



**US Army Corps  
of Engineers®**  
St. Paul District

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## **Appendix E: Civil-Site**

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Fargo Moorhead Metropolitan Area  
Flood Risk Management Project

### **Outlet Structure and Reach 1**

Engineering and Design Phase

P2# 370365

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# Appendix E: Civil-Site

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# Appendix E: Civil-Site

## E.1 GENERAL

Civil design for this project will include demolition, levee and excavated material berm (EMB) layout, access road layout, utility relocations, civil design at outlet structure, general grading, and storm water pollution prevention. This section summarizes the proposed layout, method of analyses, and support for preparation of the plans, specifications, and cost estimate.

## E.2 DEMOLITION

The farmstead located on the Palmer Ihnken property located at approximately Station 54+00 to Station 64+00 will require demolition to construct the diversion. The Local Sponsor will be responsible for structure demolition prior to construction of the diversion. This demolition will include the removal of structures, foundations, septic systems, and capping of wells. All holes will be temporarily filled to not create a safety hazard.

Demolition by the diversion contractor will include clearing and grubbing mature trees. Existing roads located within the proposed diversion, levees, and EMB areas will also require demolition. Underground utilities abandoned in place will need to be removed by the diversion contractor. See Section F.7 for additional discussion on demolition of utilities. The Phase I Environmental Investigation (Phase I ESA) will address the removal and disposal of materials. The non-federal local sponsor is responsible for providing all lands.

## E.3 DIVERSION CHANNEL LAYOUT

The control for the centerline of the diversion channel was set to flow in alignment with the existing centerline of the Red River of the North. The control alignment for the Reach I/Outlet project is 22,700 feet which begins at Station 0+00 and ends at Station 227+00. Station 0+00 ties into the existing centerline of the Red River. The diversion begins at Station 25+50.50. The outlet structure begins 550 feet further upstream at Station 31+00.50 and ends at Station 36+75.50. Reach I diversion continues upstream from Station 36+75.50 and ends at Station 227+00.

Within Reach 1 is the CR 31/CR 4 bridge reach (Station 81+86 to Station 91+86) which will be designed by the local sponsor. The proposed 580 foot bridge located at approximately Station 86+50 will be designed to allow traffic from the realigned CR 31 and CR 4 to cross the new channel. In addition to the bridge and associated road realignments, this Bridge Reach also includes design of 1000' of diversion channel and EMB's to be designed by the local sponsor.

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### **E.3.1 Low Flow Channel and Sinuosity**

The low flow channel within the main diversion channel for Reach 1 has a 52' wide bottom with a 2% cross slope and 1V:4H side slopes. The low flow channel side slopes extend and tie into the main diversion channel bottom which has a cross slope of 2%. The top of the low flow channel is approximately 100' wide. The low flow channel begins at Station 36+75.50 and continues with a straight portion for 500' upstream. At Station 41+75.50, the low flow channel will begin to meander upstream and continue to meander until the CR 31 Bridge reach. There will be a straight portion of low flow channel 100' upstream and downstream of the CR 31 bridge crossing. The low flow channel meanders within a 200' wide meander belt width. Based on the width of the meander belt and this constraint, the sinuosity within the low flow channel is somewhat restricted. The average sinuosity for Reach 1 up to the end at Station 225+00 is 1.09.

### **E.4 LEVEES/EXCAVATED MATERIAL BERMS (EMB)**

The Excavated Material Berms (EMBs) on the sides of the diversion begin at approximately Station 48+00 on the left bank and at approximately Station 60+00 on the right bank when looking downstream of the diversion. The EMB can be constructed to a maximum initial height as determined by geotechnical analysis and will include a 10' high bench from the outlet up to the CR31/CR4 Bridge Reach at Station 81+86. Upstream of the Bridge Reach at Station 91+86, the EMB can be constructed to a maximum initial height without a bench. The initial max height is the top edge of the EMB closest to the diversion channel. The initial maximum height next to the channel ranges from 10' to 14'. The EMB will rise at a 2% slope from that point to a crest point, then down at a 2% slope to the backside edge of the EMB. The EMBs will continue along the length of the diversion up to the end of the Reach I project to Station 225+00. The alignment and configuration of the channel and EMBs are based on Hydraulic and Geotechnical considerations.

With the continuation of design, coordination with, and support of the local sponsor, final layout of the EMB's will take into account the desired end use as determined by the local sponsor. The final layout will involve balancing excavation/fill while generally placing 50% of the volume on each side of the channel. Other factors affecting EMB layout include drainage structures, bridge relocations, and real estate acquisition.

#### **E.4.1 Shrink/Swell/Overexcavation/Rebound**

Guidance Memo (GM)-002 Excavated Material Berm Design with Swell Factor Variations, provides guidance for design considerations of the EMBs for shrink and swell variations of the excavated material. The EMB has been designed to accommodate a 15% swell factor in the excavation material. The right bank EMB must be constructed to the neatlines shown in the drawings, and within allowable tolerances. The left bank EMB may be constructed between the neatline shown and the minimum berm limits shown on the plans.

#### **E.4.2 Excavated Material Piles**

Excavated material piles are being designed for the placement of excess material if the swell factor exceeds 15%. Six (6) excavated material piles have been designed and are directly adjacent to the local drainage ditch on both the right bank and left bank. The piles were designed with a 1V:6H side slope and a maximum height not to exceed the maximum height of the EMB directly adjacent to the pile. The top slope of the pile will slope at a minimum of 1% to provide positive drainage.

#### **E.4.3 Viewshed**

GM-001 Construction Heights of EMBs, provides guidance for design considerations related to the construction height of EMBs. Cultural considerations included a viewshed analysis to determine visual impacts to the project. The analysis determined EMBs over 20 feet in maximum height will be visually intrusive, therefore the maximum construction height of the EMB is 21 ft. and accounts for an expected settlement of 12" for a final height of 20 ft.

#### **E.4.4 Recreation/Undulations**

The minimum EMB width recommended by the Local Sponsor to accommodate the undulations for the right bank EMB is 250'. Below this minimum, it would be difficult to balance earthwork with the undulation grading and could impact the user experience with the future recreational features. The right bank EMB considered this minimum width and where practical, this 250' guidance was followed.

### **E.5 LOCAL DRAINAGE STRUCTURES**

Local drainage is being designed by the local sponsor for incorporation into the Reach 1 construction documents. The local drainage design includes drainage ditches that run parallel along the right and left bank EMB's. The local ditches convey local runoff from adjacent properties, as well as the EMB's, to larger County Drains or rivers. Cass County Drain 29 flows east towards the Red River and would intercept the project footprint at approximately Station 91+00. Cass County Drain 30 flows east to the Sheyenne River and will intercept the diversion at approximately Station 222+20.

Drain 29 will be rerouted to parallel the diversion channel on the left side of the left bank EMB and will connect to the outlet to discharge directly into the Red River. The existing Drain 29 on the outside of the right bank EMB will continue to the Red River. Local drainage ditches being designed by the local sponsor will parallel the outside of the right bank EMB and discharge to the existing Drain 29.

The width of the EMB at Drain 30 will be narrowed to reduce the length of the drainage structure required. The local drainage outside of the diversion work limits will be designed by the local sponsor to continue to flow towards Drains 29 and 30 and to provide positive drainage away from the EMBs. The local drainage on both sides of the diversion will be designed by the local sponsor and will include a drainage ditch adjacent to and parallel to the diversion and EMBs and be located within the diversion channel work limits. A minimum 20' wide buffer will be provided between the toe of the EMB and the local drainage ditch.



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Additional information on the Non-Federal Sponsor Local Drainage Plan can be found in Appendix C, Attachment 02.

Culverts for the Local Drainage Ditch will be either corrugated steel pipe (CSP) or arch corrugated steel pipe (CSPA). CSPA provides greater capacity at shallow depths. Some of the local drainage channels will have relatively shallow normal water depths as indicated in the Local Drainage Report and therefore, CSPA is recommended.

Draft technical memorandum prepared by Houston Moore dated 12/18/2012, AWD-0005, Local Drainage Plan, provided sizing of the culverts in Table 2 for the local drainage ditches.

### **E.5.1 Field Drainage and Drainage Ditch Inlets**

Reach 1 includes drainage ditches along the outside of the EMB's that convey runoff from the EMB's and adjacent properties to Drain 29 and Drain 30. These ditches were designed by the local sponsor design team and incorporated into the Reach 1 plans by the PDT. These ditches intersect large drains (County Drains), small drains (Road Ditches), and open swales on adjacent agricultural fields. These intersection points, referred to as drainage ditch inlets, were designed to provide adequate drainage and minimize erosion.

The Local Sponsor's drainage ditch design includes side berms to contain the 10 year event and not allow it to back into the adjacent field. Side berms are not necessary in Reach 1 to contain the 10 year event. However, side berms can be added on a case by case basis, if it provides a better drainage solution than open swales/ditches.

Design of inlets is in accordance with GM-003, Local Drainage Features Outside of the Diversion Channel. Based on research by the local sponsor design team, there are no farm fields within Reach 1 that have field tile drainage. Therefore, all the side ditch inlets are "open swale".

The design team analyzed base topography and aerial photography to identify each location where the drainage ditch intersected an adjacent drainage feature. A vast majority of these intersections are with farm field swales. Each intersection point is identified in the drawings, along with the type of inlet. Based on GM-003, most were open swale with riprap. These are required when an open swale enters the drainage ditch, and the height difference between the swale and the drainage ditch invert is greater than 2' (See Detail on CS504). Each of these inlets consists of riprap (9' wide, 1.5' thick R20 on geotextile) and site-specific grading within a 50' offset from the drainage ditch.

## **E.6 ACCESS ROADS AND PARKING AREAS**

The alignment of the channel will result in modifications to the local transportation system, including realignments of 25<sup>th</sup> Street SE (CR4) and 173<sup>rd</sup> Avenue SE (CR31). The proposed roadway re-alignment and bridges will be designed and constructed by others. A new 580 foot long bridge at approximately diversion channel station 86+50 is proposed to allow traffic from both CR31 and CR4 to cross the new channel. The CR31/CR4 Bridge Reach is between diversion channel Station 81+86 and Station 91+86. County Roads 173<sup>rd</sup> Avenue SE (CR31) and 25<sup>th</sup> Street SE (CR4) as well as local roads 24<sup>th</sup> Street SE and

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172<sup>nd</sup> Avenue SE are currently being proposed for realignment. 171<sup>st</sup> Avenue SE is proposed to be cutoff where the diversion intersects.

A permanent access road for operation and maintenance of the outlet is proposed by utilizing the existing 173<sup>rd</sup> Avenue SE (CR 31) proposed for cutoff after the alignment is rerouted by the local sponsor. The existing road in this location has a gravel surface and can also be used for access during construction. The alignment of the permanent O&M access road on the north side of the diversion and adjacent to the left bank will be dependent on the realignment relocation of Drain 29 to the outlet and the realignment of CR31/4 to avoid drainage crossings. The existing 173<sup>rd</sup> Avenue SE (CR31) road can be used for access to the right bank near the outlet. The permanent access will include a cul-de-sac for turnaround as well as a parking area.

Permanent access roads for operation and maintenance of the EMBs are proposed at the CR31/CR4 bridge crossing over the diversion. Access roads will be designed off the realigned road to the top of the EMB on both the right bank and left bank and will be incorporated into the project documents once design information is received from the Local Sponsor.

Temporary access off of existing 25<sup>th</sup> Street SE (CR4) that is proposed for cutoff where the diversion intersects can be used for construction access. CR 4 will be realigned by the Local Sponsor. The roadway proposed for removal can be used during Reach 1 construction prior to removal and/or abandonment. The existing road surface is gravel. 25<sup>th</sup> Street SE continues west through Argusville and has access to County Road 81 and Interstate 29.

171<sup>st</sup> Avenue SE currently has a bridge over existing Drain 30 that will remain for access to the property north east of the bridge. The road will cutoff where the diversion intersects the existing road. The Local Sponsor will be responsible for abandoning 171<sup>st</sup> Avenue SE. A permanent access road for operation and maintenance of the Drain 30 structure and EMB and access for use during construction is proposed where 171<sup>st</sup> Avenue SE dead ends on both sides of the diversion channel. The existing road in this location has a gravel road service. 171<sup>st</sup> Avenue SE off the left side of the diversion is accessible via 25<sup>th</sup> Street SE (CR4) and off the right side of the diversion via 27<sup>th</sup> Street SE to County Road 81.

The design of permanent access roads for operation and maintenance of the diversion and EMBs will include culverts where the roads cross over local drainage ditches.

### **E.6.1 Geometric Design Criteria – Access Road**

The geometric design criteria and guidance used for the design of the access and maintenance roads is summarized below:

- 20' wide with 8" thick ND Class 13 gravel surface
- Grade of ramp should be no steeper than 1:10.
- Design Speed of vertical curves 15 mph minimum
- Design Length of vertical curves 100 ft minimum
- Side slopes should not be less that 1:3 to allow grass cutting equipment to operate.
- Turnouts should be provided at intervals of approximately 2,500 feet, provided there are no ramps within that reach.

- Turnarounds shall be provided at dead ends. Cul-de-sacs are designed with 50' radius for turnaround and emergency vehicles near the outlet.

EM 1110-2-1913 defines some design considerations for permanent project access ramps as well as maintenance roads.

6" gravel over geotextile fabric is a typical section for Cass County roads in this area. The maintenance and access roads are designed with 8" gravel over geotextile fabric due to the uncertainty in the compaction that will be achieved in the excavated material berms (EMBs).

## E.7 UTILITY INFORMATION

Utility information, including surveyed locations, was obtained from Moore Engineering under contract with the local sponsor.

### E.7.1 Existing Utilities

No existing utilities were identified within the Outlet Structure limits. Utility lines identified within the limits of Reach 1 include overhead electrical power lines; underground telephone lines and water lines. A total of fourteen utility lines were identified through review of utility mapping and field locates. Field locates were conducted in December of 2011 and April of 2012.

The following table lists identified utilities within the construction limits of Reach 1:

**Table E-1: Utilities Reach 1**

UTILITY	CROSSING STATION	DESCRIPTION
<b>ELECTRIC</b>		
Cass County Electric	Underground line crosses at Station 39+99.	Line runs east-west along the south side of an un-named town road, intersects with power line running parallel (north – south) with 173 <sup>rd</sup> Ave. SE Single Phase Underground.
Cass County Electric	Underground line crosses at Station 51+84	Line runs North-South along the east side of 173 <sup>rd</sup> Ave. SE. Single Phase Underground.
Minnkota Power	Overhead line crosses Reach 1 center line at Station 54+12	Line runs North-South along the West side of 173 <sup>rd</sup> Ave. SE width of project. 69KV transmission.

UTILITY	CROSSING STATION	DESCRIPTION
Cass County Electric	Overhead line crosses from the east to a point approximately 900 feet NE from center line at Station 58+00	Service line to farm stead.
Cass County Electric	Overhead line crosses at Station 202+70	Line runs North-South along the East side of 171 <sup>st</sup> AVE SE
Minnkota Power	Overhead line crosses at Station 210+64	69 KV Transmission line, line runs North-South.
<b>COMMUNICATION</b>		
Century Link	Underground copper line crosses at Station 39+91	Line runs east-west along the south side of an un-named town road; crosses 173 <sup>rd</sup> Ave. SE and runs north along the west side of 173 <sup>rd</sup> Ave. SE. One 6-pair copper.
Century Link	Underground copper line crosses at Station 52+34	Line runs North-South along the east side of 173 <sup>rd</sup> Ave. SE width of project. One 6-pair copper.
Century Link	Two underground copper lines cross at Station 156+09/156+20	Two 25 pair copper lines run east-west along the south side of 25 <sup>th</sup> St. SE width of project.
Century Link	Underground copper line crosses at Station 202+80	Two single pair copper lines runs north-south along 171 <sup>st</sup> Ave SE.
<b>WATER</b>		
Cass Rural Water Users, Inc.	Water Service line serves existing farmstead, ends at Sta. 58+00, 200' LT, extends to 173 <sup>rd</sup> Ave. SE.	1 ½ "Service line to farmstead. Line runs parallel to 173 <sup>rd</sup> Ave. SE along the west edge of R/W.
Cass Rural Water Users, Inc.	Station 84+00	Water line runs east- west along the north R/W of 24 <sup>th</sup> St. SE

UTILITY	CROSSING STATION	DESCRIPTION
Cass Rural Water Users, Inc.	Station 153+81	1 ½" water main
Cass Rural Water Users, Inc.	Station 204+16	2" water line runs north-south along west edge of 171 <sup>st</sup> Ave. SE

## E.7.2 Utility Relocations

Utility relocations will comply with the MFR-010 Utility Relocation Requirements, and local/state requirements. All relocations will be performed prior to construction. Utility relocation plans will be provided to the contractor as a plan reference document.

### E.7.2.1 Overhead Electric

Overhead electrical lines will be relocated by the utility owner prior to project construction. Demolition of existing lines and poles will be the responsibility of the utility owner.

### E.7.2.2 Buried Communication Lines

Buried Communication lines will be relocated by the utility owner prior to project construction. Existing lines will be abandoned in place by the Utility Company and removed by the Reach 1 Contractor during construction of the diversion channel. The removals will be included in the Reach 1 plans.

### E.7.2.3 Water Mains

Existing water mains will be relocated by the utility owner prior to project construction. The Reach 1 contractor's demolition activities may include demolition of existing water mains/lines abandoned in place.

## E.8 VEGETATION MANAGEMENT ZONE (VMZ) / VEGETATION FREE ZONE (VFZ)

The Vegetation Free Zone (VFZ) and Vegetation Management Zone (VMZ) will comply with the requirements of the Memorandum for Record MFR-001 (MVP MFR-Fargo-Moorhead Metro Flood Risk Management (FMMFRM) Project-Levees and Excavated Material Berms along the Diversion Channel). The requirements for VFZ are outlined in the USACE Technical Letter ETL 1110-2-571 which the MFR-001 has been developed in accordance with. The VFZ will be a minimum of 15' from the toe of stand-alone levees and partially embedded levees. The VMZ will extend 15' from the landside crown of the levees embedded within EMB's. The VFZ/VMZ lines will not be shown in the Reach 1 contract documents, but will be defined in the O&M documents provided to the local sponsor at project completion.

Reach 1 levees are embedded; therefore the embedded levee will have a VMZ and not a VFZ.

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## **E.9 REAL ESTATE/WORK LIMITS/CONSTRUCTION**

### **E.9.1 Easements**

Fee title real estate is set at 50' from the toe of the outermost project feature which includes excavated material piles, access and maintenance roads, and the local drainage ditch. Temporary easements are being set at 200' from the 50' fee title real estate line. Permanent easements are shown for the CR31/4 Bridge over the Reach 1 diversion. Temporary easements will be used for a variety of construction purposes, including temporary storage of stripped topsoil. The access and maintenance roads are included in the fee title real estate. Temporary easements are shown for the contractor staging areas. Fee title, permanent easement, and temporary easements are shown on the real estate plans. The construction plans identify only the outermost work limit that typically represents the temporary easement.

### **E.9.2 Construction Staging Areas**

Two (2) Staging Areas are proposed for Reach 1 construction activities. These areas will be a minimum of 10 acres. One staging area is located north of 24<sup>th</sup> Street SE, east of 172<sup>nd</sup> Ave SE, and adjacent to the left bank. The second staging area is located south of 25<sup>th</sup> Street SE (CR4), east of 171<sup>st</sup> Ave SE, and adjacent to the left bank. Staging on the right side of the diversion during construction is not being recommended due to potential flood plain issues. It is also anticipated that deliveries will be from the west via Interstate 29 and 25<sup>th</sup> Street SE (CR4); therefore staging on the left bank is considered the most practical location.

### **E.9.3 Stormwater During Construction**

A temporary plug at the outlet to the Red River is proposed for Reach 1 during construction activities to minimize sediment discharge into the Red River. Existing material will be left in place directly upstream of the Red River outlet connection to create a temporary plug while Reach 1 is being constructed. Excavation of the channel would begin upstream of this plug. The plug would not be removed until Reach 1 is stabilized upstream and meets final stabilization requirements for the applicable NPDES permit.

The plug is shown with a top elevation at 879 near Station 30+00 to minimize the percentage of time during high flow periods for the Red River to overtop into the construction area. Elevation-Flow Rating Curves on the Red River of the North at the Diversion Outlet indicates a flow of 25,000 cfs at elevation 879 which has 10% of time equaled or exceeded in the month of April per the Flow Duration Curves. The temporary plug was designed beginning at Station 30+00 to avoid an existing drainage swale near Station 29+00. This swale has a potential overtopping elevation around elevation 867 into the Red River which has a higher time of exceedence during lower flows.

The primary purpose of the temporary outlet plug is to minimize sediment discharge into the Red River to be in compliance with the applicable NPDES permit. A secondary benefit would minimize overtopping of backwater from the Red River into the construction area. The contractor will be responsible to protect and armor the plug and may construct the temporary plug to a higher elevation to lower the risk associated with flooding and overtopping issues during construction.

The constructed rock outlet upstream of the temporary plug will result in a low point that can be used as a temporary sediment basin that will require dewatering. Dewatering can be discharged into the temporary Drain 29 prior to discharge into the Red River. A temporary coffer dam will be required in the Red River for removal of the temporary plug.

## E.10 TECHNICAL GUIDELINES AND REFERENCES

<b><i>A Policy on Geometric Design of Highways and Streets</i></b> , Fifth Edition; American Association of State Highway and Transportation Officials (AASHTO); 2004.
<b><i>Guidelines for Geometric Design of Very Low-Volume Local Roads</i></b> , American Association of State Highway and Transportation Officials (AASHTO); 2001
USACE EM 1110-2-1913, Design and Construction of Levees
USACE EM 1110-2-2902, Conduits, Culverts and Pipes
USACE ETL 1110-2-571, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures
USACE MVP MFR-001-Fargo-Moorhead Metro Flood Risk Management (FMMFRM) Project- Levees and Excavated material Berms along the Diversion Channel
USACE MVP MFR-010-Utility Relocation Requirements; Fargo-Moorhead Metropolitan Area Flood Risk Management Project
USACE MVP GM-001, Guidance Memo, Construction Heights of EMBs
USACE MVP GM-002, Guidance Memo, Excavated Material Berm Design with Swell Factor Variations