Appendix K
Civil Engineering

Fargo-Moorhead Metropolitan Area Flood Risk Management

Final Feasibility Report and Environmental Impact Statement

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US Army Corps of Engineers ®

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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.