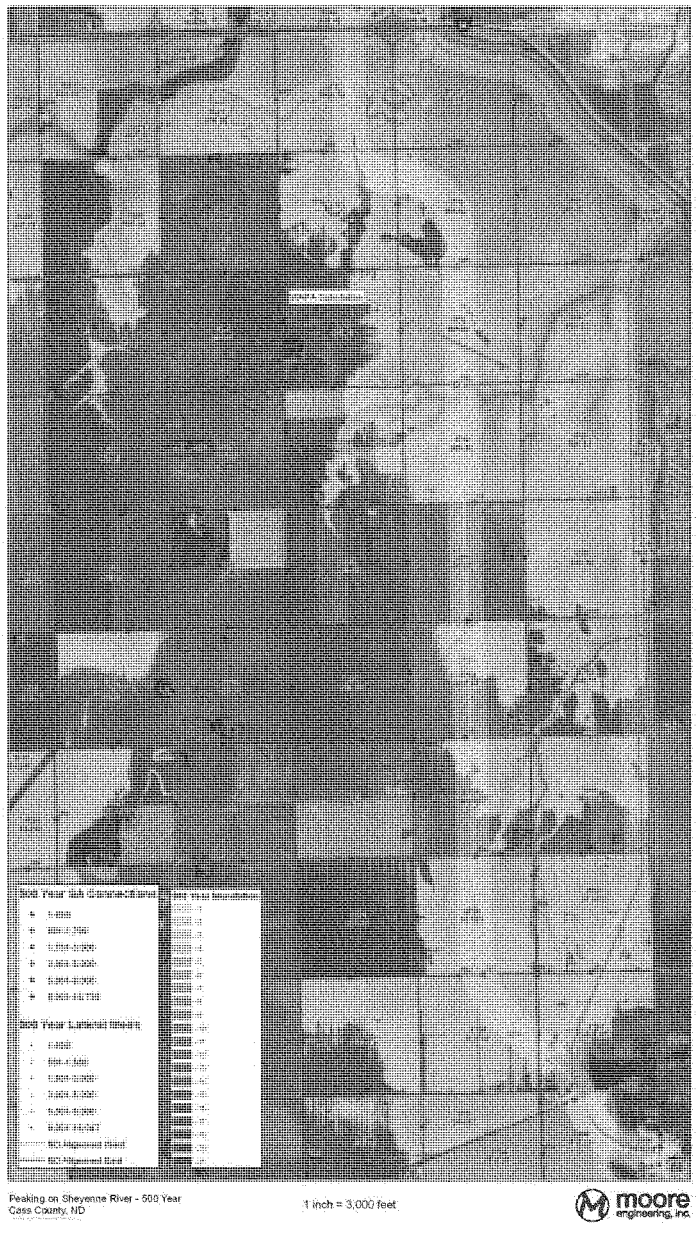
The North Dakota West alignment generally runs 1.5 miles to the west of the North Dakota East Diversion between Horace, ND and West Fargo. A formal request to consider moving the diversion to the West alignment was based on local concerns that were identified during the comment period that was held for 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

8.4.4.1.1 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 2 – Sheyenne River Floodplain – 0.2-percent chance event.



The Sheyenne River floodplain can be seen in Figure 2 for the 0.2-percent chance event (500-year); although it is 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.

8.4.4.2.2 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.

8.4.4.2.3 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 flood plain. 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.

8.4.4.2.4 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.

8.4.4.2.5 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 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 North Dakota East or West diversion would significantly reduce the flood risk along the Sheyenne River between Horace and West Fargo.

8.4.4.2.6 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 2 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.

8.4.4.2.7 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.

8.4.4.3 Alternative Scenarios for LPP Diversion
The Metro Flood Management Committee working group requested that additional scenarios be investigated to assist with local decision making for the project. This information was to be provided based on a rough technical analysis with a primary focus of identifying any possible cost saving measures. In addition, local entities including Oxbow, ND and Cass County requested that consideration be given to moving the inlet of the North Dakota diversion alignment south of Oxbow to reduce flood risk for the towns of Oxbow and Hickson, as well as the Bakke Subdivision.

As part of this analysis six scenarios were investigated and a report was developed, see Attachment 7. The investigation included the following scenarios:

- Scenario 1 - Enlarge storage area 1 and reduce upstream staging
- Scenario 2 - Eliminate storage area 1 and reduce upstream staging and increase downstream impacts
- Scenario 3 - Add large storage cell on downstream end of diversion and reduce upstream staging
- Scenario 4 - Eliminate storage area 1 and eliminate staging (basically ND35K plan)
- Scenario 5 - Eliminate storage area 1 and increase upstream staging
- Scenario 6 - Diversion alignment south of Oxbow, Hickson, and Bakke ND.

8.4.4.3.1 Scenarios 1 and 3
Scenarios 1 and 3 were developed to determine if the addition of storage areas could be a cost effective way to reduce the upstream staging. These scenarios in essence just transfer where the storage is located and does not impact the quantity of storage which is necessary for the project. The results of the analysis were that increasing the size of Storage Area 1 or constructing another storage area downstream would not be cost effective, nor would they have any other appreciable environmental benefits, since the water would simply be shifted to another location. If pursued, Scenario 1 and 3 would increase the project cost by approximately $62 and $78 million, respectively. For the above reasons, Scenarios 1 and 3 have been eliminated from further consideration. However, the Corps will continue to look at the appropriate combination of features (storage areas and staging) to determine the optimal operation for the project, and will provide supplemental NEPA documentation should future project design differ from the selected alternative, making it appropriate to do so.

8.4.4.3.2 Scenario 2
Scenario 2 was developed to determine if elimination of Storage Area 1 and increased downstream impacts would be cost effective. The analysis included stage increases of greater than 6 inches at Thompson, ND for the 1-percent chance event compared to existing conditions. Although not completely analyzed, these impacts would likely continue into Canada If Storage Area 1 is eliminated, additional land would be likely be removed from the floodplain, raising issues of compliance with Executive Order 11988. Scenario 2 would decrease the project cost by approximately $105 million, but would cause additional downstream impacts similar to the ND35K alternative. For the above reasons, Scenario 2 has been eliminated from further consideration. As with Scenarios 1 and 3, the Corps will continue to look at the appropriate combination of features (storage areas and staging) to determine the optimal operation for the project, and will provide supplemental NEPA documentation as necessary.

8.4.4.3.3 Scenario 4
Scenario 4 is essentially the ND35K plan, which has been fully analyzed in this EIS.

8.4.4.3.4 Scenario 5
Scenario 5 was to eliminate Storage Area 1 and increase the upstream staging to account for the loss of Storage Area 1. This would result in additional staging of approximately 1.2 feet to offset the loss of additional storage, which would require larger structures, increases in levee length and height, and the acquisition of additional land for staging. If Storage Area 1 is eliminated, additional land would be likely be removed from the floodplain, raising issues of compliance with Executive Order 11988. Furthermore, fish passage would likely be adversely impacted, since the project would operate for a longer duration. If pursued Scenario 5 would decrease the project cost by approximately $7 million, without consideration for environmental costs or impacts. For the above reasons, Scenario 5 has been eliminated from further consideration. As with the other scenarios, the Corps will continue to look at the appropriate combination of features (storage areas and staging) to determine the optimal operation for the project, and will provide supplemental NEPA documentation as necessary.

8.4.4.3.5 Scenario 6
Prior to the alternative scenario investigation an initial assessment was completed to determine if moving the North Dakota diversion channel alignment south could be pursued. It was determined that moving the diversion alignment south would likely have several adverse consequences. These consequences are due in part to the fact that moving the diversion channel south of the town of Oxbow would take additional land out of the floodplain, which would require additional storage. In addition, the topography in the area is such that the best upstream staging area is located in the Oxbow area, immediately upstream of the current diversion alignment. South of Oxbow, the land rises more quickly, which reduces the available storage volume on each acre of land. The investigation identified that for the diversion channel to move south it would take approximately 2.6 feet of additional staging to offset the loss of additional storage. This would require larger structures, increases in levee length and height, and impact approximately 5,900 acres of additional land. This could impact communities further upstream and involve additional technical challenges with constructing higher structures and levees. If pursued Scenario 6 would increase the project cost by approximately $35 million, without consideration for environmental impacts. Furthermore, moving the alignment south from its current location would have implications under EO 11988, which requires that federal projects minimize floodplain impacts and do not induce development of the floodplain. The current diversion channel alignment would have fewer impacts to the floodplain while still providing flood risk management for the Red River and the five tributaries. For these reasons, the scenario of moving the channel alignment south of Oxbow has been eliminated from further consideration.

8.4.5 Distributed Flood Storage versus Upstream Staging and Storage
The 200,000 acre feet of staging and storage as part of the LPP is effective and reliable storage. The further away storage is located from Fargo-Moorhead, the less effective and reliable it becomes and the smaller the benefits. To have an equal amount of effective storage further upstream, other studies have estimated that 2-5 times more storage is required. The total acre-feet required would be significantly more than what is needed

with the LPP. This is because of the fact that the storage would have to be located in the right place for each particular flood event. To implement the effective storage upstream equal to the 200,000 acre feet in the storage and staging areas would require many sites, which would result in greater impacts to more people, property, agriculture, and the environment. Storage would likely require upwards of 60,000 acres. Even if distributed storage were feasible it would be very difficult to implement on a large scale due to the number of sites required, the technical challenges to operate all of the sites, and the environmental impacts of the large area that would be impacted. The North Dakota State Water Commission published a paper titled Flood Retention: Not Always the Silver Bullet, referenced in Section 1.5.1.9, which reached similar conclusions.

Based on that information, distributed storage is screened from further consideration as an alternative to upstream staging and storage. The upstream staging and storage is more implementable from a logistical perspective, will have greater reliability, and will have less overall impacts than distributed storage.

8.4.6 Consideration of 20-percent flow reduction

The Red River Basin Commission has proposed a 20-percent flow reduction plan to reduce flood damages to the basin. The plan for 20-percent flow reduction is based on the 1997 flood, which is a relatively small flood event in the Fargo-Moorhead area of 28,000 cfs. The 20-percent reduction would provide some benefits for that event, but it would not significantly reduce the flood risk to the Fargo-Moorhead area. The proposed diversion project is designed for flows in excess of 61,000 cfs. To achieve the 20-percent reduction for a large flood event, such as 61,000 cfs, would require much more storage than is practical to implement upstream of Fargo-Moorhead, due to the number of sites required and the availability of sites. Even if it was possible to construct enough upstream storage to reduce a 0.2-percent (500-yr) event by 20-percent, the resulting peak flow at the Fargo gage would exceed that seen in 2009 by more than 60-percent (48,800 cfs). In addition, the large acreage required to implement the 20-percent flow reduction plan would have an impact on property owners, agriculture, and the environment.

Based on that information the 20-percent flow reduction is screened from further consideration.

8.4.7 Flows from Devils Lake

Flows from Devils Lake could have both a water quantity and water quality impact on the Fargo-Moorhead area. If Devils Lake were to overtop, flow estimates for a controlled overflow are 3,000 cfs and flow estimates for an uncontrolled overflow with erosion are approximately 14,000 cfs. If a North Dakota alignment diversion channel (LPP or ND35K) were in place, it would have the capacity to capture those flows during flood events and provide flood risk management benefits to the communities. With a Minnesota alignment diversion channel (FCP) or no diversion channel, the communities could be subject to additional flooding if the flows from Devils Lake were coupled with a spring or summer flood event.

8.5 PHASE 4 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, of the main report.

8.5.1 Comparison of Plan Features

Features of the alternative plans (LPP, FCP, and ND35K) are displayed in a comparative format on Table 19. The costs of these features are included on Table 20, also in a comparative format.

Table 19 – 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	1153	976	1053
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	1533*	3616*	3405*
Upstream max stage increase (inches)	98.8	6.8	0.2
Number of structures impacted upstream	838**	36	--
Land removed from 1% floodplain (sq. miles)	69	30	80

* Calculated to Drayton, ND

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

Table 20 – Final Comparison of Alternative Plan Costs including Recreation (October 2011 Price Level)

Account	Item	LPP	FCP	ND35k
01	Lands & Damages	278,372	73,617	66,076
02	Relocations	154,291	109,709	110,444
06	Fish and Wildlife Facilities	61,987	25,053	100,261
08	Roads, Relocations and Bridges	60,045	164,383	65,590
09	Channels & Canals	783,778	604,135	877,583
11	Levees, Floodwalls, & Floodproofing	143,435	25,328	3,983
14	Recreation Facilities	29,800	25,845	31,832
30	Planning, Engineering and Design	183,850	142,249	182,714
31	Construction Management	85,790	66,382	85,265
	Total First Costs	**$1,781,348**	**$1,236,701**	**$1,523,748**
	Annual OMRR&R Diversion Cost	$3,501	$3,508	$3,436
	Annual OMRR&R Recreation Cost	$130	$40	$130
	Toal Annual OMRR&R	$3,631	$3,548	$3,566
	All costs in thousands ($1,000)			

8.5.2 System of Accounts

8.5.2.1 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.

8.5.2.2 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 21. 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. Table 6 indicates 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 7.4.3 of this appendix, 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 21 - National Economic Development (NED) Account (all dollar values in thousands)

	LPP	FCP	ND35k
Total Diversion First Cost	$1,745,033	$1,205,207	$1,484,913
Interest During Construction and Discounting	$296,914	$232,405	$252,655
Present worth of Investment	$2,041,947	$1,437,611	$1,737,568
Annualized Investment Cost	$97,097	$68,360	$82,623
Annual OMRR&R Cost	$3,501	$3,508	$3,436
Induced Damages	$0	$153	$153
Average Annual Diversion Charges	$100,598	$72,021	$86,212
Total Recreation First Cost	$36,315	$31,494	$38,835
Interest During Construction and Discounting	$791	$2,015	$801
Present worth of Investment	$37,106	$33,509	$39,636
Annual Recreation First Cost	$1,764	$1,593	$1,885
Annual Recreation OMRR&R Cost	$130	$40	$130
Average Annual Recreation Charges	$1,894	$1,633	$2,015
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	**$74,219**	**$100,433**	**$87,565**
Annual Net Recreation Benefit	$3,236	$3,722	$3,115
Total Annual Net Benefit	$77,455	$104,155	$90,680
Diversion Benefit-Cost Ratio	**1.74**	**2.39**	**2.02**
Recreation Benefit-Cost Ratio	2.71	3.28	2.55
Benefit-Cost Ratio	**1.76**	**2.41**	**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

8.5.2.3 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 22.

Table 22 – 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

Table 22 - Environmental Quality (EQ) Account (continued)

	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 or indirectly impact approximately 1153 acres of wetlands	Could directly or indirectly impact approximately 976 acres of wetlands	Could directly or indirectly impact approximately 1053 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.

8.5.2.4 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 23. 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 4 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 23 – 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 ^ %

8.5.2.5 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 and for a scenario assuming failure of the selected plan. (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 24 lists and describes the social factors.

Table 24 – 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 25. 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 25 – 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.

8.5.3 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.

8.5.3.1 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.

8.5.3.2 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 26. The objectives of this study as described in section 1.8 of this appendix 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 26 – 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.

8.5.3.3 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 27.

Table 27 – Efficiency of plans – Net Benefits (all dollar values are in thousands)

	NO Action	LPP	FCP	ND35k
Net Benefits of Plan (NED)	$0	$74,219	$100,433	$87,565
Residual Damages	$194,800	$32,000	$30,000	$32,000

8.5.3.4 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.

8.5.3.4.1 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.

8.5.3.4.2 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 stage increases (and decreases) are shown in Table 28 through Table 31.

Table 28 – 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 29 – 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 30 – Upstream and downstream stage impacts (1-percent chance 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 31 – 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 25.0 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 chance 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. 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.

8.5.3.4.3 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.

8.5.3.4.4 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.

8.5.3.4.5 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 plans 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 plans 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.

8.5.3.5 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 1.9 of this appendix and repeated here 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 plans 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.

8.5.4 Trade-off Analysis

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.

8.5.4.1 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.

8.5.4.2 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) all provide 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.

8.6 PHASE 4 CONCLUSIONS

8.6.1 NED Plan
The NED plan was identified in Phase 3 of the planning process as the MN40K diversion and no changes were made to that plan during Phase 4. This plan was eliminated from further consideration in Phase 3 and is only identified here as a point of reference.

8.6.2 FCP
The FCP was identified in Phase 3 of the planning process as the MN35K diversion. In Phase 4 the hydraulic models needed to assess downstream impacts were extended to Emerson, Manitoba, Canada. The models show that there would be no significant impacts to stages in Canada from the FCP. The economic value of the induced damages was included in the total project cost. This plan sets the basis for cost sharing of the LPP.

8.6.3 ND35K
The ND35K plan was identified in Phase 3 of the planning process. In Phase 4 the only change to the ND35K was to adjust the alignment northwest of Harwood, ND to avoid Drain 13. The hydraulic models were not extended beyond Thompson, ND. The hydraulic modeling to Thompson was compared with the extended models for the FCP, and it was concluded that hydraulic impacts of the ND35K plan would likely extend into Canada because the impacts from the ND35K were generally greater than those of the FCP. The economic value of the induced damages was included in the total project cost.

8.6.4 LPP
The LPP was identified in Phase 4 of the planning process. This plan is a modification of the ND35K diversion which incorporates features that allow upstream storage and staging designed to minimize the downstream impacts and the extent of those impacts.

8.6.5 Conclusion—Selected plan
The LPP is the selected plan based on the request of the non-federal sponsors and the analysis contained in this report. The selected plan will undergo continued refinement and improvement in the design and implementation phases. Extensive efforts will be taken to work with the non-federal sponsors, impacted communities and resource agencies to ensure that the project is implemented in a timely and effective manner.

9.0 CORPS POLICY CONSIDERATIONS

9.1 SYSTEMS/WATERSHED CONTEXT

The selected plan (LPP) substantially reduces flood risk in the largest urban area in North Dakota and western Minnesota. It greatly enhances the stability of the governmental, economic, educational, medical and social infrastructure for the entire Red River Basin region, which contributes to the national economy. The LPP addresses flooding from the Red River of the North and five of its tributaries in the study area. Significant portions of two counties in two states receive benefits from the project. The plan was developed in partnership with the cities of Fargo, North Dakota and Moorhead, Minnesota. Cass

County and the Cass County Joint Water Resource District in North Dakota and Clay County and the Buffalo-Red River Watershed District in Minnesota participated heavily in the project development process.

The Corps invited the following agencies to be formal Cooperating Agencies:

- U.S. Environmental Protection Agency
- Federal Emergency Management Agency
- U.S. Fish and Wildlife Service
- North Dakota State Water Commission
- North Dakota Department of Game and Fish
- North Dakota Department of Health
- North Dakota State Historic Preservation Office
- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency
- Minnesota State Historic Preservation Office

Although some of these agencies expressed initial interest in serving as Cooperating Agencies, no formal agreements were executed. In discussing the opportunity with these agencies, it was generally determined that there were insufficient agency resources to take on tasks beyond each agency's official mission. Despite the absence of a formal agreement, all of the agencies participated in the planning process at appropriate times and provided the necessary input to ensure that issues were raised and addressed as soon as possible in the process.

9.2 ENVIRONMENTAL OPERATING PRINCIPLES

The seven Environmental Operating Principles listed below were followed during the entire planning process as indicated in the paragraph below.

1. Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
2. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.
3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.
6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.

7. Respect the views of individuals and groups interested in Corps activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

The 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 discussion 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 as well as 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.

9.3 CAMPAIGN PLAN

The four goals and underlying objectives of the Corps of Engineers campaign plan are listed below. This study directly meets the following goals and objectives: 2a, 2b, 2c, 4a, and 4b.

1. Ready for All Contingencies - Deliver USACE support to combat, stability and disaster operations through forward deployed and reach back capabilities.
    a. USACE is ready, responsive and reliable in delivering high performance, all-hazard, contingency mission execution in a world-wide theater of operations.
    b. Prepare Theater Engineer Commands (TEC) to support Combatant Commanders throughout the spectrum of operations.
    c. Establish human resources and family support programs that promote readiness and quality of life.
    d. Institutionalize USACE capabilities in interagency policy and doctrine

2. Engineering Sustainable Water Resources – Deliver enduring and essential water resource solutions through collaboration with partners and stakeholders.
    a. Deliver integrated, sustainable, water resources solutions.
    b. Implement collaborative approaches to effectively solve water resource problems.
    c. Implement streamlined and transparent regulatory processes to sustain aquatic resources.
    d. Enable Gulf Coast recovery.
3. Delivering Effective, Resilient, Sustainable Solutions – Deliver innovative, resilient, sustainable solutions to the Armed Forces and the Nation.
    a. Deliver sustainable infrastructure via consistent and effective military construction and real estate support to customers
    b. Improve resilience and lifecycle investment in critical infrastructure.
    c. Deliver reliable infrastructure using a risk-informed asset management strategy.
    d. Develop and apply innovative approaches to delivering quality infrastructure.
4. Recruit and Retain Strong Teams – Build and cultivate a competent, disciplined, and resilient team equipped to deliver high quality solutions.
    a. Identify, develop, maintain, and strengthen technical competencies in selected Communities of Practice (CoP).
    b. Communicate strategically and transparently.
    c. Standardize business processes.
    d. Establish tools and systems to get the right people in the right jobs, then develop and retain this highly skilled workforce.

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 level of flood risk management to the citizens of the Fargo-Moorhead Metropolitan area.

APPENDIX O
ATTACHMENT 1

Feasibility Scoping Meeting Memorandum for Record

CEMVP-PM-A October 17, 2009
Updated status of issues noted in the PGM for the Subject FSM

CEMVP-PM-A June 23, 2009

MEMORANDUM FOR RECORD

SUBJECT: Feasibility Scoping Meeting (FSM) – Fargo-Moorhead Metro Feasibility Study, Red River of the North.

1. Subject meeting was held on 19-May-09 via teleconference. The primary purpose of the meeting was to discuss the future without project, discuss the plan formulation strategy, and resolve any policy issues through the involvement of the sponsors and Corps vertical team. The primary project purpose is to reduce flood risk.

2. Attendance during the Feasibility Scoping Meeting: **MVP**: Aaron Snyder, Craig Evans, Mike Wyatt, Molly McKegney, Jon Sobiech, Mike Lesher, Jeff McGrath, Kurt Heckendorf, Michael Bart. **MVD**: Robert Petersen, Susan Smith, David Vigh, Frankie Griggs, Bitsy Sloan, and Larry Kilgo. **HQ**: Zoltan Montvai, John Lucyshyn, Tom Hughes, Scott Murphy, Lee Ware. **City of Fargo**: April Walker. **City of Moorhead**: Bob Zimmerman.

3. MVP received written comments from MVD. Comments and responses are included in Enclosure 1.

4. A list of 7 possible policy issues were identified by the Project Delivery Team and provided to the vertical team in advance of the meeting. See Enclosure 2. Additional topics are included in the "Issues and Discussions" below.

5. The team will take a 4-pronged approach for formulation: they will develop stand alone levee/floodwall, diversion, non-structural, and internal drainage measures which will be combined and then screened as part of the initial screening.

6. Issues and Discussions

    a. Future without project conditions – The city of Fargo's "Southside Flood Control Project" is on a parallel track with the Corps Metro feasibility study, and it would provide protection for a portion of the Corps study area. The city intends to implement their project only if there is no Federal project, or as a locally preferred plan within a larger Federal project. MVP considered having two future without-project conditions. The vertical team advised against this and recommended having one future without condition and then using the other as a sensitivity analysis. **The vertical team indicated that the team should assume that the southside project is not in place for the future without-project condition.** This

appears to be 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." **MVP understands that the economic analysis should assume no southside project in place. MVP will assess alternatives to the proposed southside project in order to define the NED plan, and impacts of the southside project will be assessed as a potential locally preferred plan.**

NOTE: During the NEPA scoping meeting that was held on 20-May-09 with state and federal agencies, EPA commented that the Fargo Southside project and the feasibility study appear to be connected actions, so they think it is not appropriate to develop two separate EIS analyses. The city of Fargo wants to continue independently in case the Corps study stalls or does not find a Federal interest. The city and FEMA are considering how to resolve the issue, but it is unresolved at this time.

OCT 2009 Status: FEMA withdrew its support for the Fargo-Southside project, because the project had grown beyond the scope of the original FEMA grant from 1997. The city of Fargo put the Southside project on hold pending the results of the Corps Feasibility study. Depending on what the NED plan looks like, the City may ask to include portions of the Southside project as a locally preferred plan.

b. Flood fights and Emergency Levees – During the ATR and some previous project discussions it was suggested that credit be given to the emergency flood fighting activities that have been successful in the past. MVP indicated that past successful flood fights are not reliable over the long term, they are reliant on predictions from the National Weather Service, the project area is in the upper portion of the basin with short times to respond, FEMA does not give credit to emergency measures under 44 CFR 65.10, and no insurance company is willing to credit those measures. HQ stated that the efforts in an emergency are one time justified events and those measures are removed following the event, so no long term reliability can be given. MVD indicated that credit should not be given to the emergency measures, however some justification should be given as to why this is the case. **MVP should have discussions with the ATR team regarding the minimal probability of success. It should be acknowledged that the probability is not 0 but is very low, and MVP should discuss this in the report. A sensitivity analysis should also be conducted to provide the decision makers with the information. The analysis should include residual damage, prevention of future flood fighting costs, and loss of life.**

OCT 2009 Status: Econ analysis did not give credit for flood fights. ATR issues will be addressed when we revise the draft report.

c. Credit to existing levees – MVP completed the credit to existing levees based on ETL 1110-2-556 which was rescinded, and MVP was looking for guidance on what should be done. This was coordinated with MVD and the PCX prior to the meeting. **The vertical team concurred that MVP should use the analysis that it had already conducted and should continue to follow ETL 1110-2-556.**

d. Climate Change – MVP was looking for guidance on how to incorporate climate change or climate variability into the analysis. MVP proposed using expert elicitation to determine the best way to proceed. There appears to be a 40-year trend of increasing peak flows in the basin, and this should be addressed. HQ indicated this can be handled with a sensitivity analysis. IWR is leading the Corps climate change and MVP should contact Lynn Martin. **The vertical team concurred with seeing expert elicitation to determine the best path forward and the use of a sensitivity analysis.**

OCT 2009 Status: An Expert Opinion Elicitation panel was convened on 28-30 Sep 2009. Discussion was good, but results are unclear. Currently working with HEC to determine how to use the EOE panel results and to refine other aspects of the hydrology that have arisen during the study.

e. Loss of Life – MVP was seeking guidance on how loss of life should be addressed. MVP plans to do an analysis on the statistical loss of life that could be expected during existing and proposed conditions, with a focus on failure of emergency levees. The Corps currently uses population at risk for budgeting purposes. ASA(CW) has not been willing in the past to quantify a benefit associated with potential loss of life. **MVP should conduct a loss of life analysis for the future without project condition (assuming flood fighting) and for the tentatively recommended plan; however no dollar value should be attributed to this. The report should describe qualitatively any changes to the population at risk caused by our project and describe the effectiveness of evacuations.**

OCT 2009 Status: MVP is waiting for the tentatively recommended plan to be defined before proceeding with loss of life analyses.

f. Study Scope –
1) Geographic Scope - This study is focused on the Fargo-Moorhead Metropolitan region. There is some interest in looking at the whole RRN basin. This is a regional plan for FRM and is not considering a holistic solution for the entire RRN basin. MVP proposes to use the Fargo-Moorhead Upstream Feasibility study to analyze upstream storage and use

that existing analysis for this feasibility study. **The vertical team concurred with the current approach.**

2) Ecosystem Restoration – The draft report identifies planning objectives to restore degraded riverine and riparian habitat, provide additional wetland habitat, and provide recreational opportunities in conjunction with other project features. MVP does not plan to propose stand-alone ecosystem restoration features, but some FRM alternatives will provide opportunities to meet these objectives. See comment #2 in Enclosure 1. **The vertical team concurred with this approach.**

g. Executive Order 11988 – MVP will develop federal alternatives to reduce flood risk south of Fargo as part of the plan formulation and should consider future development pressures. Executive order 11988 indicates that we are not supposed to encourage development in a floodplain unless there is no practicable alternative. The city of Fargo anticipates that the area within the proposed southside project will be developed over time even if no flood project is built. Checklist item #43 – MVP should take all reasonable measures to eliminate/mitigate impacts, there is no special cost sharing. **Any locally preferred plan would need to be approved by the ASA(CW), and we expect EO 11988 to be a factor in making that decision. The report will discuss development that is expected to occur over time in the absence of a flood control project**

OCT 2009 Status: EO 11988 is still expected to be an issue. The currently proposed diversion alternatives need to be further refined to minimize impacts on the existing floodplain. We expect Fargo may request a locally preferred plan that may follow closely the earlier proposed Fargo Southside flood control project which takes additional land out of the floodplain.

h. Non-Structural – Checklist item #46 – No special action is necessary from MVP. **MVP will work with the non-structural flood proofing committee and the feasibility documentation will be sufficient.**

i. Changes to the P&G – MVP was looking for guidance on changes to the P&G. The vertical team indicated those impacts are unknown at this time and that MVP should not worry about it.

j. MVP requested Vertical Team assistance to streamline the planning process to meet our aggressive schedule. We are assuming that a capability level of funding will be provided (FY10 appropriations will be a test). Vertical Team suggested that we keep Eric Thaut and the FRM PCX involved, especially regarding the Independent External Peer Review.

OCT 2009 Status: It appears that FY 2010 funding will be sufficient to complete the feasibility study. Schedule remains extremely aggressive.

7. The Feasibility Scoping meeting was very productive and it helped to clarify the direction of the study and what needs to be done moving forward. The next scheduled vertical team meeting is the Alternative Formulation Briefing scheduled for April 2010. MVP may request earlier in-progress reviews as this project progresses and will welcome Vertical Team assistance and guidance at any time deemed appropriate by MVD or the MVD-RIT.

Craig Evans	Aaron Snyder
Project Manager	Project Manager

Enclosure 1: MVD comments and MVP responses
Enclosure 2: Fargo-Moorhead Metro FSM – Issues to Discuss

Fargo-Moorhead FSM
MVD Comments and MVP Responses

1. COMMENT: Paragraph 3j of the MVD approval memo of the Section 905(b) analysis indicates that the inclusion of the phrase "and allied purposes" does not specifically include environmental restoration. Has MVP-OC made an assessment of the study authority to determine if the phrase "and allied purposes" is broad enough to authorize the investigation of ecosystem restoration as a project purpose?

RESPONSE: MVD-OC and MVP-OC are coordinating this issue. It may not be pertinent, since MVP is not proposing stand-alone ecosystem restoration features.

OCT 2009 status: MVD-OC and MVP-OC have concluded that there is no legal issue. MVD-PD-N indicated via e-mail on 11-Sep-09 that there is no policy issue either. Issue is closed. MVP will proceed with the understanding that the phrase "and allied purposes" is sufficient to support the types of ecosystem restoration we anticipate with this project.

2. COMMENT: The documentation is very unclear as to ecosystem restoration. The Project Study Issue Checklist seems to indicate that MVP is formulating for an aquatic ecosystem restoration component. However, ecosystem restoration (ER) is not mentioned on page 1 in the Report Purpose and Scope and, on page 9, National and Local Planning Goals, the document indicates that they are not formulating for ER, but there may be incidental ER benefits. Without a clear understanding of the study purpose, problems, opportunities, and objectives, it will be very difficult to have clearly defined plan formulation. If the PDT is formulating for flood risk management (FRM) alone, but anticipates the possibility of incidental ER benefits, I would suggest the Project Study Issue Checklist be revised to indicate that they are not formulating for ER (especially since there are a number of potential policy issues identified for ER). Suggest this be discussed at the FSM and any inconsistencies between the documents corrected. Also suggest during the FSM that the PDT step the meeting participants through the plan formulation process that has occurred to date.

RESPONSE: The draft report identifies planning objectives to restore degraded riverine and riparian habitat, provide additional wetland habitat, and provide recreational opportunities in conjunction with other project features. MVP does not plan to propose stand-alone ecosystem restoration features, but some FRM alternatives will provide opportunities to meet these objectives. For instance, flood-plain evacuation could lead to increased acres of habitat, and diversion channels could be built to incorporate wetland habitat. Such features are consistent with the Corps Environmental Operating Procedures, and could possibly be needed for mitigation of other features. **MVP will revise the Project Study Issue Checklist to show that we are not formulating for ER, but we do not want to lose track of any potential issues there might be with formulation because of the inclusion of incidental ER features.**

3. COMMENT: It is unclear why 2 scenarios are being used for the future without project condition. Does the reasonable future condition include the Southside Flood Control Project or not? This needs to be discussed at the FSM.

RESPONSE: Discussion during the FSM resolved this issue. MVP will assume that the Southside project is not in place for purposes of economic analysis and determining the NED plan. We anticipate that the Sponsor will want to include the Southside project as a locally preferred plan if it is not the NED plan.

4. COMMENT: The problem identified on page 17 is related to FRM, yet the opportunities are related to ER and recreation. Normally, there is a correlation between problems and opportunities which provides the foundation for the formulation process.

RESPONSE: The Corps Planning Manual, IWR Report 96-R-21, page 70 discusses the definition of problems and opportunities. According to that document, the difference between a problem and an opportunity is one's point of view—a problem is a current negative condition that needs to be fixed, and an opportunity is a positive future condition that can be achieved. In the case of Fargo-Moorhead, we chose to frame the flood issues as a problem and the environmental issues as opportunities. The objectives that spring from these problem and opportunity statements should be clear, at least after the discussion at the FSM.

5. COMMENT: There are a number of critical ATR comments which must be resolved.

RESPONSE: Concur. We will work with the ATR team to resolve those issues as we continue the study.

6. COMMENT: The MVP transmittal memo correctly identifies policy and procedural issues which should be discussed at the FSM. With regard to expediting the study, have discussions with the sponsor taken place regarding possibly advancing some Phase 3 work items? I note that if you could advance the CWRB by 1-2 months, you may be able to complete a Chief's Report by 31 Dec 10, which would position the project in case Congress would elect to contingently authorize the project in a potential WRDA 2010.

RESPONSE: We believe the current schedule, which calls for the CWRB in September 2010, will allow for completion of a Chief's Report by 31-Dec-2010 and a contingent authorization.

7. COMMENT: Main report and appendices use several different terms (100-year event, 100-year frequency, 1-percent chance, 1% chance event) to reference the same flood event. To be consistent and to comply with ER 1110-2-1450 suggest using the terms "[x] percent chance exceedance flood" or "x percent flood".

RESPONSE: Concur. We will revise the text for consistency prior to the AFB submittal.

8. COMMENT: The economic appendix page c-1, paragraph 2 lists a different 1 percent flood elevation for the Fargo gage than listed in the main report on page 11 paragraph ©.

RESPONSE: Concur. The main report talks about the "FEMA 100-year" stage, which is different from what the Corps is using for our analyses. MVP plans to use higher flows and stages to better reflect the hydrologic record; FEMA has chosen an administratively determined flow that is lower than the "best available information." Future reports will need to make the distinction more clearly between our numbers and FEMA's.

Fargo-Moorhead Metro FSM – Issues to Discuss
19-May-09

1) Future without project conditions
    a. Southside project and other projects: Assume both in place and not. Two future without project conditions because it is a major uncertainty for the future and we will know better later in the planning process. Not enough information at this time.

    b. Flood-fights and emergency levees. What is an appropriate assumption regarding their effectiveness? Uncertainties about getting protection in place (rain events can also happen here), Uncertainties about performance. If required to do this will use the alignments city used in this flood fight.

    c. Credit to existing levees: ETL 1110-2-556 being rescinded, plan to use what we have already done. (Geotech – did coordinate this with MVD and FRM PCX).

2) Climate Change

3) Loss of Life Discussions

4) Study scope: This study is focused on the F-M region. There is some interest in looking at the whole RRN basin. This is a regional plan for FRM, if there is a push for a holistic solution for the basin we will not make our schedule.

    a. Proposals for flood storage are not likely to have a Federal interest, so the implementation will need to be at the State or Watershed District level. We could help put a basin-wide plan together, but that will take more time and should be part of the Red River Basin Wide Study not this one.

    b. Ecosystem restoration: will be related to FRM measures, not stand-alone measures unless needed for mitigation.

5) Executive Order 11988.
    a. How will this impact us?
    b. City will want to incorporate the Southside project eventually—will there be an issue with that from anyone?
    c. Checklist item #43 "land development opportunities" and special cost sharing—does this apply to our situation?

6) Non-structural: are there any landmines here? (Checklist item #46) Anticipate some areas can only be helped using a non-structural approach.

7) Streamlining the planning process—any help Vertical Team can offer will be greatly appreciated.

APPENDIX O
ATTACHMENT 2

November 2009 In-Progress Review Memorandum for Record

CEMVP-PD-F November 19, 2009

MEMORANDUM FOR RECORD

SUBJECT: In-Progress Review – Fargo-Moorhead Metro Feasibility Study, Red River of the North, 5-Nov-09.

AGENDA

0800 Introductions

0810 Purposes:
1) Make the Corps' vertical team aware of the issues and preliminary findings
2) Seek concurrence with alternative screening done to date
3) Obtain vertical team recommendations for the path forward

0815 Study Overview

0835 Discussion of Issues

0920 Summary and Follow-up Actions

0930 Tour Overview

1000 Tour

1130 Lunch

1230 Resume tour

1500 Conclude tour
and prepare for 3:30 p.m. Metro Flood Management Work Group meeting

ISSUES DISCUSSED

1) Future without project conditions
   a. Southside project—not included in future without project condition
   b. Flood-fights and emergency levees – no credit will be given in the economic analyses (assume they are not effective). A sensitivity analysis will be completed to show how this assumption affects the NED plan. Need to be careful about double counting—including the cost of future flood-fights but not the benefits, although we know the costs are real but benefits are not guaranteed. Also need to describe dangers associated with flood-fighting and the (non-economic) value of avoiding emergency operations.

c. Feasibility report needs to project how development would occur without a project and with the project to compare over the 50-year period of analysis.
d. If development would require fill to raise homes above the flood plain, avoiding the cost of that fill could be a benefit of the project.

2) Climate Change Expert Opinion Elicitation results
   a. EOE panel was held 28-30 Sep 2009.
   b. Panel found that traditional hydrologic analysis probably underestimates the risk of flooding in the next 30-50 years.
   c. Panel recommended splitting the hydrologic record into dry and wet periods and making assumptions/sensitivity runs about when the wet cycle will end.
   d. HEC is assisting MVP to incorporate EOE recommendations into the final analyses.

3) Executive Order 11988
   a. ND and MN diversion plans cannot be seen as practicable alternatives to each other, since the ND plan benefits a different and larger geographic area. But we should look at a separate Maple River diversion in addition to the MN diversion to see if that provides similar benefits to the ND diversion alone.
   b. Potential locally preferred tie-back levee alignments may still cause EO 11988 issues.

4) Revised Principles and Guidelines—changes are still in progress. HQ will get info to us ASAP, but we need to follow the current P&G for now.

5) Preliminary Screening results
   a. Major conclusion: focus on diversions and levees
      i. Our work so far supports dropping levee plans from consideration if requested by the Sponsors. Levees have significantly higher residual risk; diversions are more effective and more cost-effective.
   b. Uncertainties
      i. Mitigation costs
         1. Fish passage
         2. Hydraulic impacts
      ii. Additional benefits
         1. Tributary flooding
         2. Transportation
         3. Advanced Replacement
         4. Floodproofing cost savings
   c. **Corps Vertical Team concurs with screening actions to date** as described in the draft Screening Document. Vertical Team will furnish comments in the near future to allow us to finalize the screening document

and use that text in the feasibility report and EIS. This includes elimination of all levee alternatives from further consideration as the National Economic Development Plan. No other levee plans will be examined unless based on the request of the local sponsors as a locally preferred plan. The levee plans are being eliminated with the following uncertainties:

i. Upstream impacts of the levee alternatives were not included in the costs, initial calculations indicate a 0.8 foot increase for the 100-year event increasing to 3.8 feet for a 500-year event. Downstream diversion impacts are on the magnitude of 0.3 feet for the 100-year.
ii. The current levee plans were based only on earthen levees, use of floodwalls would be assumed to increase levee costs.
iii. Advanced replacement benefits have not been included for the diversion or levee plans, benefits would be assumed to be greater for levee plan.
iv. Floodproofing cost savings benefits have not been included for the diversion or levee plans, benefits would be assumed to be greater for the diversion plans.
v. Transportation benefits have not been included, benefits would be assumed to be greater for the diversion plans.
vi. Impacts to historical properties have not be fully assessed, costs are assumed to be greater for the levee plans.
vii. Mitigation costs have not been included, costs would be assumed to be greater for the diversion plans although the plan is to avoid and minimize prior to the need for mitigation.

In addition to those considerations the levee options could only provide a 100-year level of risk reduction to the communities, this level of risk reduction may not be an acceptable level of risk reduction for the communities or the Federal government. By comparison, the new Corps levee at Grand Forks/ East Grand Forks has a top elevation equivalent to the 500-year flood profile and the diversion project at Winnipeg, Manitoba has a level of protection exceeding a 700-year event.

6) Locally preferred plans—what factors influence ASA(CW) approval?
   a. ASA(CW) will look at the impacts of the plans, agency views, mitigation needs, etc.
   b. We need to look at alignments that would bring the diversion back to the RRN earlier and describe the hydraulic issues that make that undesirable.

7) Communication Plan
   a. MVP plans to release an unofficial "tentatively selected plan" to the public in Jan 2010 with appropriate caveats. Caveats will include noting that study results are preliminary and not supported by the Corps until

b. Other technical information may be released throughout the study as long as it is caveated in a similar fashion.

ATTENDEES

HQUSACE: Zoltan Montvai, John Lucyshyn, Mark Matusiak, Tom Hughes

MVD: Larry Kilgo, Ken Klaus, Susan Smith, Brandy Alexander, Robert Petersen, Cassandra Price, Burke S. Torrey

MVP: Col. Jon Christensen, Craig Evans, Aaron Snyder, Jon Sobiech

Fargo: Mayor Dennis Walaker, Mark Bittner, Nathan Boerboom

Moorhead: Bob Zimmerman,

Cass County: Keith Berndt

ND DOT: Bob Walton

Moore Engineering: Jeffry Volk, Lee Beauvais

Houston Engineering: Gregg Thielman

APPENDIX O
ATTACHMENT 3

Alternative Formulation Briefing Project Guidance Memorandum

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

MAY 24 2010

CECW- MVD

MEMORANDUM FOR: Commander Mississippi Valley Division (ATTN: CEMVD-PD-SP)

SUBJECT: HQUSACE Policy Compliance Review, Fargo-Moorhead Metropolitan Area

1. Reference is made to CEMVP-PD-F memorandum dated 26 March 2010, subject: Fargo-Moorhead Metro Alternative Formulation Briefing Documents.

2. The Alternative Formulation Briefing (AFB) for the Fargo-Moorhead Metropolitan study was held on 26 April 2010 at the St. Paul District. Complete documentation of discussions and decisions reached during the AFB is provided in the enclosed project guidance memorandum (PGM). The AFB was held to provide an agency review of the project issues and to discuss remaining activities needed to be accomplished in order to complete the draft feasibility report.

3. As a result of the AFB all policy issues are resolved. The draft feasibility report may be released for public and agency review contingent on including information in the draft report as discussed in the PGM. The PGM presents the policy review comments, responses, discussions, and required actions.

4. The draft report shall be submitted to CECW-MVD for policy compliance review concurrently with the release for public review. To assist in expediting the Washington level concurrent review process, the submittal should include a compliance memorandum that specifies where and how each of the enclosed comments is addressed in the draft report.

5. Questions regarding this guidance should be directed to John Lucyshyn at 202-761-4515.

Theodore A. Brown

Encls

THEODORE A. BROWN, P.E.
Chief, MVD Regional Integration Team
Directorate of Civil Works

20 May 2010

FARGO-MOORHEAD
FLOOD RISK MANAGEMENT FEASIBILITY STUDY
ALTERNATIVE FORMULATION BRIEFING
DRAFT PROJECT GUIDANCE MEMORANDUM

1. BACKGROUND.

A. Alternative Formulation Briefing (AFB).

1) The AFB meeting was held in the St. Paul District Office on April 26, 2010. Staff from HQUSACE, MVD, St. Paul District, the non-federal sponsors and engineering firms working for the sponsors participated in the discussion. (See attached attendance list.) This memorandum summarizes the discussion, conclusions and required actions agreed upon at the meeting.

2) A follow-on teleconference was held on May 5, 2010 with the vertical team to discuss environmental mitigation issues, as requested at the AFB meeting (per action item 2.A.b below). Results of the phone conference are reflected in this memorandum.

B. Study Area. The Fargo-Moorhead metropolitan area is located in the Red River of the North Basin. Fargo and Moorhead are situated on the west and east banks, respectively, of the Red River of the North. Although Fargo-Moorhead is located along the Red River, the Wild Rice, Sheyenne, Maple and Rush Rivers in North Dakota and the Buffalo River in Minnesota also cross the study area. The Red River originates at the confluence of the Otter Tail and Bois de Sioux Rivers south of Fargo, North Dakota. The river is approximately 453 river miles and flows north where it empties into Lake Winnipeg in Manitoba, Canada. The study area is approximately 2,810 square miles and had a population of 174,367 in 2000. It is estimated that the population in the Fargo-Moorhead metropolitan region will increase to 227,150 by 2015. The Fargo-Moorhead metropolitan area is the largest urban area in North Dakota and a principal regional economic and social center.

C. Problem. Because of the relatively low elevation and flat topography, the majority of the study area is located in the regulatory floodplain. As a result, when the river flows over the banks, much of Fargo and Moorhead are susceptible to being inundated with flood waters. The Red River of the North has exceeded the National Weather Service flood stage of 18 feet in 47 of the past 108 years, and every year from 1993 through 2010. Flooding in Fargo-Moorhead typically occurs in late March and early April. Average annual flood damages in the Fargo-Moorhead metropolitan area are estimated to be over $77 million. 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.

CECW-MVD
SUBJECT: AFB PGM – Fargo-Moorhead Flood Damage Reduction Study

D. Study Authorization. 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 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 local 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).

E. Plan Formulation. The feasibility study team collected pertinent data on engineering, economic, social and environmental information needed to evaluate the study objectives. Potentially affected landowners and interested parties were identified, and potential issues and opportunities were defined. An array of possible flood risk reduction measures and alternatives were considered and screened to define the costs, benefits, and impacts to the project area. The study analyzed a number of possible measures that could reduce the flood risk in the Fargo- Moorhead Metropolitan area. These measures included: No Action - Continue emergency measures; Nonstructural measures; Flood barriers; Increase conveyance; and 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. This analysis was included 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.

The plans that were analyzed in detail were the:

No Action – synonymous with "Without Project Condition"
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 design, alignments, and features were refined and a baseline cost estimate for each plan was completed.

F. Recommended Plan. The NED plan was identified as the MN20K diversion and the LPP was identified as the ND35K diversion. The MN20K diversion channel would be a 25 mile diversion channel with a base width of 175 feet, a maximum depth of 30 feet, and includes 20 highway bridges, 4 railroad bridges, and a Red River Control Structure. This plan would provide protection to Fargo and Moorhead residents up to a 1-percent chance (100 year) flood. The NED plan would start just north of the confluence of the Red and Wild Rice Rivers and extend north and east around the cities of Moorhead and Dilworth and re-enter the Red River Fargo-Moorhead Metro Feasibility ES-11 near the confluence of the Red and Sheyenne Rivers. The diversion channel and spoils would affect approximately 4,485 acres.

The ND35K diversion channel would be a 36 mile diversion channel that would start approximately four miles south of the confluence of the Red and Wild Rice Rivers and would re-enter the Red River north of the confluence of the Red and Sheyenne Rivers. The LPP would incorporate the existing Horace to West Fargo Sheyenne River diversion channel. The channel bottom width varies between from 100 and 300 feet and has a maximum depth of 32 feet. The plan includes 18 highway bridges, four railroad bridges, and would approximately 6,560 acres.

2. REVIEW OF ALTERNATIVE FORMULATION BRIEFING DOCUMENTATION.

A. GENERAL.

Incomplete nature of report. Several portions of the report (e.g., part 4.2.1.4 on page 95, states that "information for the Maple River and Wild Rice River will be included in the final report") indicate that additional information is needed to complete the report. The environmental impacts and mitigation plan has not been fully developed. Economic impacts of increased flooding, a takings analysis, and an evaluation of mitigation

alternatives for those impacts have not been completed. Completion and review of the full report will be necessary prior to its final approval.

MVP Response: Concur. The established schedule has additional ATR and vertical team reviews scheduled prior to the report's final approval; the vertical team review is scheduled to begin in August. A preliminary takings analysis was completed and will need to be revisited based on the new hydrology. All data gaps will be finalized in the final version of the report, which will be able to incorporate some of the survey information being collected this summer. It is unlikely that mitigation for the downstream stage impacts would be economically justified. The analysis will first determine if there is a taking, then determine if there is a justified solution and then any unmitigated damages will be included in the project as a cost. The non-Federal sponsors will continue to be actively involved in this effort.

Discussion: The downstream hydraulic impacts of the NED Plan and Locally Preferred Plan were discussed in detail, along with options to mitigate. The district advised that it is unlikely that mitigation would be economically justified as an incremental feature (social or environmental) or justified as a result of a takings analysis. If this is the case unmitigated damages would need to be included as an economic cost in the economic analysis. It was also recognized that non-Federal Sponsor could chose to include downstream mitigation measures should the mitigation measures be found to be not supportable either economically or thru a takings analysis. It was agreed that the draft report going out for public review would discuss the range of impacts.

Required Action: The district will more fully develop the mitigation plans utilizing the most recent hydrologic and hydraulic data. Any unmitigated downstream hydraulic damages would need to be included as an economic cost in the economic analysis. The draft report going out for public review at a minimum will discuss the range of downstream hydraulic impacts with the final report presenting the full analysis.

B. PROBLEMS, NEEDS AND OPPORTUNITIES.

1. Problems and Opportunities. There is no clear 'problem and opportunity' statement. Per the Planning Manual and Planning Guidance Notebook (ER-1105-2-100), the first step of the planning process is a clearly defined statement of problem and need. A clear statement of problem and opportunity provides a focal point for all stakeholders.

a. Additionally, the problems listed for the proposed project do not include ecological problems; however, there are ecological objectives for the proposed project. The opportunities for the flood risk management portion

of the proposed study do not adequately reflect the plan formulation that has been conducted.

b. Furthermore, the primary problem cited is "high risk of flood damage to urban infrastructure", yet this is not specific to the cause of flooding, timing, or importance.
c. Opportunities are limited to improving wildlife habitat.
d. ER 1105-2-100 App E Para E3 states that problems and opportunities should be defined in terms of their nature, cause, location, dimensions, origin, timeframe, and importance. Be specific on the sources of flooding, as well as the timing and overall significance of the flooding. Also be specific to the location and significance of improving wildlife habitat. As such, the problems and opportunities should be revised in accordance with the above-comments.

MVP Response: Concur. The PDT will revisit the Problems and Opportunities to ensure they adequately capture the information located in other portions of the report. The revisions will not impact the plan formulation nor the efforts completed to date. Additionally, the PDT coordinated the development of the problems and opportunities with the local sponsors, natural resource agencies, and had particularly heavy involvement from the EPA.

Required Action: The district will revisit the Problems and Opportunities discussion in the main report to ensure discussions adequately capture the information located in other portions of the report and ensure the draft main report to be released to the public fully documents the problems and opportunities identified.

2. Objectives. The objectives that are identified for the study are extremely vague and do not allow for sufficient evaluation of the project alternatives. ER 1105-2-100 E Para E3 states "Objectives, as well as constraints, are written statements that should generally include the following four types of information: effect (the verb that expresses the intent to bring about an objective and not to violate a constraint); subject (what is to be changed for the better through meeting the objective or not changed through avoiding a constraint); location (often the study area, which defines where the objective is to be achieved); and timing and duration (often the study period of analysis, which define when and how long the objective is to be achieved or the constraint to be avoided). Developing specific, flexible, measurable, realistic, attainable, and acceptable objectives and constraints is

critical to the success of the entire planning process." The objectives must be restated consistent with the ER.

MVP Response: Concur. The PDT will revisit the Objectives to ensure they adequately capture the information located in other portions of the report. The revisions will not impact the plan formulation nor the efforts completed to date. Additionally, the PDT coordinated the development of the problems and opportunities with the local sponsors, natural resource agencies, and had particularly heavy involvement from the EPA.

Required Action: The district will revisit the Objectives discussion in the main report to ensure it captures the information located in other portions of the report and will ensure the draft main report to be released to the public fully documents the study objectives.

C. WITHOUT PROJECT CONDITIONS.

1. Flood Fighting. The text indicates that no credit is taken for flood fighting although it has been very successful in reducing damages for the most recent flooding events. It is not evident in the main report material what the costs of these flood fighting efforts have been or how they might vary for different flooding events. Since it is indicated that flooding is somewhat predictable based on snow melt, it is anticipated that the level of efforts expended by public employees and community volunteers during these emergency actions would vary by event. It isn't evident from the main report how these efforts are captured as part of emergency costs in the damage analysis. The Economics Appendix has much more information on emergency costs including the residuals anticipated for the various diversion plans. HQ suggests that more information be provided in the main report so that the reader can get a basic understanding of the emergency costs incurred and how they translate into benefits. Table 12 on page 69 alludes to reduced risk and emergency actions, but makes no distinction between the impacts of the diversion plans regarding the extent of reduction. The emergency costs should be specifically addressed under the without-project conditions text as a basis for impact assessment under the with-project conditions. See ER 1105-2-100, paragraph 2-4.b.(1).

MVP Response: Concur the information from the economics appendix will be added to the main report and the emergency costs will be specifically addressed. We will talk about the sensitivity analysis in the main report.

Required Action: As identified in the response the district will add information from the economics appendix to the main report and the emergency costs will be specifically addressed.

2. Base Year. The text doesn't clearly state what the assumed base year is for the analyses. This defines the start of the 50-year period of analysis and should be discussed in the without-project condition section. It is critical to the forecasting of future without-project conditions and comparison of alternative effects over time. The Implementation Requirements shown in Section 3.9 indicate the project completion date is in October 2018, which may be the base year. However, Table 19 shows construction continuing into 2019, so it isn't clear what the base year is assumed to be. Page C-74 of the Economics Appendix shows the flood proofing cost savings calculation over the period 2018-2068. Clarification is needed per ER 1105-2-100, paragraph 2-4.b.(1).

MVP Response: Concur. MVP will revise the analyses to make the two plans directly comparable regarding the base year. This will be adjusted in the future as we are completing a detailed construction schedule for both the NED and LPP plans.

Discussion: The district indicated it is preparing a detailed schedule for both the NED plan and the LPP and will coordinate with the Office of Water Project Review (OWPR) to ensure that the analysis is correct and will adjust the benefits accordingly.

Required Action: The district will prepare a detailed schedule for both the NED plan and the LPP and coordinate with the OWPR to ensure that the analysis is performed correctly and will adjust the benefits accordingly.

3. Period of Analysis. Paragraph 2-4.j. of ER 1105-2-100 requires that the period of analysis be the same for each alternative plan. However page C-60 of the Economic Appendix indicates that the MN diversion plans could be implemented after 6.5 years of construction and the ND diversion plans would require 8.5 years. In order to compare these plans on a comparable period of analysis, the ND plans should be shifted to the same 50-year timeframe as those in MN using the appropriate economic factors. This may make the ND plans more competitive, since the construction costs would be discounted for comparison.

MVP Response: Concur. MVP will revise the analyses to make the two plans directly comparable regarding the period of analysis. MVP will coordinate changes with OWPR to be sure the intent of the comment has been addressed.

Required Action: The district will revise the analyses to make the two plans directly comparable regarding the period of analysis. Prior to revising the report, the changes will be coordinated with OWPR to ensure the intent of the comment has been addressed.

4. Reach Delineation. Economic Appendix (pg C-7) does not adequately address land use and the reasoning of the subdivision of the reaches. ER 1105-2-100 states that floodplain characteristics and land use should be determined. Existing land use and characteristics must be determined before its actual use can be estimated. Recommend further explanation of project area and reach delineation and land use.

MVP Response: Concur. The information will be added regarding the reasoning for the reaches.

Discussion: The district explained that reaches were determined by beginning damage elevation and other factors such as existing infrastructure and geographic location. The district agreed to add a better description of how reaches were determined to the economics appendix and will include a description of the location in terms of river miles, existing structures, etc.

Required Action: The District will add appropriate discussion in the report concerning the rationale for reach delineations

D. FORMULATION OF ALTERNATIVE PLANS.

1. Screening of Management Measures. The AFB document, in particular Appendix O, does not adequately discuss how the management measures were screened, retained, and/or combined into alternatives. Management measures form the basis of alternatives, and typically lack the details that are required to evaluate alternatives. Utilizing cost to screen management measures or even an initial array of alternatives without adequate detail could lead to a flawed formulation process. Additionally, the screening of management measures by mitigation is not appropriate as sufficient detail is not yet included to evaluate the effects of each measure. It is typically not possible to quantify compensatory mitigation requirements from features or activities that lack detailed designs, locations, etc. Some

management measures such as flood barriers, were described as having low positive impacts in Section 2.2.3. However, in Section 2.2.3.1 titled Natural Resources, it states that the effects would be neutral. A table should be provided that demonstrates the rationale used to evaluate the management measures. Moreover the management measures that are listed in Section 1.6 seem to be different than the management measures that are evaluated in Section 2.4. The document needs to more fully document the screening process taking into account the requirements identified above.

MVP Response: Concur. The information will be clarified in the main report and in Appendix O. The information will be updated by including more detail from the Alternatives Screening Document attached to Appendix O. This document provides adequate rationale for the screening that was completed. Although there was a large list of initial screening criteria, some of those were weighted differently. For example, the separable mitigation was included as requested by the local sponsors and was important for their decision making, but it did not necessarily lead to the dismissal of any measures. Tables are used in Appendix O to clarify this information; this will be added to other portions of the report.

Discussion: The district agreed to review the discussions in the report to ensure they accurately explain the screening process. The details surrounding the alternative selection/ screening process will be presented in the main report rather than in an Appendix.

Required Action: As noted in discussion.

2. <u>Screening of Alternatives.</u> Reasons for why the particular Alternative Screening Criteria were chosen and how they were measured and quantified in comparing alternatives is not clearly explained. It is difficult to determine why these screening criteria were uniquely used and if they have individual weighting separate from criteria such as completeness, effectiveness, efficiency and acceptability. In ER 1105-2-100 paragraph 2-3 it is suggested that each alternative plan should be formulated in consideration of the four criteria. If the 11 criteria presented in the Alternatives Screening Document cover these criteria it should be explained why this is the case and why this particular method of screening was used. Recommend adding an explanation of the criteria used, why they were selected, and how this fits in with the prescribed methods of evaluation in ER 1105-2-100.

MVP Response: Concur. The PDT will add information on why each criterion was selected and how this fits with the prescribed methods.

Required Action: The district will revise the report to include appropriate information on why each screening criterion was selected and how it fits with the prescribed methods.

3. Ecosystem Restoration Measures. The plan formulation for the proposed project lists two objectives as having ecosystem restoration intentions; however, the initial formulation of management measures, subsequent screening, and formulation of alternatives do not discuss ecosystem restoration until further into the report. It appears that some management measures or alternatives were eliminated due to environmental degradation; however, there is not mention of how these measures or alternatives would perform in regards to the objectives. As such, the plan formulation should be revised to include an evaluation of ecosystem restoration potential for each of the measures and alternatives.

MVP Response: The primary objective of the study is flood risk management. If individual measures were not able to substantially contribute to flood risk management, they were screened out early in the process. As the study progressed it was determined that very few opportunities in the project area for ecosystem restoration would have a federal interest except as incidental components of a flood risk reduction project. The Objectives will be clarified to identify FRM as the primary objective and that ecosystem restoration is secondary to FRM. The main report will be clarified to discuss any environmental measures that were considered where relevant, this will be completed by pulling information out of the alternative screening document.

Discussion: The district affirmed that FRM is the primary objective and that the report will be revised to identify FRM as the primary objective and that ecosystem restoration is secondary to FRM. Although not apparent at this time, there still may be opportunities for restoration associated with potential downstream hydraulic mitigation measures.

Required Action: The district will revise the report to clarify the planning objective and pull info out of the alternatives screening document to explain how ecosystem objectives were considered.

4. Alternative Development. Page 24 of the main report indicates that no further consideration was being given to grassland, wetland, and storage measures as stand-alone features, but they would be considered further in combined plans with diversions.

Additionally, the Economic Appendix states there is a possibility for incremental non-structural measures. However, further discussions of plan formulation in the main text do not mention these measures being considered in combination with the diversion plans. Additional rationale needs to be presented in the main text on what consideration was given to these measures in combination with diversion and how they were written off during further formulation in order to present a complete and logical formulation story.

MVP Response: Partially Concur. Non-structural measures are included in the NED plan but not the LPP, as discussed in paragraph 3.3.5 on page 52 of the main report. The wetland and grassland restoration measures were similar to storage, and it was determined that they would not be incrementally justified along with any of the diversion channels. This is primarily due to the large costs associated with these plans and their limited ability to provide any incremental flood risk management benefits. This information will be taken from the screening document and included in the main report.

Required Action: The district will revise the main report to include additional information regarding how grassland and wetland restoration were screened out. It was agreed that information from the Alternatives Screening Document should be used to pull information into the report.

5. NED Plan. The MN20K diversion plan is designated as the NED plan in the text, however it is also noted that with the reanalysis of hydrology the NED plan designation may change. It is important to establish the NED plan per 2-3.f.(1) of ER 1105-2-100 prior to release of the draft report because the NED plan forms the basis for cost sharing when a larger LPP is proposed for recommendation and the waiver package being coordinated through ASA(CW) for approval as well as the draft feasibility report must detail the incremental differences between the LPP and NED plans. Further discussion is needed at the AFB regarding the NED plan designation based on the latest available information and consideration of the various review concerns which have potential to impact the plan formulation.

MVP Response: Concur. The NED plan should be identified by May 10, 2010 and will be incorporated into the draft report prior to public release. The incremental differences will be included in the draft report, this will be based on each line of the cost estimate. This information will be presented to the vertical team for final approval to release the draft report to the public and for concurrent MVD/HQ review. Following the updating of the H&H, information will be included in the main report indicating why the changes do not

impact the results of the screening, and actually strengthen it. An ATR will be completed on the updated work.

Discussion: The district agreed to prepare appropriate read ahead information to describe and summarize the final NED analyses for the vertical review team and will arrange for a vertical team Teleconference to discuss. The LPP and NED plan will need to be developed in the same level of detail because the NED plan will form the basis for Federal share in the LPP. The district will also discuss effects the revised hydrology will have on the alternatives screening analysis and confirm that the screening based on the traditional analysis remains valid.

Required Action: Prior to release of the draft report to the public the district will arrange for a vertical team teleconference call to discuss the results of the updated NED plan identification.

6. Value Engineering Study. It is difficult to determine if any of the VE study comments / recommendations were incorporated into the alternatives. This information should be included in the report documentation.

MVP Response: The VE comments were considered with further development of the plans. Most of the VE recommendations were not able to be implemented. The VE report will be updated to include responses from the PDT, and these will be included in the VE report for the final report.

Required Action: The district will draft responses to the VE recommendations and include in the VE report for the final report.

E. EVALUATION AND COMPARISON OF PLANS.

1. Downstream Effects. Section 3.5.3.4.2 indicates that the diversion plans would all have downstream effects that have not been analyzed except for the MN35K and ND35K diversion plans to identify maximum extent. It is indicated that additional analyses will be conducted for only the LPP and NED Plans. However, it is unclear how significant the differences might be between various scale plans and whether there is potential for these considerations to affect the NED plan designation. For example, what is the extent of any "new" acreage that would be subject to inundation by the induced rises in downstream flood elevations? Other factors that should be addressed include how the increased flood

elevations would affect structures, traffic patterns, access to residences, provision of emergency services, and agricultural land use.

These analyses should be performed for each of the detailed alternatives utilizing the most recent H&H analysis as a basis for plan comparison and selection. Per E-18.f. , ER 1105-2-100 induced flooding damages should be investigated to determine if mitigation is warranted and if not, unmitigated damages should be accounted for in the economic analysis and the impacts displayed and discussed in the report. Clarification is needed as to the effects of the induced flooding on the detailed alternative plan formulation and NED plan designation.

MVP Response: Concur. The NED and LPP plans will be updated based on the new H&H analysis, and this will be included in the final report. In general, the area that will be impacted will already be under water and there will be minimal additional disruption or damages caused by the additional downstream stages. The PDT will complete an economic analysis of the downstream impacts based on the future without project condition. Although the downstream impacts are expected to vary between the plans, it was assumed that those variations between the plans would not be significant, therefore the screening of the alternatives would be valid. This will be verified by the results of the final NED and LPP evaluations. The downstream impacts that will be provided to the public in the Draft report will be identified as preliminary and new numbers will be provided to the public as soon as possible. The future without project condition includes levees to the 100-year plus 3 feet for the communities of Georgetown, Perley, and Hendrum. Halstad has a 250-year levee already in place.

Discussion: The district indicated that additional hydraulic modeling based on revised hydrology will be required to assess downstream hydraulic effects. The district will ensure that unsteady modeling for both the LPP and NED plan is completed for the final report. The district clarified that the extent of downstream impacts is most likely just past Halstad and that there is no increased agricultural damage because of the time of the year floods usually occur—March and April, when no crops are planted. It was agreed that the district will need to account for induced damages and demonstrate that the difference in impacts between the plans does not influence the determination of the NED plan. The district advised that if the updated hydraulic downstream analysis would identify significant environmental effects additional public review would be required to comply with NEPA. It was agreed the draft report could be released to the public without final resolution of the downstream impact numbers but the draft report will need to be clear that the impacts are

preliminary. It was recognized that there is risk associated with going out for public review before final impacts are determined.

The district further explained that many of the downstream communities currently have plans for state project engineered levees that are at 100-yr + 3 feet of protection; these levees will probably be in place prior to the completion of the proposed Fargo-Moorhead project; and that future without project conditions in the feasibility study assume that new levees are in place for the downstream communities.

Required Action: For the NED plan and LPP the district will present the downstream hydraulic effects based on results the revised hydraulic modeling reflecting the updated hydrology and will discuss in the report any effects on plan formulation.

2. Additional wetland habitat, Table 13. It is unclear how the alternatives would provide increases in the acres of wetland habitat in the study area. Is the additional wetland provided in the bottom of the diversion channels?

MVP Response: Concur. The wetlands will be at the bottom of the diversion.

Discussion: The district clarified that wetlands in the project area are of poor quality in the region.

Required Action: The report will address how the alternatives would provide for increases in the acres of wetland habitat in the study area.

3. Other Social Effects. Table 12 presents information on the Other Social Effects account however in most cases the information presented for each OSE consideration uses the identical general statement for each alternative. This provides little value for distinguishing between the effects of the alternatives. It would be anticipated that the plan effects would vary for the MN versus ND alternatives and various scales of diversion. The text should be clarified to provide more definitive information on the other social effects for each of the scales of the diversion alternatives as a basis for comparison.

MVP Response: Concur, the table will be updated. Generally all of the plans under consideration provide a large level of flood risk reduction, this results in the other social effects being very similar on size and location. Will add info on impacts of the NED plan to Dilworth and will add downstream effects discussion to the OSE portion.

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Discussion: The district indicated it review the table and clarify impacts where necessary. Since all the plans under consideration provide 100-yr protection or better, from a social perspective all the plans perform strongly. There was an issue in the City of Dilworth where concern was raised overt the diversion cutting off developable lands. The district indicated this concern was analyzed and will be addressed in the report.

Required Action: The district will update the other social effects table as noted in the MVP response.

4. Expected Average Annual Damages. Table 9 shows the NED account analysis for the various plans based on the analyses conducted prior to incorporating the EOE panel recommendations. It is noted that the average annual diversion benefit varies between $61,780,000 and $71,454,000 for the various MN short alternatives based on the EAAD of $77.1M, whereas table 6 indicates residual damages would vary between 15,290,000 and 26,490,000 for EAAD= $104,000,000 (benefits would increase substantially and would vary from $77.060,000 to $88,710,000). Please clarify why the EAAD and benefits differ so significantly between the information presented in the two tables and why formulation results would not be expected to change based on the revised H&H information.

MVP Response: Concur. The numbers will be reviewed and updated for the draft report.

Required Action: As noted in the MVP response.

5. Interest During Construction (IDC). In Table 9, page 61 the values shown for IDC on the North Dakota plans are much higher than the MN plans in comparison. For instance, the 35K MN plan has a first cost of $999,733,000 with IDC of $149,047,000 whereas the 30K ND plan has a cost of $1,026,030,000 and IDC of $210,856,000. So a $27M cost difference results in a $60M IDC difference. These differences are not explained in the main report, but page C-60 of the Economic Appendix indicates the construction period for ND plans would be 8.5 years while the MN plans would take 6.5 years. It is not clear why the schedules/and IDC calculations would vary so significantly between the MN and ND plans. Is this due to the extent of structures in the ND plan? It is also unclear why the construction period would be the same for all the MN plans. Further explanation should be provided to support the assumed construction periods and the basis for IDC calculations, since this has potential to impact the formulation. See D-3.e.(11) of ER 1105-2-100.

MVP Response: Concur. A critical path analysis was completed and determined the construction schedules for each of the diversion alternatives. The difference has to do primarily with how the large tributary structures are constructed and brought on line. The Maple River structure is the critical path on the ND diversion, and the rail yard modification is the critical path on the MN diversion. A detailed construction schedule will be completed for both alternatives. The plans will be revisited to ensure that the IDC is comparable.

Discussion: The district advised they are currently working on a detailed schedule and phasing for both the ND and MN alignments. Currently the district is comparing the NED 2018 numbers to the LPP 2020 number because the NED plan will take two years less to construct. The district is recommending comparing the two plans using 2020 numbers. This will make the IDC comparable.

Required Action: The district will explain the construction schedules for the NED plan and LPP in the main report and their impact on the cost estimates. The economic analysis will be revised to reflect the different schedules.

6. Beneficial Effects on Floodplains. Table 9 shows that economic benefits for Flood Insurance Administrative Cost Savings are the same ($1,000,000) for all the diversion plans. Flood Proofing Costs Savings are the same for the two ND plans ($10,430,000) and for all of the larger MN diversion plans ($6,240,000) with the MN 20K plan slightly less ($5,960,000). However, the information in Table 10 under Floodplains (EO 11988) states that floodplains were not analyzed for the ND30K, MN20K (NED Plan), and MN30K. For the diversion plans analyzed the floodplain area taken out of the 1% chance event floodplain varies between 30.5 sq. mi. (MN25K) and 81.3 sq. mi. (ND35K). Given these variations and the limited analyses conducted it isn't clear why the FIA cost savings would be shown as the same for each alternative or how flood proofing cost savings could be estimated for the various plans with confidence. Please provide further explanation, since these benefit categories have significant values relative to the difference in benefits between plans.

MVP Response: Concur. The information provided will be clarified, generally speaking all plans considered significantly reduce the 1% chance floodplain and there are only minor differences between the 20K-35K plans. The FIA cost savings is based on the number of existing policies in place under the existing conditions, this will be revisited to consider refinancing that may take place.

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Discussion: The district explained that flood proofing cost savings were based on flood outlines from the contractor. The district had different flood plains for different project alignments. Benefits varied with channel size. Flood insurance cost savings is based on existing policies. The ATR reviewer made the comment that they haven't considered future changes to flood insurance. The assumption is that FEMA regulations will not change.

Required Action: The district will revisit the FIA cost savings to consider refinancing that may take place and revise the report to clarify that generally all plans considered significantly reduce the 1% chance floodplain and there are only minor differences between the 20K-35K plans.

7. **Sanitary Sewers.** Economic Appendix (C-12) discusses damages accruing in the existing conditions caused by backwater flow through the sewer system. Please clarify how the beginning damage elevations were adjusted downward to the lower zero-damage elevation for the sanitary sewer basin and how this information was used in the damage calculations.

MVP Response: Concur. Information will be included in the draft report as well as discussions on what other incremental measures could be used to reduce sewer backups.

Required Action: The district will include discussion in the report addressing what other incremental measures could be employed to reduce sewer backup.

F. MITIGATION

1. **Use of ratios in mitigation planning.** Several sections of the main report (examples include Sections 3.8.1.3, 5.2.1.8, 5.4.1.9 and 5.5) state that mitigation acreage ratios of 2:1 would be utilized for wetlands, geomorphic/fisheries and riparian impacts. This proposal is inconsistent with paragraph C-3(d)(5) of ER 1105-2-100, which states that habitat-based evaluation methodologies shall be used to the extent possible to describe and evaluate ecological resources and impacts associated with alternative plans.

MVP Response: Concur - The mitigation portion of the report will be updated and better defined to ensure that it is policy compliant. The initial report used a 2:1 replacement approach, which should result in a conservative cost estimate to address the mitigation needs in the future. It is acknowledged that ER1105-2-100 requires specific habitat evaluation, including CE/ICA of mitigation actions. A large amount of survey work is ongoing, and any results from that will be used to complete the analysis in the feasibility

report. The report will be updated to include all of the items discussed in WRDA 2007, Section 2036. MVP will coordinate with MVD/HQ on the mitigation approach and will receive future guidance on this.

The updated mitigation plan will not be available for the May draft report to be released for public review, but it will be included in the August 2010 submittal for the CWRB. The CE/ICA will be done after completion of the mitigation analysis, the intent is to develop a plan that can be included in the final report.

Discussion: A follow-on vertical team conference call was held on 5 May to discuss the mitigation approach in more detail. Based on this teleconference it was decided that: 1) the 2:1 ratio approach will be removed from the draft report scheduled to be released in May 2010; 2) A habitat evaluation will be completed for the impacts and to determine the mitigation requirements. There are existing models that might be approved for use or could be. Coordination with the ECO-PCX is necessary; 3) An appendix on adaptive management will be developed for the August report. This will include pre and post-project monitoring plans, post-construction mitigation monitoring costs and metrics that can be used to assess the mitigations effectiveness; 4) There are two options for mitigation the first being stream remeandering and riparian corridor restoration, the second being dam removal downstream (note this would not be for fish connectivity mitigation but to mitigate for the riparian impacts); and 5) The second approach would constitute out-of-kind mitigation, but may be environmentally preferable, and will need to be closely coordinated with the natural resource agencies, and letters of support should be provided .

Required Action: As noted in the discussion.

2. <u>CE/ICA needed for mitigation plan.</u> Neither the main report nor the Environmental Appendix F contains a CE/ICA for the mitigation plan. The use of CE/ICA is required consistent with paragraph C-3(e)(8) of ER 1105-2-100.

MVP Response: Concur - The mitigation portion of the report will be updated and better defined to ensure that it is policy compliant. See response to comment F.1.

Required Action: For the final report appropriate CE/ICA analysis will be performed to support the selected mitigation plan.

3. <u>Proposed mitigation plan for wooded areas, Section 5.2.1.8, page 187</u>. This section of the report states that the loss of wooded areas would be replaced at a ratio of 2:1 by tree plantings along the recreational corridor of the LPP. Plates 1-3 of Appendix M show that the recreation corridor is along certain segments of the ND 35 diversion channel. In the absence of a habitat-based analysis, it is unclear whether the proposed plantings would

adequately replace the functions of the wooded areas lost due to the construction activities, or would result in either over-mitigation or under-mitigation of the impacts. The mitigation for loss of wooded areas should be evaluated using both a habitat-based assessment and CE/ICA, consistent with ER 1105-2-100.

MVP Response: Concur - The mitigation portion of the report will be updated and better defined to ensure that it is policy compliant. See response to comment F.1.

Required Action: See F.1.

4. Mitigation costs inconsistent between main report and Appendix F. Table 42 on pages 242-243 of the main report states that mitigation costs are $43,903,000 for while an un-named 11 by 17 inch table in Appendix F gives the mitigation cost for the ND Alignment as $60,518,726. Given the title of Table 42, the $43 million figure accounts only for fisheries mitigation measures. HQUSACE recommends that costs for all needed mitigation measures, including riparian and wetlands losses, be incorporated in Section 5 of the main report. Also, it is unclear whether the riparian losses discussed in Section 5 refer to the same resource as the loss of wooded areas discussed in Section 5.2.1.8 of the main report.

MVP Response: Concur. The tables and information will be updated and verified for the draft report.

Required Action: Section 5 will be updated to include all needed mitigation measures, including riparian and wetlands losses. The tables and information will be updated and verified for the draft report.

5. Mitigation performance standards, monitoring and adaptive management. The draft feasibility report should include mitigation performance standards, mitigation monitoring costs and duration, and an adaptive management plan, as discussed in the August 31, 2009 implementation guidance for Section 2036(a) of WRDA 2007.

MVP Response: Concur. The information required in Section 2036 will be included in the final report, this will include: Draft performance standards and monitoring plans for mitigation; costs for monitoring all mitigation areas; and adaptive management (including monitoring) to implement if original project is not effective. See response to comment F1.

Discussion: The district explained that the project will create many more acres of wetland in the bottom of the channel than the project is affecting. A question was raised -- Does the vertical team concur that it would be acceptable to use those wetland acres to mitigate for the wetland loss as long as the resource agencies concur? Before this could be

answered it was explained that we need to know enough about what will be created to justify the claim that the project is self-mitigating. The discussion then focused on how to address performance standards and mitigation requirements of Section 2036. Specifically, the district will need to write performance standards into the feasibility report that can be used to verify impacts after the project is constructed. It was recommend to the district speak with the Regulatory folks about suitable standards that could be used. The district was advised to be careful in writing performance standards, because the Corps will be accountable for whatever mitigation it claims will be offered. In addition the current plan has no adaptive management included. Adaptive management needs to be part of the plan until those wetlands are successful. If it is determined the mitigation doesn't perform as intended, the adaptive management will need to be modified (this adaptive management could go beyond 5-yrs). But it was pointed out that adequate analysis need to be performed upfront and not use adaptive management as a solution.

Required Action: The district will include performance standards and monitoring plans for mitigation in the report as noted in the comment. The district will also include appropriate discussion of contingency measures and adaptive management (including monitoring) to implement if original proposed mitigation does not perform as intended.

6. Consideration of mitigation banks. Section 2036(c) of WRDA 2007 directs that the Secretary, where appropriate, shall first consider the use of the mitigation bank if the bank contains sufficient available credits to offset the impact and the bank is approved in accordance with the Mitigation Rule (73 Fed. Reg. April 10 2008). The November 6, 2008 implementation guidance for this section of WRDA states that the analysis and documentation of the rationale for the determination concerning the use of banks should be included in the project decision document. Also, please be advised that the mitigation bank does not have to be capable of providing all of the mitigation needed for the project in order to be eligible for consideration. The implementation guidance is available at the following link:
http://www.usace.army.mil/CECW/Documents/cecwp/leg_manage/wrda2007/sec_2036c.pdf

MVP Response: Concur. Mitigation banks will be considered and information will be included in the final report. There are currently no mitigation banks in the study area.

Required Action: The district will consider use of mitigation banks and include appropriate discussion in the final report.

7. Refinement of Mitigation Plan. The text indicates that the mitigation plans require refinement during PED. Page 236 indicates that the costs and features may differ from what is described in the text. It further indicates that mitigation was developed based on

only existing data to assess potential impacts and no detailed studies, analyses, or modeling was performed. An appropriate level of detail is needed to evaluate the project impacts through the period of analysis and mitigation requirements should be identified based on an average annual habitat value as a basis for CE/ICA analyses. The checklist indicates on page 2 that there is no CE/ICA analysis, but it is pending. Based on the checklist guidance (page 2) an issue paper should be submitted when analyses are proposed for deferral into PED. This does not appear to be included in the AFB package and should be discussed during the AFB due to its potential for changing the costs of the various plans.

MVP Response: Concur - The mitigation portion of the report will be updated and better defined to ensure that it is policy compliant. See response to comment F.1.

Discussion: It was agreed that the mitigation analysis cannot be put off to PED.

Required Action: The mitigation portion of the report will be updated and better defined to ensure that it is policy compliant, including requirements of Section 2036 of WRDA 2007.

G. ENVIRONMENTAL AND ENVIRONMENTAL COMPLIANCE.

1. Cultural resources. Part 4.2.2 on pages 115-119 indicate that historically significant resources may exist in the project area. Part 5.4.2 on pages 234-235 indicate that at least one listed or eligible historic property could be affected by either the NED or LPP plans. As the report acknowledges, further information and analysis of the potential impact of the NED or LPP plans on cultural resources will need to be provided, along with an explanation of appropriate measures to be taken to assess such potential impacts and to coordinate with appropriate state officials.

MVP Response: Concur. Information on the cultural resources and how impacts will be addressed will be included in the final report.

Required Action: The district will include information on the cultural resources and how impacts will be addressed will be included in the final report

2. Water Quality Effects. The Environmental Quality table lists no expected water quality effects for any alternative, however the document later states (Sec 5.2.1.2.2, P. 126) that all diversion alternatives would create temporary minor adverse impacts (3.5.2.3, p 64). All possible impacts and environmental effects should be clearly identified in the AFB document as well as all pertinent agency coordination.

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MVP Response: Concur. The report will be clarified to list impacts and environmental effects.

Required Action: As noted in the response.

3. Sediment Transport. Because the TSP involves significant changes to the flow regime for the Red and Sheyenne Rivers, changes to sediment movement could impact the stream habitat. The sediment transport analysis seems inadequate to support conclusions presented in the report. Please provide more detail on the sediment transport that demonstrates the TSP will maintain proper aquatic habitat.

MVP Response: Concur. The PDT is using the limited data that is available and is coordinating with the appropriate resource agencies to design the project to minimize impacts to geomorphology. Additional information was gathered during the 2010 flood event to address these concerns, but the data will not be available in time to be incorporated into the final report. Some mitigation is assumed for geomorphic impacts that will not be adequately addressed by design. Based on the available info, we do not anticipate major issues. The river systems contain mostly fines (silts and clay) the project will allow 2-yr or greater flows on the tributaries and 5-yr flows on the Red these are anticipated to be high enough so that sediment transport won't be an issue. The final report will include a qualitative analysis of bed sediment transport concerns. Adaptive management will be used to address residual concerns.

Discussion: The district explained that geomorphology is an issue the resource agencies are most concerned about regarding adaptive management. Based on the available info, the district does not think there will be major issues. Mostly fines (silts and clay). 2-yr flows on tributaries and 5-yr flow on the Red will be high enough so that sediment transport won't be an issue. The district is confident these concerns will not affect O&M of hydraulic structures and will use the new info that is currently being collected and analyzed by the USGS based on the 2010 flood event to verify assumptions. USGS data will not be available before the end of June 2010. The district will have a qualitative analysis of bed sediment transport concerns by June, but will not have a quantitative analysis until the final report submittal. Some mitigation was included on the Wild Rice River, because there is more bed load in that river. Adaptive management will be used to address residual concerns.

Required Action: The district will include qualitative data in draft report to be released to the public with quantitative data included in the final report.

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4. Status of environmental coordination activities and resource agency views. The main report should contain a brief summary of resource agency views and environmental coordination activities, as noted in ER 1105-2-100, Exhibit G-5, item 10. Appendix Q, Public Involvement and Coordination, includes letters from several Federal and State resource agencies, as well as non-governmental environmental organizations.

MVP Response: The main report will be updated to include the information on the coordination and the information from the resource agencies. This will be much more important after we receive the formal responses from the agencies on the draft report.

Required Action: The district will include a summary of info already presented in Appendix Q into the main report.

5. Environmental Compliance Status Table. Table 17 on page 85 presents information on the status of project compliance with applicable statutes and laws. The status is shown as Full Compliance or N/A for each of the statutes and EOs. This is not appropriate at this stage of the study and compliance status should reflect the current status of compliance, not what is anticipated at the study completion. Please revise to show partial compliance based on the studies and coordination accomplished to date and revise the text to correct for typo errors which have shifted the statute names and status into incorrect locations. See 2.b. of Exhibit H-4 in ER 1105-2-100.

MVP Response: Concur. The information will be reviewed and updated to reflect the current status.

Required Action: As noted in the response.

6. Pending Environmental Compliance. As described in the Project Study Issue Checklist accompanying the District's transmittal, substantial environmental compliance remains "pending." Similarly, as indicated in part 3.9.4 on page 88 of the report, the sponsor still requires additional state or local permits. These environmental compliance and permitting requirements will need to be completed prior to final approval of the report.

MVP Response: Partially Concur. The required environmental compliance issues will be completed for the final report. However, it is not necessary to obtain permits to complete the feasibility study and report. The sponsors cannot apply for permits until there is an authorized plan and detailed plans and specifications are completed.

Required Action: The required environmental compliance issues will be completed for the final report, recognizing that the non-Federal sponsors cannot apply for permits until there is an authorized plan and detailed plans and specifications are completed.

H. LEGAL.

1. District legal review. CEMVP's March 26, 2010 transmittal memo states that the St. Paul Office of District Counsel has reviewed the main report and that "[n]o significant legal issues are apparent at this time." This review should be memorialized in a written certification of the report's legal sufficiency signed by the District Counsel. *See* ER 1105-2-100 para. 7.d. (requiring that "decision documents [] be reviewed throughout the study process for their compliance with law and policy") and ER 1105-2-100 Appendix H, page H-2.d.3. ("District and Division Counsel are responsible for ensuring the legal sufficiency of each decision document") ("District Counsel is responsible for the legal review of each decision document and signing a certification of legal sufficiency.").

MVP Response: Concur. A certification of legal review indicating that there are no significant issues at this time will be provided for the final report and all future submittals.

Required Action: As noted in the response.

2. Reliance on future WRDA. Part 3.9 on page 84 of the report states that the "schedule for project implementation assumes authorization in the proposed Water Resources Development Act of 2010." Given that an actual draft WRDA 2010 has not yet been formally proposed or moved forward in the legislative process, suggest this be revised to read "schedule for project implementation assumes authorization in a Water Resources Development Act of 2010 if enacted, or other future WRDA."

MVP Response: Concur. The report will be updated as suggested.

Required Action: As noted in the response.

3. Cost sharing.

a. Cost sharing calculation. The report does not make sufficiently clear how the sponsor's cost share is calculated. As reflected in the Executive Summary on pages ES-8 and ES-9, and in parts 3.9.2 and 3.9.3 on pages 87 and 88 of the report, the project includes a $523,061 Federal share, and a $590,245 non-Federal share, for a total project cost of $1,113,306. Similarly, the chart in Table 18 includes a substantial cash contribution ($426,057) toward the cost of the flood risk management features, it is not clear how this

number is calculated or how the sponsor is in fact providing its required 35 percent cost share. Similarly, with regard to the recreation features, it is not clear how the sponsor's cash contribution amounts to its 50 percent cost share.

MVP Response: Concur. The report will be clarified to show how the NED plan is the driving factor in the cost sharing. The incremental costs of the LPP will be identified as 100% the responsibility of the local sponsors. Tables will be added to show the incremental difference in the plans.

Discussion: The non-Federal sponsors will be required to cost share more than 50% of the cost because they have chosen the LPP and not the NED plan. The report will need to step through the cost sharing process and show how the total Federal cost share was determined. The district expects to get sponsor's letter before July 14th stating that they agree to pay the additional project costs beyond 50% for the LPP. This letter will be in final document, but not in document out for public review.

Required Action: The report will be revised to clearly explain why the NED plan is the driving factor in the cost sharing. The incremental costs of the LPP will be identified as 100% the responsibility of the non-Federal sponsors. Appropriate tables will be added to the report show the incremental difference in the plans. Cost apportionment tables for both LPP and NED plan will also be included.

b. "Special cost sharing." Page 4 of the Project Study Issue Checklist makes reference to "special cost sharing". It is not clear from the report what this means. From the local cooperation items listed in the recommendations section of the report, traditional cost sharing appears to be contemplated. The District should clarify this statement

MVP Response: The answer to Checklist item #43 will be changed to the following: "NO. No special cost-sharing applies, per the FSM discussion." No special cost sharing is anticipated--standard cost sharing is assumed for all project items, and the non-Federal sponsor will pay 100% for all costs in excess of the NED plan.

Required Action: As noted in the response.

4. <u>Sponsor letter of intent and financial self-certification.</u> Part 3.9.5 on page 88 of the report indicates that the local sponsor supports the project and has certified its financial capability to implement the tentatively selected plan. However, the sponsor's written commitment to the project, in the form of a letter of intent and the aforementioned financial certification, do not appear to be included in the report. These items should be included to ensure that sufficient local support for the project will enable it to be implemented, as required by ER 1105-2-100, Appendix G, at G-9 ("The non-Federal

sponsor's acceptance of, or desired departures from, the terms of the applicable model PCA must be presented, including: 1) applicable cost sharing and financial policies; 2) policies regarding provision and valuation of non-Federal lands, easements, rights-of-way, and disposal areas provided by non-Federal sponsors; 3) policies governing non-Federal project construction; and, 4) other provisions required by law and policy for new start construction projects.").

MVP Response: Concur. The report will be clarified. The sponsors will be providing their letter of intent and financial self certification on July 15th. They have provided a letter requesting the LPP. This letter was submitted with the LPP waiver request.

Required Action: As noted in the response.

5. Items of Local Cooperation. The items of local cooperation included in the Recommendation, Section 8.0 include no provisions for the sponsors to pay for LPP costs in excess of the Federal cost share for the NED plan. These items appear to be the standard requirements and indicate the local share is a minimum of 35% and would not exceed 50% of the total FRM costs. Table 18 shows the FRM share as $573,124,000 out of a total FRM cost of $1,079,065,000 or 53.1%. Appropriate cost sharing requirements should be included that address the non-Federal share exceeding 50% of the project costs based on the responsibility of the sponsors to pay for the additional LPP costs for the larger plan.

MVP Response: Concur. The items of local cooperation were updated just after the draft went to print, it now includes a statement on how the locals will pay the entire increment for the LPP.

Required Action: The draft report will include appropriated provisions related to non-Federal requirements associated with recommendation of the LPP.

I. COST ESTIMATING.

1. MCACES. The MCACES cost estimate (for NED and LPP) should be included in the report as prescribed in ER 1110-2-1302 (see paragraph 8.0) and ER 1105-2-100 (see Exhibit H).

MVP Response: Concur. This information will be included in the final report.

Required Action; The district will remove Exhibits A through G in Appendix L Cost engineering and include the MCACES estimates for the NED plan and LPP in the report.

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2. Cost and Schedule Risk Assessment (CSRA). The information presented in paragraph L13.0 describes the CSRA process and procedures for the development of contingency. However, it is not very clear who participated in the meetings. Also, it is not evident the CSRA results have been reviewed and approved. The requirement for cost risk analysis is prescribed ER 1110-2-1302 (see paragraph 20) and ETL-1110-2-573 (see Appendix G).

MVP Response: Concur. The CSRA will be included in the cost appendix in the August report. The report will be updated to include information on who participated. The participants were the local sponsors, Corps PDT members, AE team members, and a member of the Cost Engineering DX in Walla Walla District. Walla Walla will be completing a second CSRA based on the final costs of the NED and LPP plans, this will be included in the final report.

Discussion: The district explained that Walla Walla Cost DX assisted us with the CSRA and that the final CSRA will be included final report.

Required Action: The district will include the CSRA in the cost appendix in the final report.

3. Total Project Cost Summary (TPCS). A TPCS should be submitted as prescribed in ER 1110-2-1302. Guidance for preparing a TPCS is described in ETL 1110-2-573.

MVP Response: Concur. The TPCS will be provided as prescribed; all costs in the feasibility report will be to the October 2009 price level.

Required Action: Project cost for the NED plan and LPP in the final feasibility report should be in October 2009 price level.

4. Executive Summary TPCS. The Total Project Cost for the recommended plan stated in the Executive Summary (ES) is not consistent with the cost stated in the Project Cost Summary Sheet (PCSS) in Appendix L. The ES shows $1,113,307,000 based on October 2009 price level. However, the PCSS shows $1,113,726,000 based on December 2009 price level. Also, Table 2 in the ES shows $1,113,306,000.

MVP Response: Concur. The numbers in the report will be checked for consistency.

Required Action: As noted in the response.

5. Inconsistent Cost Data. Table 8 of the main report has an anomaly regarding the costs for levees and floodwalls for the various MN Short Alignment alternatives. Although

Table 7 shows each alternative to have a 9.9 mile long tie-back levee with a height of 8 feet, the costs in Table 8 for the 20K, 25K, 30K, and 35K plans are shown as 13,561, 12,682, 14,992, and 12,682 for the plans, respectively. It is unclear why plan costs would vary in that manner, based on the description in Table 7 and whether this could potentially impact formulation when considered with other comments. Clarification is needed to assure costs are accurately estimated as a basis for alternative comparisons.

MVP Response: Concur. The numbers will be reviewed and corrected, and any oddities that are correct will be explained in the text.

Required Action: As noted in the response.

6. Excavation Costs. Comparison of information shown in Tables 7 and 8 shows that the ND plans have significantly higher costs for channels and canals in comparison to the MN plans. For example the ND 30K plan has costs of $620,367,000 versus $524,576,000 for MN35K despite the fact that the MN plan involves an additional 1mcy of excavation (55 vs. 54 mcy). It isn't apparent why the costs should vary so significantly between the two alignments- the ND plan costs about $95,000,000 more to excavate 1mcy less material. Is this a function of the river crossings and drop structures required for the ND plans? Please explain.

MVP Response: The information will be checked for accuracy.

Discussion: Concern was raised concerning suitability of excavated material to be used to construct levees. The district explained that there is such a massive quantity of material that is being excavated in order to construct the diversion channel that they are not very concerned about material qualities. The built up on the banks of the diversion channel are more for disposal than for the levees. However, for the LPP levees will be required. The MN side doesn't need levees in middle reaches. The upstream and downstream ends for the MN do need levees for the 500-yr level of protection.

Required Action: As noted in the response.

7. Fully Funded Estimate. Table 19 on page 88 shows the schedule of funding for the LPP from FY11 through FY19. The first line for Federal E&D costs shows all funding occurring between FY 11 and FY14, with no funding scheduled between FY15 and FY19 where the majority of construction is taking place. This raises a question as to whether the

E&D shown is fully accounting for the engineering during construction requirements versus Preconstruction Engineering and Design. Please clarify to assure the appropriate E&D costs are included in the fully funded project cost and planning.

MVP Response: Concur. The E&D was assumed to be for the entire design effort, however this will be modified based on the comment and spread out over the entire project implementation period.

Discussion: It was clarified that some additional material for concrete structures and rip rap, but all other material will come from excavation of the channel

Required Action: As noted in the response E&D costs will be spread out over the entire project implementation period.

8. Cost Apportionment. Table 18 on page 87 shows the cost apportionment for the LPP (ND35K plan). Values are missing or shown as zero in the total column for two entries (Planning Engineering & Design, Fish and Wildlife Facilities) that need to be corrected. The subtotal for flood risk management should show FRM rather than FDR, consistent with the heading. In addition, the report will need to clearly explain the cost sharing for the NED plan as a basis for comparison to show that the LPP is being cost shared appropriately.

MVP Response: Concur. The information will be reviewed and corrected.

Required Action: As noted in the response.

J. REAL ESTATE.

1. Is it assumed that all spoil material from the channel excavation will be used in the project area and that no disposal areas will be required? Will there be any additional material needs such as Borrow Material? If so then this must be addressed.

MVP Response: Concur. The spoil will all be in the project area and no borrow is anticipated. Aggregate for concrete structures and riprap will be needed.

Required Action: The REP will address use of spoil material from the channel and need of borrow material.

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2. Does the Fee Estate include any Mineral Restrictions?

MVP Response: No mineral restrictions are needed.

Required Action: The REP will address no mineral restrictions are needed

3. The REP states that there are previous Federal Project lands in the area. Recommend that these lands be placed on future mappings to insure their placement.

MVP Response: Concur. The information will be added for the draft report.

Required Action: As noted in the response.

4. The current acquisition schedule in paragraph 16 shows a total of 87 months from the time that the PCA is signed until the Real Estate is made available. If there is indication of phasing the construction for this project, then a brief sentence stating such should be included.

MVP Response: Concur. A detailed construction schedule is being developed that will have phasing, this will be completed for the final report (submitted in August).

Required Action: As noted in the response.

5. The estimate of project costs in the Tentatively Selected Plan Table 16 in the Draft Feasibility Report do not match the Real Estate Plan totals in the REP listed on page 10.

MVP Response: Concur. The costs will be corrected.

Required Action: As noted in the response.

6. The REP paragraph 12 mentions relocations that have not been fully determined. There is a relocations figure in the feasibility report in Table 16 that has a figure. Where did this figure come from?

MVP Response: Concur. The utility relocation information should be very good in the report and was determined by identifying each of the impacted utilities. Information is still being developed on business and real estate relocations and this will be included in the final report.

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Discussion: The district explained that it does not have a clear idea of business and real estate relocations at this time and it will be able to refine this as more information is available.

Required Action: Information on business and real estate relocations will be included in the final report.

7. The REP does not have a Sponsor Capability Checklist attached.

MVP Response: Concur. The checklist will be included in the final report once the official non-federal sponsor has been identified.

Required Action: As noted in the response.

K. MISCELLANEOUS.

1. The Table of Contents should be updated to correspond to the pages of the main report where the topics are discussed. For example, the Recommendations section is found on page 251, not 243; the Environmental Consequences are found on page 125, not 121.

MVP Response: Concur. The TOC will be updated. We had some issues with the auto formatting which have been corrected.

Required Action: As noted in the response.

2. On page ES-3, text is missing some words in the last sentence of paragraph 4 concerning the 6,560 acres. It is not clear what is intended as written- appears to be the surface area needs for the project features as explained on page 187.

MVP Response: Concur. The text will be corrected.

Required Action: As noted in the response.

3. On page 27 the text shown as bold heading, "Figure 8 through" should be converted to text as the start of the paragraph in future versions.

MVP Response: Concur. The text will be corrected.

Required Action: As noted in the response.

4. Page 76, second paragraph- The first cost of the LPP is missing three zeros, and should read as $1,113,307,000.

MVP Response: Concur. Three zeros are pretty significant! The information will be corrected.

Required Action: As noted in the response.

5. Table 14 on page 71 shows the net benefits of the No Action Plan as -$77,100,000, the EAAD. This doesn't make sense as there are no benefits or costs to that alternative. The table should be revised to show to show zero net benefits and $77,100,000 as the residual damages for the No Action plan.

MVP Response: Concur. The information will be corrected.

Required Action: As noted in the response.

6. Reference is made to the Rush River and Lower Rush River however figures generally show Rush River for both locations. Please label appropriately for clarity.

MVP Response: Concur. The figure labels will be corrected.

Required Action: As noted in the response.

7. Numerous sections of the AFB document reference geographic locations, project features, and other sites but do not support such references with maps. In addition, some of the maps are not legible due to the quality of reproduction, scale and detail, or lack of notations. The quantity and quality of the illustrations should be reviewed for quality control. Clear delineations of project boundaries and state/municipal boundaries should also be provided. For the draft and final report consideration should be given to use of fold out pages to increase the size and readability.

MVP Response: Concur. Maps and other information will be reproduced in larger forms when possible, and maps will be updated. It is challenging with such a large project area.

Required Action: As noted in the response.

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8. Content Ratio. Economic Appendix (C-15) states that the content damage functions are based on a content-to-structure value ratio of 100%. This is not correct. The content damages are a function of structure value without any implied valuation of content value. In order to use these damage curves with the flood damage analysis package, you need to set content value to 100% of structure value to get the software to correctly use the content damage curves.

MVP Response: Concur. This information will be reviewed and corrected.

Required Action: As noted in the response.

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SUBJECT: AFB PGM – Fargo-Moorhead Flood Damage Reduction Study

ATTACHMENT 1
AFB ATTENDEES

Attendees (In Person)

Name	Affiliation	Name	Affiliation
Elizabeth Killian	USACE-MVP	Kevin Bluhm	USACE-MVP
Tom Crump	USACE- Regional Planning Div. North	Jeff DeZellar	USACE-MVP
Susan Smith	USACE-MVD	Jeff Hansen	USACE-MVP
Tom Hughes	USACE-HQ	Lance Awsumb	USACE-MVP
Larry Kilgo	USACE-MVD	David Kollars	USACE-MVP
Edith Pang	USACE-MVP	Tony Fares	USACE-MVP
Chanel Kass	USACE-MVP	Jim Merritt	CECC-MV
Mike Lesher	USACE-MVP	Joe Willging	MVP-OC
Renee Turner	USACE-MVD U-5	Buddy Torrey	CEMVD-PD-SP
Rayford Wilbanks	USACE-MVD	Elliott Stefanik	CEMVD-PD-E
John Lucyshyn	USACE-RIT	Jeff McGrath	CEMVP-PD-F
Zoltan Montvai	USACE-MVD-RIT	Mark Nelson	CEMVP-RE
Craig Evans	USACE-MVP-PD-F	Alex Nelson	MVP-EC-H
Tom Koopmeiners	USACE-MVP	Kurt Heckendorf	CEMVP-EC-D
Jodi Kormanik-Sonterre	USACE-MVD	Mark Bittner	City of Fargo
Frankie Griggs	USACE-MVD	Cliff Fitzsimmons	OASA(CW)
Eric Wittine	USACE-MVP	Katie Young	CEMVP-PD-F
Chris Fassero	USACE- Omaha	Aaron Snyder	USACE-MVP-PM-A
Jon Sobiech	USACE- MVP		
April Walker	City of Fargo		

Participants By VTC

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Jody Bertrand	City of Moorhead
Lee Beauvais	Moore Engineering
Gregg Thielman	Houston Engineering

Participants by Phone

Name	Affiliation
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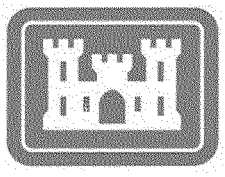
Mark Matusiak	USACE-OWPR
Miguel Jumilla	USACE-OWPR
Stuart McClean	HQUSACE
Steven Fischer	PA from NWK
Roger Perk	USACE-MVR
Kelly Baerwaldt	PA from MVR
Julie Watkins	PA from SAM
Durund Elzey	PA from MVN
Steve Fischer	PA from NWK
Charissa Kelly	PA from SWF
Melissa Montag	PA from SPK
Ray Wimbrough	PA from SAJ
Joy Muncy	IWR
David Schulenberg	PA from LRB

APPENDIX O
ATTACHMENT 4

Alternatives Screening Document

Alternatives Screening Document
Fargo-Moorhead Metropolitan Area Flood Risk Management



US Army Corps of Engineers ®

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December 2009

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Fargo-Moorhead Metropolitan Area Flood Risk Management

ALTERNATIVES SCREENING DOCUMENT

December 2009

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1.0 INTRODUCTION

1.1 PURPOSE AND AUTHORITY

This Alternatives Sereening Doeument was prepared to document the results of the screening process for the initial array of alternatives and to identify the alternatives that will be considered in greater detail. The initial array of alternatives being considered was developed as part of the National Environmental Policy Act (NEPA) scoping process as presented in the document titled *Scoping Document Fargo-Moorhead Metropolitan Area Flood Risk Management Environmental Impact Statement* dated September 2009 and prepared by the U.S. Army Corps of Engineers.

The Fargo-Moorhead Metropolitan Area is located in the Red River of the North basin. 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. Funds to initiate the feasibility study were provided in the Consolidated Appropriations Act, 2008, approved December 26, 2007 (Public Law 110-161).

The study will produce a decision document in the form of a feasibility report and associated NEPA document in accordance with the Corps' Planning Guidance Notebook, ER 1105-2-100, and the Project Management Plan. The feasibility study will investigate measures to reduce flood risk and analyze the potential for Federal participation in implementing a flood damage reduction project in the Fargo-Moorhead Metropolitan Area.

The feasibility study will focus on reducing flood risk in the entire Fargo-Moorhead Metropolitan Area.

The Corps of Engineers issued a Notice of Intent in the Federal Register on May 5, 2009.

1.2 PROJECT BACKGROUND

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 have also caused significant flood damages. The Red River of the North has exceeded the National Weather Service flood stage of 18 feet in 50 of the past 107 years, and every year from 1993 through 2009. The study area is between the Wild Rice River (North Dakota), the Sheyenne River, and the Red River of the North; interbasin flows complicate the hydrology of the region and contribute to extensive flooding. Average annual flood damages in the Fargo-Moorhead Metropolitan Area are currently estimated at over $74 million.

Fargo and Moorhead 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. Both communities have well documented standard operating procedures for flood fights. Both communities avoided major flood damages in the historic floods of 2009 and 1997 by either raising existing levees or building temporary barriers. Since the 1997 flood, and in the aftermath of the 2009 flood, both communities have implemented mitigation measures, including acquisition of more than 100 floodplain homes, raising and stabilizing existing levees, installing permanent pump stations, and improving storm sewer lift stations and the sanitary sewer system. 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. Failure of emergency measures would be catastrophic and could result in billions of dollars in damages.

1.3 PURPOSE, NEED AND PLANNING OBJECTIVES

1.3.1 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.

1.3.2 Objectives

- 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.

1.4 PRIOR STUDIES, REPORTS, AND PROJECTS

1.4.1 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:

1.4.1.1. 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 Otter Tail River in Minnesota; channel improvements on the lower Sheyenne, Maple and Rush Rivers in North Dakota; channel improvements on the Mustinka, Otter Tail, 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.

1.4.1.2. 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.

1.4.1.3. 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.

1.4.1.4. "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 likely were 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."

1.4.1.5. 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.

1.4.1.6. 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.

1.4.1.7. 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.

1.4.1.8. Scoping Document, Fargo-Moorhead Metropolitan Area Flood Risk Management Environmental Impact Statement, Corps of Engineers, September 2009. This document lays out the alternatives that will be considered as part of the Fargo-Moorhead Metropolitan Feasibility Study. The alternatives were

determined from meetings with Federal, State, and local agencies and other entities; four public meetings; a scoping meeting; and written comments provided by agencies, organizations, and the interested public.

1.4.2. Current Studies

The following studies are being conducted:

1.4.2.1. 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 Otter Tail 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.

1.4.2.2. Fargo Southside Flood Control Project, City of Fargo, North Dakota. Since the 1997 flood, the City of Fargo and the Southeast Cass County Water Resource District have been 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 have been explored, including combinations of levees, diversion channels, channel modifications, and flood storage. The study is currently on hold pending completion of the Fargo-Moorhead Metropolitan Area Flood Risk Management study.

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

1.4.2.4. 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.

1.4.3 Existing Water Resource Projects

1.4.3.1. 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 St. Paul District, Corps of Engineers.

1.4.3.2. 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.)

1.4.3.3. 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 storage.

1.4.3.4. Fargo levees: The Corps participated in a permanent flood control project completed in Fargo in 1963. The project was recommended in the Corps' 1947 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 4th Street South between 1st Avenue South and 10th Avenue South. The top of levee is at approximately a 40.0-foot stage. The city later extended the levee south to 13th Avenue. Fargo has several other publicly and privately owned sections of levee throughout the city. The current line of protection has top elevations that vary from a stage of 30 feet to 42 feet, but several 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.)

1.4.3.5. Moorhead levees: No federally constructed levees are in Moorhead. The Corps proposed an 1,800-foot-long levee in the 1947 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.

1.4.3.6. 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 to provide approximately 35,000 acre-feet of storage on the Maple River; 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 projects were essentially completed in 1993 and 1994, respectively. A pump station was added to the West Fargo project in 2003 and emergency generators were provided in 2007. The Maple River dam was deauthorized in 2002 for Federal participation, and the Southeast Cass Water Resource District completed the project without Federal assistance in 2007. These projects protect 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 bank levee contain the 1-percent-chance event plus 2 feet; the right bank levee is higher, providing the city with protection from the Standard Project Flood plus 3 feet. 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 the 1-percent chance event.

1.4.3.7. A Section 208 (1954 Flood Control Act) clearing and snagging project was completed in Fargo-Moorhead in 1991 to remove trees affected by Dutch elm disease. Dead and dying trees were removed along a 9.7-mile reach of the Red River.

1.4.3.8. 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.

1.4.3.9. 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.

1.4.3.10. A Section 205 (1948 Flood Control Act) small flood control project is under construction for Fargo's Ridgewood neighborhood. The project will tie into a recently reconstructed floodwall at the Department of Veterans Affairs hospital.

1.5 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The initial development and screening of alternatives relied on existing information, the detailed development of new information, hydrology from Phase I of the feasibility study, expert judgment, and public input, along with prior reports, studies, and projects that were conducted in the Red River basin. There may be changes to some technical information presented in this Screening Document those changes will be incorporated into the final feasibility report and are not expected to change the results of the initial screening. The potential effects and issues identified for each of the alternatives were derived from those sources.

1.6 ALTERNATIVE DEVELOPMENT

Several alternatives have been identified for consideration in evaluating future possible actions in the Fargo-Moorhead Metropolitan Area. Input provided at public meetings and directly from stakeholders provided a wide array of initial alternatives that were considered. The alternatives identified initially for evaluation were:

No Action: Continue emergency measures

Nonstructural measures
- Buy and relocate flood-prone structures
- Flood proofing
- Elevate structures
- Flood warning systems
- Flood insurance
- Wetlands

Grasslands

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 riverbank
- 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
- Pay landowners for water retention

1.7 ALTERNATIVE SCREENING CRITERIA

Screening criteria were developed to focus evaluation and design efforts on the most implementable alternatives. The following criteria were used to assess the overall characteristics of each alternative to identify those alternatives most likely to meet the project purpose and objectives.

Effectiveness: Whether the alternative would be effective in maintaining an acceptable level of flood risk management for the Fargo-Moorhead Metropolitan Area.

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 changed environmental conditions resulting from the construction or operation of the project.

Social Effects: Direct and indirect effects on socio-economic resources such as transportation, regional growth, public safety, employment, recreation, public facilities, and public services.

Acceptability: Controversy and potential effects on community cohesion and compliance with policy are indicators of acceptability.

Implementability: Whether there are significant outstanding technical, social, legal or institutional issues that affect the ability to implement the alternative.

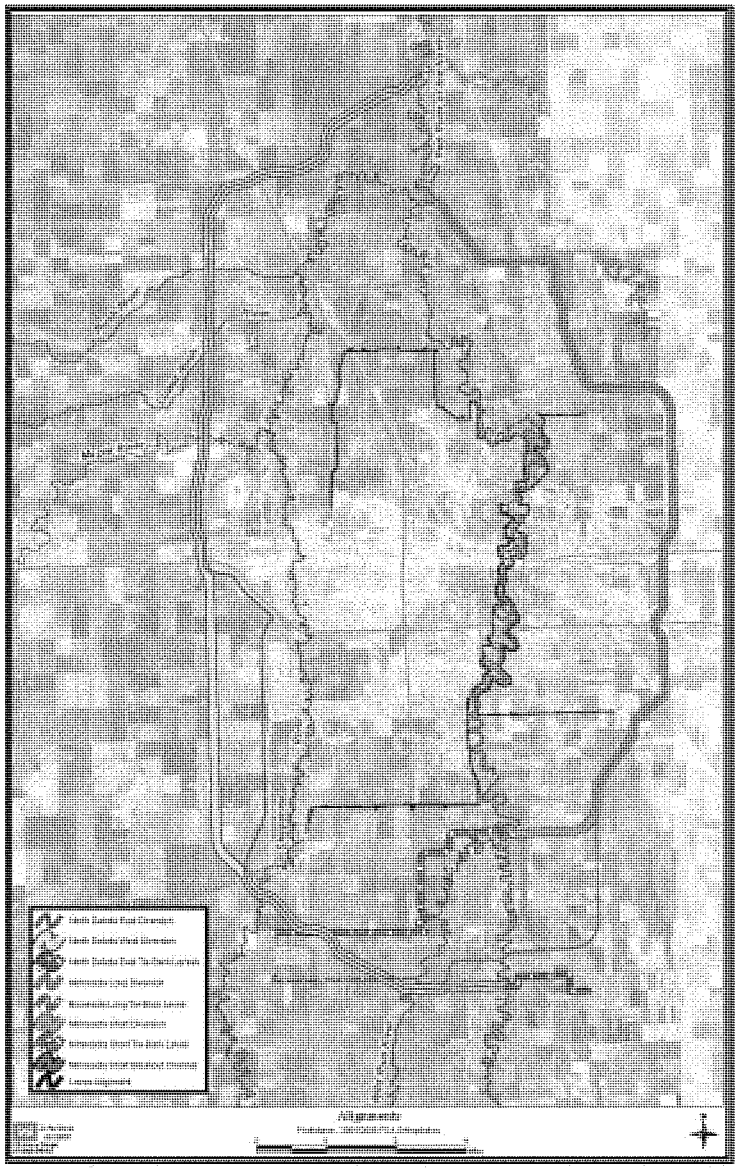
Cost: The first cost of the project, costs of local operations and maintenance, and long-term residual costs.

Risk: The uncertainties, vulnerabilities, and potential consequences of the alternative.

Separable Mitigation: Whether there is a need for mitigation resulting from the project's implementation to address environmental, hydraulic or other impacts. Is mitigation possible, what does it cost, and how does it impact the project cost?

Cost Effectiveness: Comparison of expected economic benefits and estimated costs for each alternative and between alternatives.

Figure 1: Fargo-Moorhead Metropolitan Feasibility Study Area and Screening Alignments



2.0 SCREENING RESULTS

2.1 FUTURE WITHOUT PROJECT CONDITION (NO ACTION)

2.1.1 Alternative Description

This alternative assumes no Federal project is implemented, but the types of emergency measures currently employed in the project area would continue to be implemented as necessary due to flooding. These emergency measures include such actions as temporarily raising existing levees to protect the cities of Fargo and Moorhead as well as surrounding cities, constructing temporary levees and floodwalls in various areas, and sandbagging. During the 2009 flood, more than 80 miles of temporary measures were built in less than two weeks, including the placement of more than three million sandbags by thousands of volunteers. The local governments would continue to implement local measures to assist with future flood fights, this includes construction of small segments of levees and floodwalls and continued buyouts of flood prone structures. If no alternatives were determined to be feasible for federal implementation the local sponsors would pursue larger scale flood risk management solutions such as the Southside flood control project or upstream storage which has been studied by the local sponsors. The measures identified with this alternative are the base condition to which other alternatives are to be compared for impact assessment under NEPA.

2.1.2 Effectiveness

This alternative does not provide consistent reliable long-term flood risk management especially during high flow events. The emergency measures are only temporary and are only beneficial for one-time events; following those events these measures are removed. Emergency measures demand extremely high numbers of temporary untrained workers in extreme weather conditions, resulting in varying quality of the constructed measures. Although heroic emergency measures saved the city from destruction in both 1997 and 2009, this approach cannot be expected to provide effective long-term risk reduction for the area. The effectiveness of this alternative is low.

2.1.3 Environmental Effects

This alternative would have moderate negative impacts.

2.1.3.1 Natural Resources

The emergency levees used for flood fights are very susceptible to erosion; as a result more sediment is distributed in the Red River and other tributaries. Terrestrial vegetation, including trees shrubs and herbaceous plants, is adversely impacted by the placement of the levees. Excavation at the borrow sites also has adverse impacts. Overall the effects on natural resources would be negative.

2.1.3.2 Cultural Resources

Much of the project area has not been surveyed for cultural resources. However, existing information indicates that there is potential for effects on unknown cultural resources along the Red River and tributaries. Excavating borrow material, building temporary levees/floodwalls, removing temporary levees/floodwalls all have the potential to have adverse effects on cultural resources. Failure of the temporary levees/floodwalls would also have adverse impacts to cultural properties/resources. Overall the effects on cultural resources would be negative.

2.1.4 Social Effects

Flood-fighting causes extreme impacts to the community. Businesses shut down, transportation routes including emergency routes are affected, and recreational facilities are negatively impacted. During flood events all focus is on the emergency protection which results in a lack of public services during those events. Over the long term, the flood risk makes the community less attractive for businesses than less flood-prone areas. Failure of emergency measures during a large flood would mean loss of nearly the entire community, loss of community cohesion, decreased public safety, and potential loss of life. The alternative would have highly negative social effects.

2.1.5 Acceptability

This alternative is not an acceptable long-term solution for the sponsors or the nation. Although flood-fighting has been largely successful in the past, continued reliance on flood fighting would eventually have adverse effects on the local community and the region. The sponsors have indicated that a level of permanent protection in excess of the 100-year event is necessary for local acceptability. The alternative has a low level of acceptability.

2.1.6 Implementability

This alternative represents the base condition that would be implemented in the absence of a Federal project. Legal and technical issues complicate implementation of emergency measures. Obtaining rights-of-entry on short notice is difficult and controversial. The maximum level of protection is limited to the highest natural ground available to begin and end emergency barriers. The time available to implement the emergency measures varies during each event; in 2009 the communities had one week to construct more than 80 miles of emergency levees. This alternative was successfully implemented in both 1997 and 2009. The alternative is moderately implementable.

2.1.7 Cost

A 500-year flood event could exceed $6 billion in damages to the community. Average annual damages from all flood events has been calculated to be in excess of $74 million. Emergency flood fighting in 2009 cost an estimated $60 million. This alternative has extremely high costs.

2.1.8 Risk

The probability is extremely high that the community would continue to be at risk of flooding from both spring run-off and summer rainfall events. The effectiveness of emergency measures is very poor. Emergency measures in the Fargo-Moorhead area are typically constructed by volunteers working in adverse weather conditions with temperatures below freezing. Frozen sandbags and materials placed on frozen ground cannot be adequately compacted to eliminate voids. Because of the large extent of emergency levees needed, it is difficult to mobilize manpower to the correct locations to ensure a successful flood fight. People who remain in flood-prone areas to build temporary measures are at high risk if those measures fail unexpectedly. In 2009 only small portions of the community evacuated if the emergency measures would have failed the community would have been filled with very cold water and there would have been a large potential for hypothermia and loss of life. Emergency levees block roads adversely impacting the public's ability to move and evacuate during a catastrophe. This alternative has extremely high risk.

2.1.9 Separable Mitigation

Repair of damaged properties following flood event is necessary. The costs for removal and repair are large. This includes repair and replacement of material (borrow) used in the construction of the emergency measures which typically comes from nearby agricultural fields and sports fields. The 2009 flood required repair and cleaning of many roads within the community. This alternative has a high level of separable mitigation.

2.1.10 Cost Effectiveness

Emergency measures are cost effective, because they prevent damages far in excess of their cost when they are successful. Over the long-term these measures would not be cost effective as failures would result in large damages to the communities. This alternative is moderately cost effective.

2.1.11 Recommendation

The future without project (no action) alternative should be retained as the base condition for comparison with all other alternatives.

2.2 FLOOD BARRIERS

2.2.1 Alternative Description

This feasibility study evolved from the city of Fargo's initial request that the Corps study a levee and floodwall plan to protect the city's downtown area. The communities in the study area have historically relied on both temporary and permanent levees to prevent flood damages, and they have been largely successful. Any Federal project would consist only of permanent features.

For the initial screening, this study analyzed flood barrier systems at two different top profiles to reliably contain the 2-percent chance flood and the 1-percent chance flood. Initial analyses were based on constructing levees in both Fargo and Moorhead to the design levels and assessing the costs and economic benefits of the plans.

This alternative includes the use of permanent flood barrier systems including levees, floodwalls, invisible floodwalls, gate closures, and pump stations. Levees are engineered embankments built to keep flood waters on one side and remain dry on the other side. Floodwalls are typically concrete and steel structures that provide a barrier to flood water both underground and above ground. Invisible floodwalls are floodwalls with removable portions above ground that can be installed only when needed during floods. Gate closures are placed where storm sewers pass through the levee or floodwall. The gates would remain open except during floods, when they would be closed to prevent flood waters from passing through the line of protection. During floods, storm drainage and snow melt inside the protected area would be redirected to pump stations designed to lift the water over the flood barrier. These features would be considered alone and in concert with other potential measures as part of a flood risk management system for the study area.

Closure structures would be built where roads and railroads cross the line of protection. During floods, the roads and railroads would be closed to traffic before flood waters reach the closure elevation, and traffic would resume only after the risk of flooding had passed.

The unique geology of the Fargo-Moorhead area makes it difficult to construct permanent features near the river banks. Earthen levees would need to be located hundreds of feet landward of the river to remain stable. Floodwalls could be located somewhat closer to the river banks, but they are significantly more expensive to build and maintain. More than 1,000 existing structures along the river, including homes and businesses, would be removed to build the barrier system and vacate the land on the flooded side of the system.

It would be possible to build new recreation facilities and habitat areas adjacent to the river between the North Dakota and Minnesota barriers if the land riverward of the barriers is vacated. Such facilities could include trails for walking, biking or skiing and additional access to the river for boating. Floodplain forest and prairie restoration areas could be incorporated into a flood barrier plan.

2.2.2 Effectiveness

Flood barriers would be effective in maintaining a reduced level of flood risk for the Fargo-Moorhead Metropolitan Area. Levees would reduce the susceptibility to frequent flooding in the area and would minimize the impacts of emergency measures. However, flood barriers would only be effective up to the design event and a maximum of approximately the 1-percent chance exceedence flood level. This alternative is moderately effective.

2.2.3 Environmental Effects

This alternative would have low positive impacts

2.2.3.1 Natural Resources

Some wetland and upland resources would be affected by the construction of levees/floodwalls. Some mitigation may be required for impacts on wetlands and tree removal, but the impacts would likely be offset with the increased open space between the barriers and the river. This may provide environmental benefits by reconnecting the river to a larger floodplain and creating more opportunity for riparian woodland habitat. Riprap in the river could have in-stream impacts. There is potential for loss of floodplain connectivity upstream and downstream of reaches of the levee. Overall the effects on natural resources would likely be neutral.

2.2.3.2 Cultural Resources

There are a number of historical structures that would be directly or indirectly impacted by the construction of the levees, and mitigation would be required for the adverse impacts. There are also a number of deeply buried archeological sites within the study area, so there is great potential for adverse impacts to cultural resources. The barriers would prevent flooding of historical structures which could be extensively damaged during flood events. Overall the effects on cultural resources would likely be negative.

2.2.4 Social Effects

This alternative would provide several positive social effects. Public safety would be better than in the base condition for most flood events. Regional business growth could continue as a result of the decreased risk to the infrastructure. Emergency actions would be needed much less frequently, reducing physical and mental stresses of recurring flood fights. Recreational components could be integrated into the project that would provide benefits. Public facilities and services would be able to continue during flood events.

A flood barrier plan would also have negative social effects. The risk of catastrophic failure for events larger than the design event poses a significant threat to public safety, especially if growth occurs in currently undeveloped areas within the protected area. There would be a loss of more than 1,000 structures due to the construction of the project. The impacts on local transportation during flood events would be large. Road relocations and closures would be necessary for the alternative to function. During large flood events the cities would be essentially shut off from each other, and major evacuation routes could be closed. An evacuation plan would need to be developed to address potential flood-fighting issues.

The alternative would have moderate positive social effects.

2.2.5 Acceptability

The removal of more than 1,000 structures would have significant impacts on community cohesion. This plan would impact the major railroad line that runs though Fargo-Moorhead, and flood barriers would likely increase flood stages upstream by confining the river through the urban area. It may be possible to mitigate for otherwise unacceptable economic impacts. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative is moderately acceptable.

2.2.6 Implementability

This plan could be implemented and is technically feasible for levels up to the 1-percent chance level. There would be large social impacts to the local communities which could make timely implementation difficult. Flood barriers must start and end at naturally high ground so flood water cannot get around the ends of the system. The floodplain in the Fargo-Moorhead area is very flat and only slightly above the 1-percent chance flood elevation. On the North Dakota side, the highest ground upstream is located on the ridge east of Horace, ND, effectively limiting the height of any North Dakota levees to about the 1-percent chance flood level, including allowances for risk and uncertainty. The ground on the Minnesota side is higher, but barriers must be extended several miles away from the river to reach sufficient elevations. It is not technically feasible to build certifiable barriers higher than the 1-percent chance level in the Fargo-Moorhead area due to these constraints. This alternative is moderately implementable.

2.2.7 Cost

Two levee plans were considered in detail for the screening analysis. Initial cost estimates for the two levee plans evaluated were $840 million for a levee to reliably contain a 2-percent chance flood (50-year) and $902 million to contain a 1-percent chance flood (100-year). The 1-percent levee plan would leave the community susceptible to residual damages averaging more than $20 million annually. This alternative has high costs.

2.2.8 Risk

Levees and other properly designed and constructed flood barriers can prevent damages from most flood events that do not exceed their maximum design event. However, flood events may overtop the barriers or cause unexpected breaches at levels below the design event, leading to catastrophic failure of the system. For that reason, there is always residual flood risk to areas "protected" by flood barriers. That risk is often misunderstood or ignored by people using those areas. This plan would provide risk reduction up to the design event; once that event is exceeded the risk for catastrophic damages would be increased. This plan may also induce additional growth between the 1-percent chance and 0.2-percent chance flood plains resulting in greater risk to the community over time. This alternative has a moderate level of risk reduction.

2.2.9 Separable Mitigation

It is possible that mitigation may be necessary to offset measurable economic impacts to upstream and downstream landowners from increased flood stages. These impacts could possibly be mitigated with upstream storage, ring levees, or non-structural solutions. Not all stage increases result in measurable damages, and no mitigation would be included to address perceived damages that cannot be quantified. Impacts to natural resources would likely be offset with the establishment of the riparian corridor and mitigation for those impacts would not be necessary. This alternative has a moderate level of separable mitigation.

2.2.10 Cost Effectiveness

Of the two levee plans investigated, only the 1-percent chance levee was determined to be cost effective. The 1-percent chance levee provided nearly $7.7 million average annual net benefits and had a benefit to cost ratio (BCR) of 1.17. The BCR for the smaller levee was 0.88. The alternative is moderately cost effective.

2.2.11 Recommendation

The levee plans would provide a limited level of risk reduction, have large short term social impacts, high costs and are moderately cost effective. Therefore it is recommended that levee plans be removed from further consideration as a stand alone plan. The levee plans are being eliminated with the following uncertainties:

2.2.11.1 Upstream impacts of the levee alternatives were not included in the costs, initial calculations indicate a 0.8-foot increase for the 100-year event increasing to 3.8 feet for a 500-year event.

2.2.11.2 The current levee plans were based only on earthen levees; use of floodwalls would be assumed to increase levee costs.

2.2.11.3 Advanced replacement, flood proofing cost savings, and transportation benefits have not been included but are anticipated to be relatively low.
2.2.11.4 Impacts to historical properties have not been fully assessed, the costs for this are anticipated to be high.
2.2.11.5 Environmental mitigation costs have not been included, these costs are anticipated to be low.

2.3 DIVERSION CHANNELS

2.3.1 Alternative Description

This alternative would involve diversion channels to route flood flows around the metropolitan area, thus reducing stages in the natural channel through town. A control structure would be required on the Red River to divert flows into the diversion channel and drop structures would be necessary to allow local drainage to enter the diversion channel. Tie-back levees at the southern limits of the project would be necessary to tie into high ground. No tie-back levees at the north end of the project would be necessary.

Nine separate diversion plans were analyzed during the initial screening, including a total of four separate alignments, two in Minnesota and two in North Dakota, and various capacities. The Red River control structure allows for the maximum benefit for a given diversion channel capacity by reducing water surface elevations immediately downstream of the structure. Additionally, the control structure allows 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. Because of the Wild Rice River's proximity to the Red at the south end of the project, three of the four alignments also include control structures on the Wild Rice River. The North Dakota alignments would require additional hydraulic structures where the diversion alignments cross the Wild Rice, Sheyenne, Maple and Rush Rivers.

The Minnesota short alignment is approximately 25 miles long, starting near the confluence of the Wild Rice and Red Rivers and ending near the confluence of Sheyenne and Red Rivers. Three separate diversion capacities were analyzed for the Minnesota alignments including 25,000, 35,000, and 45,000 cubic feet per second (cfs). The channel configuration should have a maximum depth of approximately 30 feet due to geotechnical concerns, and channel bottom widths ranged from 250 to 500 feet. The Minnesota short alignment includes 20 highway bridges and 4 railroad bridges. The flow split between the diversion channel and the Red River would be controlled by a combination of a control structure on the Red River at the south end of the project and a weir at the entrance to the diversion channel.

The Minnesota long alignment started approximately 3 miles south of the confluence of the Red and Wild Rice Rivers and would end at the Red River near the confluence of the Red and Sheyenne Rivers. The alignment would be approximately 29 miles long. Because this alignment begins south of the confluence of the Red and Wild Rice Rivers, an extension of the diversion channel would be required between the Red and Wild Rice Rivers. The tie-back levee would be required to extend west from the Wild Rice control structure to higher ground.

The North Dakota west alignment would start approximately 4 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 would end at the Red River north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, Minnesota. The alignment would be approximately 35 miles long. The North Dakota east alignment generally followed the North Dakota west alignment except that, after crossing the Sheyenne River, it would use the existing Horace to West Fargo Sheyenne River Diversion

corridor between Horace and I-94. The North Dakota east alignment would be approximately 36 miles long.

The North Dakota alignments would require an extension of the diversion channel between the Red and Wild Rice Rivers which would begin south of the confluence of the Red and Wild Rice Rivers, like the Minnesota long alignment. The tie-back levee associated with these alternatives would extend east from the Red River control structure to high ground. The North Dakota west alignment was analyzed for 35,000 and 45,000 cfs, and the North Dakota east alignment was analyzed for 35,000 cfs. The channel configuration for each event 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 alignments. The channel bottom width for both capacities would be 100 feet, and the maximum depth would be approximately 32 feet. The North Dakota alignments would include 18 highway bridges and 4 railroad bridges. A combination of control structures on the Red and Wild Rice Rivers at the south end of the project, along with a weir at the entrance to the diversion channel, would control the flow split between the Red and Wild Rice River channels and the diversion channel. This alignment would cross several rivers, including the Sheyenne, Maple, Lower Rush, and Upper Rush. Hydraulic structures would be necessary at the point where the diversion channel crosses these rivers. The purpose of these hydraulic structures would be to allow some base flow to continue down the various rivers while diverting excess water during flood events to the diversion channel. This would result in added flood protection along all of the affected tributaries downstream of the crossing.

2.3.2 Effectiveness

Diversion channels would be very effective in reducing flood risk in the Fargo-Moorhead Metropolitan Area. The smallest diversion considered in the screening exercise (25,000-cfs capacity) would reduce a 0.2-percent chance event to approximately the 1-percent chance stages through town, and a 1-percent chance event would be reduced to less than 10-percent chance stages. The communities begin emergency measures between the 15 and 20-year events meaning that a diversion would nearly eliminate the need for emergency measures during smaller, more frequent floods, but flood fighting would still be needed for events approximately 1-percent chance or larger. Larger diversion alternatives could nearly eliminate the need for flood fighting except for the extremely rare and large events. This alternative is highly effective.

2.3.3 Environmental Effects

This alternative would have moderately positive impacts.

2.3.3.1 Natural Resources

There is a potential for adverse effects on aquatic habitat from the structures necessary on the Red River and the tributaries. Those structures could impact fish passage which could result in adverse effects on fish populations in the Red River. Agencies have identified that fish passage would have to be a key design criterion. Sedimentation in the diversion channel or on the Red River could be a potential issue resulting in adverse effects to aquatic habitat and the river ecology.

The diversion channels could have potential adverse effects on the aquatic resources caused by impacts to fish passage and fish trapping. The alternative would be designed to ensure that impacts to aquatic habitat would be minimized to the greatest extent possible and that the overall impact to the resource would be less than significant. Wetlands along the alignment would be intercepted by the channel and removed or drained, and the channel would impact the depth of groundwater near the channel. The channel would be

designed to include wetland and/or prairie swale-type habitat within the diversion channels which could lead to increased habitat quantity and value compared to the existing conditions.

The Minnesota diversion would run close to the Buffalo Aquifer which provides some of the region's drinking water. The project would be designed to ensure that the aquifer would not be impacted with any of the Minnesota diversion alignments. The North Dakota diversions could have greater adverse effects on the aquatic habitat due to the 5 tributary structures (Wild Rice, Sheyenne, Maple, Lower Rush, and Rush Rivers) which would be necessary where the diversion channel intersects those rivers.

Overall the effects on natural resources would likely be neutral.

2.3.3.2 Cultural Resources

Historical structures might be directly or indirectly impacted by the construction of a diversion channel. Mitigation would be required for any significant adverse effects. There are also a number of deeply buried archaeological sites within the study area, so there is great potential for adverse impacts to archeological sites. A number of historical structures located inside the benefited area would be less prone to future flooding.

Overall the effects on cultural resources would likely be negative.

2.3.4 Social Effects

The diversion channel would require a large amount of agricultural land, and in excess of 10 homes would be removed along any of the alignments. The reduced flood risk would lead to continued regional growth, public safety would improve as the risk of catastrophic flooding would be largely minimized, employment would continue to grow with the region and businesses would not need to provide support for regular emergency measures, recreational features would be included along the project alignment that would benefit the public. Local transportation would be negatively affected by the limited number of bridges crossing the diversion channel, although the bridge locations would be optimized to ensure these impacts were as minimal as possible, and the channel would be designed to allow for future expansion of the local infrastructure. During flood events local transportation and evacuation routes would remain open and accessible to the public. This alternative would have high positive social effects.

2.3.5 Acceptability

The diversion channel would impact a number of agricultural properties which currently do not experience flooding. This could create the perception of a rural versus urban conflict and have negative effects on community cohesion in the region. There could also be actual or perceived downstream impacts due to increased flood stages that may need to be addressed. These impacts could add to the perception of rural versus urban conflict. Within the communities during non-flood events the community would be allowed to grow with minimal threat of flooding for the future. The diversion channels could limit growth on the outside of the channels and future expansion may be required at some point to expand beyond the channel, this would require additional bridges and infrastructure. If the diversion channel were placed in Minnesota there could be conflicts between the two states, Minnesota and North Dakota, as the majority of the benefits occur in North Dakota, but the impacts of construction would be in Minnesota. However, it is important to note that the diversion channel would provide large benefits to Minnesota, and the Corps of Engineers does not consider state boundaries when identifying the best plan for the nation. If the diversion channel were placed in North Dakota there would be potential impacts to the aquatic habitat

which may not be consistent with national or Corps policies. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative would be moderately acceptable.

2.3.6 Implementability

Implementing this plan has some technical issues: the largest concern would be with the Red River control structure and designing it in a manner that would be both hydraulically and environmentally sound. A North Dakota diversion would have additional technical challenges with building the structures that intercept the tributaries. These structures would be extremely complex and would need to accommodate fish passage; it is uncertain if that can be achieved.

Diversions have been employed successfully on other projects in the Red River basin, including projects at Breckenridge, Minnesota; Grand Forks, North Dakota/East Grand Forks, Minnesota; and, most notably, Winnipeg, Manitoba. A diversion channel is being proposed as part of the recently approved Roseau, Minnesota, project. This alternative could be constructed in a timeframe currently estimated at 8-10 years.

Several legal and institutional issues would need to be resolved prior to any implementation, including how the lands would be acquired, how the local tax base would be impacted, who would operate and maintain the project, who would pay for the project and how the costs of the project would be shared. The local sponsors have set up a committee which consists of the Moorhead City Council, Fargo City Commission, the boards for Clay County, Minnesota and Cass County, North Dakota and the two watershed/water resource districts to develop the answers to those questions.

This alternative would be highly implementable.

2.3.7 Cost

Costs for the nine diversion alternatives investigated range from $962 million to $1.46 billion. Although the North Dakota diversion plans are longer and more expensive than the Minnesota alignments, they would benefit a larger area and a greater number of people. They would also provide benefits from floods on the tributaries on the Dakota side. However, the North Dakota alignments with their tributary crossing structures would be significantly more complicated and expensive to operate and maintain and have greater potential for negative environmental effects than the Minnesota alignments. The plans all reduce the residual risk to the communities to less than $14 million annually and would allow for emergency flood fighting if necessary. This alternative has a medium cost.

2.3.8 Risk

Diversions generally provide a high level risk reduction because they cannot fail suddenly and catastrophically. If a diversion fails to perform, flood stages are no higher than they would have been without the project in place. However, diversions do not eliminate flood risk, and they are not fool-proof. Some residual risk often remains from flood events larger than the design event, and emergency flood fighting would still be required for those extremely rare events which could lead to risks similar to the without project condition. There is a potential for blockage of the channel due to ice and debris which would be most likely where structures were located either in the diversion channel or on the rivers. This is greater for the 5 tributary structures for the North Dakota alignments. Overall this alternative provides a high level of risk reduction.

2.3.9 Separable Mitigation

If the project causes increased flood damages downstream, economic impacts could result in the need for ring levees, relocations, or buyouts in downstream locations. Impacts to the aquatic resources that cannot be addressed through project design could result in the need for mitigation, possibly including increasing fish passage at other locations in the basin. Mitigation may be necessary for fish passage on the tributaries and it is possible that the impacts may be too large to mitigate. This alternative has a moderate to high level of separable mitigation.

2.2.10 Cost Effectiveness

Of the nine diversion plans investigated in preliminary screening, five provided positive net benefits and four did not. The Minnesota Short Diversion plans significantly outperformed the Minnesota Long Diversion plans, providing average annual net benefits ranging from $2.5 million to $11.0 million. The smallest diversion, with a channel capacity of 25,000 cfs, provided the greatest net benefits and had a benefit to cost ratio (BCR) of 1.22. None of the North Dakota plans were found to be cost effective, with BCRs ranging from 0.91 to 0.95 and average annual net benefits ranging from -$6.7 million to -$3.1 million. At an optimal capacity, a diversion would be highly cost effective.

2.2.11 Recommendation

The diversion concept should be retained for further refinement. Preliminary analysis indicates that the Minnesota Short diversion is the most cost effective of the diversions being considered and would be implementable and highly effective. Additional study is needed to optimize the capacity and alignment of the plan and address impacts to the aquatic habitat. Additional assessment is needed for the North Dakota plans to determine potential economic benefits from tributary flooding and potential impacts or mitigation for aquatic habitat.

2.4 NON-STRUCTURAL MEASURES

2.4.1 Alternative Description

Non-structural measures remove damageable property from flood waters rather than redirecting the flood waters away from property. Non-structural measures include a variety of actions, such as evacuating flood plains, relocating structures, and elevating structures above the design flood level.

2.4.1.1 Relocation of Structures:

This measure allows for moving structures as part of the project and buying the land upon which the structures are located. It makes most sense when structures can be relocated from a high flood hazard area to an area that is completely out of the floodplain. Due to the relatively flat nature of the floodplain this is not possible within Fargo and may not be possible within Moorhead. Therefore, any structure relocation would consist of moving the structure from an area of high flood hazard to an area of lower flood hazard and then using the nonstructural measure of elevation to achieve the desired level of flood risk reduction within the metropolitan area. Development of relocation sites where structures could be moved to achieve the planning objectives and retain such aspects as community tax base, neighborhood cohesion, etc., would be investigated as part of any relocation project. This measure is applicable anywhere in the metropolitan area.

2.4.1.2 Buyout and Demolition of Structures:

This measure requires buying the structures and the land as part of the project. The structures are either demolished or sold to others and relocated to a location beyond the floodplain, all as part of the project. This measure will be considered and is applicable anywhere in the metropolitan area. This approach has been implemented on a small scale by the local commnities and since the 1997 flood more than 100 flood prone structures have been removed. Ecosystem restoration and/or recreational amenities could be pursued on the purchased lands for either this option or the Relocation of Structures option.

2.4.1.3 Elevation of Structures:

This measure requires lifting the structure above a particular flood event. In the metropolitan area, the most acceptable elevation measure might be on extended foundation walls. Because most of the structures to be elevated have basements under them, the concept would be to elevate the basement off the ground. Then, depending on the design flood elevation, the elevated basement could be fully developed if the basement floor was above the Flood Insurance Rate Map (FIRM) base flood elevation (BFE) or the design flood elevation, whichever is higher. Basements could be kept undeveloped and wet flood proofed to equalize hydrostatic force or could be developed with more comprehensive wet flood proofing concepts. Owners with fully developed pre-elevated basements would be compensated if the post-elevated basement cannot be developed. This measure is applicable anywhere in the metropolitan area unless the required elevation is greater than 15 feet above the adjacent grade. Velocity and hydrodynamic force would also have to be considered. This measure is generally applicable throughout the metropolitan area depending on flood depth and floodway location. Local building codes required that new construction be built approximately 1.3 to 2.5 feet above the 100-year base flood elevation which has resulted in a lot of new construction using fill to get to that elevation and constructing on top.

2.4.1.4 Removal of Basement:

This measure requires filling the existing basement without elevating the remainder of the structure. This measure could be used if the structure's first floor was above the BFE or above the design elevation, whichever is higher. Adding onto the side of the structure as part of the project would be possible with this measure so as to compensate the owner for the lost basement space. If the add-on is not possible because of lot constraints or because the owner opposed it, compensation to the owner for the lost basement space could be in order. This measure would only be applicable where the design flood depth is relatively small [first floor already above the design depth]. Hydrodynamic force would also be a consideration. This measure is applicable throughout the metropolitan area.

2.4.1.5 Dry Flood Proofing

This measure concerns waterproofing the structure, which can be done to residential structures as well as all other types. This measure achieves flood risk reduction but it is not recognized by the National Flood Insurance Program (NFIP) for any flood insurance premium rate reduction if applied to residential property. Based on tests at the Corps' Engineering Research and Development Center (ERDC), a "conventional" built structure can generally only be dry flood proofed up to 3 feet on the walls. A structural analysis of the wall strength would be required if it was desired to achieve higher protection. A sump pump is required and perhaps a French drain system is installed as part of the project. Closure panels are used at openings. This concept does not work with basements. It would not work with crawl spaces in the metropolitan area because of the long duration of flooding. This measure would work in the metropolitan area if design flood depths are generally less than 3 feet and on an appropriate structure as discussed. Hydrodynamic force would also be a consideration. This measure has potential applicability throughout the metropolitan area.

2.4.1.6 Wet Flood Proofing

This measure is applicable as either a stand alone measure or as a measure combined with other measures such as elevation as discussed above. As a stand alone measure, all eonstruction materials and finishing materials need to be water resistant. All utilities must be elevated above the design flood elevation. Because of these requirements, wet flood proofing of finished residential structures is generally not recommended. Wet flood proofing is quite applicable to commercial and industrial structures when combined with a flood warning, flood preparedness, flood response plan. This measure is generally not applicable to large flood depths and high velocity flows.

2.4.1.7 Berms, Levees, and Floodwalls

This measure is applicable to locations within the metropolitan area. As nonstructural measures, berms, levees and walls are generally no higher than 6 feet above grade and are not certifiable for the NFIP, meaning that flood insurance and floodplain management requirements of the NFIP are still applicable in the protected area. These nonstructural measures are intended to reduce the frequency of flooding but not eliminate floodplain management and flood insurance. These measures ean be used for all types of structures in the metropolitan area. They can be around a single structure or a small group of structures. With application of these measures to be nonstructural, they cannot raise the water surface elevation of the 100-year flood by any amount. These measures must be placed with velocity in mind. The local communities have been working to implement these types of solutions for some of the most flood prone properties, individual landowners have also been building their own berms, levees, and floodwalls.

2.4.1.8 Flood Warning, Preparedness, Evacuation Plans and Pertinent Equipment Installation

These measures are applicable to the metropolitan area. All of the above nonstructural measures with the exception of buyout and of relocation to a completely flood free site require the development and implementation of flood warning/preparedness planning. The development of such plans and the installation of pertinent equipment such as data gathering devices [rain gages, stream gages], data processing equipment [computer hardware and software], and dial out devices [cellular, land line] can be part of the project. The communities in the area have developed emergency operation plans for floods and those plans are updated during and after flood events. The City of Fargo and the City of Moorhead have a reverse 911 system which can relay messages to neighborhoods related to where volunteer workers are needed to help with emergency measures and to order evacuations.

2.4.1.9 Land Acquisition

Land acquisition can be in either the form of fee title or permanent easement with preference to fee title. Land use after acquisition is open space use via deed restriction that prohibits any type of development that can sustain flood damages or restrict flood flows. Land acquired as part of a nonstructural project can be converted to a new use such as ecosystem restoration and/or recreation that is open space based such as trails, canoe access, etc. Conversion of previously developed land to open space means that infrastructure no longer needed, such as utilities, streets, sidewalks, etc., can be removed as part of the project. The conversion to new use [ecosystem restoration and/or recreation] can also be part of the project. By incorporating "new uses of the permanently evacuated floodplains" into the nonstructural flood risk reduction project, the economic feasibility of the buyout or relocation is enhanced. This feasibility enhancement is due to partial transfer from flood risk reduction costs to ecosystem restoration and also by adding benefits [and costs] of recreation. This effect would be determined by use of the "Separable Costs/Remaining Benefits" guidance. Other Federal agencies such as the Natural Resources

Conservation Service (NRCS) have permanent easement programs to restore wetlands in "evacuated" floodplains that could be used in a collaborative mode with a Corps nonstructural program. The local communities have focused on the purchase of flood prone properties in the past and would likely continue to do so.

2.4.1.10 Floodplain Management Plans

A floodplain management plan (FPMP) is required of the Corps non-Federal project sponsor. The intent of an FPMP is to "protect" the Corps' partnered project from diminishing the frequency of flood risk reduction provided by the project. This activity is required of a non-Federal sponsor but, if done during the feasibility phase of study, can be cost shared on the same basis as the feasibility study. This method makes sense for the sponsor from the cost share and from the holistic flood risk reduction perspectives. This latter perspective makes sense for the Corps as well. By integrating the FPMP with the feasibility study, both the FPMP and the ultimate project are bettered. This should be done within this feasibility study.

2.4.1.11 Vertical Construction for Residential Occupancy

This concept refers to condominium living within floodplains, where the at-grade floor is used for open-space uses and the upper stories (which are all above even the most infrequent floods) are used for residences. This vertical construction is proposed for consideration within the metropolitan area, especially in Fargo, because no area close to Fargo is high enough above the Red River floodplain, or that of its tributaries, for flood-free residential construction. This situation may be the same for Moorhead. This concept to change residential construction from single-family homes to vertical construction would probably face tough political/social criticism. However, it merits consideration if the metropolitan area is to achieve a significant flood risk reduction in the long term.

2.4.1.12 Flood Insurance

The National Flood Insurance Program (NFIP) could be utilized more to reduce the individual risk to flooding. This program can help to rebuild after a flood; however it does not prevent the flood from occurring and would still have large residual impacts on public safety and infrastructure.

2.4.1.13 Wetland Restoration and Grassland Restoration

Wetland and Grassland restoration are discussed in Section 2.10.

2.4.2 Effectiveness

Non-structural measures would be very effective for risk reduction to structures and their contents; however non-structural measures would not reduce flood impacts on local infrastructure including streets, sewers, storm drainage systems, pumping stations, and other critical facilities. The alternative would only be effective up to the design event. The plan would also not be effective in maintaining evacuation routes. During prior flood events, citizens of Fargo and Moorhead have chosen to stay and fight the floods rather than evacuating the cities. The plan would not be effective in preventing disruption to daily life and business activities during a flood event. This alternative would be highly effective.

2.4.3 Environmental Effects

This alternative would have moderately positive impacts

2.4.3.1 Natural Resources

The removal/relocation of homes would create opportunities to develop riparian habitat along the river corridor. Opportunities to restore wetlands, and provide more greenway for recreational and ecosystem benefits would also exist. The removal/relocation of homes would impact the areas that would be moved into as new infrastructure would need to be developed. Impacts from this would be expected to be minimal.

Overall the effects on natural resources would likely be positive.

2.4.3.2 Cultural Resources

There would be a number of historical structures that would be directly or indirectly impacted by non-structural measures, and mitigation would be required for the adverse effects. Some historical structures may be modified from their historical condition while flood proofing, raising, etc. The alternative would minimize the threat of flooding to a number of historical properties. There are a number of cultural sites within the study area, so there is potential for adverse impacts to archeological sites.

Overall the effects on cultural resources would likely be neutral.

2.4.4 Social Effects

During flood events, evacuation would be required causing large disruptions to transportation and businesses potentially lasting more than a month. A large percentage of the structures in the study area would need to be either removed, relocated, or modified to achieve a standard level of protection, so nearly the entire community would be affected, reducing community cohesion and changing the entire appearance of the city. Regional growth could be negatively affected because businesses would not want disruptions from the evacuations that would be necessary with this alternative. However, if recreation features were built on vacated lands, the project could provide significant recreational benefits during non-flood times. This alternative would have high negative social effects.

2.4.5 Acceptability

The necessary modifications to thousands of individual structures would be extremely controversial and would be politically difficult resulting in little support from the local sponsors. Community cohesion would be disrupted during the implementation of this alternative and there could be long term issues with frequent flooding that would limit access to many structures during flood events. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative would have a low level of acceptability.

2.4.6 Implementability

This project would be very difficult to implement, because it directly affects an enormous number of property owners. Forcing the public to raise structures may not be possible, reducing the overall effectiveness of the plan. There would be legal issues as to what authorities would be used to force people to modify their structures. It would take a great deal of time to implement the project due to the large number of structures being modified. This alternative would have a low level of Implementability.

2.4.7 Cost

For the initial screening, stand-alone non-structural plans were developed for the 1-percent chance flood level and the 0.2-percent chance flood level. Total cost for the 1-percent chance level was $1.6 billion, and the total cost for the 0.2-percent chance flood level was $4.7 billion. Even if the 1-percent or the 0.2-percent plans were developed the community would still be at risk of flooding and there would be residual damages to local infrastructure. This alternative would have extremely high costs.

2.4.8 Risk

The risk of flooding to public infrastructure would remain. Evacuation routes would continue to be flooded. During flood events the population could be required to be evacuated in excess of a month when looting and property damage would be a concern. The properties modified would be protected up to the design event but there would be the residual risk of flood damage above that event. This alternative has a moderate level of risk reduction.

2.4.9 Separable Mitigation

No separable mitigation is anticipated. This alternative has a low level of separable mitigation.

2.4.10 Cost Effectiveness

Two levels of stand-alone non-structural plans were investigated for the study area: 1-percent chance and 0.2-percent chance. Neither plan was cost-effective, with BCRs of 0.35 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. The alternative has a low level of cost effectiveness.

2.4.11 Recommendation

Non-structural measures should no longer be considered as stand-alone alternatives. However, the non-structural concept should be retained as a possible measure for smaller areas not otherwise benefited by the project or to mitigate for adverse effects caused by the project.

2.5 FLOOD STORAGE

2.5.1 Alternative Description

Flood storage involves both preserving natural floodplain areas and also 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 would be located in any watershed upstream of the Fargo-Moorhead Metropolitan area and distribution would be throughout that area.

Natural storage in the floodplain occurs as the water rises and fills up low-lying areas adjacent to the rivers. Constructed flood storage projects (impoundments) would be located on the main channel of a river or "off-channel" on a ditch or other manmade connection to a river. Impoundments could be designed to remain dry until a flood event, or to retain a pool during non-flood times for conservation or water supply purposes.

Three Corps-owned flood storage projects in the Red River basin benefit the study area: Lake Traverse, Orwell Lake, and Lake Ashtabula. Opportunities exist to build additional flood storage, but previous Corps studies have found insufficient national economic interest to support Federal involvement in such projects. The studies have also shown that flood storage alone cannot provide an acceptable level of risk reduction for the Fargo-Moorhead Metropolitan Area.

Despite the lack of Federal financial involvement, the Cass County Joint Water Resource District recently built a dam on the Maple River upstream and approximately 35 miles southwest of Fargo. The Bois de Sioux Watershed District in the headwaters of the Red River basin and the Buffalo-Red River Watershed District are also designing and constructing flood storage projects. These smaller projects provide incremental benefits, but they are not sufficient to prevent major flood damages in the Fargo-Moorhead Metropolitan Area. It is likely that additional flood storage would be built upstream of the study area, but that storage alone is not likely to adequately reduce flood risk to the study area over the next 50 years.

2.5.2 Effectiveness

The effectiveness of flood storage depends on many factors, including distance from the benefited area, volume of water retained, timing of the storage, size of the drainage area controlled, and the amount of runoff contributed from the controlled area during each particular flood event. Because each flood event is different with respect to the major sources and timing of runoff, it would be very difficult to ensure that a system of remote storage sites would be reliably effective at reducing flood stages in the Fargo-Moorhead area.

The St. Paul District's Fargo-Moorhead and Upstream Area Feasibility Study is assessing the viability of multipurpose projects to provide both flood storage and aquatic ecosystem restoration. In 2005, Phase 1 of that study determined that it may be possible to build 400,000 acre-feet of flood storage in the watershed using projects of 2,000 to 20,000 acre-feet each. (Note: this capacity is the most storage determined to be possible, due to limits of topography and landowner willingness.) An impoundment downstream of White Rock Dam near the North Dakota/South Dakota border that could provide up to 60,000 acre-feet of storage was also considered. A model of such a system of impoundments indicated that it could reduce the 1-percent chance flood stage in Fargo-Moorhead by less than 1.6 feet.

The Energy and Environmental Research Center (EERC) at the University of North Dakota conducted a study of the "Waffle concept" to use the existing road network with additional water control structures to store flood water from spring floods on farm fields. According to EERC's final report for the Waffle Project, dated December 2007, between 49,000 and 100,900 acre-feet of Waffle storage could be obtained upstream of Fargo-Moorhead (calculated from Table 7, page 47). The study found that flood stages in Fargo-Moorhead during the 1997 flood (nearly a 1-percent chance flood event) could have been reduced by 3.3 to 4.4 feet if the Waffle Project had been in place (Table 16, page 68).

This alternative would have a low level of effectiveness.

2.5.3 Environmental Effects

This alternative would have moderate positive impacts

2.5.3.1 Natural Resources

Flood storage would have both potential beneficial and adverse impacts on habitat types resulting from the land-use changes. Dams on the main stems of rivers are generally considered detrimental to the environment. Dams affecting existing wetlands are also less likely to provide true environmental benefits. Off-channel storage located on poorly-drained agricultural sites, former wetlands, or drained lakes can be environmentally beneficial if designed and managed properly.

Overall the effects on natural resources would likely be positive.

2.5.3.2 Cultural Resources

Flood storage projects could result in cultural resources being covered by the storage pools; construction could also have impacts on archeological resources. A number of cultural sites are within the upper Red River watershed, so the potential exists for adverse impacts on archeological sites.

Overall the effects on cultural resources would likely be negative.

2.5.4 Social Effects

Large amounts of land would be necessary to implement a flood storage project of sufficient scale to benefit the Fargo-Moorhead area. For a Federal project, most of that land would need to be taken out of agricultural production, potentially impacting rural communities. Transportation impacts could result because roads may need to be relocated. The waffle concept envisioned paying farmers to store spring runoff temporarily on active farmland, which may have fewer social impacts. Although most flood storage projects would provide benefits in the local area, it may be perceived that the benefits of these projects were mainly for the urban areas while the rural areas would be providing the land necessary for the project. Depending on the depth of the storage areas and timing of storage, recreational opportunities such as boating, fishing, or hunting might be provided. This alternative would have moderate positive social effects.

2.5.5 Acceptability

This alternative would affect a large number of landowners and would not provide a large amount of flood risk reduction for the Fargo-Moorhead area. Controversy between the urban areas and the rural areas could arise over the need for project lands. Depending on the location the storage areas could have a large impact to rural communities which would need to be relocated. Transportation disruptions could have negative impacts on community cohesion. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative would have a low level of acceptability.

2.5.6 Implementability

The project would be difficult to implement in a reasonable amount of time, less than 10 years. Acquisition of land needed for permanent projects has legal issues. Appropriate and economical storage sites are scarce in the watershed upstream of Fargo-Moorhead. Local implementation of small projects within the basin could be a viable local solution, but the individual projects would not likely have a major impact on flooding in the Fargo-Moorhead Metropolitan Area. Implementing the waffle concept would require significant coordination, study and political action by various stakeholders in three States, and appears not to be implementable in the near-term. A large number of landowners would be impacted along with transportation impacts that create a rural versus urban controversy. The local communities would need to develop special institutional and legal arrangements to ensure that they had the authority to implement the project. This alternative would have a low level of Implementability.

2.5.7 Cost

The Fargo-Moorhead and Upstream study estimated that a system of flood storage sites to provide between 200,000 and 400,000 acre-feet of storage would cost between $160 million and $400 million to construct. EERC's estimates of the present value of 50-year implementation costs for the Waffle Plan ranged from $208 million to $543 million, depending on acreage and the amounts paid to farmers (EERC, 2007, p. 151). Even with those concepts in place there would still be large residual damages in the Fargo-Moorhead area. This alternative would have extremely high costs.

2.5.8 Risk

Flood storage could provide significant stage reductions for smaller, more frequent flood events, but its effect on larger events is less dramatic. Estimated stage reductions in Fargo-Moorhead for a 1-percent chance flood range from less than 1.6 feet to 4.4 feet. Stage reductions for larger events are smaller. This alternative would leave the communities with significant residual flood risk and the need for continued flood fighting. Dams on main stems of rivers must be carefully designed with adequate emergency spillways in order to avoid the risk of catastrophic failure during a large flood event. Because the origin of major spring runoff cannot be predicted there is no guarantee that sufficient storage could be built to capture it in any given flood event. This alternative would provide a moderate level of risk reduction.

2.5.9 Separable Mitigation

The need for mitigation would depend on the location and project design. It is likely that it would not be possible to adequately mitigate for the environmental impacts at some main stem locations, while other sites could provide environmental benefits and need no separable mitigation. Mitigation of hydraulic impacts, possibly by purchasing flowage easements, would also probably be necessary as far upstream as water could be impounded. This alternative has a moderate level of separable mitigation.

2.5.10 Cost Effectiveness

Prior studies have been inconsistent regarding the cost-effectiveness of flood storage. It appears unlikely that a large system of flood storage projects would be economically justified from a Federal perspective, although some individual projects may be justified. Only preliminary economic benefits of the system were assessed for the Fargo-Moorhead area, but those results showed that the National Economic Development benefits would equal less than one third of the cost, making it unlikely that there is sufficient federal interest based solely on flood damage reduction.

An economic analysis presented in the Waffle plan report indicated that the Waffle concept may be economically justified, but there are several outstanding technical, social and political issues and institutional arrangements that need additional development before the concept could be implemented. The Waffle concept, as described in the report, does not fit any existing Corps of Engineers implementation authorities.

It is important to note that lack of Federal economic justification does not imply that flood storage should not be built or is not justified from a regional or local perspective. On the contrary, it is probable that local jurisdictions would find compelling reasons to construct flood storage projects that are effective on a small scale. Agricultural areas and rural infrastructure located downstream of small impoundments receive substantial benefits during summer rainstorms and spring snow-melt events.

The alternative has a low level of cost effectiveness.

2.5.11 Recommendation

Flood storage should no longer be considered as a stand-alone alternative for the Fargo-Moorhead area. The flood storage concept should be retained for possible implementation to mitigate for any adverse impacts of other plans or where it can be otherwise incrementally justified. The local communities should continue to seek opportunities for storage in the basin.

2.6 TUNNELING

2.6.1 Alternative Description

Large tunnels would be used to divert flows under the communities; this would function similar to a diversion channel, just 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. Tunneling would require little real estate acquisition, very little bridge or road building or modification, and the soil in the project area is very soft and would be easy to bore. Real estate interests would still be required to tunnel under private property, and real estate would also be required to dispose of the 10,370,000 cubic yards of excavated material.

2.6.2 Effectiveness

Tunneling, similar to diversion channels, would be very effective in reducing flood risk in the Fargo-Moorhead Metropolitan area. The effectiveness of the diversion channels is presented here to demonstrate what the impacts of tunneling could be. The smallest diversion considered in the screening exercise (25,000 cfs capacity) would reduce a 0.2-percent chance event to approximately 1-percent chance stages through town, and a 1-percent chance event would be reduced to less than 10-percent chance stages. The communities begin emergency measures between the 15 and 20-year events meaning that a diversion would nearly eliminate the need for emergency measures during smaller, more frequent floods, but flood fighting would still be needed for events approximately 1-percent chance or larger. Larger diversion alternatives could nearly eliminate the need for flood fighting except for the extremely rare and large events. This alternative is highly effective.

2.6.3 Environmental Effects

This alternative would have moderate negative impacts

2.6.3.1 Natural Resources

There would be potential adverse effects to habitat types due to land-use changes where the spoil material would be placed, aquatic habitat could be impacted due to loss of fish passage and potential sedimentation issues.

Overall the effects on natural resources would likely be negative.

2.6.3.2 Cultural Resources

Archeological resources near the tunnel inlet and where the spoil material is placed could be impacted. Cultural resources could be in or near the spoil areas and could be negatively impacted. Cultural resources in the existing floodplain in the Fargo-Moorhead area would receive benefits from tunneling and would not be as prone to flooding.

Overall the effects on cultural resources would likely be neutral.

2.6.4 Social Effects

Tunneling would still require a fairly large amount of agricultural land. The reduced flood risk would lead to continued regional growth, employment would continue to grow with the region and businesses would not need to provide support for regular emergency measures. Public safety would improve as the risk of catastrophic flooding would be largely minimized, however there would be risks to public safety at the inlet location of the tunnels, especially during high flow events. Local transportation would not be impacted due to the tunnel being underground. During flood events local transportation and evacuation routes would remain open and accessible to the public. This alternative would have high positive social effects.

2.6.5 Acceptability

Tunneling would have positive impacts on community cohesion. There could also be actual or perceived downstream impacts due to increased flood stages that may need to be addressed. These impacts could create a perception of a rural versus urban conflict. Within the communities during non-flood events the community would be allowed to grow with minimal threat of flooding for the future. There would be impacts to the aquatic habitat which may not be consistent with National or Corps policies. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative would be moderately acceptable.

2.6.6 Implementability

There are several technical issues to implementing a tunnel plan. The largest concern would be ensuring that the project would be able to function over the long-term. Sedimentation and maintenance issues with an underground project would be difficult. Tunnel plans have been employed successfully in San Antonio, Texas and the Port of Miami.

This alternative would be moderately implementable.

2.6.7 Cost

Research on other tunneling projects found that costs for a single bore tunnel varied from approximately $37 million per mile for the San Antonio, Texas River Tunnel to $677 million per mile for a proposed Port of Miami project, but typical costs range from $100 million to $350 million per mile. Assuming $50 million per mile, the three tunnels proposed for the Fargo-Moorhead project would cost $3.75 billion. This alternative would have extremely high costs.

2.6.8 Risk

Tunnels provide a high level risk reduction because they cannot fail suddenly and catastrophically. If a tunnel fails to perform, flood stages are no higher than they would have been without the project in place. However, tunnels would not eliminate flood risk, and are not fool-proof. Significant residual risk often remains from flood events larger than the design event, and emergency flood fighting would still be required for those extremely rare events which could lead to risks similar to the without project condition. There is a potential for blockage of the tunnel due to ice, debris, and sediment which would be most likely at the tunnel inlet. This alternative has a high level of risk reduction.

2.6.9 Separable Mitigation

If the project causes increased flood damages downstream, economic impacts could result in the need for ring levees, relocations, or buyouts. Impacts to the aquatic resources that cannot be addressed through project design could result in the need for mitigation, possibly including increasing fish passage at other locations in the basin. This alternative has a moderate level of separable mitigation.

2.6.10 Cost Effectiveness

The benefits of a tunnel alternative would be similar to a diversion channel with similar capacity. Considering the estimated cost of the tunneling, it does not appear that tunneling would be cost effective. The alternative has a low level of cost effectiveness.

2.6.11 Recommendation

There would be a number of positive aspects to a tunnel alternative, however due to the cost of this alternative being substantially greater than any of the diversion channels while providing similar benefits, and other uncertainties with long term maintenance and repair, it is recommended that no additional study of tunnels be conducted.

2.7 BRIDGE REPLACEMENT OR MODIFICATION

2.7.1 Alternative Description

Bridges can restrict the flow during flood events. Raising or modifying bridges can increase conveyance in the channel and reduce flood stages.

2.7.2 Effectiveness

The existing bridges in the study area were included in the hydraulic models for this study. Removing the bridges entirely had only minor effects on predicted flood stages. Modifying individual structures may provide some benefits, but it would not be effective as a stand-alone measure. This alternative would have a low level of effectiveness.

2.7.3 Environmental Effects

This alternative would have neutral impacts.

2.7.3.1 Natural Resources

No appreciable adverse effects. Overall the effects on natural resources would likely be neutral.

2.7.3.2 Cultural Resources

A number of cultural sites are in the study area so there is potential for adverse impacts to archeological sites near the bridge abutments and along the bridge piers. Overall the effects on cultural resources would likely be negative.

2.7.4 Social Effects

Impacts to transportation during construction would be minimal. Emergency evacuation routes would be able to stay open during flood events. Additional lands may be needed for construction. This alternative would have low positive social effects.

2.7.5 Acceptability

This alternative would have minimal impacts to community cohesion and little controversy would be expected. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative would provide only minor levels of flood risk reduction. This alternative would have a low level of acceptability.

2.7.6 Implementability

This alternative would be implementable and it has no major issues. This alternative has a high level of Implementability.

2.7.7 Cost

No estimates for bridge modification were prepared for this study. If this alternative were constructed the community would still have a residual flood risk of nearly $74 million annually. This alternative would have extremely high costs.

2.7.8 Risk

The community would continue to be at risk of flooding. This alternative has a extremely low level of risk reduction.

2.7.9 Separable Mitigation

No separable mitigation would be necessary. This alternative has a low level of separable mitigation.

2.7.10 Cost Effectiveness

Based on prior experience on other projects and on the hydraulic modeling conducted for this project, it appears unlikely that raising or modifying bridges would be cost effective in Fargo-Moorhead. This alternative has a low level of cost effectiveness.

2.7.11 Recommendation

This alternative should not be considered further as a stand-alone plan, but should be retained for possible inclusion in an overall plan if it can be incrementally justified.

2.8 INTERSTATE 29 VIADUCT

2.8.1 Alternative Description

Reconstructing the Interstate 29 (I-29) corridor to serve as an open viaduct during floods was considered. The reconstructed corridor 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.

2.8.2 Effectiveness

The corridor, like a diversion channel, would be very effective in providing flood risk management for the Fargo-Moorhead Metropolitan Area. This level of risk reduction could provide a high level of flood risk management. For events in excess of the design event it would reduce the possibility of catastrophic failures and the cities would likely be able to flood fight those events. This alternative is highly effective.

2.8.3 Environmental Effects

This alternative would have low negative impacts.

2.8.3.1 Natural Resources

The alternative could have potential adverse effects on the aquatic resources caused by impacts to fish passage and fish trapping. The alternative would be designed to ensure that impacts to aquatic habitat would be minimized to the greatest extent possible and that the overall impact to the resource would be less than significant. The channel would impact the depth of groundwater near the channel. There would be little opportunity to provide and environmental enhancements to the project as it would also function as an interstate highway.

Overall the effects on natural resources would likely be negative.

2.8.3.2 Cultural Resources

Cultural resource impacts would be minimal. They would mainly occur at the inlet and outlet of the corridor. Historic structures would be less likely to flood and would benefit from this alternative. Overall the effects on cultural resources would likely be positive.

2.8.4 Social Effects

Traffic would face major disruptions during flood events, unless the highway was elevated. I-29 serves as a major evacuation route during flood events, which would be a major life-safety issue. Regional growth, public safety, and employment would be affected positively. The project would have minimal positive impacts on recreation because those features could only be incorporated at the inlet and outlet channels. This alternative would have moderate positive social effects.

2.8.5 Acceptability

This plan would eliminate a major transportation route for the duration of a flood event which would not be acceptable. If I-29 were elevated the project would have the same acceptability as the diversion channels. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative would be highly acceptable.

2.8.6 Implementability

Making a raised road in the corridor or putting the road on the bottom of the corridor would have significant technical issues. The project would require demolition of the existing infrastructure, construction of the diversion channel and reconstruction of the infrastructure. This would cause long disruptions to interstate traffic during construction. This alternative has a low level of implementability.

2.8.7 Cost

Excavation volumes per mile for this alternative would be similar to those of a comparable diversion plan, although the total length could be shorter. Demolition and reconstruction of the existing interstate would cost at least $400 million. Real estate would be required to dispose of the excavated material. Total cost of this alternative would likely be $1.4 billion to 4.0 billion. Operation and maintenance costs of the corridor and the roadway would be high. Residual damages would be similar to the diversion channels. This alternative has high costs.

2.8.8 Risk

Concerns with this alternative include 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 a highway located at the bottom of the channel. The risk of floods would decrease significantly, similar to the diversion channels. This alternative has a moderate level of risk reduction.

2.8.9 Separable Mitigation

If the project causes increased flood damages downstream, economic impacts could result in the need for ring levees, relocations, or buyouts in downstream locations. Impacts to the aquatic resources that cannot be addressed through project design could result in the need for mitigation, possibly including increasing fish passage at other locations in the basin. Mitigation may be necessary for fish passage on the Red River. This alternative has a moderate to high level of separable mitigation.

2.8.10 Cost Effectiveness

The cost to excavate the I-29 viaduct would be similar to the diversion alternatives, but the total cost would include additional demolition and reconstruction of the interstate corridor. The costs appear to exceed any diversion alternative being considered. Because the concept would provide similar benefits at greater cost, it does not appear to be cost effective. This alternative would have a low level of cost effectiveness.

2.8.11 Recommendation

The I-29 viaduct concept should no longer be considered for further analysis.

2.9 DREDGING AND WIDENING THE RED RIVER

2.9.1 Alternative Description

Digging the Red River channel deeper and wider to allow for more flow to pass through the Fargo-Moorhead Metropolitan Area was considered. This alternative could also be looked at underneath existing bridges to prevent the damming effect the bridges can create.

2.9.2 Effectiveness

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. Sedimentation following project implementation would be a concern, and if maintenance was not completed properly, any benefits of the project would be lost. This alternative has a low level of effectiveness.

2.9.3 Environmental Effects

This alternative would have high negative impacts.

2.9.3.1 Natural Resources

Dredging and widening the channel would have a variety of potential adverse effects. Increased sedimentation, displacement of mussels, erosion issues, riparian forest habitat loss, aquatic habitat, and wildlife mortality issues would need to be addressed. Overall the effects on natural resources would likely be negative.

2.9.3.2 Cultural Resources

Dredging and widening the channel would have a large potential impact on archeological resources, which are typically located on riverbanks, and would be disturbed by this alternative. These impacts would require costly mitigation. Overall the effects on cultural resources would likely be negative.

2.9.4 Social Effects

This alternative would change the appearance and function of the river in Fargo and Moorhead. Properties along the river would need to be acquired to address slope stability issues, which would require that the banks be cut back to allow for a deeper channel. Local bridges would need to be modified to accommodate the larger channel and dredging operations. This alternative would have high negative social effects.

2.9.5 Acceptability

This alternative is not acceptable and violates many local and national policies. There would be a great deal of controversy. This alternative has a low level of acceptability.

2.9.6 Implementability

It is not possible to implement this project. This alternative has a low level of Implementability.

2.9.7 Cost

Costs would be excessive. Operations and maintenance costs would be high and long-term. Environmental mitigation costs would be extreme, assuming mitigation would be possible. The communities would still face large residual risks, and if continued dredging was not maintained, any benefits of the project would be lost. This alternative has extremely high costs.

2.9.8 Risk

The project would be at risk of failure due to sedimentation. The community would still be at risk of flooding. This alternative has a low level of risk reduction.

2.9.9 Separable Mitigation

It would probably not be possible to mitigate for the environmental impacts of this alternative. This alternative would have extremely high levels of separable mitigation.

2.9.10 Cost Effectiveness

Cost effectiveness was not determined, but it is very unlikely that benefits would outweigh costs. This alternative would have a low level of cost effectiveness.

2.9.11 Recommendation

This concept to dredge and widen the Red River should no longer be considered for further analysis.

2.10 WETLAND AND GRASSLAND RESTORATION

2.10.1 Alternative Description

This alternative includes restoration of drained wetlands, restoration of grasslands, and changes in land use practices in the watersheds upstream of the Fargo-Moorhead Metropolitan Area. These features would reduce peak runoff, change flood frequency, and serve as water storage during flooding. The features

would be distributed throughout the upstream portion of the basin and would generally provide low level storage that would be primarily used for wetlands and habitat.

2.10.2 Effectiveness

Effects would be primarily localized. Major beneficial effects on flood damage reduction in the Fargo-Moorhead Metropolitan Area are unlikely. The effectiveness in any given year would depend on the antecedent conditions. A significant effect on flood flows in the Fargo Moorhead Metropolitan area would likely require landscape scale changes and major modifications. The effectiveness would be expected to be less than that of flood storage. This alternative has a low level of effectiveness.

2.10.3 Environmental Effects

This alternative would have high positive impacts.

2.10.3.1 Natural Resources

Wetland and grassland habitat would be greatly enhanced. Associated benefits such as reduced sedimentation, turbidity downstream, and improvements in water quality would be expected. Overall the effects on natural resources would likely be positive.

2.10.3.2 Cultural Resources

A number of cultural resource sites are within the study area so there is potential for adverse impacts to archeological sites. Converting land use to wetland or grassland would likely require minimal excavation or fill activities causing minor temporary impacts. Overall the effects on cultural resources would likely be neutral.

2.10.4 Social effects

Large amounts of land would be necessary for the implementation of this alternative, primarily impacting agricultural production. Roads may need to be relocated, which would have impacts on transportation. The flood benefits of these projects could be mainly for the urban areas while the rural areas would be providing the land necessary for the project. The alternative could create recreational opportunities such as hunting and bird watching. This alternative would have moderately positive social effects.

2.10.5 Acceptability

This alternative would affect a large number of landowners and would not provide a large amount of flood risk reduction for the Fargo-Moorhead Area. Conflict between the urban areas and the rural areas could arise because of the need for project land. It may be acceptable to implement this in conjunction with another alternative. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative has a moderate level of acceptability.

2.10.6 Implementability

The project would be difficult to implement in a reasonable amount of time, and there are legal issues with the ability to acquire the land necessary for the project. Site identification could be difficult, and

ensuring that the restoration was located in the right areas to provide the necessary storage to ensure reliability of the system could be a challenge. Local implementation of small projects within the basin could be a viable local solution, but the benefits would not likely have a major impact on flooding in the Fargo-Moorhead Metropolitan Area. This alternative has a low level of implementability.

2.10.7 Cost

The cost of this alternative is expected to be high. It would be higher than that of flood storage alone because of the need to have a greater number of shallow storage sites along with the costs to ensure the proper native plant species get established. This alternative would have an extremely high cost.

2.10.8 Risk

The project would likely provide less than the 1.6 feet of stage reduction identified in the flood storage alternative for a 1 percent chance event at Fargo-Moorhead. The communities would remain at risk of flooding. Identification and implementation of this alternative in a reasonable timeframe is also unlikely. This alternative would have low level of risk reduction.

2.10.9 Separable Mitigation

No separable mitigation would be necessary. This alternative would have a low level of separable mitigation.

2.10.10 Cost Effectiveness

Restoring wetlands and grasslands is not likely to be cost-effective for flood damage reduction. It may be considered cost-effective for environmental purposes. This alternative would have a low level of cost effectiveness.

2.10.11 Recommendation

Restoring wetlands and grasslands should no longer be considered as a stand-alone alternative, but may be considered for inclusion to mitigate for other adverse project effects where it can be incrementally justified.

2.11 CUT-OFF CHANNELS

2.11.1 Alternative Description

Building cut-off channels across meanders in the cities was considered. Such channels would provide the water a straighter path through the city and potentially reduce peak stages. The channels would be designed with a bottom elevation above a certain design stage to allow the river to flow naturally up until a design event at which time the excess flow would flow into the cut-off channel. Four cut-off channels in the Fargo-Moorhead Area were constructed as part of the Federal flood control project completed in 1963.

2.11.2 Effectiveness

Cut-off channels would not be effective as a stand alone alternative. They could be used in conjunction with a levee plan to increase conveyance in the channel and reduce upstream stages. This alternative has a low level of effectiveness.

2.11.3 Environmental Effects

This alternative would have high negative environmental effects.

2.11.3.1 Natural Resources

Cut off channels would have a potential adverse effect on the fishery resource in the Red River when the flows exceed the design event. Riparian habitat would be negatively affected because of loss of woodlands from construction. Channels could disrupt the normal geomorphology of the stream, and if erosion occurred, the river channel could be permanently altered. Overall the effects on natural resources would likely be negative.

2.11.3.2 Cultural Resources

A number of historical structures could be directly or indirectly affected by flood storage measures, and mitigation would be required for the adverse effects. A number of cultural sites are in the study area, so there is potential for adverse impacts on archeological sites. Overall the effects on cultural resources would likely be negative.

2.11.4 Social Effects

Flooding in the Fargo-Moorhead area would likely continue and the social effects would be similar to the existing condition. This alternative would have highly negative social effects.

2.11.5 Acceptability

This alternative is not acceptable to the resource agencies and potentially could violate a number of State and Federal policies. The sponsors have indicated that a level of permanent protection in excess of the 1-percent chance level is necessary for local acceptability, however if there are no other options permanent protection at the 1-percent level could be pursued. This alternative has a low level of acceptability.

2.11.6 Implementability

This alternative is not implementable as a stand alone alternative. It could be implemented as an additional measure for other plans if acceptability issues can be overcome. This alternative has a low level of Implementability.

2.11.7 Cost

Costs were not estimated for screening purposes. It would be assumed that residual damages would continue within the community resulting in similar damages as the existing condition. The costs of this alternative are extremely high.

2.11.8 Risk

Environmental impacts would possibly be large and the community would continue to be at risk of flooding. This alternative would have a high level of risk.

2.11.9 Separable Mitigation

Impacts to the aquatic resources that cannot be addressed through project design could result in the need for mitigation, possibly including increasing fish passage at other locations in the basin. The loss of riparian habitat caused by the cut-off channel will have to be mitigated. This alternative would have a low level of separable mitigation.

2.11.10 Cost Effectiveness

Cost effectiveness would be site specific and no specific analysis has been conducted. It is anticipated that there would be a low to moderate level of cost effectiveness.

2.11.11 Recommendation

Cut-off channels should not be considered as a stand-alone alternative but should be retained for possible inclusion in an overall plan where they could be incrementally justified.

3.0 RECOMMENDATION

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

- Future without Project Condition--No Action
- Diversion Channels

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

- Levees/Floodwalls
- Non-Structural Measures
- Flood Storage
- Tunneling
- Bridge Replacement or Modification
- Interstate 29 Viaduct
- Dredging and Widening the River
- Wetland and Grassland Restoration
- Cut-Off Channels

The following measures should be considered for possible inclusion as features of the overall plans evaluated in detail where they can be incrementally justified:

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

Table 1: Alternative Screening Summary

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 are $73.7 million.

Table 2: Alternatives Screening Summary Matrix

Resource Category	Alternative			
	Future Without Project Conditions	Flood Barriers	Diversion Channels	Non-Structural Measures
Alternative Description	Emergency measures currently being pursued in the project area will continue to be implemented as necessary due to flooding. These include raising levees, constructing temporary levees and floodwalls in various areas, and sandbagging.	This alternative includes the use of permanent flood barrier systems including levees, floodwalls, invisible floodwalls, gate closures, and pump stations. Two different top profiles to reliably contain the 2% chance flood and the 1% chance flood. Initial analyses were based on constructing levees in both Fargo and Moorhead to the design levels and assessing the costs and economic benefits of the plans.	Route flood flows around the metropolitan area. Several potential alignments will be considered, including alignments in both Minnesota and North Dakota and incorporating the existing Sheyenne Diversion from Horace to West Fargo.	Relocation of structures, buyout and demolition of structures, elevation of structures, removal of basement, dry flood proofing, wet flood proofing, land acquisition, flood management plans, vertical construction for residential occupancy. Additionally flood warning, preparedness, evacuation plans and pertinent equipment installation, and nonstructural berms, levees, and floodwalls are considered.
Effectiveness	(Low) Not expected to provide consistent/reliable long-term risk reduction. Emergency measures are temporary, demand high number of workers in extreme weather, are a risk to human health.	(Moderate) Levees and other properly designed and constructed flood barriers can prevent damages from most flood events that do not exceed their maximum design event.	(High) Effectively eliminate flooding for small events, but require flood fighting for large events. Diversions generally provide robust risk reduction.	(High) Effectively reduces risk to structures and their contents up to the design event. Floods would still have potentially large impacts on infrastructure, evacuation routes, and daily life and business activities.
Environmental Effects - Natural Resources	(Negative) Emergency levees are susceptible to erosion, feeding sediment into the river. They adversely impact terrestrial vegetation, and borrow sites.	(Neutral) Resources affected along embankment alignment. Wetland mitigation may be required. Open space between barrier and river will provide benefits. Larger riparian areas.	(Neutral) Issues such as fish passage and sedimentation arise. Also, wetlands and ground water may be impacted. The channel would be designed to include wetland and/or prairie swale type habitat within the diversion channels which could lead to increased habitat quantity and value from the existing conditions.	(Positive) Removal/relocation of homes allows to develop riparian habitat, restoration of wetlands, greenway area for recreational and ecosystem benefits.
Environmental Effects - Cultural Resources	(Negative) Excavating borrow material, building temporary levees/floodwalls, removing temporary levees/floodwalls all have the potential to have adverse effects on cultural resources. Failure of the temporary levees/floodwalls would also have adverse impacts to cultural properties/resources.	(Negative) There are a number of historical structures that would be directly or indirectly impacted by the construction of the in-town levees, and mitigation would be required for the adverse impacts. Potential for adverse impacts on deeply buried archeological sites, and historical structures and requires mitigation.	(Negative) High potential for impact to archeological sites within the area, particularly buried sites where channels leave, enter, or cross rivers. Historical structures may be directly or indirectly impacted.	(Neutral) A number of historical structures would be directly or indirectly impacted. Potential adverse impact to archeological sites. The alternative would also minimize the chance of flooding to historical structures.
Social Effects	(High Negative) Negative effect on businesses, transportation, recreational facilities, and public services. Emergency measures failure may result in loss of community, community cohesion, public safety, and potential loss of life.	(Moderate Positive) Positive: improved public safety during flood events, regional business growth, less frequent emergency actions, addition of recreational components. Negative: 1000 structures removed, road closures during floods. Failure would result in significant threat to public safety.	(High Positive) A large amount of agricultural land would be necessary. Regional growth, public safety, employment, and recreation would all benefit from the project.	(High Negative) Required evacuation during floods would adversely effect transportation, business, regional growth. Large percentage of structures would be impacted by the required modifications.
Acceptability	(Low) Not acceptable as a long term solution. Eventually flood fighting will adversely effect the local community and region.	(Moderate) Alternative will disrupt community cohesion by removal of approximately 1000 structures, railroad lines, increased flood stages upstream, and will not meet sponsors desired level of protection.	(Moderate) This plan is acceptable but will impact a number of agricultural properties. There could also be actual or perceived downstream impacts due to increased flood stages that may need to be addressed. Controversy will be more of an issue depending on which diversion is selected.	(Low) Necessary modifications to individual structures would be extremely controversial and have little support from local sponsors.
Implementability	(Moderate) Legal and technical issues complicate implementation of emergency measures. Obtaining rights of access on short notice is difficult and controversial. Maximum level of protection limited by natural ground..	(Moderate) Difficulty in timely implementation. Feasible protection can be constructed up to a maximum of 1% chance level.	(High) There are some technical issues to implementing this plan, the largest concern would be with the Red River control structure and the tributary structures. Diversions have been successfully used in other projects in the Red River Valley.	(Low) Difficult implementing due to enormous number of affected properties.
Cost	(Extremely High) Extremely high costs ($74 million / year). 500yr event may exceed $6 billion.	(High) 2% chance flood protection estimated at $840 million, and $902 million for 1% chance level of protection. The 1% levee plan would leave the community susceptible to residual damages averaging more than $20 million annually.	(Medium) Costs for the nine diversion alternatives investigated range from $962 million to $1.46 billion. The plans all reduce the residual risk to the communities to less than $14 million annually and would allow for emergency flood fighting if necessary.	(Extremely High) 1% and 0.2% chance floods estimated to cost $1.6 billion and $4.7 billion respectively. Even if the 1% or the 0.2% plans were developed the community would still be at risk of flooding and there would be residual damages to local infrastructure.
Risk*	(Extremely low) Extremely low level of risk reduction and there would be a high risk of future flooding. Reliability of emergency measures is poor. Mobilizing man power is difficult and unreliable, and those people are placed at risk. Unreliable protection as a result of construction measures.	(Moderate) This plan will provide risk reduction up to the design event; once that event is exceeded catastrophic damages will occur. This plan may also induce additional growth between the 1% chance and 0.2% chance flood plains resulting in greater risk to the community over time.	(High) Flood stages are no higher than they would have been without the project in place. They are not fool-proof and significant residual risk often remains from flood events larger than design event, and there is potential for channel blockage from debris and ice.	(Moderate) High risk to public infrastructure, looting and property damage, evacuation routes. Population relocation may be required.
Separable Mitigation	(High) Repair of damaged properties following flood event is necessary resulting in large costs for removal and repair.	(Moderate) The plan may result in quantifiable damages resulting from increased flood stages up and downstream and would require mitigation with option such as upstream storage, ring levees, and non-structural solutions.	(Moderate to High) If project causes increased flood damages downstream, mitigation would be required such as ring levees, buyouts, and relocations. Aquatic resource mitigation may be required and would be more likely with the tributary structures.	(Low) None is anticipated.
Cost Effectiveness	(Moderate) Emergency measures are cost effective, because they prevent damages far in excess of their cost.	(Moderate) From the investigated levee plans only 1% chance levee was determined cost effective.	(Low-High) Smaller diversions were found to provide better cost effectiveness, and all of the Minnesota short diversions were cost effective	(Low) Not cost effective with BCRs of less than 0.35.
Recommendation	The future without project (no action) alternative should be retained as the base condition for comparison with all other alternatives.	Levee plans should no longer be considered as a stand-alone alternative. The levee plans would provide a limited level of risk reduction, have large short term social impacts, high costs, and relies on emergency measures for larger flood events.	Diversion concept should be retained for further refinement. Preliminary analysis shows that the Minnesota Short Diversion appears implementable, effective, and cost effective.	Non-structural measures should no longer be considered as stand-alone alternatives

* Risk is measured based on the risk reduction, therefore a plan with a rating of high would have a high level of risk reduction, meaning the community would be less susceptible to flooding.

Table 2: Alternatives Screening Summary Matrix

Resource Category	Alternative: Flood Storage	Tunneling	Bridge Replacement or Modification	Interstate 29 Viaduct
Alternative Description	Preserve natural floodplain areas, restore wetalnds, build dams and other water retention facilities to hold water during flood events. Impoundments may be designed to remain dry until a flood event or to retain a pool during nonflood times for conservation or water supply purposes.	A series of tunnels underneath the city to convey the water and reduce the water levels in the river.	Bridges can restrict the flow during flood events. Raising or modifying bridges can increase conveyance in the channel and reduce flood stages.	Reconstructing the Interstate 29 corridor to serve as an open viaduct during floods was proposed. The reconstructed corridor would function as an interstate highway during non-flood times.
Effectiveness	(Low) Very difficult to ensure that the system would be reliable and effective. A model of system of impoundments with 400,000 acre feet of storage indicated that it could reduce the 1% chance flood stage in Fargo-Moorhead by less than 1.6 feet.	(High) Tunneling, would be effective in reducing flood risk, eliminating emergency measures during smaller floods. Large floods would also see a reduction in flood risk. Overall flood risk reduction is dependent on tunnel capacity.	(Low) Not an effective stand alone measure. Removing the bridges entirely has only minor effects.	(High) Would effectively provide flood risk management, reducing flood risk for small and large events.
Environmental Effects - Natural Resources	(Positive) May be both beneficial and detrimental, with dams causing adverse effects, and off-channel storage can be beneficial. Off-channel storage located on poorly-drained agricultural sites, former wetlands, or drained lakes can be environmentally beneficial if designed and managed properly.	(Negative) There are adverse effects on aquatic habitat due to loss of fish passage and potential sedimentation. Potential adverse effects on areas where spoil material would be placed.	(Neutral) No appreciable adverse effects.	(Negative) Issues such as fish passage and sedimentation arise. There would be little opportunity to provide any environmental enhancements to the project as it would also function as an interstate highway.
Environmental Effects - Cultural Resources	(Negative) Flood storage project may cover cultural resources and impact archeological resources.	(Neutral) Possible adverse impact to archeological resources near tunnel inlet/outlet and location of spoil material placement are possible. Cultural resources in the existing floodplain in the Fargo-Moorhead area would receive benefits from tunneling and would not be as prone to flooding.	(Negative) Potential for impact to archeological sites near bridge abutments and piers. Potential to adversely affect National Register eligible or listed bridges.	(Positive) Minimal impacts could occur at the inlet and outlet of the corridor. Historic structures would be less likely to flood and would benefit from this alternative.
Social Effects	(Moderate Positive) Large amounts of agricultural land would be necessary for acquisition or may be impacted. Depending on the depth of the storage areas and timing of storage, there could be a potential for recreational opportunities such as boating, fishing, or hunting.	(High Positive) Alternative requires a substantial amount of agricultural land. Regional growth, public safety, employment, and recreation would all benefit from the project.	(Low Positive) There would be minimal impact to transportation during construction, and emergency evacuation routes would be able to stay open during flood events.	(Moderate Positive) There would be major negative impacts to the transportation and evacuation route during flood events. Positive effects that may be seen are regional growth, public safety, and employment.
Acceptability	(Low) Very difficult to implement in reasonable amount of time. Issues with land acquisition such as legal processes and scarcity in economical storage.	(Moderate) There could be actual or perceived downstream impact that will need to be addressed. There would also be an adverse impact to the aquatic habitat.	(Low) Because of minimal levels of risk reduction this plan is not acceptable.	(High) The resulting impact to the transportation would not be acceptable. Elevation of the interstate would bring the project to the acceptability of the diversion.
Implementability	(Low) It is likely that additional flood storage will be built upstream of the study area, but that storage alone is not likely to adequately reduce flood risk to the study area over the next 50 years.	(Moderate) There are technical issues such as sedimentation and maintenance for an underground project to make sure the functionality of the alternative over a long-term.	(High) Alternative is implementable with no major issues.	(Low) Significant technical issues raising or lowering the road which involve demolition and reconstruction.
Cost	(Extremely High) Cost range from $160-$543 million depending on level of protection and type of plan. The communities would still face a large residual flood costs.	(Extremely High) Typical costs range from $100 - $350 million per mile.	(Extremely High) No estimates were prepared. Alternative would not reduce the residual flood risk. If this alternative were constructed the community would still have a residual flood risk of nearly $74 million annually.	(High) Estimated cost of $1.4 - 4.0 billion, with large operation and maintenance cost.
Risk*	(Moderate) Able to help with small events, but the estimated stage reduction for large events is not significant.	(High) Large flood risk reduction is achieved with this alternative. There is minimal risk of sudden or catastrophic failure. Residual risk often remains from flood events larger than the design event, and emergency flood fighting would still be required for those extremely rare events which could lead to risks similar to the without project condition.	(Extremely Low) Community would continue to be at risk of flooding.	(Moderate) Risks include ice jams, access to evacuation routes during floods, maintenance of the structure, backwater during minor floods. The risk of floods would decrease significantly, similar to the diversion channels.
Separable Mitigation	(Moderate) Mitigation depends on the project location, and is likely that it would not be possible to adequately mitigate environmental impacts.	(Moderate) If alternative results in increased flood damage downstream, mitigation would be required.	(Low) None is anticipated.	(Moderate) If project causes increased flood damages downstream, mitigation would be required such as ring levees, buyouts, and relocations. Aquatic resource mitigation may be required.
Cost Effectiveness	(Low) Unlikely to be economically justifiable for large systems, but may be considered for small areas.	(Low) Alternative is much more expensive than diversion with similar benefits.	(Low) Unlikely to be cost effective.	(Low) Cost similar to diversion alternative plus additional to demolish and reconstruct the roadway, with similar benefits to the diversions.
Recommendation	Flood storage should no longer be considered as a stand-alone alternative for the Fargo-Moorhead area as part of this project. Local communities should continue to seek opportunities for storage in the basin.	There would be a number of positive aspects to a tunnel alternative, however due to the cost of this alternative being substantially greater than any of the diversion channels while providing similar benefits, and other uncertainties with long term maintenance and repair, it is recommended that no additional study of tunnels be conducted.	Bridge replacement/modification should not be considered further as a stand-alone plan, but should be retained for possible inclusion in an overall plan if it can be incrementally justified.	The I-29 viaduct concept should no longer be considered for further analysis.

* Risk is measured based on the risk reduction, therefore a plan with a rating of high would have a high level of risk reduction, meaning the community would be less susceptible to flooding.

Table 2: Alternatives Screening Summary Matrix

Resource Category	Alternative: Dredging and Widening the River	Alternative: Wetland and Grassland Restoration	Alternative: Cut-off Channels
Alternative Description	Digging the Red River channel deeper and wider to allow for more flow to pass through the Fargo-Moorhead Metropolitan Area was proposed. This alternative could also be looked at underneath existing bridges to prevent the damming effect the bridges can create.	Restoration of grassland and wetlands to reduce peak runoff and serve as water storage during flooding events was proposed.	Building cut-off channels across meanders in the cities was proposed. It would provide the water a straighter path through the city and potentially reduce peak stages.
Effectiveness	(Low) Very limited hydraulic effectiveness and would likely negatively affect the stability of the river banks. Sedimentation following project implementation would be a concern and if maintenance was not completed properly any benefits of the project would be lost.	(Low) Effects are localized with no likely major benefit for Fargo-Moorhead Metropolitan Area. The effectiveness would be expected to be less than that of flood storage.	(Low) Alternative is not effective as a stand-alone.
Environmental Effects - Natural Resources	(Negative) There would be increased sedimentation, displacement of mussels, erosion issues, riparian forest habitat loss, aquatic habitat impacted, and wildlife mortality issues during dredging.	(Positive) Wetland and grassland habitat would greatly be enhanced and provide associated benefits to the water quality downstream.	(Negative) Alternative would impact riparian habitat, geomorphology of the stream, and fishery resource when flow exceeds design event.
Environmental Effects - Cultural Resources	(Negative) High potential for impact to archeological resources located on river banks.	(Neutral) There are a number of cultural sites within the study area so there is potential for adverse impacts to archeological sites.	(Negative) Alternative has potential to affect historical structures, and high potential to affect archeological sites.
Social Effects	(High Negative) Alternative would change appearance and function of the river. Properties along the river would need to be acquired due to slope stability issues which would require that the banks be cut back to allow for a deeper channel.	(Moderate Positive) Large amounts of land acquisition is required impacting agriculture and urban areas, and potentially transportation. Benefits are recreational opportunities such as hunting.	(High Negative) Social effects similar to existing condition with a similar risk of flooding.
Acceptability	(Low) Not an acceptable alternative and violates many local and national policies.	(Moderate) Alternative impacts a large number of landowners, and does not provide a lot of flood risk reduction.	(Low) Alternative is unacceptable to the resource agencies and potentially violates state and federal policies.
Implementability	(Low) Not Implementable.	(Low) The project is difficult implementing due to large amount of impacted land, and legal issues.	(Low) Not implementable as a stand-alone.
Cost	(High) Excessive – operations and maintenance costs would be large and long term. Environmental mitigation costs would be extreme. The communities would face large residual risks and if continued dredging was not maintained any benefits of the project would be lost.	(Extremely High) Cost is expected to be large, exceeding that of the storage alternative.	(Extremely High) No estimates were prepared. Cost of residual damage is assumed to be similar to the existing condition.
Risk*	(Low) There would be risk of project failure due to sedimentation. The community would still be at risk of flooding.	(Low) The impact of implementation of this alternative would not provide sufficient flood risk reduction leaving the areas at high risk of future flooding.	(High) There would possibly be large environmental impacts and community will continue to be at high flood risk.
Separable Mitigation	(Extremely High) Not possible to mitigate environmental impacts.	(Low) None is anticipated.	(Low) Besides replacement of trees, none is anticipated.
Cost Effectiveness	(Low) Not determined, but it is likely that the costs will outweigh the benefits.	(Low) Unlikely to be cost effective for flood damage reduction.	(Low to moderate) Cost effectiveness would be site specific.
Recommendation	Dredging and widening the river should no longer be considered.	Restoring wetlands and grasslands should no longer be considered as a stand-alone alternative, but may be considered for inclusion to mitigate for other adverse project effects where it can be incrementally justified.	Cut-off channels should not be considered as stand-alone alternatives but should be retained for possible inclusion in an overall plan where they could be incrementally justified.

* Risk is measured based on the risk reduction, therefore a plan with a rating of high would have a high level of risk reduction, meaning the community would be less susceptible to flooding.

APPENDIX O
ATTACHMENT 5

Value Engineering Study Report

ST. PAUL DISTRICT
VALUE ENGINEERING STUDY

U.S. Army Corps
of Engineers

VALUE ENGINEERING STUDY SUMMARY REPORT

FARGO-MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT

FARGO, NORTH DAKOTA & MOORHEAD, MINNESOTA

U.S. Army, Engineering District
St. Paul, Minnesota

VALUE ENGINEERING TEAM STUDY

DOD SERVICE: USACE
CONTROL NO: CEMVP-VE-10-01
VALUE ENGINEERING OFFICER: Robert Dempsey

Value Engineering Study on the

FARGO-MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT

December 2009
U.S. Army Engineer District, St. Paul

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VALUE ENGINEERING TEAM STUDY

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VALUE ENGINEERING TEAM STUDY
PROJECT DESCRIPTION AND BACKGROUND
PROJECT TITLE: Fargo-Moorhead Flood Risk Management Project
PROJECT LOCATION: Fargo, North Dakota & Moorhead, Minnesota.

The Fargo-Moorhead area, population 196,000, is located in Cass County ND & Clay County MN on the Red River. The community has a long history of dealing with flooding on the Red River and has been subjected to recent flood events in 2009, 2001 & 1997. The communities have flood control levees and a diversion channel project around sections of West Fargo on a reach of the Sheyenne River but the community has no comprehensive flood control system to protect it from a 100 year event. To that end the community and the U.S. Army Corps of Engineers have initiated planning studies aimed at identifying a project that would provide a permanent 100 year level of protection in the Fargo-Moorhead area. Project management for that effort requested a Value Engineering (VE) study be performed on the feasibility level report that identifies nine alternatives that would convey flood flows both through the city and around their perimeter utilizing 700-1000' wide channels measuring 20-30' in depth.

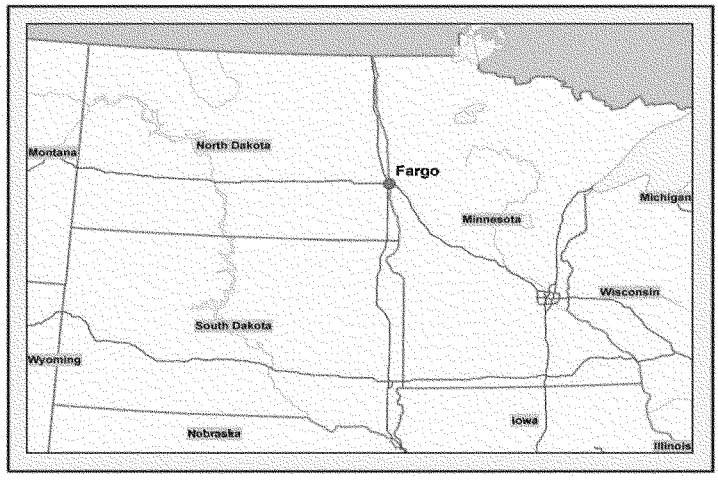


Figure 1 – Vicinity Map

Any of the proposed project alignments in the feasibility report are estimated to cost in excess of $900M which invokes the requirements of Engineering Regulation ER 11-1-321 (Value Engineering) requiring all projects and procurements greater than $1M in scope to have an appropriate VE study completed. This effort targeted only the alignments developed in the feasibility report and does not satisfy the project VE requirement by it self. As the project moves forward into design, additional studies on the selected design features would be required.

VALUE ENGINEERING TEAM STUDY

EXECUTIVE SUMMARY

Fargo- Moorhead Metro Flood Risk Management Study

Value Engineering is a process used to study the functions a project is to provide. As a result, it takes a critical look at how these functions are met and develops alternative ways to achieve the same function while increasing the value of the project. In the end, it is hoped that the project will realize a reduction in cost, but adding value over reducing cost is the focus of VE.

The VE study was initiated during the week of 30 Nov – 4 December 2009 at the Marriot Courtyard hotel in Moorhead, Minnesota. The team reviewed the Fargo-Moorhead (F-M) Metro feasibility report and cost estimates published in September of 2009 which details proposed project features of nine potential project alignments to divert a significant portion of floodwaters that currently threaten the community into diversion channels that could be constructed along the perimeter of either city. The team also completed a general tour of the vicinity to become familiar with the project site. VE team personnel then applied their engineering skills to develop the ideas presented in this report. VE ideas presented in this report will be reviewed by the Project Delivery team for comment prior to this report being finalized.

The VE study was accomplished as follows:

30 November - 8 a.m. – Project Manager briefing on the Feasibility Study.
10 a.m. – Travel to Moorhead, Minnesota
3 p.m. – Site Visits along West Fargo & City Levee projects.

1-3 December 8 -4:30 p.m. – VE Team Discussion and Report Preparation

4 December 8 a.m. - Return to District office and Continue VE report preparation

Both Local Sponsors and the City of Winnipeg (Diversion project) personnel were invited to participate in this VE study. One representative, Ms. April Walker from the City of Fargo, was able to attend. The team received additional informational briefings from the Project Manager and members of the feasibility report team during the study.

The project was studied using the Corps of Engineers standard VE methodology, consisting of five phases:

Information Phase: The Team studied drawings, figures, descriptions of project work, and cost estimates to fully understand the work to be performed and the functions to be achieved. Cost Models (see Appendix C) were compared to determine areas of relative high cost to ensure that the team focused on those parts of the project which offered the most potential for cost savings.

Speculation Phase: The Team speculated by conducting brainstorming sessions to generate ideas for alternative designs. All team members contributed ideas and critical analysis of the ideas was discouraged (see Appendix B).

Analysis Phase: Evaluation, testing and critical analysis of all ideas generated during speculation was performed to determine potential for savings and possibilities for risk. Ideas were ranked by priority for development. Ideas which did not survive critical analysis were deleted.

Development Phase: The priority ideas were developed into written proposals by VE team members during an intensive technical development session. Proposal descriptions, along with sketches, technical support documentation, and cost estimates were prepared to support implementation of ideas. Additional VE Team Comments were included for items of interest which were not developed as proposals, and these comments follow the study proposals.

Presentation Phase: Presentation is a two-step process. The published VE Study Report is distributed for review by project supporters and decision-makers. A briefing is later conducted to decide which proposals merit implementation into project design. The Summary of Proposals follows on the next page.

As this study was focused on nine separate alignments, the VE team did not focus on any individual alignment but decided to generically review all alignments presented in the feasibility report. Time constraints further reduced this review to the primary corridors of the alignments as the 25,000, 35,000 and 45,000 CFS capacity channels which generally follow the same geographic pathways from inlet to outlet on both the Minnesota and North Dakota sides (See figure #2). The team then examined these alignments in the speculation and analysis phase of the study for possible cost and functional improvements.

One hundred and two ideas for ways to improve project function or reduce costs were generated during the speculation phase of this study. The analysis phase of the study reduced the number of ideas to fifty-five for development. Twenty three ideas became candidates for further review which were evaluated. Like ideas were then combined to generate eleven cost proposals which, if accepted, can result in improved project function and lower cost to one or more of the feasibility report alignments. Twenty two of the ideas were reviewed and grouped into fourteen design comments.

BACKGROUND INFORMATION:

The following information was provided to the team for this VE study. It is presented here as background information. The recommendations developed in this report are founded in this information and the cost and engineering appendices to this report.

(*Excerpted from 2009 Moore Engineering Report*):

"PROJECT OBJECTIVES

The main objectives of this study were to develop a total of nine alternatives for potential diversions. The diversion alternatives studied included three capacities in each of two alignments through Minnesota and a total of three combined capacities in two alignments through North Dakota. The products of this study include preliminary hydraulic, civil, and structural design as well as cost estimates and property needs for each alternative. Additionally, water surface profiles on the Red River were provided for eight separate frequency events for each of the nine alternatives for use by the Corps of Engineers in determining the economic benefit.

3 SUMMARY OF PROJECT ALTERNATIVES AND FEATURES

The nine separate project alternatives analyzed include a total of four separate alignments, two in Minnesota and two in North Dakota. The alignments studied in Minnesota are roughly based on alignments used during Phase I of the FM Metro Study. These basic alignments were modified based on several considerations including total diversion length and existing ground elevation. The first diversion alignment in North Dakota was based roughly on an alignment that was originally created by Moore engineering as part of work done for the City of Fargo on the Southside Flood Control project. This alignment was also modified from its original location, based mainly on the total diversion length and ground elevations. The second North Dakota alignment, while similar to the first through much of its length, follows a portion of the existing Horace to West Fargo Sheyenne River Diversion alignment.

All of the alignments include control structures on the Red River at the south end of the project as well as a number of drop structures to allow adjacent drainage to enter the channel. The Red River control structure allows for the maximum benefit for a given diversion channel capacity by reducing water surface elevations immediately downstream of the structure. Additionally, the control structure allows 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. Because of the Wild Rice River's proximity to the Red at the south end of the project, three of the four alignments also include control structures on the Wild Rice River. The North Dakota alignments required additional hydraulic structures where the diversion alignments cross several rivers. Each diversion alternative also includes a tie-back levee at the southern limits of the project. No tie-back levees at the north end of the project are included in the scope of this project. A more detailed discussion of the alignments follows.

3.1 Minnesota Short Alignment

The Minnesota short alignment starts just north of the confluence of the Red and Wild Rice Rivers and extends north around the Cities of Moorhead and Dilworth and ultimately re-enters the Red River near the confluence of the Red and Sheyenne Rivers. The alignment is approximately 25 miles long. In addition to the main diversion channel, this alignment requires additional 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 miles long and has a 50 foot bottom width. 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. Three separate diversion capacities were analyzed for the Minnesota short alignment including 25,000 cfs, 35,000 cfs, and 45,000 cfs. The total flow analyzed is based on a 0.2% (500-year) Red River event. The channel configuration for each event was largely determined by the maximum recommended excavation depth of approximately 30 feet. The channel bottom widths for the 25,000 cfs, 35,000 cfs, and 45,000 cfs channels are 250 feet, 380 feet, and 500 feet respectively. Excavation quantities, being the largest portion of the construction for the diversion alternatives, are approximately 48 million, 62 million, and 74 million cubic yards for the 25,000 cfs, 35,000 cfs, and 45,000 cfs channels respectively. The Minnesota short alignment also includes 20 highway bridges and four railroad bridges. The flow split between the diversion channel and the Red River is controlled by a combination of a control structure on the Red River at the south end of the project and a weir at the entrance to the diversion channel.

3.2 Minnesota Long Alignment

The Minnesota long alignment starts approximately three miles south of the confluence of the Red and Wild Rice Rivers and extends north around the Cities of Moorhead and Dilworth and ultimately re-enters the Red River near the confluence of the Red and Sheyenne Rivers. The alignment is approximately 29 miles long. Because this alignment begins south of the confluence of the Red and Wild Rice Rivers, an extension of the diversion channel is included between the Red and Wild Rice Rivers. The tie-back levee associated with this alternative extends west from the Wild Rice control structure to relatively high ground.

The same three capacities that were analyzed for the Minnesota short alignment were analyzed for the Minnesota long alignment. Similar to the short alignment, the channel configuration for each event was largely determined by the maximum recommended excavation. The channel bottom widths for the 25,000 cfs, 35,000 cfs, and 45,000 cfs channels are 265 feet, 400 feet, and 530 feet respectively. The portion of the diversion connecting the Red and Wild Rice Rivers is 100 feet wide. Excavation quantities for the 25,000 cfs, 35,000 cfs, and 45,000 cfs channels are approximately 53 million, 70 million, and 87 million cubic yards respectively. The Minnesota long alignment includes 21 highway bridges and four railroad bridges. The flow split between the diversion channel and the Red River is controlled by a combination of control structures on the Red and Wild Rice Rivers at the south end of the project and a weir at the entrance to the diversion channel.

3.3 North Dakota West Alignment

The North Dakota west 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 35 miles long. Because this alignment begins south of the confluence of the Red and Wild Rice Rivers, like the Minnesota long alignment, an extension of the diversion channel is included between the Red and Wild Rice Rivers. The tie-back levee associated with this alternative extends east from the Red River control structure to high ground. The North Dakota west alignment was analyzed for 35,000 cfs and 45,000 cfs. Like the Minnesota alignments, the capacities analyzed are based on a 0.2% (500-year) Red River event. The channel configuration for each event 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 alignments. The channel bottom width for both capacities is 100 feet and the excavation quantities are approximately 58 million and 73 million cubic yards for the 35,000 cfs and 45,000 cfs capacities, respectively. The North Dakota west alignment includes 18 highway bridges and four railroad bridges.

A combination of control structures on the Red and Wild Rice Rivers at the south end of the project, along with a weir at the entrance to the diversion channel, control the flow split between the Red and Wild Rice River channels and the diversion channel. Additionally, this alignment crosses several rivers, including the Sheyenne, Maple, Lower Rush, and Upper Rush. Hydraulic structures are necessary at the point where the diversion channel crosses these rivers. The purpose of these hydraulic structures is to allow some base flow to continue down the various rivers while diverting excess water during flood events to the diversion channel. The result of this is added flood protection along all of the affected rivers.

3.4 North Dakota East Alignment

The North Dakota east alignment generally follows the North Dakota west alignment except that, after crossing the Sheyenne River, it utilizes the existing Horace to West Fargo Sheyenne River Diversion corridor between Horace and I-94. The alignment is approximately 36 miles long.

The North Dakota east alignment was analyzed only for 35,000 cfs. The channel configuration for this alternative is similar the 35,000 cfs North Dakota west alignment, with a maximum depth of approximately 32 feet and an approximate excavation quantity of 62 million cubic yards. The North Dakota west alignment, like the North Dakota east alignment, includes 18 highway bridges and four railroad bridges. The North Dakota east diversion alignment includes all of the same hydraulic structures as are necessary in the North Dakota west alignment.

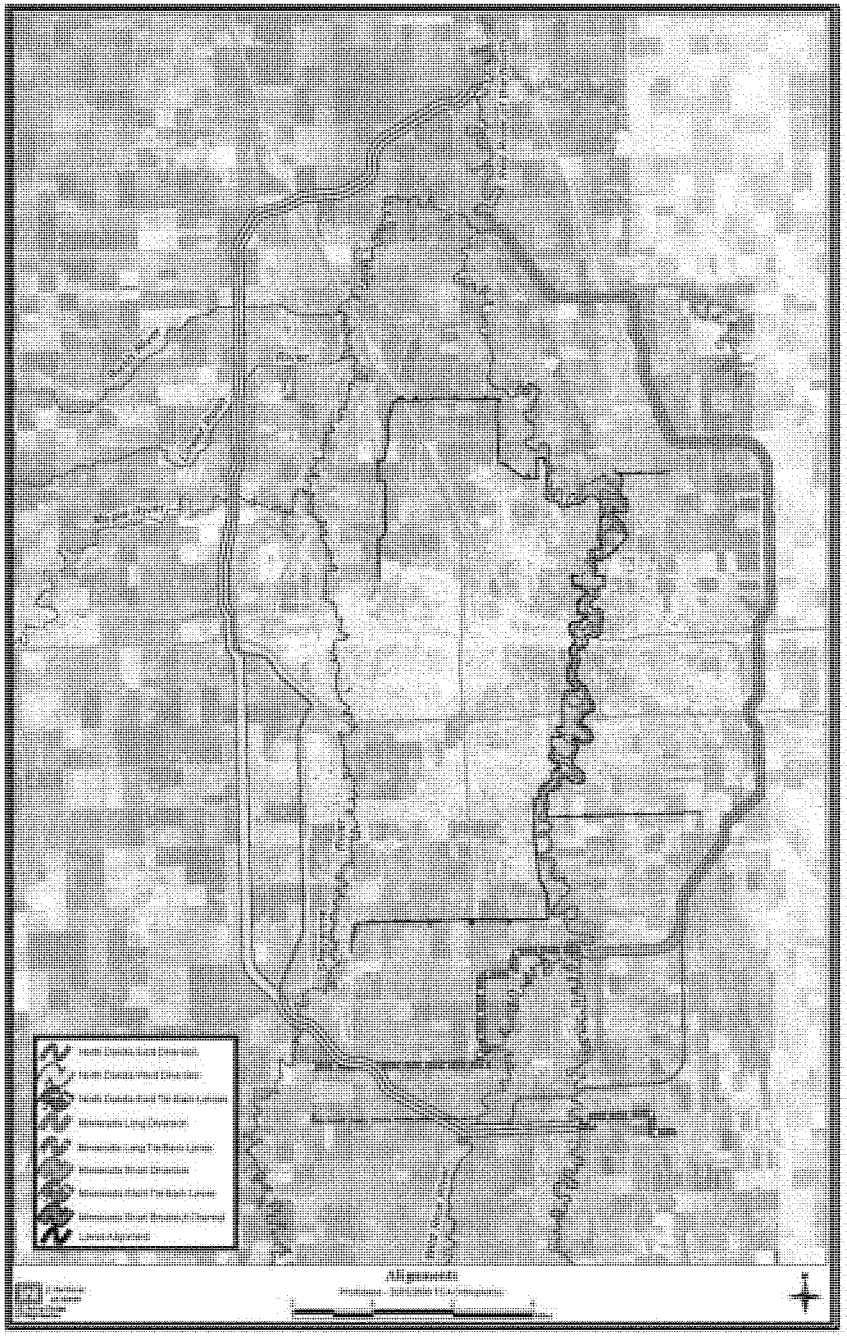


Figure 2 – Minnesota and North Dakota Diversion Channel alignments
As presented in the Fargo-Moorhead Metro feasibility report.

F-M Alternative Cost Summary:

The following table summarizes the nine feasibility alignment construction costs as they were presented to the VE team for review:

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	Downstream Impacts **
MN Short Diversion 25K	962	11.0	14.3	1.22	2.1
MN Short Diversion 35K	1,092	9.4	9.3	1.17	2.5
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	3.0
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
** Inches during 1% Chance flood (100-year)
Note: Expected average annual damages without a project are $73.7 million.

Table 1- F-M Feasibility study summary table.

In order to understand what features are includes in the construction cost of each option the VE team broke down the MN Short Diversion 25,000 CFS to better understand how where the project resources were being spent:

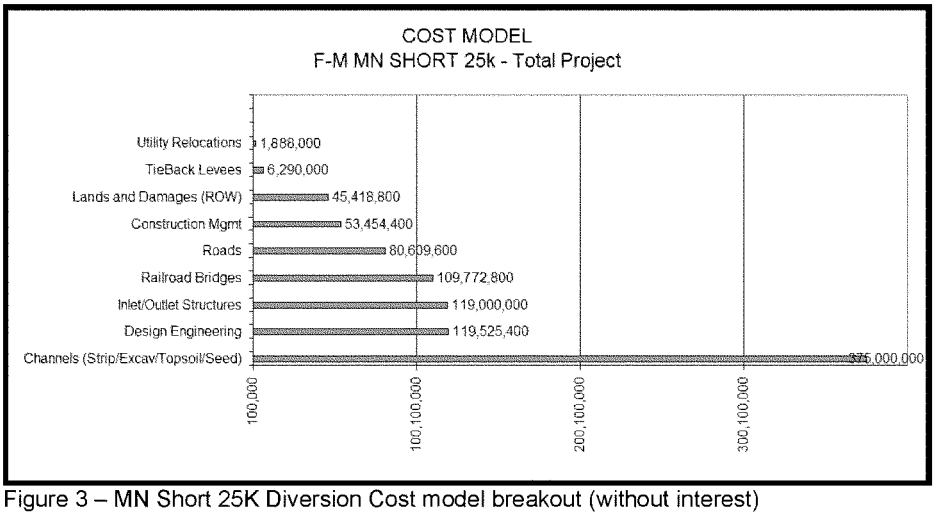


Figure 3 – MN Short 25K Diversion Cost model breakout (without interest)

The cost model breakout pinpoints the highest potential items to study. The items with higher cost have the greatest potential for project savings in a review. In the MN short 25,000 CFS alignment, the channels and railroad construction items have the greatest potential for cost savings. The design engineering cost will decrease with any savings identified in the construction cost and cannot in itself be studied.

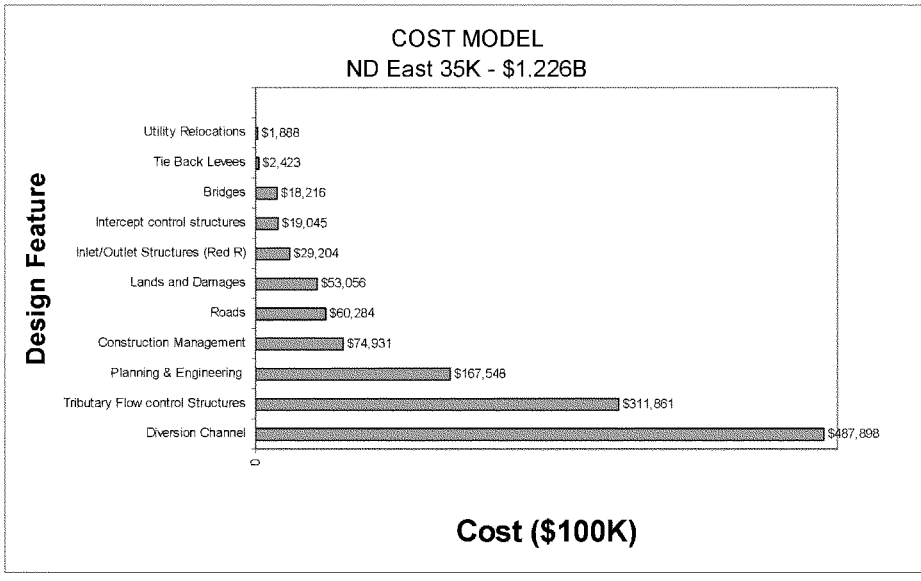


Figure 4 – ND East Cost model.

The ND East alignment had a similar cost model distribution. The significant differences between the MN and ND option are the addition of the Tributary Control Structures (Maple/Rush/Sheyenne R) and additional diversion construction on the ND side.

From this point the VE team reviewed both the MN and ND alignments in an attempt to identify design decisions that significantly influenced feasibility alignments and their associated project costs. The team identified 11 high potential ideas which were assigned a VE Proposal number 1-11 and are presented in detail in this report. This VE study is unique as each proposal may only apply to the MN or ND side and the ideas presented may only improve cost or function to a single alignment or to all alignments depending on the proposal. Once a single alignment is selected for design, several of these VE proposals may be eliminated from further consideration.

VALUE ENGINEERING TEAM STUDY

SUMMARY OF PROPOSALS

PROPOSAL No.	DESCRIPTION	SAVINGS
P1	Realign ND diversion East of the Sheyenne River Protect Harwood, ND by ring levee (applies to ND west/east)	$245.4M
P2	Realign MN diversion by shortening channel & Re-orienting outlet works (Applies to MN alignments)	$25.8M
P3	Begin ND Diversion channel further North	$142M
P4	Redesign Wild Rice Diversion for MN alignments	-$2.05M
P5	Replace bridged crossings with at grade crossings	$3.7M/Bridge
P6	Realign N end of ND diversion/outlet further South	$17.4M
P7	Construct U-Channel through areas of multiple bridges	$1M
P8	Redesign intercept inlet works	$3M(MN) - $4M(ND)
P9	Raise in-city protection to 100 year level	-$10.56M
P10	Railroad yard relocation (MN Alignment)	$81M

*** TOTAL POTENTIAL CUMULATIVE SAVINGS (MN –Aligns)** *$122M MN*

**** TOTAL POTENTIAL CUMULATIVE SAVINGS (ND –Aligns)** *$407M ND*

Additional costs recommended – complete Fargo city levees - $10M

Proposal	Minnesota Alignment	North Dakota Alignment	
1- Re-align ND end		$245M	
2- Re-Align MN end	$25.8M		
3- Re-Align ND start		$142M	
4. Re-designWild Rice Diversion	-$2.05M		
5. Replace bridges with at grade x-ing	$3.7M/bridge – 4 est. $12M	$3.7M/Bridge -5 est. $18M	
6. Realign ND outlet S		$17.4M	
7. U channel @multiple bridges	$1M	$1M	
8. Road Bypass			
9 Redesign intercept	$3M	$4M	
10 Complete city levees	-$10M	-$10M	
11 RR yard purchase	$81M		
Potential Cost Savings	$123M savings $12.05M Costs	$410M savings $10.0M Costs	

A detailed Proposal breakdown follows:

PROPOSAL NO: 1 – REJECTED PAGE NO: 1 OF 3
DESCRIPTION: Reroute ND Diversion East of Sheyenne River

ORIGINAL DESIGN: The North Dakota East alignment generally follows the North Dakota West alignment except that, after crossing the Sheyenne River, it utilizes the existing Horace to West Fargo - Sheyenne River Diversion corridor between Horace and I-94. The alignment is approximately 36 miles long. The channel configuration has a maximum depth of approximately 32 feet and an approximate excavation quantity of 62 million cubic yards. The North Dakota east alignment includes 18 highway bridges and four railroad bridges. The North Dakota east diversion alignment includes many of the hydraulic structures as are necessary in the North Dakota west alignment.

PROPOSED DESIGN: The proposed design is to revise the channel alignment in the northern part of the ND channel reach. North of the West Fargo diversion, the proposed channel would be realigned east of the Sheyenne River and discharge into the Red River of the North south of confluence of the Sheyenne River (See Drawing No. 1 on next page).

ADVANTAGES:
1. The length of channel is shortened thus reducing real estate & construction project costs.
2. Eliminates the need for flow control structures at the Maple River, Lower Rush and Rush River tributaries thus reducing costs.
3. Reduce construction duration
4. Fewer local drains to construct.

DISADVANTAGES:
1. No added flood protection along affected tributaries.
2. Ring levee may needed to support benefits for city of Harwood
3. Additional bridges are required

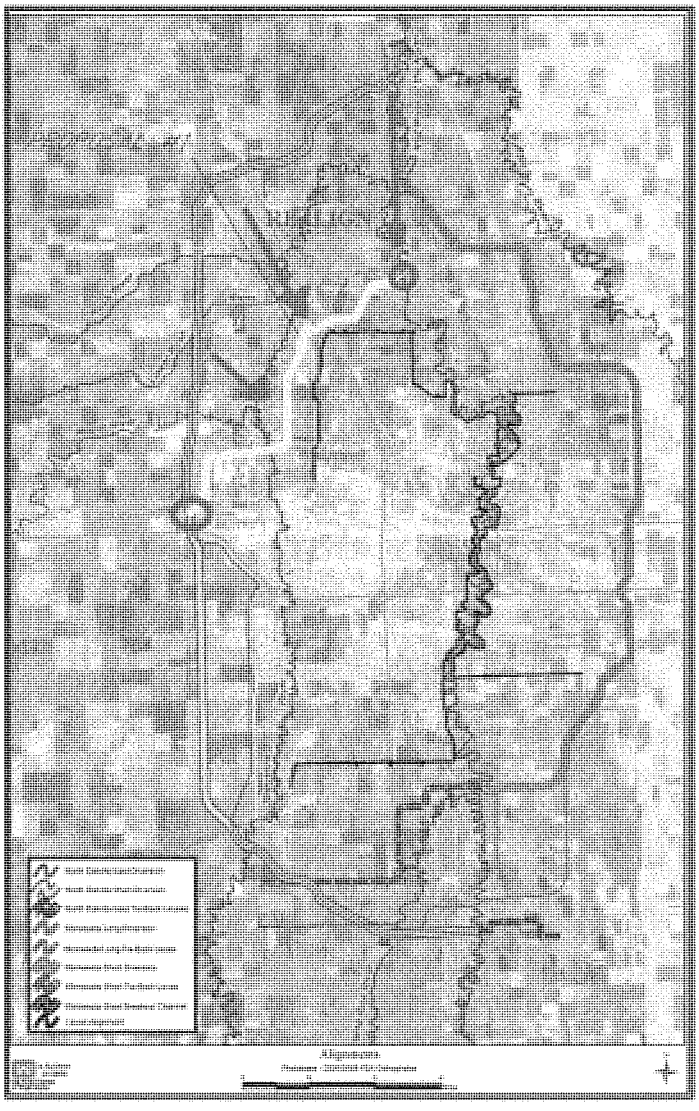
JUSTIFICATION: This proposal maintains flood protection for the F-M Metro area while significantly reducing project costs. Flood protection for F-M Metro area is not affected thus preserving major benefits of protecting developed areas while not protecting as much undeveloped areas.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 1 PAGE NO: 2 OF 3

Drawing No. 1

REVISED ALIGNMENT EAST OF SHEYENNE RIVER



	COST ESTIMATE WORKSHEET				
	Proposal #1 - Realign ND East				
			DELETIONS		
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
					$0
	Channel North of Fargo Diversion	FT	89265	$3,000.00	$267,795,000
	Flow Control Structure - Maple River	LS	1	$77,908,600.00	$77,908,600
	Flow Control Structure - Lower Rush River	LS	1	$48,644,500.00	$48,644,500
	Flow Control Structure - Rush River	LS	1	$49,937,100.00	$49,937,100
	Bridge: 25th Street SE	LS	1	$3,200,000	$3,200,000
	2 - 2x 72" local drains	EA	2	$874,552.00	$1,749,104
	2 1 x 72" local drains	EA	2	$451,928.00	$903,856
					$0
					$0
					$0
			Total Deletions		$450,138,160
			ADDITIONS		
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
					$0
	Channel East of Sheyenne River	FT	60674.4	$3,000.00	$182,023,200
	Flow Control Structure @ Sheyenne River	LS	1	$54,000,000	$54,000,000
	Bridge: CR17	LS	1	$3,200,000	$3,200,000
	Bridge: CR20	LS	1	$3,200,000	$3,200,000
	Bridge: 12th Ave NW	LS	1	$3,200,000	$3,200,000
	(Note: some bridges could be at-grade				$0
	crossings- see VE Proposal 5)				$0
					$0
					$0
					$0
					$0
			Total Additions		$245,623,200
			Net Cost Decrease		$204,514,960
	Engineering and Construction Mgmt		Mark-ups	20.00%	$40,902,992
			Total Cost Decrease		$245,417,952
	All Mark-ups included in Unit Prices. Contingency or S&I applied.				

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 2 - REJECTED PAGE NO: 1 OF 4

DESCRIPTION: Realign Minnesota Channel alignment north of Dilworth, MN.

ORIGINAL DESIGN: The Minnesota alignment follows a 136,256 foot path from the south side of Fargo through Dilworth, MN before rejoining with the Red River to the north of Fargo, ND. The major interception points on the Red River on the upstream and downstream ends appear to be locked in by hydraulic requirements. Sections of the channel between these two points are detailed in the feasibility plan as shown below in Figure #1. While the south end of the alignment appears to be locked in by a series of gateway openings (freeway & railroad) available to fit the channel through – the northern section appears to be routed on an alignment to contain the Town of Kragnes within the project limits.

PROPOSED DESIGN: In the northern reaches of the MN side feasibility design(s) the channel stays eastward of Moorhead before turning westward after passing the Town of Kragnes. By re-aligning the channel further west than the alignment presented in the feasibility study (as shown below in figure #1), the design channel could be shortened by 6,000-8,000 linear feet. This could also reduce the number of bridges and local drainage inlets in this reach by 1. Thought to placing the MN alignment into the coulee located east of the current Red River channel might also be considered. Realignment as show below could reduce the diversion channel's length by an estimated 7,000'. In addition the feasibility plan outlet works for this alignment is plotted to be in a location that would block current Red River flows (See Figure #2) and could be relocated. Shortening channel leading to the outlet work would also shorten the project length by 500-1000' (Also see VE proposal # 5 for constructing at- grade crossings to further reduce bridges in the alignment).

Should additional protection for Kragnes be required it might be possible to construct tie-back levees with excess channel cut soils. Flooding threat to this area was attributed as being backwater effects Buffalo River and not Red River flooding (project manager).

For purposes of obtaining a VE cost savings for this proposal a gross cost per foot of constructed channel was extracted from the Cost estimates provided. Channel excavation costs (Stripping, Excavation, topsoil and seeding) and lands account for approximately 55% of the project cost (J. Hansen 1 Sep MN Short 25K Cost summary sheet). For the purpose of this study a unit cost per foot of channel was therefore calculated to be 55% of project cost and a smaller share or Design & Construction management costs (40% for less detailed design) / Length of constructed channel (136,256') to yield a estimated channel construction cost ($381.4M). The 14581' southern channel was also considered into the unit cost of excavation.

Cost to Construct 1' of 250' wide channel = $2700 L.Ft.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 2 PAGE NO: 2 OF 4

Realign MN Short 25K channel further west

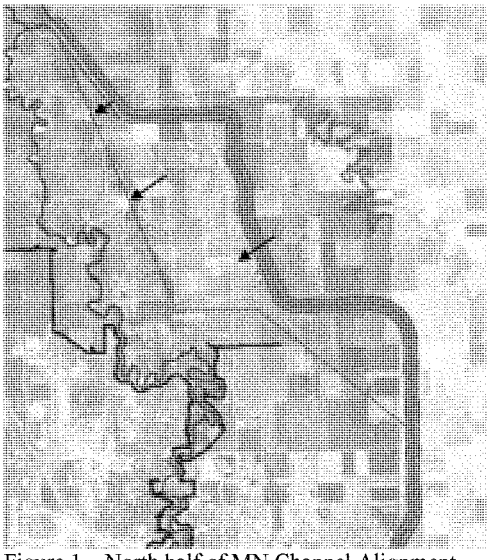
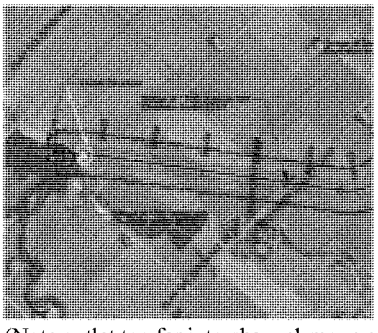
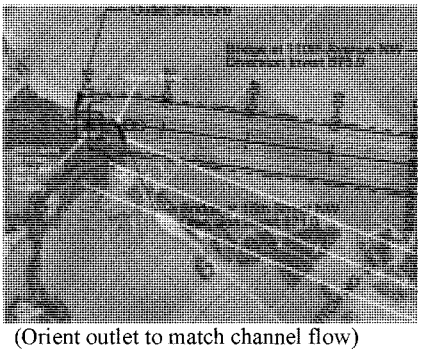


Figure 1 – North half of MN Channel Alignment – Change: Move channel westward.

Outlet Design: The outlet design as presented in the feasibility also appears to be set near the center of the existing Red River channel in the feasibility report (see below). Revision of the outlet design is required. Unidentified costs may be required to properly construct a hydraulic outlet in this area.



(Note outlet too far into channel-move east)



(Orient outlet to match channel flow)

Figure #2 & #3 – Moving channel westward or relocating outlet further east are two Cost savings ideas contained in this proposal.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 2 PAGE NO: 3 OF 4

Realign MN Short 25K channel further west

ADVANTAGES: Cost savings with no loss of project function. The proposed alignment is 7000' (1.3 miles shorter) (5%) than the feasibility plan and could be constructed faster & cost less. Fewer bridges and inlets in the area would be required as a result of this alignment change. The lands in this area were represented to the study team as lying above the floodplain and are not protected by these future works – so there would be no loss in protected area. Revising the channel outlet location by 1000' would also correct what appears to be an error in the feasibility location and relocation would result in less blockage of flow in the Red River if constructed further upstream as shown in figure #3.

DISADVANTAGES: The town of Kragnes loses any protection it may have received from the channel construction. Re-alignment does present the possible loss of existing environmental habitat if existing river channel is folded into the diversion alignment. Mitigation land acquisition may be required for loss of habitat. Channel orientation (diagonal to area north-south roads) requires bridges to be lengthened.

JUSTIFICATION: Cost savings estimated at $25.8M or 3% of the project cost.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 2 Realign MN channel further west PAGE NO: 4 OF 4

COST ESTIMATE WORKSHEET

Proposal #2 - Revise MN Short 25K Northern alignment

DELETIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
					$0
1	Delete 1 hwy bridge (hwy 100?)	ea	1	$3,700,000.00	$3,700,000
2	Construct 7000' less channel	foot	7,000	$2,700.00	$18,900,000
3	Relocate channel outlet 800' U/S	foot	800	$2,700.00	$2,160,000
4	1 less local drainage inlet	ea	1	$1,100,000.00	$1,100,000
					$0
			Total Deletions		$25,860,000

ADDITIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	None				$0
	Mitigating land?				$0
					$0
			Total Additions		$0
			Net Cost Decrease		$25,860,000
			Mark-ups	0.00%	$0
			Total Cost Decrease		$25,860,000

All Mark-ups included in Unit Prices. Contingency or S&I applied.

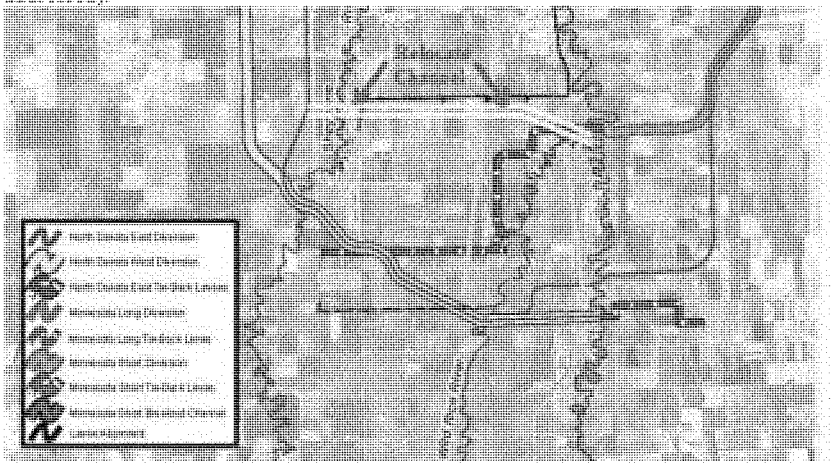
VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 3 - REJECTED PAGE NO: 1 OF 2

DESCRIPTION: Shorten ND East Diversion

ORIGINAL DESIGN: The North Dakota East Diversion starts at the Red River upstream of the confluence with the Wild Rice River. It intersects the Wild Rice, Sheyenne, Maple, Lower Rush, and Rush Rivers over a total length of 191,948 feet.

PROPOSED DESIGN: Start the diversion just downstream of the confluence of the Red and Wild Rice Rivers. Proceed west to the existing Horace Diversion and join the original design path. This cuts 22,490 feet from the length of the channel, or 11.72% of the length. (Tie back levee issues not addressed).



ADVANTAGES: This eliminates the intersection structures with the Wild Rice River. Because it intersects the Sheyenne River downstream of the Horace Diversion inlet and captures the water from the West Fargo Diversion, it is possible that neither Sheyenne River crossing will require an inlet to the diversion. It shortens the diversion by about 4 miles. It eliminates the railroad bridge near Horace and the 48th Street and 46th Street (and possibly the 44th Street) road bridges. (It does require a second intersection structure with the Sheyenne River.) Because the channel is shorter, there would be less maintenance on the finished channel.

DISADVANTAGES: It significantly reduces the protected area. Because the Sheyenne River is "perched," it might not be possible to start the diversion below the confluence of the Red and the Wild Rice Rivers and flow downhill to the Sheyenne before reaching more heavily developed neighborhoods. Depending on how far the Maple River could back into the Sheyenne, an inlet might be needed at the downstream crossing or below it (after the confluence of the Sheyenne and Maple Rivers).

JUSTIFICATION: Reduced cost- $140,000,000.

**Note that both the original estimate and this proposal do not include a necessary bridge where U.S. Highway 81 Bus. Crosses proposed channel at the south end of the diversion just west of the Red River. (This will be added to the Comment list as an omission)

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 3 PAGE NO: 2 OF 2

COST ESTIMATE WORKSHEET

Speculation Item # 3 - Realign ND East channel further north

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
				$0
Delete Channel construction	ft	11,000	$2,700.00	$29,700,000
Delete local inlets	ea	4	$1,100,000.00	$4,400,000
Delete Wild Rice diversion structure		1	$79,978,800.00	$79,978,800
Delete Sheyenne Diversion structure		1	$53,784,500.00	$53,784,500
44th street bridge	ea	1	$2,966,900.00	
46th street bridge	ea	1	$2,975,800.00	$2,975,800
48th street bridge	ea	1	$2,975,900.00	$2,975,900
Railroad bridge	ea	1	$3,571,000.00	$3,571,000
Less land acquisition (assume -10%)	acres	640	$6,500.00	$4,160,000
				$0
				$0
		Total Deletions		$181,546,000

ADDITIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
				$0
Sheyenne Diversion Structure	ea	1	$55,000,000.00	$55,000,000
Real estate (Horace) relocate houses?	acres	10	$300,000.00	$3,000,000
				$0
		Total Additions		$58,000,000
		Net Cost Decrease		$123,546,000
Reduces E&D / CM**		Mark-ups	15.00%	$18,531,900
		Total Cost Decrease		$142,077,900

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: P4 - ACCEPTED PAGE NO: 1 OF 5

DESCRIPTION: Modify Wild Rice Diversion Channel - MN Short Alignment

ORIGINAL DESIGN: The Minnesota Short alignment contains provisions for tie back levees and a 4000' diversion channel section on the North Dakota side of the Red River along the west bank of the Wild Rice. The tie back levee extends several miles to the west before ending near the Sheyenne River. Breakout flows from the Wild Rice and Sheyenne Rivers are forecast to move eastward and cross I-29 through a new 50' wide channel and freeway bridges proposed for this area (Moore-Appendix E- plate 6- see Figure 1).

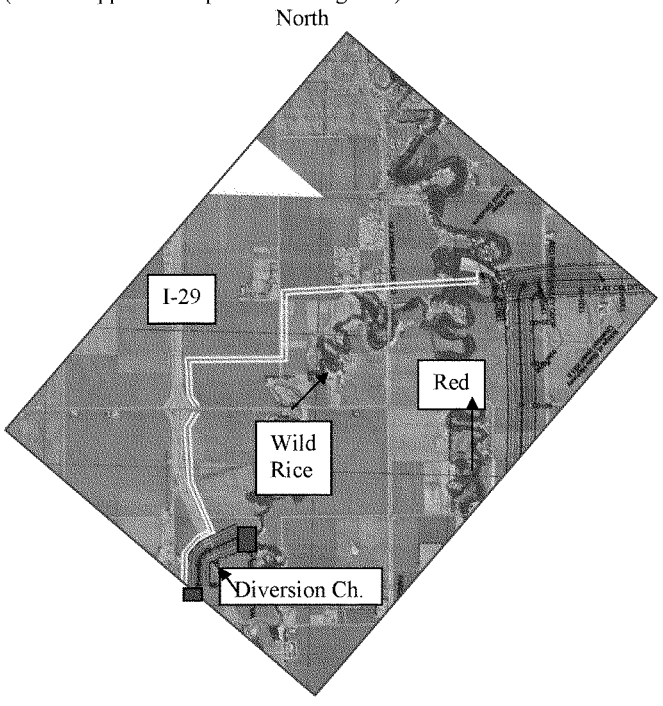


Figure 1- Tie Back Levees connecting to Diversion Channel under I-29 at the Wild Rice River South of Fargo, ND.

ADDITIONAL SITE INFORMATION: There are two existing I-29 bridges; located 5500' south of the proposed new breakout diversion channel that span the Wild Rice River. The existing bridge decks are at Elev. 917 while the new bridge decks are estimated to be at Elev. 922.2. The bridge deck on the existing bridge over the Wild Rice is at elev. 917 and low steel is at elevation 913. The existing span is 220' long and the proposed span for the new I-29 diversion channel overpass is 300' long. At elevation 917, the freeway typically does not flood during an event.

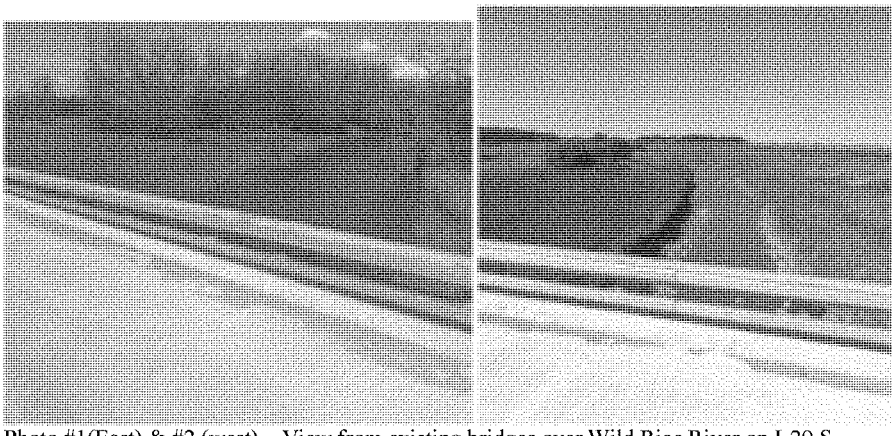
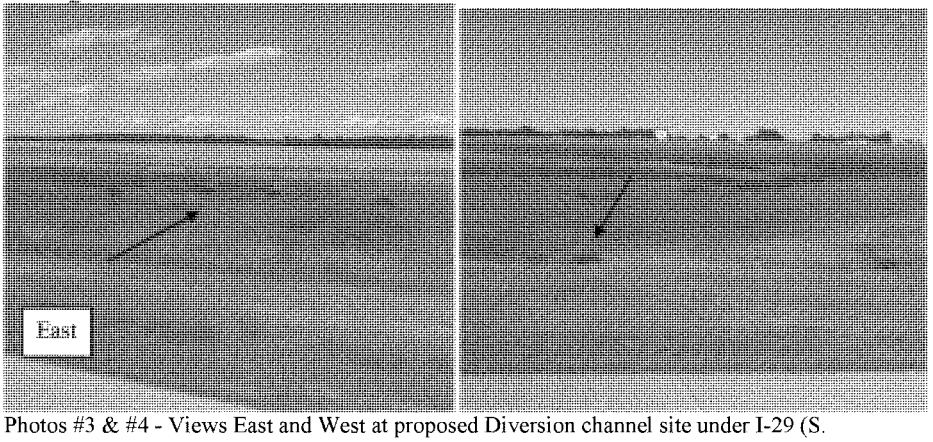


Photo #1(East) & #2 (west) – View from existing bridges over Wild Rice River on I-29 S. of Fargo. Bridge Deck Elev. 917 – Low Chord – Elev. 913

Existing Culverts under I-29



Photos #3 & #4 - Views East and West at proposed Diversion channel site under I-29 (S. Fargo, ND) - Note existing culverts near elevation 914'. Road Elevation is 917'.

PROPOSED DESIGN: The feasibility design as presented is a combination of levees and a freeway underpass channel that is designed to convey breakout flows from the Sheyenne and Wild Rice Rivers back to the Wild Rice River. Examination of this portion of the project site shows the existing I-29 bridge over the Wild Rice River would be smaller than the new bridge built to span the proposed diversion. The new levee also cuts off Rose Coulee and other potential drains from channeling breakout flows through town as is currently done.

The proposed design would be to reconstruct the I-29 bridges spanning the Wild Rice River to both widen and raise the low bridge steel out of the flood and increase capacity through the bridge opening. This "improvement" to the channel is projected to curtail some of the breakout flow but if additional measures were still needed, Levees and channel sections could be constructed to divert breakout flows southward, back to the main river channel.

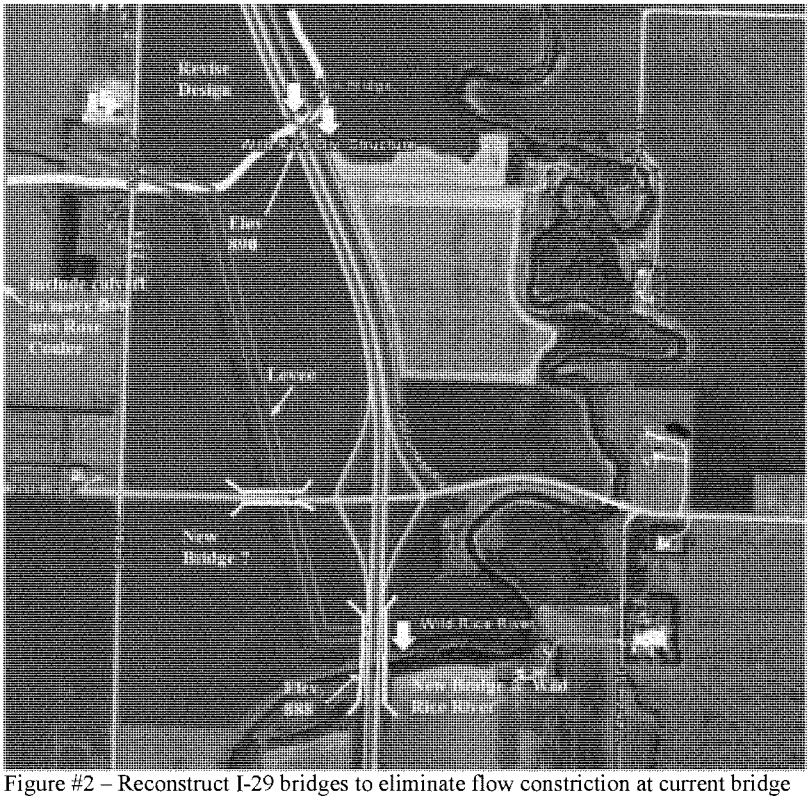


Figure #2 – Reconstruct I-29 bridges to eliminate flow constriction at current bridge And channel all flows through this point. Material excavated to build channels to convey flows back to the Wild Rice River would be side-cast to create protective levee for I-29.

ADVANTAGES: Potentially eliminates a set of "new" bridges and replaces a set of bridges that negatively impact the hydraulic design in the area. Less Bridge maintenance (3 vs. 4 bridges) and proposed plan retires an older set of bridges & reduces excavation and improves ice flow under existing I-29 bridges. Deletes requirement for new drop structure at new channel.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: P4 PAGE NO: 4 OF 5

DESCRIPTION: Modify Wild Rice Diversion Channel - MN Short Alignment

DISADVANTAGES: A third bridge may be required at 124th Street. Evaluation of the 124th Street Bridge over the Wild Rice east of I-29 might also be required.

JUSTIFICATION: Improves hydraulic design over current situation by removing bridge constriction, reduced future bridge maintenance & improved ice passage.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: P4 PAGE NO: 5 OF 5

DESCRIPTION: Modify Wild Rice Diversion Channel - MN Short Alignment

COST ESTIMATE WORKSHEET

Proposal P-4 - Modify Wild Rice Diverson plan

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Delete new I-29 Bridge SB	ea	1	$3,093,100.00	$3,093,100
Delete new I-29 Bridge NB	ea	1	$3,093,100.00	$3,093,100
Eliminate 4000' diversion channel	ft	4,000	$1,080.00	$4,320,000
Eliminate Drop Structure **	ea	1	$250,000.00	$250,000
Modify Levee Plan- reduce by 30%	ea	0.33	$6,290,100.00	$2,075,733
				$0
		Total Deletions		$12,831,933

** Cost not in feasibility estimate

ADDITIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Demo I-29 Bridges NB & SB @ WR river	ea	1	$400,000.00	$400,000
Rebuild I-29 Bridges NB and SB	ea	2	$3,500,000.00	$7,000,000
				$0
New `124th St Bridge * optional ?	ea	1	$2,552,000.00	$2,552,000
New diversion channel	ft	5,500	$800.00	$4,400,000
				$0
				$0
				$0
		Total Additions		$14,352,000
		Net Cost Decrease		-$1,520,067
		Mark-ups	35.00%	-$532,023
		Total Cost Decrease		-$2,052,090

All Mark-ups included in Unit Prices. Contingency or S&I applied.

Proposal results in a net cost - not factored in are savings in bridge maintenance and reduced future bridge replacement cost. Improved project function (larger hydraulic opening) not factored in.

**Note: The cost estimate and design plates for this section of the project (Fig 1) provided to the VE team may be missing the cost of a drop structure at the head of the diversion channel a $250,000 cost was assumed to be necessary and was added to the cost equation for this option.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 5 - ACCEPTED PAGE NO: 1 OF 3

DESCRIPTION: Cross channel using at grade crossing (low Flow) vs. bridges

ORIGINAL DESIGN: The feasibility design(s) call for bridges to traverse the diversion channels to maintain area access. In the Mn Short 25,000K option there are 20 proposed highway bridges and 4 railroad bridges that cross the 136,256' long diversion adding $55.56M to the project estimate. The bridges in this feasibility report typically exceed 500' in span. A typical bridge adds $2M in construction cost and an estimates $500K in design and construction management cost. Currently there are 39 roads that cross the proposed Mn Short 25K channel alignment.

Bridge list:	Interstate 29 (SB & NB)	50th Ave S	15th Street NW
	110th Avenue S.	Interstate 94 (EB & WB)	110th Ave N
	State Highway 75 south	US Hwy 10 (EB & WB)	90th Ave N
	80th Ave S	28th Ave N	
	60th Ave S	57th Avenue N.	
	CSAH 52	CR14	
	State Highway 75 north	100th Ave N	

PROPOSED DESIGN: Revise the bridge plan to convert some crossings to an at grade culvert crossing in the base of the channel. Typically this roadway would be closed during flood events limiting the number of bridges that could be converted to this option. Only secondary road bridges would be considered for this option and bridge designs would remain on primary roadways. From the VE team review of the proposed alignments, there are several locations where the channel design was placed at right angles to area roads to minimize the bridge lengths (and therefore bridge cost – but increasing channel cost). Designing at grade crossings into the design would also allow the channel alignment to be straightened; decreasing channel length and further reducing project cost.

ADVANTAGES: Cost savings, potential to construct additional crossings in the project area at reduced cost which would improve safety and reduce fuel consumption in the area. There would be less bridge maintenance and no future replacement costs for structures. Some bridge designs in the feasibility report require lengthy grade increases to have the bottom girders clear estimated flood heights. The use of at-grade crossings would also eliminate the need to re-grade sections of road approaching bridges resulting in an additional project savings of $0 to $50,000 per bridge. Bridges in this area can be icy during winter driving season requiring additional salt/sand operations. No ice jams that could occur at bridge deck locations. Area intercept control structures could be redesigned as ditch drainage along the roadway – current construction cost for a single 72" inlet is $600K.

DISADVANTAGES: Flash flooding could occur in the channel, fog and icy conditions could also develop in the crossings. Construction of roads into the channel cut introduces the potential for undesired off road activities in the project area. Roads would need to be closed during floods which require blocking structures and signage to direct traffic to nearest bridge crossings. Roads are blocked once flooding begins and only bridged crossings could be used. Bridges might also be used for utility crossings. Side slopes of the channel are too steep for road grades 14%, therefore additional excavation to reduce this slope to 8% is recommended. Post flood roadway cleanups & possible repair would be necessary.

VALUE ENGINEERING PROPOSAL

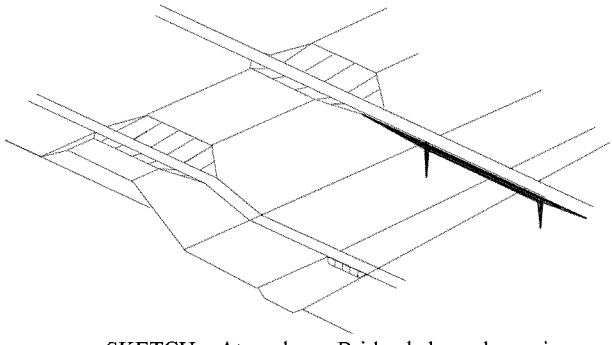
PROPOSAL NO: 5 PAGE NO: 2 OF 3

DESCRIPTION: Cross channel using at grade crossing (Low Flow)vs. bridges

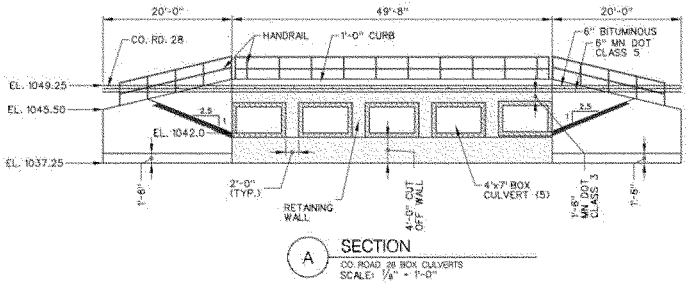
JUSTIFICATION: Cost and increased public access in the project area. Each alignment needs to be reviewed to determine which bridges might be replaced by at grade crossings. An estimated $2.2M can be saved at each converted crossing. To benefit public access in the area more at grade crossings might be used.

DRAWINGS & SKETCHES

EXAMPLE OF A LOW FLOW CHANNEL/ROAD CROSSING



SKETCH – At grade vs. Bridged channel crossing



Possible low flow crossing at channel grade
(Add knock down railings)

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 5 At-Grade Channel Crossings vs. Bridges PAGE NO: 3 OF3

COST ESTIMATE WORKSHEET

Proposal #5 - at--grade channel crossing

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Use Typical Secondary bridge				$0
15th Street NW MN Short	ea	1	$2,185,000.00	$2,185,000
Delete local drainage inlet - 2 of 7	ea	2.0	$600,000.00	$1,200,000
				$0
				$0
		Total Deletions		$3,385,000

ADDITIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
				$0
Double Box Culverts (2- 4x9')	lf	84	$1,100.00	$92,400
Install double box	lf	84	$550.00	$46,200
Guardrails	lf	200	$200.00	$40,000
Slope end sections	ea	4	$8,000.00	$32,000
precast drop wall	ea	4	$1,950.00	$7,800
Transport box culvert	ea	14	$450.00	$6,300
Transport end section	ea	4	$450.00	$1,800
Excavate roadway	cy	2,000	$5.00	$10,000
surfaced roadway 34.5' W	lf	1,500	$210.00	$315,000
gates/signage	ea	1	$20,000.00	$20,000
Local drainage interception structures	ea	2	$100,000.00	$200,000
		Total Additions		$771,500
		Net Cost Decrease		$2,613,500
Contingency 25% E&D 15%		Mark-ups	40.00%	$1,045,400
		Total Cost Decrease		$3,658,900

Note- Low flow crossings have not been designed- estimate only.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 6 - ACCEPTED PAGE NO: 1 OF 3

DESCRIPTION: Re-align north end of North Dakota East diversion channel along the south side of 25th Street SE (County Road 4)

ORIGINAL DESIGN: The original design has the north end of the North Dakota East diversion channel extending northeast from the 25th Street SE/171st Avenue SE intersection and discharging to the Red River between 23rd and 24th Streets SE. This is related to VE proposal #1 – but the re-alignment is north of the Sheyenne river.

PROPOSED DESIGN: Re-align the north end of the North Dakota diversion channel to remain south of 25th Street SE, extending the channel directly east of the 25th Street SE/171st Avenue SE intersection until it discharges to the Red River.

ADVANTAGES:

1) Reduce diversion channel length by approximately 4,000 feet
2) Eliminate the 25th Street SE bridge
3) Eliminate 24th Street SE road crossing (no bridge is included in the existing cost estimate)
4) Eliminates utility crossing shown in drawing #1
5) Eliminate at least 1 local drain.

DISADVANTAGES: Unknown hydraulic impact.

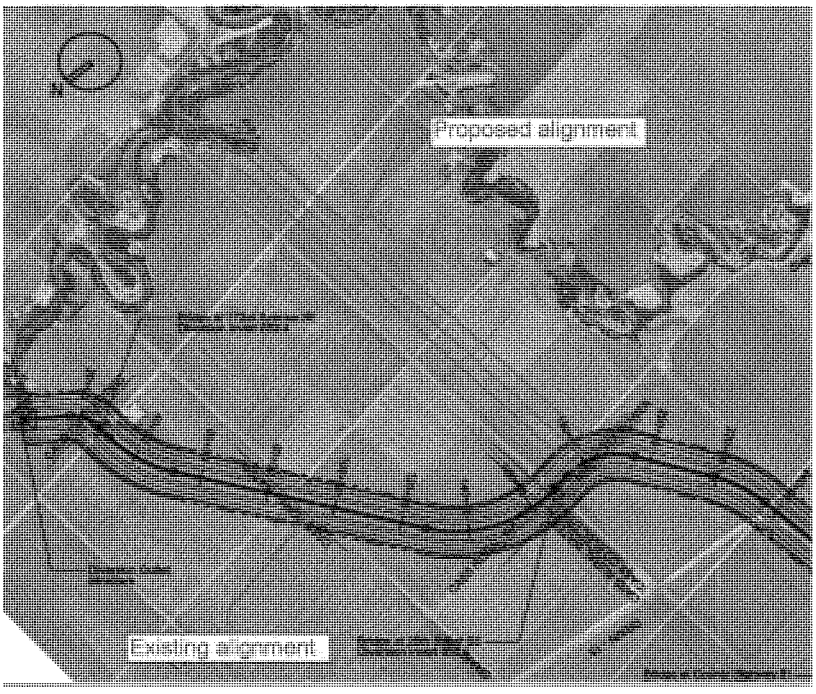
JUSTIFICATION: This proposal has the potential to save $17.6 million in channel excavation and bridge construction costs without adding any additional road crossings.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 6 PAGE NO: 2 OF 3

Drawing No. 1

RELOCATED DIVERSION CHANNEL ALIGNMENT, NORTH END OF NORTH DAKOTA EAST ALIGNMENT



	COST ESTIMATE WORKSHEET				
	Speculation Item # P6				
	Realign ND channel outlet further South				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Channel excavation	LF	17,600	$2,722.00	$47,907,200
	25th Street SE bridge	LS	1	$3,192,300.00	$3,192,300
	Eliminate 1 local Drain	ea	1	$1,100,000.00	$1,100,000
	Less Land Acquisiton (2%)	acres	120	$6,500.00	$780,000
			Total Deletions		$52,979,500
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Channel excavation	LF	13,650	$2,722.00	$37,155,300
					$0
					$0
			Total Additions		$37,155,300
			Net Cost Decrease		$15,824,200
	35% on features only		Mark-ups		$1,775,305
	(bridges,inlet, land)		Total Cost Decrease		$17,599,505
	All Mark-ups included in Unit Prices. Contingency or S&I applied.				

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 7 - ACCEPTED PAGE NO: 1 OF 3

DESCRIPTION: Integral Concrete Abutment/Channel Wall at Bridges

ORIGINAL DESIGN: The North Dakota east alignment generally follows the North Dakota west alignment except that, after crossing the Sheyenne River, it utilizes the existing Horace to West Fargo Sheyenne River Diversion corridor between Horace and I-94. The alignment crosses I-29 on the North side of Fargo where there a 4 bridges in close proximity. The bridges are included for I-29 (2), County 81, and a Railroad bridge. The current design is to provide 4 independent bridges spanning a trapezoidal earth channel design.

PROPOSED DESIGN: The proposed design is to provide a rectangular channel integrating the bridge abutments with a channel wall (See Drawing No. 1 on next page). In between bridges could be earth channel or T-wall side channel walls.

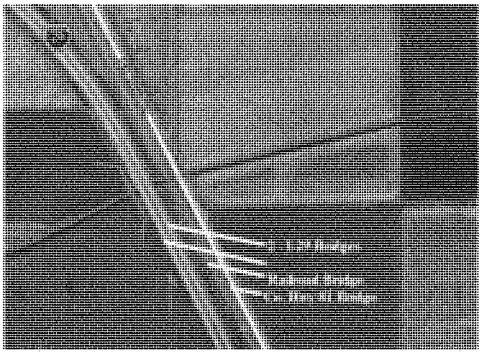
ADVANTAGES:

1. The each bridge span length is reduced by about 169 feet
2. Reduce construction duration
3. Smaller foot print
4. Could reduce beam sizes if 3 support column design is retained
5. Could consider 2 beam support bridge/longer spans
6. Less Ice blockage problem with reduced column design
7. Less bridge maintenance.

DISADVANTAGES:

1. Additional excavation and scour protection
2. Large gravity abutments are required to retain soil
3. Longer span (2 column bridge) has deeper beams – may need more road track raise.

JUSTIFICATION: The proposal saves initial cost of construction of bridges and requires a smaller foot print thus reducing initial impacts.



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 7 PAGE NO: 2 OF3

Drawing No. 1

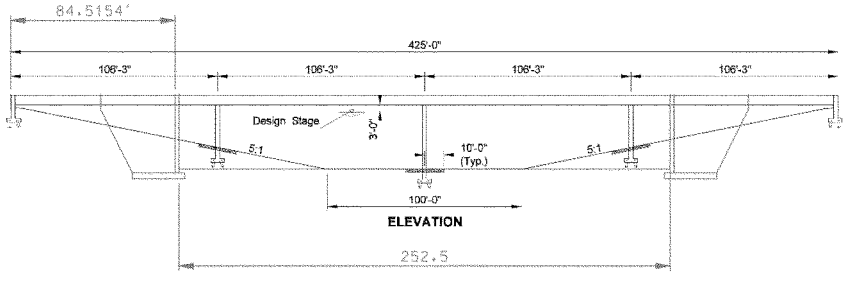
CURRENT BRIDGE COSTS AND PROPOSED SECTION

Bridge Cost Estimates

Location	Bridge Area (SF)	Cost per SF	Approach Road Cost	Temporary Bypass Cost	Bridge Cost	Total Cost
Interstate 29 (NB-South)	17,000	$115	$35,000	$80,000	$1,955,000	$2,070,000
Interstate 29 (SB-South)	17,000	$115	$35,000	$80,000	$1,955,000	$2,070,000
48th Street SE	12,200	$130	$10,000	$55,000	$1,585,000	$1,650,000
170th Avenue SE	12,200	$130	$0	$55,000	$1,585,000	$1,640,000
Railroad Bridge 4	7,200	$205	$120,000	$385,000	$1,475,000	$1,980,000
46th Street SE	12,200	$130	$0	$55,000	$1,585,000	$1,640,000
44th Street SE	12,200	$130	$5,000	$55,000	$1,585,000	$1,645,000
41st Street SE	12,200	$130	$5,000	$55,000	$1,585,000	$1,645,000
Interstate 94 (EB)	18,063	$115	$0	$80,000	$2,075,000	$2,155,000
Interstate 94 (WB)	18,063	$115	$0	$80,000	$2,075,000	$2,155,000
Railroad Bridge 3	15,200	$165	$140,000	$760,000	$2,510,000	$3,410,000
36th Street SE	12,200	$130	$15,000	$55,000	$1,585,000	$1,655,000
33rd Street SE	12,963	$130	$20,000	$55,000	$1,685,000	$1,760,000
Railroad Bridge 2	7,650	$205	$235,000	$385,000	$1,570,000	$2,190,000
31st Street SE	12,963	$130	$15,000	$55,000	$1,685,000	$1,755,000
28th Street SE	12,963	$130	$20,000	$55,000	$1,685,000	$1,760,000
Interstate 29 (SB-North)	18,063	$115	$45,000	$80,000	$2,075,000	$2,200,000
Interstate 29 (NB-North)	18,063	$115	$45,000	$80,000	$2,075,000	$2,200,000
Railroad Bridge 1	7,650	$205	$565,000	$385,000	$1,570,000	$2,520,000
County Hwy 81	12,963	$130	$30,000	$55,000	$1,685,000	$1,770,000
25th Street SE	12,963	$130	$30,000	$55,000	$1,685,000	$1,770,000
173rd Avenue SE	13,725	$130	$45,000	$55,000	$1,785,000	$1,885,000

Total ND East - 35,000 CFS $43,525,000

The bridges in this proposal are the 3rd-6th bridges from the bottom of the table. (I-29 SB-north $2.2M, I-29 NB- North $2.2M, RR Bridge #1 @ $2.52M and County Rd 81 bridge $1.77M)



	COST ESTIMATE WORKSHEET				
	Speculation Item # 7				
			DELETIONS		
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
					$0
	1 Bridge Spans Reduced(using avg $/SF)	SF	7267	$142.00	$1,031,914
	Excavation	CY	4,141	$5	$20,704
					$0
			Total Deletions		$1,052,618
			ADDITIONS		
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Qty - 1 Bridge span				$0
	Abutment Concrete				
	Side Walls	CY	607	$525	$318,733
	Footing	CY	270	$525	$141,750
	Front wall	LB	258	$525	$135,450
	Rebar	CY	153,240	$1	$176,226
	Excavation	CY	1,851	$5	$9,253
	Riprap		280	$84.00	$23,520
					$0
					$0
			Total Additions		$804,932
			Net Cost Decrease		$247,685
			Mark-ups	0.00%	$0
			Total Cost Decrease		$247,685
	Total Cost Decrease for 4 bridges ==>				$990,742
	All Mark-ups included in Unit Prices. Contingency or S&I applied.				
***	Could also be applied to Proposal 11 - MN RR yard				

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 8 – ACCEPT 4-6 ONLY PAGE NO: 1 OF 13

DESCRIPTION: Alternatives for local drainage side inlets

ORIGINAL DESIGN: Existing drainage ditch flow is directed to a drop inlet structure that outlets to the diversion channel (see Drawing No. 1).

PROPOSED DESIGN:

9-1) Raise the outlet elevation into the diversion channel and add riprap (see Drawing No. 2)

9-2) "Neck in" fill at local drainage side inlets (see Drawing No. 3)

9-3) Move riser to inside of spoil berm, either by extending the drainage ditch channel across the berm (see Drawing No. 4) or installing a horizontal pipe through the berm (see Drawing No. 5)

9-4) Downsize inlet structures for smaller drainage ditches that don't require a 72-inch pipe to pass flow (the current plans assume 72" pipes for all drainage ditch intercepts)

ADVANTAGES:

9-1) Decrease vertical and horizontal pipe lengths; reduce excavation needed for pipe placement

9-2) Decrease horizontal pipe length

9-3) If the drainage ditch channel is extended across the spoil berm, which has up to a 300-foot top width, a significant amount of pipe can be eliminated. If horizontal pipe was still used to transfer drainage ditch flow to the inside of the spoil berm, moving the riser to the inside of the berm would require less excavation

9-4) Reduce pipe sizes

DISADVANTAGES:

9-1) Requires riprap along diversion channel side slope below pipe outlet; may lead to erosion of diversion channel side slopes

9-2) Increased diversion channel side slope increases the possibility of erosion.

9-3) Extending the drainage ditch across the spoil berm reduces the top-of-berm elevation, which may reduce the capacity of the diversion channel.

9-4) None

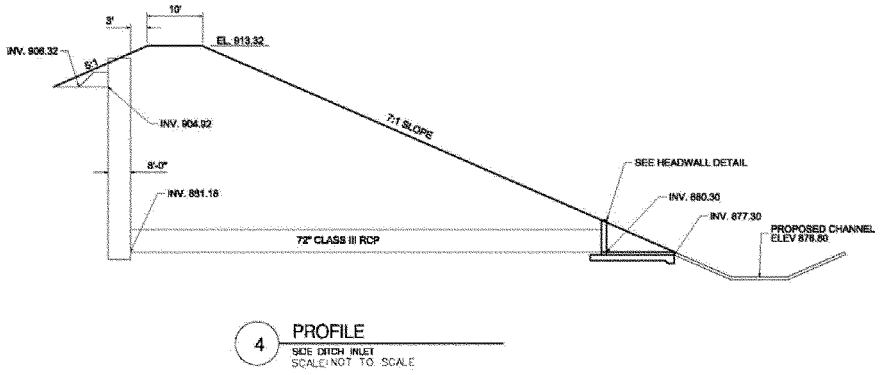
JUSTIFICATION: If changes are made to all of the drainage side inlets, this proposal has the potential to save up to $4.8 million dollars for the North Dakota west alignment and up to $3.9 million dollars for the Minnesota short alignment. A cost estimate was not performed for Proposal 9-4 as this requires hydraulic analysis beyond the scope of this VE report. However, it is assumed that the drainage side inlets in the final design will be based on specific hydraulic computations, which will most likely lead to a reduction in pipe sizes and therefore a reduction in cost.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 8 PAGE NO: 2 OF 13

Drawing No. 1

FLOOD CONTROL-SIDE INLET (TYPICAL)

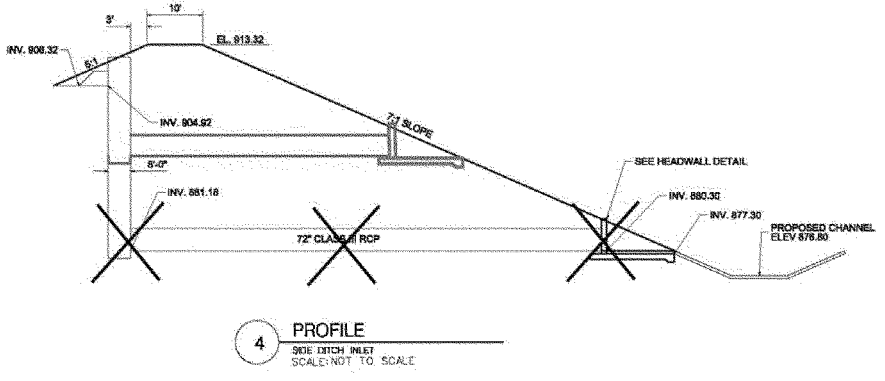


Sheet Reference Number S-412,
Flood Control - Side Inlet (typical)

Drawing No. 2

FLOOD CONTROL-SIDE INLET P9-1

RAISE OUTLET ELEVATION



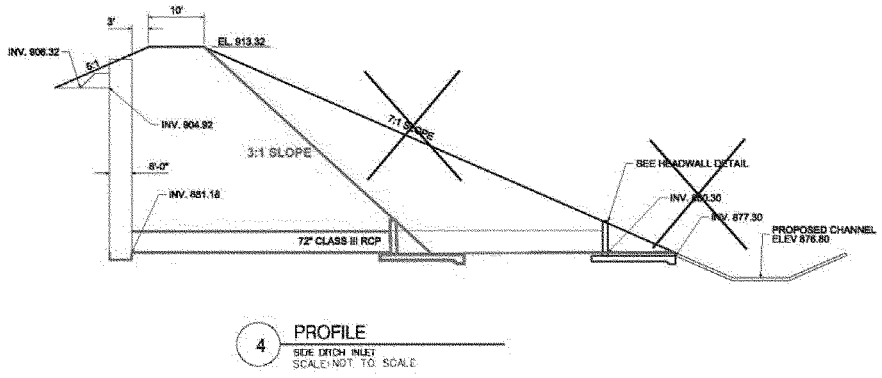
Sheet Reference Number S-412,
Flood Control - Side Inlet (typical)

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 8 PAGE NO: 3 OF 13

Drawing No. 3

FLOOD CONTROL-SIDE INLET P9-2
"NECK IN" FILL AT INLET

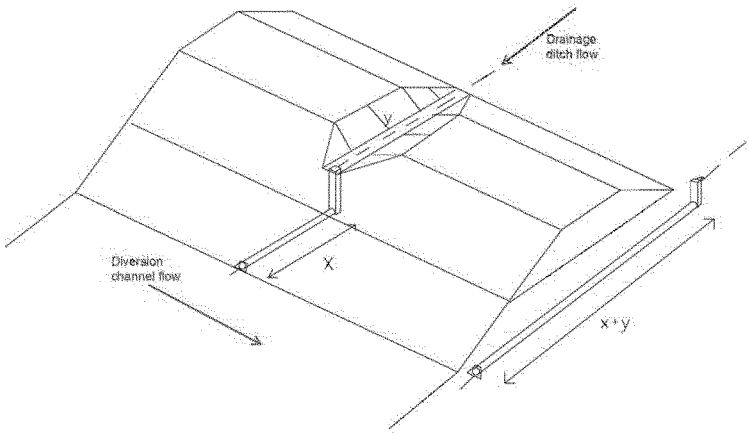


4 PROFILE
SIDE DITCH INLET
SCALE: NOT TO SCALE

Sheet Reference Number S-412,
Flood Control - Side Inlet (typical)

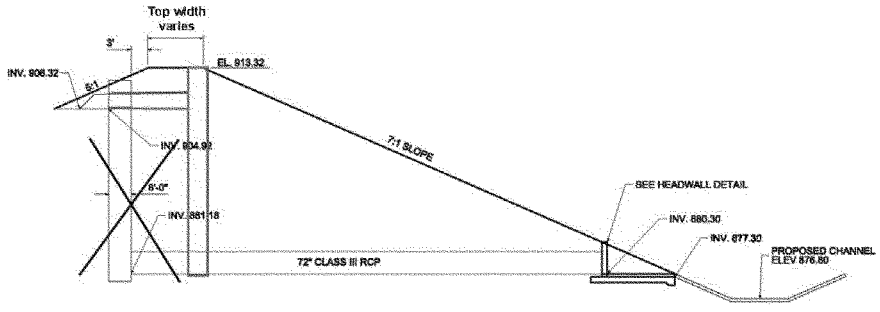
Drawing No. 4

FLOOD CONTROL-SIDE INLET P9-3A
MOVE RISER TO INSIDE OF SPOIL BERM BY EXTENDING DRAINAGE DITCH



Drawing No. 5

FLOOD CONTROL-SIDE INLET P9-3B
MOVE RISER TO INSIDE OF SPOIL BERM USING HORIZONTAL PIPE



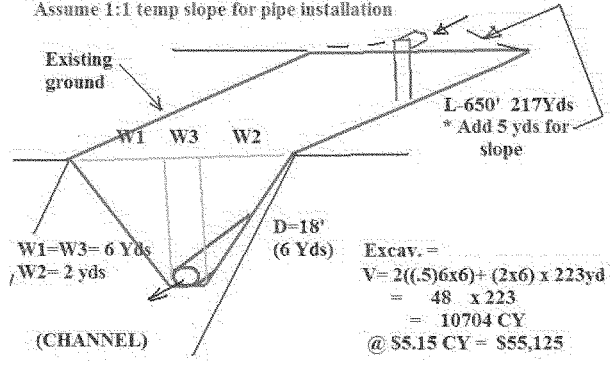
Sheet Reference Number S-412, Flood Control - Side Inlet (typical)

Drawing No. 6

FLOOD CONTROL-SIDE INLET
EXCAVATION ESTIMATE

Excavate outlets past berm for local drainage :

D= 18' Avg (channel bottom) W- 650' (Berm width)
Assume 1:1 temp slope for pipe installation



Excav. =
V= 2((.5)6x6)+ (2x6) x 223yd
= 48 x 223
= 10704 CY
@ $5.15 CY = $55,125

	COST ESTIMATE WORKSHEET				
	Speculation Item # P9-1 ND West Alignment				
	Raise pipe outlet elevation				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	96" Reinforced Concrete Manhole	LF	1,085	$3,000.00	$3,255,000
	72" Reinforced Concrete Pipe	LF	18,725	$400.00	$7,490,000
	Excavation - single pipe (see Dwg. 6)	CY	160,560	$5.15	$826,884
	Excavation - double pipe (see Dwg. 6)	CY	133,800	$5.15	$689,070
					$0
					$0
					$0
					$0
					$0
					$0
					$0
			Total Deletions		$12,260,954
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	96" Reinforced Concrete Manhole	LF	455	$3,000.00	$1,365,000
	72" Reinforced Concrete Pipe	LF	14,350	$400.00	$5,740,000
	Riprap (single pipe: 1'T x 22.6'W x 146.4'L)	CY	1,838	$56.00	$102,935
	Riprap (double pipe: 1'T x 31.8'W x 146.4'L)	CY	1,724	$56.00	$96,559
	Geotextile fabric (22.6'W x 146.4'L)	SY	5,514	$9.00	$49,630
	Geotextile fabric (31.8'W x 146.4'L)	SY	5,173	$9.00	$46,555
					$0
			Total Additions		$7,400,679
			Net Cost Decrease		$4,860,275
			Mark-ups	0.00%	$0
			Total Cost Decrease		**$4,860,275**
	Notes:				
	1. Assume 15 single pipe structures, 10 double pipe structures (ND West alignment)				
	1. Assume elevations and slopes from Dwg. 2 to determine pipe lengths				
	2. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	3. Assume spoil berm top width = 300'				
	4. Assume top of manhole at 912.0, new outlet invert 898.0, 0.0035 ft/ft pipe slope				
	5. 1' thick riprap blanket extends down slope from new invert (898) to old (877.3); 22.7' wide (single pipe), 31'10" wide (double pipe)				
	6. Assume no excavation for proposed, as pipes will be at existing ground elevation				

	COST ESTIMATE WORKSHEET				
	Speculation Item # P9-2 ND West Alignment				
	"Neck-in" fill at inlet to diversion channel				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	18,725	$400.00	$7,490,000
					$0
					$0
					$0
			Total Deletions		$7,490,000
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	14,105	$400.00	$5,642,000
					$0
					$0
					$0
			Total Additions		$5,642,000
			Net Cost Decrease		$1,848,000
			Mark-ups	0.00%	$0
				Total Cost Decrease	**$1,848,000**
	1. Assume 15 single pipe structures, 10 double pipe structures (ND West alignment)				
	2. Assume elevations and slopes from Dwg. 3 to determine pipe lengths				
	3. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	4. Assume spoil berm top width = 300'				
	5. Assume excavation amount won't change				

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 8 PAGE NO: 8 OF 13

	COST ESTIMATE WORKSHEET				
	Speculation Item # P9-3a ND West Alignment				
	Move riser to inside of spoil berm by extending drainage ditch				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	18,725	$400.00	$7,490,000
	Excavation - single pipe (see Dwg. 6)	CY	160,560	$5.15	$826,884
	Excavation - double pipe (see Dwg. 6)	CY	133,800	$5.15	$689,070
					$0
					$0
			Total Deletions		$9,005,954
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	8,435	$400.00	$3,374,000
	Excavation - single pipe (see Dwg. 6, L=360)	CY	86,400	$5.15	$444,960
	Excavation - double pipe (see Dwg. 6, L=360')	CY	72,000	$5.15	$370,800
					$0
					$0
			Total Additions		$4,189,760
			Net Cost Decrease		$4,816,194
			Mark-ups	0.00%	$0
			Total Cost Decrease		**$4,816,194**
	1. Assume 15 single pipe structures, 10 double pipe structures (ND West alignment)				
	2. Assume elevations and slopes from sheet S-412 to determine pipe lengths				
	3. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	4. Assume spoil berm top width = 300'				
	5. Set riser 10' into spoil berm to permit access during flooding				

	COST ESTIMATE WORKSHEET				
	Speculation Item # P9-3b ND West Alignment				
	Move riser to inside of spoil berm using horizontal pipe				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Excavation - single pipe (see Dwg. 6)	CY	160,560	$5.15	$826,884
	Excavation - double pipe (see Dwg. 6)	CY	133,800	$5.15	$689,070
					$0
					$0
			Total Deletions		$1,515,954
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Excavation - single pipe (see Dwg. 6, L=360)	CY	86,400	$5.15	$444,960
	Excavation - double pipe (see Dwg. 6, L=360')	CY	72,000	$5.15	$370,800
					$0
					$0
			Total Additions		$815,760
			Net Cost Decrease		$700,194
			Mark-ups	0.00%	$0
			Total Cost Decrease		**$700,194**
	1. Assume 15 single pipe structures, 10 double pipe structures (ND West alignment)				
	2. Assume elevations and slopes from Dwg. 5 to determine pipe lengths				
	3. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	4. Assume spoil berm top width = 300'				
	5. Set riser 10' into spoil berm to permit access during flooding				
	6. Assume no excavation for pipe through spoil berm (above ground elevation)				

	COST ESTIMATE WORKSHEET				
	Speculation Item # P9-1 MN Short Alignment				
	Raise pipe outlet elevation				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	96" Reinforced Concrete Manhole	LF	899	$3,000.00	$2,697,000
	72" Reinforced Concrete Pipe	LF	15,515	$400.00	$6,206,000
	Excavation - single pipe (see Dwg. 6)	CY	74,928	$5.15	$385,879
	Excavation - double pipe (see Dwg. 6)	CY	147,180	$5.15	$757,977
					$0
					$0
					$0
					$0
			Total Deletions		$10,046,856
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	96" Reinforced Concrete Manhole	LF	377	$3,000.00	$1,131,000
	72" Reinforced Concrete Pipe	LF	11,890	$400.00	$4,756,000
	Riprap (single pipe: 1'T x 22.6'W x 146.4'L)	CY	858	$56.00	$48,037
	Riprap (double pipe: 1'T x 31.8'W x 146.4'L)	CY	1,897	$56.00	$106,215
	Geotextile fabric (22.6'W x 146.4'L)	SY	2,573	$9.00	$23,160
	Geotextile fabric (31.8'W x 146.4'L)	SY	5,690	$9.00	$51,211
					$0
			Total Additions		$6,115,623
			Net Cost Decrease		$3,931,234
			Mark-ups	0.00%	$0
			Total Cost Decrease		**$3,931,234**
	Notes:				
	1. Assume 7 single pipe structures, 11 double pipe structures (MN Short alignment)				
	1. Assume elevations and slopes from Dwg. 2 to determine pipe lengths				
	2. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	3. Assume spoil berm top width = 300'				
	4. Assume top of manhole at 912.0, new outlet invert 898.0, 0.0035 ft/ft pipe slope				
	5. 1' thick riprap blanket extends down slope from new invert (898) to old (877.3); 22.7' wide (single pipe), 31'10" wide (double pipe)				

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 8 PAGE NO: 11 OF 13

	COST ESTIMATE WORKSHEET				
	Speculation Item # P9-2 MN Short Alignment				
	"Neck-in" fill at inlet to diversion channel				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	15,515	$400.00	$6,206,000
					$0
			Total Deletions		$6,206,000
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	11,687	$400.00	$4,674,800
					$0
					$0
			Total Additions		$4,674,800
			Net Cost Decrease		$1,531,200
			Mark-ups	0.00%	$0
				Total Cost Decrease	**$1,531,200**
	1. Assume 7 single pipe structures, 11 double pipe structures (MN Short alignment)				
	2. Assume elevations and slopes from Dwg. 3 to determine pipe lengths				
	3. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	4. Assume spoil berm top width = 300'				
	5. Assume excavation amount won't change				

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 8 PAGE NO: 12 OF 13

	COST ESTIMATE WORKSHEET				
	Speculation Item # P9-3a MN Short Alignment				
	Move riser to inside of spoil berm by extending drainage ditch				
	DELETIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	15,515	$400.00	$6,206,000
	Excavation - single pipe (see Dwg. 6)	CY	74,928	$5.15	$385,879
	Excavation - double pipe (see Dwg. 6)	CY	147,180	$5.15	$757,977
					$0
			Total Deletions		$7,349,856
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	72" Reinforced Concrete Pipe	LF	6,989	$400.00	$2,795,600
	Excavation - single pipe (see Dwg. 6, L=360)	CY	40,320	$5.15	$207,648
	Excavation - double pipe (see Dwg. 6, L=360')	CY	79,200	$5.15	$407,880
					$0
			Total Additions		$3,411,128
			Net Cost Decrease		$3,938,728
			Mark-ups	0.00%	$0
			Total Cost Decrease		**$3,938,728**
	1. Assume 7 single pipe structures, 11 double pipe structures (MN Short alignment)				
	2. Assume elevations and slopes from sheet S-412 to determine pipe lengths				
	3. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	4. Assume spoil berm top width = 300'				
	5. Set riser 10' into spoil berm to permit access during flooding				

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Excavation - single pipe (see Dwg. 6)	CY	74,928	$5.15	$385,879
	Excavation - double pipe (see Dwg. 6)	CY	147,180	$5.15	$757,977
			Total Deletions		$1,143,856
	ADDITIONS				
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Excavation - single pipe (see Dwg. 6, L=360)	CY	40,320	$5.15	$207,648
	Excavation - double pipe (see Dwg. 6, L=360')	CY	79,200	$5.15	$407,880
					$0
			Total Additions		$615,528
			Net Cost Decrease		$528,328
			Mark-ups	0.00%	$0
			Total Cost Decrease		**$528,328**
	1. Assume 7 single pipe structures, 11 double pipe structures (MN Short alignment)				
	2. Assume elevations and slopes from Dwg. 5 to determine pipe lengths				
	3. Unit costs from BARR cost estimate, eff. Date 8/26/2009				
	4. Assume spoil berm top width = 300'				
	5. Set riser 10' into spoil berm to permit access during flooding				
	6. Assume no excavation for pipe through spoil berm (above ground elevation)				

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 9 - REJECT PAGE NO: 1 OF4

DESCRIPTION: Raise In-City protection to 100 Year Levels

(25K plan doesn't protect downtown Fargo during 100-year (Elm St closed, 2nd St. dike installed))

ORIGINAL DESIGN: The design would use a diversion channel to route flood flows around the metropolitan area resulting in lower stages in the natural channel through town. The design for a MN 25,000 cfs diversion channel would lower the expected water surface elevation at the River Gage in Fargo as illustrated in the table below.

	Stage at the Fargo Gage		
	2% Chance (50% Year)	1% Chance (100 Year)	0.2% Chance (500 Year)
Existing Condition	37.8 RG	39.5 RG	43.9 RG
25 K Condition	29.1 RG	30.4 RG	39.2 RG

The residual flow on a 100 year and 500 year events through the natural channel would require emergency measures to continue. Please see the attached map indicating the current levels of protection. With a residual stage of 30.4 feet 0.62 miles (3317 feet) of temporary measures would still be required for the 100 year flood fight within Fargo to protect to a stage of 31 feet. In addition 28.12 miles (148,513 feet) of temporary measures would still be required for the 500 year event within Fargo to protect to a stage of 40 feet.

Moorhead would not need to build any temporary lines of protection for the proposed 100 year water surface elevation. Moorhead begins sandbagging efforts at a River gage of 33.5 feet and would require extensive effort at the anticipated 39.2 River Gage that would still be expected for the 500 year event.

PROPOSED DESIGN: The proposed design includes construction of the MN 25,000 cfs channel as it was originally designed but also includes construction of a floodwall from 4th Avenue North to Northern Pacific Avenue and from Main Avenue to the existing 4th street levee. The floodwall would be designed to accommodate the anticipated 500 year flow with an additional 3' foot of freeboard resulting in a top of wall at a River Gage of 42.2.

North of Main avenue this would require a structural floodwall of approximately 12 feet in height at a length of 2400 feet. This would require 5 temporary road closures. These closures are at the following locations: on 2nd Street just north of 4th Avenue North, on 4th Avenue North at the intersection with 2nd street North, on 3rd Avenue North at the intersection with 2nd Street North, on 2nd street at intersection with 1st Avenue North, and on Northern Pacific Avenue at approximately the intersection with 1st Street North.

South of Main Avenue the structural floodwall height would be approximately 11 feet for a length of 1500 feet with 2 temporary closures just south of Main Avenue and at the tie in point with the 4th Street levee.

ADVANTAGES: The addition of permanent flood walls with temporary road closures decreases the vulnerability of the system during events. It also decreases the cost to fight future events. Greater reliability provides reduced residual risk.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 9 PAGE NO: 2 OF 4

DISADVANTAGES: Raises the overall cost of the project.

JUSTIFICATION: Significant losses could still be experienced without the inclusion of additional measures. Many properties will remain at risk for those events around the 100 year recurrence interval and higher. It is important to note that the City has already faced at least one event higher than the 100 year recurrence.

The Flood fight costs would continue to be incurred and would require extreme mobilization to provide temporary measures. During the levee construction the amount of truck traffic increases and due to the nature of their work they are often provided priority over the rest of the traveling public, while necessary, this disrupts the traffic flow and can create hazardous conditions for the traveling public.

In addition each flood event that requires these mobilizations decreases the lifespan of City infrastructure and roads. Storm sewers in the vicinity of the earth levees become clogged with materials and require cleaning following an event. Inlets are often damaged, curb lines are destroyed from the effort of constructing the levees in the street. The levee removal process destroys the pavement markings and requires their replacement.

These temporary measures also have a significant impact to the environment, during an emergency earth levees are in direct contact with flood waters. They are not vegetated and have no other erosion protection applied to them. Therefore the floodwaters pick up soil particles and they are discharged down river.

VALUE ENGINEERING PROPOSAL

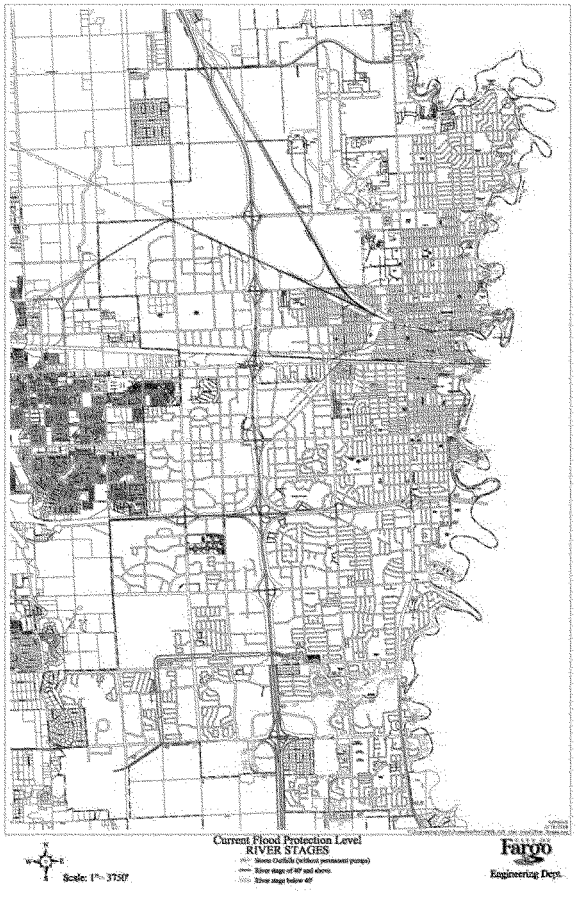
PROPOSAL NO: 9 PAGE NO: 3 OF 4

Drawing No. 1

FARGO TEMPORARY PROTECTION REQUIRED BY RIVER STAGE

(EARTH LEVEES, SANDBAGS, AND INNOVATIVE FLOOD FIGHT PRODUCTS)

River Stage	Cum Temp Prot (Feet)	Cum Temp Prot (Miles)	River Stage	Cum Temp Prot (Feet)	Cum Temp Prot (Miles)	River Stage	Cum Temp Prot (Feet)	Cum Temp Prot (Miles)	River Stage	Cum Temp Prot (Feet)	Cum Temp Prot (Miles)
30	2,252	0.42	33	3,317	0.62	36	10,663	2.01	39	88,401	16.74
31	3,317	0.62	34	3,705	0.7	37	20,746	3.92	40	148,513	28.12
32	3,317	0.62	35	4,315	0.81	38	47,093	8.91	41	222,842	42.2
									42	244,143	46.23



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 9 PAGE NO: 4 OF 4

COST ESTIMATE WORKSHEET

Speculation Item # P 10
Raise City Protection to 100 yr levels

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
				$0
		Total Deletions		$0

ADDITIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
R.C. Floodwall 8-12 feet	SF	36,380	$70.00	$2,546,600
R. C. Floodwall Footing 8-12 feet	LF	3,900	$940.00	$3,666,000
Removable Floodwall	SF	8,920	$200.00	$1,784,000
Removable Floodwall Footing	LF	760	$600.00	$456,000
		Total Additions		$8,452,600
		Net Cost Decrease		-$8,452,600
		Mark-ups	25.00%	-$2,113,150
		Total Cost Decrease		-$10,565,750

All Mark-ups included in Unit Prices. Contingency or S&I applied.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 10 - REJECTED PAGE NO: 1 OF 6

DESCRIPTION: MN RR Yard relocation issues

ORIGINAL DESIGN: The alignments for the Minnesota diversions cross an area just east of Dilworth, MN that contains an existing railroad switching yard facility. The feasibility report indicates the yard will be relocated at a cost of $90M to facilitate construction of a 500' wide diversion channel through the area. This relocation represents 10% of the estimated $926M project cost. The feasibility design still requires a two track bridge cross the channel at this location to facilitate rail traffic once the diversion channel is built. The crossing does not require significant modifications in grade in this according to the bridge design tables in the feasibility report.

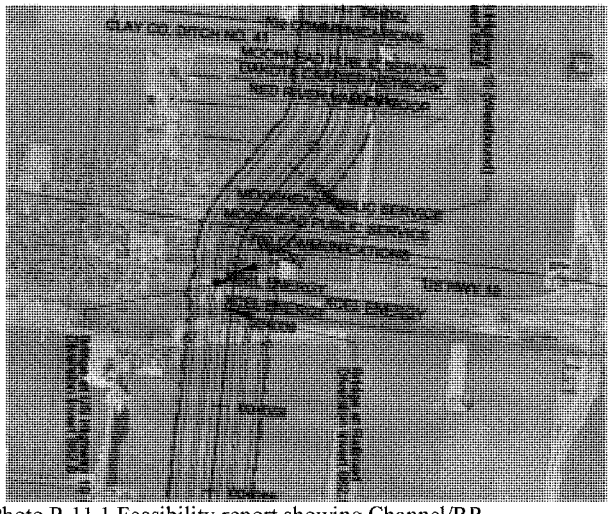


Photo P-11.1 Feasibility report showing Channel/RR crossing area. (Report Plate 7)

PROPOSED DESIGN: There are two design options forwarded by the VE review team that could be considered in the Railroad yard area:

A. Design a rectangular channel section to cross under the existing rail yard and cross in the area designated in the feasibility study. The estimated width of a U-Channel design for the MN 25,000 CFS option is 400' in width. The VE team walked the area and found that there are 5 tracks and a rail crew access road that cross in the proposed channel area. The team also observed a straight section of rail yard long enough to construct a 400' wide U-channel through the area without requiring significant disruption to the switching yards located to the east and west of this are

VALUE ENGINEERING PROPOSAL

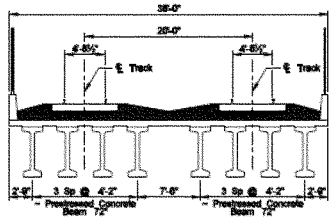
PROPOSAL NO: 10 PAGE NO: 2 OF 6

DESCRIPTION: MN RR Yard relocation issues

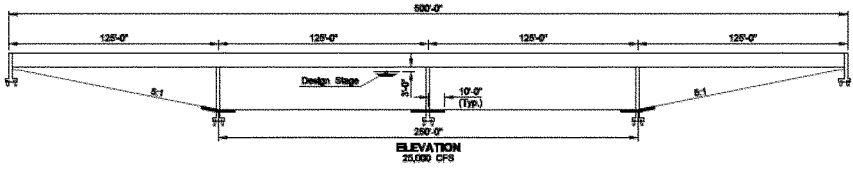
Photo P11.1 – Proposed Mn Diversion channel area through rail yard -Dilworth, MN

This proposal would construct the channel through the area and maintain current usage of the area for the railroad by construction of new RR bridges. The spoil banks normally side cast in the design would be hauled to an alternate disposal location to minimize width of the channel through the yard.

Utilizing a U-channel section would reduce the bridge lengths similar to the cost savings of Proposal 07 which reduced bridge costs by $250K a bridge on the North Dakota side.



Typical Section



ELEVATION
25,000 CFS

Proposed 500' Bridge design for Harwood Area railroad crossing of new Diversion channel (MN 25,000) (Railroad Bridge #1).

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 10 PAGE NO: 3 OF 6

DESCRIPTION: MN RR Yard relocation issues

B. The second proposed design for the railroad yard would be to miss the existing rail facility entirely. The existing rail yard extends some 6000' to the east before the multiple tracks converge into the main line set of two tracks. At this location there is a grain storage facility and a self storage business on the north side of the tracks.

To determine whether of not this option was cost effective- the VE team calculated the per foot cost of the MN short 25,000 CFS channel and found that the average excavation cost per foot of project was $2600/L. Ft. of channel. To extend the channel further east would move the alignment as shown below:

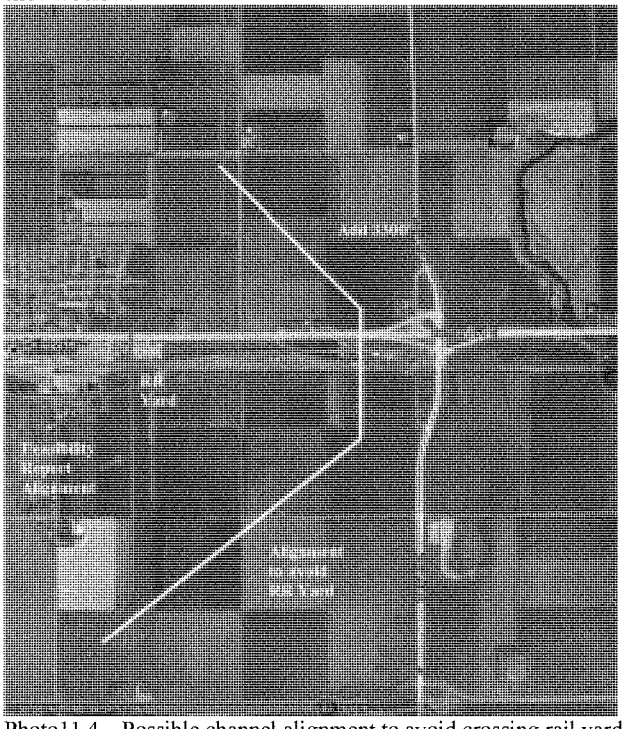


Photo11.4 – Possible channel alignment to avoid crossing rail yard.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 10 PAGE NO: 4 OF 6

DESCRIPTION: MN RR Yard relocation issues

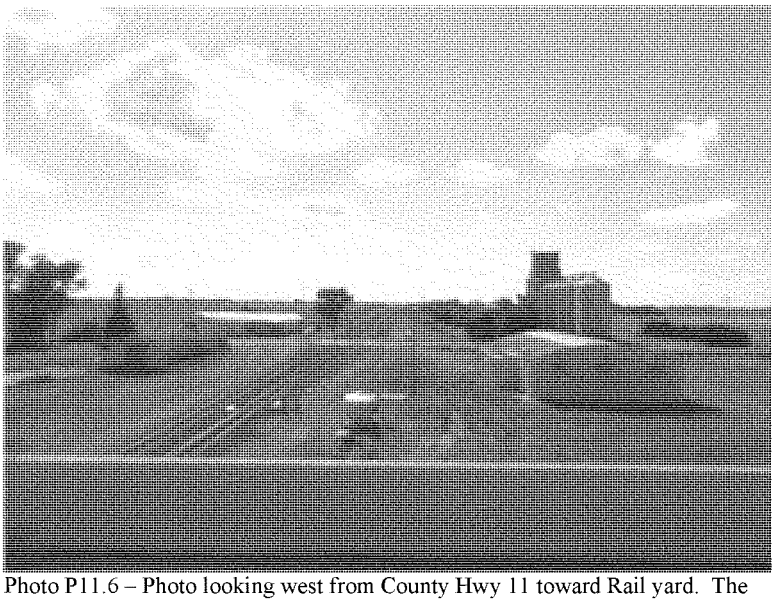


Photo P11.6 – Photo looking west from County Hwy 11 toward Rail yard. The Diversion channel could be moved further east into this area to avoid Rail yard and its associated relocation cost.

This alignment extends the project by 3300' which would increase the channel length and project excavation cost.

ADVANTAGES:

A. Reduced cost, less disruption to area businesses and employment. Smaller bridges,

B. Move project away from city limits, increased safety.

C. Reduced cost, additional water storage capacity (3300' more channel), less disruption to area businesses & area employment and less bridges than option A of this VE proposal – with only two rail tracks to cross.

DISADVANTAGES: A. Additional structures (2 additional bridges will be required), additional construction time and bridge maintenance. Channel cut runs a few 100 ' from an existing sewage lagoon to the west of the project – seepage?

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 10 PAGE NO: 5 OF 6

DESCRIPTION: MN RR Yard relocation issues

B. Longer alignment, additional land acquisition. Cost to relocate self storage business. This alignment is closer to the Buffalo Aquifer which was roughly identified as lying beneath County Hwy 11 alignment to areas further east but could factor in this option.

JUSTIFICATION: Same project function at a lower cost.

Both options A& B will generically cost $10M to construct. Relocation of the entire rail yard would be avoided at an estimated $90M. The net benefit to constructing either option is an $80M Savings to MN 25K – increasing the project B/C ratio from 1.22 to 1.30

Alternative B has added benefit of fewer structures than Alternative A and is generically located in a safer location away from Housing area in Dilworth and the sewage lagoons near the rail yard. See cost estimates.

Note: Additional savings ($1M) would be possible if Proposal 7 (u-channel @ multiple bridges) is adopted to reduce bridge sizes.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 10 PAGE NO: 6 OF 6

COST ESTIMATE WORKSHEET

Proposal #11 -Eliminate RR yard relocation
Alternative A - U Channel + Bridges

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Railroad yard relocation cost	EA	1	$90,000,000.00	$90,000,000
Railroad bridge construction cost (#1)	ft	500	$7,490.00	$3,745,000
Reduced excavation	cy	4,141	$5.00	$20,705
				$0
				$0
		Total Deletions		$93,765,705

ADDITIONS

Alt. A. -3 bridge through RR yard

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
1- 2 track RR bridge @400'	ft	400	$7,490.00	$2,996,000
1- 2 track RR bridge @400'	ft	400	$7,490.00	$2,996,000
1- 1 track/road access bridge@400	ft	400	$6,000.00	$2,400,000
From Proposal #7				
Move berm to disposal area (not sidecast)	cy	12,500	$2.00	$25,000
U - Channel costs (abutments/wall/riprap)	ea	3	$805,000.00	$2,415,000
		Total Additions		$10,832,000
		Net Cost Decrease		$82,933,705
	E&D	Mark-ups	10.00%	$8,293,371
	Alt A	Total Cost Decrease		$91,227,076

Alt. B. - extend channel east -avoid yard

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Additional channel Excavation	ft	3,300	$2,600.00	$8,580,000
Relocated RR bridge	ea	500	$7,490.00	$3,745,000
topsoil/seeding	ea	1	$100,000.00	$100,000
(Business relocations considered equal to feasbility alignment - gravel operation moved in feasibility -self store operation in this alternative)				
		Total Additions		$12,425,000
		Net Cost Decrease		$81,340,705
	E&D	Mark-ups	10.00%	$8,134,071
	Alt A	Total Cost Decrease		$89,474,776

Alternative A Saves an estimated	$82.9M
Alternative B saves an estimated	$81.4M

VALUE ENGINEERING TEAM STUDY
COMMENT LIST

The following value "Comments" were proposed during the study or were identified during proposal development. These comments represent substantial ideas that should be reviewed by the design team to add value to the project but were not selected as cost saving proposals due to time or other informational constraints.

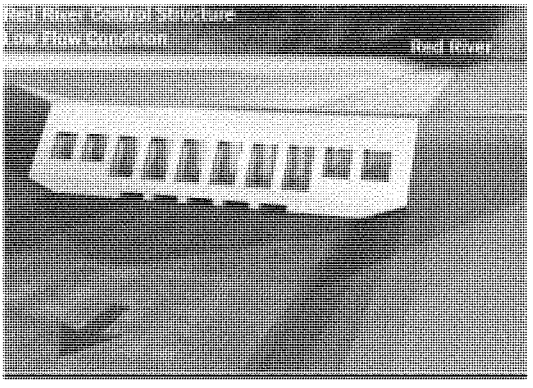
C1. Plan Recreation Facilities into Project Construction. The current plan could be improved by adding recreational features into the project. Though the current plan is to add recreational features in the future, several ideas were identified. Some of these features may require pre-planning and would require some consideration during the project design. Additionally, some features should be considered in the initial design/construction as costs will tend to increase with time. The vast area that will be impacted by a diversion channel provides an almost unlimited opportunity for recreational features. The following list are some features that could be incorporated into the project:

a. Bike paths
b. Horse Trails and associated parking/entry points
c. ATV Park and or Trails (do to erosion, maybe limited to spoil berms)
d. Hiking Trails
e. Open Air Amphitheater
f. Fishing Ponds
g. Garden Plots
h. With minimum low flow, Tubing/Kayaking/canoeing
i. Cross County Skiing
j. Sledding Parks
k. Wildlife Management Area/Hunting

C2 - Beneficial use of Channel Spoil Material (Speculation List Item No 11). The current plan produces significant quantities of spoil material that could have beneficial uses. Potential uses include local and private flood control outside the protected area or other private or public projects requiring fill. A program could be developed that allows for individuals or agencies to apply for use and any cost associated with loading and hauling of spoil material would be covered by the applicant.

C3 - Farming of Channel Side Slopes. The current plan indicates side slopes of 1 on 7 and it was not clear if farming would be allowed or how effective farming would be on these slopes. An evaluation of channel slide slopes and how it might affect farm productivity and channel design should be considered. The evaluation would balance the effects of side slope on farm productivity, channel hydraulics, and real estate requirements.

C4 – Construct diversion channel structure capable of passing ice jams. While the actual design of a diversion structure is yet to come, news reports from the Winnipeg diversion project cited icing problems with their diversion channel this year. Design considerations for gates should include those that will not be affected by late season ice. Having at least one submergible gate to pass ice through might be considered. Tainter gate designs used on the Mississippi River have shown good serviceability in winter conditions should also be considered.



C5 – Add a bridge to Diversion structure design for local access across Red River. The opportunity to create another river crossing exists with the construction of the proposed diversion structure. The closest bridges that span the Red River in this location are 2.4 miles south or north of the proposed diversion location. This bridge would be above flood levels and allow access to the diversion inlet from the ND side. The 110th street bridge located 2.4 miles south might be closed during a flood.

C6 - Manage Diversion Channel to Support Wetland/Wildlife. The current plan could be improved by adding wetland/wildlife management plan that would provide environmental enhancement. The plan could vary from a simple conservation program (similar to CRP land) or prairie restoration program to an actively managed wetland/

wildlife refuge. The simple conservation/restoration plan could reduce soil erosion, reduce sedimentation in river, establish wildlife habitat and enhance wetland resources. An actively managed plan could provide for periodic flooding of diversion channel and/or a minimum flow to support wetland growth and wildlife habitat. The actively managed plan would require a flow control or low flow structure at the upstream end.

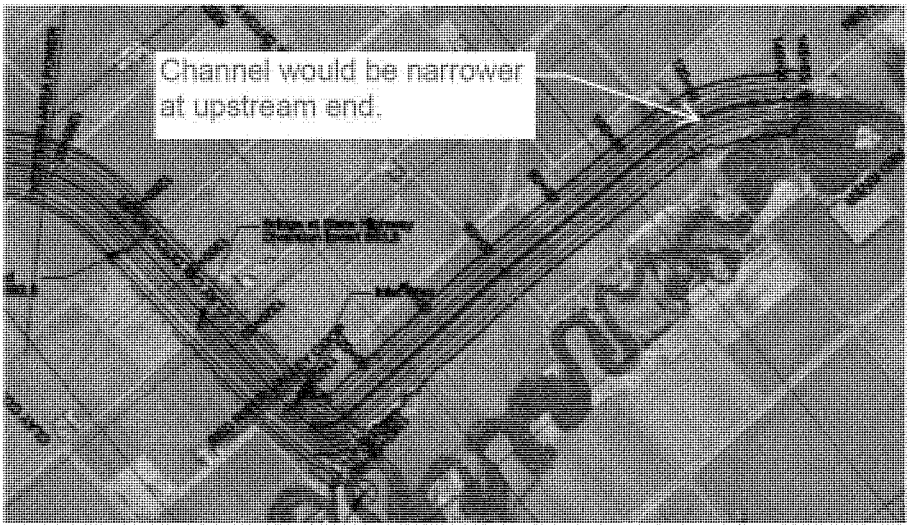
C7 – Send percentage of diversion flow into Buffalo River. Investigate capability of channeling flows eastward toward the Buffalo River. Aquifer issue may rule this option out.

C8- Develop project with and Ice friendly design. Recent experiences in Winnipeg and past experiences in Minnesota require all new construction should not constrict ice flow which typically results in localized flooding. Consider adequate clearance or passages for ice flow.

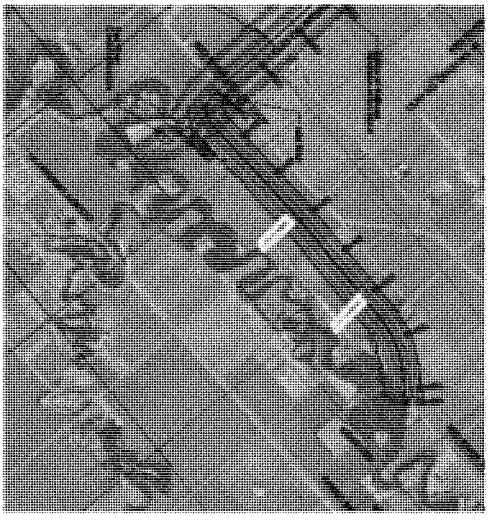
C9 - Vary spoil berm elevation. Constructing a higher spoil berm on the side of the diversion channel closer to Fargo/Moorhead should be considered. A slightly higher berm on the "city" side of the diversion channel would provide added flood protection by allowing flow exceeding the capacity of the diversion channel to flow away from heavily populated areas.

C10 - Road raise for North Dakota Alignment tie-back levees . The North Dakota East and West Alignments include a tie-back levee extending east from the Red River control structure to high ground. Approximately 1.5 miles of the proposed levee alignment runs along 130th Avenue South. Raising this road and incorporating it into the tie-back levee would reduce the amount of material needed to construct the levee.

C11 - **Minnesota Short Diversion -- Lateral Drains above Inlet**. There is an extension of the Minnesota Short Diversion to the upstream of the primary inlet. Rather than make this a uniform cross-section channel from its own inlet point to the diversion, make it a tapered channel with multiple entrance points: a "manifold" collection channel drawing water from potential break-out points along the reach between the most upstream inlet to the primary inlet. The image shows three possible locations.



C12 - Cutoff channels in the Red River upstream of the diversion. To reduce stage impacts, cutoff channels in the Red River upstream of the diversion structure should be considered.

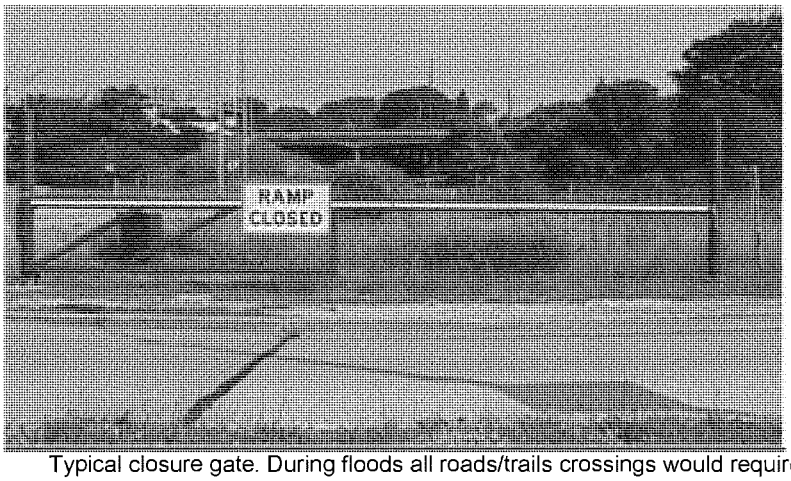


Add additional connections to limit stage
Increases U/S of diversion structure.

C13 - Low flow channel within diversion channel. The original diversion channel design calls for a flat bottom channel, which would cause low flows to meander around and more quickly degrade the channel bottom. A V-channel section within the flat bottom channel would limit low flows to the center of the channel and prevent low flow meandering and channel degradation, thereby reducing the need for channel maintenance.

C14 - Low flow crossing for segmented farm fields. For portions of the diversion channel cutting across farm fields, Texas crossings should be installed to allow farmers access to both segments of their field. When possible, landowners with property on both sides of the diversion channel could be reorganized in a land "swap" to establish cropland located on only one side of the channel. This would eliminate the need for low flow crossings to provide access to segmented cropped areas.

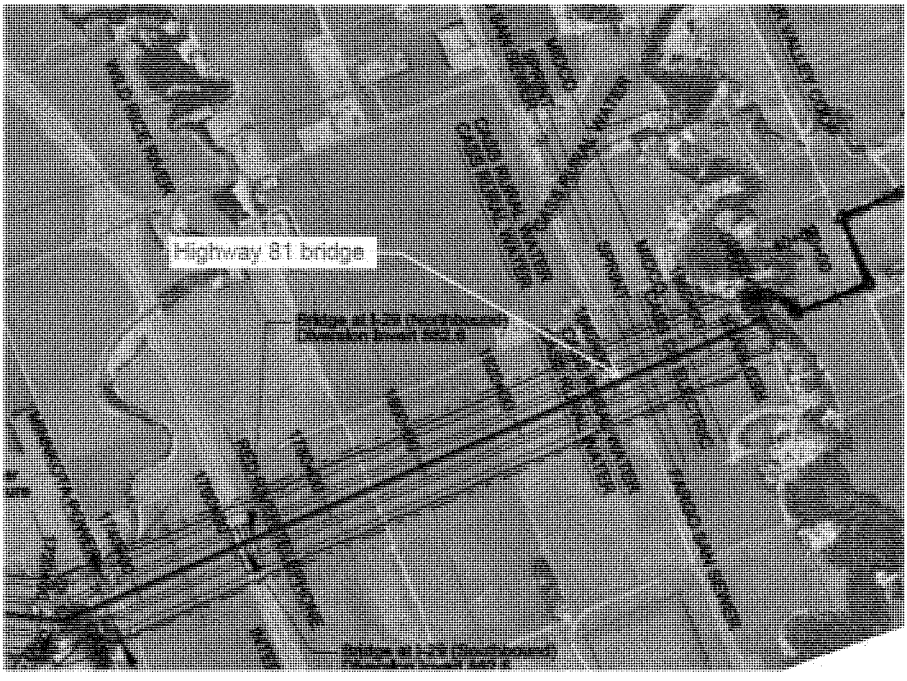
C15 – Address safety issues during floods. Operation of the diversion channel will decrease flood issues for residents in some areas and introduce new hazards into others. All activities that might be allowed in the diversion channel during "normal" non-flood years (See comment C-1) will need to be suspended during operation of the channel. Should at grade crossings be permitted (P-5) they would be closed during operation of the diversion. Gates and signage should be developed that restrict floodway usage. News articles from Winnipeg indicate that they sound a horn when the diversion is opened. With a minimum channel length of 25 miles a single horn would not be sufficient. Development of the O&M manual and public warning system in the area would be required as this project advances.



Typical closure gate. During floods all roads/trails crossings would require closure.

C16 - Select grass mixes for weed control and directly seed clay in channels.
Grass seed mixes should be selected to prevent weed growth in the diversion channel. This will reduce maintenance costs and provide ecological diversity for the project. Also, the possibility of eliminating topsoil placement in the diversion channel and directly seeding the exposed natural soils should be investigated. Removing top soil from the diversion channel would reduce the cost of the Minnesota Short 35K alignment by $5.59M.Items that follow were identified during the development of VE team ideas for the written report:

C17 - Add Bridge on US Hwy 81 Bus to ND alignments. The North Dakota East 35 K cost estimate is to be missing a bridge construction cost at Highway 81. This would be the first bridge across the diversion after the inlet.



Add bridge cost to project estimates.

C18a - Minnesota Railroad Yard Crossing. The Minnesota diversion crosses a BNSF railroad yard near Dilworth. The estimate includes a railroad bridge at $6.75M. This bridge would need to carry not only railroad tracks (presumably at least the 7 that exist) but vehicle and pedestrian traffic that supports railroad operations. It seem like the estimate might be low for the amount of bridge width required.

***C18b* - Minnesota Railroad Yard Crossing**. The railroad bridge at the BNSF Dilworth yard will require deep girders, perhaps 10 feet, to support train weight. These girders will impede channel flow. Please verify there will be sufficient channel cross-section below the girders to allow the required channel flow. One solution is to use plate girders on the sides, but this does not allow redundancy.

C18c -Minnesota Railroad Bridge (northernmost) The northernmost customer of the railroad is 1.5 miles north of Moorhead. According to the Dilworth yard manager, the railroad would probably be willing to abandon its line to the north and the project could thus save the cost of the bridge.

***C19* - Add Drop Structure for Western diversion channel - MN short alignments – to the project cost estimate.** Drop structure contained on plans is not found in cost estimate for the project.

***C20* - Use a maximum 2-3% grade on transition section on major roads.** The 6% transitional grades cited in this report are steeper than the average grade found on the national freeway system where it is constructed on flat lands. Max 2-3% is cited as an acceptable slope. This will increase approach modification cost(s) at all bridges.

C21 – Review Utility relocation estimates – ND and MN are the same figure. The utility relocation costs on both the MN short 25K and ND East 35K are listed at $1,888,000 – having 10 additional miles of channel on the ND side is likely to result in additional utility relocation costs. Revise estimate.

FEASIBILITY IDEAS-

Additional VE ideas were brought forward that the team did not develop due to time constraints and they appeared to be off the principle task of studying ND or MN alignment issues. They are recorded here for potential later development by the PDT team or next VE review.

VALUE ENGINEERING FEASIBILITY IDEAS

F1. Determine future status of the West Fargo Diversion channel? Abandoned sections are projected if North Dakota alignment is selected. Should these be filled or closed for safety?

F2. Parallel channels were discussed in our briefing in ND alignments in the Horace to West Fargo reach- but only 1 channel was shown on the handouts. Are there two channels planned?

F3. Item 9.05 in the FMM cost estimate is not clear if it includes both MN inlets on the Red River - the main diversion structure and a inlet structure for the 14500' long – southern extension?

F4. In areas where flow line is higher than existing grades will we need pump stations for Local interception drains?

F5. New Utility towers that span new channel will likely be built on new fill- settlement issues?

F6. Power relocation estimate $350K seems low for this (MN) project. One set of power towers that can span the 400' wide channel are costly. Review cost.

F7. Existing condition river (water) level table neglects the effects of flood fighting. Red River rises through town as local measures are implemented. (Source: City representative).

F8. Develop a comprehensive exterior drainage plan.

F9. Wave action may be a concern. Wide channels and lengthy straight sections may erode banks- do we need rock protection on some sections of channel?

F10. Review Winnipeg Diversion Channel lessons learned.

F11. Are there any 100-yr farmsteads or historical building issues in either alignment?

F12. If spoil banks were placed on only one side of the channel would it be easier on local farmers, improved drainage or result in other operational benefits?

SUPPORTING DOCUMENTS

CONTACT DIRECTORY

VALUE ENGINEERING TEAM STUDY
APPENDIX A: CONTACT DIRECTORY & VE STUDY TEAM MEMBERS

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SPECULATION LIST

IDEA #	Fargo-Metro Feasibility Study - VE Idea List	Code	#
	PROPOSALS		
6	Align ND diversion east of Sheyenne	P	1
75	Ring dike Harwood	P	1
12	Realign MN diversion (shorten, protect towns with levees)	P	2
56	Re-orient MN short outlet to Red further south	P	2
60	Move MN short alignment west of Kragnes, provide ring levee if necessary	P	2
16	Start ND diversion further north to reduce excavation	P	3
35	Re-route the Sheyenne around Fargo	P	3
46	Move ND east inlet d/s of Wild Rice/Red confluence	P	3
49	S. end of ND diversion shortened	P	3
40	Re-align MN short levee toward Wild Rice/I-29	P	4
41	Dig new channel along I-29 to Wild Rice (get rid of new I-29 crossing)	P	4
43	Modify bridges to reduce construction ("Texas crossings", reduce bridge span, etc.)	P	5
57	15th Street NW bridge (MN short), change skew angle of approach or make Texas crossing	P	5
58	In Kragnes (MN short), consolidate bridges to east of town	P	5
59	Texas crossing at middle Kragnes proposed bridge	P	5
48	N. end of ND diversion, go directly east to Red River	P	6
52	Tunnel under I-29/Co81/RR crossing of ND diversion (near Harwood), or combine bridges	P	7
	P8 eliminated (merged with P2)	P	8
65	Inlets for localized drainage discharge higher in diversion channel (w/riprap)	P	9
66	"Neck/bend" berm fill at localized drainage inlets to reduce pipe length	P	9
67	If can't do 66, move riser to inside of berm top (300' top width)	P	9
68	Downsize outlet structures	P	9
83	25K plan doesn't protect downtown Fargo during 100-year (Elm St closed, 2nd St. dike installed)	P	10
26	Explore options for railroad yard (tunnel, bridges, etc.) – Identify multiple tracks issue.	P	11
	Bypass costs are included in multiple lane road estimates	P	12
	VE COMMENT list		
7	Plan recreation facilities into construction	C	1
8	Bike path	C	1
9	Horse trail	C	1
10	Frisbee golf	C	1
18	ATV park	C	1
19	Hiking trail	C	1
84	Amphitheater	C	1
85	Fishing ponds	C	1
86	Garden plots	C	1
88	Tubing/kayaking/canoeing	C	1
89	Cross country skiing	C	1
90	Sledding hill	C	1
11	Find beneficial use for spoil/cut material	C	2
13	Allow farming in channel	C	3
14	Diversion structure w/ tainter gate design	C	4
15	Add bridge over diversion structure	C	5
17	Wildlife (CRP) preserve	C	6
94	Develop management plan to periodically flood diversions/create wetland	C	6
87	Prairie restoration	C	6
30	Percentage of MN diversion sent to Buffalo River	C	7
31	Build ice passage into diversion	C	8
32	Ice friendly design	C	8
47	Vary embankment elevation/make one bank lower	C	9
51	Road raise for levee feature ND East (east of Red River)	C	10
72	Lateral side drains vs. 3-mile extension channel	C	11

74	"Manifold" inlets at MN short north inlet	C	11
73	Cutoff channels in Red u/s of diversion to reduce stage impacts	C	12
76	Low flow channel within diversion channel	C	13
77	Low flow crossing for segmented farm fields	C	14
78	Address safety issues during floods (patrols, signage, etc.)	C	15
92	Select grass mixes for weed control	C	16
93	Directly seed clay in channels, no topsoil	C	16
	Select bridge designs that don't block flow - requiring smaller approaches	C	17
	Re-organize segmented farms to one side of the channel	C	14

FEASIBILTIY IDEAS

54	Future status of West Fargo diversion channel?	RI
55	Parallel channel question, dwgs show merged design	RI
62	9.05 in cost estimate, does this include both MN south inlets	RI
69	Question? cost estimate = $888M in VE, slide = $962M	RI
70	During flood do we need pump stations for local drainage ditches?	RI
79	Powerline towers built on berms? Possible foundation issues	RI
80	Power relocation estimate ($350K) seems small	RI
81	Existing condition river level table neglects flood fighting (would raise Red levels)	RI
82	25K channel requires flood fight efforts in Fargo at 500-year flood	RI
91	Comprehensive drainage plan, exterior etc.	RI
97	Consider wave action protection in diversion channels (very wide channels)	RI
98	Review Winnipeg diversion lessons learned	RI
99	100-yr farmstead/historical building issues?	RI
100	Place spoil material on one side of channel only (better local drainage, less side slopes)	RI
101	Quantity calculation checks? 45M for MN short vs. 60M hand calc w/25' avg depth	RI

1	Pump Water into diversion Channel	X
3	Hybrid levee/channel system	X
20	Tunnel under I-29 diversion	X
21	Sell water to those who need it	X
22	Move continental divide	X
24	Build to 700-yr level of protection (consortium wants this)	X
25	Use no diversion structures (consortium wants this)	X
33	Haul ice away before flood	X
34	Pump tributaries over diversion channel	X
37	Relocated Fargo	X
38	Ring levee Fargo	X
44	New I-94/38th interchange if ND diversion not combined w/ Horace channel	X
45	Buyouts	X
50	How does existing W. Fargo operate with overlap	X
53	Merge Rush/Lower Rush/Maple Rivers to one structure	X
61	MN short 3-mile extension to south not same x-section as diversion channel	X
63	MN short x-section at 30' depth, discrepancy in channel width on plate	X
64	Does estimate include 3.6M cubic yds for 3-mile extension?	X
71	Widen entrance channel (MN short) to accept additional water, eliminate 3-mile extension	X
95	Grazing rights in diversion channel	X
96	Life jackets/swimming lessons for residents	X
4	Divert Sheyenne River to Red River	X
5	Connection channel b/w Red/Cheyenne	X

2	Do nothing	BD
23	Merge Horace and ND diversion plan	BD
36	Optimize diversion channel size/minimize control structures	BD
42	Minimize structures	BD

27	Dredge Red River through town	PS
28	Straighten Red River	PS
29	Upstream retention	PS

FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

NOT COMPLETED FOR FEASIBILITY LEVEL STUDY

VALUE ENGINEERING TEAM STUDY
APPENDIX D: PDT TEAM REVIEW COMMENTS

FMM Feasibility VE Study - Comments

Proposal	Civil	PM	Structures	Geotech	H&H	Environmental
#1						
Realign ND diversion East of the Sheyenne River & protect Harwood, ND with ring levees.	The ND alignment is a locally preferred alignment and therefore they chose the locations to be taken out of the flood plain to include Harwood. By placing a ring levee around Harwood it would defeated the local sponsors goal of eliminating the small town from becoming isolated each flood season. In addition, the Federal Government would not be able to play a role in a ring levee proposal for the town of Harwood because the Benefit to Cost ratio is not above 1.0 and therefore the local sponsors would have to come up with other means on their own to accomplish this proposal in full.					
#2						
Realign MN diversion by shortening channel & re-orienting outlet works.	This proposal is to realign and shorten the MN diversion by shifting the alignment to the West of Kragness. The alignment is to include the town of Kragness to eliminate their flooding from the Buffalo River which is to the East of the town. If the channel were aligned to exclude the town of Kragness it would also make the city of Moorhead feel as though they are being squeezed for future development which was not acceptable for their city's acceptance of the MN diversion alternative.				Figures 2 & 3 regarding the outlet design and location of the MN alignment were agreed and completed during phase 3 of the feasibility study.	
#3						
Begin ND diversion channel further North.	Again, the ND alignment is a locally preferred alignment and therefore they chose the general location for the inlet. Their reasoning for the location of the inlet being further South than the MN alignment was to accommodate the city of Fargo's current future plans of development and to protect the city from the Wild Rice River flooding to the South.	To eliminate and relocate the 10 houses of Horace will not be acceptable to the Locally Preferred Plan sponsors.			With the new location proposed of the inlet structure it is very probable that a control structure of some sort will need to be placed at the intercept of the Wild Rice River and the Red River of the North due to the amount of water build up that will occur. This is a similar concept to the extension channel on the MN alignment that was needed for conveyance, no structure at the proposed ND inlet on the Wild Rice will potentially disrupt the design of the channel.	
#4						
Redesign Wild Rice Diversion for MN alignments.	Agreed...This is a possibility to consider during plans and specifications if the MN alignment is chosen.					
#5						
Replace bridged crossings with at grade crossings.			The level of design that has been done is only feasibility level and for the purpose of feasibility the cost needs to be as close as possible to construction cost and therefore actual bridges were only considered at this stage. This is an option to look into during plans and specifications as each crossing will need to be considered individually. The major issue with this idea is the impedance it will cause with the low flow channel. The purpose of the low flow channel was to continually pass enough flow through the channel so that it did not change the environmental habitat that will be meandering through for example the northern end of the ND alignment. This idea will require the concurrence of the natural resource agencies, the safety council for the required work to patrol the roads during every rain storm as well as the hydraulics department to ensure the overall channel purpose will not be affected. This is a possibility for cost savings and will be considered during plans and specifications.			

#6						
Realign North end of ND diversion/outlet further South.	As the ND alignment is a locally preferred alignment the inlet and outlet locations were generally chosen by the local sponsors. During plans and specifications the exact locations will be further surveyed and analyzed for project acceptance and local sponsor acceptance.					
#7						
Construct U-Channel through areas of multiple bridges.				This is a possible betterment that could be considered during plans and specifications, but additional geotech modeling would be required because of the poor stability with the interaction of the Brenna and Argusville interface around 30-35 feet below ground surface.		
#8						
Redesign intercept inlet works.			Concepts #4 & #6 should be farther examined during the plans and specifications stage of the project.	After completeing phase 3 design of the channel two significant changes have been made. The channel was having stability issues with the depth of the channel on the ND alignment and the MN alignment was having uplift issues with the Buffalo aquifer. To eliminate these issues both alignment designs now include a minimum of a 50 foot bench to increase the neutral block on global stability analysis. The second alteration to the design was side slopes being maintained at a 7:1. Drawing #2 of the proposal shows the invert 72" pipe being raised, this would cause too much errosion for stability purposes of the channel. Drawing #3 reverts to a side slope of 3:1, this is also not possible with the requirements of stability factors		
#9						
Raise in city protection to 100 year level		Due to the phase 3 hydrology of the synthetic events and calibration with the 2009 flood event it has been found that the cities of Fargo and Moorhead now have never faced a 100 year event. The cities goal of passing a 100 year event with a stage no greater than 30.0 feet at the Fargo gage and a 500 year event with a stage no greater than 36.0 feet at the Fargo gage is now no longer feasible with the 25K cfs plan. It has been determined that the National Economic Development plan through further analysis is the MN 40K plan. The cities have come to agreement that the ND 35K cfs plan provides enough protection and is what they can afford, therefore the ND 35K plan is now compared with what is known as the Federally Comparable Plan, FCP, the MN 35K plan. The FCP is the plan that provides equal benefits to the Locally Preferred Plan. In conclusion, it is no longer possible due to the development in the hydrology and hydraulics for the cities to raise their in town level of protection to the 100 year, without sacrificing a dramatically large levee footprint along the Red River of the North.				
#10						
Railroad yard relocation.	Due to the constraints of the Buffalo Aquifer it is as impossible to construct the diversion channel East of BNSF's rail yard as it is for them to shift or expand their rail yard any farther East. This was learned in a conference with BNSF where they explained to the FMM PDT that their last refueling station lies just East of their rail yard and they had looked into expanding East, but were not able to because of the Buffalo Aquifer proximity the rail yard.		The other part of this proposal involved constructing the diversion channel through the rail yard. After the conference with BNSF they explained that this was not an acceptable design option for them due to safety and operation. The safety factor included for them how dangerous it is to have a car derail over the diversion channel in the yard, where they would have to drag it off the bridged rail yard. The operation for the rail yard required that they not be interrupted with this construction and if they are to make use of their existing rail yard while under construction they expressed the need for an alternate functioning location because they would not be able to shut down the main line or any switching on bridges even if they			

APPENDIX O
ATTACHMENT 6

ASA(CW) Approvals to tentatively recommend the Locally Preferred Plan

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

APR 2 8 2010

MEMORANDUM FOR DEPUTY COMMANDING GENERAL FOR CIVIL AND EMERGENCY OPERATIONS

SUBJECT: Fargo-Moorhead Metropolitan Area, North Dakota and Minnesota – Deviation from the National Economic Development Plan

I am responding to the Mississippi Valley Division Regional Integration Team's memorandum of April 19, 2010, that requests an exception to the policy that requires the U.S. Army Corps of Engineers to recommend the National Economic Development (NED) Plan. The exception would allow the Corps to recommend a Locally Preferred Plan (LPP) for flood damage reduction improvements in the Fargo-Moorhead Metropolitan Area in a pending draft feasibility report and draft environmental impact statement. The request indicates that the cities of Fargo, North Dakota, and Moorhead, Minnesota, as the non-Federal sponsors, and Cass and Clay counties have requested implementation of the LPP in lieu of the NED Plan.

After reviewing the materials you provided, I have decided to grant the requested policy exception because the LPP would significantly reduce flood damages, the risk of loss of life, and the need for emergency flood fighting measures. The LPP would reduce average annual damages about $17,000,000 more than the NED Plan and reduce the residual damages to about $9,704,000 (about 13 percent of damages without a project) compared to $22,667,000 for the NED Plan. The LPP would remove about 80 square miles from the 100-year floodplain, which is about 50 square miles more than the NED Plan. The LPP would benefit about 6,625 more people and protect about 3,100 more structures than the NED Plan. As proposed, the non-Federal sponsors would be responsible for the extra costs of the LPP, so the Federal cost would remain the same for the NED Plan and the LPP, currently estimated at $505,940,000. The non-Federal cost share would increase from about $272,430,000 with the NED Plan to about $573,543,000 with the LPP.

The Corps has indicated that the St. Paul District is currently revising the hydrologic, hydraulic, economic, and mitigation analyses for the NED Plan and the LPP, and that these revisions may change the NED Plan designation to a larger capacity diversion in Minnesota. Such a change would decrease the differences between the NED Plan and the LPP described above. This approval is subject to the Corps finding that the differences in effects between the NED Plan and the LPP are similar to or smaller than those described above.

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The St. Paul District may prepare a draft report and environmental impact statement recommending the LPP. I concur that the added cost of the LPP relative to the NED Plan, currently estimated at $301,133,000, would be a non-Federal cost, with the remainder of the first cost shared 65 percent Federal, 35 percent non-Federal consistent with current policy.

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

APR 2 8 2011

MEMORANDUM FOR DEPUTY COMMANDING GENERAL FOR CIVIL AND EMERGENCY OPERATIONS

SUBJECT: Fargo-Moorhead Metropolitan Area, North Dakota and Minnesota – Deviation from the National Economic Development (NED) Plan

I am responding to the U.S. Army Corps of Engineers' April 25, 2011, memorandum requesting that I confirm that the policy exception that I provided on April 28, 2010, to support efforts to reduce flood risks in the Fargo-Moorhead Metropolitan Area remains valid or that I grant a new policy exception. The Corps' request would enable the St. Paul District to release a supplemental draft feasibility report and environmental impact statement, which tentatively selects a Locally Preferred Plan (LPP) in lieu of the NED Plan. The memorandum identifies significant changes in the ongoing feasibility study. The request includes an April 6, 2011, letter from the non-Federal sponsors requesting the tentative selection of the LPP for implementation and acknowledging that they would be responsible for all costs in excess of the Federal share of the Federally Comparable Plan (FCP).

After reviewing the materials provided, I have determined that the LPP and NED Plan have changed significantly during the past year and that my previous policy exception is no longer valid. I have determined that the revised LPP does warrant a new exception because the revised LPP would significantly diminish flood damages, reduce the risk of loss of life, and lessen the need for emergency flood fighting measures. The Corps may publicly release the supplemental draft feasibility report and environmental impact statement and therein identify the LPP as the tentatively selected plan with the non-Federal sponsors responsible for the non-Federal cost share of the FCP in accordance with Section 103(a) of the Water Resources Development Act of 1986, as amended, plus the added costs of the LPP.

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

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APPENDIX O
ATTACHMENT 7

Red River Diversion - Alternatives Scenario Analysis

RED RIVER DIVERSION

FARGO – MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT, FEASIBILITY STUDY, PHASE 4

ALTERNATIVE SCENARIOS ANALYSIS

Report for the cities of Fargo, North Dakota & Moorhead, Minnesota

FINAL REPORT: April 8, 2011

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1.0 BACKGROUND AND OVERVIEW

1.1 PURPOSE FOR STUDY

This report is a follow up to the February 28, 2011 report entitled "*Red River Diversion, Fargo - Moorhead Metro Flood Risk Management Project, Feasibility Study, Phase 4, Report for the US Army Corps of Engineers, and the cities of Fargo, ND & Moorhead, MN*". The purpose of the alternative scenario analysis was to develop preliminary hydraulic designs for several design modifications to the Locally Preferred Plan (LPP) presented in the February 28, 2011 report that would still match the hydraulic profiles through Fargo-Moorhead that were developed with the LPP. The costs and impacts associated with these alternative scenarios provide necessary information for decision making officials to consider when evaluating and the LPP.

1.2 PHASE 4 SUMMARY (FEBRUARY 28, 2011 REPORT)

The February 28, 2011 technical report documents the Phase 4 design and impact analysis for the LPP and the impact analysis for the Federally Comparable Plan (FCP). The FCP was not redesigned from the Phase 3 design. The LPP and FCP alignments are shown in Figure 1. The Phase 4 LPP design incorporates "smart storage" (Storage Area 1) and staging on the upstream side of the project in order to eliminate adverse downstream impacts. This in turn reduces the amount of flow required to pass through the diversion and allows for a smaller diversion channel. The inclusion of these features to the project required the use of HEC-RAS unsteady flow models for the project feasibility design. Previously, steady flow models were used for the project feasibility design and unsteady flow models were utilized for the determination of project impacts. An extensive effort was required to develop unsteady flow models that were suitable for the feasibility level design. The development of the existing conditions unsteady flow models, along with the subsequent modifications for the LPP design, are discussed in great detail in Appendix B of the February 28, 2011 report. The result of the Phase 4 LPP design is that the downstream impacts are adequately mitigated by staging 6.50 feet and 8.25 feet of water upstream of the diversion for the 1-percent and 0.2-percent chance floods, respectively. The inundation areas associated with staging for these two events are shown in Figure 2 and Figure 3. The water surface profiles for existing conditions and for the LPP are shown in Figure 4. The estimated project cost of the Phase 4 LPP is $1,760,453,000. See Table 17 for detailed breakdown of the estimated costs.

1.3 OVERVIEW OF ALTERNATIVE SCENARIOS ANALYSIS

The analysis of the alternative scenarios was completed by modifying the Phase 4 HEC-RAS unsteady flow models developed for the Phase 4 LPP to reflect the geometry changes associated with each scenario. With the exception of one scenario, the alternatives follow the Phase 4 LPP alignment and include modifications to specific design features and operations. While generally following guidelines related to hydraulic and other environmental impacts set out during previous design phases, the potential modifications may include additional impacts not included in previous phases of design or impacts that were considered by some parties to be too large during previous EIS comment periods. In each scenario, only the 1-percent and 0.2-percent chance events

were analyzed as it was assumed that upstream and downstream impacts would be less of a concern for more frequent events. The six alternative scenarios considered for this analysis are briefly described below.

1. Preliminary hydraulic design of a modified LPP including a larger "smart storage" area and reduced upstream staging.
2. Preliminary hydraulic design of a modified LPP with no "smart storage" area, reduced upstream staging and allowing some downstream impacts (generally in the 3" to 6" range at Thompson).
3. Preliminary hydraulic design of a modified LPP including Storage Area 1 with the addition of one or more large off stream storage areas downstream of the project and reduced upstream staging.
4. Preliminary hydraulic design of a modified LPP with no "smart storage" and with no upstream staging.
5. Preliminary hydraulic design of a modified LPP including no "smart storage" but including increased upstream staging.
6. Preliminary hydraulic design of a modified LPP including Storage Area 1 with the south end of the diversion alignment modified to a location south of Hickson, Oxbow and Bakke Subdivision.

In each case, the location and magnitude of the hydraulic impacts of the scenario when compared to existing conditions, both upstream and downstream of the project, has been determined and the results are provided in a series of summary tables and maps. Feasibility cost estimates have been developed for each alternative. These cost estimates have used the Phase 4 LPP cost estimates as a basis but have been developed to a lower level of detail. The cost estimates include costs related to mitigating hydraulic impacts upstream and downstream of the project based on the Phase 4 LPP design, but do not include any considerations for increased or decreased mitigation requirements as result of the environmental impacts associated with the modifications involved with the alternative scenarios. The background information on the development of these alternative scenarios and the results for each one are discussed in further detail in this report.

2.0 MODELING

2.1 HYDROLOGY

C2.1.1 Design Event Hydrology. The Phase 4 LPP was designed for only the 10-, 2-, 1- and 0.2-percent chance events, in all cases using the hydrology scenario corresponding to project year zero. The geometries for each return period event were identical, but the gate operations for the control structures were adjusted to meet the flow criteria established for each structure and each design event. For this alternative scenario analysis, only the 1-percent and 0.2-percent chance events were modeled and analyzed for impacts because it was assumed that upstream and downstream impacts would be less of a concern for more frequent events. Refer to Appendix A in the February 28, 2011 report for background information on the development of the hydrology used in this analysis.

2.2 HYDRAULICS

2.2.1 Existing Conditions Models. The existing conditions models for Phase 4 were produced by Houston Engineering, Inc. (HEI). HEI had developed earlier versions of the unsteady flow models used to analyze the previous diversion designs. These models underwent extensive updates due to the modeling needs presented in Phase 4, including the addition of hundreds of storage areas and the extension of the model downstream to Drayton, North Dakota and upstream to Abercombie, North Dakota. The Sheyenne River and Maple River systems were also added to the models. The updated models were completed through collaboration with other members of the design team- USACE, Moore Engineering, Barr Engineering and HDR Engineering- with support provided for GIS analysis, hydrologic modeling and peer reviews. HEI has documented the development of these models in Appendix B of the February 28, 2011 report.

2.2.2 Reference Model. The existing conditions models discussed above include separate geometry files representing conditions with and without emergency protection measures in place within the project area. These emergency measures would be structural barriers like clay levees, sand bag levees and flood walls that were used by the communities for protection during actual flood events. The existing conditions models were calibrated to measured high water marks during the 2009 spring flood. The existing conditions model was also verified with the 1997, 2006, and 2010 historic flood events. Because the emergency measures were in place during the historic flood events, they are reflected in the geometry used in the models in order to get an accurate calibration. After calibration, the emergency levees were removed to produce the geometry for the unprotected condition. This allows for the determination of the full benefits of the project by comparing it to the damages that would be incurred if nothing was done to protect the communities. All impacts presented in this report reference the "without emergency protection" condition for both existing and with-project conditions.

2.2.3 Phase 4 With-Project Conditions Models. The design for Phase 4 of this study involved new aspects, namely storage cells and staging upstream of the FM Metro area, which could not be properly accounted for with the steady state models that had been used in the previous phases. The design and subsequent impact analysis for Phase 4 was based on the unsteady flow models developed by HEI for existing conditions. While the design for Phase 4 shifted to an unsteady flow modeling methodology, the premise behind the design for the diversion channel and the associated hydraulic structures remained essentially the same. The addition of the upstream storage and staging added additional components to the design, but they simply resulted in different design discharges for the diversion channel and structures. Appendix C in the February 28, 2011 report details the modifications made to the existing conditions models to develop the with-project models for Phase 4. The impacts associated with the Phase 4 LPP design for the 1-percent and 0.2-percent chance events are shown in Table 1 and Table 2, respectively.

Table 1: Phase 4 LPP – 1-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 1% Chance Event								2-28-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection	
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)
Drayton Gage	1062362	801.73	119255	801.81	120751	0.08	1496
ND SH#17/ MN SH317	1223286	804.09		804.16		0.07	
Co. Hwy 15	1315673	805.08		805.13		0.05	
Minimum Impact Location	1410241	811.47		811.51		0.04	
Oslo Gage	1416287	813.01		813.07		0.06	
DS Grand Forks Levees	1533523	827.98		828.13		0.15	
Grand Forks Gage	1558518	832.97	107980	833.21	110497	0.24	2517
Maximum Impact Location	1573768	835.27		835.56		0.29	
32nd Ave, Grand Forks	1580152	835.83		836.11		0.28	
Thompson Gage	1667877	847.35	82926	847.39	82608	0.04	-317
Co. Hwy 25/ Co. Rd 221	1726274	854.46		854.44		-0.02	
DS Sandhill River/ Climax	1763746	857.34		857.30		-0.04	
Nielsville	1829877	861.66	75745	861.62	76038	-0.04	293
DS Marsh River	1864960	863.43		863.40		-0.03	
US Goose River/ Shelly	1891054	865.36		865.32		-0.04	
Halstad Gage	1981580	869.09	71581	869.03	70992	-0.06	-589
Hendrum	2038409	873.75	67278	873.69	66095	-0.06	-1183
Perley	2129181	878.50	61723	878.22	57044	-0.28	-4679
Georgetown	2194021	883.36		883.11		-0.25	
North River/ Clay Co. Hwy 93	2305647	893.73		886.48		-7.25	
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	899.08		890.50		-8.58	
Fargo Gage (13th Ave S, 12th Ave S)	2388223	903.86 (41.12*)	34875	893.54 (30.8*)	11718	-10.32	-23157
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	907.71		897.66		-10.05	
US ND Wild Rice River	2484618	910.70		901.71		-8.99	
US LPP Diversion	2531315	914.65		922.88		8.23	
Hickson Gage	2563754	917.52	21730	922.90	18655	5.38	-3075
Abercrombie	2764835	935.62	23000	935.73	23000	0.11	0

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

Table 2: Phase 4 LPP – 0.2-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 0.2% Chance Event								2-28-2011
Location	Station	Existing No Protection		ND Diversion (FCP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	804.12	168364	804.23	171002	0.11	2638	
ND SH#17/ MN SH317	1223286	805.99		806.06		0.07		
Co. Hwy 15	1315673	806.74		806.83		0.09		
Minimum Impact Location	1410241	812.15		812.19		0.04		
Osio Gage	1416287	813.88		813.93		0.05		
DS Grand Forks Levees	1533523	829.92		830.04		0.12		
Grand Forks Gage	1558518	836.36	146225	836.58	149112	0.22	2887	
Maximum Impact Location	1561353	838.53		838.80		0.27		
32nd Ave, Grand Forks	1580152	839.75		839.98		0.23		
Thompson Gage	1667877	850.69	112422	850.64	111394	-0.05	-1027	
Co. Hwy 25/ Co. Rd 221	1726274	859.38		859.26		-0.12		
DS Sandhill River/ Climax	1763746	862.75		862.60		-0.15		
Nielsville	1829877	867.04	107296	866.88	105953	-0.16	-1344	
DS Marsh River	1864960	868.06		867.92		-0.14		
US Goose River/ Shelly	1891054	869.30		869.17		-0.13		
Halstad Gage	1981580	871.54	101754	871.32	92746	-0.22	-9007	
Hendrum	2038409	875.77	97650	875.47	90871	-0.30	-6779	
Perley	2129181	879.89	90756	879.53	79857	-0.36	-10899	
Georgetown	2194021	884.48		884.15		-0.33		
North River/ Clay Co. Hwy 93	2305647	895.35		892.96		-2.39		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	900.31		898.32		-1.99		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	905.8 (43.06*)	61717	902.77 (40.03*)	29865	-3.03	-31852	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	909.13		907.08		-2.05		
US ND Wild Rice River	2484618	911.54		910.23		-1.31		
US LPP Diversion	2531315	915.94		922.44		6.50		
Hickson Gage	2563754	919.69	35636	922.54	32491	2.85	-3145	
Abercrombie	2764835	940.90	44308	940.91	44308	0.01	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

2.2.4 Alternative Scenarios With-Project Models. Each scenario is discussed in detail in Section 3 below, including the required modifications to the LPP unsteady flow models. In each case, only the design features identified for modification were altered in the original geometry files. However, the models include hydraulic structures with gates that are operated within the model with the use of rules that were developed to maintain specific discharges and water surface profiles within the protected area. With the alternative scenarios, the flow conditions can be changed enough that the rules had to be adjusted to maintain the desired results within the protected area.

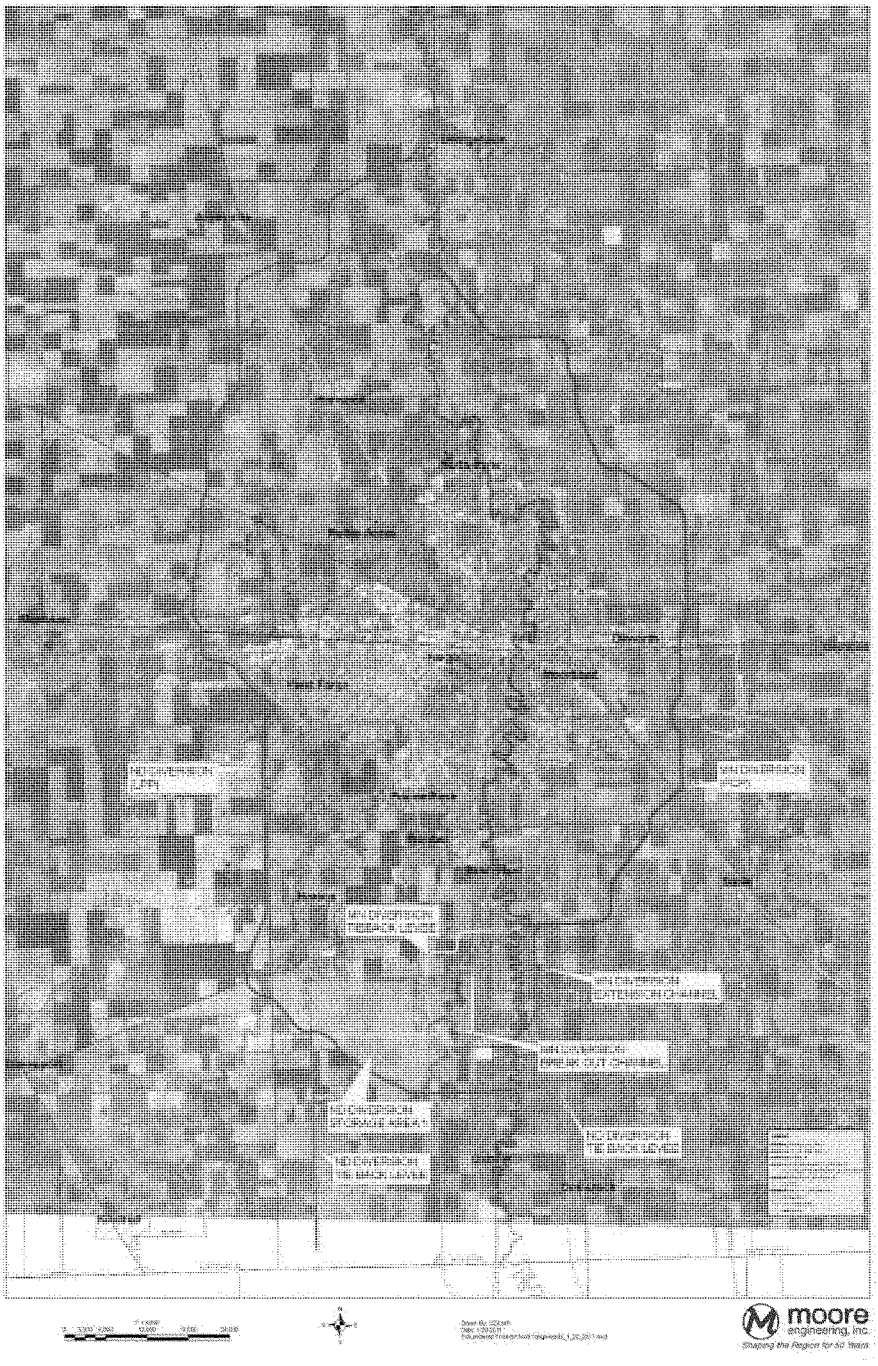


Figure 1: Red River Diversion Channel Alignments (FCP and LPP)

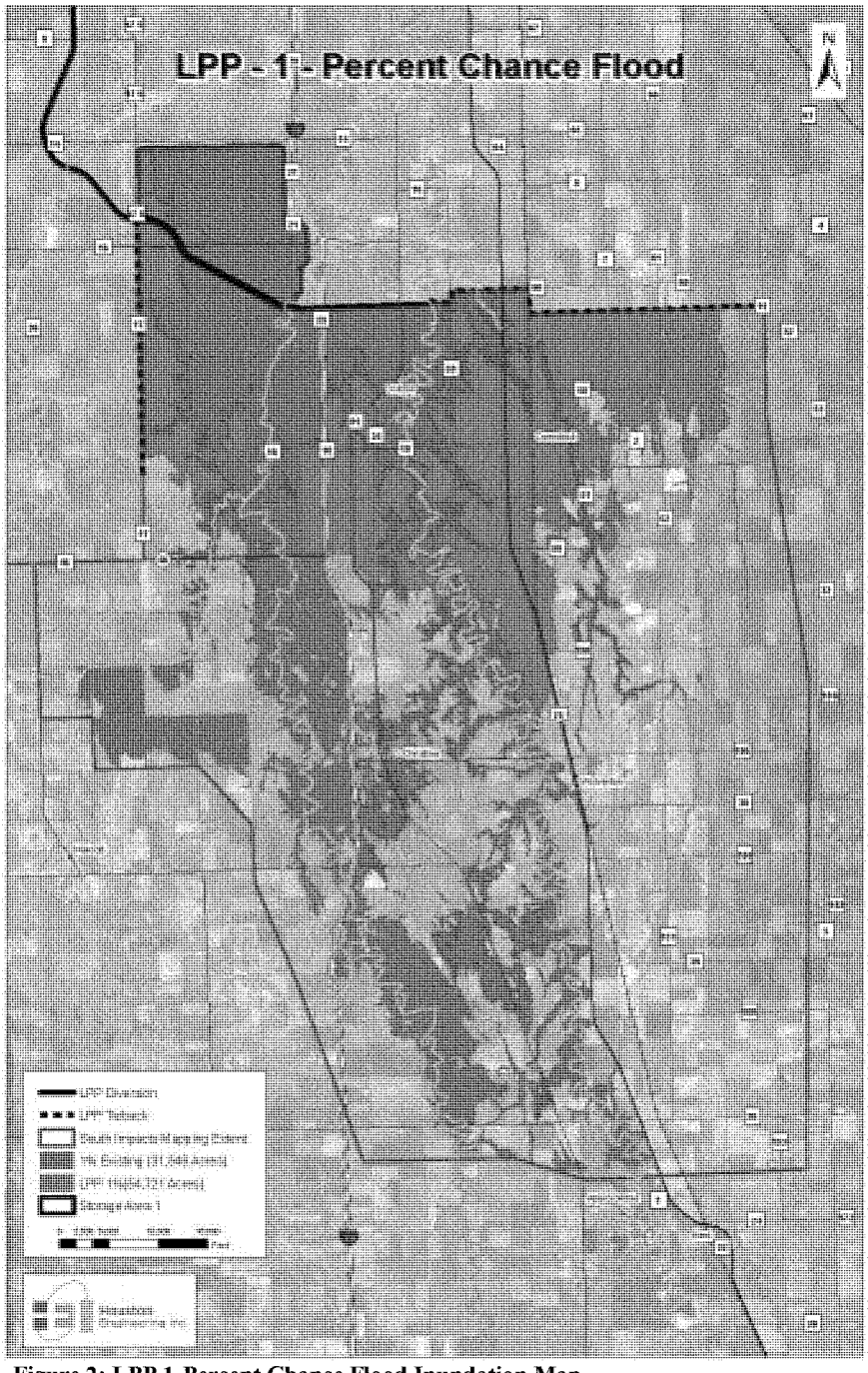


Figure 2: LPP 1-Percent Chance Flood Inundation Map

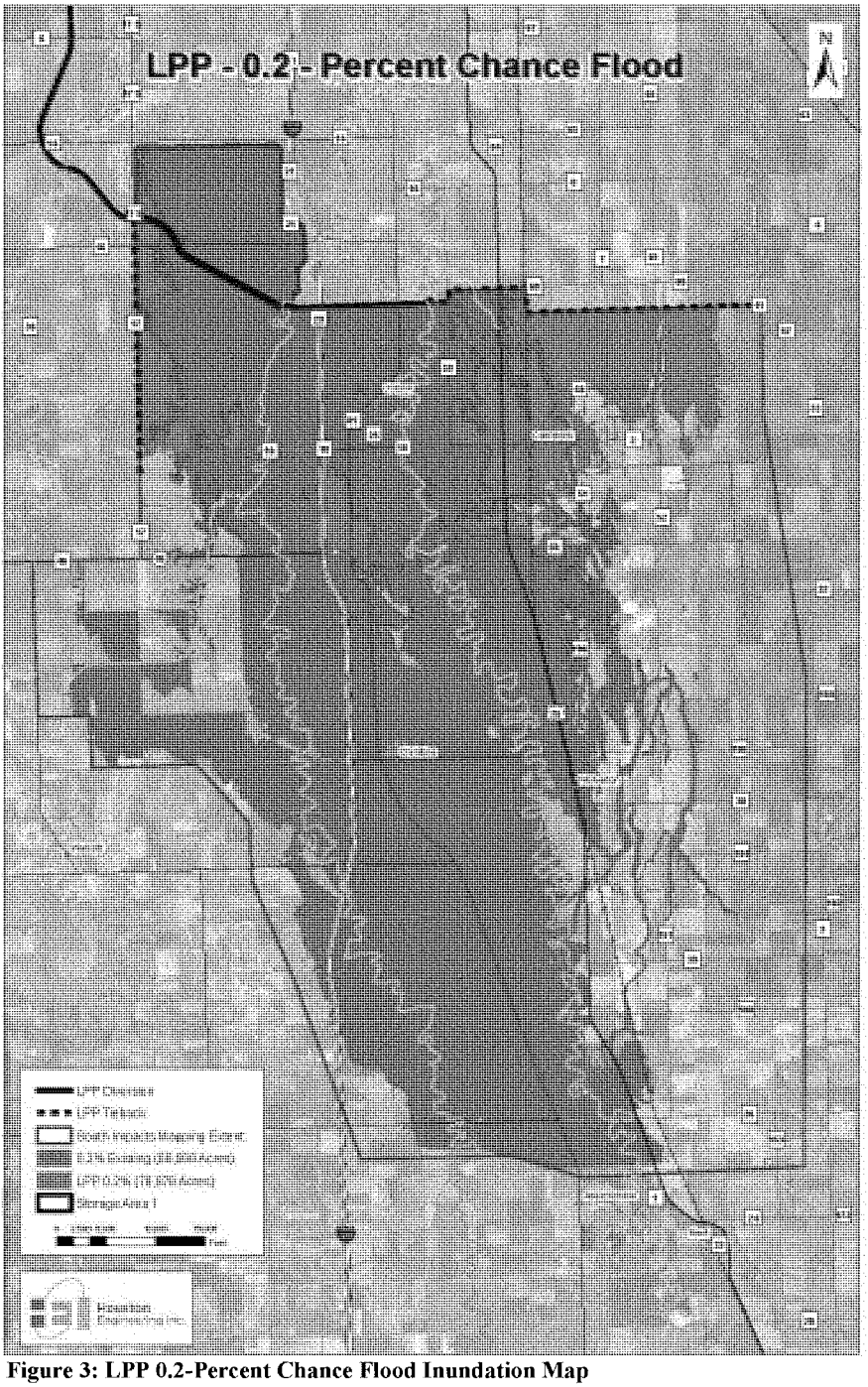


Figure 3: LPP 0.2-Percent Chance Flood Inundation Map

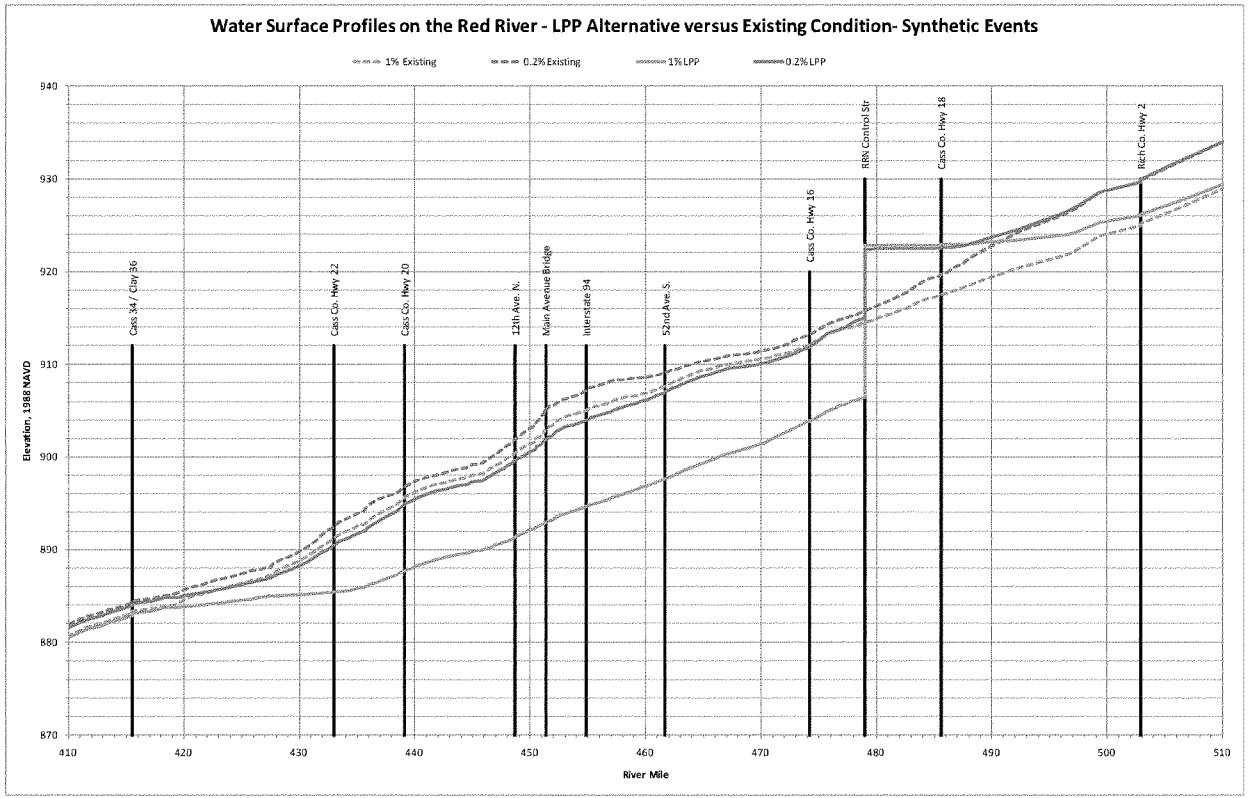


Figure 4: Water Surface Profiles on the Red River- LPP vs. Existing Condition

3.0 ALTERNATIVE SCENARIOS ANALYSIS

3.1 SCENARIO 1

3.1.1 Description. Scenario 1 includes preliminary hydraulic design of a modified LPP including a larger "smart storage" area (Storage Area 1) and reduced upstream staging.

3.1.2 Development. The original footprint of Storage Area 1 in the February 28, 2011 report covered an area north of the LPP alignment to an area just south of Cass Highway 14 (100th Ave). This area was extended further north to just south of 76th Ave with Scenario 1. Storage Area 1 included in the Phase 4 LPP design was 4,160 acres, with 55,800 acre-feet of volume at an elevation of 923. With Scenario 1, the enlarged storage area is 6,120 acres, with 85,800 acre-feet of volume at an elevation of 923. The location of the larger Storage Area 1 in relation to the overall project is shown in Figure 5 and is shown in greater detail in Figure 6.

For this scenario, the water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. Since the storage capacity of Storage Area 1 was increased, additional water was passed into the diversion channel in order to maintain the same level of downstream impacts as with the Phase 4 LPP design. This required that the diversion inlet weir be increased from 90 to 100 feet. The gate operations for the control structures on the Wild Rice River, Red River, and Wolverton Creek were not changed from what was included in the Phase 4 LPP for this scenario.

3.1.3 Costs. The estimated cost of a Scenario 1 LPP project is $1,822,018,300. A breakdown of the estimated costs associated with this project is included in Table 17.

3.1.4 Impacts. Compared to existing conditions, the increase in water surface elevations upstream of the Red River control structure for the 1-percent and 0.2-percent chance events is approximately 7.6 and 6.0 feet, respectively. When compared to the results presented for the LPP in the February 28, 2011 report, the upstream staging decreased 0.64 and 0.52 feet for the 1-percent and 0.2-percent chance events, respectively. As mentioned previously, the water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. The impacts of Scenario 1 for the 1-percent and 0.2-percent chance events with respect to existing conditions are presented in Table 3 and Table 4, respectively. The impacts of this scenario in relation to the Phase 4 LPP design are presented in Table 15 and Table 16. The inundation areas associated with the upstream staging for each event are shown in Figure 7 and Figure 8, respectively.

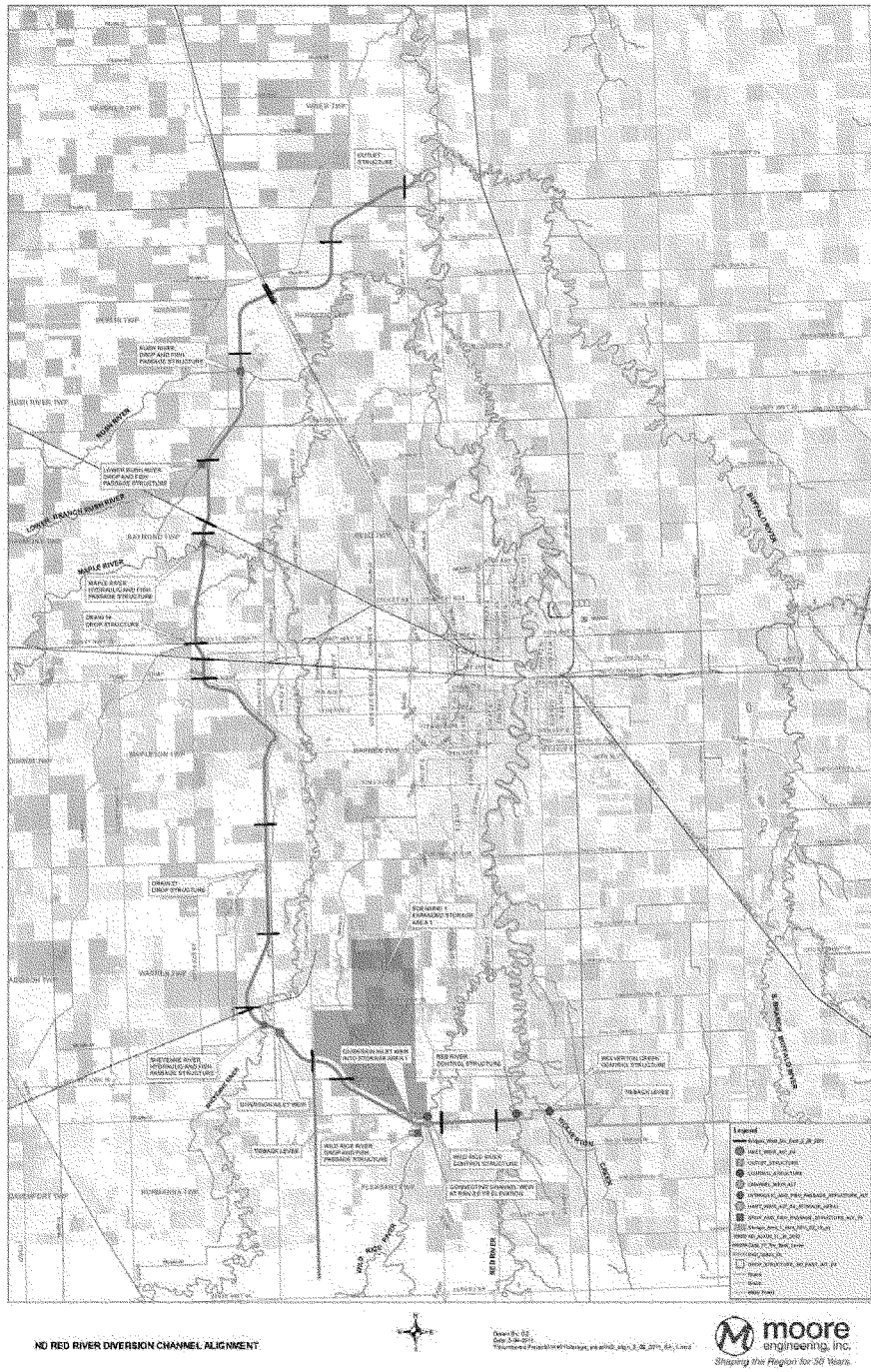


Figure 5: Scenario 1 Layout

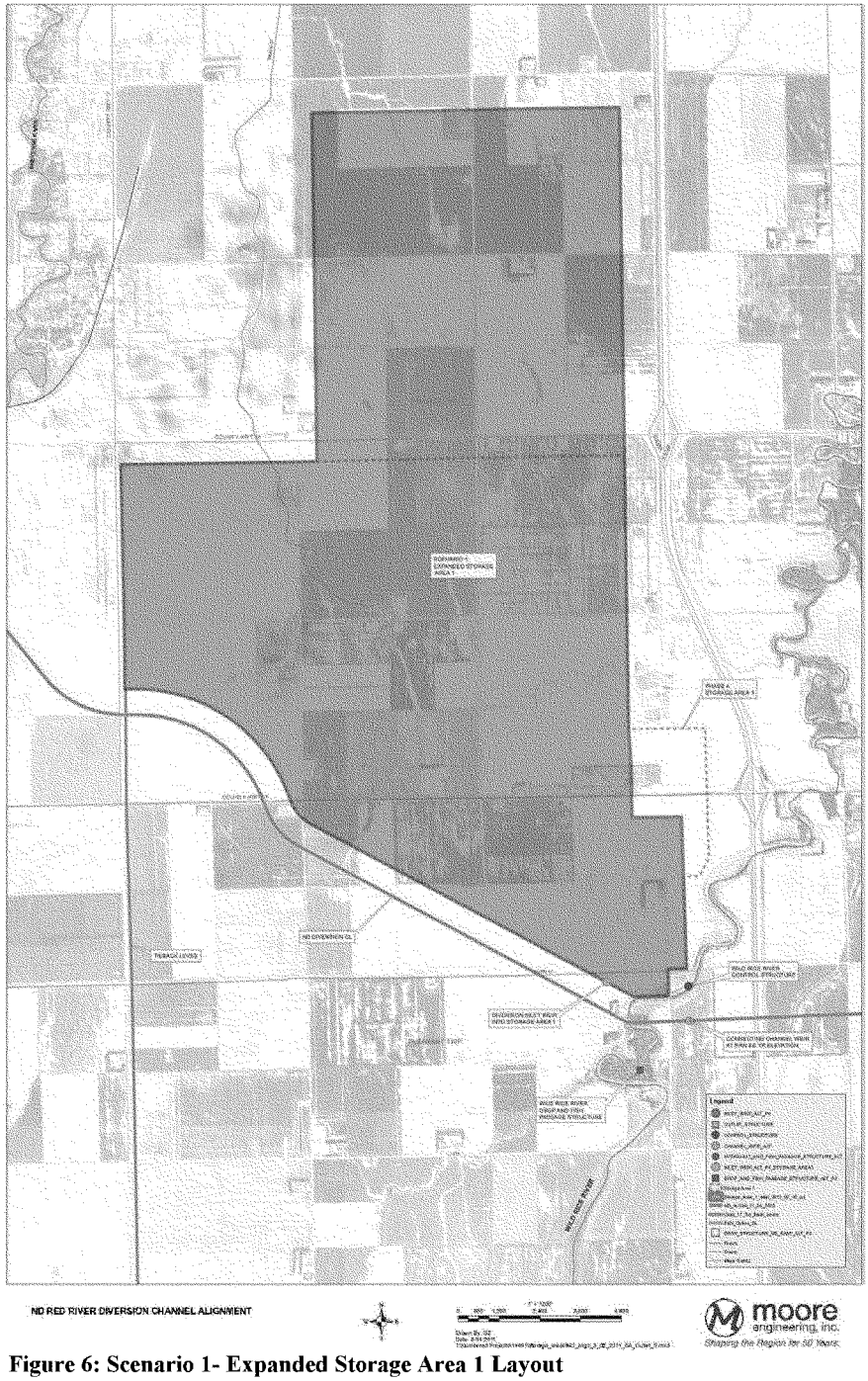


Figure 6: Scenario 1- Expanded Storage Area 1 Layout

Table 3: Scenario 1– 1-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 1% Chance Event- Scenario 1								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	801.73	119255	801.79	120546	0.06	1291	
ND SH#17/ MN SH317	1223286	804.09		804.15		0.06		
Co. Hwy 15	1315673	805.08		805.12		0.04		
Minimum Impact Location	1408098	811.34		811.37		0.03		
Oslo Gage	1416287	813.01		813.06		0.05		
DS Grand Forks Levees	1533523	827.98		828.11		0.13		
Grand Forks Gage	1558518	832.97	107980	833.19	110245	0.22	2265	
Maximum Impact Location	1573768	835.27		835.53		0.26		
32nd Ave, Grand Forks	1580152	835.83		836.08		0.25		
Thompson Gage	1667877	847.35	82926	847.37	82493	0.02	-433	
Co. Hwy 25/ Co. Rd 221	1726274	854.46		854.42		-0.04		
DS Sandhill River/ Climax	1763746	857.34		857.28		-0.06		
Nielsville	1829877	861.66	75745	861.60	75918	-0.06	173	
DS Marsh River	1864960	863.43		863.38		-0.05		
US Goose River/ Shelly	1891054	865.36		865.31		-0.05		
Halstad Gage	1981580	869.09	71581	869.03	70744	-0.06	-837	
Hendrum	2038409	873.75	67278	873.68	65966	-0.07	-1313	
Perley	2129181	878.50	61723	878.23	57037	-0.27	-4686	
Georgetown	2194021	883.36		883.10		-0.26		
North River/ Clay Co. Hwy 93	2305647	893.73		886.37		-7.36		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	899.08		890.39		-8.69		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	903.86 (41.12*)	34875	893.42 (30.68*)	11593	-10.44	-23282	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	907.71		897.55		-10.16		
US ND Wild Rice River	2484618	910.70		901.60		-9.10		
US LPP Diversion	2531315	914.65		922.24		7.59		
Hickson Gage	2563754	917.52	21730	922.27	19516	4.75	-2215	
Abercrombie	2764835	935.62	23000	935.72	23000	0.10	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

Table 4: Scenario 1– 0.2-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 0.2% Chance Event- Scenario 1								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	804.12	168364	804.22	169109	0.10	745	
ND SH#17/ MN SH317	1223286	805.99		806.06		0.07		
Co. Hwy 15	1315673	806.74		806.82		0.08		
Minimum Impact Location	1410241	812.15		812.19		0.04		
Oslo Gage	1416287	813.88		813.93		0.05		
DS Grand Forks Levees	1533523	829.92		830.03		0.11		
Grand Forks Gage	1558518	836.36	146225	836.56	148864	0.20	2887	
Maximum Impact Location	1561353	838.53		838.77		0.24		
32nd Ave, Grand Forks	1580152	839.75		839.95		0.20		
Thompson Gage	1667877	850.69	112422	850.62	111230	-0.07	-1191	
Co. Hwy 25/ Co. Rd 221	1726274	859.38		859.24		-0.14		
DS Sandhill River/ Climax	1763746	862.75		862.57		-0.18		
Nielsville	1829877	867.04	107296	866.85	105705	-0.19	-1591	
DS Marsh River	1864960	868.06		867.90		-0.16		
US Goose River/ Shelly	1891054	869.30		869.15		-0.15		
Halstad Gage	1981580	871.54	101754	871.31	96680	-0.23	-5074	
Hendrum	2038409	875.77	97650	875.45	90590	-0.32	-7060	
Perley	2129181	879.89	90756	879.52	79588	-0.37	-11168	
Georgetown	2194021	884.48		884.14		-0.34		
North River/ Clay Co. Hwy 93	2305647	895.35		892.88		-2.47		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	900.31		898.18		-2.13		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	905.8 (43.06*)	61717	902.57 (39.83*)	29092	-3.23	-32625	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	909.13		906.94		-2.19		
US ND Wild Rice River	2484618	911.54		910.13		-1.41		
US LPP Diversion	2531315	915.94		921.92		5.98		
Hickson Gage	2563754	919.69	35636	922.04	34272	2.35	-1365	
Abercrombie	2764835	940.90	44308	940.91	44308	0.01	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

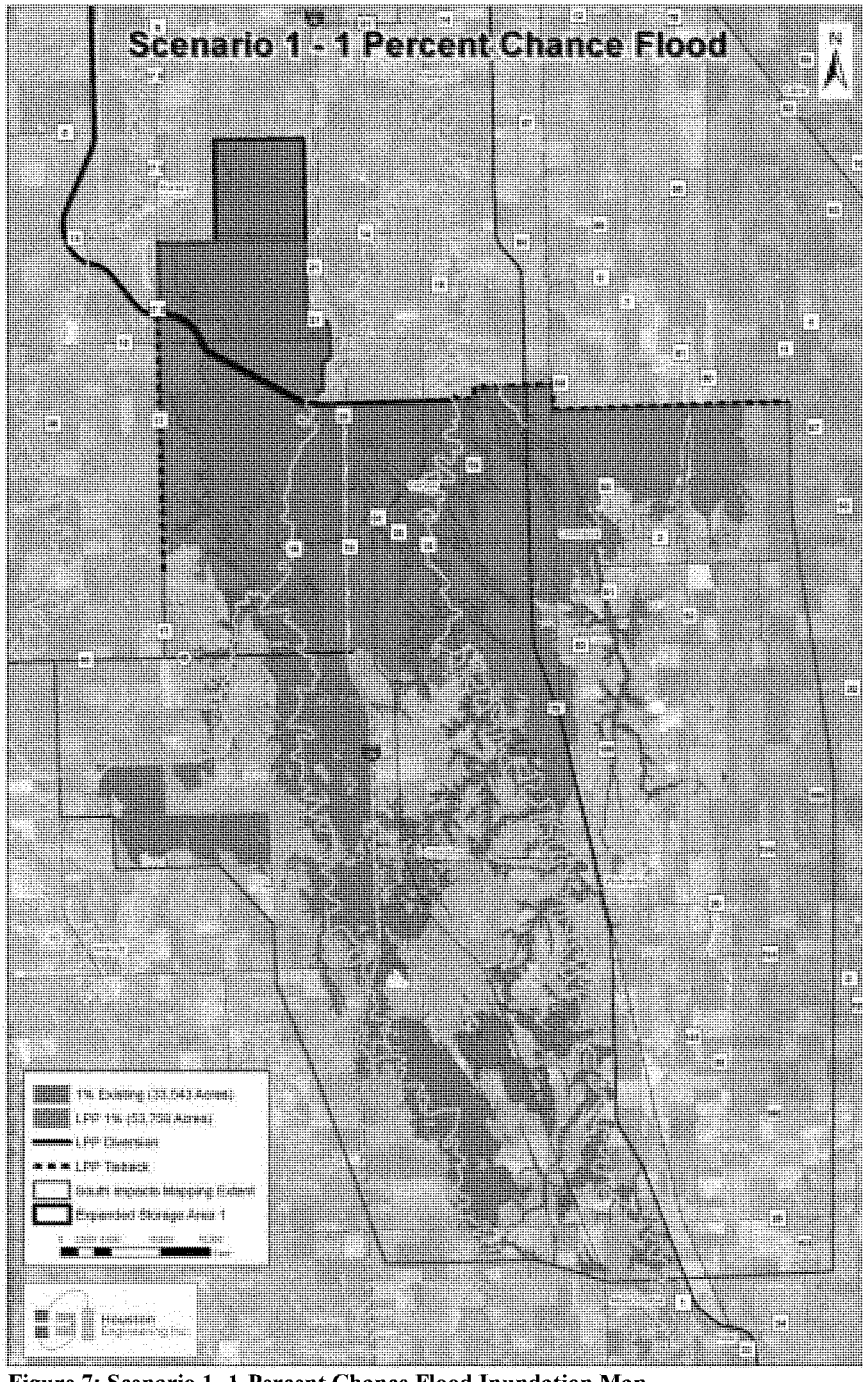


Figure 7: Scenario 1- 1-Percent Chance Flood Inundation Map

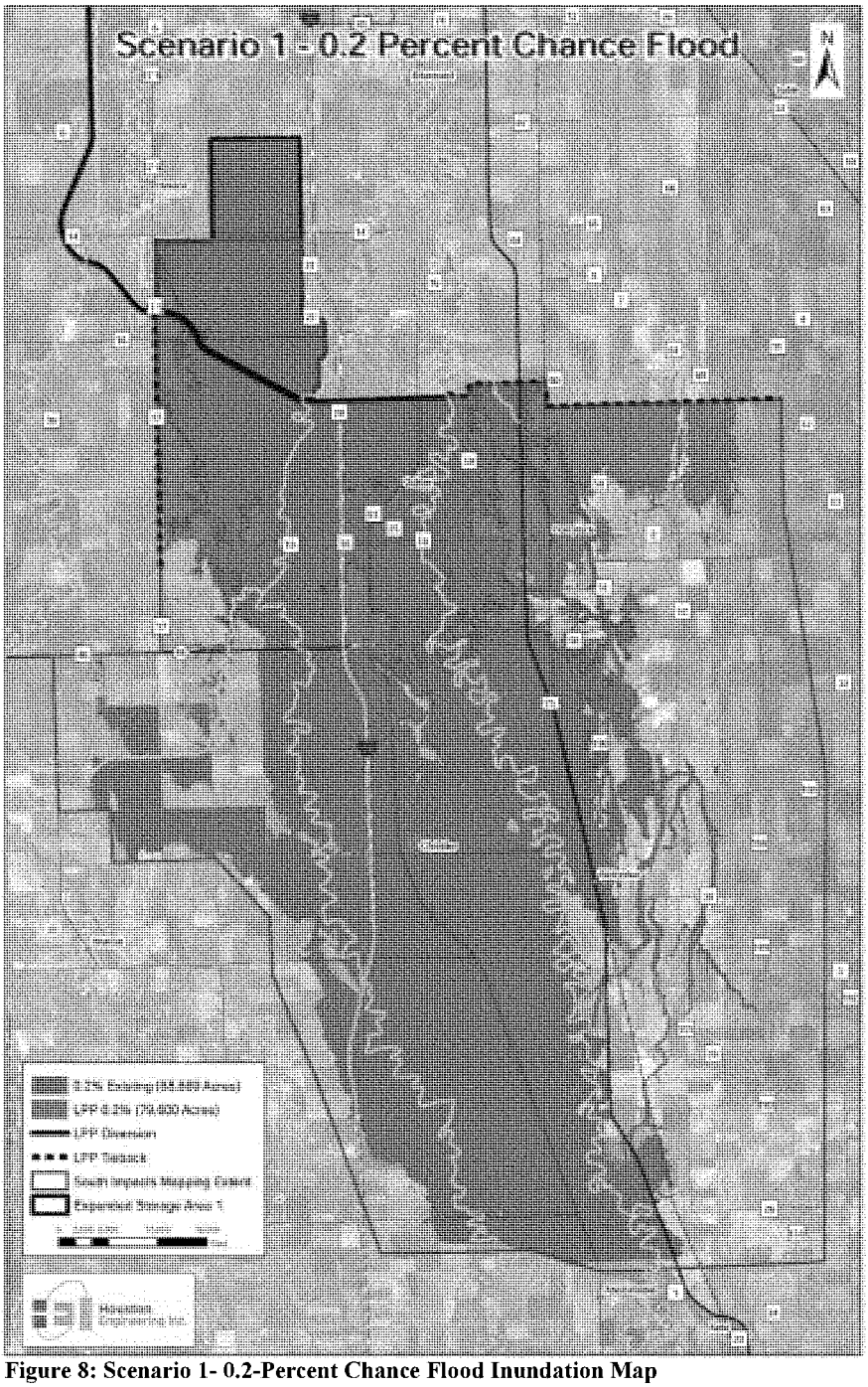


Figure 8: Scenario 1- 0.2-Percent Chance Flood Inundation Map

3.2 SCENARIO 2

3.2.1 Description. Scenario 2 includes preliminary hydraulic design of a modified LPP with no "smart storage" area (i.e., no Storage Area 1), and reduces upstream staging while allowing some adverse downstream impacts (generally in the 3 to 6 inch range at Thompson).

3.2.2 Development. Storage Area 1 included in the Phase 4 LPP design was removed from the model geometry, and the original geometry from the existing conditions model encompassing this area was inserted back into the model. For reference, Storage Area 1 included in the Phase 4 LPP design was 4,160 acres, with 55,800 acre-feet of volume at an elevation of 923.

For this scenario, the water surface elevation at the Fargo Gage was kept approximately the same as what was presented for the LPP in the February 28, 2011 report. Additional water was passed into the diversion channel to meet the criteria of approximately 6 inches of impact at Thompson. This required that the diversion inlet weir be increased from 90 to 150 feet. The gate operations for the Red River were modified to meet these criteria, while the gate operations for the Wild Rice and Wolverton Creek structures were not changed from what was included in the Phase 4 LPP. Multiple iterations of increasing the diversion inlet weir length, date and time of opening of gates, and/or gate rate opening was conducted. The Red River gate operations were not significantly modified from those presented for the LPP in the February 28, 2011 report, so as to provide a comparable operation and project performance.

3.2.3 Costs. The estimated cost of a Scenario 2 LPP project is $1,655,474,800. A breakdown of the estimated costs associated with this project is included in Table 17.

3.2.4 Impacts. Compared to existing conditions, the increase in water surface elevations upstream of the Red River control structure for the 1-percent and 0.2-percent chance events is approximately 7.5 and 6.0 feet, respectively. When compared to the results presented for the LPP in the February 28, 2011 report, the upstream staging decreased 0.71 and 0.55 feet for the 1-percent and 0.2-percent chance events, respectively. As mentioned previously, the water surface elevation at the Fargo Gage was kept approximately the same as what was presented for the LPP in the February 28, 2011 report.

The water surface elevations compared to existing conditions at Thompson for the 1-percent and 0.2-percent chance events increase 0.52 and 0.20 feet, respectively. The maximum downstream impact for the 1-percent chance event is 0.77 feet, whereas the Phase 4 LPP in the February 28, 2011 report had a maximum downstream impact of 0.29 feet. The minimum downstream impact for the 1-percent chance event is 0.07 feet, whereas the Phase 4 LPP had a minimum downstream impact of 0.04 feet. The maximum downstream impact for the 0.2-percent chance event is 0.47 feet compared to a maximum downstream impact of 0.27 feet with the Phase 4 LPP design. The minimum downstream impact for the 0.2-percent chance event is 0.06 feet, whereas the Phase 4

LPP had a minimum downstream impact of 0.04 feet. The impacts of Scenario 2 for the 1 and 0.2-percent chance events in relation to existing conditions are presented in Table 5 and Table 6, respectively. The impacts of this scenario in relation to the Phase 4 LPP design are presented in Table 15 and Table 16. The inundation areas associated with the upstream staging for each event are shown in Figure 9 and Figure 10, respectively.

Table 5: Scenario 2– 1-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 1% Chance Event- Scenario 2								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	801.73	119255	801.92	122897	0.19	3642	
ND SH#17/ MN SH317	1223286	804.09		804.27		0.18		
Co. Hwy 15	1315673	805.08		805.22		0.14		
Minimum Impact Location	1408098	811.34		811.41		0.07		
Oslo Gage	1416287	813.01		813.11		0.10		
DS Grand Forks Levees	1533523	827.98		828.25		0.27		
Grand Forks Gage	1558518	832.97	107980	833.41	112531	0.44	4551	
32nd Ave, Grand Forks	1580152	835.83		836.38		0.55		
Thompson Gage	1667877	847.35	82926	847.87	86384	0.52	3459	
Co. Hwy 25/ Co. Rd 221	1726274	854.46		855.17		0.71		
DS Sandhill River/ Climax	1763746	857.34		858.09		0.75		
Maximum Impact Location	1813905	860.78		861.55		0.77		
Nielsville	1829877	861.66	75745	862.42	79734	0.76	3990	
DS Marsh River	1864960	863.43		864.07		0.64		
US Goose River/ Shelly	1891054	865.36		865.88		0.52		
Halstad Gage	1981580	869.09	71581	869.36	75114	0.27	3533	
Hendrum	2038409	873.75	67278	874.00	70404	0.25	3125	
Perley	2129181	878.50	61723	878.57	62579	0.07	856	
Georgetown	2194021	883.36		883.40		0.04		
North River/ Clay Co. Hwy 93	2305647	893.73		887.59		-6.14		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	899.08		890.81		-8.27		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	903.86 (41.12*)	34875	893.49 (30.75*)	11554	-10.37	-23320	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	907.71		897.58		-10.13		
US ND Wild Rice River	2484618	910.70		901.64		-9.06		
US LPP Diversion	2531315	914.65		922.17		7.52		
Hickson Gage	2563754	917.52	21730	922.22	18276	4.70	-3454	
Abercrombie	2764835	935.62	23000	935.76	23000	0.14	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

Table 6: Scenario 2– 0.2-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 0.2% Chance Event- Scenario 2								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	804.12	168364	804.29	171759	0.17	3395	
ND SH#17/ MN SH317	1223286	805.99		806.12		0.13		
Co. Hwy 15	1315673	806.74		806.88		0.14		
Minimum Impact Location	1408098	812.00		812.06		0.06		
Oslo Gage	1416287	813.88		813.96		0.08		
DS Grand Forks Levees	1533523	829.92		830.13		0.21		
Grand Forks Gage	1558518	836.36	146225	836.75	151224	0.39	2887	
Maximum Impact Location	1577593	839.50		839.97		0.47		
32nd Ave, Grand Forks	1580152	839.75		840.21		0.46		
Thompson Gage	1667877	850.69	112422	850.89	114799	0.20	2377	
Co. Hwy 25/ Co. Rd 221	1726274	859.38		859.65		0.27		
DS Sandhill River/ Climax	1763746	862.75		863.06		0.31		
Nielsville	1829877	867.04	107296	867.37	109806	0.33	2509	
DS Marsh River	1864960	868.06		868.35		0.29		
US Goose River/ Shelly	1891054	869.30		869.56		0.26		
Halstad Gage	1981580	871.54	101754	871.63	101481	0.09	-273	
Hendrum	2038409	875.77	97650	875.72	95126	-0.05	-2524	
Perley	2129181	879.89	90756	879.74	85676	-0.15	-5080	
Georgetown	2194021	884.48		884.31		-0.17		
North River/ Clay Co. Hwy 93	2305647	895.35		892.88		-2.47		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	900.31		898.17		-2.14		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	905.8 (43.06*)	61717	902.54 (39.8*)	28917	-3.26	-32800	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	909.13		906.91		-2.22		
US ND Wild Rice River	2484618	911.54		910.11		-1.43		
US LPP Diversion	2531315	915.94		921.89		5.95		
Hickson Gage	2563754	919.69	35636	922.04	31941	2.35	-3696	
Abercrombie	2764835	940.90	44308	940.91	44308	0.01	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

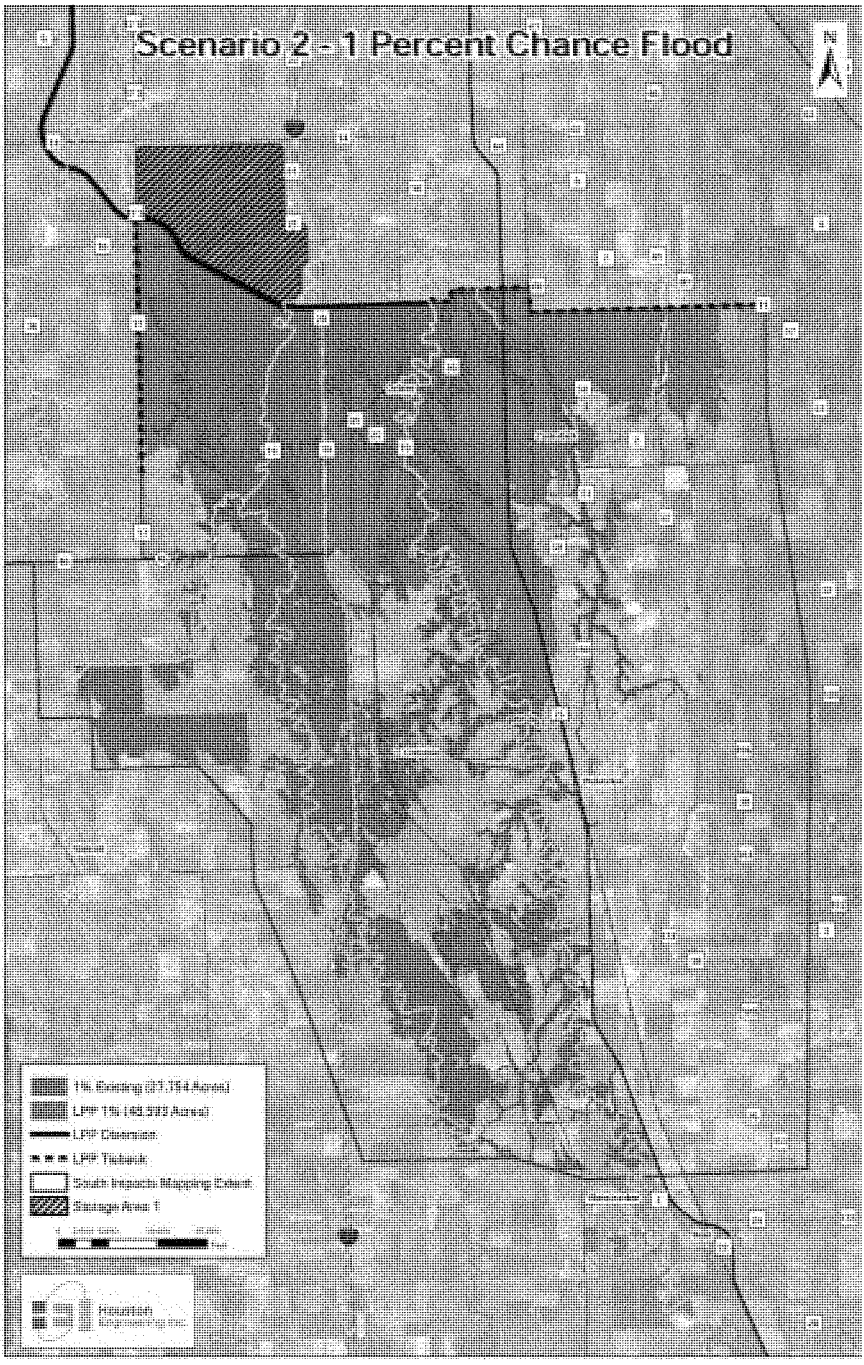


Figure 9: Scenario 2- 1-Percent Chance Flood Inundation Map

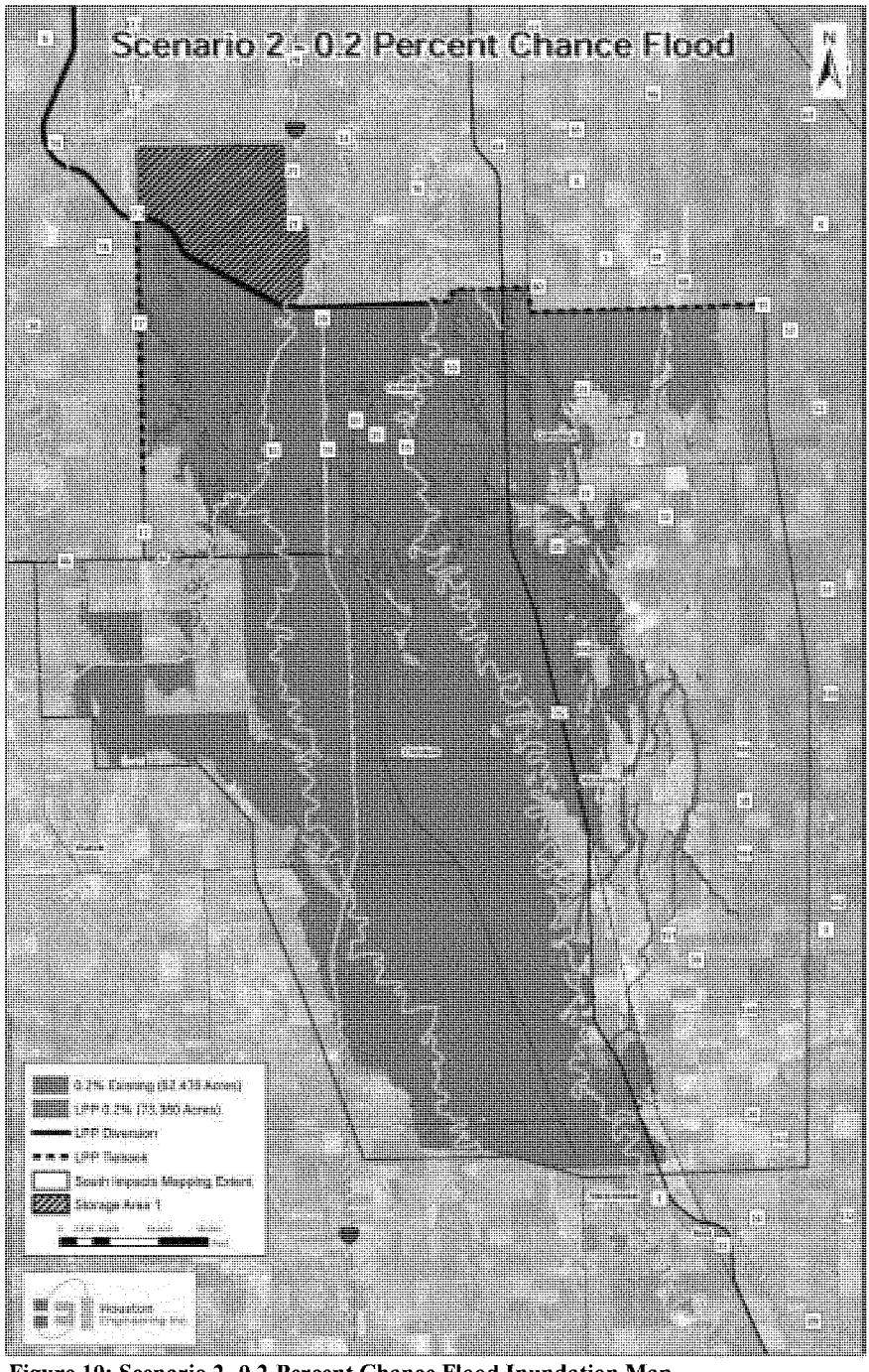


Figure 10: Scenario 2- 0.2-Percent Chance Flood Inundation Map

3.3 SCENARIO 3

3.3.1 Description. Scenario 3 includes preliminary hydraulic design of a modified LPP including Storage Area 1 with the addition of one or more large off stream storage areas downstream of the project along with reduced upstream staging.

3.3.2 Development. An initial screening analysis for this scenario was performed with two sites identified at a location near the outlet of the LPP diversion. Each site was analyzed separately, and also in conjunction with the other. One site was located just downstream (north) of the diversion outlet, and is referred to as "Outlet Storage Downstream," which is shown in Figure 11. The other site was located just upstream (south) of the diversion outlet, and is referred to as "Outlet Storage Upstream." The purpose of these sites is to pull water off the diversion only during the peak of high flows, thus preserving the volume available in these storage areas until the water surface elevation in the diversion channel becomes high enough to flow into them. The storage areas and cross sections included in the existing conditions model that encompass the area of each of these sites were either removed or modified accordingly from the LPP geometry.

Outlet Storage Downstream is approximately 3,650 acres, with a volume of 21,500 acre-feet at an elevation of 885, and 39,700 acre-feet at an elevation of 890. Outlet Storage Upstream is smaller in size and volume potential with an area of 1,545 acres and volume of 4,565 acre-feet at an elevation of 885, and 12,260 acre-feet at an elevation of 890.

For Outlet Storage Downstream, the weir controlling flows into the site was set at an elevation 0.5, 1.0, 1.5, and 2.0 feet below the 1-percent chance water surface elevation in the diversion channel included in the Phase 4 LPP. For Outlet Storage Upstream, the weir controlling flows into the site was set at an elevation 0.5 and 1.0 feet below the 1-percent chance water surface elevation in the diversion channel associated with the Phase 4 LPP. There was no added benefit between 0.5 and 1.0 feet for this site, and therefore the 1.5 and 2.0 feet options were not analyzed. The length of the weir at the Outlet Storage Downstream site was 4,000 feet, and the length of the weir at the Outlet Storage Upstream site was 5,000 feet. For the combined analysis, the same weir length at both of the storage sites was kept, while the crest for the weirs at Outlet Storage Downstream and Outlet Storage Upstream were set at an elevation 1.5 and 0.5 feet below the 1-percent chance water surface elevation, respectively. These elevations of 1.5 and 0.5 feet provided the most benefit downstream when these sites were analyzed separately. The gate operations for the control structures on the Wild Rice River, Red River, and Wolverton Creek were not changed from the Phase 4 LPP design for the initial screening of this scenario.

After analyzing the two storage sites separately and then combined, it was determined that the upstream site did not provide nearly the amount of benefit as the downstream site and that there was no added benefit by combining these two sites. Therefore, the results presented for scenario 3 are for Outlet Storage Downstream only. For this scenario, the

water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. Since available storage associated with Outlet Storage Downstream provided a benefit downstream by reducing impacts, additional water was passed into the diversion channel in order to maintain the same level of downstream impacts as with the Phase 4 LPP design. This required that the diversion inlet weir be increased from 90 to 110 feet. The gate operations for the Red River were modified from the Phase 4 LPP settings in order to meet these criteria, while the gate operations for the Wild Rice and Wolverton Creek structures were not changed. Multiple iterations were conducted by increasing the diversion inlet weir length, in addition to modifying the date and time of the gate opening. The gate operations were not significantly modified from those presented for the Phase 4 LPP in the February 28, 2011 report, so as to provide a comparable operation and project performance.

3.3.3 Costs. The estimated cost of a Scenario 3 LPP project is $1,838,260,600. A breakdown of the estimated costs associated with this project is included in Table 17.

3.3.4 Impacts. Compared to existing conditions, the increase in water surface elevations upstream of the Red River control structure for the 1-percent and 0.2-percent chance events is approximately 7.6 and 5.9 feet, respectively. When compared to the results presented for the LPP in the February 28, 2011 report, the upstream staging decreased 0.62 feet for both the 1-percent and 0.2-percent chance events. For more frequent events, the addition of this storage area could increase downstream impacts because the weir may prevent water from reaching areas that would have been inundated under existing conditions. For example, under existing conditions the 2-percent chance flood would inundate the floodplain, but the weir on the proposed storage area would prevent flows from a 2-percent chance flood from entering the storage area occupying the same area. As mentioned previously, the water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. The impacts of Scenario 3 for the 1-percent and 0.2-percent chance events in relation to existing conditions are presented in Table 7 and Table 8, respectively. The impacts of this scenario in relation to the Phase 4 LPP design are presented in Table 15 and Table 16. The inundation areas associated with the upstream staging for each event are shown in Figure 12 and Figure 13, respectively.

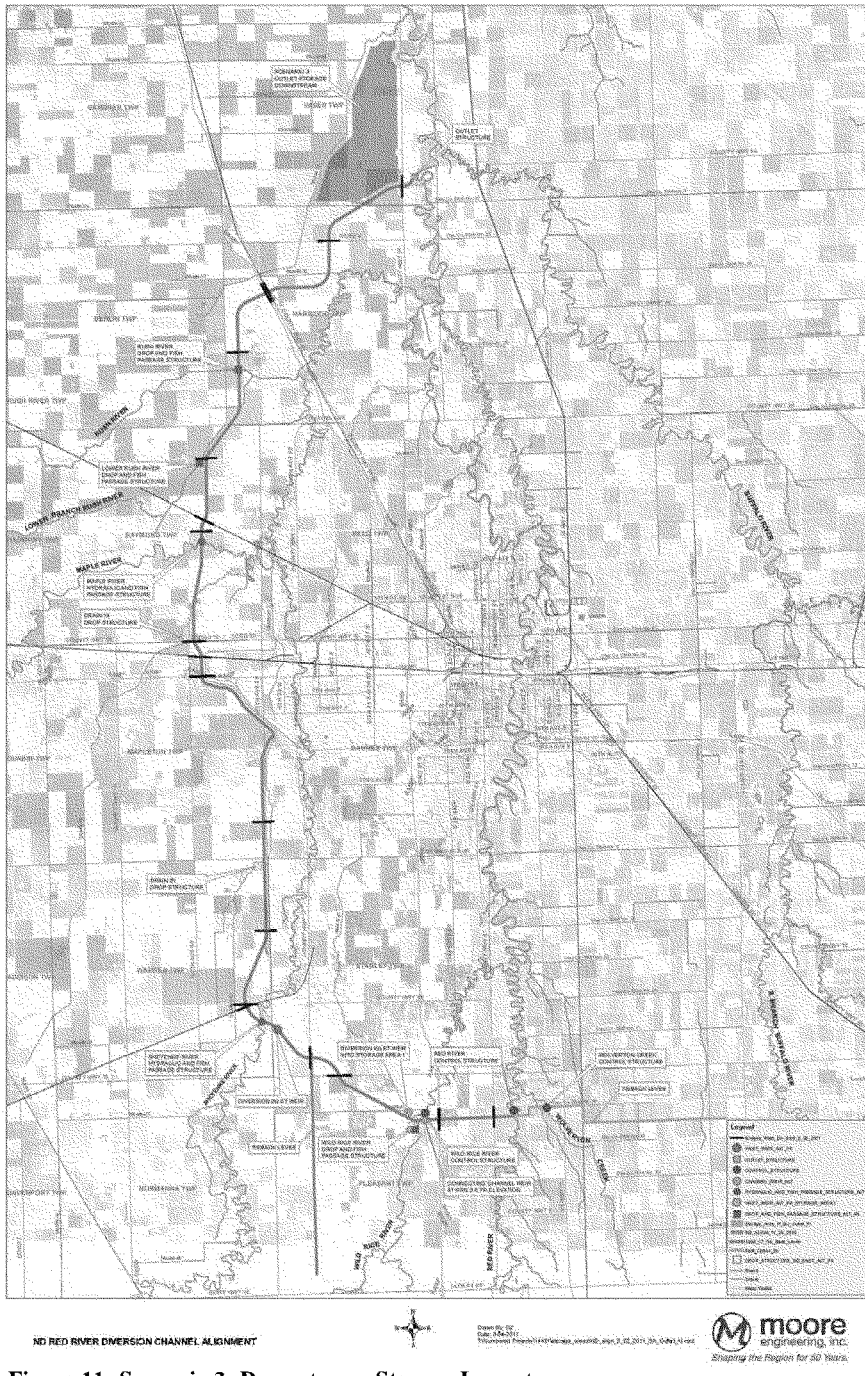


Figure 11: Scenario 3- Downstream Storage Layout

Table 7: Scenario 3– 1-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 1% Chance Event- Scenario 3-Downstream Storage Area								3-08-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	801.73	119255	801.82	120982	0.09	1727	
ND SH#17/ MN SH317	1223286	804.09		804.17		0.08		
Co. Hwy 15	1315673	805.08		805.14		0.06		
Minimum Impact Location	1408098	811.34		811.38		0.04		
Oslo Gage	1416287	813.01		813.08		0.07		
DS Grand Forks Levees	1533523	827.98		828.15		0.17		
Grand Forks Gage	1558518	832.97	107980	833.25	110844	0.28	2864	
Maximum Impact Location	1572542	835.22		835.55		0.33		
32nd Ave, Grand Forks	1580152	835.83		836.14		0.31		
Thompson Gage	1667877	847.35	82926	847.39	82562	0.04	-363	
Co. Hwy 25/ Co. Rd 221	1726274	854.46		854.44		-0.02		
DS Sandhill River/ Climax	1763746	857.34		857.30		-0.04		
Nielsville	1829877	861.66	75745	861.61	75812	-0.05	68	
DS Marsh River	1864960	863.43		863.39		-0.04		
US Goose River/ Shelly	1891054	865.36		865.30		-0.06		
Halstad Gage	1981580	869.09	71581	868.99	70024	-0.10	-1557	
Hendrum	2038409	873.75	67278	873.61	64662	-0.14	-2616	
Perley	2129181	878.50	61723	878.16	55836	-0.34	-5887	
Georgetown	2194021	883.36		883.43		0.07		
North River/ Clay Co. Hwy 93	2305647	893.73		886.52		-7.21		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	899.08		890.46		-8.62		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	903.86 (41.12*)	34875	893.46 (30.72*)	11585	-10.40	-23289	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	907.71		897.56		-10.15		
US ND Wild Rice River	2484618	910.70		901.60		-9.10		
US LPP Diversion	2531315	914.65		922.26		7.61		
Hickson Gage	2563754	917.52	21730	922.30	18948	4.78	-2783	
Abercrombie	2764835	935.62	23000	935.73	23000	0.11	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

Table 8: Scenario 3– 0.2-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 0.2% Chance Event- Scenario 3-Downstream Storage Area								3-08-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	804.12	168364	804.22	171125	0.10	2761	
ND SH#17/ MN SH317	1223285	805.99		806.06		0.07		
Co. Hwy 15	1315673	806.74		806.82		0.08		
Minimum Impact Location	1410241	812.15		812.19		0.04		
Oslo Gage	1416287	813.88		813.93		0.05		
DS Grand Forks Levees	1533523	829.92		830.03		0.11		
Grand Forks Gage	1558518	836.36	146225	836.56	148819	0.20	2887	
Maximum Impact Location	1561353	838.53		838.77		0.24		
32nd Ave, Grand Forks	1580152	839.75		839.95		0.20		
Thompson Gage	1667877	850.69	112422	850.64	111449	-0.05	-973	
Co. Hwy 25/ Co. Rd 221	1726274	859.38		859.27		-0.11		
DS Sandhill River/ Climax	1763746	862.75		862.60		-0.15		
Nielsville	1829877	867.04	107296	866.87	105698	-0.17	-1598	
DS Marsh River	1864960	858.06		867.91		-0.15		
US Goose River/ Shelly	1891054	869.30		869.16		-0.14		
Halstad Gage	1981580	871.54	101754	871.33	95980	-0.21	-5774	
Hendrum	2038409	875.77	97650	875.44	89998	-0.33	-7652	
Perley	2129181	879.89	90756	879.52	79646	-0.37	-11110	
Georgetown	2194021	884.48		884.73		0.25		
North River/ Clay Co. Hwy 93	2305647	895.35		892.95		-2.40		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	900.31		898.28		-2.03		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	905.8 (43.06*)	61717	902.69 (39.95*)	29543	-3.11	-32174	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	909.13		907.02		-2.11		
US ND Wild Rice River	2484618	911.54		910.18		-1.36		
US LPP Diversion	2531315	915.94		921.82		5.88		
Hickson Gage	2563754	919.69	35636	921.98	33108	2.29	-2528	
Abercrombie	2764835	940.90	44308	940.91	44308	0.01	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

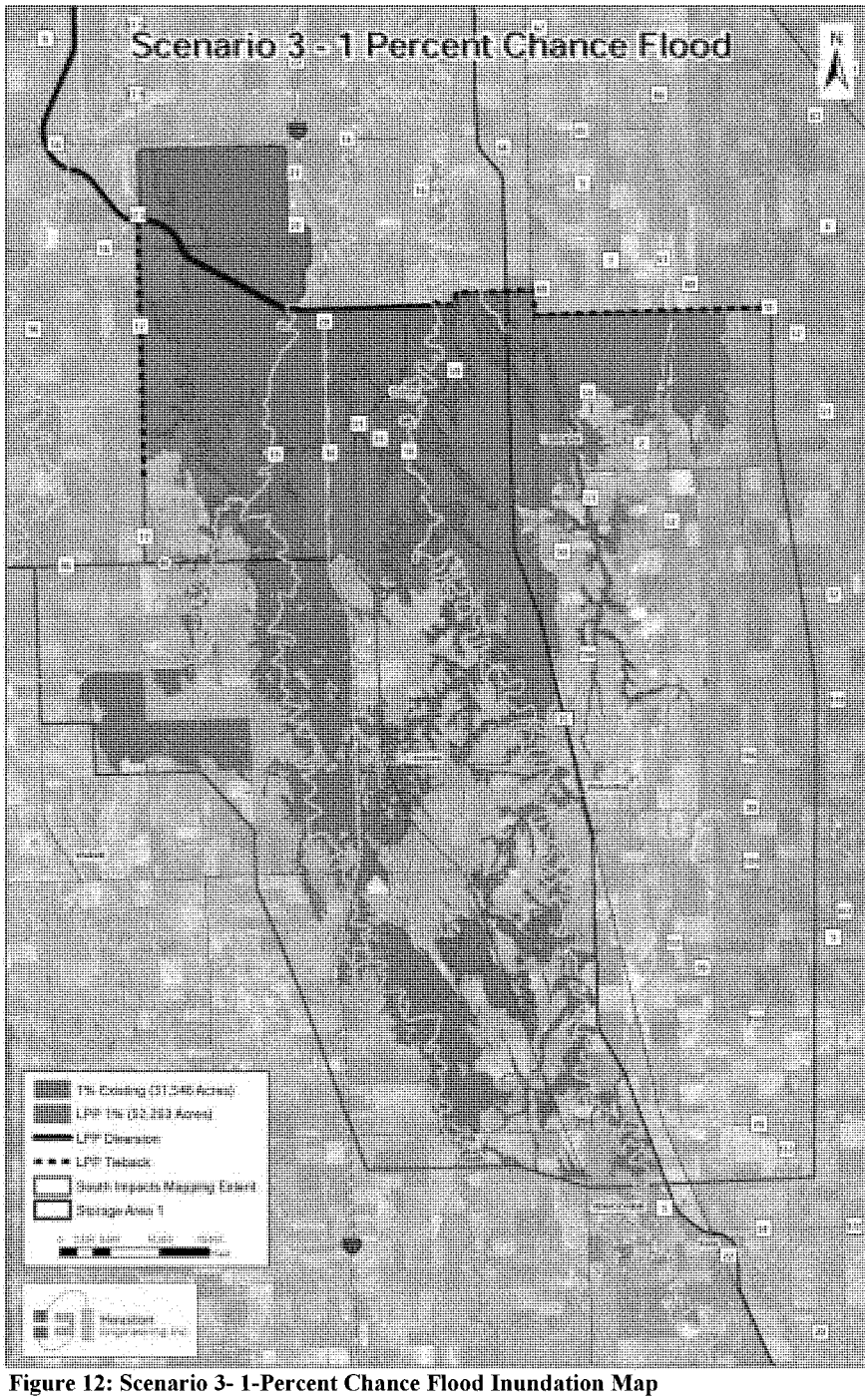


Figure 12: Scenario 3- 1-Percent Chance Flood Inundation Map

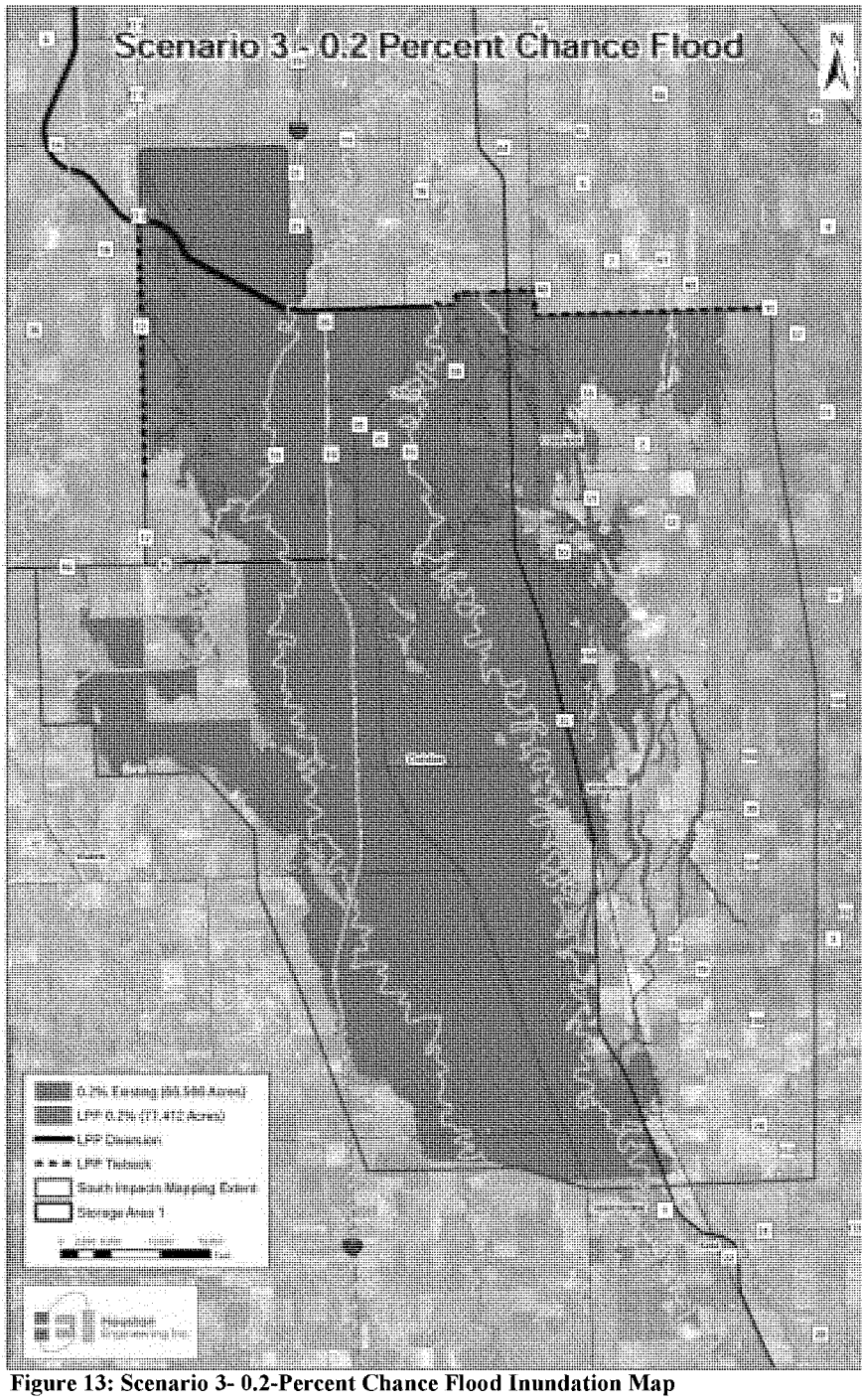


Figure 13: Scenario 3- 0.2-Percent Chance Flood Inundation Map

3.4 SCENARIO 4

3.4.1 Description. Scenario 4 includes preliminary hydraulic design of a modified LPP with no "smart storage" and with no staging. This is essentially the Phase 3 design incorporated into the latest unsteady flow models with modifications made as necessary for model stability and operational goals.

3.4.2 Development. The Phase 4 LPP diversion geometry was replaced with the Phase 3 design for this scenario. This Phase 3 design is associated with a diversion channel capable of diverting 35,000 cfs from the Red and Wild Rice Rivers for the 0.2-percent chance event. In addition, Storage Area 1 was removed from the LPP geometry, and the existing conditions geometry for this area was inserted back into the model geometry. The channel and hydraulic structure dimensions for this scenario can be found in the Phase 3.1 report entitled "*Fargo – Moorhead Metro Flood Risk Management Project, Feasibility Study Report for the US Army Corps of Engineers, and the Cities of Fargo, ND & Moorhead, MN Phase 3 (Phase 3.1 Hydrology)*" published on July 30, 2010.

Modifications to the diversion inlet weir were performed to ensure that the project design of 35,000 cfs for the 0.2-percent chance event was being diverted into the diversion channel, while still maintaining the criteria of no significant increase in upstream water surface elevations and maintaining approximately the same water surface elevation at the Fargo Gage as the Phase 4 LPP design. The diversion inlet weir geometry for this scenario involves a two tier configuration, with a 270 foot bottom width set at an elevation of 903.9 feet, and a top weir spanning a total width of 2,130 feet set at an elevation of 914.51 feet. Previous phases of this study used a three tiered weir configuration, to ensure that adequate performance for more frequent events such as the 10-percent chance event was maintained. Since the scope of this analysis did not include events smaller than a 1-percent chance event, a three tiered weir configuration was not developed. Any future analysis for events smaller than the 1-percent chance event would need modifications to the current two tier configuration used for this scenario.

3.4.3 Costs. The estimated cost of a Scenario 4 LPP project is $1,505,470,000. This estimate was developed by the USACE during Phase 3 of the study.

3.4.4 Impacts. The water surface elevations compared to existing conditions at Thompson for the 1-percent and 0.2-percent chance events increase 1.33 and 0.57 feet, respectively. The maximum downstream impact for the 1-percent chance event is 2.17 feet, whereas the Phase 4 LPP in the February 28, 2011 report had a maximum downstream impact of 0.29 feet. The minimum downstream impact for the 1-percent chance event is 0.18 feet, whereas the Phase 4 LPP had a minimum downstream impact of 0.04 feet. The maximum downstream impact for the 0.2-percent chance event is 1.07 feet compared to a maximum downstream impact of 0.27 feet with the Phase 4 LPP design. The minimum downstream impact for the 0.2-percent chance event is 0.13 feet, while the Phase 4 LPP had a minimum downstream impact of 0.04 feet. The impacts of Scenario 4 for the 1 and 0.2-percent chance events in relation to existing conditions are

presented in Table 9 and Table 10, respectively. The impacts of this scenario in relation to the Phase 4 LPP design are presented in Table 15 and Table 16.

Table 9: Scenario 4– 1-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 1% Chance Event- Scenario 4								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	801.73	119255	802.19	127915	0.46	8661	
ND SH#17/ MN SH317	1223286	804.09		804.50		0.41		
Co. Hwy 15	1315673	805.08		805.43		0.35		
Minimum Impact Location	1408098	811.34		811.52		0.18		
Oslo Gage	1416287	813.01		813.27		0.26		
DS Grand Forks Levees	1533523	827.98		828.59		0.61		
Grand Forks Gage	1558518	832.97	107980	834.01	118988	1.04	11008	
32nd Ave, Grand Forks	1580152	835.83		837.14		1.31		
Thompson Gage	1667877	847.35	82926	848.68	93049	1.33	10123	
Co. Hwy 25/ Co. Rd 221	1726274	854.46		856.39		1.93		
DS Sandhill River/ Climax	1763746	857.34		859.41		2.07		
Maximum Impact Location	1813905	860.78		862.95		2.17		
Nielsville	1829877	861.66	75745	863.77	87867	2.11	12122	
DS Marsh River	1864960	863.43		865.27		1.84		
US Goose River/ Shelly	1891054	865.36		866.92		1.56		
Halstad Gage	1981580	869.09	71581	870.12	86012	1.03	14430	
Hendrum	2038409	873.75	67278	874.72	81528	0.97	14250	
Perley	2129181	878.50	61723	879.29	75002	0.79	13279	
Georgetown	2194021	883.36		884.00		0.64		
North River/ Clay Co. Hwy 93	2305647	893.73		888.39		-5.34		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	899.08		891.39		-7.69		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	903.86 (41.12*)	34875	893.78 (31.04*)	10689	-10.08	-24185	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	907.71		897.09		-10.62		
US ND Wild Rice River	2484618	910.70		900.28		-10.42		
US LPP Diversion	2531315	914.65		916.00		1.35		
Hickson Gage	2563754	917.52	21730	918.24	21828	0.72	98	
Abercrombie	2764835	935.62	23000	935.66	23000	0.04	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

Table 10: Scenario 4– 0.2-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 0.2% Chance Event- Scenario 4								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection	
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)
Drayton Gage	1062362	804.12	168364	804.48	177240	0.36	8876
ND SH#17/ MN SH317	1223286	805.99		806.24		0.25	
Co. Hwy 15	1315673	806.74		806.99		0.25	
Minimum Impact Location	1410241	812.15		812.28		0.13	
Oslo Gage	1416287	813.88		814.03		0.15	
DS Grand Forks Levees	1533523	829.92		830.32		0.40	
Grand Forks Gage	1558518	836.36	146225	837.15	156371	0.79	2887
32nd Ave, Grand Forks	1580152	839.75		840.73		0.98	
Thompson Gage	1667877	850.69	112422	851.26	119705	0.57	7283
Co. Hwy 25/ Co. Rd 221	1726274	859.38		860.19		0.81	
DS Sandhill River/ Climax	1763746	862.75		863.69		0.94	
Maximum Impact Location	1806800	865.87		866.94		1.07	
Nielsville	1829877	867.04	107296	868.06	116763	1.02	9466
DS Marsh River	1864960	868.06		868.97		0.91	
US Goose River/ Shelly	1891054	869.30		870.14		0.84	
Halstad Gage	1981580	871.54	101754	872.07	111678	0.53	9925
Hendrum	2038409	875.77	97650	876.19	104903	0.42	7253
Perley	2129181	879.89	90756	880.11	97828	0.22	7072
Georgetown	2194021	884.48		884.69		0.21	
North River/ Clay Co. Hwy 93	2305647	895.35		892.83		-2.52	
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	900.31		898.03		-2.28	
Fargo Gage (13th Ave S, 12th Ave S)	2388223	905.8 (43.06*)	61717	902.28 (39.54*)	27760	-3.52	-33957
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	909.13		906.67		-2.46	
US ND Wild Rice River	2484618	911.54		909.88		-1.66	
US LPP Diversion	2531315	915.94		916.00		0.06	
Hickson Gage	2563754	919.69	35636	919.66	35560	-0.03	-76
Abercrombie	2764835	940.90	44308	940.90	44308	0.00	0

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

3.5 SCENARIO 5

3.5.1 Description. Scenario 5 includes preliminary hydraulic design of a modified LPP with no "smart storage" but including increased upstream staging.

3.5.2 Development. Storage Area 1 included in the Phase 4 LPP design was removed from the model geometry, and the original geometry for this area from the existing conditions model was inserted back into the model. For reference, Storage Area 1 included in the Phase 4 LPP design was 4,160 acres, with 55,800 acre-feet of volume at an elevation of 923.

For this scenario, the water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. To maintain these criteria, additional staging was needed. This required that the diversion inlet weir be decreased from 90 to 75 feet. The gate operations for the Red River from the Phase 4 LPP were modified to meet these criteria, while the gate operations for the Wild Rice and Wolverton Creek structures were not changed. Multiple iterations of decreasing the diversion inlet weir length, date and time of opening of gates, and/or gate rate opening were conducted. The gate operations were not significantly modified from those presented for the LPP in the February 28, 2011 report, so as to provide a comparable operation and project performance.

3.5.3 Costs. The estimated cost of a Scenario 5 LPP project is $1,785,344,236. A breakdown of the estimated costs associated with this project is included in Table 17.

3.5.4 Impacts. Compared to existing conditions, the increase in water surface elevations upstream of the Red River control structure for the 1-percent and 0.2-percent chance events is approximately 9.4 and 7.7 feet, respectively. When compared to the results presented for the LPP in the February 28, 2011 report, the upstream staging increased 1.18 and 1.16 feet for the 1-percent and 0.2-percent chance events, respectively. The impacts for the 1-percent and 0.2-percent chance events are shown in Table 11 and Table 12, respectively. As mentioned previously, the water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. The impacts of Scenario 5 for the 1-percent and 0.2-percent chance events in relation to existing conditions are presented in Table 11 and Table 12, respectively. The impacts of this scenario in relation to the Phase 4 LPP design are presented in Table 15 and Table 16. The inundation areas associated with the upstream staging for each event are shown in Figure 14 and Figure 15, respectively.

Table 11: Scenario 5– 1-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 1% Chance Event- Scenario 5								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	801.73	119255	801.82	121008	0.09	1753	
ND SH#17/ MN SH317	1223286	804.09		804.17		0.08		
Co. Hwy 15	1315673	805.08		805.14		0.06		
Minimum Impact Location	1408098	811.34		811.38		0.04		
Oslo Gage	1416287	813.01		813.07		0.06		
DS Grand Forks Levees	1533523	827.98		828.14		0.16		
Grand Forks Gage	1558518	832.97	107980	833.24	110742	0.27	2762	
Maximum Impact Location	1574433	835.27		835.59		0.32		
32nd Ave, Grand Forks	1580152	835.83		836.14		0.31		
Thompson Gage	1667877	847.35	82926	847.40	82658	0.05	-267	
Co. Hwy 25/ Co. Rd 221	1726274	854.46		854.45		-0.01		
DS Sandhill River/ Climax	1763746	857.34		857.31		-0.03		
Nielsville	1829877	861.66	75745	861.63	76167	-0.03	422	
DS Marsh River	1864950	863.43		863.41		-0.02		
US Goose River/ Shelly	1891054	865.36		865.33		-0.03		
Halstad Gage	1981580	869.09	71581	869.03	70952	-0.06	-629	
Hendrum	2038409	873.75	67278	873.68	65974	-0.07	-1304	
Perley	2129181	878.50	61723	878.21	56675	-0.29	-5048	
Georgetown	2194021	883.36		883.08		-0.28		
North River/ Clay Co. Hwy 93	2305647	893.73		887.06		-6.67		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	899.08		890.65		-8.43		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	903.86 (41.12*)	34875	893.52 (30.78*)	11434	-10.34	-23441	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	907.71		897.52		-10.19		
US ND Wild Rice River	2484618	910.70		901.50		-9.20		
US LPP Diversion	2531315	914.65		924.06		9.41		
Hickson Gage	2563754	917.52	21730	924.08	16458	6.56	-5272	
Abercrombie	2764835	935.62	23000	935.79	23000	0.17	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

Table 12: Scenario 5– 0.2-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 0.2% Chance Event- Scenario 5								3-04-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	804.12	168364	804.24	169298	0.12	934	
ND SH#17/ MN SH317	1223286	805.99		806.08		0.09		
Co. Hwy 15	1315673	806.74		806.84		0.10		
Minimum Impact Location	1408098	812.00		812.04		0.04		
Oslo Gage	1416287	813.88		813.94		0.06		
DS Grand Forks Levees	1533523	829.92		830.06		0.14		
Grand Forks Gage	1558518	836.36	146225	836.61	149493	0.25	2887	
Maximum Impact Location	1561353	838.53		838.83		0.30		
32nd Ave, Grand Forks	1580152	839.75		840.01		0.26		
Thompson Gage	1667877	850.69	112422	850.66	111646	-0.03	-775	
Co. Hwy 25/ Co. Rd 221	1726274	859.38		859.30		-0.08		
DS Sandhill River/ Climax	1763746	862.75		862.64		-0.11		
Nielsville	1829877	867.04	107296	866.92	106359	-0.12	-937	
DS Marsh River	1864960	868.06		867.96		-0.10		
US Goose River/ Shelly	1891054	869.30		869.21		-0.09		
Halstad Gage	1981580	871.54	101754	871.34	97336	-0.20	-4418	
Hendrum	2038409	875.77	97650	875.49	91110	-0.28	-6540	
Perley	2129181	879.89	90756	879.54	80087	-0.35	-10669	
Georgetown	2194021	884.48		884.15		-0.33		
North River/ Clay Co. Hwy 93	2305647	895.35		892.89		-2.46		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	900.31		898.19		-2.12		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	905.8 (43.06*)	61717	902.56 (39.82*)	29043	-3.24	-32674	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	909.13		906.93		-2.20		
US ND Wild Rice River	2484618	911.54		910.11		-1.43		
US LPP Diversion	2531315	915.94		923.60		7.66		
Hickson Gage	2563754	919.69	35636	923.66	29566	3.97	-6070	
Abercrombie	2764835	940.90	44308	940.91	44308	0.01	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

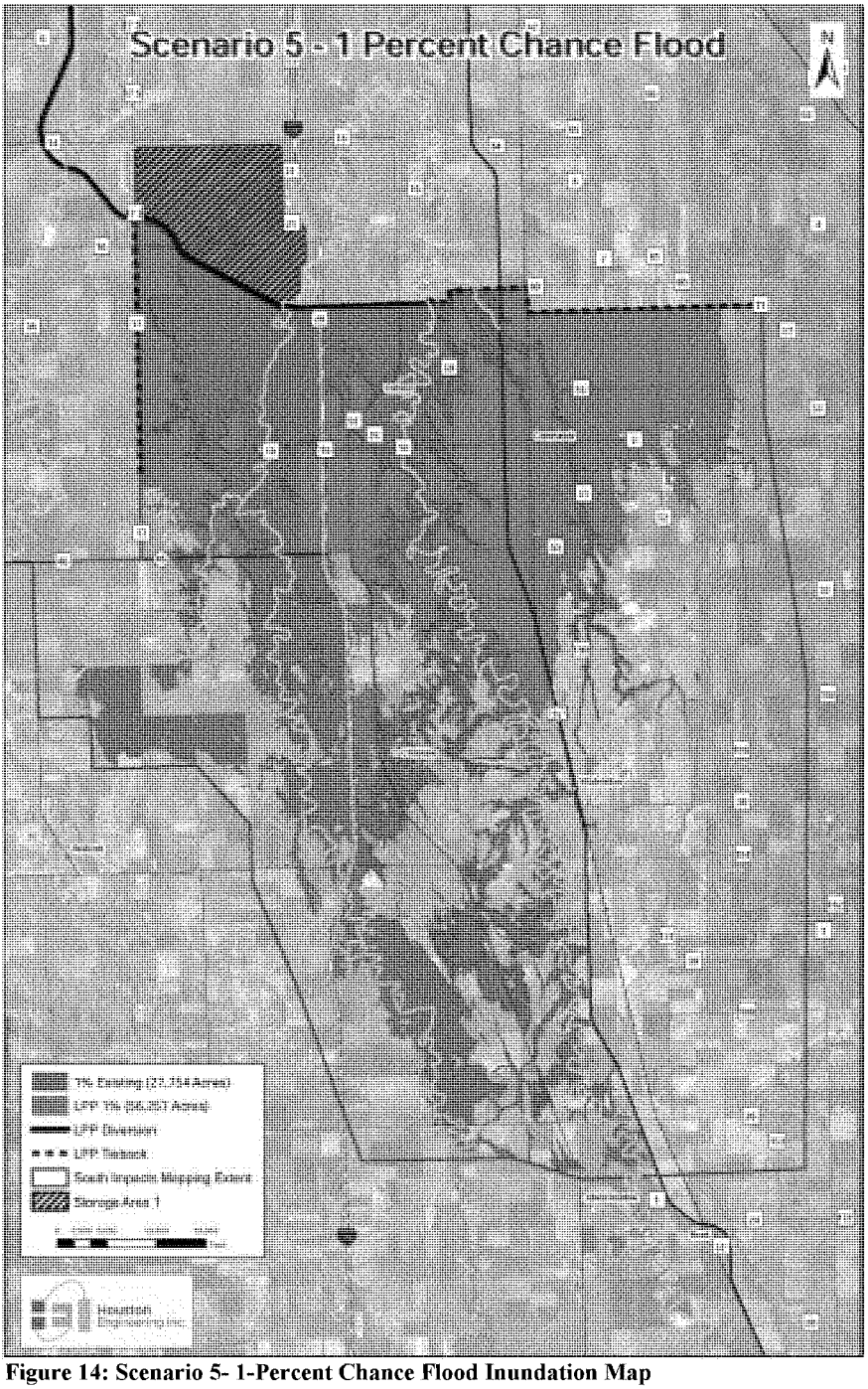


Figure 14: Scenario 5- 1-Percent Chance Flood Inundation Map

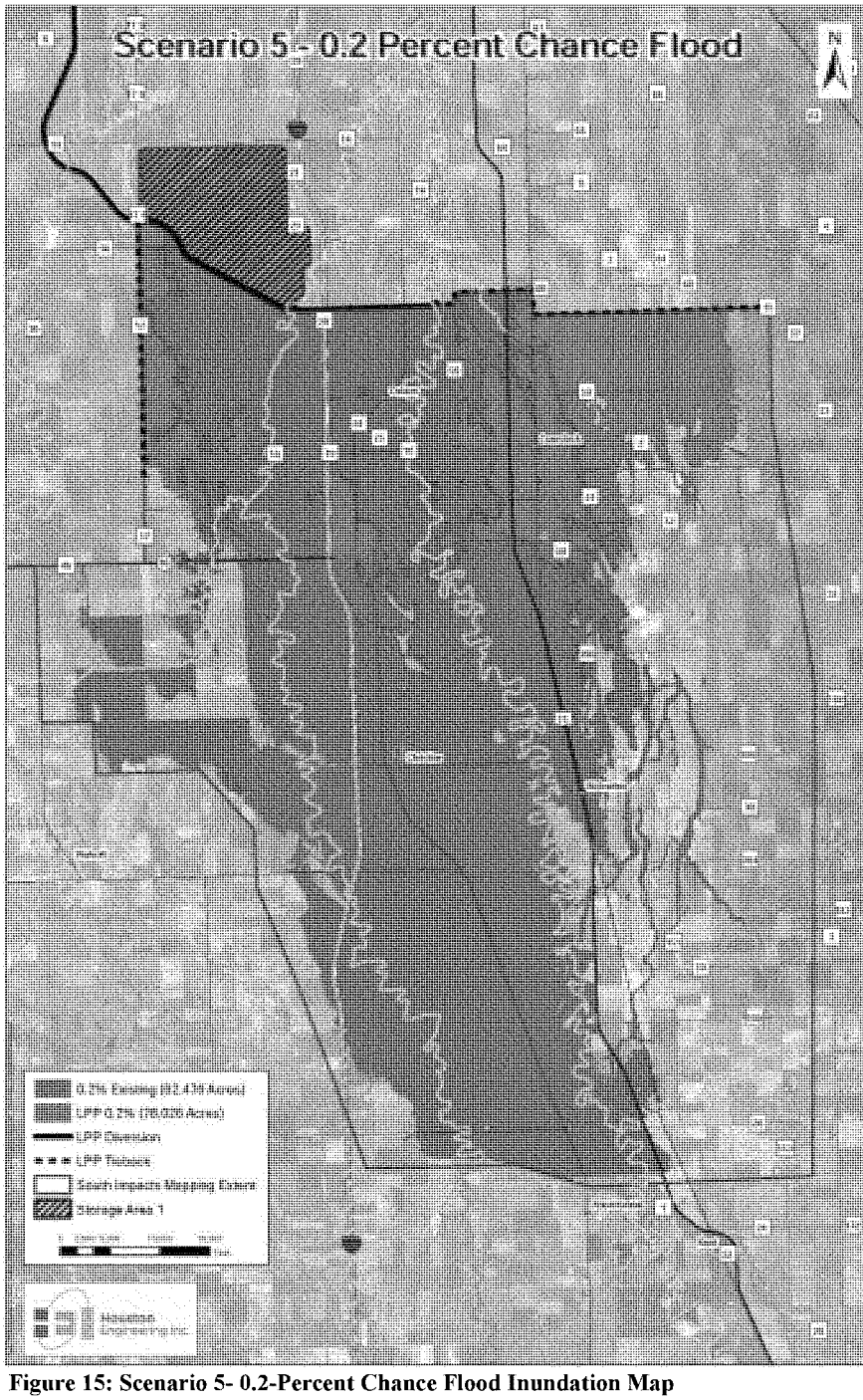


Figure 15: Scenario 5- 0.2-Percent Chance Flood Inundation Map

3.6 SCENARIO 6

3.6.1 Description. Scenario 6 includes the preliminary hydraulic design of a modified LPP with the south end of the diversion alignment moved to provide protection to the communities of Hickson, ND, Oxbow, ND, and the Bakke Subdivision (Oxbow Area). The proposed Scenario 6 diversion alignment begins at the Red River in the S1/2 of Section 24, Pleasant Township and extends west to the west side of Interstate 29. It then progresses north along the west side of Interstate 29 until it meets the original Phase 4 LPP diversion channel near the Wild Rice River control structure.

3.6.2 Development. For this scenario, the water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. To maintain these criteria while providing protection to the Oxbow Area, additional staging was necessary above what was included in the original LPP. The additional staging required the diversion inlet weir be narrowed from 90 to 70 feet. The gate operations for the Red River were modified to match the LPP criteria, while the gate operation for the Wild Rice River structure was not changed from the Phase 4 LPP. Multiple iterations of decreasing the diversion inlet weir length, date and time of opening of gates, and/or gate rate opening were conducted. The gate operations were not significantly modified from those presented for the LPP in the February 28, 2011 report, so as to provide a comparable operation and project performance.

3.6.3 Costs. The estimated cost of a Scenario 6 LPP project is $1,795,054,900. A breakdown of the estimated costs associated with this project is included in Table 17.

3.6.4 Impacts. Compared to existing conditions, the increase in water surface elevations upstream of the Red River control structure for the 1-percent and 0.2-percent chance events is approximately 8.0 and 5.5 feet, respectively. Since the Red River control structure is in a different location for Scenario 6 than the original LPP, a direct upstream stage comparison is difficult to present. Generally, the 1-percent chance staged elevation for Scenario 6 is 2.6 feet higher than the original LPP. As mentioned previously, the water surface elevations at the Fargo Gage and downstream of the diversion were kept approximately the same as what was presented for the LPP in the February 28, 2011 report. The impacts of Scenario 6 for the 1 and 0.2-percent chance events in relation to existing conditions are presented in Table 13 and Table 14, respectively. The impacts of this scenario in relation to the Phase 4 LPP design are presented in Table 15 and Table 16. The inundation areas associated with the upstream staging for each event are shown in Figure 16 and Figure 17, respectively.

Table 13: Scenario 6– 1-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 1% Chance Event- Scenario 6								3-21-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	801.73	119255	801.81	120871	0.08	1617	
ND SH#17/ MN SH317	1223286	804.09		804.17		0.08		
Co. Hwy 15	1315673	805.08		805.14		0.06		
Minimum Impact Location	1408098	811.34		811.38		0.04		
Oslo Gage	1416287	813.01		813.07		0.06		
DS Grand Forks Levees	1533523	827.98		828.14		0.16		
Grand Forks Gage	1558518	832.97	107980	833.23	110644	0.26	2664	
Maximum Impact Location	1573768	835.27		835.57		0.30		
32nd Ave, Grand Forks	1580152	835.83		836.13		0.30		
Thompson Gage	1667877	847.35	82926	847.40	82657	0.05	-269	
Co. Hwy 25/ Co. Rd 221	1726274	854.46		854.45		-0.01		
DS Sandhill River/ Climax	1763746	857.34		857.31		-0.03		
Nielsville	1829877	861.66	75745	861.63	76149	-0.03	405	
DS Marsh River	1864960	863.43		863.41		-0.02		
US Goose River/ Shelly	1891054	865.36		865.33		-0.03		
Halstad Gage	1981580	869.09	71581	869.04	71065	-0.05	-516	
Hendrum	2038409	873.75	67278	873.69	66326	-0.06	-952	
Perley	2129181	878.50	61723	878.22	56966	-0.28	-4757	
Georgetown	2194021	883.36		883.10		-0.26		
North River/ Clay Co. Hwy 93	2305647	893.73		886.65		-7.08		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	899.08		890.46		-8.62		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	903.86 (41.12*)	34875	893.42 (30.68*)	11472	-10.44	-23402	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	907.71		897.49		-10.22		
US ND Wild Rice River	2484618	910.70		901.50		-9.20		
Co. Rd 16 / Co. Rd 4	2516193	913.59		905.07		-8.52		
Hickson Gage / US LPP Diversion	2563754	917.52	21730	925.47	14607	7.95	-7123	
Abercrombie	2764835	935.62	23000	935.91	23000	0.29	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

Table 14: Scenario 6– 0.2-Percent Chance Flood Impacts

North Dakota Diversion (LPP) - 0.2% Chance Event- Scenario 6								3-21-2011
Location	Station	Existing No Protection		ND Diversion (LPP)		Difference (ft) Project vs. Existing No Protection		
		Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	Elevation (ft)	Discharge (cfs)	
Drayton Gage	1062362	804.12	168364	804.23	169237	0.11	873	
ND SH#17/ MN SH317	1223286	805.99		806.07		0.08		
Co. Hwy 15	1315673	806.74		806.83		0.09		
Minimum Impact Location	1410241	812.15		812.19		0.04		
Oslo Gage	1416287	813.88		813.93		0.05		
DS Grand Forks Levees	1533523	829.92		830.05		0.13		
Grand Forks Gage	1558518	836.36	146225	836.59	149216	0.23	2887	
Maximum Impact Location	1561353	838.53		838.81		0.28		
32nd Ave, Grand Forks	1580152	839.75		839.99		0.24		
Thompson Gage	1667877	850.69	112422	850.63	111297	-0.06	-1125	
Co. Hwy 25/ Co. Rd 221	1726274	859.38		859.26		-0.12		
DS Sandhill River/ Climax	1763746	862.75		862.59		-0.16		
Nielsville	1829877	867.04	107296	866.87	105941	-0.17	-1355	
DS Marsh River	1864960	868.06		867.92		-0.14		
US Goose River/ Shelly	1891054	869.30		869.16		-0.14		
Halstad Gage	1981580	871.54	101754	871.31	96965	-0.23	-4789	
Hendrum	2038409	875.77	97650	875.47	93481	-0.30	-4169	
Perley	2129181	879.89	90756	879.52	79789	-0.37	-10967	
Georgetown	2194021	884.48		884.15		-0.33		
North River/ Clay Co. Hwy 93	2305647	895.35		892.98		-2.37		
19th Ave N Fargo/ 28th Ave N Moorhead	2360321	900.31		898.36		-1.95		
Fargo Gage (13th Ave S, 12th Ave S)	2388223	905.8 (43.06*)	61717	902.86 (40.12*)	30241	-2.94	-31476	
52nd Ave S Fargo/ 60th Ave S Moorhead	2438085	909.13		907.14		-1.99		
US ND Wild Rice River	2484618	911.54		910.30		-1.24		
Co. Rd 16 / Co. Rd 4	2516193	914.66		913.81		-0.85		
Hickson Gage / US LPP Diversion	2563754	919.69	35635	925.15	28778	5.46	-6858	
Abercrombie	2764835	940.90	44308	940.91	44308	0.01	0	

* Flood stage at USGS Gaging Station 05054000, Fargo, ND

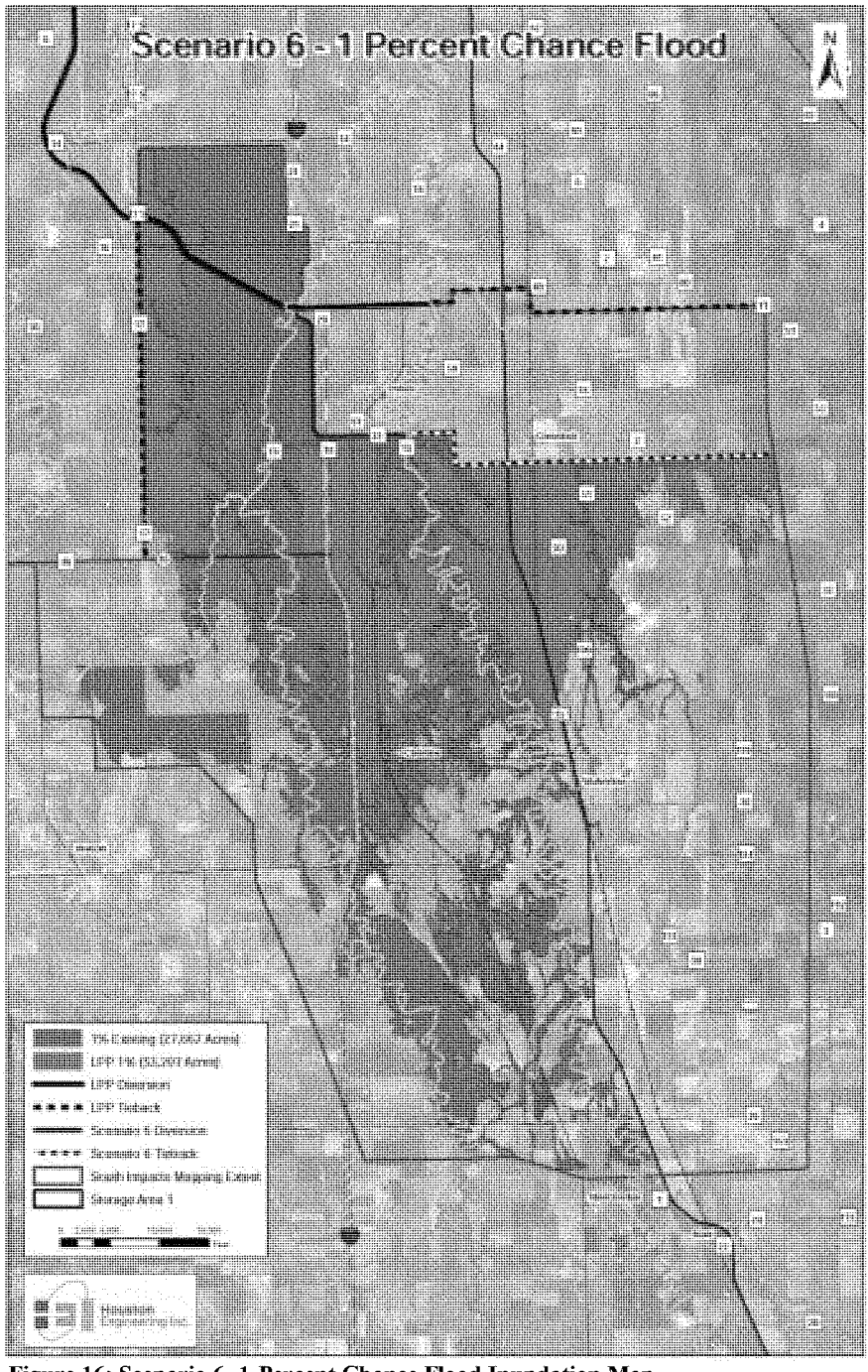


Figure 16: Scenario 6- 1-Percent Chance Flood Inundation Map

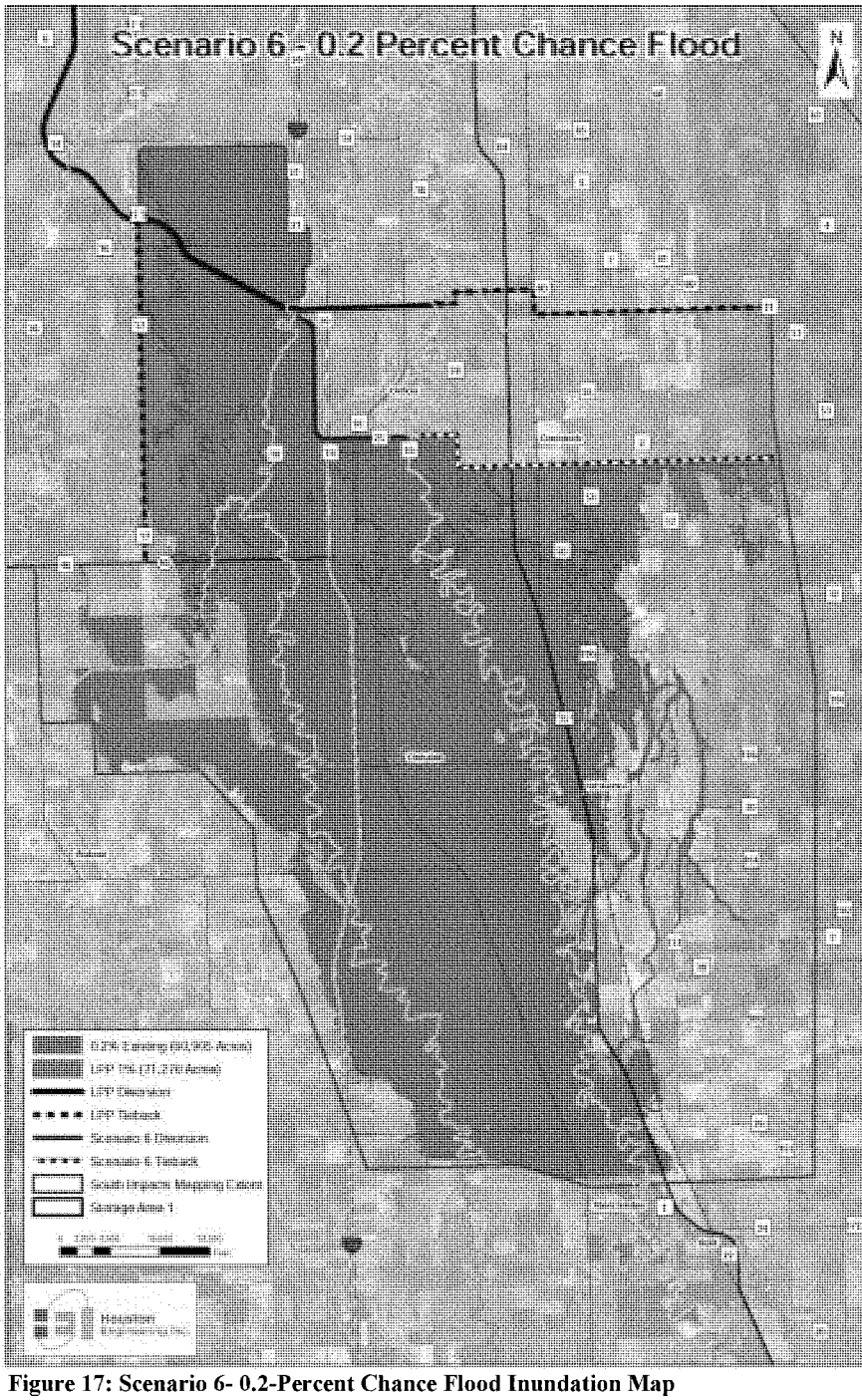


Figure 17: Scenario 6- 0.2-Percent Chance Flood Inundation Map

3.7 IMPACT COMPARISON

Table 15 and Table 16 provide a summary of the impacts associated with each scenario when compared to the Phase 4 LPP design for the 1-percent chance and 0.2-percent chance floods, respectively.

Table 15: Alternative Scenarios- 1-Percent Chance Flood Impact Summary

Alternative Scenario Analysis Summary - 1% Chance Event (Scenario vs. Phase 4 LPP)									
		Existing (No Protection)	Phase 4 LPP ND Diversion	Scenario #1	Scenario #2	Scenario #3	Scenario #4	Scenario #5	Scenario #6
Location	Station	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
Grand Forks Gage	1558518	832.97	0.24	-0.02	0.20	0.04	0.80	0.03	0.02
Thompson Gage	1667877	847.35	0.04	-0.02	0.48	0.00	1.29	0.01	0.01
Hendrum	2038409	873.75	-0.06	-0.01	0.31	-0.08	1.03	-0.01	0.00
Fargo Gage (13th Ave S, 12th Ave S)[1]	2388223	41.12	-10.32	-0.12	-0.05	-0.08	0.24	-0.02	-0.12
US LPP Diversion[2]	2531315	914.65	8.23	-0.64	-0.71	-0.62	-6.88	1.18	---
Hickson Gage (Staging Area)	2563754	917.52	5.38	-0.63	-0.68	-0.60	-4.66	1.18	2.57
Minimum Impact			0.04	-0.01	0.03	0.00	0.14	0.00	-0.04
Location (River Station)			(1410241)	(1408098)	(1408098)	(1408098)	(1408098)	(1408098)	(1408098)
Maximum Impact			0.29	-0.03	0.48	-0.02	1.88	0.03	(0.29)
Location (River Station)			(1573768)	(1573768)	(1813905)	(1573768)	(1813905)	(1574433)	(1573768)
Inundation Area Upstream of Project[3]									
		Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)
Additional 1% Inundation Area (above existing)			23,175	20,215	20,839	20,717	0	28,503	25,630

[1] Flood stage at USGS Gaging Station 05054000, Fargo, ND

[2] Upstream LPP Diversion Location for Scenario #6 is at the Hickson Gage

[3] Inundation Areas Upstream of Project correspond to Scenario Inundation Maps

Table 16: Alternative Scenarios- 0.2-Percent Chance Flood Impact Summary

Alternative Scenario Analysis Summary - 0.2% Chance Event (Scenario vs. Phase 4 LPP)									
		Existing (No Protection)	Phase 4 LPP ND Diversion	Scenario #1	Scenario #2	Scenario #3	Scenario #4	Scenario #5	Scenario #6
Location	Station	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
Grand Forks Gage	1558518	836.36	0.22	-0.02	0.17	-0.02	0.57	0.03	0.01
Thompson Gage	1667877	850.69	-0.05	-0.02	0.25	0.00	0.62	0.02	-0.01
Hendrum	2038409	875.77	-0.30	-0.02	0.25	-0.03	0.72	0.02	0.00
Fargo Gage (13th Ave S, 12th Ave S)[1]	2388223	43.06	-3.03	-0.20	-0.23	-0.08	-0.49	-0.21	0.09
US LPP Diversion[2]	2531315	915.94	6.50	-0.52	-0.55	-0.62	-6.44	1.16	
Hickson Gage (Staging Area)	2563754	919.69	2.85	-0.50	-0.50	-0.56	-2.88	1.12	2.61
Minimum Impact			0.04	0.00	0.02	0.00	0.09	0.00	0.00
Location (River Station)			(1410241)	(1410241)	(1408098)	(1410241)	(1410241)	(1408098)	(1410241)
Maximum Impact			0.27	-0.03	0.20	-0.04	0.80	0.03	0.03
Location (River Station)			(1561353)	(1561353)	(1577593)	(1561353)	(1806800)	(1561353)	(1561353)
Inundation Area Upstream of Project[3]									
		Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)	Area (Acres)
Additional 0.2% Inundation Area (above existing)			12,310	10,931	10,904	10,846	0	15,550	10,373

[1] Flood stage at USGS Gaging Station 05054000, Fargo, ND

[2] Upstream LPP Diversion Location for Scenario #6 is at the Hickson Gage

[3] Inundation Areas Upstream of Project correspond to Scenario Inundation Maps

3.8 COST COMPARISON

The preliminary feasibility costs for each scenario were estimated by Barr Engineering (Barr) with input from Moore Engineering and HEI. A breakdown of the costs associated with the original Phase 4 LPP design and each alternative scenario are included in Table 17. Barr had completed the cost estimate for the Phase 4 LPP design that was included in the February 28, 2011 report. Unless otherwise noted, these cost estimates utilized the Phase 4 FCP and LPP cost estimates as a basis but were developed to a lower level of detail. The cost estimates include costs related to mitigating hydraulic impacts upstream and downstream of the Phase 3 LPP project, but do not include any considerations for increased or decreased mitigation requirements as a result of the environmental impacts associated with the modifications involved with the alternative scenarios.

Table 17: Alternative Scenarios Analysis- Feasibility Cost Summary

Fargo-Moorhead Metro Flood Risk Management Project
LPP North Dakota Diversion
Additional Alternative Scenario Concepts - Opinion of Cost Summary
Revised 3-22-2011 based on USACE DRAFT TPCS (3-4-2011) with Additional Scenerios

Additional Scenario Costs shown are Project Costs in 2010 US Dollars, including Contingency. Costs do not include temporary escalation and are not fully funded amounts.

Item	Description	Phase 4 Contract Cost	(1) Phase 4 Contingency	Phase 4 Contingency %	Phase 4 Project Cost	Phase 4 Percent of Total	(2) Scenario 1 Enlarged Storage Area 1 Smart Storage & Reduced Upstream Staging	(2) Scenario 2 Eliminate Storage Area 1 (No Smart Storage) and Reduced Upstream Staging with Some Impacts at Thompson	(2) Scenario 3 Storage Area 1 with Addition of One Large Off-Stream Storage Area Downstream and Reduced Upstream Staging	(2) Scenario 4 Eliminate Storage Area 1 and Eliminate Staging	(2) Scenario 5 Eliminate Storage Area 1 and Increase Upstream Staging	(2) Scenario 6 Storage Area 1 with Modified Diversion Alignment to a location South of Hickson, Oxbow and Bakke
1	LANDS & DAMAGES (3)											
	ROW and Easements - Diversion Channel (and Storage Area 1)	44,554,000	11,138,500	25%	65,705,000	3.3%	77,640,200	43,760,100	88,246,600	Phase 3 LPP	43,585,100	67,892,900
	ROW and Easements - Upstream Staging Area	156,823,351	39,205,900	25%	239,766,800	11.5%	239,766,800	239,766,800	239,766,800	Phase 3 LPP	320,895,400	227,592,900
2	RELOCATIONS											
	Utility Relocations	15,862,000	3,968,100	25%	19,828,100	1.2%	19,828,100	19,828,100	19,828,100	Phase 3 LPP	19,828,100	20,374,300
	Roadway Bridges, Road Raises & Local Road Construction	103,611,800	25,903,000	25%	129,514,800	7.6%	129,514,800	129,514,800	129,514,800	Phase 3 LPP	151,465,000	115,788,600
6	FISH & WILDLIFE FACILITIES											
	Environmental Mitigation Features	73,135,700	18,284,000	25%	91,419,700	5.4%	91,419,700	91,419,700	91,419,700	Phase 3 LPP	91,419,700	91,419,700
8	ROADS, RAILROADS & BRIDGES											
	Railroad Bridges	46,497,500	11,624,400	25%	58,121,900	3.4%	58,121,900	58,121,900	58,121,900	Phase 3 LPP	58,121,900	58,121,900
9	CHANNELS AND CANALS											
	Diversion Channel	320,911,600	80,228,800	25% (25% Alt. 6)	401,141,400	23.5%	401,141,400	401,141,400	401,141,400	Phase 3 LPP	401,141,400	414,720,000
	Diversion Channel Landscape Plantings	1,098,000	274,500	25%	1,372,500	0.1%	1,372,500	1,372,500	1,372,500	Phase 3 LPP	1,372,500	1,372,500
	Control Structure on Red River	47,355,300	11,838,900	25%	59,194,200	3.5%	59,194,200	59,194,200	59,194,200	Phase 3 LPP	65,842,000	63,626,000
	Hydraulic Structure at Wolverton Creek	4,290,500	1,072,700	25%	5,363,200	0.3%	5,363,200	5,363,200	5,363,200	Phase 3 LPP	5,363,200	5,363,200
	Hydraulic Structure at Wild Rice River	29,348,100	7,337,000	25%	36,685,100	2.1%	36,685,100	36,685,100	36,685,100	Phase 3 LPP	37,400,000	37,876,000
	Hydraulic Structure - East Weir (at Connecting Channel)	219,666	54,916	25%	274,600	0.0%	274,600	274,600	274,600	Phase 3 LPP	274,600	274,600
	Hydraulic Structure - Inlet Weir to Diversion	9,786,200	2,446,600	25%	12,232,800	0.7%	12,232,800	12,232,800	12,232,800	Phase 3 LPP	12,232,800	12,232,800
	Hydraulic Structures at Sheyenne River	49,677,800	12,419,600	25%	62,097,400	3.6%	62,097,400	62,097,400	62,097,400	Phase 3 LPP	62,097,400	62,097,400
	Hydraulic Structure - Drain 14 - Large Drain Structure	8,236,300	2,059,100	25%	10,295,400	0.6%	10,295,400	10,295,400	10,295,400	Phase 3 LPP	10,295,400	10,295,400
	Hydraulic Structures at Maple River	45,108,900	11,277,300	25%	56,386,200	3.3%	56,386,200	56,386,200	56,386,200	Phase 3 LPP	56,386,200	56,386,200
	Hydraulic Structures at Lower Rush River	17,256,300	4,314,100	25%	21,570,400	1.3%	21,570,400	21,570,400	21,570,400	Phase 3 LPP	21,570,400	21,570,400
	Hydraulic Structures at Rush River	17,215,100	4,303,900	25%	21,519,000	1.3%	21,519,000	21,519,000	21,519,000	Phase 3 LPP	21,519,000	21,519,000
	Small Drain Structures (2)	504,800	126,185	25%	631,000	0.0%	631,000	631,000	631,000	Phase 3 LPP	631,000	631,000
	Large Drain Structure (1)	448,900	112,200	25%	561,100	0.0%	561,100	561,100	561,100	Phase 3 LPP	561,100	561,100
	Side Channel Inlets 1X72" (19)	8,342,900	2,085,700	25%	10,428,600	0.6%	10,428,600	10,428,600	10,428,600	Phase 3 LPP	10,428,600	10,428,600
	Side Channel Inlets 2X72" (7)	5,616,800	1,404,200	25%	7,021,000	0.4%	7,021,000	7,021,000	7,021,000	Phase 3 LPP	7,021,000	7,021,000
	Outlet to Red River	22,007,700	5,502,000	25%	27,509,700	1.6%	27,509,700	27,509,700	27,509,700	Phase 3 LPP	27,509,700	27,509,700
11	LEVEES AND FLOODWALLS											
	Tie-Back Levee - TBL East 2B (Constructed in MN)	18,576,700	4,644,350	25% (35% Alt. 5, 6)	23,221,000	1.4%	23,221,000	23,221,000	23,221,000	Phase 3 LPP	26,561,000	13,771,000
	Tie-Back Levee - TBL Cass 17 (Constructed in ND)	6,320,100	1,580,100	25% (35% Alt. 5, 6)	7,900,200	0.5%	7,900,200	7,900,200	7,900,200	Phase 3 LPP	10,500,000	12,800,000
	Levee - Connecting Channel - Reach 2018 (ND-23, 26)	1,683,900	420,900	25% (35% Alt. 5, 6)	2,104,200	0.1%	2,104,200	2,104,200	2,104,200	Phase 3 LPP	2,600,000	19,600,000
	Levee - Connecting Channel - Reach 2019 (ND-25)	6,969,900	1,742,500	25% (35% Alt. 5, 6)	8,712,400	0.5%	8,712,400	8,712,400	8,712,400	Phase 3 LPP	11,150,000	0
	Storage Area 1 Embankment and Inlet	57,964,900	14,491,200	25% (35% Alt. 1, 6)	72,456,100	4.2%	112,870,000	0	72,456,100	Phase 3 LPP	0	32,750,000.00
	Storage Area 1 Closure/Drainage Structure (North)	5,169,800	1,292,600	25%	6,462,400	0.4%	6,462,400	0	6,462,400	Phase 3 LPP	0	6,462,400
	Storage Area 1 Closure/Drainage Structure (East)	5,169,800	1,292,600	25%	6,462,400	0.4%	6,462,400	0	6,462,400	Phase 3 LPP	0	6,462,400
	Storage Area 1 Road Raise for Levees	1,987,500	496,900	25%	2,484,400	0.1%	3,557,000	0	2,484,400	Phase 3 LPP	0	2,517,000
	New Items Shown Below in Italic:											
	Levee - Connecting Channel Reach 2017 and 2018 (where Storage Area 1 Embankment is not created)			35%			0	20,580,000	0	0	24,453,836	0
	Downstream Storage Area			35%			0	0	44,016,000	0	0	0
	Downstream Storage AreaRoad Raise			25%			0	0	3,541,000	0	0	0
14	RECREATION FACILITIES											
	Recreation Facilities	23,219,700	5,805,200	25%	29,024,900	1.7%	29,024,900	29,024,900	29,024,900	Phase 3 LPP	29,024,900	29,824,500
30	PLANNING, ENGINEERING & DESIGN (PED)											
	PED	143,446,000	35,861,500	25%	179,307,500	10.5%	184,992,000	168,707,000	185,932,000	Phase 3 LPP	174,699,000	184,373,000
31	CONSTRUCTION MANAGEMENT (CM)											
	CM	66,942,000	16,735,500	25%	83,677,500	4.9%	86,330,000	78,730,000	86,768,000	Phase 3 LPP	81,526,000	86,061,000
	Total	**$1,365,358,917**	**$341,343,901**		**$1,760,453,000**	**100.0%**	**$ 1,822,018,300**	**$ 1,655,474,800**	**$ 1,838,260,600**	**$ 1,505,470,000**	**$ 1,785,344,236**	**$ 1,795,054,900**
	Change from Phase 4						$61,565,300	-$104,978,200	$77,807,600	-$254,983,000	$24,891,236	$34,601,900

(1) Allowance for costs that will be in the Project Cost and are not included in Contract Cost. Does not account for changed conditions either in final design or during construction.
(2) All costs shown are for the purposes of conceptual alternative comparisons only. A detailed cost estimate for each alternative would be required to refine / quantify within the estimates shown.
(3) Lands and Damages costs are based on the information included in the document "Preliminary Real Estate Summary, Fargo-Moorhead Metropolitan Feasibility Study, Phase 4" provided by Brent Coleman (USACE - St. Paul District) via e-mail on March 12, 2011 and supplemental information provided by Rodney Peterson (USACE - St. Paul District) via e-mail on March 16, 2011. Using the methodology as outlined in these documents, the Lands and Damages costs for the various scenarios were updated for this study.

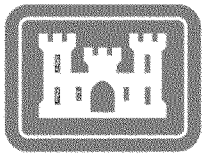
Revision to Phase 4 LPP Item Estimated by: Houston Engineering, Inc.
Moore Engineering, Inc.
Structure Estimates by MED and Economic Estimates by HEI
Houston Engineering Co. (in lieu of revised costs per USACE, Alternative 6 Revisions to 02 Relocations: Utility Relocations, 06 Fish and Wildlife Facilities and 14 Recreation Facilities made on diversion inlet/gate ratio basis)
MED assumed as 15% on construction costs (NOT including 01 Lands & Damages), CM assumed as 7% on construction costs (NOT including 01 Lands & Damages)
Item Assumed To be Unchanged from Phase 4 (by Bookton Hydraulics) by USACE

Appendix P
Non-Structural

Fargo-Moorhead Metropolitan Area Flood Risk Management

Final Feasibility Report and Environmental Impact Statement

July 2011



US Army Corps of Engineers ®

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USACE-MVP-0000087980

Appendix P

Non-structural

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Part 2: July 2011 Supplemental non-structural assessment (33 pages)

PART 1
NONSTRUCTURAL ASSESSMENT
FOR THE
FARGO-MOORHEAD METRO FEASIBILITY STUDY
MAY 2010

FARGO–MOORHEAD METRO AREA NONSTRUCTURAL REPORT

1.0 Introduction to Nonstructural Assessment

The Corps of Engineers, St Paul District [MVP] is engaged in a feasibility study to reduce flood damages, improve ecosystems, and realize other related water resource opportunities in Fargo, North Dakota and Moorhead, Minnesota. In terms of flooding, the Red River of the North is the major flood threat for the cities with the Wild Rice, Sheyenne, Maple, and Rush Rivers influencing the Fargo area and the Buffalo River influencing the Moorhead area.

MVP completed a report entitled "Fargo-Moorhead Metropolitan Area Reconnaissance Study" in March 2008 and then revised the report in April 2008 (Reference 1). This report concluded that "cost effective engineering solutions to water resource problems in the Fargo-Moorhead Metropolitan Area can be formulated that will result in one or more projects with benefits in excess of project costs". The report addressed nonstructural measures and stated "Nonstructural measures alone would not meet the overall planning objectives. However, all of these measures should be considered for integration with structural measures to maximize effectiveness of the alternatives". The Mississippi Valley Division, after its review of the report stated "Nonstructural flood risk management measures should be fully addressed in the feasibility study". The present direction of the feasibility study is to investigate flood risk reduction opportunities, both nonstructural and structural, that can be used to achieve the planning objectives of reducing flood damages/risk and restoring/improving degraded riverine and riparian habitat.

This appendix contains detailed technical information used in the analysis of existing conditions, in the development of problem solving measures, and in the analysis, evaluation, comparison, screening, and selection of alternative nonstructural plans. The appendix is currently presented as tentatively selected recommendations contained in the main report. This appendix functions as a complete technical document to support the nonstructural analysis portion of the feasibility study process. However, because of the complexity of the plan formulation process used in this planning study, the information contained herein should not be used without parallel consideration and integration of all other appendices, and the main report that summarizes all findings and recommendations.

Nonstructural measures are proven methods and techniques for reducing flood risk and flood damages in floodplains. Thousands and thousands of structures across the nation are subject to reduced risk and damage or no risk and damage due to implementation of nonstructural measures. Besides being very effective for both short and long term flood risk and flood damage reduction, nonstructural measures can be very cost effective when compared to structural measures. A particular advantage of nonstructural measures when compared to structural measures is the ability of nonstructural measures to be sustainable over the long term with minimal costs for operation, maintenance, repair, rehabilitation, and replacement (OMRRR).

Nonstructural measures are obviously very building/structure specific. Each structure is different and may require a different nonstructural measure. In order to achieve this level of specificity, each structure will have to be inspected by a team consisting of a floodplain engineer, structural engineer, cost engineer, civil engineer, and real estate specialist in order to determine, prior to implementation, the specifics relative to each type of measure employed. Because of the nature of this level of investigation, this degree of specificity was not possible within this phase of study.

Nonstructural measures require different implementation as compared to structural measures. Since each structure is owned and occupied by people, agreements must be entered into with each owner.

In order to achieve flood risk/flood damage reduction, structure owners need to participate in any project incorporating nonstructural measures. This can be either voluntary or mandatory depending upon the needs of the project and the desires of the community. Voluntary is always the preferred method of implementation, but could result in a patchwork effect due to some owners refusing to participate in the project.

With implementation of any flood risk/flood damage reduction project, the ability of the project to achieve the objectives must be considered not just for the short term but also for the long term. Nonstructural measures are most advantageous over structural measures especially for the long term if full, unbiased consideration is given to OMRRR costs not just for the economic life of the project which is normally 50 years, but for the ability of the project to provide the desired level of flood risk reduction for as long as the damage center exists which is in perpetuity. Within the context of nonstructural measures, measures which can be implemented in the short term by the Corps of Engineers in partnership with Fargo and Moorhead will be considered. However, measures that may require intermediate terms and long terms for implementation should also be identified at least in concept and incorporated into each community's floodplain management plan for development and implementation as opportunities voluntarily arise or as opportunities are made to happen.

The ability of nonstructural measures to be implemented in very small increments, each increment producing flood risk reduction benefits, and the ability to initiate and close a nonstructural program with relatively minimal costs are important characteristics of this form of flood risk reduction. Also important is the ability to implement measures over intermediate and long periods such that layering of measures, each one providing a higher degree of risk reduction, is possible and given both Federal and non Federal funding constraints probable.

The overall most important objective and result of this study effort for the cities of Fargo and Moorhead is to implement a program of "No Flood Risk." While it is unrealistic to assume that these communities can ever achieve a state of "No Flood Risk" due to their far remoteness from topography that is high enough in elevation above any flood source to be flood free for even the most rare frequency of flood, this should be a goal. The essence of the "No Flood Risk" concept is that flood risk is an integral part of each and

every decision within the metro area by all entities ranging from private to public. Each decision should be made to reduce flood risk as much as possible and to move to a "No Flood Risk" community as much as possible.

1.2 Flood Risk Perspective and Nonstructural Measures

Flood risk in the United States continues to increase despite many efforts during the past decades to reduce and eliminate that risk. Flood risk is defined as the product of the frequency of flooding and the consequences of flooding. Early efforts to reduce flood risk were focused on controlling floods by reducing the frequency of flooding with the use of structural alternatives such as dams, levees, channels, and diversions. These structural alternatives modified the characteristics of floods. This concept began to fade in the 1960's as it became apparent that structural means alone could not reliably control nature and contain flooding. The focus then evolved to flood *damage* reduction. The theory with the flood damage reduction focus was in order to reduce flood damage from an economic perspective the focus had to be not only on reducing the frequency of flooding but also the consequences of flooding. The flooding could be made less damaging through modifying the characteristics of floods [structural alternatives] and also modifying the characteristics of development in the floodplain and the behavior of people living within the floodplain [nonstructural alternatives]. Flood damage reduction focused primarily on damages and their effects on the economy. In the past several years; however, the nation has shifted its thinking to overall flood *risk* reduction and *flood risk management*. The nation has recognized that the adverse affects of flooding were manifested comprehensively across many categories including loss of life, rather than simply economic damages. In the flood risk reduction/flood risk management environment, floodplain/flood risk managers realize that to effectively reduce flood risk, all "tools" in the flood risk reduction "tool box" must be used. These "tools" include both structural and nonstructural measures. These measures, when considered in the context of reducing flood risk, become alternatives that can be compared with other alternatives.

The overall purpose of a nonstructural alternative is to reduce flood risk. Nonstructural alternatives 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, nonstructural alternatives do not modify the characteristics of floods nor do they induce development in a floodplain that is inconsistent with reducing flood risk. Some nonstructural measures that can be formulated into nonstructural 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 nonstructural alternatives since it contains programs to provide minimum standards for floodplain regulation, to provide flood insurance, and to provide flood hazard mitigation. In contrast, structural alternatives reduce flood risk by modifying the characteristics of the flood. Structural alternatives do not modify the characteristics of existing development in the floodplain. Because structural alternatives reduce the frequency of flooding within a particular floodplain, they can

affect the behavior of people living in or near the floodplain by allowing them to think that the floodplain is no longer subject to flooding. Because of this, structural alternatives, while they decrease the frequency of flooding, can actually increase flood risk if the consequences of flooding are allowed to increase. This occurs when new development is placed in the floodplain that is inconsistent with reducing flood risk.

Some of the *basic* measures used to develop nonstructural alternatives are as follows:

- Relocate buildings from the floodplain to a flood-free location
- Acquire the floodplain land on which the relocated buildings previously existed and enforce deed restrictions so the land will never be developed in the future for uses that are subject to flood risk
- Acquire floodplain land that is in existing open space used to prevent future development that could be at flood risk
- "Buy out" buildings within the floodplain, destroy them, and enforce deed restrictions to prevent future development that could be at flood risk
- Elevate buildings above a particular flood elevation.
- Dry flood proof buildings (traditional building waterproofing)
- Wet flood proof buildings (retrofitting existing buildings below a design flood elevation with water resistant materials and allowing flood water to easily flow into and out of the building)
- Install small levees, berms, and walls around one building or a few buildings that are in close proximity to one another. Such levees, berms, and walls are never accredited for the National Flood Insurance Program
- Install flood warning systems
- Develop and implement flood preparedness plans
- Floodplain regulation and floodplain management
- Restoring natural and beneficial floodplain functions
- Communication and education programs aimed at achieving no flood risk
- The National Flood Insurance Program
- Watershed/floodplain land use planning
- Transfer of development rights and purchase of development rights
- Development impact fees
- Land development redirection
- Land taxation policies and special assessments

Each of these general categories of nonstructural measures can be applied as single measures or can be applied in combination with one another or with structural measures to reduce or eliminate flood risk. The range of benefits, costs, and residual damages associated with the application of each measure is broad. The extent and severity of social and economic impacts associated with the various measures can be likewise broad and must be identified for any plan. Depending upon the nonstructural measures selected for application and the relative percentage of each applied to the metro area, the future land use pattern of the area could look considerably different in specific areas of the metro and the excitement, aesthetics,

and livability experience of the metro area greatly enhanced while flood risk is reduced.

In terms of flood risk, it is unfortunate that floodplain areas are so attractive to commercial, residential, and industrial developers. The consequences associated with locating damageable property and people within such areas can be extreme to not only property owners and floodplain occupants but to taxpayers at all levels who have, over the decades, largely evolved to "foot the bill" for flood response, recovery, and rebuild when a flood source decides to reoccupy its traditional floodplain.. Within the context of this study, an objective is to identify strategies and measures that can be used in tandem to both discourage development in high risk areas and to encourage development in areas of low and no risk. Some strategies and measures may be more appropriate for Federal action while others will be more attuned to local regulatory action and administration. In either case, these measures must be effective, socially acceptable, environmentally suitable, and mindful of the existing neighborhood and community social and economic systems within which they would be implemented. It is the intent of this appendix to identify such nonstructural measures.

1.3 Floodplain and Flood Risk Characteristics

Fargo and Moorhead are both exposed to flood risk from the Red River of the North. While other flood sources are located in the area as mentioned above, the Red River of the North remains as the primary flood source of concern. While some permanent levees have been constructed along the Red River and some upstream flood storage exists in the Red River Basin upstream from the metro area, flood water surface elevations from the 100-year and larger floods in the metro area are excessive. As stated earlier, the floodplains in both Fargo and Moorhead are relatively flat. An examination of a flooded area map for the metro area shows the floodplain for the 500-year flood to cover almost all of Fargo. As stated earlier, the topography of Moorhead, while relatively flat, does provide greater elevation relative to the Red River than does Fargo. For this reason, a much larger percentage of Moorhead than Fargo is located above the 500-year flood. Depths of flooding for 100-year and 500-year floods can vary from several feet to zero depending on location.

The source of the most major historic floods from the Red River is spring snowmelt, with summer rainfall events also causing flood problems. Because of the characteristics of the Red River Basin, flood warning is generally quite ample to enable human intervention to reduce flood damages. Because of the basin characteristics and the characteristics of the Red River within the metro area, actual flood duration can last from days up to weeks.

The floodplain within Fargo and Moorhead consists of basically the entire spectrum of development—residential, commercial, industrial, and governmental. Basements are prevalent. Almost all residential structures have basements, with many being a form of "walk out". Basements also exist in some of the other building types. Age of development is also across the entire spectrum from new to old.

The floodplain for purposes of this appendix is considered to be the entire floodplain from the Red River. This is not just the 100-year floodplain that the National Flood

Insurance Program specifically relates to but rather the entire floodplain that is subject to flooding from any flood, regardless of how infrequent that flood is. With that definition of floodplain, no part of the present Fargo Metro Area is located out of this floodplain. Looking at the Moorhead Metro Area, the same is probably true with the caveat that there does exist locations within Moorhead that are on higher ground, but probably still located within the above definition of floodplain. What this paragraph discussion is really saying is from the perspective of reducing flood risk in the Fargo-Moorhead Metro Area in its totality, further floodplain development within this total Metro Area would appear now to make most sense to be in the eastern portion of Moorhead rather than within Fargo.

1.4 Executive Order 11988

This executive order [EO] was issued by President Jimmy Carter on 24 May 1977 and is entitled "Floodplain Management". In issuing the EO the President stated "in order to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative, it is hereby ordered that each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities...". The nonstructural analysis was done in complete compliance with the EO meaning that any nonstructural measures that are incorporated into alternatives recommended for implementation support the vision of the EO.

1.5 Critical Facilities

Structures/facilities exist in the metro area which should never be flooded. These are called critical facilities in terms of Executive Order 11988 [EO]. They are essential during a flood to provide human safety, health, and welfare. Facilities that could, if flooded, add to the severity of the disaster such as petroleum terminals, waste water treatment plants, toxic material storage sites, are considered critical. Critical facilities are also generally those services required during the flood such as police and fire protection, emergency operations, people evacuation sites, and medical care. Facilities that house elderly people that require extensive evacuation time would also be considered critical. Each critical facility within the guidelines of the EO should be located at a flood free site. If this is not possible or practicable, the facility should be located external to the 500-year floodplain. If this is not possible or practicable, the facility must be, at a minimum, protected to the extent that it can function as intended during all floods up to and equal to a 500-year event.

Within the nonstructural analysis, all such facilities meeting the critical facility criteria discussed above were treated with nonstructural measures to meet the above objectives for critical facilities. If they were located in the 500-year floodplain, they were considered for relocation if the 500-year flood depth was greater than 9 feet. For flood depths less than 9 feet, other nonstructural measures were considered with the assumption that the facility could continue to function as intended during the flood with implementation of those nonstructural measures.

1.6 Nonstructural Flood Risk Reduction
Two planning objectives exist for this assessment. They are 1) reducing flood damages and 2) restoring or improving ecosystems. Two planning constraints exist. They are 1) avoiding increasing peak Red River flood stages and 2) complying with the Boundary Waters Treaty of 1909 and other pertinent international agreements. Both the planning objectives and the planning constraints can be accommodated with the use of a combination of nonstructural measures.

1.7 Nonstructural Measures Description
The following nonstructural measures were investigated to reduce flood risk within the Metropolitan Area:

1.7.1 Relocation of Structures. This measure requires physically moving the structure as part of the project and buying the land upon which the structure is located. It makes most sense when structures can be relocated from a high flood hazard area to an area that is located completely out of the floodplain. As discussed above, this is not possible within Fargo and may not be possible within Moorhead. Therefore, any structure relocation would consist of moving the structure from an area of high flood hazard to an area of lower flood hazard and then using the nonstructural measure of elevation to achieve the desired level of flood risk reduction within the metro area. Development of relocation sites where structures could be moved to achieve the planning objectives and retain such aspects as community tax base, neighborhood cohesion, can be part of any relocation project. This measure is applicable anywhere in the metro area.

1.7.2 Buyout and Demolition of the Structure. This measure consists of buying the structure and the land as part of the project. The structure is either demolished or the structure is sold to others and relocated to a location external to the floodplain. Development sites, if needed, can be part of the project in order to have locations where displaced people can build new homes within the metro area. This measure is applicable anywhere in the metro area.

1.7.3 Elevation of Structures. This measure requires lifting the entire structure or the habitable area to be above a particular flood event. In the metro area, probably the most acceptable elevation measure would be on extended foundation walls. Since most all of the structures to elevate have basements under them, the concept would be to basically elevate the basement out of the ground. Then depending on the design flood elevation, the elevated basement could be fully developed if the basement floor was located above the Flood Insurance Rate Map [FIRM] base flood elevation [BFE] or the design flood elevation whichever is higher, could be kept undeveloped and wet flood proofed in the regard of equalizing hydrostatic force, or could be developed but with wet flood proofing concepts in more totality. If the basement had been fully developed pre elevation and could not be developed post elevation, compensation of the basement space would be in order to the owner. This measure is applicable anywhere in the metro area unless the

required elevation is greater than a maximum of 12 feet above the adjacent grade. Velocity and hydrodynamic force would also have to be considered.

1.7.4 Removal of Basement. This measure consists of filling in the existing basement without elevating the remainder of the structure. This would occur if the structure first floor was located above the BFE or above the design elevation whichever is higher. With this measure, placing an addition on to the side of the structure as part of the project could occur to compensate for the lost basement space to the owner. If the addition could not be done because of limited space within the lot or because the owner did not want it, compensation for the lost basement space would be in order to the owner. This measure would only be applicable where the design flood depth is relatively small [first floor already above the design depth]. Hydrodynamic forces would also be a consideration.

1.7.5 Dry Flood Proofing. This measure basically consists of waterproofing the structure. This can be done to residential homes as well as all other types. This measure achieves flood risk reduction but it is not recognized by the NFIP for any flood insurance premium rate reduction if applied to residential. Based upon NFPC sponsored tests at ERDC, a "conventional" built structure can generally only be dry flood proofed up to 3 feet on the walls. A structural analysis of the wall strength would be required if it was desired to achieve higher protection. A sump pump for sure and perhaps French drain system is installed as part of the project. Closure panels are used at openings. This concept does not work with basements nor does it work with crawl spaces in the metro area due to the long duration of flood. This measure will work in the metro area if design flood depths are generally less than three feet and on an appropriate structure as discussed. Hydrodynamic forces would also be a consideration. For buildings with basements and/or crawlspaces, the only way that dry flood proofing could be considered to work is for the first floor to be made impermeable to the passage of floodwater.

1.7.6 Wet Flood Proofing. This measure is applicable as either a stand alone measure or as a measure combined with other measures such as elevation which was discussed above. As a stand alone measure, all construction materials and finishing materials need to be of water resistant material. All utilities must be elevated above the design flood elevation. Because of these requirements, wet flood proofing of finished residential structures is generally not recommended. Wet flood proofing is quite applicable to commercial and industrial structures when combined with a flood warning, flood preparedness, flood response plan. This measure is generally not applicable to large flood depths and high velocity flows.

1.7.7 Berms, Levees, and Floodwalls. This measure is applicable to locations within the metro area. As nonstructural measures, berms, levees, and walls should be constructed to no higher than 6 feet above grade and are not certifiable for the NFIP, meaning that flood insurance and floodplain management requirements of the NFIP are still applicable in the protected area. These nonstructural measures are intended to reduce the frequency of flooding but not eliminate floodplain management and flood insurance requirements. These measures can be used for all types of structures in the metro area. They can be placed around a single structure or a small group of structures. With application of these

measures to be nonstructural, they cannot raise the water surface elevation of the 100-year flood by any more than 0.00 feet.

1.7.9 Flood Warning, Preparedness, Evacuation Plans and Pertinent Equipment Installation. These measures are applicable to the metro area. All of the above nonstructural measures with the exception of buyout and of relocation to a completely flood free site require the development and implementation of flood warning/preparedness planning. The development of such plans and the installation of pertinent equipment such as data gathering devices (rain gages and stream gages) and data processing equipment (computer hardware and software) can be part of the project.

1.7.10 Land Acquisition. Land acquisition can be in either the form of fee title or permanent easement with fee title the preference. Land use after acquisition is open space use via deed restriction that prohibits any type of development that can sustain flood damages or restrict flood flows. Land acquired as part of a nonstructural project can be converted to a new use such as ecosystem restoration and/or recreation that is open space based such as trails, canoe access, etc. Conversion of previously developed land to open space means that infrastructure no longer needed such as utilities, streets, sidewalks, etc can be removed as part of the project. The conversion to new use [ecosystem restoration and/or recreation] can also be part of the project. By incorporating " new uses of the permanently evacuated floodplains" into the nonstructural flood risk reduction project, economic feasibility of the buyout or relocation projects is enhanced due to transfer of some flood risk reduction costs to ecosystem restoration and by adding benefits [and costs] of recreation. This will be determined by use of the "Separable Costs/Remaining Benefits" guidance. Other Federal agencies such as the NRCS have permanent easement programs to restore wetlands in "evacuated" floodplains that could be used in a collaborative mode with a Corps nonstructural program.

1.7.11 Floodplain Management Plans. A floodplain management plan (FPMP) is required of the Corps non-Federal project sponsor. The intent of a FPMP is to maintain the integrity of the Corps partnered project from having the frequency of flood risk reduction provided by the project from being diminished. This is a non-Federal sponsor required activity, but if done during the feasibility phase of study, can be cost-shared on the same basis as the feasibility study. This makes sense for the local sponsor from not only the cost-share perspective, but also from the holistic flood risk reduction perspective. This latter perspective makes sense for the Corps as well. By integrating the FPMP with the feasibility study, both the FPMP and the ultimate project are bettered. It is recommended that the FPMP be prepared within this feasibility study.

1.7.12 Vertical Construction for Residential Occupancy. This nonstructural concept refers to condominium type habitation, where people live within floodplains but they live in apartment type buildings where the at-grade floor is reserved for open space type uses such as auto parking. The remaining floors of the building which are all located above even the most infrequent flood are where the residential construction occurs. This vertical construction is proposed for consideration within the metro area for the simple

reason that, especially in Fargo, no area within a close proximity to Fargo is high enough in elevation above the Red River floodplain to be totally above the floodplain for flood free construction of residential structures. This may be the same for Moorhead. This concept to change residential construction from single family home to vertical condominium will probably face tough political/social criticism. However, it merits consideration if the metro area is to, in the long term, achieve a No Flood Risk status.

1.7.13 Communication and Education Aimed at Achieving No Flood Risk. Communication and education concerning flood risk is extremely vital and must be done on a continuous basis. People who have received the education tend to forget and new people coming into the metro area need to be educated quickly about the flood risk that exists in the metro area. Far too often communities make an effort to "disguise" the true flood risk from people because the local economic engine of property tax base and new development overrides any thoughts on flood risk and safety from floods. This position is, in a de facto sense, supported by State and Federal government because of the availability of post flood funding for flood response, flood recovery, and flood rebuild from such government agencies via taxpayers. Any communication and education programs must cover all entities within the metro area. At a bare minimum, annual emergency drills and testing of flood warning equipment must occur. This must include not only government responsible functions but also individual responsible functions. The owner of each structure within a floodplain should have a flood emergency/response plan that they practice each year. The essence of any communication and education program within the metro area should focus on moving the communities to a No Flood Risk environment to the maximum extent possible by instilling in all entities of the community from individuals to business owners to developers to government officials the importance of asking the following question in any decision process: "What will this decision do in regard to moving my property or my community toward no flood risk?"

1.7.14 Floodplain Regulation and Floodplain Management. Floodplain regulation and floodplain management have proven time and again to be very effective tools in reducing flood risk and flood damage. The basic principles of these tools are based nationally in the NFIP which requires minimum standards of floodplain management and floodplain regulation for those communities that participate in the NFIP. Both Fargo and Moorhead participate in the NFIP. These minimum standards of the NFIP have been shown to be overall inadequate to reduce flood risk and flood damage. This is verified by the fact that the NFIP has been in existence since 1968 and that flood risk and flood damage in the nation has continued to increase over the four decades since the NFIP began with no end to increasing flood risk in sight. This does not mean that the concept of floodplain management and floodplain regulation are not valid. It simply means that the standards are too low and building continues to be done in areas that are too hazardous and in areas that are too low. Both Fargo and Moorhead have standards that are in excess of the minimum standards of the NFIP. This is good. However, from development patterns that currently exist, it shows that these standards should also be enhanced to provide greater consideration of eliminating all flood risk from the metro area.

1.7.15 Restoring Natural and Beneficial Floodplain Functions. As discussed earlier, the nation has employed the concepts of flood control, flood damage reduction, and now flood risk reduction in order to satisfy the desire to gain economic use of floodplains and to also minimize economic damages due to floods. Within the Principles and Guidelines which guide Federal involvement in water resources issues, four accounts presently exist. They are national economic development, regional economic development, other social effects, and environmental quality. Among these four accounts, national economic development has received the most attention in terms of achievement with any water resources projects. The other accounts, while open for consideration, are less emphasized in the decision making process. Within the environmental quality account is where the traditional emphasis was on "restoring natural and beneficial functions" of floodplains. Over the decades of trying to reduce flood damages via water resources projects, it has become increasingly clear and important to include opportunities to enhance, protect, and preserve the environment. The natural and beneficial functions of floodplains are numerous but the ability of a "natural" floodplain to reduce flood damages has not been emphasized nearly to the degree it should. As a nonstructural measure to reduce flood risk, undeveloped floodplains [whether natural or manmade non development] not only reduce flood risk because non damageable property is located in a floodplain, but also reduce downstream flood stages by providing natural floodplain storage for flood water.

1.7.16 National Flood Insurance Program (NFIP). The NFIP is a nonstructural measure. The NFIP contains 3 basic parts; flood insurance, flood mitigation, and floodplain regulation. In terms of reducing flood risk, only flood mitigation and floodplain regulation have a direct impact in theory. In regard to the flood insurance part of the NFIP, flood insurance simply allows spreading the flood risk across multiple properties as does any insurance program. It does not reduce flood risk, it shares flood risk. In fact, the ability of property owners to purchase flood insurance in hazardous areas has overall increased flood risk because property owners with flood insurance are much more willing to accept the risk of hazardous floodplain development since their risk is absorbed by flood insurance that within the NFIP, is rated too low for the insured flood risk. In terms of the NFIP as a nonstructural measure to truly reduce flood risk, the flood mitigation and floodplain regulation parts of the NFIP are those measures. Five mitigation programs exist within the NFIP. They are hazard mitigation grant program, pre disaster mitigation grant program, flood mitigation assistance program, repetitive loss program, and severe repetitive loss program. Within the floodplain regulation part of the NFIP, this serves as a nonstructural mitigation measure indirectly through adoption of minimum floodplain management standards by communities participating in the NFIP. While theoretically these minimum floodplain management standards are good, in reality the focus on the 100 year flood as the de facto floodplain limit has actually promoted development and increased flood risk within those floodplains occupied by floods with frequency of occurrence less than that of the 100 year. The NFIP is discussed in this appendix as a nonstructural measure because the overall intent of the program is to reduce flood risk. However, as briefly pointed out above, some aspects of the program have actually resulted in and continue to result in increased flood risk. While concepts to implement at the national level that would enable the NFIP to be much more friendly to reducing flood risk could be offered within this appendix, that is beyond the influence of this appendix

and of these communities. However, while the communities of Fargo and Moorhead cannot change the national minimum NFIP standards, they can change local standards that achieve higher levels of flood risk reduction. Some of those possible higher standards are:

- replace elevation requirements based on the 100 year to the 500 year
- implement a zero rise floodway
- adopt cumulative damages as the trigger for substantial damage determination

1.7.17 Transfer of Development Rights and Purchase of Development Rights. This concept is based on land owners rights to develop property that can be separated from other land rights and traded within a market like system. In general, any land use controls that are specific to a property and significantly decrease the market value of property or remove an opportunity to receive some economic value or use from the property have been considered a taking. In order to facilitate moving development rights from one property that is most flood prone to another property that is much less flood prone or, ideally, flood free, the concept of transfer of development (TDR) rights developed. Another variation of this concept of removing development rights from a flood prone property is called purchase of development (PDR) rights. In either case, removing development rights from a particular property is voluntary so a takings issue does not exist. Within TDR, the development rights are purchased and sold in a market setting. Under TDR, the cost to a public entity is minimal generally being limited only to administrative type costs. PDR is similar in removing development rights from a flood prone property, but it requires the public entity to purchase the development rights and to not sell the rights. PDR is quite similar to easement programs where specific property rights are purchased by a public entity, the landowner retains title to the property with specified rights, property taxes can be lowered to reflect the loss of rights, and the public entity gains specific use rights to the property as negotiated. Both of these measures reduce flood risk by nonstructural methods and should be considered as tools to reduce flood risk both short term and long term.

1.7.18 Development Impact Fees. Development Impact Fees are accessed by public entities in return for permits to develop property. Within floodplains, such fees could be used to mitigate any impacts that such a development would have on other property in terms of flood risk increase. They could also be used to pay for any future flood related costs to property located within the development area. This could apply to both public property such as streets, infrastructure in or serving the developed area and to private property such as homes and businesses that are located in the developed area. This concept can be implemented as a nonstructural measure to reduce flood risk.

1.7.19 Land Development Redirection. Directing future land use away from high flood hazard areas is the basis of this concept. This can be done via several concepts such as those already discussed above and it can be done via specific actions that redirect growth and development into less hazardous areas. These later actions are not only land acquisition but also infrastructure development in areas of less and ideally no flood hazard. Within the metro area, this concept really means redirecting growth into areas of low or no flood hazard regardless of where the growth occurs in the metro area. If such

redirected growth remains with areas subject to flood hazard but at a reduced level relative to other areas, implementation of the basic nonstructural measure of elevation must be incorporated into the redirection rather than simply build at grade as if a flood hazard did not exist. Then rely on implementation of a structural measure such as a levee to further reduce the flood risk by decreasing the frequency of flooding. As discussed earlier, redirecting growth while attempting to reduce flood risk with a levee will ultimately result in increased flood risk as the consequences of floodplain occupation are increased.

1.7.20 Land Taxation Policies and Special Assessments. This concept works by requiring higher taxes and special assessments on property that is at high flood risk than property that is of low or no flood risk. This concept makes sense because of higher costs incurred by communities to maintain services, respond to floods, etc, etc within such areas. This type of economic disincentive would discourage development and redevelopment in high flood hazard areas. The essence of these nonstructural measures is to reflect the high flood hazard in higher costs to those who choose to develop in, own property in, and live in such areas that require a larger burden on communities. It is basically letting the cost to the property be reflective of the flood hazard.

1.8 Criteria for Implementation of Nonstructural Measures

Implementation of nonstructural measures can be quite specific in terms of there application to structures or land or they can be quite non specific with quite broad application. Of the above discussed measures, those that are quite structure/land specific are as follows:

- Relocation of structures
- Buyout and demolition of structures
- Elevation of structures
- Removal of basement
- Dry flood proofing
- Wet flood proofing
- Berms, levees, and flood walls
- Land acquisition

Of those measures discussed, those that are quite broad in terms of application are as follows:

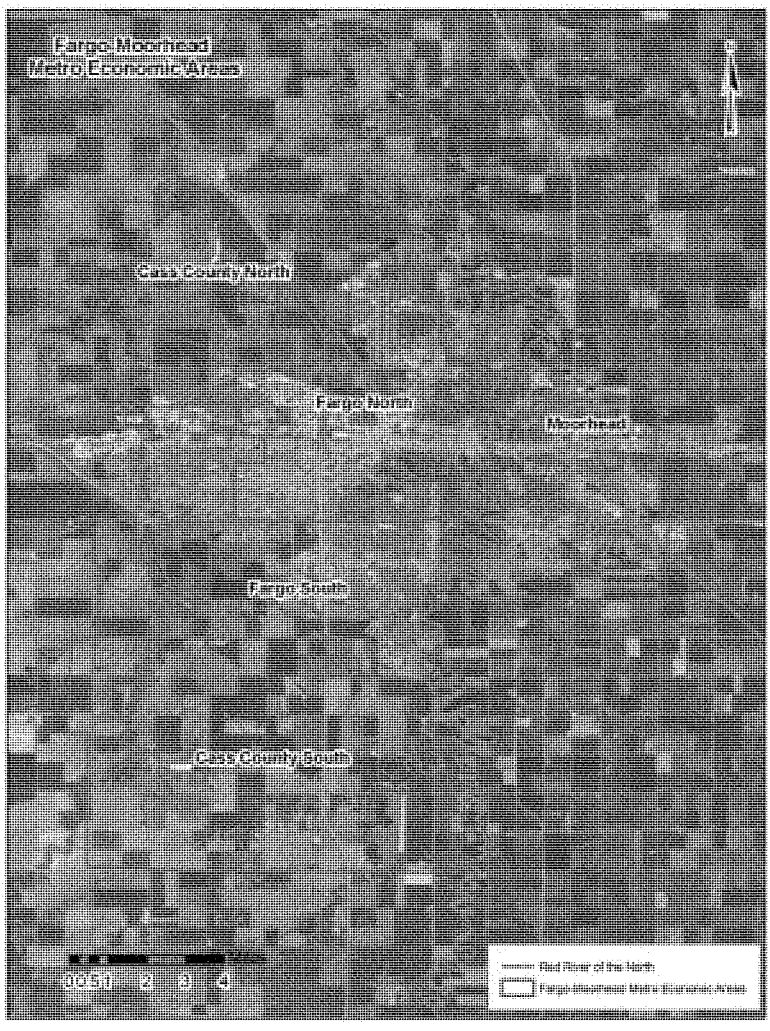
- Flood warning, preparedness, evacuation plans and pertinent equipment installation
- Floodplain management plans
- Vertical construction for residential occupancy
- Communication and education aimed at achieving no flood risk
- Floodplain regulation and floodplain management
- Restoring natural and beneficial floodplain functions
- National Flood Insurance Program
- Transfer of development rights and purchase of development rights
- Development impact fees
- Land development redirection

- Land taxation policies and special assessments

The following paragraphs will address each structure/land specific measure with further specificity in terms of application to the Fargo-Moorhead Metro Area. These paragraphs will also discuss any criteria developed by the NFPC in order to consider the application of each measure.

The metro area contains multiple structures. These structures are generally residential, commercial, industrial, and public. The economic subunit and the data contained within are exactly as provided to the NFPC by St. Paul District. The location of the economic subunits is presented in Figure 1. For a nonstructural analysis, each structure must be examined for purposes of what type of nonstructural measure is most appropriate for that particular structure given what it is, where it is located within the floodplain, what the flood characteristics are, etc. The task within this phase of study for the NFPC team was to develop a "stand alone" nonstructural alternative consisting of 100% nonstructural measures that could be used to provide specific flood risk reduction to all specific structures.

Figure 1
Economic Subunit Location



This was a daunting task considering the time constraint, the readiness of data from St. Paul District, and the specificity of the data relative to each and every structure. In terms of specificity of data, data was not available that was needed in order to correctly and thoroughly analyze each structure and apply a nonstructural measure. Some examples of this lack of specific data are presence of basements, condition of basements, elevation of basement floor, elevation of first floor, number of doors and windows in each building, elevation of the doors and windows, composition of the floor separating the basement from the first floor and number of openings in this floor, number of finished basements, type of basement finish, size of structure relative to the size of lot, materials the buildings are made of, etc, etc, etc. With this many unknowns, the NFPC team had to make many assumptions in order to accomplish the task of developing "stand alone" nonstructural alternatives with cost estimate and ultimate benefits. Following are some of those assumptions:

- Gas stations, drug store, grocery stores, bakeries, restaurants, bowling alleys, warehouses, theaters, hotels and motels, auto dealerships, industrial buildings, processing plants, etc did not have basements
- All other structures/buildings had basements
- All structure/building footings were 7 feet below ground
- All buildings with basements had the basement floor 6 feet below ground elevation
- All nonstructural flood walls were assumed attached to the building and the length determined by building perimeter
- All basement fills are done up to 30 inches below the first floor
- Some nonresidential structures having basements were assumed to be able to waterproof the floor/ceiling between the first floor and the basement to make it impenetrable for flood water
- The value of a finished basement and of a non finished basement was assumed to be 60% and 15% respectively of the value of the finished non basement area on a square foot basis

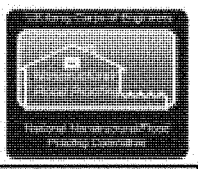
Nonstructural measure applicability is determined by the flood, building, and site characteristics making each application of nonstructural measures unique to that structure. Table 1 contains the criteria developed by the NFPC to apply nonstructural measures to each structure based on flood depth at the structure, the type of structure, and whether or not a basement existed.

The NFPC decided that the frequency of flood to be mitigated by nonstructural measures should be the same as that used for structural measures. For purposes of this phase of study three floods were considered, the 100-year, 200-year, and 500-year. If the structural analysis involves flood frequencies less than 100-year, the application of most all nonstructural measures that do not relocate or buyout the structure require the minimum standard to be the 100-year. This is because of the substantial improvement requirement of the NFIP that basically states if a structure is improved more than 50% of its pre-improvement value; it must be brought into full compliance with the NFIP which means a 100-year level of flood risk reduction.

Table 1
NFPC Flood Damage Reduction Matrix

US Army Corps Of Engineers

National Nonstructural/ Flood Proofing Committee



FLOOD DAMAGE REDUCTION MATRIX	NON-STRUCTURAL MITIGATION MEASURES														STRUCTURAL MITIGATION MEASURES			
	Evacuation on Activation of Warning System	Elevation on Piers	Elevation on Fill	Acquisition/ Buyout	Acquisition and Conversion to Open Space	Floodwalls and Levees with Interior Drainage	Dry Flood Proofing	Wet Flood Proofing	Flood Warning Systems	NFIP: Flood Plain Regulation	NFIP: Flood Insurance	NFIP: Flood Mitigation Assistance	Channel	Levee/Wall	Dams	Diversions
Flooding Characteristics																
Flood Depth																
Shallow (<3 ft)	Y	Y	N	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	N	Y
Moderate (3 to 6 ft)	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Deep (greater than 6 ft)	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Flood Velocity																
Slow (less than 2 fps)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Moderate (3 to 5 fps)	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
Fast (greater than 5 fps)	N	N	N	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
Flash Flooding																
Yes (less than 1 hour)	Y	Y	N	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	Y
No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ice and Debris Flow																
Yes	N	N	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Site Characteristics																
Site Location																
Coastal Flood Plain																
Beach Front	N	N	N	Y	N	Y	Y	N	N	N	N	Y	Y	Y	N	N
Inlet/or (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Riverine Flood Plain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Soil Type																
Permeable	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y
Impermeable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Building Characteristics																
Structure Foundation																
Slab on Grade	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Crawl Space	Y	N	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Basement	Y	N	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Structure Construction																
Concrete or Masonry	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Metal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Wood	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Structure Condition																
Excellent to Good	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fair to Poor	N	N	N	N	N	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y
Needs/Gaps/Recreation/Social Characteristics																
Economic																
Structure Protected	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	[1]	N	Y	Y	Y
Cost to Implement	M	M	M	M	M	H	M	M	L	L	L	L	A/M	H	H	H
Potential Flood Insurance Cost Reduction (Residential)	Y	Y	Y	Y	Y	Y	N	N	N	N	N	[2]	-	Y	Y	Y
Potential Flood Insurance Cost Reduction (Commercial)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	[2]	-	Y	Y	Y
Potential Adverse Flooding Impact on Other Properties	N	N	N	N	Y	N	N	Y	Y	N	N	N	Y	N	N	Y	Y	Y
Reduction in Admin Costs of NFIP	N	N	N	N	Y	Y	N	N	N	N	N	[3]	-	[4]	[5]	[6]
Reduction in Costs of Disaster Relief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Reduction in Emergency Costs	N	N	N	N	N	Y	N	N	N	N	N	N	N	[4]	Y	Y
Reduction in Damage to Public Infrastructure	N	N	N	N	N	Y	Y	N	N	N	N	N	N	[4]	Y	Y
Potential for Catastrophic Damages if Design Exceedes Exceeded	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	Y	N
Promotes Flood Plain Development	N	N	N	N	N	N	N	N	N	N	N	N	N	[4]	Y	Y	Y	Y
Environmental																
Ecosystem Restoration Possible	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N
Potential Adverse Environmental Impact	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y
Recreation																
Recreation Potential	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	Y	N	N
Social																
Community Remains Intact	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Population Protected	N	N	N	N	Y	Y	N	N	N	Y	N	N	Y	Y	Y	Y	Y	Y
Potential Structure Marketability Increase	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y

[1] NFIP Flood Mitigation may vary but it is usually buyout/acquisition
[2] Not generally recommended
[3] Buy-out/acquisition only
[4] Elevation only
[5] Post FIRM construction only
[6] Post FIRM structures elevation on fill
[7] Yes, if project provides 100 year or greater protection
[8] Yes, if on flood plains less frequent than the 100-year

Y-Yes
N-No
L-Low
M-Medium
H-High

May 2007

The US Army Corps of Engineers National Nonstructural/Flood Proofing Committee [NFPC] is available to assist in any aspect of formulating and implementing nonstructural flood damage reduction measures and realizing the opportunities that exist with nonstructural.

For more information, please contact the NFPC Chairman, Mr. Joe Remondini at 918-669-7190 / e-mail joseph.remondini@usace.army.mil or contact the NFPC website at https://www.nwo.usace.army.mil/nfpc/.

Basements are an integral part of living in the Fargo-Moorhead Metro Area as can be seen by the large numbers of structures having basements. While this type of space under a building may make sense from a structure economic perspective, it does not make sense from the perspective of trying to make structures flood safe during flood periods. While the NFPC fully realizes the NFIP accepted flood proofed basement concept employed on some basements in the metro area, the NFPC does not advocate such construction techniques in flood prone areas in the future because of the vulnerability of structures with basements to floods that can exceed the design level of the flood proofed basement.

1.8.1 Relocation of structures. This measure was used for structures that were in floodplains where flood water was greater than 9 feet deep on structures that were considered "critical" as defined in this appendix. While no critical facilities should be located anywhere in a 500 year or more frequent floodplain this is not an option in Fargo or Moorhead due to the lack of "flood free" sites. For such critical facilities where relocation is recommended, the method of relocation is to buyout the structure and land, demolish the structure, and build a new facility at a flood free location or, if in a floodplain, to build the facility to be able to function during a flood with no flood damages to the building or contents.

1.8.2 Buyout and demolition of structures. This measure was recommended for all structures to be removed from the floodplain. With this measure, those property owners would be compensated for the property and would be able to move to any part of the metro area that is not subject to a flood of any greater frequency than the flood that this project is providing flood risk reduction for. Costs for this measure were provided by MVP. This measure was used throughout the metro area for all areas in the NFIP floodway, within all areas 450 feet of the centerline of the Red River, and within all areas that are in defined peninsulas within the meander belt of the Red River whichever is greater in width. It was also required for every structure located anywhere in the metro area that had a design flood depth greater than 9 feet and it was evaluated for cost effective comparison with other nonstructural measures for all depths greater than 6 feet.

1.8.3 Elevation of structures. This measure was considered for all residential structures and for all depths up to 12 feet for residential. It was not considered for nonresidential but for a few exceptions such as building types considered to generally be small. Elevation was not considered viable for nonresidential because of the assumed size of holistic nonresidential buildings.

1.8.4 Removal of basements. This measure was considered for all buildings that had basements and had flood depths greater than 6 feet on the grade adjacent to the structure. With filling the basement, the lost space was compensated for by payment or by adding on to the side of the structure if the first floor of the structure was above the design flood elevation.

1.8.5 Dry flood proofing. This measure was considered for all structures that did not have basements and that did not have design flood depths greater than 3 feet above the first floor. This measure was considered for some nonresidential structures with

basements assuming the basement could be filled to prevent future use and assuming that the floor/ceiling between the first floor and the basement could be completely sealed and made impenetrable by flood water. Dry flood proofing for these applications does not have any structural steel to provide structural strength to resist hydrostatic force. The resistance to hydrostatic force is provided by the building itself. The dry flood proofing simply waterproofs the building.

1.8.6 Wet flood proofing. Wet flood proofing was not used for any residential structures unless elevation was used to elevate the first floor and the lower, unfinished area was wet flood proofed. Wet flood proofing was considered for cost effectiveness for some nonresidential structures that did not have basements and that had design flood depths less than 6 feet.

1.8.7 Berms, levees, and flood walls. No berms or levees were considered in this analysis for any structures. Flood walls were considered for cost effectiveness in many instances involving nonresidential buildings. Flood walls were not considered for any application where the above adjacent grade design flood depth was greater than 9 feet. Flood walls were considered for structures without basements having design flood depths greater than 3 feet. Flood walls were considered for cost effectiveness for nonresidential structures having basements where basements were filled, the basement ceiling/first floor was made impenetrable to flood water, and the flood depth on the first floor was greater than 3 feet. Floodwalls were also considered for nonresidential structures having basements where the basement was not filled and the flood wall was built to tie into the basement floor and extend up above the design flood depth. All flood walls were assumed to be attached to the structure.

1.8.8 Land acquisition. All relocations and buyouts that involved land acquisition also have incorporated the concept of "new uses of the evacuated floodplain" such as recreation and ecosystem restoration. Costs and benefits related to these uses were determined and the impact of those new uses integrated into the BCR of the nonstructural measures of relocation, buyout, and land acquisition.

1.8.9 Voluntary versus mandatory. Corps nonstructural projects can be either voluntary or mandatory in terms of property owner participation. This can be an issue with the nonstructural measure implementation that is not an issue of the structural measure implementation since, by definition, nonstructural measures directly impact the consequences (development) in floodplains. Voluntary is always the preferred method of implementation. However, often with voluntary participation by property owners within the normal timeframe of Corps project implementation, not all property owners desire to participate. If this is the case, mandatory implementation may be needed in order to achieve the overall objectives of the project. If mandatory, the local community may have to exercise condemnation authority. This is generally politically unacceptable unless proper State, local government, property owner, media, and political coordination has occurred to achieve "buy in" to that concept. Normally, voluntary or mandatory implementation becomes the greatest impact on the nonstructural measures of buyout and relocation where people and structures are removed or moved from the floodplain. With

buyout and relocation, all property owners really need to participate in order to be able to implement the concept of "new uses of the evacuated floodplain" within the Corps project. Within this concept, the Corps project will incorporate not only reducing the flood risk in the floodplain by removal of property subject to flooding but will also convert the land to a "new use" such as recreation and/or ecosystem restoration that is compatible with the natural and beneficial aspects of EO 11988 and is long term sustainable with minimal input of resources by the local community who must do the OMRRR on the project in perpetuity. Without the ability to convert floodplains to such new uses because some property owners remain, the community must not only expend funds to do such things as mow the vacant lots but must also continue to provide services to the area such as utilities, streets, snow removal, etc, etc.

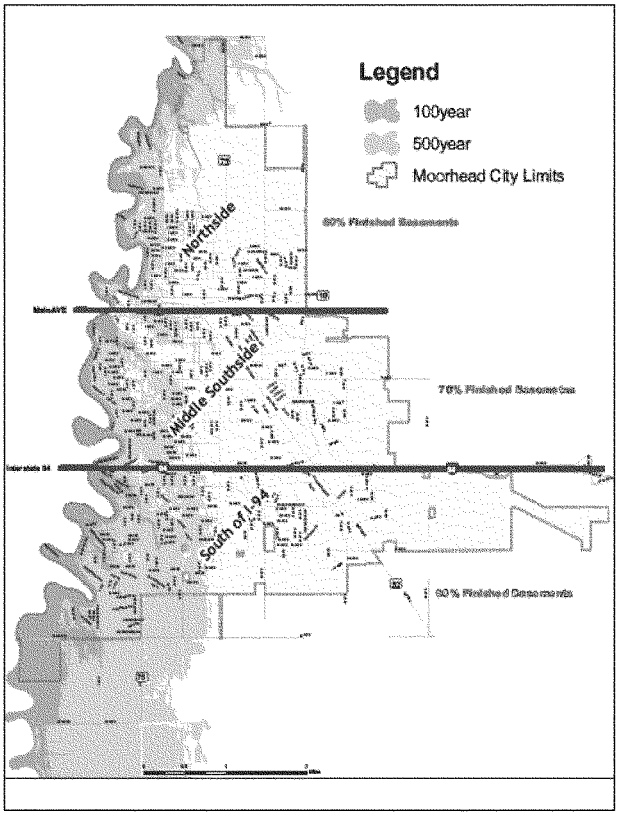
1.8.10 Uniform relocation act (Public Law 91-646). This Public Law relates to the nonstructural measures of relocation and buyout only. With these measures, property owners and tenants are relocated from their pre project property where they live. The provisions of this PL apply to mandatory relocation of buyout nonstructural projects only and do not apply to a pure voluntary relocation and buyout project. This PL provides monetary benefits to people relocated from where they live by the project with the intent that the impacts of relocation on such people is as minimal as possible.

1.8.11 Nonstructural project feasibility. Within any nonstructural analysis to determine economic feasibility, some structures, if examined on an individual basis, may not be economically feasible even though the entire group of structures of which these individually infeasible structures are located, is feasible. Within any nonstructural economic feasibility analysis, the determination of economic feasibility will not be based on individual structure feasibility but will be based on groups of structures. This makes nonstructural economic feasibility on the same basis as economic feasibility for structural measures.

2.0 Nonstructural Techniques Used in Assessing Residential Structures
Nonstructural flood risk reduction techniques used for residential structures include elevating the entire structure, elevating the main floor, wet flood proofing, and permanent acquisition (buyout). Additional methods can be combined with the methods listed above such as filling in basements, constructing additions to compensate for lost square footage, and building additions to house utilities.

Basements are common in the Fargo-Moorhead area. Since figuring out which structures had finished or unfinished basements would require a structure by structure survey, which is outside the scope for this assessment, the cities provided us with the following information. In Fargo, structures that were constructed before 1970 had 50% finished basements, and 90% finished after 1970. In Moorhead, the city provided a map outlining the estimated percent of finished basements by location, which is shown in figure 2.

Figure 2
Estimated Percent of Finished Basements in Moorhead



2.1 Elevating Entire Structure

Elevating the entire structure requires raising the structure up from its original footings to an elevation above the design flood elevation. This technique was used on residential structures with and without basements and bi-level structures. To calculate the vertical distance of rise for each structure on the Fargo side, the stage of the 100-yr flood was used and then 2.5 feet was added per the guidelines listed in the Floodproof Construction Requirements for the City of Fargo, then the lowest level stage was subtracted. For structures on the Moorhead side, the stage of the design flood was used and then 1 foot plus the average floodway rise (0.8 ft.) was added. This design elevation was then subtracted from the structures lowest level stage. For the 200-yr and 500-yr flood events the water surface elevations were greater then 2.5 feet above the 100-yr event. These elevations were used directly with the lowest elevation stage to determine the vertical distance of the raise. The structures with raises less than 12 feet were analyzed with this technique. The cost to elevate the structure was figured by utilizing the equations base on structure square footage and listed in Table 2.

Table 2

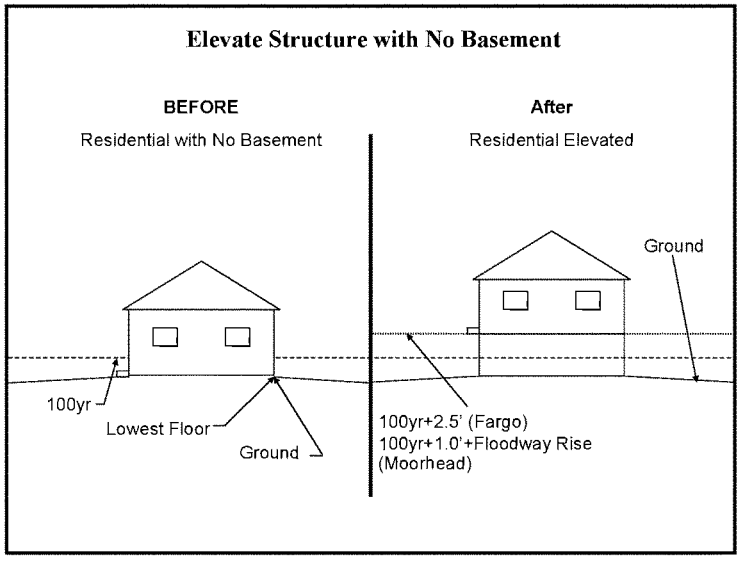
Estimated Cost to Elevate Structures

Square Foot Range	Cost to Elevate Equations
0 - 1250	1000 x (3.100 x MF_Rise + 87.5)
1250 - 1750	1000 x (3.233 x MF_Rise + 91)
1750 - Greater	1000 x (3.533 x MF_Rise + 101)

Figure 3 is an example of a residential structure without a basement before and after this nonstructural flood reduction technique.

Figure 3

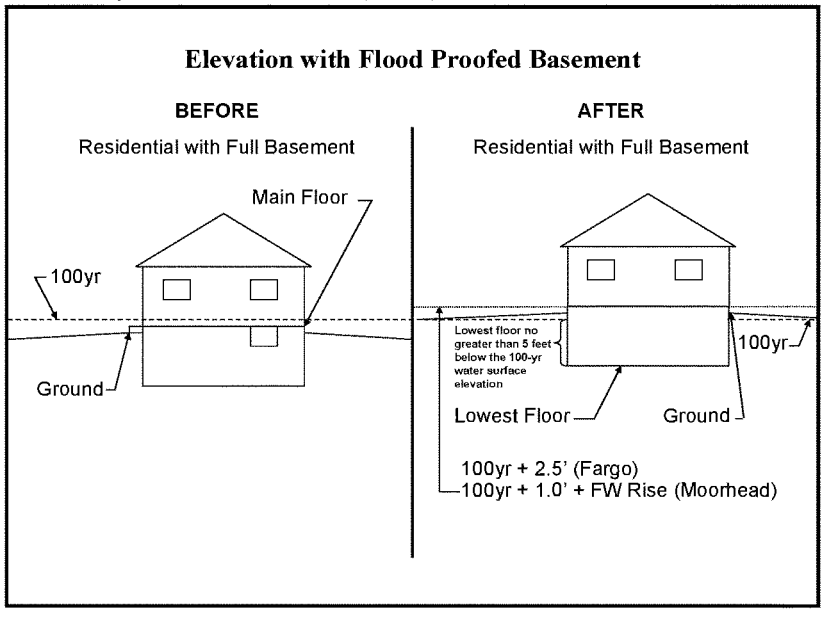
Schematic of Structure without Basement



2.2 Elevation with Dry Flood Proofed Basement

The City of Fargo and the City of Moorhead both have a basement exemption. A basement exemption allows a basement to be present in a residential structure in the floodplain when the structure follows strict building codes. Elevating with dry flood proofing was used for residential structures when elevating the basement level up would be greater then 12 feet. For these structures the main level was elevated above the design elevation and new basement would be constructed following the flood proofing guidelines. The same cost estimating equations were used based on the vertical distance of elevations in Table 2. An example is shown (Figure 4) of a residential structure with a basement before and after this nonstructural flood reduction technique.

Figure 4
Schematic of Elevated Structure with Flood Proofed Basement



2.3 Fill Basement with Main Floor Addition

Filling in the basement was an option for structures with flood depths below the main floor. The basement was filled with clean sand or fill. The area of the structure was provided by the St. Paul District. To compensate for the lost area, the owner of the structure was either paid for the loss of the basement or if feasible an addition was built above the design event. The size of the addition was based on 75% of the total area of a finished basement and 50% of the total area of an unfinished basement. Cost estimates for the fill and the loss of the basement is summarized in Table 3. Cost estimates for the addition is summarized in Table 4. Figure 5 is a simple example of filling a basement and adding an addition to the residence.

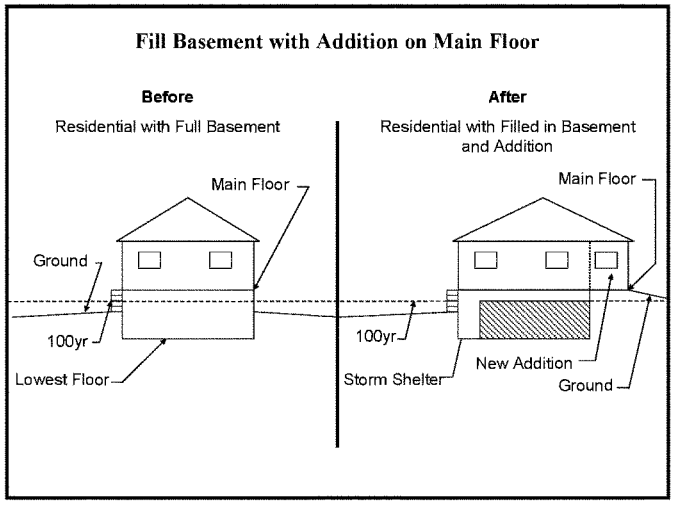
Table 3
Cost Estimating Parameters for Filling Basements for Residential Structures

Item:	Cost/Units	Quantity
Sand	$1.30/Cubic Foot	Area x 8 ft
Lost Square Footage (Unfinished)	13% of Structure Value	
Lost Square Footage (Finished)	37.5% of Structure Value	

Table 4
Cost for Addition to Residential Structures

Size	100 Square Feet	500 Square Feet	750 Sqnare Feet	1000 Square Feet	1500 Square Feet
Cost	$21,000.00	$95,000.00	$134,100.00	$171,700.00	$247,300.00

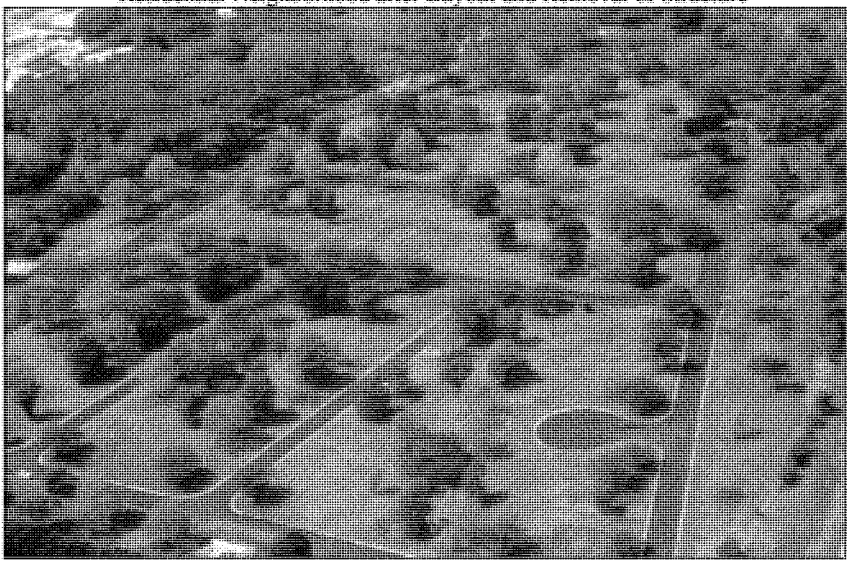
Figure 5
Schematic of Structure with Basement Filled in and Addition on Main Floor



2.4 Permanent Acquisition (Buyout)

Buyout of residential structures requires buying the structure and the land and either demolishing the structure or relocating it to a place that is out of the floodplain. This nonstructural method was applied to structures that are located within the regulatory floodway, fell within the 450 ft buffer of the Red River of the North that was put in place by the City of Fargo, or had a depth of flooding on the structure greater than 12 feet. This method was also applied to structures that fell with in the "green space" corridors that were identified by city officials from Fargo and Moorhead. Costs for this estimate were figured by taking the structure value plus the land value, which were provide by St. Paul District, and multiplying that figure by a multiplier of 1.18. Figure 6 shows a neighborhood where a buyout program was implemented.

Figure 6
Residential Neighborhood after Buyout and Removal of Structure



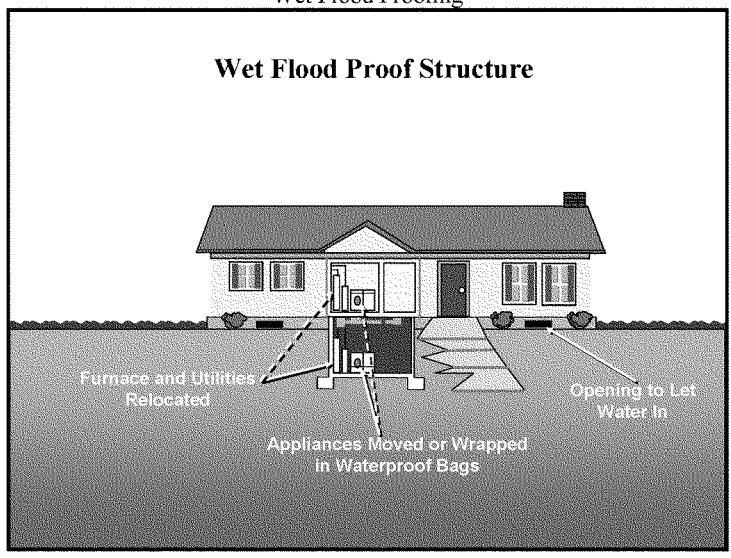
2.6 Wet Flood Proof

Wet flood proofing requires that water can enter the structure but not cause extensive damage to the structure. It basically could be hosed out and dried and be back to pre-flood event condition. Water must be permitted to flow freely in and out of the structure to equalize hydrostatic pressures on the structure to prevent failure of the walls and foundation. All utilities must be raised, or removed and installed in an addition that is located above the design event. This nonstructural method was applied to structures that had basements, but were unfinished, and the main floor elevation was above the design flood elevation. Costs for this estimate were figured by paying the homeowner for lost square footage, which amounted to 13% of the structure value. Cost for raising or relocating the utilities, and installing flood vents in the walls is summarized in Table 5. The square footage of the structures was provided to us by St. Paul District. Figure 7 illustrates wet flood proofing a residential structure.

Table 5
Cost estimating parameters for wet flood proofing residential structures

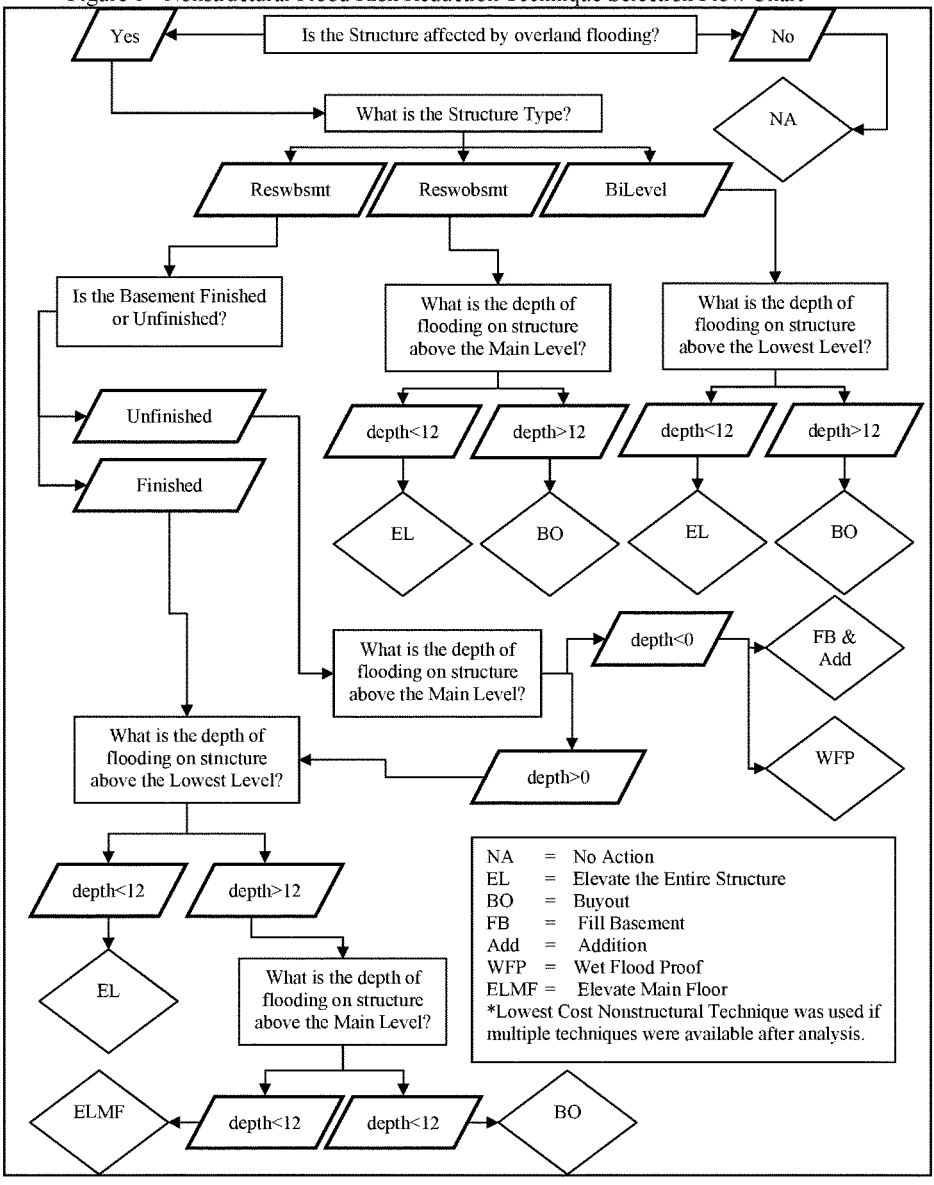
Item:	Cost/unit	Quantity
Removing Flood Damageable Materials	$3,900	1
Flood Vents	$472 each	6

Figure 7
Wet Flood Proofing



2.7 Nonstructural Flood Risk Reduction Technique Selection Flow Chart
Figure 8 shows a general flow chart of developing the nonstructural flood risk reduction techniques. Also to select a flood risk reduction technique the lowest cost solution was used unless the criteria for selection overruled as is the case for the permanent acquisition structures.

Figure 8 - Nonstructural Flood Risk Reduction Technique Selection Flow Chart



3.0 Nonstructural Techniques Used in Assessing Commercial Structures.
Nonstructural flood risk reduction techniques used for commercial structures include dry flood proofing, elevating the entire structure, constructing floodwalls, permanent acquisition (buyout), relocation of structures and wet flood proofing. These techniques can be combined and the additional techniques are filling basements with a dry flood proofed main floor, filling basements with a constructed floodwall. This list of techniques is long because each commercial structure often has unique characteristics. This report section will describe how each of these techniques was used in the nonstructural analysis and how the cost estimates was completed.

Basements are common in the Fargo-Moorhead Area. Table 6 summarizes the structures with and without basements based on their Hydrologic Engineering Center- Flood Damage Reduction Analysis (HEC-FDA) occupancy code.

Table 6
Summary of commercial properties identified in the HEC-FDA analysis by occupancy name and occupancy description.

HEC-FDA: Occupancy Name	HEC-FDA: Occupancy Description	Assigned Basement	Assigned Basement Type
Apt1	Apt on slab (Apartment - one story)	No Basement	----------
Apt2	Apt w/ FF -4' (Apartment - one story)	Basement	Finished
102	Gas station w/ svcs (Service station)	No Basement	----------
103	Drug, grocery chain stores (Grocery)	No Basement	----------
104	Department stores - Sears, Penney's, etc.	No Basement	----------
105	Hardware, paint, sporting goods, auto parts stores	Basement	Finished
106	Barber and beauty shops	Basement	Unfinished
107	Laundromat, cleaners	Basement	Unfinished
108	Bakeries, quick shop (?)	No Basement	----------
109	Fast food - Dairy Queen, A&W, etc.	No Basement	----------
110	Rest., larger fast foods - McDonald's, etc.	No Basement	----------
111	Fashion, shoe, etc. stores (Clothing)	Basement	Finished
112	Liquor store, tavern	Basement	Unfinished
113	Bowling alley	No Basement	----------
114	Wrhse, storage bldg (Wrhse - non-refrig)	No Basement	----------
115	General office - doctor, realtor, bank, etc.	Basement	Unfinished
116	School, church (School, church combined)	Basement	Finished
130	Newspaper office	Basement	Finished
131	Small theater	No Basement	----------
132	Motel (Hotel/motel)	No Basement	----------
133	Funeral home	Basement	Finished
229	Wrhse/off comb, (Wrhse non-refrig)	No Basement	----------
27	Antique store	Basement	Finished
29	Auto dealer	No Basement	----------

HEC-FDA: Occupancy Name	HEC-FDA: Occupancy Description	Assigned Basement	Assigned Basement Type
401	Community hall - VFW, Legion, etc.	Basement	Finished
405	Mach. shop, small mnfctrg (Light mnftrg)	No Basement	----------
50	Dental office (Medical office)	Basement	Unfinished
52	Hospital (Hospital)	Basement	Finished
56	Florist	Basement	Unfinished
59	Furniture store (Furniture store)	Basement	Finished
72	Jewelry store	Basement	Unfinished
97	TV repair shop	Basement	Unfinished
98	Miscellaneous	Basement	Finished
Pub1	Public property - less damageable type	No Basement	----------
Pub2	Public property - more damageable type	Basment	Finished
Farmstead	Farmstead	No Basement	----------
Storage	Ag storage buildings	No Basement	----------
College1	College bldgs with FF at ground	No Basement	----------
College2	College bldgs with FF 4' below ground	Basement	Unfinished
BsmtUnfin	Dwntwn comml bsmts unfinished	Basement	Finished
BsmtFin	DwnTtwn comml bsmts finished	Basement	Unfinished

3.1 Dry Flood Proofing

Dry flood proofing for commercial structures involves applying a water resistant sealant around the structure to prevent flood water from entering. Doorways and windows are sealed with flood shields or by similar method. Cost estimates were developed for structures without basements and design flood depths of less than 3 feet. The costs used in the estimate are summarized in Table 7. The outside perimeter of a structure was determined by the building footprint shapefile provided by St. Paul District.

Table 7
Cost estimating parameters for dry flood proofing commercial structures.

Item:	Cost/unit	Quantity
Spray-on Cement (1/8 inch)	$5.00/feet squared	Perimeter x Flood Depth
Asphalt (2 Coats below grade)	$2.00/feet squared	Perimeter x Flood Depth
Periphery Drainage	$35.00/feet	Perimeter
Flood Shields (metal)	$110 Each	2 (used as estimate)

3.2 Elevate Entire Structure

Elevating the entire structure requires raising the structure up from its original footings and to an elevation above the design flood elevation. For commercial structures, elevating the entire structure was not considered as a primary technique of nonstructural flood risk reduction. This was due to the general large area when compared to residential construction and construction materials of most commercial buildings. Only a small number of commercial structures having a small structure footprint were elevated. Costs for these structures were estimated through the same cost equations used for elevating residential structures as described in Sections 2.1.

3.3 Floodwall

Structures with and without basements, and flood depths less then 12 feet were analyzed for this nonstructural flood risk reduction method. For buildings with basements, a floodwall extending to the footings of the building is required to prevent flood water from seeping under the floodwall and creating damages. For structures without basements, the floodwall extends to the lowest adjacent grade. Costs were determined on a linear foot basis and the length was determined by the outside perimeter of the structure. The cost per linear foot is summarized in Table 8 for floodwall heights 0 to 12 feet.

Table 8
Cost estimating parameters for floodwall for commercial structures.

Height (ft)	Cost/Linear Feet
0-6	$356
7	$498
8	$501
9	$615
11	$696
12	$803

3.4 Fill Basement

Structures with flood depths below the main floor elevation with basements were analyzed for this nonstructural flood risk reduction method. The basements were filled with sand or clean fill. The cost estimate information is summarized in Table 9. The basement area of a structure was determined by the building footprint shapefile provided by St. Paul District. The basements were assumed to have a depth of 8 feet. In addition to the cost of filling in the basement, the removal of building square footage requires compensation and the cost schedule is also summarized in Table 9.

Table 9
Cost estimating parameters for filling basements for commercial structures.

Item:	Cost/unit	Quantity
Sand	$1.30/cubit feet	Area x 8ft
Lost Square Footage (Unfinished)	13% of Structure Value	
Lost Square Footage (Finished)	37.5% of Structure Value	

3.5 Fill Basement and Dry Flood Proof

Structures with flood depths less than 3 feet above the main floor elevation with basements were analyzed for this nonstructural flood risk reduction method. The basements were filled with sand or clean fill. The exterior of the remaining existing building would be dry flood proofed. It is important that the basement level be entirely filled and sealed to prevent floodwater from infiltrating the filled area and subsequently infiltrating the main floor. The cost estimating information for this method is summarized in Tables 7 and Table 9.

3.6 Fill Basement and Construct Floodwall

Structures with flood depths less than 12 feet with basements were analyzed for this nonstructural flood risk reduction method. The basements were removed by filling them with sand or clean fill. The remaining existing structure would be protected by a flood wall. The floodwall would have openings for building entry and access for deliveries. These opening would be closed with a structural component during high water scenarios to provide continuous protection to the structure. The height of the floodwall was set by the design water elevation to lowest adjacent grade. The cost estimate information for this method is summarized in Tables 3 and Table 8.

3.7 Permanent Acquisition (Buyout)

The criterion for commercial structures to be identified as permanent acquisition was based on location and flood depth. For structures located in the floodway or located within a 450 feet buffer zone from the centerline of the Red River of the North were identified as permanent acquisition structures. Structures in the floodway decrease flood flow. It is advantages to remove these structures and return the floodway back to a natural condition. The 450 feet buffer zone was establish by the communities as a guide to prevent sloughing of the river bank into the channel. In addition to the above criterion, structures located in an oxbow were identified as permanent acquisition structures. Structures with flood depths greater than 12 feet were also identified as permanent acquisitions. The costs were estimated for these properties through collaboration with St. Paul District. The data from the acquisitions of properties in the communities of Grand Forks, North Dakota and East Grand Forks, Minnesota were reviewed and a general multiplier was established, as shown in table 10. The multiplier established was then applied to the tax assessor's structure and land value.

Table 10
Cost estimating parameters for permanent acquisition multipliers

Structure Type	Multiplier
Residential	1.18
Commercial	1.29

3.8 Wet Flood Proof

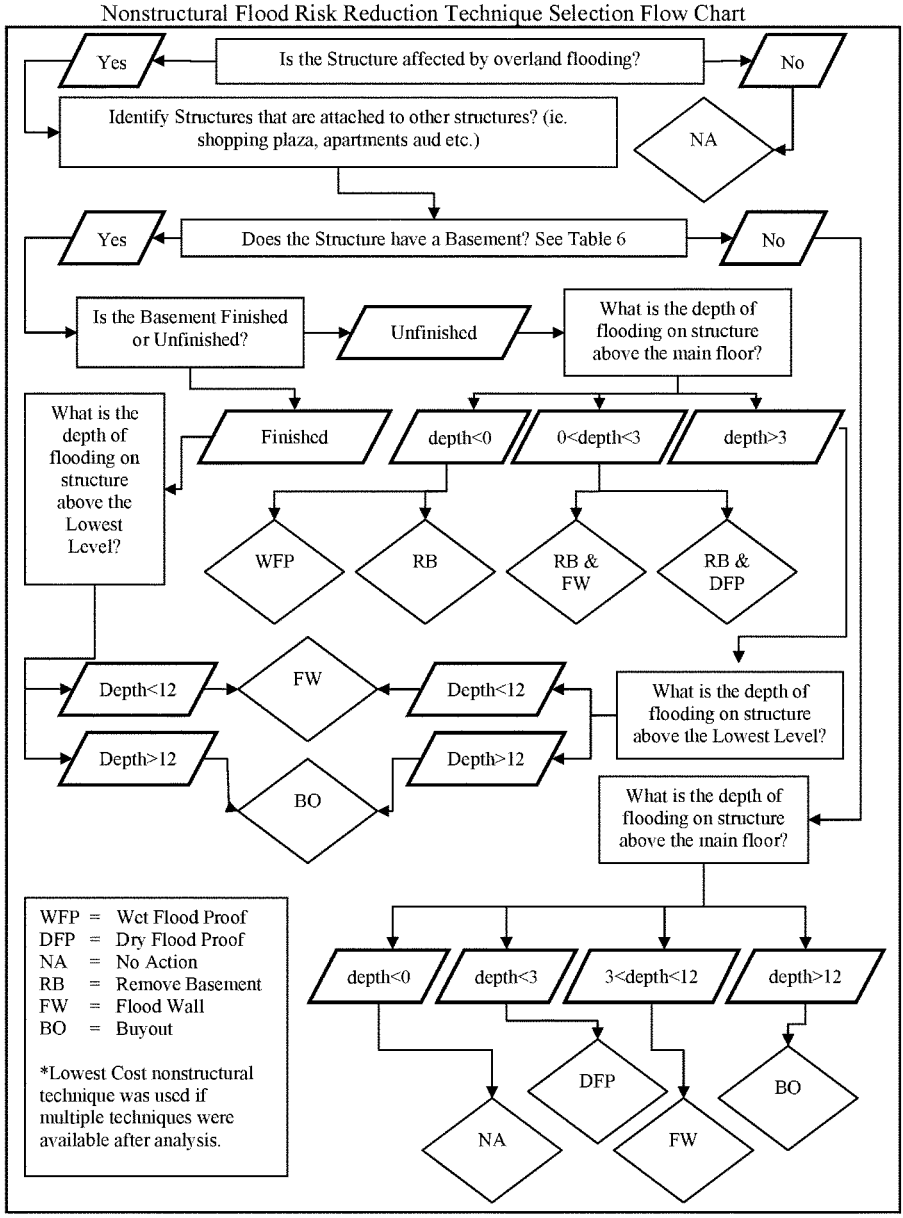
Structures with flood depths below the main floor elevation with basements were analyzed for this nonstructural flood risk reduction method. The basements of these structures were stripped of material damageable by flood waters. The only required action after the flood would be hose out the basement. Flood vents were installed to allow floodwaters to equalize between the exterior and interior of the basements. The cost to remove the damageable materials and the number of flood vents would greatly vary from structure to structure. With additional data not available, values were estimated based on average cost and square footage. The removal of building square footage requires compensation and the cost schedule is also summarized in Table 9. The additional costs estimating parameters for these properties are summarized in Table 11.

Table 11
Cost estimating parameters for wet flood proofing commercial structures

Item:	Cost/unit	Quantity
Removing Flood Damageable Materials	$3,900	1
Flood Vents	$472 each	6

3.9 Nonstructural Flood Risk Reduction Technique Selection Flow Chart
Figure 9 shows a general flow chart of developing the nonstructural flood risk reduction techniques. Also to select a flood risk reduction technique the lowest cost solution was used unless the criteria for selection overruled as is the case for the permanent acquisition structures.

Figure 9
Nonstructural Flood Risk Reduction Technique Selection Flow Chart



4.0 Nonstructural Techniques Used in Assessing Critical Facilities
As with the residential and commercial structures, the critical facilities were evaluated in their respective economic regions. These were Cass County North, Cass County South, Fargo North, Fargo South, and Moorhead.

Locations and information for Critical facilities that were evaluated in this study were provided by Cass County, North Dakota, and City governments of Fargo, North Dakota and Moorhead, Minnesota. Unlike the residential and commercial facilities, the critical facilities were only evaluated and flood proofed to the 0.2% chance annual flood (500-yr). Under Executive Order 11988, Floodplain Management, critical facilities are required to be protected to the 0.2 percent annual chance flood so they can be operational during an emergency.

4.1 Relocate
Relocation of critical facilities requires physically moving the structure from an area of high flood hazard to an area of lower flood hazard and then purchasing the property on which the structure was located. This nonstructural method was only applied to structures that were either in the regulatory floodway or had a depth of flooding on the structure of 12 feet or greater. Costs for this estimate were figured by taking the structure value plus the land value, multiplied by a cost multiplier of 1.29.0

4.2 Dry Flood Proof
Dry flood proofing critical facilities requires applying a sealant around the structure to prevent flood waters from entering the structure. Entrances and windows will be sealed by using bolt on or slide in place flood shields. This nonstructural method was only applied to structures without basements and for flood depths of less than 3 feet. Costs for this estimate are summarized in Table 12. The perimeter was determined from the building footprints provided by St. Paul District.

Table 12
Cost Estimating Parameters for Dry Flood Proofing Critical Facilities

Item:	Cost/Units	Quantity
Spray on Cement (1/8 inch)	$5.00/Square Foot	Perimeter x Flood Depth
Asphalt (2 Coats below grade)	$2.00/Square Foot	Perimeter x Flood Depth
Periphery Drainage	$35.00/Each	Perimeter
Flood Shields (metal)	$110.00 Each	2 (Used as Estimate)

4.3 Floodwall

Structures with and without basements, and flood depths below 12 feet were analyzed for this nonstructural flood risk reduction method. For structures with basements the floodwall was extended down to the footings to prevent flood waters from seeping under the floodwall and causing damages to occur. For structures without basements the floodwall extends to the lowest adjacent grade. Floodwall cost was determined on a linear foot basis as shown in Table 13. This was determined by the building footprints which were provided by the St. Paul District.

Table 13
Cost Estimate for Floodwalls. For use in Critical Facilities

Height	Cost/Linear Foot
0-6	$356
7	$498
8	$501
9	$615
11	$696
12	$803

5.0 100-Year Stand-Alone Nonstructural Flood Risk Reduction Plan

For the Fargo-Moorhead Metro Area the 100-yr floodplain would inundate approximately 11,300 structures. These structures include residential, commercial, and public structures and are summarized by economic subunit in Table 14. The water surface elevations for the 100-yr project were determined from the existing conditions first generation hydraulic modeling completed by St. Paul District prior to July 2009. The structures were identified as being in the 100-yr floodplain if the difference in the 100-yr water surface elevation and the ground elevation was greater than zero. It is important to note here that the structures were not selected based on 100-yr floodplain delineations and the structure location.

Table 14
Residential, Commercial and Critical Facilities Summary by Economic Subunits for the 100-yr Nonstructural Flood Risk Reduction Plan

Economic Subunit	Total Residential Structures	Total Commercial Structures	Total Critical Facilities
100yr Plan			
Cass County North	176	5	1
Cass County South	266	7	1
Fargo North	2,975	1,658	23
Fargo South	3,848	829	9
Moorhead	1,437	102	57
Total	8,702	2,601	91

5.1 Plan Development

For the nonstructural flood risk reduction analysis of the Fargo-Moorhead Metro Area, a number of valuable datasets were obtained. The City of Fargo, City of Moorhead, Cass County, North Dakota and U.S. Army Corps of Engineers, St. Paul District provided the data for this study.

Detailed structure and economic data was provided by St. Paul District. The economic data was in the form of HEC-FDA output files and the files were the initial base data used to begin the analysis. For the economic analysis, the St. Paul District completed the assembly of ground elevations and foundation height for each structure in the Fargo-Moorhead Area. The ground elevations were extracted from Light Detection and Ranging (LiDAR) survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided occupancy type, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations.

Structure GIS data was provided by St. Paul District and supplemented through the city and county GIS departments. The data was valuable to determine the spatial locations of the structures in the economic analysis. The files provided structure location, plan view area and footprint. The economic data and structure GIS data were joined together through ArcMap and used as the base data.

Hydraulic data was provided by the St. Paul District. The hydraulic model included cross sections for the Red River of the North. The elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. The elevations were checked to the hydraulic model and found to be in good agreement.

5.2 Summary of 100-Year Stand-Alone Nonstructural Plan

The 100-yr nonstructural flood risk reduction plan was completed for five economic subunits. The subunits include Moorhead, Cass County North, Cass County South, Fargo North and Fargo South. In these five economic subunits, the residential structures were divided into three occupancy types; residential structures with basements, residential structures without basements, and bi-level homes. The occupancy types for commercial structures were not divided for separate analysis. Apartments, college and storage structures were included in the commercial analysis. Additionally, no separation was made for industrial structures.

Nonstructural flood risk reduction techniques were assigned to the structure based on the criteria discussed in Report Sections 2.2 and 2.3. These structures and techniques are summarized in Tables 15 to Table 19.

Table15
Cass County North 100-Year Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	81	26,264,558	324,254
Elevate the Main Floor	13	1,395,537	107,349
Elevate the Entire Structure	46	5,720,867	124,367
Bi-level Homes			
Buyout	23	5,236,486	227,673
Elevate the Entire Structure	12	1,415,785	117,982
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	0	0	0
Total Residential			
Buyout	104	31,501,044	302,895
Elevate the Main Floor	13	1,395,537	107,349
Elevate the Entire Structure	58	7,136,652	123,046
Total Residential Cost of Nonstructural Flood Risk Reduction		**$40,033,233**	
Commercial Structures			
Dry Flood Proof	3	61,545	20,515
Remove Basement Dry FP	1	81,198	81,198
Flood Wall	1	401,500	401,500
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$544,243**	
Total 100yr Plan Cost in Cass County North		**$40,577,476**	

Table 16
Cass County South 100-Year Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	83	23,700,182	285,544
Elevate the Main Floor	9	1,015,308	112,812
Elevate the Entire Structure	70	9,690,437	138,435
Bi-level Homes			
Buyout	41	10,102,924	246,413
Elevate the Entire Structure	62	7,227,625	116,575
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	0	0	0
Total Residential			
Buyout	124	33,803,106	272,606
Elevate the Main Floor	9	1015307.76	112,812
Elevate the Entire Structure	132	16,918,062	128,167
Total Residential Cost of Nonstructural Flood Risk Reduction		**$51,736,475**	
Commercial Structures			
Floodwall	8	1,304,775	163,097
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$1,304,775**	
Total 100-yr Plan Cost for Cass County South		**$53,041,250**	

Table 17
Fargo North Economic Area 100-Year Nonstructural Flood Risk Reduction
Plan Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	132	28,398,352	215,139
Elevate the Main Floor	119	12,914,264	108,523
Elevate the Entire Structure	2,260	274,299,760	121,372
Fill Basement w/ Addition	10	415,000	41,500
Wet Flood Proof	6	232,517	38,753
Bi-level Homes			
Buyout	51	7,481,790	146,702
Elevate the Entire Structure	346	40,169,130	116,096
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	14	933,512	66,679
Total Residential			
Buyout	183	35,880,142	196,066
Elevate the Main Floor	119	12,914,264	108,523
Elevate the Entire Structure	2,620	315,402,402	120,383
Fill Basement w/ Addition	10	415,000	41,500
Wet Flood Proof	6	232,517	38,753
Total Residential Cost of Nonstructural Flood Risk Reduction		**$364,844,325**	
Commercial Structures			
Buyout	31	37,209,147	1,200,295
Dry Flood Proof	262	5,859,854	22,366
Fill Basement	38	1,304,926	34,340
Flood Wall	193	36,923,371	191,313
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$81,297,298**	
Total 100-yr Plan Cost in Fargo North		**$446,141,623**	

Table 18
Fargo North Economic Area 100-Year Nonstructural Flood Risk Reduction
Plan Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	272	114,289,018	420,180
Elevate the Main Floor	74	8,623,047	116,528
Elevate the Entire Structure	1,518	201,798,377	132,937
Bi-level Homes			
Buyout	47	12,744,236	271,154
Elevate the Entire Structure	1,692	189,385,349	111,930
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	245	19,318,403	78,851
Total Residential			
Buyout	319	127,033,254	398,223
Elevate the Main Floor	74	8,623,047	116,528
Elevate the Entire Structure	3,455	410,502,129	118,814
Total Residential Cost of Nonstructural Flood Risk Reduction		**$546,158,430**	
Commercial Structures			
Buyout	106	87,636,150	826,756
Dry Flood Proof	483	3,195,972	6,617
Fill Basement	21	1,476,182	70,294
Fill Basement w/ Floodwall	49	9,140,599	186,543
Floodwall	84	19,076,786	227,105
Wet Flood Proof	8	1,008,987	126,123
No Action	78	0	0
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$121,534,677**	
Total 100-yr Plan Cost in Fargo South		**$667,693,106**	

Table 19
Fargo South Economic Area 100-Year Nonstructural Flood Risk Reduction Plan Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	511	116,007,806	227,021
Elevate the Main Floor	322	37,371,274	116,060
Elevate the Entire Structure	502	68,088,788	135,635
Fill Basement w/ Addition	84	4,567,400	54,374
Bi-level Homes			
Buyout	6	865,530	144,255
Elevate the Entire Structure	12	1,603,026	133,585
Residential Structures Without Basements			
Buyout	1	57,060	57,060
Elevate the Structure	36	2,663,353	73,982
Total Residential			
Buyout	518	116,930,396	225,734
Elevate the Main Floor	322	37,371,274	116,060
Elevate the Entire Structure	550	72,355,167	131,555
Fill Basement w/ Addition	84	4,567,400	54,374
Total Residential Cost of Nonstructural Flood Risk Reduction		**$231,224,237**	
Commercial Structures			
Buy Out	16	5,181,027	323,814
Dry	20	497,603	24,880
Elevate Structure	14	1,589,968	113,569
Floodwall	44	8,498,140	193,140
Relocate	7	1,775,814	253,688
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$17,542,552**	
Total 100-yr Plan Cost in Fargo South		**$248,766,789**	

5.3 Project Benefits

Project benefits were calculated by St. Paul District using HEC-FDA computer model. A modified with-project condition HEC-FDA input file was created for each economic subunit and the data was run in HEC-FDA to determine damages of the project condition. The difference between the pre-project and with-project damages was then used as the project benefits. Table 20 displays these benefits and benefit to cost ratios.

Table 20
Fargo-Moorhead Metro Nonstructural Flood Risk Reduction 100-Year Plan Summary

Unit	100- Year Plan Total Cost	100-Year Plan Estimated Annual Cost	100-Year Plan Estimated Annual Benefits	100-Year Plan Benefits to Cost	100-Year Plan Net Benefits
Cass County North	$43,458,596	$2,243,976	$584,216	0.26	-$1,659,760
Cass County South	$56,807,340	$2,933,235	$934,175	0.32	-$1,999,060
Fargo North	$477,819,023	$24,672,086	$13,526,428	0.55	-$11,145,658
Fargo South	$715,101,326	$36,924,108	$10,746,925	0.29	-$26,177,183
Moorhead	$266,429,979	$13,757,056	$2,403,667	0.17	-$11,353,389
Total 100-Year Plan	$1,559,616,264	$80,530,461	$28,195,411	0.35	-$52,335,050

6.0 200-Year Stand-Alone Nonstructural Flood Risk Reduction Plan

For the Fargo-Moorhead Metro Area the 200-yr floodplain would inundate approximately 29,254 structures. These structures include residential, commercial, and public structures and are summarized by economic subunit in Table 21. The water surface elevations for the 200-yr project were determined from the existing conditions first generation hydraulic modeling completed by St. Paul District prior to July 2009. The structures were identified as being in the 200-yr floodplain if the difference in the 200-yr water surface elevation and the ground elevation was greater than zero. It is important to note here that the structures were not selected based on 200-yr floodplain delineations and the structure location.

Table 21
Residential, Commercial and Critical Facilities Summary by Economic Subunits for the 200-Year Nonstructural Flood Risk Reduction Plan

Economic Subunit	Total Residential Structures	Total Commercial Structures	Total Critical Facilities
200yr Plan			
Cass County North	225	10	1
Cass County South	334	15	1
Fargo North	10,106	2,567	23
Fargo South	9,589	1,446	9
Moorhead	4,735	227	57
Total	24,989	4,265	91

6.1 Plan Development

For the nonstructural flood risk reduction analysis of the Fargo-Moorhead Metro Area, a number of valuable datasets were obtained. The City of Fargo, City of Moorhead, Cass County, North Dakota and U.S. Army Corps of Engineers, St. Paul District provided the data for this study.

Detailed structure and economic data was provided by St. Paul District. The economic data was in the form of HEC-FDA output files and the files were the initial base data used to begin the analysis. For the economic analysis, the St. Paul District completed the

assembly of ground elevations and foundation height for each structure in the Fargo-Moorhead Area. The ground elevations were extracted from LiDAR survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided occupancy type, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations.

Structure GIS data was provided by St. Paul District and supplemented through the city and county GIS departments. The data was valuable to determine the spatial locations of the structures in the economic analysis. The files provided structure location, plan view area and footprint. The economic data and structure GIS data were joined together through ArcMap and used as the base data.

Hydraulic data was provided by the St. Paul District. The hydraulic model included cross sections for the Red River of the North. The elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. The elevations were checked to the hydraulic model and found to be in good agreement.

6.2 Summary of Plan

The 200-year nonstructural flood risk reduction plan was completed for five economic subunits. The subunits include Moorhead, Cass County North, Cass County South, Fargo North and Fargo South. In these five economic subunits, the residential structures were divided into three occupancy types; residential structures with basements, residential structures without basements, and bi-level homes. The occupancy types for commercial structures were not divided for separate analysis. Apartments, college and storage structures were included in the commercial analysis. Additionally, no separation was made for industrial structures.

Nonstructural flood risk reduction techniques were assigned to the structure based on the criteria discussed in Report Sections 2.2 and 2.3. These structures and techniques are summarized in Tables 22 to Table 26.

Table 22
Cass County North 200-yr Nonstructural Flood Risk Reduction Summary Table.

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	96	30,494,386	317,650
Elevate the Main Floor	13	1,248,740	96,057
Elevate the Entire Structure	69	6,954,800	100,794
Bilevel Homes			
Buyout	25	5,394,016	215,761
Elevate the Entire Structure	21	2,388,999	113,762
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	1	69,477	69,477
Total Residential			
Buyout	121	35,888,402	296,598
Elevate the Main Floor	13	1,248,740	96,057
Elevate the Entire Structure	91	9,413,276	103,443
Total Residential Cost of Nonstructural Flood Risk Reduction		**$46,550,418**	
Comercial Structures			
Dry Flood Proof	2	46,048	23,024
Remove Basement Dry FP	4	1,058,744	264,686
Flood Wall	3	965,450	321,817
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$2,070,242**	
Total 200-yr Plan Cost in Cass County North		**$48,620,660**	

Table 23
Cass County South 200-Year Nonstructural Flood Risk Reduction Summary Table.

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	70	22,455,046	320,786
Elevate the Main Floor	9	1,015,437	112,826
Elevate the Entire Structure	112	13,648,045	121,858
Wet Flood Proof	3	346,098	115,366
Bilevel Homes			
Buyout	33	7,452,762	225,841
Elevate the Entire Structure	106	12,008,741	113,290
Residential Structures Without Basements			
Buyout	1	298,540	298,540
Elevate the Entire Structure	0	0	0
Total Residential			
Buyout	104	30,206,348	290,446
Elevate the Main Floor	9	1,015,437	112,826
Elevate the Entire Structure	218	25,656,786	117,692
Wet Flood Proof	3	346,098	115,366
Total Residential Cost of Nonstructural Flood Risk Reduction		**$57,224,669**	
Commercial Structures			
Buy Out	1	1,032,000	1,032,000
Flood Wall	14	3,472,294	248,021
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$4,504,294**	
Total 200-yr Plan Cost in Cass County South		**$61,728,963**	

Table 24
Fargo North 200-Year Nonstructural Flood Risk Reduction Summary Table.

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	156	32,036,056	205,359
Elevate the Main Floor	120	12,980,847	108,174
Elevate the Entire Structure	6,908	814,883,467	117,962
Fill Basement w/ Addition	260	29,744,000	114,400
Wet Flood Proof	1,623	72,296,690	44,545
Bi-level Homes			
Buyout	17	3,206,060	188,592
Elevate the Entire Structure	1,000	108,520,591	108,521
Residential Structures Without Basements			
Buyout	0		
Elevate the Entire Structure	17	1,184,212	69,660
Total Residential			
Buyout	173	35,242,116	203,712
Elevate the Main Floor	120	12,980,847	108,174
Elevate the Entire Structure	7,925	924,588,269	116,667
Fill Basement w/ Addition	260	29,744,000	114,400
Wet Flood Proof	1,623	72,296,690	44,545
Total Residential Cost of Nonstructural Flood Risk Reduction		**$1,074,851,923**	
Commercial Structures			
Buyout	99	129,355,911	1,306,625
Dry Flood Proof	859	10,157,988	11,825
Fill Basement w/ Dry FP Main Floor	275	28,053,801	102,014
Fill Basement w/ Floodwall	599	74,182,435	123,844
Floodwall	589	93,562,675	158,850
Wet Flood Proof	42	3,221,204	76,695
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$338,534,014**	
Total 200-yr Plan Cost in Fargo North		**$1,413,385,936**	

Table 25
Fargo South 200-Year Nonstructural Flood Risk Reduction Summary Table.

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	200	78,545,638	392,728
Elevate the Main Floor	74	8,623,047	116,528
Elevate the Entire Structure	3,582	448,608,136	125,240
Wet Flood Proof	66	3,659,228	55,443
Fill Basement w/ Addition	31	3,546,400	114,400
Bi-level Homes			
Buyout	47	12,744,236	271,154
Elevate the Entire Structure	3,615	394,053,341	109,005
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	526	37,962,109	72,171
Total Residential			
Buyout	247	91,289,874	369,595
Elevate the Main Floor	74	8,623,047	116,528
Elevate the Entire Structure	7,723	880,623,585	114,026
Wet Flood Proof	66	3,659,228	55,443
Fill Basement w/ Addition	31	3,546,400	114,400
Total Residential Cost of Nonstructural Flood Risk Reduction		**$987,742,134**	
Commercial Structures			
Buyout	53	13,951,995	263,245
Dry Flood Proof	671	6,238,265	9,297
Fill Basement w/ Dry FP	74	12,770,319	172,572
Fill Basement w/ Floodwall	162	40,482,009	249,889
Floodwall	461	50,230,887	108,961
Wet Flood Proof	9	919,998	102,222
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$124,593,472**	
Total 200-yr Plan Cost in Fargo South		**$1,112,335,606**	

Table 26
Moorhead 200-Year Nonstructural Flood Risk Reduction Summary Table.

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	213	38,595,204	181,198
Elevate the Main Floor	508	60,559,989	119,213
Elevate the Entire Structure	3,143	403,554,637	128,398
Fill Basement w/ Addition	654	50,456,600	77,151
Bi-level Homes			
Buyout	9	1,924,344	213,816
Elevate the Entire Structure	46	5,949,579	129,339
Residential Structures Without Basements			
Buyout	1	185,850	185,850
Elevate the Entire Structure	92	7,582,665	82,420
Total Residential			
Buyout	223	40,705,398	182,535
Elevate the Main Floor	508	60,559,989	119,213
Elevate the Entire Structure	3,281	417,086,881	127,122
Fill Basement w/ Addition	654	50,456,600	77,151
Total Residential Cost of Nonstructural Flood Risk Reduction		**$568,808,868**	
Commercial Structures			
Buy Out	31	24,273,677	783,022
Dry	20	385,925	19,296
Floodwall	220	46,897,031	213,168
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$71,556,633**	
Total 200-yr Plan Cost in Moorhead		**$640,365,501**	

6.3 Project Benefits

Project benefits were calculated by St. Paul District using HEC-FDA computer model. A modified with-project condition HEC-FDA input file was created for each economic subunit and the data was run in HEC-FDA to determine damages of the project condition. The difference between the pre-project and with-project damages was then used as the project benefits. Table 27 displays these benefits and benefit to cost ratios.

Table 27
Fargo-Moorhead Metro Nonstructural Flood Risk Reduction 200-Year Plan Summary

Subunit	200- Year Plan Total Cost	200-Year Plan Estimated Annual Cost	200-Year Plan Estimated Annual Benefits	200-Year Plan Benefits to Cost	200-Year Plan Net Benefits
Cass County North	$48,620,660	$2,688,722	$621,768	0.23	-$2,066,954
Cass County South	$61,728,963	$3,413,674	$1,019,232	0.30	-$2,394,442
Fargo North	$1,413,385,936	$78,161,680	$43,340,376	0.55	-$34,821,304
Fargo South	$1,112,335,606	$61,513,290	$17,788,660	0.29	-$43,724,630
Moorhead	$640,365,500	$35,412,863	$3,663,416	0.10	-$31,749,447
Total 200-Year Plan	$3,276,436,665	$181,190,229	$66,433,451	0.37	-$114,756,778

7.0 500-Year Stand-Alone Nonstructural Flood Risk Reduction Plan

For the Fargo-Moorhead Metro Area the 500-yr floodplain would inundate approximately 33,183 structures. These structures include residential, commercial, and public structures and are summarized by economic subunit in Table 28. The water surface elevations for the 500-yr project were determined from the existing conditions first generation hydraulic modeling completed by St. Paul District prior to July 2009. The structures were identified as being in the 500-yr floodplain if the difference in the 500-yr water surface elevation and the ground elevation was greater than zero. It is important to note here that the structures were not selected based on 500-yr floodplain delineations and the structure location.

Table 28
Residential, Commercial and Critical Facilities Summary by Economic Subunits for the 500-Year Nonstructural Flood Risk Reduction Plan

Economic Subunit	Total Residential Structures	Total Commercial Structures	Total Critical Facilities
500yr Plan			
Cass County North	293	16	1
Cass County South	433	18	1
Fargo North	11,687	2,856	23
Fargo South	8,379	1,533	9
Moorhead	7,471	497	57
Total	28,263	4,920	91

7.1 Plan Development

For the nonstructural flood risk reduction analysis of the Fargo-Moorhead Metro Area, a number of valuable datasets were obtained. The City of Fargo, City of Moorhead, Cass County, North Dakota and U.S. Army Corps of Engineers, St. Paul District provided the data for this study.

Detailed structure and economic data was provided by St. Paul District. The economic data was in the form of HEC-FDA output files and the files were the initial base data used to begin the analysis. For the economic analysis, the St. Paul District completed the

assembly of ground elevations and foundation height for each structure in the Fargo-Moorhead Area. The ground elevations were extracted from LiDAR survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided occupancy type, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations.

Structure GIS data was provided by St. Paul District and supplemented through the city and county GIS departments. The data was valuable to determine the spatial locations of the structures in the economic analysis. The files provided structure location, plan view area and footprint. The economic data and structure GIS data were joined together through ArcMap and used as the base data.

Hydraulic data was provided by the St. Paul District. The hydraulic model included cross sections for the Red River of the North. The elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. The elevations were checked to the hydraulic model and found to be in good agreement.

7.2 Summary of Plan

The 500-year nonstructural flood risk reduction plan was completed for five economic subunits. The subunits include Moorhead, Cass County North, Cass County South, Fargo North and Fargo South. In these five economic subunits, the residential structures were divided into three occupancy types; residential structures with basements, residential structures without basements, and bi-level homes. The occupancy types for commercial structures were not divided for separate analysis. Apartments, college and storage structures were included in the commercial analysis. Additionally, no separation was made for industrial structures.

Nonstructural flood risk reduction techniques were assigned to the structure based on the criteria discussed in Report Sections 2.2 and 2.3. These structures and techniques are summarized in Tables 29 to Table 33.

Table 29
Cass County North 500-Year Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	127	39,902,998	314,197
Elevate the Main Floor	15	1,611,258	107,417
Elevate the Entire Structure	96	11,585,405	120,681
Bi-level Homes			
Buyout	28	6,191,814	221,136
Elevate the Entire Structure	26	2,959,546	113,829
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	1	69,983	69,983
Total Residential			
Buyout	155	46,094,812	297,386
Elevate the Main Floor	15	1,611,258	107,417
Elevate the Entire Structure	123	14,614,934	118,821
Total Residential Cost of Nonstructural Flood Risk Reduction		**$62,321,004**	
Commercial Structures			
Total Commercial			
Dry	4	100,152	25,038
Fill Basement/Dry Flood Proof	6	3,290,827	548,471
Fill Basement/Floodwall	1	108,035	108,035
Floodwall	3	994,772	331,591
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$4,493,786**	
Total 500-yr Plan Cost in Cass County North		**$66,814,790**	

Table 30
Cass County South 500-Year Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	91	29,097,384	319,751
Elevate the Main Floor	16	1,740,375	108,773
Elevate the Entire Structure	140	16,851,988	120,371
Wet Flood Proof	20	1,342,792	67,140
Bi-level Homes			
Buyout	36	8,056,686	223,797
Elevate the Entire Structure	129	14,757,943	114,403
Residential Structures Without Basements			
Buyout	1	298,540	298,540
Elevate the Entire Structure	0	0	0
Total Residential			
Buyout	128	37,452,610	292,599
Elevate the Main Floor	16	1,740,375	108,773
Elevate the Entire Structure	269	31,609,931	117,509
Wet Flood Proof	20	1,342,792	67,140
Total Residential Cost of Nonstructural Flood Risk Reduction		**$72,145,708**	
Commercial Structures			
Buyout	1	1,032,000	1,032,000
Floodwall	17	3,970,938	233,585
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$5,002,938**	
Total 500-yr Plan Cost in Cass County South		**$77,148,646**	

Table 31
Fargo North 500-Year Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	180	38,270,704	212,615
Elevate the Main Floor	406	43,171,930	106,335
Elevate the Entire Structure	9,013	1,094,293,032	121,413
Fill Basement w/ Addition	49	5,605,600	114,400
Wet Flood Proof	710	28,726,896	40,460
Bi-level Homes			
Buyout	69	10,747,440	155,760
Elevate the Entire Structure	1,237	138,007,063	111,566
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Entire Structure	22	1,596,014	72,546
Total Residential			
Buy Out	249	49,018,144	196,860
Elevate the Main Floor	406	43,171,930	106,335
Elevate the Entire Structure	10,272	1,233,896,109	120,122
Fill Basement w/ Addition	49	5,605,600	114,400
Wet Flood Proof	710	28,726,896	40,460
Total Residential Cost of Nonstructural Flood Risk Reduction		**$1,360,418,679**	
Commercial Structures			
Buyout	153	178,172,607	1,164,527
Dry Flood Proof	512	6,449,605	12,597
Fill Basement	8	314,474	39,309
Fill Basement w/ Dry FP	252	30,162,604	119,693
Fill Basement w/ Floodwall	729	273,795,033	375,576
Floodwall	1,151	162,824,484	141,463
Wet Flood Proof	10	848,320	84,832
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$652,567,127**	
Total 500-yr Plan Cost in Fargo North		**$2,012,985,806**	

Table 32
Fargo South 500-Year Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	202	80,613,234	399,075
Elevate the Main Floor	464	52,979,872	114,181
Elevate the Entire Structure	3,394	449,339,579	132,392
Wet Flood Proof	8	488,153	61,019
Fill Basement w/ Addition	4	457,600	114,400
Bi-level Homes			
Buyout	49	13,323,026	271,898
Elevate the Entire Structure	3,704	422,671,251	114,112
Residential Structures Without Basements			
Buyout	0	0	0
Elevate the Structure	554	44,578,035	80,466
Total Residential			
Buyout	251	93,936,260	374,248
Elevate the Main Floor	464	52,979,872	114,181
Elevate the Entire Structure	7,652	916,588,865	119,784
Wet Flood Proof	8	488,153	61,019
Fill Basement w/ Addition	4	457,600	114,400
Total Residential Cost of Nonstructural Flood Risk Reduction		**$1,064,450,749**	
Commercial Structures			
Buyout	52	11,249,550	216,338
Dry Flood Proof	173	1,738,927	10,052
Fill Basement w/ Dry FP	37	6,757,140	182,625
Fill Basement w/ Floodwall	142	57,573,896	405,450
Floodwall	1,126	142,850,904	126,866
Wet Flood Proof	3	302,539	100,846
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$220,472,955**	
Total 500-yr Plan Cost in Fargo South		**$1,284,923,705**	

Table 33
Moorhead 500-Year Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Residential Structures With Basements			
Buyout	245	43,853,756	178,995
Elevate the Main Floor	873	122,272,857	140,061
Elevate the Entire Structure	4,246	535,063,264	126,016
Fill Basement w/ Addition	1,878	58,308,000	31,048
Bi-level Homes			
Buyout	19	3,847,862	202,519
Elevate the Entire Structure	56	7,311,775	130,567
Residential Structures Without Basements			
Buyout	1	185,850	185,850
Elevate the Entire Structure	119	11,674,236	98,103
Total Residential			
Buyout	265	47,887,468	180,707
Elevate the Main Floor	873	122,272,857	140,061
Elevate the Entire Structure	4,421	554,049,275	125,322
Fill Basement w/ Addition	1,878	58,308,000	31,048
Total Residential Cost of Nonstructural Flood Risk Reduction		**$782,517,600**	
Commercial Structures			
Total Commercial			
Buy Out	48	37,628,655	783,930
Dry	8	1,100,932	137,617
Floodwall	430	84,934,765	197,523
Relocate	13	8,659,125	666,087
Total Commercial Cost of Nonstructural Flood Risk Reduction		**$132,323,477**	
Total 500-yr Plan Cost in Moorhead		**$914,841,077**	

7.3 Project Benefits

Project benefits were calculated by St. Paul District using HEC-FDA computer model. A modified with-project condition HEC-FDA input file was created for each economic subunit and the data was run in HEC-FDA to determine damages of the project condition. The difference between the pre-project and with-project damages was then used as the project benefits. Table 34 displays these benefits and benefit to cost ratios.

Table 34
Fargo-Moorhead Metro Nonstructural Flood Risk Reduction 500-Year Plan Summary

Subunit	500-Year Plan Total Cost	500-Year Plan Estimated Annual Cost	500-Year Plan Estimated Annual Benefits	500-Year Plan Benefits to Cost	500-Year Plan Net Benefits
Cass County North	$71,558,839	$3,694,926	$642,940	0.17	-$3,051,986
Cass County South	$82,626,436	$4,266,399	$1,064,460	0.25	-$3,201,939
Fargo North	$2,155,913,856	$111,320,162	$48,719,156	0.44	-$62,601,006
Fargo South	$1,376,157,155	$71,057,587	$19,869,401	0.28	-$51,188,186
Moorhead	$979,797,547	$50,591,642	$4,334,295	0.09	-$46,257,347
Total 500-Year Plan	$4,666,053,833	$240,930,716	$74,630,252	0.31	-$166,300,464

8.0 Critical Facilities Stand-Alone Nonstructural Flood Risk Reduction Plan

For the Fargo-Moorhead Metro Area the 500-year floodplain would inundate approximately 33,183 structures. These structures include residential, commercial, and public structures and are summarized by economic subunit in Table 35 The water surface elevations for the 500-year project were determined from the existing conditions first generation hydraulic modeling completed by St. Paul District prior to July 2009. The structures were identified as being in the 500-year floodplain if the difference in the 500-yr water surface elevation and the ground elevation was greater than zero. It is important to note here that the structures were not selected based on 500-year floodplain delineations and the structure location.

Table 35
Residential, Commercial and Critical Facilities Summary by Economic Subunits for the 500-Year Nonstructural Flood Risk Reduction Plan

Economic Subunit	Total Residential Structures	Total Commercial Structures	Total Critical Facilities
500yr Plan			
Cass County North	293	16	1
Cass County South	433	18	1
Fargo North	11,687	2,856	23
Fargo South	8,379	1,533	9
Moorhead	7,471	497	57
Total	28,263	4,920	91

8.1 Critical Facilities Stand-Alone Nonstructural Plan Development

For the nonstructural flood risk reduction analysis of the Fargo-Moorhead Metro Area, a number of valuable datasets were obtained. The City of Fargo, City of Moorhead, Cass County, North Dakota and U.S. Army Corps of Engineers, St. Paul District provided the data for this study.

Detailed structure and economic data was provided by St. Paul District. The economic data was in the form of HEC-FDA output files and the files were the initial base data used to begin the analysis. For the economic analysis, the St. Paul District completed the assembly of ground elevations and foundation height for each structure in the Fargo-Moorhead Area. The ground elevations were extracted from LiDAR survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided occupancy type, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations.

Structure GIS data was provided by St. Paul District and supplemented through the city and county GIS departments. The data was valuable to determine the spatial locations of the structures in the economic analysis. The files provided structure location, plan view area and footprint. The economic data and structure GIS data were joined together through ArcMap and used as the base data.

Hydraulic data was provided by the St. Paul District. The hydraulic model included cross sections for the Red River of the North. The elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. The elevations were checked to the hydraulic model and found to be in good agreement.

8.2 Summary of Plan

The nonstructural flood risk reduction plan for the critical facilities was completed for five economic subunits. The subunits include Moorhead, Cass County North, Cass County South, Fargo North and Fargo South. Because of the relatively low number of structures located within these units each structure was looked at and a nonstructural flood proofing method was assigned to it. Since critical facilities are to be operational during an emergency, only the 500-year event was used in this analysis.

Nonstructural flood risk reduction techniques were assigned to the structure based on the criteria discussed in Report Sections 2.2 and 2.3. These structures and techniques are summarized in Table 36.

Table 36
Critical Facilities Stand-Alone Nonstructural Flood Risk Reduction Summary Table

Nonstructural Technique	# of Structures	Total Cost	Cost/Structure
Fargo North			
Relocate	3	$955,734	$318,578
Flood Wall	14	$6,956,385	$496,885
Dry	6	$1,507,641	$251,273
Fargo North Total		$9,419,760	
Fargo South			
Flood Wall	9	$13,360,122	$1,484,458
Fargo South Total		$13,360,122	
Cass County North			
Flood Wall	1	$122,820	$122,820
Cass County North Total		$122,820	
Cass County South			
Flood Wall	1	$293,246	$293,246
Cass County South Total		$293,246	
Moorhead			
Relocate	3	$287,870,337	$95,956,779
Flood Wall	51	$27,778,318	$544,673
Buyout	3	$15,662,664	$5,220,888
Moorhead Total		$331,311,319	
Total Project Cost		**$354,507,267**	

9.0 Summary of Stand-Alone Nonstructural Assessment

Three separate stand-alone nonstructural plans were assessed for the Fargo-Moorhead Metro Area. Each plan investigated the feasibility of implementing nonstructural techniques for residential, commercial, and critical facilities. None of the individual plans or any of the five economic subunits resulted in positive net benefits or a benefit to cost ratio greater than 1.0. During the nonstructural investigation there appeared to be individual structures contained within an economic subarea that resulted in an economically feasible solution. However, the analysis was based upon entire economic subunits so that project implementation would cover the entire unit and not be left to individual structures.

As a result of the nonstructural assessment, the 200-year stand-alone plan had the greatest benefit to cost ratio of 0.37. The 100-year plan had a ratio of 0.35 and the 500-year plan had a ratio of 0.31. The results for the plans are summarized in Table 37.

Table 37
Summary of Economic Analysis of Stand-Alone Nonstructural Plans

Unit	100- Year Plan Total Cost	100-Year Plan Est Annual Cost	100-Year Plan Est Annual Benefits	100-Year Plan BCR	100-Year Plan Net Benefits
Cass County North	$43,458,596	$2,243,976	$584,216	0.26	-$1,659,760
Cass County South	$56,807,340	$2,933,235	$934,175	0.32	-$1,999,060
Fargo North	$477,819,023	$24,672,086	$13,526,428	0.55	-$11,145,658
Fargo South	$715,101,326	$36,924,108	$10,746,925	0.29	-$26,177,183
Moorhead	$266,429,979	$13,757,056	$2,403,667	0.17	-$11,353,389
Total 100-Year Plan	$1,559,616,264	$80,530,461	$28,195,411	0.35	-$52,335,050

Unit	200- Year Plan Total Cost	200-Year Plan Est Annual Cost	200-Year Plan Est Annual Benefits	200-Year Plan BCR	200-Year Plan Net Benefits
Cass County North	$48,620,660	$2,688,722	$621,768	0.23	-$2,066,954
Cass County South	$61,728,963	$3,413,674	$1,019,232	0.30	-$2,394,442
Fargo North	$1,413,385,936	$78,161,680	$43,340,376	0.55	-$34,821,304
Fargo South	$1,112,335,606	$61,513,290	$17,788,660	0.29	-$43,724,630
Moorhead	$640,365,500	$35,412,863	$3,663,416	0.10	-$31,749,447
Total 200-Year Plan	$3,276,436,665	$181,190,229	$66,433,451	0.37	-$114,756,778

Unit	500-Year Plan Total Cost	500-Year Plan Est Annual Cost	500-Year Plan Est Annual Benefits	500-Year Plan BCR	500-Year Plan Net Benefits
Cass County North	$71,558,839	$3,694,926	$642,940	0.17	-$3,051,986
Cass County South	$82,626,436	$4,266,399	$1,064,460	0.25	-$3,201,939
Fargo North	$2,155,913,856	$111,320,162	$48,719,156	0.44	-$62,601,006
Fargo South	$1,376,157,155	$71,057,587	$19,869,401	0.28	-$51,188,186
Moorhead	$979,797,547	$50,591,642	$4,334,295	0.09	-$46,257,347
Total 500-Year Plan	$4,666,053,833	$240,930,716	$74,630,252	0.31	-$166,300,464

10.0 Recommendations of the Stand-Alone Nonstructural Plans
The nonstructural assessment of stand-alone plans for the 100-year, 200-year, and 500-year flood events for the Fargo-Moorhead Metro Area did not result in a project with a benefit to cost ratio greater than 1. The very large number of structures, 33,274 for the 500-year plan, the flat topography located along either side of the Red River, and the vast extent of flooding, prevented the formulation of a feasible stand-alone nonstructural plan. While the implementation of a structural project such as a diversion channel or levee system may prove to be economically feasible, it is recommended that the National Economic Development Plan utilize nonstructural techniques in support of structural measures to eliminate residual flood damages associated with the implementation of the final project.

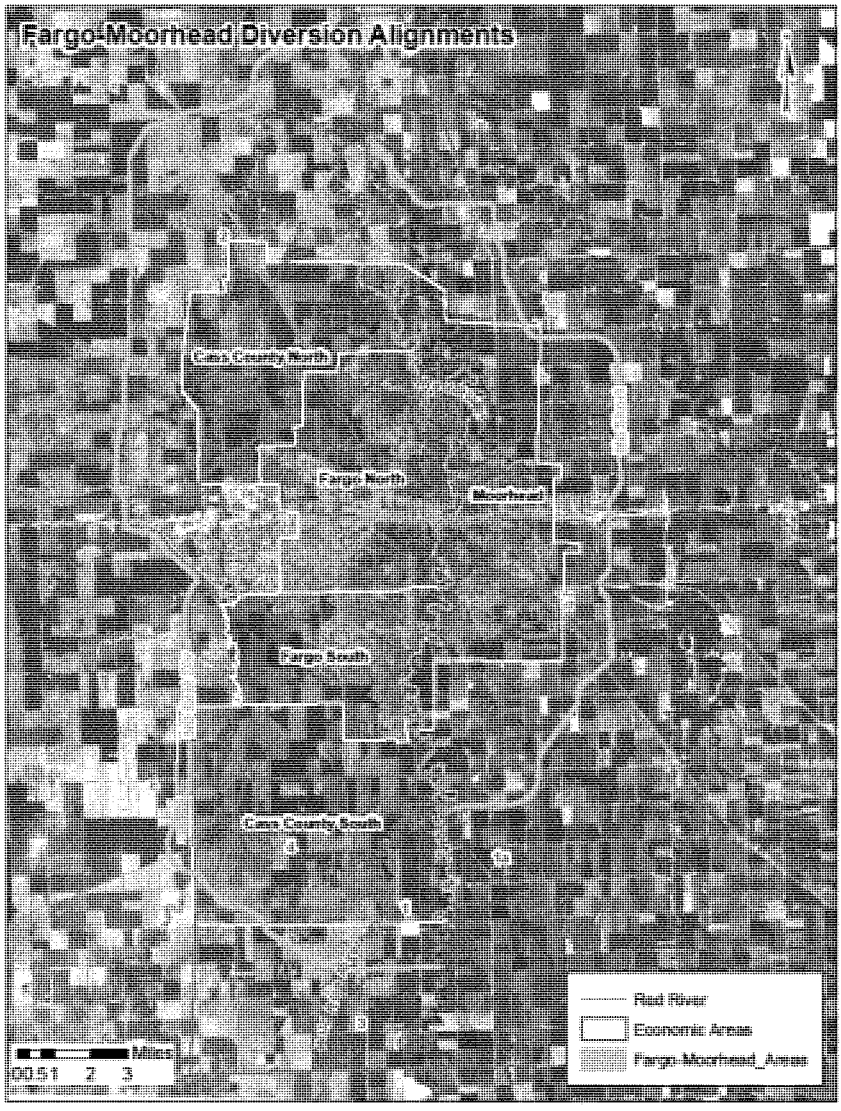
11.0 Nonstructural Flood Risk Reduction in Support of Diversion Structures
The results of the stand-alone nonstructural assessment for the 100-year, 200-year, and 500-year flood events indicate that nonstructural mitigation measures alone are not feasible on a large scale basis (benefit cost ratio varied from 0.31 to 0.35). The extremely flat terrain, large extent of flooding, coupled with the density of residential and commercial structures was not conducive to establishing a viable nonstructural plan which would eliminate flood damages while being cost effective.

The remaining sections of this report focus on the implementation of nonstructural measures and techniques in support of several diversion channel alternatives proposed for the metropolitan area. The nonstructural measures considered would eliminate the damages associated with residual flooding which the diversion channel alternatives would not be able to effectively reduce.

11.1 Diversion Alternative Description
The diversion channel alternatives would route flood flows around the metropolitan area, thus reducing stages in the natural river channel through town. A control structure would be required on the Red River to divert flows into the diversion channel and drop structures would be necessary to allow local drainage to enter the diversion channel. Tie-back levees at the southern limits of the project would be necessary to prevent flood flows from flanking the diversion.

Numerous diversion plans were analyzed during the initial screening by the St. Paul District, including a total of four separate alignments, two in Minnesota and two in North Dakota, with various capacities. The Red River control structure allows for the maximum benefit for a given diversion channel capacity by reducing water surface elevations immediately downstream of the structure. Additionally, the control structure allows the water surface elevation upstream of the project to remain at or near natural elevation to prevent erosion-causing velocities in the Red River at the upstream end of the project. The North Dakota alignments would require additional hydraulic structures where the diversion alignments cross the Wild Rice, Sheyenne, Maple and Rush Rivers. After screening was conducted on the four separate diversion channel alignments, which are described in the following paragraphs, the two alignments shown in Figure10 were assessed by nonstructural means for additional reduction of residual flood risks.

Figure 10
Fargo-Moorhead Metro Diversion Channel Alignments



Minnesota Short Alignment. The Minnesota short diversion channel alignment is approximately 25 miles long, starting near the confluence of the Wild Rice and Red Rivers and ending near the confluence of Sheyenne and Red Rivers. Four separate diversion capacities were analyzed for the Minnesota diversion alignments including 20,000, 25,000, 30,000 and 35,000 cfs. The channel configuration should have a maximum depth of approximately 30 feet due to geotechnical concerns, and the channel bottom widths range from 175 to 360 feet. The Minnesota short diversion channel alignment includes 20 highway bridges and 4 railroad bridges. The flow split between the diversion channel and the Red River would be controlled by a combination of a control structure on the Red River at the south end of the project and a weir at the entrance to the diversion channel. The Minnesota Short alignment is shown in Figure 11.

Minnesota Long Alignment. The Minnesota long diversion channel alignment was envisioned to start approximately 3 miles south of the confluence of the Red and Wild Rice Rivers and would end at the Red River near the confluence of the Red and Sheyenne Rivers. The alignment would be approximately 29 miles long. Because this alignment begins south of the confluence of the Red and Wild Rice Rivers, an extension of the diversion channel would be required between the Red and Wild Rice Rivers. A tie-back levee would be required to extend west from the Wild Rice control structure to higher ground to prevent flanking of the diversion. The Minnesota Long alignment was screened from further assessment and not considered in the nonstructural investigation.

North Dakota West Alignment. The North Dakota West diversion channel alignment was envisioned to start approximately 4 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 and would end at the Red River, north of the confluence of the Red and Sheyenne Rivers near the city of Georgetown, Minnesota. The alignment would be approximately 35 miles in length. The North Dakota West alignment was screened from further assessment and not considered in the nonstructural investigation.

North Dakota East Alignment. The North Dakota East diversion channel alignment starts approximately 4 miles south of the confluence of the Red and Wild Rice Rivers and would use the existing Horace to West Fargo Sheyenne River Diversion corridor between Horace and I-94 after crossing the Sheyenne River. The North Dakota East alignment would be approximately 36 miles in length. This alignment was analyzed for flows of 30,000 and 35,000 cfs. The North Dakota east alignment is shown in Figure 12.

This alignment requires an extension of the diversion channel located between the Red and Wild Rice Rivers which would begin south of the confluence of the Red and Wild Rice Rivers. The tie-back levee associated with this alternative would extend east from the Red River control structure to high ground. The alignment would include 18 highway bridges and 4 railroad bridges. A combination of control structures on the Red and Wild Rice Rivers at the south end of the project, along with a weir at the entrance control the flow split between the Red and Wild Rice River channels and the diversion channel. This alignment crosses several rivers, including the Sheyenne, Maple, Lower Rush, and Upper Rush.

Figure 11
Minnesota Short Alignment

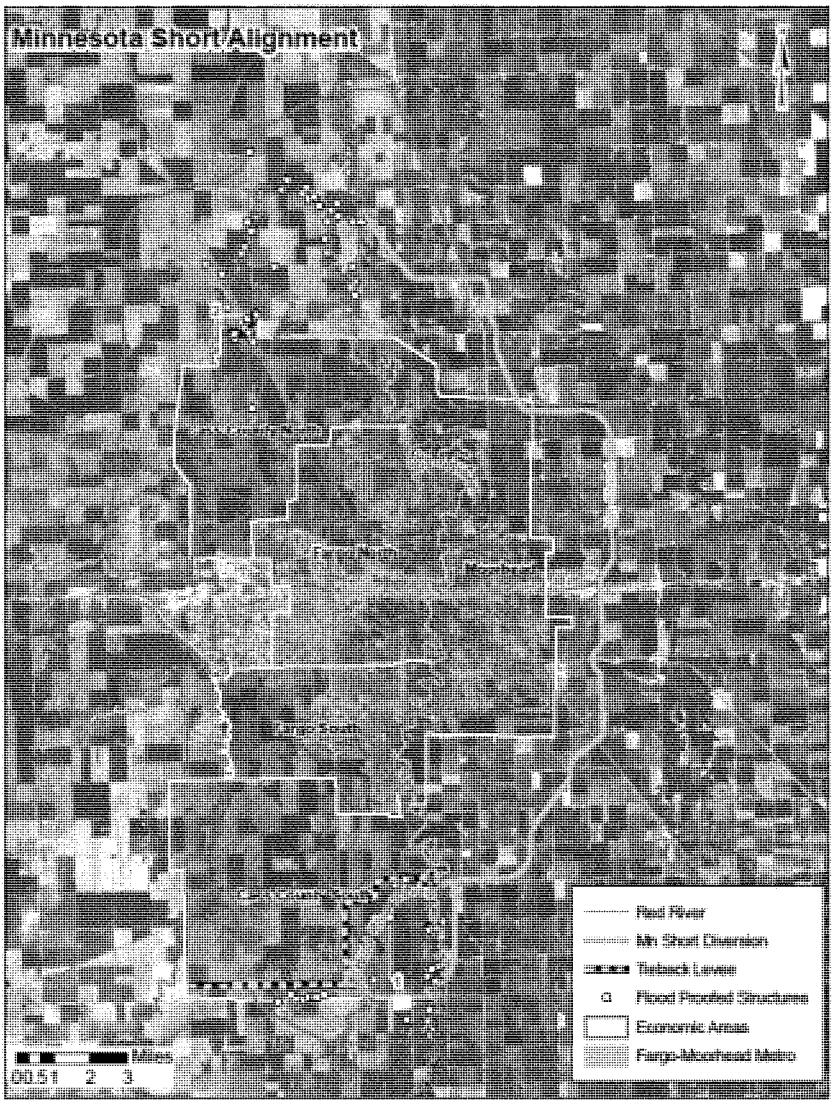
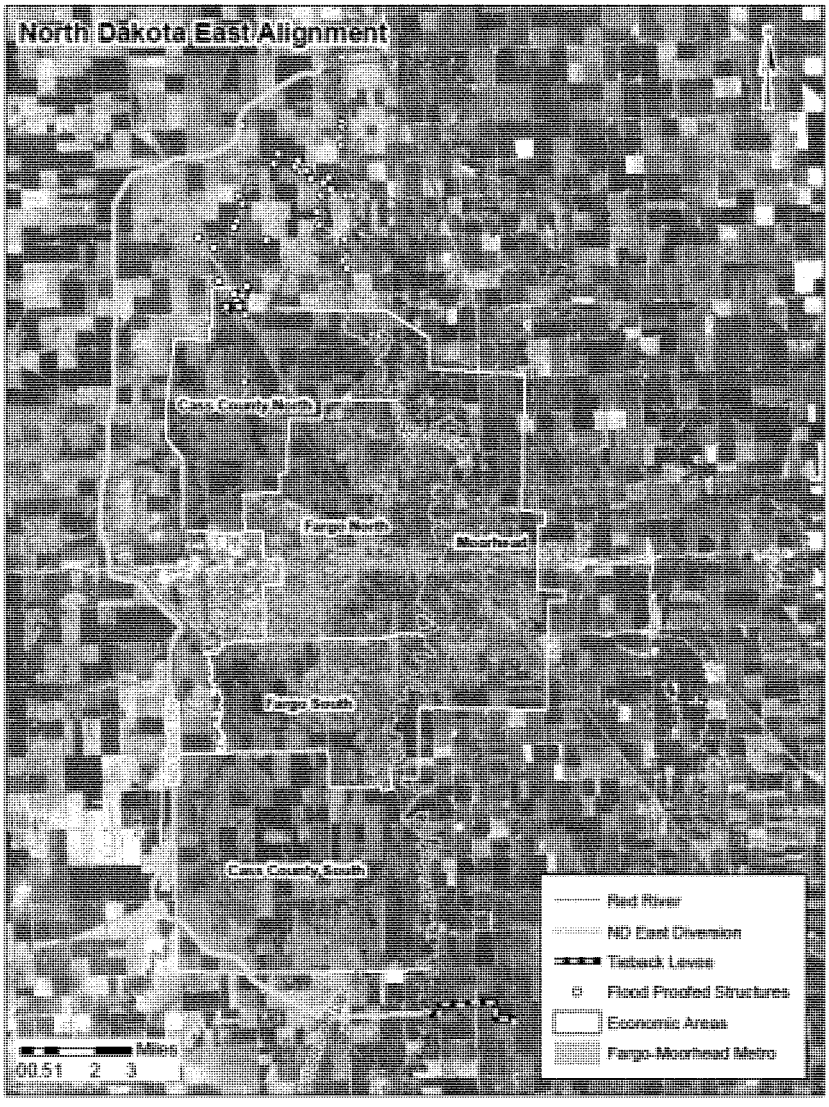


Figure 12
North Dakota East Alignment



There are six capacity alternatives associated with the diversion channel alignments, four in Minnesota and two in North Dakota. Each of the diversion channel alignments is associated with an upstream and downstream economic area containing structures which were classified as residential, commercial, or critical facility. The five economic areas assessed for the feasibility of implementing nonstructural flood damage reduction measures in support of the diversion channel alternatives are shown on Figure 10 and represented as areas 1, 1a, 2, 3, and 4. Table 38 presents the total number of structures affected by the 100-year water surface elevation and the value of total structures (residential, commercial, critical facility) for a specific capacity and diversion channel alignment.

Table 38
Summary of Total 100-Year Flood Affected Structures for Nonstructural Assessment

Diversion Alternatives (Plan)	Residential Structures	Commercial Structures	Critical Facility	Total Structures
Minnesota Short Alignment				
20,000 cfs	105	1	1	107
25,000 cfs	99	0	1	100
30,000 cfs	99	0	1	100
35,000 cfs	99	0	1	100
North Dakota East Alignment				
30,000 cfs	29	0	0	29
35,000 cfs	29	0	0	29

Diversion channel capacities of the two alignments vary between 20,000 and 45,000 cfs for the Minnesota Short diversion alignment and 30,000 and 35,000 cfs for the North Dakota East diversion alignment. Water surface profiles were determined for each diversion alternative. The profiles determined for the diversion alternatives and used in the nonstructural flood damage reduction analysis were assumed to remain equal to the without project water surface profile upstream from the diversion inlet.

The area located upstream from the diversion channel outlet (Economic Area 2) results in residual flood damages. When the water surface profiles are compared in Economic Area 2, several of the profiles are within 0.5 feet of each other regardless of the capacity of the diversion. The similarity between profiles is due to the backwater effect of the Sheyenne River and the return of the diversion flows into the Red River. To simplify computations of the nonstructural flood damage reduction analysis, water surface profiles within 0.5 feet of each other were grouped together and one water surface profile was used.

11.2 Nonstructural Techniques Used in Assessing Residential Structures.
Similar to how the residential structures were evaluated for the stand-alone nonstructural assessment, the nonstructural flood risk reduction techniques used for residential structures in support of the diversion channel alternatives includes elevating the entire structure, elevating the main floor, wet flood proofing, and permanent acquisition (buyout). Additionally, these methods were also considered in combination, such as,

filling in basements, constructing additions to compensate for lost square footage, and constructing small additions to house utilities relocated from a basement area.

11.3 Nonstructural Techniques Used in Assessing Commercial Structures.
Similar to how the commercial structures were evaluated for the stand-alone nonstructural assessment, the nonstructural flood risk reduction techniques used for commercial structures includes dry flood proofing, elevating the entire structure, constructing floodwalls, permanent acquisition (buyout), relocation of structures and wet flood proofing. These techniques were also considered in combination, in such instances where basements could be filled and combined with a dry flood proofed main floor, or filling basements and adding a floodwall.

11.4 Nonstructural Techniques Used in Assessing Critical Facilities
Similar to how the critical facility structures were evaluated for the stand-alone nonstructural assessment, these facilities were evaluated within their respective economic areas. These areas are associated with the four proposed diversion channel alignments, as shown in Figure 10, and are identified as economic areas 1, 1a, 2, 3, and 4.

Locations and information for critical facilities that were evaluated in this study were provided by Cass County, North Dakota, and the city governments of Fargo, North Dakota and Moorhead, Minnesota through the St. Paul District. Unlike the residential and commercial facilities, the critical facilities were evaluated and flood proofed for only the 0.2% annual chance flood (500-yr) event. Under Executive Order 11988, Floodplain Management, critical facilities are required to be protected to the 0.2 percent annual chance flood so they remain operational during an emergency.

12.0 Minnesota Short Alignment Nonstructural Flood Risk Reduction Plan
The 25 mile Minnesota Short diversion channel alignment was investigated for the feasible implementation of nonstructural flood risk reduction measures in the vicinity of the upstream (economic area 1) diversion channel inlet and the outlet at the confluence with the Red River (economic area 2). This is the only area located within the vicinity of the proposed diversion channel which could have residual flood impacts. The nonstructural flood risk reduction was conducted on four levels of flow for the proposed diversion channel (20,000 cfs, 25,000 cfs, 30,000 cfs, and 35,000 cfs).

12.1 20,000 CFS Plan Development
For the nonstructural flood risk reduction analysis of the 25 mile long Minnesota Short diversion channel alignment, datasets containing structure information were obtained from the City of Fargo, City of Moorhead, Cass County, and the St. Paul District. Additional detailed hydrologic data and economic information were also provided by St. Paul District. The economic data was provided in the form of HEC-FDA files which were used to develop damages and benefits for the nonstructural analysis. In order to conduct the nonstructural assessment, structure information associated with the without project and with-project 20,000 cfs discharge conditions were investigated. For the economic analysis, the St. Paul District completed the assembly of adjacent ground elevations for each structure located within the appropriate economic area. The ground elevations were

extracted from Light Detection and Ranging (LiDAR) survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided to the National Flood Proofing Committee and the Omaha District contained occupancy information, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations.

Structure data was spatially oriented so that specific locations of structures could be identified and linked to the economic analysis. The economic data and structure GIS data were joined together through ArcMap and used as the base data.

Elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. Each structure was assessed in accordance with the methodology presented in Figures 8 and 9 and Report Sections 2.7 and 3.9 respectively.

12.2 25,000 CFS Plan Development
The nonstructural assessment for the 25,000 cfs capacity plan was conducted similar to the 20,000 cfs capacity plan utilizing structure data from the same datasets. With-project water surface elevations associated with the 25,000 cfs diversion channel were used for comparison purposes to the without-project conditions.

12.3 30,000 CFS Plan Development
The nonstructural assessment for the 30,000 cfs capacity plan was conducted similar to the 20,000 cfs capacity plan utilizing structure data from the same datasets. With-project water surface elevations associated with the 30,000 cfs diversion channel were used for comparison purposes to the without-project conditions

12.4 35,000 CFS Plan Development
The nonstructural assessment for the 35,000 cfs capacity plan was conducted similar to the 20,000 cfs capacity plan utilizing structure data from the same datasets. With-project water surface elevations associated with the 35,000 cfs diversion channel were used for comparison purposes to the without-project conditions.

12.5 Summary of Minnesota Short Alignment Nonstructural Plan Costs
The nonstructural flood risk reduction plan was conducted for four different flow capacities for the Minnesota Short diversion channel. Structures investigated for nonstructural mitigation were located in Economic Areas 1 and 2. Within these two economic areas the residential structures were divided into two occupancy types; residential structures with basements, and bi-level homes. The occupancy type for commercial structures and critical facilities was not subdivided for separate analysis. Nonstructural flood risk reduction techniques were assigned to the structure based on the criteria discussed in Report Chapter 2-4. The costs associated with the nonstructural techniques are summarized in Table 39. The results of the 25,000 cfs, 30,000 cfs, and 35,000 cfs plans were the same due to the similarity in the water surface profiles.

Table 39
Minnesota Short Alignment Nonstructural Flood Risk Reduction Cost Summary Table for Economic Areas 1 and 2

Nonstructural Technique Economic Area 1	20,000 cfs Plan		25,000; 30,000; 35,000 cfs Plans	
	#	Cost ($)	#	Cost ($)
Residential Structures with Basements				
Buyout	21	6,007,730	21	6,007,730
Elevate Main Floor	1	104,029	1	104,029
Elevate Entire Structure	17	2,227,793	17	2,227,793
Bi-Level Residences				
Buyout	2	1,241,596	2	1,241,596
Elevate Entire Structure	7	809,673	7	809,673
Total Nonstructural Cost	**$10,390,821**		**$10,390,821**	
Nonstructural Technique Economic Area 2	**20,000 cfs Plan**		**25,000; 30,000; 35,000 cfs Plans**	
	#	Cost ($)	#	Cost ($)
Residential Structures with Basements				
Buyout	7	1,099,642	7	1,099,642
Elevate Main Floor	22	2,423,907	22	2,420,609
Elevate Entire Structure	22	2,757,811	19	2,368,261
Bi-Level Residences				
Buyout	6	694,912	0	0
Elevate Entire Structure	0	0	3	354,019
Commercial Structures				
Flood Wall	1	92,250	0	0
Critical Facility				
Flood Wall	1	401,500	1	348,000
Total Nonstructural Cost	**$7,470,021**		**$6,590,531**	

12.5 Minnesota Short Diversion Channel Alignment Nonstructural Details

The individual structure information for the nonstructural assessment occurring in Economic Area 2 for the 20,000 cfs capacity diversion channel is shown in Table 40 and Table 41 presents the individual structure information for the nonstructural assessment occurring in Economic Area 2 for the 25,000 cfs, 30,000 cfs, and 35,000 cfs capacity alternatives.

Table 40
Minnesota Short Diversion Channel Alignment Nonstructural Details
(20,000 cfs Channel Capacity)

ID	STREET	CITY	Nonstructural Technique	100yr Cost	Annualized Cost	Benefit (x1000)	BCR	Net Benefit
400802	110 FREEDLAND DR	Harwood	Flood Wall	401,500	22,203	14.731	0.66	-7,473
400431		Reed Twp	Elevate Structure	112,079	6,198	2.000	0.32	-4,199
400431	132 BENDER LN	Harwood	Elevate Structure	112,047	6,197	2.000	0.32	-4,197
400667	438 LIND BLVD	Harwood	Elevate Structure	124,688	6,895	10.108	1.47	3,213
400687	115 RIVERSHORE DR	Harwood	Elevate Structure	112,693	6,232	2.216	0.36	-4,016
400707	106 RIVERSHORE DR	Harwood	Elevate Structure	113,534	6,278	2.095	0.33	-4,184
400754	324 RIVERTREE BLVD	Harwood	Elevate Structure	119,871	6,629	10.386	1.57	3,757
400007	17373 25 ST SE	Harwood Twp	Buy Out	129,564	7,165	12.832	1.79	5,667
400008	2551 173 AVE SE	Harwood Twp	Buy Out	113,870	6,297	10.018	1.59	3,721
400009	2623 173 AVE SE	Harwood Twp	Buy Out	147,854	8,177	10.397	1.27	2,221
400025	2769 173 AVE SE	Harwood Twp	Buy Out	123,074	6,806	4.247	0.62	-2,559
400009	2623 173 AVE SE	Harwood Twp	Buy Out	147,854	8,177	10.397	1.27	2,221
400001	17369 25 ST SE	Harwood Twp	Elevate Main Floor	112,176	6,203	14.768	2.38	8,565
400002	17135 25 ST SE	Harwood Twp	Elevate Main Floor	113,114	6,255	13.632	2.18	7,377
400004	17201 27 ST SE	Harwood Twp	Elevate Main Floor	112,661	6,230	21.166	3.40	14,936
400005	2569 172 AVE SE	Harwood Twp	Elevate Main Floor	113,566	6,280	12.193	1.94	5,913
400006	17283 26 ST SE	Harwood Twp	Elevate Main Floor	111,885	6,187	12.316	1.99	6,129
400010	2675 173 AVE SE	Harwood Twp	Elevate Main Floor	109,202	6,039	19.610	3.25	13,571
400011	2651 173 AVE SE	Harwood Twp	Elevate Main Floor	110,236	6,096	20.908	3.43	14,812
400012	17321 27 ST SE	Harwood Twp	Elevate Main Floor	108,167	5,982	16.895	2.82	10,913
400013	2618 173 AVE SE	Harwood Twp	Elevate Main Floor	111,885	6,187	28.141	4.55	21,954
400016	2631 172 1/2 ST SE	Harwood Twp	Elevate Main Floor	111,885	6,187	0.234	0.04	-5,953
400017	17254 26 ST SE	Harwood Twp	Elevate Main Floor	111,885	6,187	17.732	2.87	11,545
400018	2695 171 AVE SE	Harwood Twp	Elevate Main Floor	108,167	5,982	11.853	1.98	5,872
400020	2774 171 AVE SE	Harwood Twp	Elevate Main Floor	105,872	5,855	6.429	1.10	574
400021	2782 171 AVE SE	Harwood Twp	Elevate Main Floor	105,872	5,855	4.736	0.81	-1,119
400022	17105 27 ST SE	Harwood Twp	Elevate Main Floor	108,167	5,982	16.314	2.73	10,332
400023	2705 171 AVE SE	Harwood Twp	Elevate Main Floor	117,866	6,518	26.945	4.13	20,427
400024	2729 173 AVE SE	Harwood Twp	Elevate Main Floor	107,003	5,918	8.654	1.46	2,737
400014	2616 173 AVE SE	Harwood Twp	Elevate Main Floor	111,885	6,187	22.340	3.61	16,153
400015	2650 173 AVE SE	Harwood Twp	Elevate Main Floor	111,885	6,187	10.305	1.67	4,117
400019	16979 28 ST SE	Harwood Twp	Elevate Main Floor	105,872	5,855	9.034	1.54	3,179
400030	17164 28 ST SE	Harwood Twp	Elevate Structure	128,955	7,132	7.316	1.03	184
400047	17010 29 ST SE	Harwood Twp	Elevate Structure	126,013	6,969	2.534	0.36	-4,435
400054	2937 171 AVE SE	Harwood Twp	Elevate Structure	126,143	6,976	3.211	0.46	-3,765
400055	2941 171 AVE SE	Harwood Twp	Elevate Structure	125,043	6,915	2.558	0.37	-4,358
400757	521 DAKOTA AVE	Harwood	Flood Wall	92,250	5,102	0.019	0.00	-5,082
400631	35 LIND CIR	Harwood	Elevate Main Floor	105,484	5,833	5.277	0.90	-556
400694	101 RIVERSHORE DR	Harwood	Elevate Structure	125,528	6,942	1.881	0.27	-5,060
400559	214 MAIN ST	Harwood	Elevate Structure	127,339	7,042	1.636	0.23	-5,406
400572	516 CHAPIN DR	Harwood	Elevate Structure	120,776	6,679	0.341	0.05	-6,338
400574	512 CHAPIN DR	Harwood	Elevate Structure	124,009	6,858	1.192	0.17	-5,666
400583	511 WALLY ST	Harwood	Elevate Structure	125,625	6,947	1.264	0.18	-5,683
400586	206 TED AVE	Harwood	Elevate Structure	123,718	6,842	1.598	0.23	-5,244
400599	104 LIND BLVD	Harwood	Elevate Structure	128,212	7,090	1.550	0.22	-5,540
400603	52 LIND BLVD	Harwood	Elevate Structure	124,688	6,895	1.254	0.18	-5,641
400626	55 LIND BLVD	Harwood	Elevate Structure	128,858	7,126	1.655	0.23	-5,471
400629	43 LIND BLVD	Harwood	Elevate Structure	122,877	6,795	0.548	0.08	-6,247
400688	113 RIVERSHORE DR	Harwood	Elevate Structure	122,166	6,756	0.646	0.10	-6,110
400704	112 RIVERSHORE DR	Harwood	Elevate Structure	123,912	6,853	0.883	0.13	-5,969
400772	317 RIVERTREE BLVD	Harwood	Elevate Structure	124,753	6,899	2.086	0.30	-4,813
400781	103 TED AVE	Harwood	Elevate Structure	122,910	6,797	0.803	0.12	-5,994
400783	203 TED AVE	Harwood	Elevate Structure	124,009	6,858	1.314	0.19	-5,544
400753	320 RIVERTREE BLVD	Harwood	Elevate Structure	127,242	7,036	2.288	0.33	-4,749
13000	12109 15 ST NW	Moorhead	Elevate Structure	129,343	7,153	0.817	0.11	-6,336
13034		Moorhead	Elevate Main Floor	109,169	6,037	0.061	0.01	-5,976
13038	9999 15 ST NW	Moorhead	Elevate Structure	125,690	6,951	0.062	0.01	-6,889
13036	10615 15 ST NW	Moorhead	Buy Out	258,184	14,278	1.587	0.11	-12,691
13037	10899 15 ST NW	Moorhead	Buy Out	179,242	9,912	0.245	0.02	-9,667

Table 41
Minnesota Short Diversion Channel Alignment Nonstructural Details
(25,000 cfs, 30,000 cfs, and 35,000 cfs Channel Capacity)

ID	STREET	CITY	Nonstructural Technique	100yr Cost	Annualized Cost	Benefits (x1000)	BCR	Net Benefit
400802	110 FREEDLAND DR	Harwood	Flood Wall	348,000	19,245	10.761	0.56	-8,484
400667	438 LIND BLVD	Harwood	Elevate Structure	123,330	6,820	10.181	1.49	3,360
400707	106 RIVERSHORE DR	Harwood	Elevate Structure	112,176	6,203	2.100	0.34	-4,103
400754	324 RIVERTREE BLVD	Harwood	Elevate Structure	118,513	6,554	10.363	1.58	3,809
400007	17373 25 ST SE	Harwood Twp	Buy Out	129,564	7,165	12.832	1.79	5,667
400008	2551 173 AVE SE	Harwood Twp	Buy Out	113,870	6,297	10.018	1.59	3,721
400009	2623 173 AVE SE	Harwood Twp	Buy Out	147,854	8,177	10.397	1.27	2,220
400025	2769 173 AVE SE	Harwood Twp	Buy Out	123,074	6,806	4.205	0.62	-2,601
400009	2623 173 AVE SE	Harwood Twp	Buy Out	147,854	8,177	10.397	1.27	2,220
400001	17369 25 ST SE	Harwood Twp	Elevate Main Floor	112,176	6,203	14.768	2.38	8,565
400002	17135 25 ST SE	Harwood Twp	Elevate Main Floor	113,114	6,255	13.632	2.18	7,377
400004	17201 27 ST SE	Harwood Twp	Elevate Main Floor	112,661	6,230	21.166	3.40	14,936
400005	2569 172 AVE SE	Harwood Twp	Elevate Main Floor	113,566	6,280	12.193	1.94	5,913
400006	17283 26 ST SE	Harwood Twp	Elevate Main Floor	111,885	6,187	12.316	1.99	6,129
400010	2675 173 AVE SE	Harwood Twp	Elevate Main Floor	109,137	6,035	19.609	3.25	13,574
400011	2651 173 AVE SE	Harwood Twp	Elevate Main Floor	110,236	6,096	20.908	3.43	14,812
400012	17321 27 ST SE	Harwood Twp	Elevate Main Floor	108,070	5,976	16.894	2.83	10,918
400013	2618 173 AVE SE	Harwood Twp	Elevate Main Floor	111,885	6,187	28.141	4.55	21,954
400016	2631 172 1/2 ST SE	Harwood Twp	Elevate Main Floor	111,885	6,187	0.234	0.04	-5,953
400017	17254 26 ST SE	Harwood Twp	Elevate Main Floor	111,885	6,187	17.732	2.87	11,545
400018	2695 171 AVE SE	Harwood Twp	Elevate Main Floor	108,070	5,976	11.853	1.98	5,877
400020	2774 171 AVE SE	Harwood Twp	Elevate Main Floor	105,484	5,833	6.365	1.09	532
400021	2782 171 AVE SE	Harwood Twp	Elevate Main Floor	105,484	5,833	4.689	0.80	-1,144
400022	17105 27 ST SE	Harwood Twp	Elevate Main Floor	108,070	5,976	16.314	2.73	10,337
400023	2705 171 AVE SE	Harwood Twp	Elevate Main Floor	117,769	6,513	26.948	4.14	20,435
400024	2729 173 AVE SE	Harwood Twp	Elevate Main Floor	106,777	5,905	8.605	1.46	2,700
400014	2616 173 AVE SE	Harwood Twp	Elevate Main Floor	111,885	6,187	22.340	3.61	16,153
400015	2650 173 AVE SE	Harwood Twp	Elevate Main Floor	111,885	6,187	10.305	1.67	4,117
400019	16979 28 ST SE	Harwood Twp	Elevate Main Floor	105,484	5,833	8.944	1.53	3,111
400030	17164 28 ST SE	Harwood Twp	Elevate Structure	128,438	7,103	7.197	1.01	94
400047	17010 29 ST SE	Harwood Twp	Elevate Structure	124,753	6,899	2.460	0.36	-4,439
400054	2937 171 AVE SE	Harwood Twp	Elevate Structure	125,043	6,915	3.142	0.45	-3,773
400055	2941 171 AVE SE	Harwood Twp	Elevate Structure	123,944	6,854	1.337	0.20	-5,518
400694	101 RIVERSHORE DR	Harwood	Elevate Structure	124,171	6,867	0.977	0.14	-5,890
400559	214 MAIN ST	Harwood	Elevate Structure	125,981	6,967	1.620	0.23	-5,347
400574	512 CHAPIN DR	Harwood	Elevate Structure	122,651	6,783	0.630	0.09	-6,153
400583	511 WALLY ST	Harwood	Elevate Structure	124,268	6,872	1.231	0.18	-5,641
400586	206 TED AVE	Harwood	Elevate Structure	122,360	6,767	0.847	0.13	-5,920
400599	104 LIND BLVD	Harwood	Elevate Structure	126,854	7,015	1.512	0.22	-5,503
400603	52 LIND BLVD	Harwood	Elevate Structure	123,330	6,820	1.224	0.18	-5,597
400626	55 LIND BLVD	Harwood	Elevate Structure	127,501	7,051	1.614	0.23	-5,437
400688	113 RIVERSHORE DR	Harwood	Elevate Structure	120,808	6,681	0.661	0.10	-6,020
400704	112 RIVERSHORE DR	Harwood	Elevate Structure	122,554	6,777	0.896	0.13	-5,881
400772	317 RIVERTREE BLVD	Harwood	Elevate Structure	123,395	6,824	2.035	0.30	-4,789
400783	203 TED AVE	Harwood	Elevate Structure	122,651	6,783	1.332	0.20	-5,451
400753	320 RIVERTREE BLVD	Harwood	Elevate Structure	125,884	6,962	2.231	0.32	-4,731
400631	35 LIND CIR	Harwood	Main Floor Raise	104,126	5,758	5.439	0.94	-31,320
13000	12109 15 ST NW	Moorhead	Elevate Structure	129,246	7,148	0.817	0.11	-5,840
13034		Moorhead	Elevate Main Floor	109,072	6,032	0.061	0.01	-368
13038	9999 15 ST NW	Moorhead	Elevate Structure	124,429	6,881	0.062	0.01	-427
13036	10615 15 ST NW	Moorhead	Buy Out	258,184	14,278	1.587	0.11	-22,659
13037	10899 15 ST NW	Moorhead	Buy Out	179,242	9,912	0.245	0.02	-2,429

12.6 Summary of Minnesota Short Alignment Project Benefits

Project benefits were calculated by St. Paul District using the HEC-FDA computer program. A modified with-project condition HEC-FDA input file was created for Economic Areas 1 and 2, where the data was run in HEC-FDA to determine damages for

the project condition. The difference between the pre-project and with-project damages was then used as the project benefit. Table 42displays the project benefits and associated benefit to cost ratios for the nonstructural analysis conducted on Economic Areas 1 and 2. The nonstructural assessment resulted in a feasible benefit to cost ratio for Economic Area 2 for all four capacities considered.

Table 42
Minnesota Short Alignment Nonstructural Flood Risk Reduction Benefits Summary
Economic Areas 1 and 2

Nonstructural Plan	Total Cost	Estimated Annual Cost	Estimated Annual Benefits	Plan Benefits to Cost	Plan Net Benefits
Economic Area 1					
20,000 cfs	10,390,821	574,623	260,310	0.45	-314,313
25,000 cfs	10,390,821	574,623	260,310	0.45	-314,313
30,000 cfs	10,390,821	574,623	260,310	0.45	-314,313
35,000 cfs	10,390,821	574,623	260,310	0.45	-314,313
Economic Area 2					
20,000 cfs	7,470,021	413,100	430,256	1.04	17,156
25,000 cfs	6,590,531	364,463	414,366	1.14	49,903
30,000 cfs	6,590,531	364,463	414,366	1.14	49,903
35,000 cfs	6,590,531	364,463	414,366	1.14	49,903

13.0 North Dakota East Alignment Nonstructural Flood Risk Reduction Plan

The 36 mile North Dakota East diversion channel alignment was investigated for the feasible implementation of nonstructural flood risk reduction measures in the vicinity of the downstream (Economic Area 2) diversion channel confluence with the Red River. This is the only area located within the vicinity of the proposed diversion channel which could have residual flood impacts. The nonstructural flood risk reduction was conducted on one level of flow for the proposed diversion channel (30,000 cfs).

13.1 30,000 CFS Plan Development

For the nonstructural flood risk reduction analysis of the 36 mile long North Dakota East diversion channel alignment, datasets containing structure information were obtained from the City of Fargo, City of Moorhead, Cass County, and the St. Paul District. Additional detailed hydrologic data and economic information were also provided by St. Paul District. The economic data was provided in the form of HEC-FDA files which were used to develop damages and benefits for the nonstructural analysis. In order to conduct the nonstructural assessment, structure information associated with the without project and with-project 30,000 cfs discharge conditions were investigated. For the economic analysis, the St. Paul District completed the assembly of adjacent ground elevations for each structure located within the appropriate economic area. The ground elevations were extracted from Light Detection and Ranging (LiDAR) survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided to the National Flood Proofing Committee and the

Omaha District contained occupancy information, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations.

Structure data was spatially oriented so that specific locations of structures could be identified and linked to the economic analysis. The economic data and structure GIS data were joined together through ArcMap and used as the base data.
Elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. Each structure was assessed in accordance with the methodology presented in Figures 8 and 9 Report Sections 2.7 and 3.9 respectively.

13.2 35,000 CFS Plan Development

The nonstructural assessment for the 35,000 cfs capacity plan was conducted similar to the 30,000 cfs capacity plan utilizing structure data from the same datasets. With-project water surface elevations associated with the 30,000 cfs diversion channel were used for comparison purposes to the without-project conditions.

13.3 Summary of North Dakota East Alignment Nonstructural Plan Costs

The nonstructural flood risk reduction plan was conducted for one flow capacity for the North Dakota East diversion channel. Structures investigated for nonstructural mitigation were located in economic area 2. Within this economic area the residential structures were divided into two occupancy types; residential structures with basements, and bi-level homes. There were no commercial structures and critical facilities contained within the datasets. Nonstructural flood risk reduction techniques were assigned to the structure based on the criteria discussed in Report Chapter 2-4. The costs associated with the nonstructural techniques are summarized in Table 43.

Table 43
North Dakota East Diversion Channel

Nonstructural Technique Economic Area 2	30,000; 35,000 cfs Plans	
	#	Cost ($)
Residential Structures with Basements		
Buyout	6	920,400
Elevate Main Floor	5	537,183
Elevate Entire Structure	17	2,149,797
Bi-Level Residences		
Elevate Entire Structure	1	115,829
Total Nonstructural Cost	**$3,723,210**	

13.4 Summary of North Dakota East Alignment Project Benefits

Project benefits were calculated by St. Paul District using HEC-FDA computer program. A modified with-project condition HEC-FDA input file was created for Economic Area 2, the only area noted for having residual structural damages, and the data was run in HEC-FDA to determine damages for the project condition. The difference between the pre-project and with-project damages was then used as the project benefits. Table 44 displays these benefits and associated benefit to cost ratios. The nonstructural assessment did not result in a feasible benefit to cost ratio for either diversion channel capacity considered.

Table 44
North Dakota East Alignment Nonstructural Flood Risk Reduction Benefits Summary for Economic Area 2

Nonstructural Plan	Total Cost	Estimated Annual Cost	Estimated Annual Benefits	Plan Benefits to Cost	Plan Net Benefits
30,000 cfs	3,723,210	205,897	132,543	0.64	-73,354
35,000 cfs	3,723,210	205,897	132,543	0.64	-73,354

14.0 Summary of Nonstructural Assessment in Support of Diversion Structures
The nonstructural assessment in support of the diversion channel alternatives was conducted in an effort to reduce residual flood damages which otherwise would not be alleviated by any of the diversion channel proposals. The only diversion plan, the Minnesota Short, resulted in a positive benefit to cost ratio for implementing nonstructural measures. The following two sections provide specific information on the results of the nonstructural assessment for the Minnesota Short diversion plan, which appears to have federal interest in implementing as part of the structural project for the Fargo-Moorhead metro area.

14.0.1 Minnesota Short 20,000 cfs Diversion Plan
The Minnesota Short 20,000 cfs Diversion Plan for Economic Area 2 resulted in a benefit to cost ratio of 1.06 and net annualized benefits of $23,239. This economic area includes a total of 57 residential structures, 1 commercial structure and 1 critical facility. The structures in this area include rural homes and structures in and around city of Harwood, North Dakota. The benefits to cost ratio for individual structures range from near 0 to 4.55. The residential structures that have the most benefit from the additional nonstructural flood risk reduction technique are those that see flood damages at the more frequent flood events.

14.0.2 Minnesota Short 25,000 cfs, 30,000 cfs, and 35,000 cfs Diversion Plans
The Minnesota Short 25,000; 30,000; and 35,000 cfs Diversion Plan Economic Area 2 resulted in a benefit to cost ratio of 1.14 and a net annualized benefit of $49,903. This economic area includes a total of 51 residential structures and 1 critical facility. The structures in this area include rural homes and structures in and around the city of Harwood, North Dakota. The benefits to cost Ratio for individual structures range from near 0 to 4.45. The residential structures that see the most benefit from the additional

nonstructural flood risk reduction techniques are those that see flood damages at the more frequent flood events.

15.0 Recommendations of Nonstructural Results in Support of Diversion Structures
While the stand-alone nonstructural plans and several of the nonstructural plans in support of the diversion channel alternatives did not result in positive net benefits or benefit to cost ratios greater than 1.0, the Minnesota Short diversion plan did indicate feasible results for the nonstructural measures. From the analyses, the nonstructural measures have a benefit to cost ratio of 1.06 for the 20,000 cfs diversion channel capacity design and 1.14 for the 25,000 cfs, 30,000 cfs, and 35,000 cfs diversion channel capacities for the Minnesota Short alignment. The structures reside in Economic Area 2, which is located at the downstream end of the proposed diversion channel.

Comprehensive flood risk management and flood damage reduction may require a combination of structural and nonstructural mitigation measures to achieve the greatest level of protection against future flooding. The nonstructural assessment considered whole economic areas as described in Section 11.1. While individual structures could be presented with a greater or lesser benefit to cost ratio than what was cumulatively developed for the entire economic area, mitigation measures should be implemented for each structure across the entire economic area, in much the same way a levee would be constructed to provide a general level of protection for each and every structure located landward of the levee, whether or not adjacent structures had the same benefit to cost ratio or similar net benefits.

The nonstructural mitigation measures proposed for Economic Area 2 in support of the Minnesota Short diversion channel alternative, shown in Tables 40 and 41, consist of buyouts, elevation, and construction of flood walls. For the 20,000 cfs capacity plan there are 57 residential structures, 1 commercial structure, and 1 critical facility (ID 400802 public school). For the 25,000 to 35,000 cfs capacity plans there are 51 residential structures and 1 critical facility (ID 400802 public school). If the Minnesota Short diversion channel alternative is selected as the National Economic Development plan, it is the recommendation of the National Nonstructural Flood Proofing Committee that the nonstructural techniques emphasized for Economic Area 2 be pursued during the PED phase and implemented if the projected costs do not significantly increase.

PART 2
SUPPLEMENTAL NONSTRUCTURAL ASSESSMENT FOR THE FARGO-MOORHEAD METRO FEASIBILITY STUDY

1.0 Introduction

This supplemental nonstructural assessment has been conducted in support of the U.S. Army Corps of Engineers, St Paul District [MVP], to analyze and develop a diversion channel to reduce the risk of flooding and flood damages at Fargo, North Dakota and Moorhead, Minnesota. The nonstructural assessment has been conducted by the National Nonstructural Flood Proofing Committee [NFPC] with support from the Flood Risk and Floodplain Management Section of the Omaha District.

MVP is nearing completion of a complex feasibility study which has resulted in the recommendation of a structural diversion project to eliminate flood damages within the metropolitan area. The proposed project is shown in Figure 1. This appendix functions as a complete technical document to support the nonstructural assessment of the project area defined as being located downstream from recommended feasibility project.

This appendix contains the detailed technical assessment used for investigating the feasibility of incorporating nonstructural mitigation measures within the project area, located downstream from the outlet of the recommended diversion channel. While the recommended diversion project appears to reduce the risk of flooding throughout the metropolitan area, a significant amount of structures continue to be damaged, under existing conditions, by extensive flooding along the Red River of the North.

While nonstructural measures are specific to the structure being investigated, when considered for the mitigation of flood damages, the cumulative effect is to determine a strategy for incorporating a full range of nonstructural measures which are economically feasible and will reduce the risk of flooding. Each structure assessed may require a different nonstructural measure. While this nonstructural assessment relies heavily upon an inventory of data collected in the field, each structure would be required to be inspected by a team consisting of a floodplain engineer, structural engineer, cost engineer, civil engineer, and real estate specialist in order to determine, prior to implementation, the mitigation details relative to each type of nonstructural measure employed. Because of the nature of this level of investigation, this degree of investigation was not conducted within this phase of the assessment.

Nonstructural measures require different implementation as compared to structural measures. Since each structure is owned and occupied by people, agreements must be entered into with each owner.

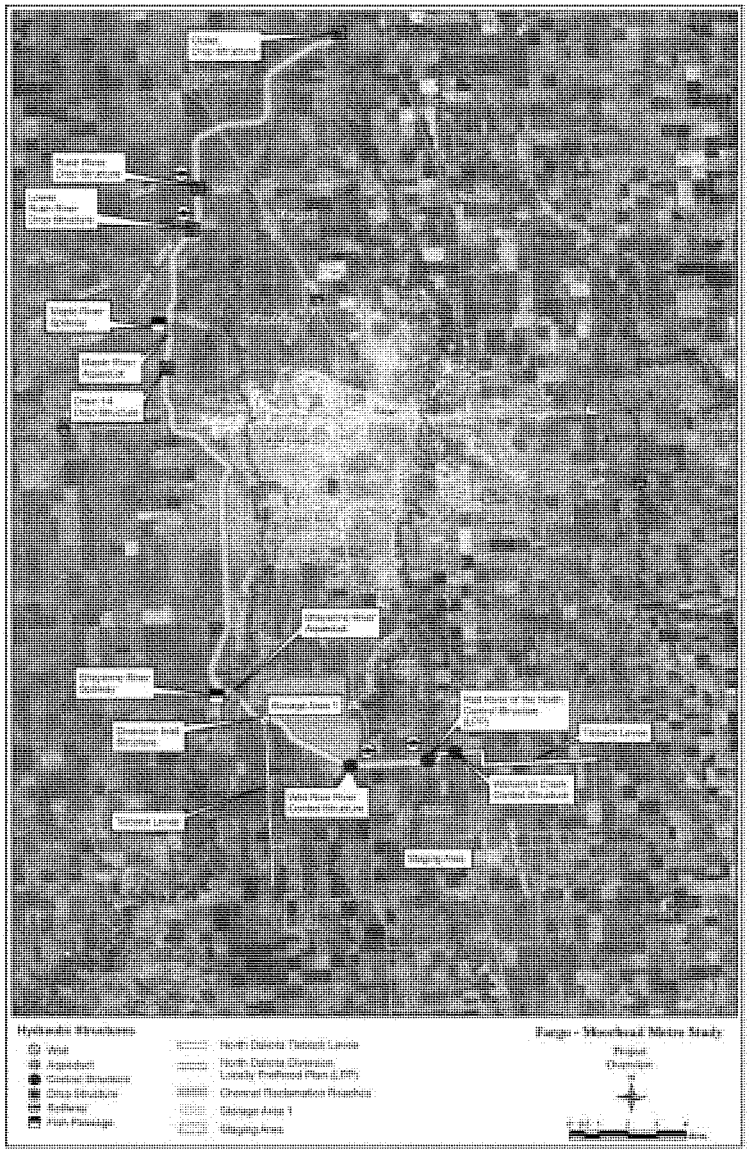


Figure 1
Recommended Diversion Channel Project Alignment

1.2 Description of Nonstructural Study Area

The nonstructural study area is shown on Figure 2.The limits of this study are from the outlet of the proposed Diversion Channel Project, downstream approximately 50 river miles.

Fargo, North Dakota and Moorhead, Minnesota are 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 are tributaries of the Red River within the general project area. The Red River of the North flows northward approximately 453 river miles to Lake Winnipeg in Manitoba, Canada. The Fargo-Moorhead Metro area is generally very flat, having wide expanses of floodplain. The topography slopes from the south to the north.

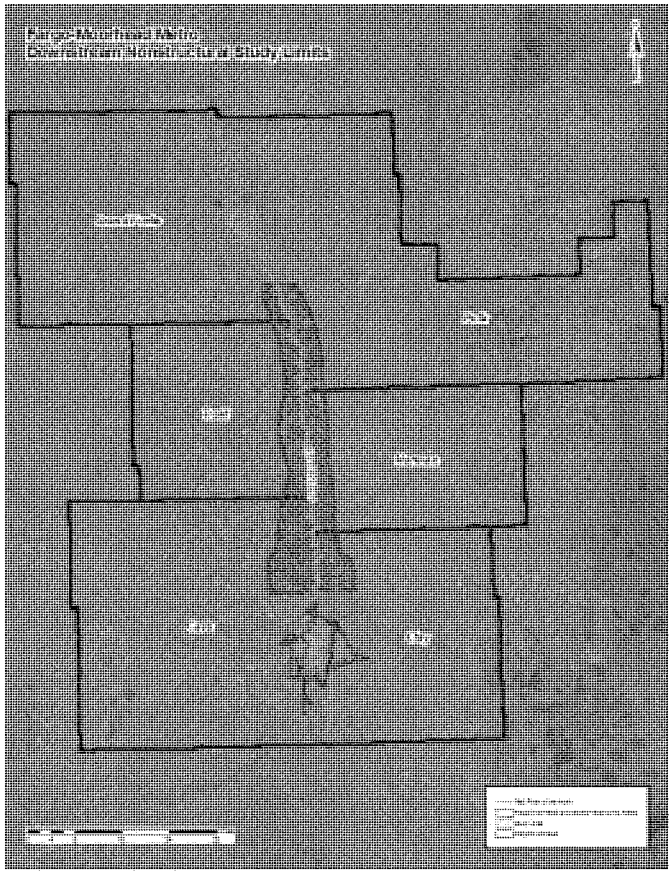


Figure 2
Nonstructural Assessment Study Location

1.3 Description of Nonstructural Assessment

For this nonstructural assessment, structure information was collected for 3,801 structures located outside of the zone of protection of the proposed Red River Diversion Channel project, shown in Figure 1.

Structure information was collected for six counties, three within Minnesota (Clay, Norman, and Polk) and three within North Dakota (Cass, Grand Forks, and Trail). Within each of these six counties the structures located within a 450-foot zone, or buffer, of the centerline of the Red River were identified, as well as all structures located within the 100-year (1% annual chance flood) delineation and the 500-year (0.2% annual chance flood) delineation. A description of the structure type investigated is shown in Table 1.

The break out of specific structure information for the individual counties is shown in Table 2. The structures located within the 450-foot buffer were considered for the buy-out option, as the depth of flooding could be significant for structures located in this area. The general study area for the nonstructural assessment is shown in Figure 2.

Table 1
Description of Structure Type

Structure Type	Structure Type Description
Commercial	Sales and transactions
Barn	Agricultural usage
Bilevel	Split level residential
Machine Shed	Agricultural Usage
Grain Bin	Agricultural usage (metal construction, cylinder)
OresWBsmt	One story residential with basement
OresWOBsmt	One story residential without basement
Silo	Agricultural usage
Hayshed	Agricultural usage
Livestock	Agricultural usage
Shop Shed	Small equipment facility
TresWBsmt	Two Story residential with basement
TresWOBsmt	Two Story residential without basement

Table 2
Inventory of Structures Located Within Six-County Assessment Area

Clay County MN				
Structure Type	**Count**	**Within 450 foot Buffer**	**Within 100-Year**	**Within 500-Year**
Commercial	3	0	3	3
Barn	6	0	1	3
Bilevel	1	0	1	1
Machine Shed	279	31	75	141
Grain Bin	289	6	40	93
OresWBsmt	73	9	27	46
OresWOBsmt	28	0	26	27
Silo	3	0	0	2
TresWBsmt	26	2	11	15
TresWOBsmt	2	0	1	2
Totals	**710**	**48**	**185**	**333**

Norman County MN				
Structure Type	**Count**	**Within 450 foot Buffer**	**Within 100-Year**	**Within 500-Year**
Commercial	3	0	1	1
Barn	10	2	6	8
Grain Bin	418	48	185	306
Hayshed	2	0	1	2
Livestock	6	0	2	4
Machine Shed	344	40	156	220
OresWBsmt	53	7	26	45
OresWOBsmt	7	0	3	3
ShopShed	4	1	3	3
Silo	2	0	0	0
SplitWBsmt	2	0	0	0
SplitWOBsmt	1	0	1	1
TresWBsmt	52	3	15	21
TresWOBsmt	1	0	0	0
Totals	**905**	**101**	**399**	**614**

Table 2 (continued)
Inventory of Structures Located Within Six-County Assessment Area

Polk County MN				
Structure Type	**Count**	**Within Floodway**	**Within 100-Year**	**Within 500-Year**
Barn	15	2	4	6
Grain Bin	176	6	20	87
Machine Shed	213	23	32	102
OresWBsmt	77	4	8	40
OresWOBsmt	2	0	0	0
Silo	1	0	0	0
TresWBsmt	1	0	0	1
Totals	**485**	**35**	**64**	**235**

Cass County ND				
Structure Type	**Count**	**Within 450 ft Buffer**	**Within 100-Year**	**Within 500-Year**
Barn	11	1	7	9
Grain Bin	284	22	121	196
Machine Shed	301	37	126	191
OresWBsmt	89	11	29	52
OresWOBsmt	2	0	1	1
Silo	5	0	3	4
TresWBsmt	13	1	1	5
Totals	**705**	**72**	**288**	**458**

Grand Forks County ND				
Structure Type	**Count**	**Within 450 ft Buffer**	**Within 100-Year**	**Within 500-Year**
Barn	8	2	1	4
Grain Bin	24	16	0	22
Machine Shed	46	11	0	25
OresWBsmt	24	5	1	9
OresWOBsmt	1	0	0	1
TresWBsmt	1	0	0	0
Totals	**104**	**34**	**2**	**61**

Table 2 (continued)
Inventory of Structures Located Within Six-County Assessment Area

Trail County ND				
Structure Type	**Count**	**Within 450 ft Buffer**	**Within 100-Year**	**Within 500-Year**
Barn	23	2	4	15
BiLevel	5	0	0	0
Commercial	2	1	0	1
Grain Bin	379	32	69	168
Machine Shed	359	40	86	194
OresWBsmt	47	3	4	26
OresWOBsmt	5	2	1	2
Shop Shed	19	1	4	9
Silo	5	2	1	4
TresWBsmt	47	3	6	22
TresWOBsmt	1	0	0	1
Totals	**892**	**87**	**179**	**441**

2.0 Nonstructural Measures Considered

This nonstructural assessment considered protection of residential, commercial, critical, and agricultural structures for a target design flood frequency of the 1% annual chance event. Each structures was analyzed based upon data collected in the field and compared to the target flood depth, where a screening process was initiated and the least cost nonstructural mitigation measure was identified.

The nonstructural measures considered during this assessment included, Elevation with Extended Foundation, Elevation with Flood Proofed Basement, Fill Basement with Main Floor Addition, Elevation on Fill, Permanent Acquisition, Nonstructural Berm, Dry Flood Proofing, and Raising Grain Bins / Silos. Each technique is discussed in detail in the following sections of this report.

2.1 Elevating Entire Structure

Elevating the entire structure requires raising the structure up from its original footings to an elevation above the design flood elevation. This technique was used on residential structures, with and without basements, and bi-level structures. To calculate the vertical distance of rise for each structure, the stage of the 1% annual chance flood event (100-year) was used and then 1.0 feet or 1.8 was added depending on the local floodplain regulations. Then the lowest level stage was subtracted. The structures with raises less than 12 feet were analyzed with this technique.

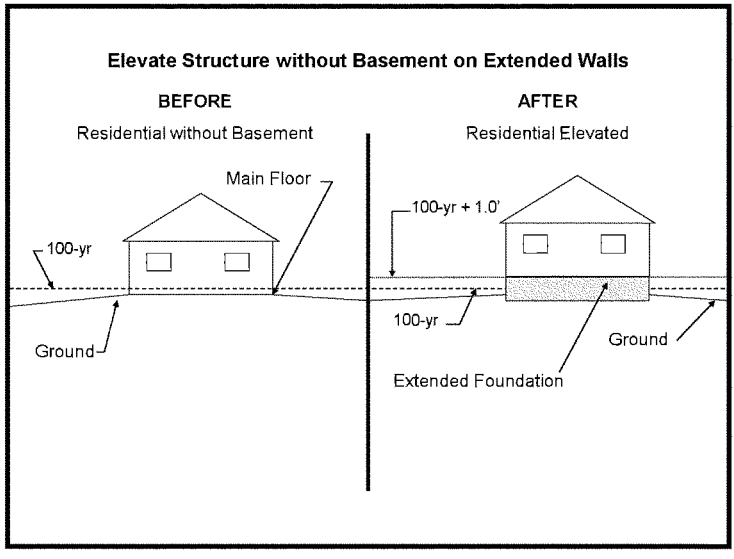
The cost to elevate the structure was figured by utilizing the equations based upon structure square footage and listed in Table 3.

Table 3
Estimated Cost to Elevate Structures

Square Foot Range	Cost to Elevate Equations
0 - 1250	1000 x (3.100 x MF_Rise + 87.5)
1250 - 1750	1000 x (3.233 x MF_Rise + 91)
1750 - Greater	1000 x (3.533 x MF_Rise + 101)

Figure 3 illustrates an example of a residential structure without a basement before and after incorporation of this nonstructural flood reduction technique.

Figure 3
Schematic of Structure without Basement



2.2 Elevation with Flood Proofed Basement

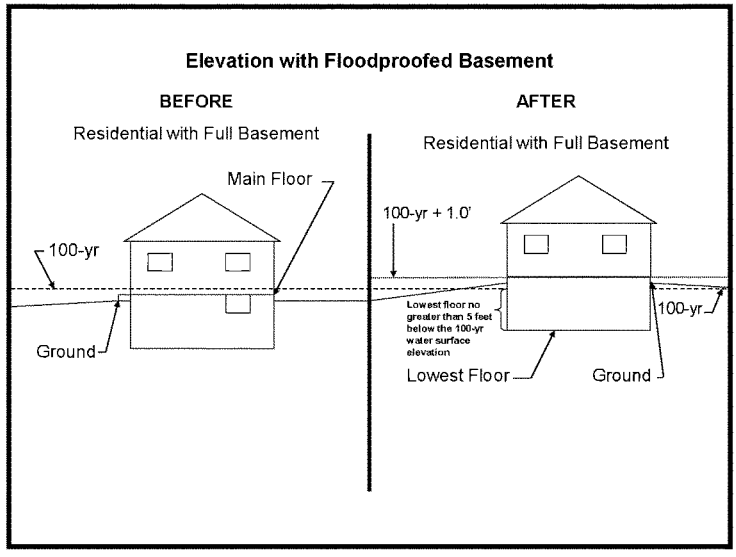
Portions of the study area, where structures contained full basements, a basement exemption may have existed. A basement exemption allows a basement to be present in a residential structure in the floodplain when the structure follows strict building codes. Elevating with dry flood proofed basement was used for residential structures where elevating the basement level up would be greater than 12 feet. For these structures, the main level was elevated above the design elevation and the new basement would be constructed following the flood proofing guidelines. The same cost estimating equations were used based on the vertical distance of elevations in Table 3, which are repeated in Table 4. Additional masonry costs may be required for determining the

overall cost of the flood proofed basement. An example of this technique is shown in Figure 4 for a residential structure with a basement for the before and after conditions.

Table 4
Estimated Cost to Elevate Structures

Square Foot Range	Cost to Elevate Equations
0 - 1250	1000 x (3.100 x MF_Rise + 87.5)
1250 - 1750	1000 x (3.233 x MF_Rise + 91)
1750 - Greater	1000 x (3.533 x MF_Rise + 101)

Figure 4
Schematic of Elevated Structure with Flood Proofed Basement



2.3 Fill Basement with Main Floor Addition

Filling in the basement was an option for structures experiencing a design flood depth below the main floor elevation. The basement was removed by filling it with clean sand or fill material and capping it with concrete. The area of the structure was provided by the St. Paul District. To compensate for the lost basement area, the owner of the structure was either paid for the loss of the basement, or if feasible, an addition was built above the design event. The size of the addition was based on 75% of the total area of a finished basement and 50% of the total area of an unfinished basement. Cost estimates for the fill and the loss of the basement is summarized in Table 5. Cost estimates for the addition is summarized in Table 6. Figure 5 is a simple example of filling a basement and adding an addition to the residence.

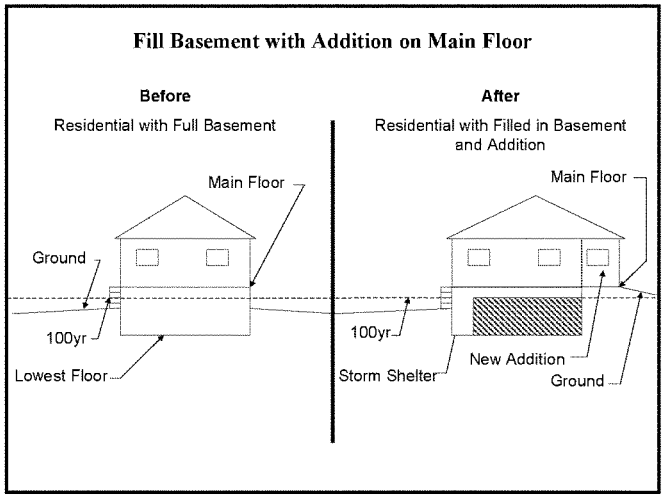
Table 5
Cost Estimating Parameters for Filling Basements for Residential Structures

Item:	Cost/Units	Quantity
Sand	$1.30/Cubic Foot	Area x 8 ft
Lost Square Footage (Unfinished)	13% of Structure Value	
Lost Square Footage (Finished)	37.5% of Structure Value	

Table 6
Cost for Addition to Residential Structures

Size	100 Square Feet	500 Square Feet	750 Square Feet	1000 Square Feet	1500 Square Feet
Cost	$21,000	$95,000	$134,100	$171,700	$247,300

Figure 5
Schematic of Structure with Basement Filled in and Addition on Main Floor

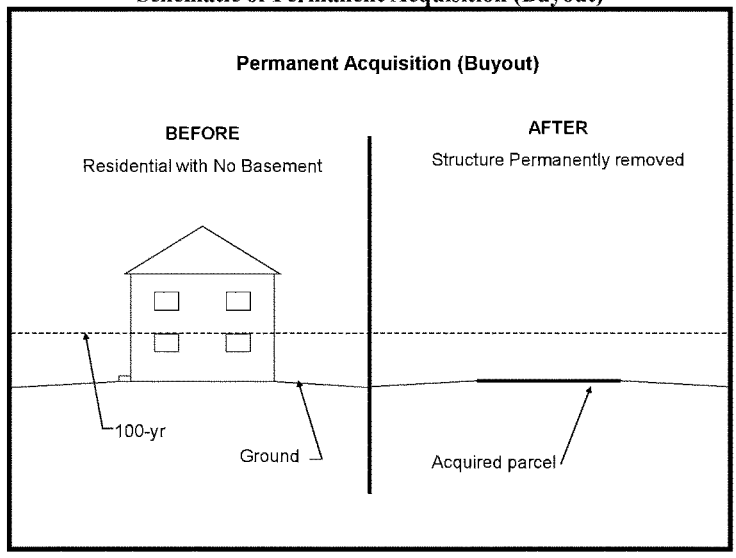


2.4 Permanent Acquisition (Buyout)

Buyout of residential structures requires purchasing the structure and the land and either demolishing the structure or relocating it to a place that is out of the floodplain. This nonstructural method is applied to structures that are either located within the regulatory floodway, fall within a predetermined buffer zone of the river (450 foot buffer for the Red River of the North), or had a depth of flooding on the structure greater than 12 feet. Costs for this

estimate were figured by taking the structure value plus the land value, which were provided by St. Paul District, and multiplying that figure by a multiplier of 1.18. Figure 6 illustrates a simple schematic where an acquisition is implemented.

Figure 6
Schematic of Permanent Acquisition (Buyout)



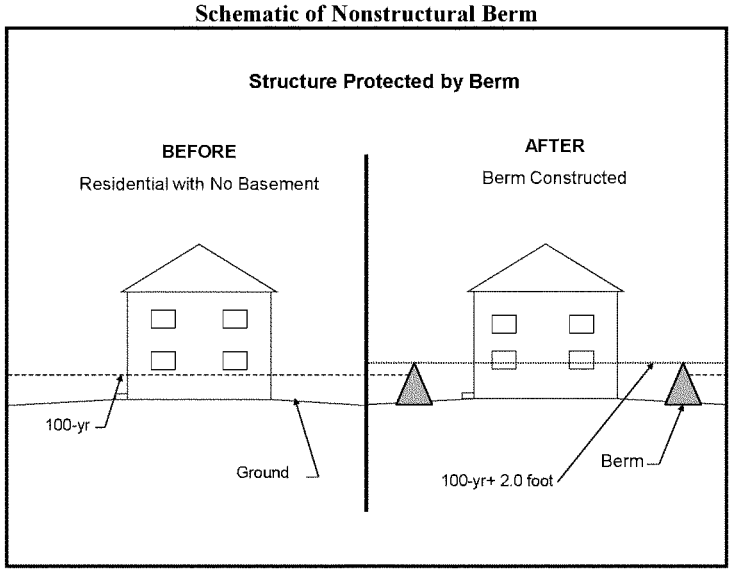
2.5 Nonstructural Berm

Nonstructural berms consist of compacted soil material placed around structures to prevent damages from flooding. For this assessment, the berms were constructed to a height of 2-foot above the design flood elevation, with a 6-foot top width, and 2.5 horizontal to 1 vertical side slopes. In some instances an existing berm was already in place and costs were considered for raising the existing berm to meet the design flood height.

Berm construction, whether to a level of protection for achieving levee accreditation through the Federal Emergency Management Agency [FEMA], as referenced in Title 44 CFR 65.10, or for personal protection preferences should be operated, maintained and repaired annually. The berm owner should conduct annual inspections and ensure closures and pumps are in good working order. As with other nonstructural measures, the NFPC advocates protecting individual structures or small groups of structures with berms, while maintaining enrollment in the National Flood Insurance Program.

For this nonstructural technique, a cost of $7.96 per cubic yard was utilized. Other costs associated with berms were for closures, pumps, seeding and maintenance. Figure 7 provides a schematic of the use of an earthen berm to protect a structure.

Figure 7
Schematic of Nonstructural Berm



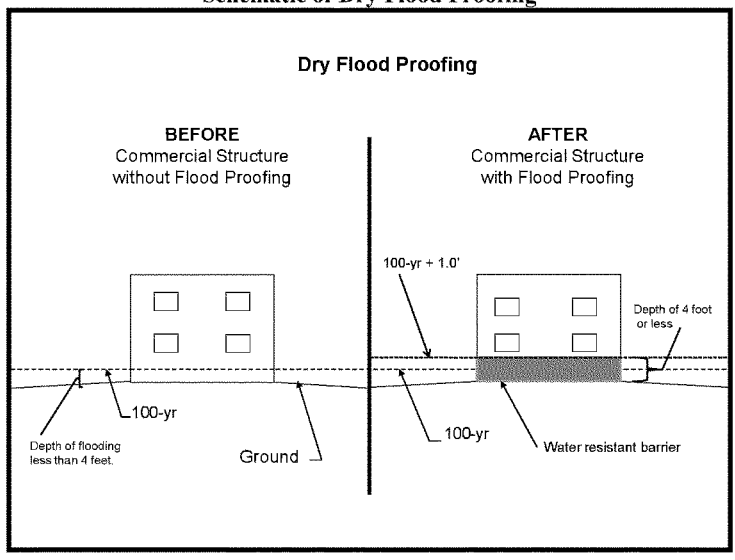
2.6 Dry Flood Proofing

Dry flood proofing for commercial structures involves applying a water resistant sealant around the structure to prevent flood water from entering. Doorways and windows are sealed with flood shields or by similar method. Cost estimates were developed for structures without basements and design flood depths of 4 feet or less. The costs used in the estimate are summarized in Table 7. The outside perimeter of a structure was determined by the building footprint shape file provided by MVP. A schematic of the dry flood proofing technique is shown in Figure 8.

Table 7
Cost Estimating Parameters for Dry Flood Proofing Commercial Structures

Item:	Cost/unit	Quantity
Spray-on Cement (1/8 inch)	$5.00/feet squared	Perimeter x Flood Depth
Asphalt (2 Coats below grade)	$2.00/feet squared	Perimeter x Flood Depth
Periphery Drainage	$35.00/feet	Perimeter
Flood Shields (metal)	$110 Each	2 (used as estimate)

Figure 8
Schematic of Dry Flood Proofing

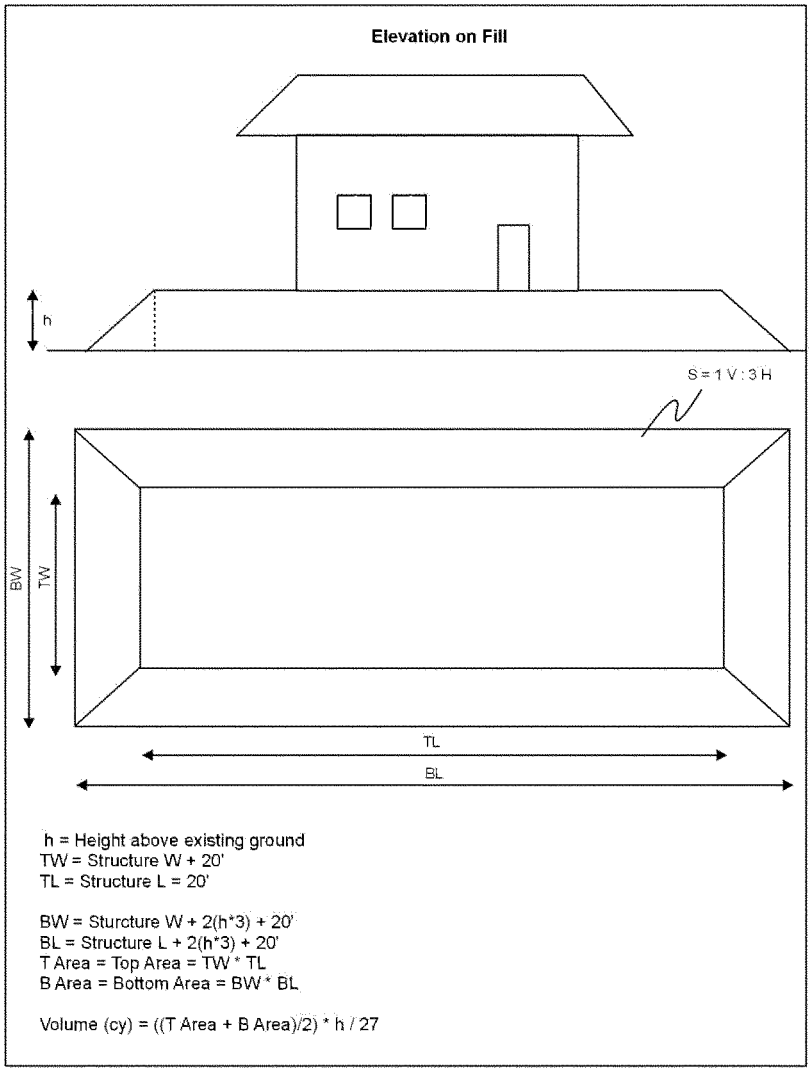


2.7 Elevation on Fill

Elevating a structure on fill material requires raising the entire structure up from its original footings to an elevation above the designated design flood elevation. This technique generally works well in rural areas, where the size of the site is not constricted. For commercial structures, elevating the entire structure was not considered as a primary technique of nonstructural flood risk reduction. This was due to the general large area required for fill placement when compared to residential construction and construction materials of most commercial buildings. Costs for elevating a structure on fill was set at $7.96 per cubic yard for the fill material only.

The height of the fill is placed at one foot above the 1% annual chance flood elevation and the side slopes are set at 3 feet horizontal to 1 foot vertical. The design elevation of the fill will be extended 10 feet from the outside of the structure. A schematic of this technique is shown in Figure 9. Equations for determining the total amount of fill material is also shown in this figure. Additional costs would be associated with temporarily elevating and moving the structure away from the existing site and then placing it onto the berm material.

Figure 9
Schematic of Elevation on Fill



2.8 Grain Bin / Silo Elevation

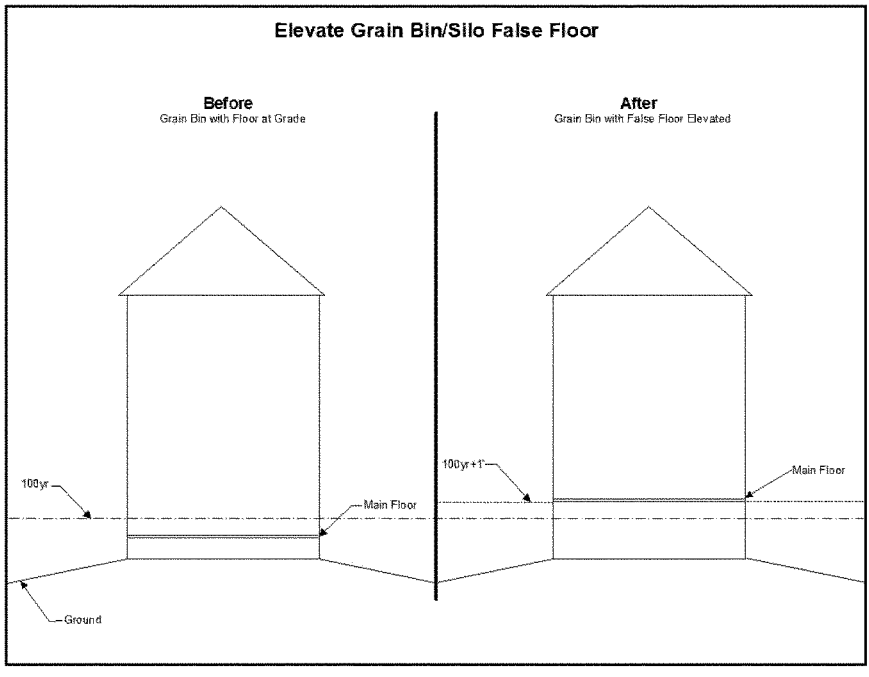
This assessment was conducted in a predominantly rural area, where agriculture was the leading industry. Within this area, numerous grain bins and silos exist. Nonstructural mitigation measures were determined for 439 bins or silos. While each of these agricultural structures is typically placed at grade, the lower elevation where the grain resides is located several feet above the adjacent grade. Even with the floor being elevated, the depth of flooding can cause significant damage to the content, which in turn could adversely impact the structure. Table 8 provides the parameters used in costing out this technique.

Table 8
Cost Estimating Parameters for Elevating Grain Bins/Silos

Bin/Silo Diameter Range (ft)	Cost to Elevate Barns
10 - 16	201x[0.6075 x [ElevHeight] + 29.853]
20 - 28	452x[0.6075x [ElevHeight] + 19.917]
32 - 40	1018x[0.6075 x [ElevHeight] + 21.613]

In order to effectively reduce flood damages, the main floor of the bin/silo is elevated to one foot above the 1% annual chance flood elevation. This technique is illustrated in Figure 10.

Figure 10
Schematic of Elevation of Grain Bins/Silos



2.9 Elevation and Wet Flood Proofing of Barns and Machine Sheds

Numerous barns and machine sheds of various sizes were also identified within the study area. All of these type structures were identified as being associated with the agricultural industry and were assessed according to their size. The parameters used to develop the costs for these structures are shown in Tables 9, 10, and 11.

Table 9
Cost Estimating Parameters for Elevating Barns

Square Foot Range	Cost to Elevate Barns
0 - 1125	750 x [0.61x[ElevHeight] + 14.52
1126 - 1875	1500 x [0.605x[ElevHeight] + 11.87
1876 - 4000	2250 x [0.6075x[ElevHeight] + 10.973
4001 - Greater	Site Specific Assessment

Table 10
Cost Estimating Parameters for Elevating Machine Sheds

Square Foot Range	Cost to Elevate Machine Sheds
0 - 3750	2500*[0.6075 * [EleHt] + 9.3333]
3750 - 6250	5000*[0.6075 * [EleHt] + 7.9967]
6250 - 10000	7500*[0.6075 * [EleHt] + 7.5333]
10000 - Greater	Site Specific Assessment

Table 11
Cost Estimating Parameters for Wet Flood Proofing Barns and Machine Sheds

Item	Cost/unit	Quantity
Removing Flood Damageable Materials	$3,900	1
Flood Vents	$472 each	Based on Area

3.0 Nonstructural Flood Risk Reduction Flow Charts

The assessment of over 3,800 structures for nonstructural mitigation purposes could be very time consuming and expensive, if a process were not developed for expediting the investigation. For this assessment, it was determined that a target design flood event equating to the 1% annual chance flood event (100-year) along the Red River of the North would be utilized. Each structure for which data had been collected in the field was compared to the target depth of flooding, from which a decision as to the most technically adequate, cost effective, and implementable nonstructural technique was determined.

In order to process all of the structures several flow charts were developed. A set of three flow charts are shown in Tables 12, 13, and 14. One flow chart focuses on the nonstructural technique decision process for residential structures, while another flow chart focuses on the nonstructural technique decision process for commercial structures, and the third flow chart focuses specifically on the implementation of earthen berms. Structures such as barns and machine sheds utilized specific techniques for elevation and wet flood proofing.

Table 12
Nonstructural Residential Structure Technique Flow Chart

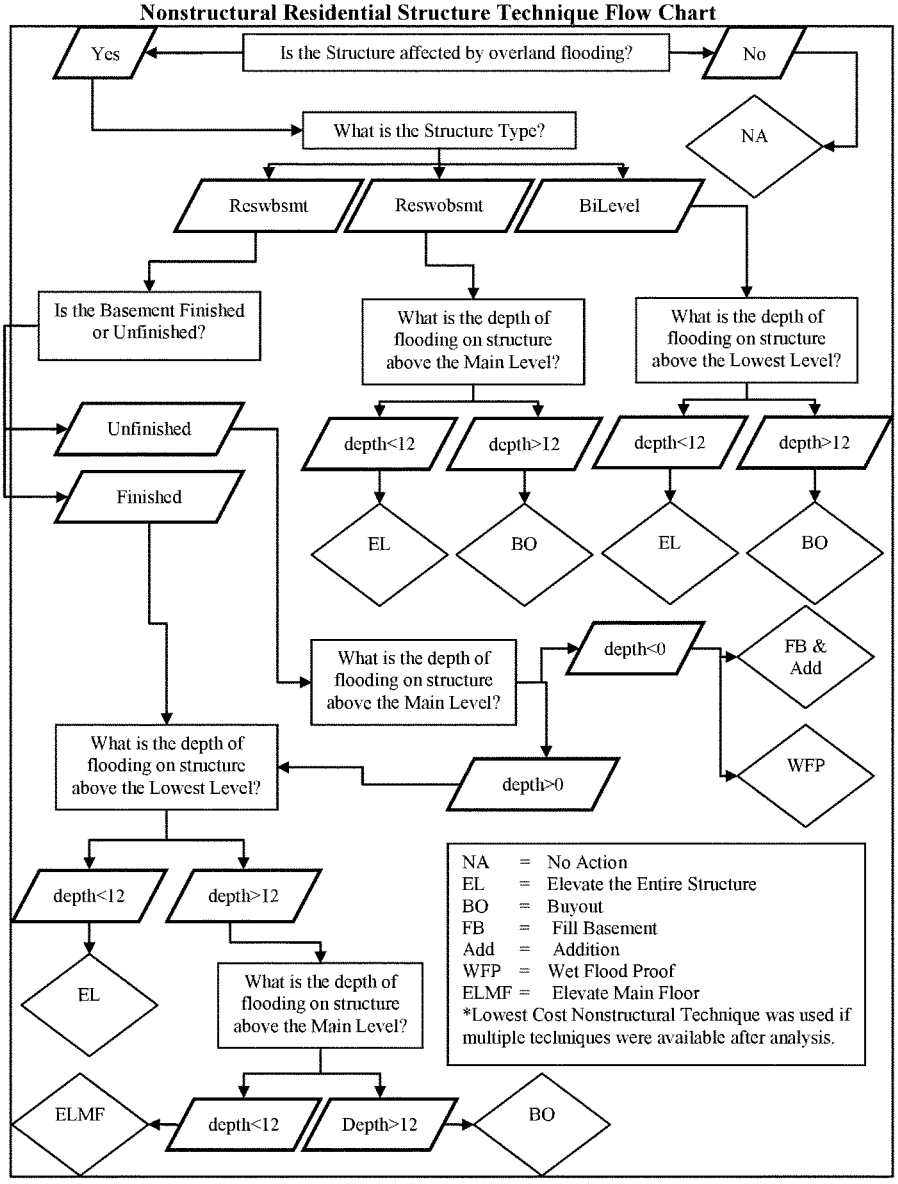


Table 13
Nonstructural Commercial Structure Technique Flow Chart

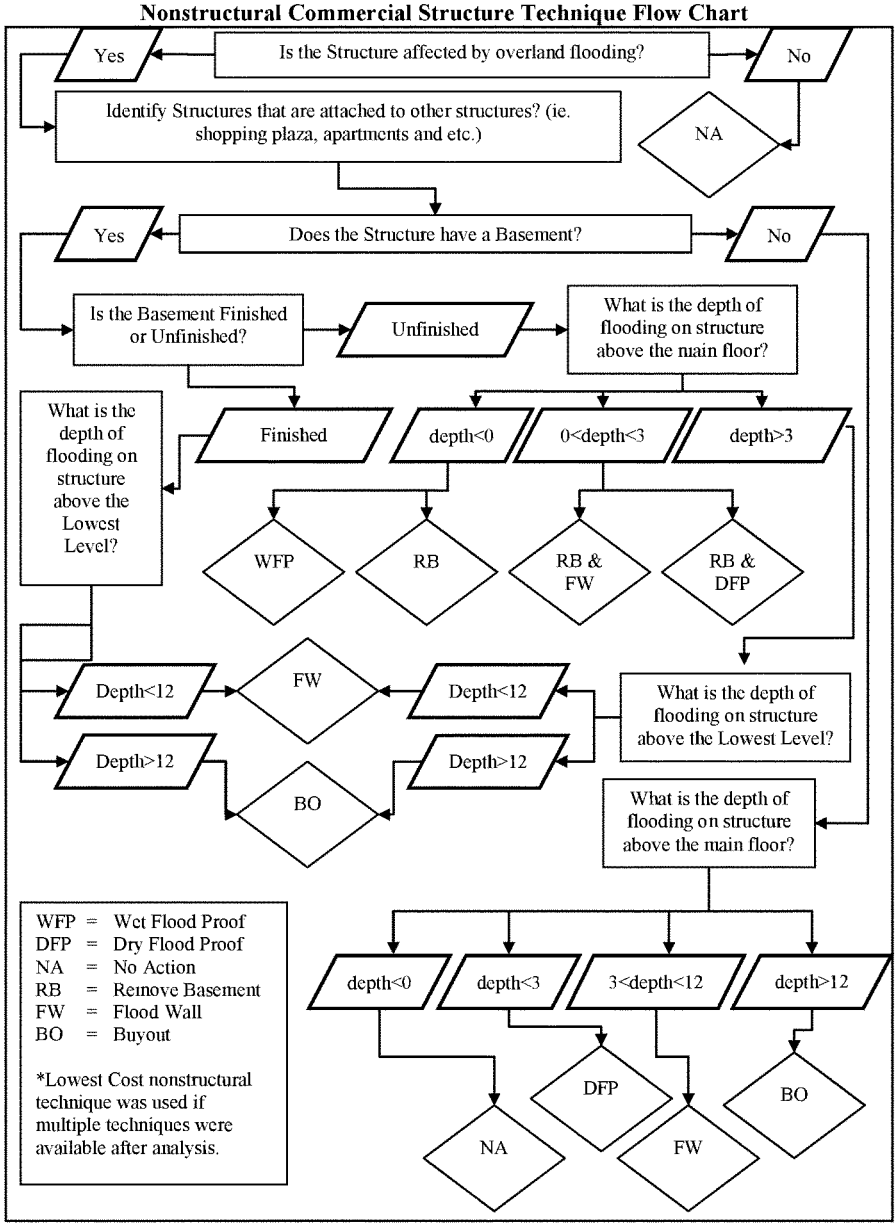
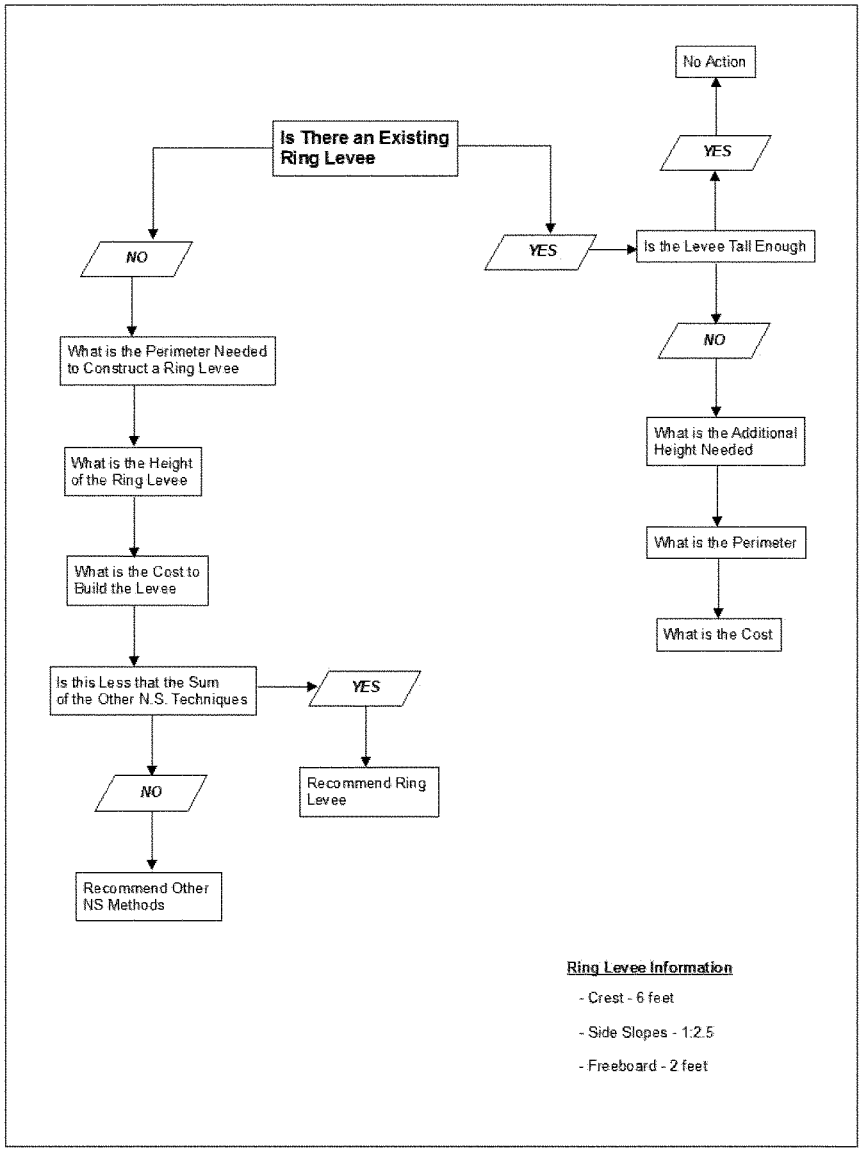


Table 14
Nonstructural Berm Selection Flow Chart



4.0 Nonstructural Plan for North Dakota Structures

For the Fargo-Moorhead Metro Downstream Area, North Dakota Subunit, the 100-year floodplain would inundate approximately 466 structures. These structures include residential and agricultural structures and are summarized in Table 15. The water surface elevations for the 100-year project were determined from the existing conditions, phase 3 hydraulic modeling, completed by MVP. The structures were identified as being in the 100-year floodplain if the difference in the 100-year water surface elevation and the ground elevation was greater than zero. It is important to note here that the structures were not selected based on 100-year floodplain delineations and the structure location within that delineation.

Table 15
Structures Considered for North Dakota Downstream Nonstructural Plan

Economic Subunit	Residential Structures	Commercial Structures	Critical Facilities	Agricultural Structures
ND 100-Year Plan				
Cass County	31	0	0	254
Trail County	15	0	0	164
Grand Forks County	1	0	0	1
Total	47	0	0	419

4.1 North Dakota Plan Development

For the nonstructural flood risk reduction analysis Downstream of the Fargo-Moorhead Metro Area, a number of valuable datasets were obtained. Cass, Trail, and Grand Forks Counties in North Dakota and MVP provided the data for this plan development.

Detailed structure and economic data was provided by MVP. The economic data was in the form of HEC-FDA output files and the files were the initial base data used to begin the analysis. For the economic analysis, MVP completed the assembly of ground elevations and foundation height for each structure Downstream of the Fargo-Moorhead Area. The ground elevations were extracted from Light Detection and Ranging (LiDAR) survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided occupancy type, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations.

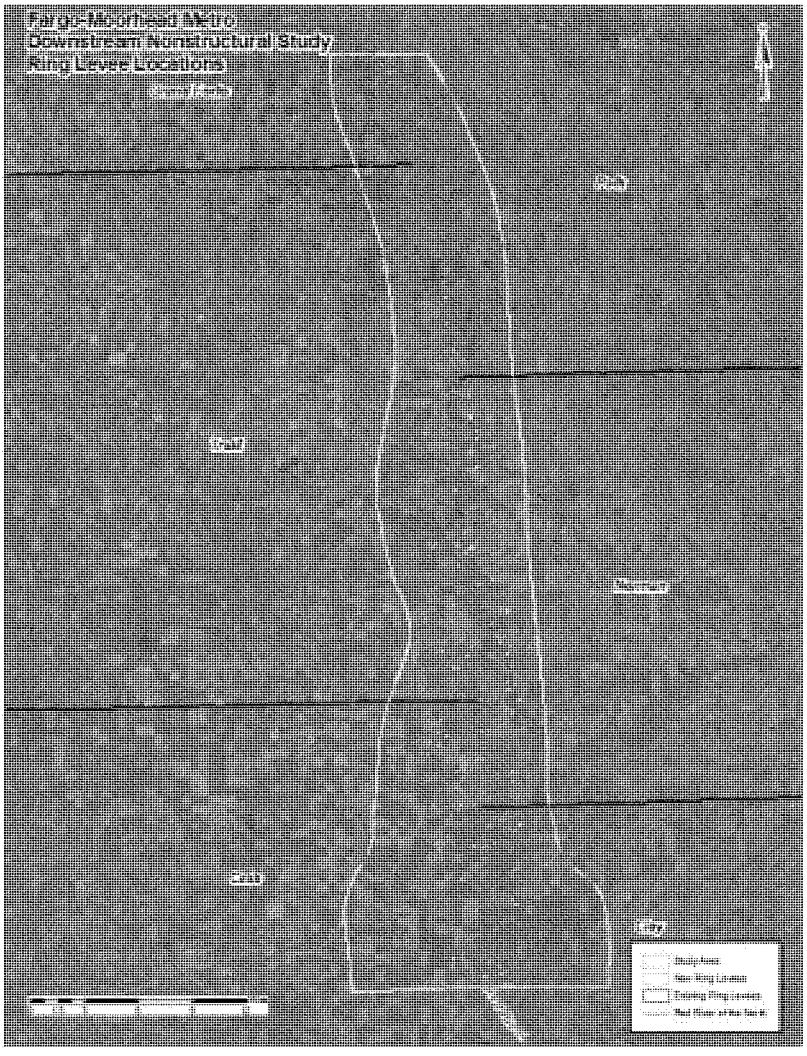
Structure GIS data was provided by MVP and supplemented through the various county GIS departments. The data was invaluable for determining the spatial locations of the structures in the economic analysis. The files provided structure location, plan view area and footprint. The economic data and structure GIS data were joined together through ArcMap and used as the base data.

Hydraulic data was also provided by MVP. The hydraulic model included cross sections for the Red River of the North. The elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. The elevations were checked to the hydraulic model and found to be in good agreement.

The 100-year nonstructural flood risk reduction plan was completed for three economic subunits. The subunits include Cass, Trail, and Grand Forks Counties in North Dakota. In these three economic subunits, the residential structures were divided into six occupancy types; one story residential structures with basements, one story residential structures without basements, two story residential structures with basements, two story residential structures without basements and bi-level homes. The agricultural structures were divided into seven occupancy types; barns, grain bins, hay sheds, livestock sheds, machine sheds, shop sheds, and silos. The occupancy types for commercial and industrial structures were not divided for separate analysis.

The Fargo-Moorhead Metro downstream area is primarily rural. This results in a majority of the structures as being located separately or grouped together on farmsteads. In this situation, earthen berms, constructed as ring levees, may provide a lower cost method of providing protection to multiple structures. Existing ring levees can be raised or new ring levees can be built around the perimeter of the farmstead. A location map illustrating the location of new and existing ring levees within the North Dakota subunit are shown in Figure 11. As previously discussed, the use of ring levees is considered a nonstructural mitigation technique, when the berm or earthen ring levee is not certified according to FEMA regulations. The ring levees in this assessment were implemented based upon a 6-foot top width, a maximum of 2-foot of freeboard above the 100-year water surface elevation, and 2.5 horizontal to 1.0 vertical side slopes.

Figure 11
Ring Levee Locations Downstream from Fargo-Moorhead



Nonstructural flood risk reduction techniques were assigned to each structure investigated according to the criteria discussed in Report Section 2. These structures and techniques are summarized in Tables 16 to Table 18 for Grand Forks, Cass, and Trail Counties.

Table 16
Grand Forks County 100-Year Nonstructural Flood Risk Reduction Summary Table

Grand Forks County Flood Risk Reduction Summary Table			
Nonstructural Technique	**Structures**	**Total Cost**	**Cost / Structure**
Barn			
New Berm	1	$12,960	$12,960
OresWBsmt			
New Berm	1	$9,718	$9,718
100-Yr Plan Cost for Grand Forks County		$22,678	

Table 17
Cass County 100-Year Nonstructural Flood Risk Reduction Summary Table

Cass County Flood Risk Reduction Summary Table			
Nonstructural Technique	**Structures**	**Total Cost**	**Cost / Structure**
Barn			
Berm Raise	1	$13,175	$13,175
New Berm	3	$26,424	$8,808
Grain Bins			
New Berm	65	$339,187	$5,218
Berm Raise	56	$175,004	$3,125
Machine Sheds			
New Berm	85	$849,110	$9,990
Berm Raise	37	$326,092	$8,813
Main Floor Raise	1	$31,805	$31,805
Wet Flood Proof	3	$26,182	$8,727
OresWBsmt			
New Berm	17	$181,895	$10,700
Berm Raise	12	$145,999	$12,167
OresWOBsmt			
New Berm	1	$7,505	$7,505
Silo			
New Berm	2	$15,072	$7,536
Berm Raise	1	$13,175	$13,175
TresWBsmt			
Berm Raise	1	$10,268	$10,268
100-Yr Plan Cost for Cass County		$2,160,894	

Table 18
Trail County 100-Year Nonstructural Flood Risk Reduction Summary Table

Trail County Flood Risk Reduction Summary Table			
Nonstructural Technique	**Structures**	**Total Cost**	**Cost / Structure**
Barn			
New Berm	1	$16,565	$16,565
Main Floor Raise	2	$48,465	$24,232
Wet Flood Proof	1	$7,579	$7,579
Grain Bins			
New Berm	50	$197,174	$3,943
Berm Raise	17	$66,562	$3,915
Raise Main Floor	2	$23,892	$11,946
Machine Sheds			
New Berm	67	$571,014	$8,523
Berm Raise	16	$249,581	$15,599
Main Floor Raise	2	$85,906	$42,953
Wet Flood Proof	1	$6,890	$6,890
OresWBsmt			
New Berm	5	$48,140	$9,628
Berm Raise	2	$79,081	$39,540
OresWOBsmt			
New Berm	1	$25,216	$25,216
Shop Shed			
New Berm	1	$24,914	$24,914
Berm Raise	3	$21,459	$7,153
Silo			
New Berm	1	$6,899	$6,899
SplitWBsmt			
Berm Raise	1	$10,949	$10,949
TresWBsmt			
New Berm	4	$38,536	$9,634
Berm Raise	2	$49,283	$24,642
100-Yr Plan Cost for Trail County		$1,578,280	

4.2 North Dakota Nonstructural Project Benefits

Project benefits were calculated by St. Paul District using the HEC-FDA computer model. A modified with-project condition HEC-FDA input file was created for each economic subunit and the data was run in HEC-FDA to determine damages for the project condition. The difference

between the without-project and with-project damages was then used as the project benefits. Table 19 illustrates these project benefits.

Table 19
North Dakota Downstream Nonstructural Plan Costs and Benefits

Economic Subunit	100-Yr Plan Total Cost	100-Yr Estimated Annual Cost	100-Yr Estimated Annual Benefits
Cass	$2,155,280	$119,189	$96,260
Trail	$1,578,280	$87,217	$56,960
Grand Forks	$22,678	$1,254	$786
Total 100-Yr Plan	$3,756,064	$207,660	$154,006

4.3 North Dakota Nonstructural Plan Summary

The nonstructural assessment for the North Dakota economic subunit which is located downstream from the Fargo-Moorhead Metro study area investigated numerous residential, commercial, and agricultural sector structures. A least-cost approach to assessing each structure impacted by a 100-year flood event was implemented. Where possible, particularly for farmsteads, where small groups of structures were located within the same proximity, earthen berms as ring levees were utilized. Otherwise, the additional nonstructural techniques described in Section 2 of this report were considered.

The North Dakota assessment indicated that there were significant benefits in implementing some nonstructural measures through the three-county economic subunits. When the structures are broken down to a structure by structure bases and structures are group within the ring levees, favorable projects emerged. Within Cass County there were 99 of 285 structures which appeared to result in a favorable benefit to cost ratio for implementing nonstructural measures. Within Trail County there were 47 of 179 structures which appeared to be feasible and in Grand Forks County the number was 1 out of 2 structures investigated. The data is summarized below in Table 20.

Table 20
Summary of Feasible Structures for North Dakota Downstream Nonstructural Plan

County	Feasible Structures	Net Benefit
Cass County	99	$23,554
Trail County	47	$6,512
Grand Forks County	1	$192

5.0 ` Nonstructural Plan for Minnesota Structures

For the Fargo Moorhead Metro Downstream Area, Minnesota side, the 100-year floodplain would inundate approximately 675 structures. These structures include residential and agricultural structures and are summarized by the economic subunit in Table 21. The water surface elevations for the 100-year project were determined from the existing conditions phase 3 hydraulic modeling completed by MVP. The structures were identified as being in the 100-year floodplain if the difference in the 100-year water surface elevation and the ground elevation was greater than zero. It is important to note here that the structures were not selected based on 100-yr floodplain delineations and the structure location.

Table 21
Structures Considered for Minnesota Downstream Nonstructural Plan

Economic Subunit	Residential Structures	Commercial Structures	Critical Facilities	Agricultural Structures
MN 100-Year Plan				
Clay County	69	3	2	144
Norman County	45	1	0	352
Polk County	8	0	0	54
Total	122	4	2	550

For the nonstructural flood risk reduction analysis Downstream of the Fargo-Moorhead Metro Area, a number of valuable datasets were obtained. Clay, Norman, and Polk Counties in Minnesota, and MVP provided the data for this study.

Detailed structure and economic data was provided by St. Paul district. The economic data was in the form of HEC-FDA output files and the files were the initial base data used to begin the analysis. For the economic analysis, the St. Paul District completed the assembly of ground elevations and foundation height for each structure Downstream of the Fargo-Moorhead Area. The ground elevations were extracted from Light Detection and Ranging (LiDAR) survey data and the foundation heights were determined by visually estimating the vertical distance from the ground and the foundation. The files provided occupancy type, property values, structure types, water surface elevations, ground surface elevations, and first floor elevations. Structure GIS data was provided by St. Paul District and supplemented through the various county GIS departments. The data was valuable to determine the spatial locations of the structures in the economic analysis. The files provided structure location, plan view area, and footprint. The economic data and structure GIS data were joined together through ArcMap and used as the base data.

The hydraulic model included cross sections for the Red River of the North. The elevations from the hydraulic model were used to determine the water surface elevation at each structure. The water surface elevations had already been assigned to the structures in the structure data provided from the economic analysis. The elevations were checked to the hydraulic model and found to be in good agreement.

5.1 Minnesota Nonstructural Plan Development

The 100-year nonstructural flood risk reduction plan was completed for three economic subunits. The subunits include Clay, Norman, and Polk Counties in Minnesota. In these three economic subunits, the residential structures were divided into six occupancy types; one story residential structures with basements, one story residential structures without basements, two story residential structures with basements, two story residential structures without basements and bi-level homes. The agricultural structures were divided into seven occupancy types; barns, grain bins, hay sheds, livestock sheds, machine sheds, shop sheds, and silos. The occupancy types for commercial and industrial structures were not divided for separate analysis. Nonstructural flood risk reduction techniques were assigned to the structure based on the criteria discussed in Report Section 2. These structures and techniques are summarized in Tables 22 to Table 24.

Table 22

Clay County 100-Year Nonstructural Flood Risk Reduction Summary Table

Clay County Flood Risk Reduction Summary Table			
Nonstructural Technique	**Structures**	**Total Cost**	**Cost / Structure**
Barn			
New Berm	1	$10,197	$10,197
Bilevel			
Elevate Entire Structure	1	$124,114	$124,114
Grain Bins			
New Berm	34	$55,502	$1,632
Berm Raise	17	$56,693	$3,335
Machine Sheds			
New Berm	41	$279,161	$6,809
Berm Raise	26	$238,633	$9,178
Main Floor Raise	2	$98,053	$49,027
Wet Flood Proof	21	$270,400	$12,876
OresWBsmt			
New Berm	12	$105,165	$8,764
Berm Raise	4	$20,963	$5,241
Main Floor Raise	13	$1,566,495	$120,500
OresWOBsmt			
Main Floor Raise	26	$1,789,258	$68,818
Silo			
Berm Raise	2	$6,577	$3,288
TresWBsmt			
New Berm	3	$24,635	$8,212
Berm Raise	2	$15,223	$7,612
Elevate Entire Sturcture	5	$653,297	$130,659
Fill Bsmt & Addition	1	$48,286	$48,286
Fill Bsmt & Pay	1	$42,678	$42,678
TresWOBsmt			
Main Floor Raise	1	$75,875	$75,875
100-Yr Plan Cost for Clay County		$5,405,328	

Table 23

Norman County 100-Year Nonstructural Flood Risk Reduction Summary Table

Norman County Flood Risk Reduction Summary Table			
Nonstructural Technique	**Structures**	**Total Cost**	**Cost / Structure**
Barn			
New Berm	4	$57,507	$14,377
Main Floor Raise	1	$33,277	$33,277
Wet Flood Proof	1	$10,400	$10,400
Grain Bins			
New Berm	114	$299,875	$2,630
Berm Raise	71	$213,469	$3,007
Hay Shed			
Buyout	1	$3,225	$3,225
Livestock Shed			
New Berm	2	$51,227	$25,613
Machine Sheds			
New Berm	115	$1,263,118	$10,984
Berm Raise	28	$348,717	$12,454
Buyout	1	$3,225	$3,225
Main Floor Raise	2	$60,071	$30,036
Wet Flood Proof	9	$85,800	$9,533
OresWBsmt			
New Berm	20	$261,336	$13,067
Berm Raise	6	$99,944	$16,657
OresWOBsmt			
New Berm	3	$66,009	$22,003
Shop Shed			
New Berm	1	$867	$867
Berm Raise	2	$12,169	$6,085
SplitWOBsmt			
New Berm	1	$2,836	$2,836
TresWBsmt			
New Berm	11	$184,569	$16,779
Berm Raise	4	$49,565	$12,391
100-Yr Plan Cost for Norman County		$3,107,206	

Table 24

Polk County 100-Year Nonstructural Flood Risk Reduction Summary Table

Polk County Flood Risk Reduction Summary Table			
Nonstructural Technique	**Structures**	**Total Cost**	**Cost / Structure**
Barn			
New Berm	3	$63,000	$21,000
Main Floor Raise	1	$13,539	$13,539
Grain Bins			
New Berm	20	$110,025	$5,501
Machine Sheds			
New Berm	30	$452,800	$15,093
OresWBsmt			
New Berm	8	$119,269	$14,909
100-Yr Plan Cost for Polk County		$758,632	

5.2 Minnesota Nonstructural Project Benefits

Project benefits were calculated by MVP using the HEC-FDA computer model. A modified with-project condition HEC-FDA input file was created for each economic subunit and the data was run in HEC-FDA to determine damages of the project condition. The difference between the pre-project and with-project damages was then used as the project benefits. Table 25 displays these project benefits.

Table 25
Minnesota Counties Nonstructural Plan Summary

Economic Subunit	100-Yr Plan Total Cost	100-Yr Estimated Annual Cost	100-Yr Estimated Annual Benefits
Clay	$5,503,243	$304,335	$69,039
Norman	$3,029,197	$167,518	$135,353
Polk	$585,556	$32,382	$16,302
Total 100-Yr Plan	$9,117,996	$504,235	$220,694

5.3 Minnesota Nonstructural Plan Summary

The nonstructural assessment for the Minnesota economic subunit which is located downstream from the Fargo-Moorhead Metro study area investigated numerous residential, commercial, and agricultural sector structures. A least-cost approach to assessing each structure impacted by a 100-year flood event was implemented. Where possible, particularly for farmsteads, where small groups of structures were located within the same proximity, earthen berms as ring levees were utilized. Otherwise, the additional nonstructural techniques described in Section 2 of this report were considered.
The Minnesota assessment indicated that there were significant benefits in implementing some nonstructural measures through the three-county economic subunit. When the structures are broken down to a structure by structure bases and structures are group within the earthen berms favorable projects emerged. Within Clay County there were 30 of 185 structures which appeared to result in a favorable benefit to cost ratio for implementing nonstructural measures. Within Norman County there were 151 of 399 structures which appeared to be feasible and in Polk County the number was 3 out of 64 structures investigated. The data is summarized below in Table 26.

Table 26
Summary of Feasible Structures for Minnesota Downstream Nonstructural Plan

County	Feasible Structures	Net Benefit
Clay County	30	$17,629
Norman County	151	$45,303
Polk County	3	$1,808

6.0 Summary of Nonstructural Assessment

The approach to this investigation was to determine the potential for implementing nonstructural measures downstream from the Fargo-Moorhead Metro area, outside of the influence of the proposed diversion channel project. The study area was widespread taking in parts of 6 counties, 3 in Minnesota and 3 in North Dakota. Over 3,800 structures were investigated, first, for being impacted by a flood event equal to or greater than a 100-year event, and secondly, for a least-cost approach to implementing nonstructural measures.

While the study area consisted of many residential and commercial structure types, there were also numerous barns, machine sheds, grain bins, and silos. These structures are more common to rural areas, where agriculture is the leading industry. For these structure types, nonstructural techniques of elevating the structure, elevating a false interior floor, wet flood proofing, or dry flood proofing was considered.

In many instances where farmsteads were identified, the structure types consisted of residential, barn, sheds, bins, and silos. Where practical, groups of structures were protected by ringing the perimeter of such groups of structures with earthen berms. Since the berms are meant to be designed using sound engineering practices, they could meet or exceed FEMA levee accreditation standards. However, constructing certified levees is not the primary goal or objective of this nonstructural assessment. Rather, this assessment is concerned with recommending measures which use sound engineering design standards to protect to a sufficient

height during a specified flood event. With that in mind, the application of nonstructural berms has been identified as a nonstructural mitigation measure.

Of the 1,117 structures assessed in detail, 395 or 35% of the structures were found to be qualified for nonstructural mitigation. Many of the 395 examples consist of ring levees where more than one structure is being protected from flooding. Numerous worksheets were developed for this investigation and contain the individual structure and groupings of structures. Since the floodplain is characteristically flat, there were no geographical subareas within which to subdivide into smaller economic units. This is why political boundaries, divided along county lines, were used to subdivide the total study area.

7.0 Nonstructural Plan Recommendations

This supplemental nonstructural assessment in support of a complex flood risk reduction study being conducted by the US Army Corps of Engineers, St. Paul District, the states of North Dakota and Minnesota, and the metropolitan area of Fargo and Moorhead, resulted in the identification of feasible nonstructural measures. While the task was to investigate the impacts of flooding from a 100-year flood event downstream from the protective influence of a proposed diversion channel project, the vastness of the study area, all within portions of six counties, made the process difficult, and reliance upon automation of the investigation became mandatory. The automated assessment process, which is illustrated by the flowcharts shown in Section 3 of this report, was used to expedite the investigation and to determine economic feasibility.

It was found that nonstructural mitigation in the form of elevation, dry flood proofing, wet flood proofing, and through berms, could provide economically feasible flood risk reduction to more than a 35% of the structures investigated and should be considered for implementation in support of the ongoing efforts to reduce flood damages along the Red River of the North.

FOR CONTINUATION OF HOUSE DOCUMENT 112-130

FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT: FARGO-MOORHEAD METROPOLITAN AREA FLOOD RISK MANAGEMENT, JULY 2011

SEE PART 6