INVESTIGATION AND ANALYSES REPORT RUSH RIVER WATERSHED RCPP AMENIA FOCUS

Prepared for

Rush River Watershed and Cass County Joint Water Resource District

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1. Background

1.1 Authority

The Cass County Joint Water Resource District (District) was established to address the common issues related to the four water resource districts in Cass County, which include the Maple River Water Resource District, the Southeast Cass Water Resource District, the North Cass Water Resource District and the Rush River Water Resource District.

The District is the sponsoring local organization (SLO) and entered into a cooperative agreement with the Natural Resources Conservation Service (NRCS) to engage in watershed planning in the Rush River watershed, a subwatershed of the Sheyenne River and the Red River of the North. The cooperative agreement is funded under the Regional Conservation Partnership Program (RCPP) as authorized in the 2014 Farm Bill that allowed the PL-566 framework for planning in watersheds.

The District utilized guidance included in the Watershed Protection and Flood Prevention Act of 1954 (PL-566) to help facilitate the watershed planning.

1.2 Location

The city of Amenia is located in Cass County, North Dakota. The Rush River flows from west to east approximately 0.5 miles north of Amenia, and the Lower Rush River flows from west to east approximately 0.75 miles south of Amenia. The watershed is drained by the Rush River, which discharges into the Sheyenne River upstream of its confluence with the Red River of the North.

1.3 Flood History

Amenia has had historic flood events and annual risks with overbank flooding from the Rush River, ice jams, and overland flooding. Additionally, preliminary FEMA flood insurance rate maps (FIRM maps) indicate that much of the city will be included in the 100-year and 500-year floodplain. Therefore, homeowners and businesses with federally-backed mortgages would be required to purchase flood insurance on their properties if the preliminary FIRM maps are adopted, which is anticipated to happen in 2020. With the rising costs associated with flood insurance, this is a considerable permanent expense for property owners unless certified flood protection is implemented. Preliminary FEMA FIRM maps have been included in Appendix A.

1.4 Proposed Project Alternatives

There are two levee alternatives described below and shown in Figure 1-1 and Figure 1-2.

Levee Alternative #1 (Preferred Alternative) proposes to construct approximately 11,820 feet of levee around the north, west, and south sides of the city of Amenia to provide flood protection from the Rush River, Lower Rush River and overland flooding to residents during a 100-year event. A 10-foot-wide channel approximately 2 feet in depth would be constructed approximately 15 feet from the toe of the levee as an additional measure of protection from flood flows and to convey summer rainfalls around the city. An internal stormwater pond would be developed for Levee Alternative #1 to capture floodwaters and runoff of approximately 180 surface acres within the levee system. Levee Alternative #1 would include constructing removable features to act as temporary levees over the ease and west crossings of county Hwy 32, north and south crossings of 155th Ave SE/Woodard Ave S, east crossing of Brown St, and the north and south railroad crossing.

Levee Alternative #2 would construct approximately 10,100 feet of levee on the south side of the Rush River, approximately 0.13 miles north of the city of Amenia to provide flood protection from the Rush River to Amenia residents for a 100-year event. A stormwater pond would be developed for Levee Alternative #2 to capture floodwaters and runoff from approximately 860 surface acres in the immediate vicinity of the levee precluded from draining directly to the river by levee construction.

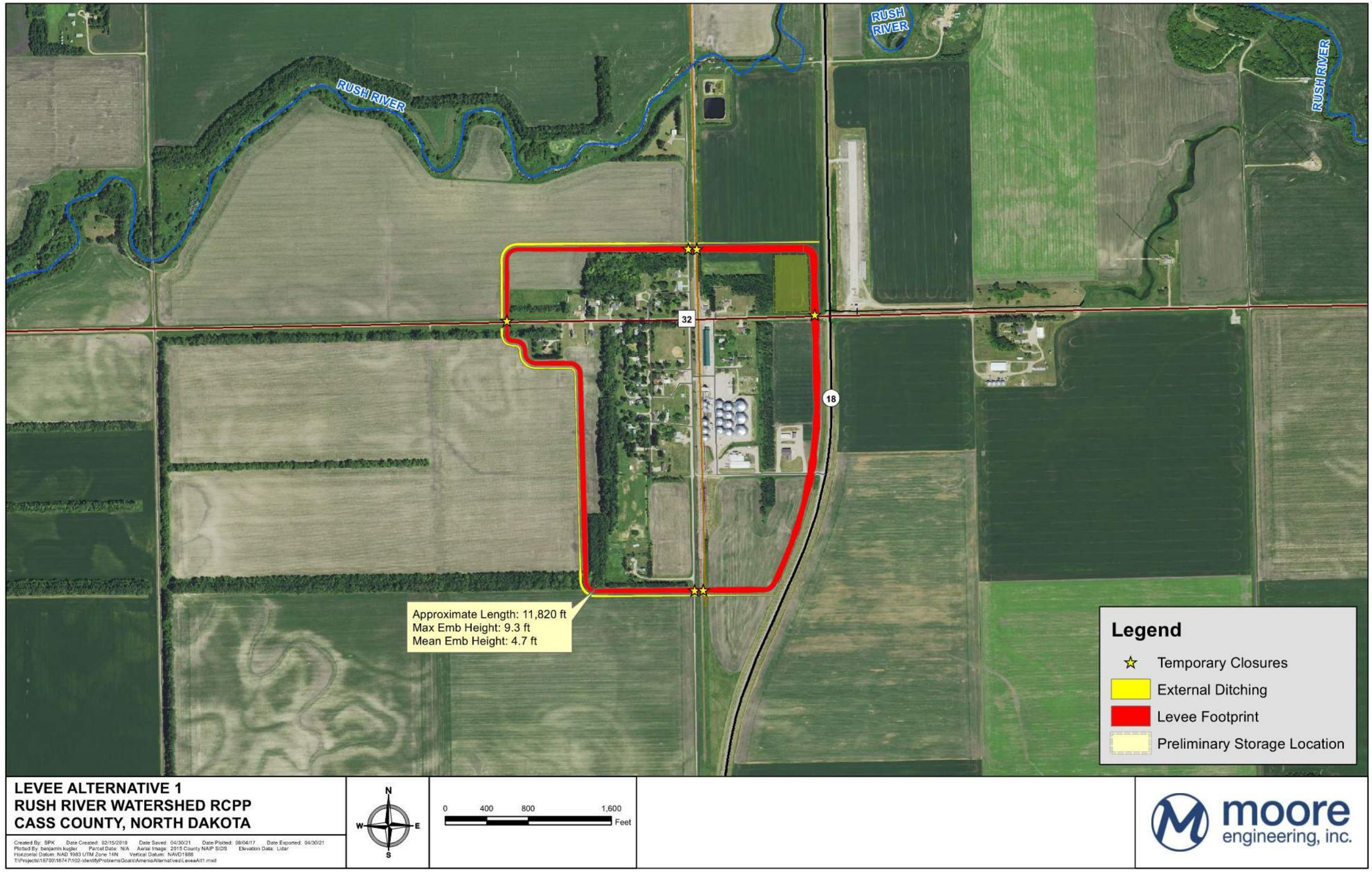


Figure 1-1 – Proposed Levee Alternative 1 for the City of Amenia, ND

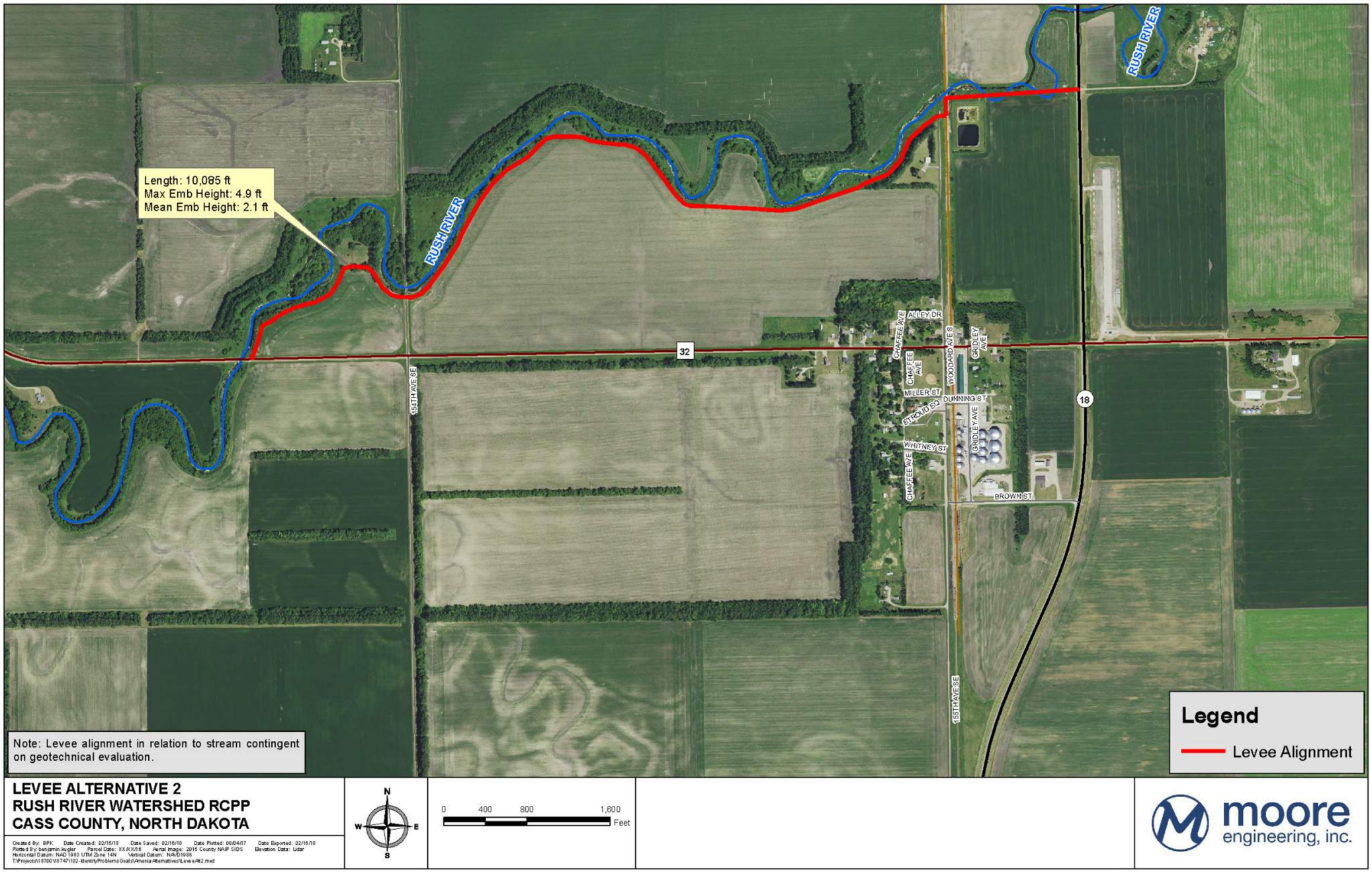


Figure 1-2 – Proposed Levee Alternative 2 for the City of Amenia, ND

2. Hydrology & Hydraulics

2.1 Alternative Hydraulic River Modeling

Inflow hydrology was originally developed during the FM Diversion Project's Final Feasibility Report and Environmental Impact Statement (FEIS) [1]. The hydrology focused on a shorter period of record developed by an Expert Opinion Elicitation (EOE) panel. This produced peak flow and balanced hydrographs that vary over time and is known as the Wet Cycle Hydrology. However, it does not include floods after 2009.

U.S. Geological Survey (USGS) gage 05060500 is located on the Rush River at Amenia and has a contributing drainage of 116 square miles. As part of the FEIS described above an analytical flow frequency study was carried out at Amenia using the USGS annual instantaneous peak flow records for a period of record of 1947 to 2009. The FEIS states, "Weighted skew, using a generalized skew coefficient from the USGS Generalized Skew study, was used to carry out the analysis." The peak flow for a 1% Annual Chance event was calculated to be 4,215 cfs. The 2006 event was used as the pattern hydrograph for developing the balanced hydrographs. The Tributary Peak Existing 100-year Phase 8.1 model uses this hydrograph at the upstream end of the Rush River. Breakout flow from the Rush River to the Lower Rush River is modeled with a lateral structure.

One change was made to the model hydrology for this study. The Phase 8.1 model has a constant 10 cfs inflow at the most upstream cross section of the Lower Rush River for model stability. This additional flow is not necessarily representative of the hydrology of the area. In order to minimize the impact of this stability baseflow, it was lowered to the lowest rate that would still allow stable model results. It was found that the model was stable with just 1 cfs for this baseflow.

2.1.1 Alternative 1 – HEC-RAS Modifications

Storage areas RUSHA64, RUSHA66, RUSHSA67, and RUSHA68 were modified to reflect the area protected by the Alternative. The storage areas had their areas reduced, and storage curves modified to reflect this change, as it was assumed the Alternative would no longer allow the protected area to be utilized as storage. It should be noted that the connections (culverts) between RUSHSA67 & RUSHSA68 in addition to those between RUSHSA64 & RUSHSA65 were maintained in the modelling. These connections (culverts) are required to pass the local drainage and breakout flows from the Rush River during times of flooding. During normal summer/fall rainfall events, the drainage from the city is assumed to be gravity drainage along the existing drainage paths. However, during a flooding scenario,

the city will need to cut off those drainage paths to prevent water from backing up into town. The existing and proposed drainage paths in town have been included in Figure 2-2.

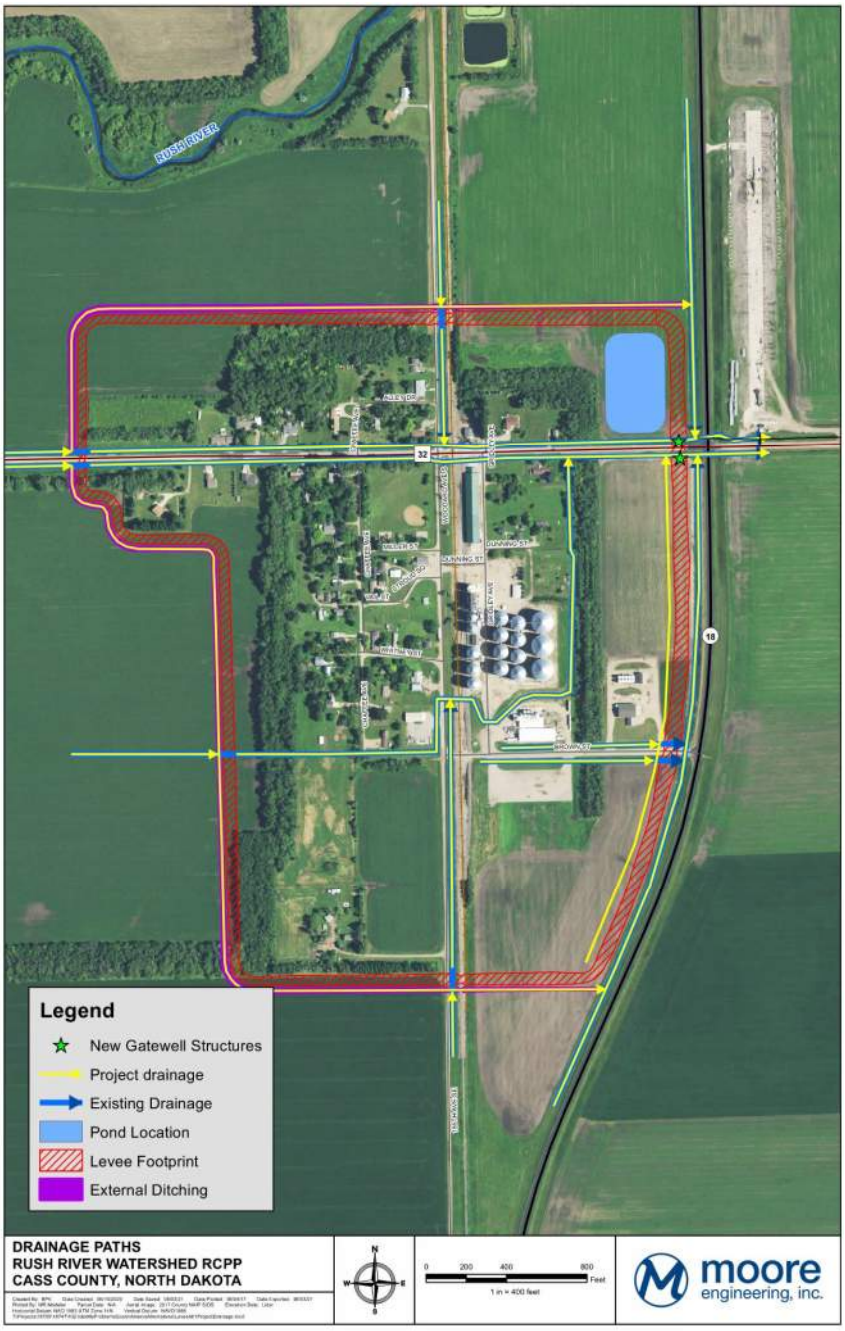


Figure 2-1 - Existing Drainage Paths

Thus, gravity flow from the protected area will not be allowed to discharge as the flow is limited to the capacity of the culverts downstream which are backing up water. Increasing culverts/bridge was an alternative considered; however, the watershed team ruled that alternative out due to increasing flows

downstream. Thus, a pump station will be required to discharge rainfall events during a flooding scenarios. The model geometry layout is shown in Figure 2-2.

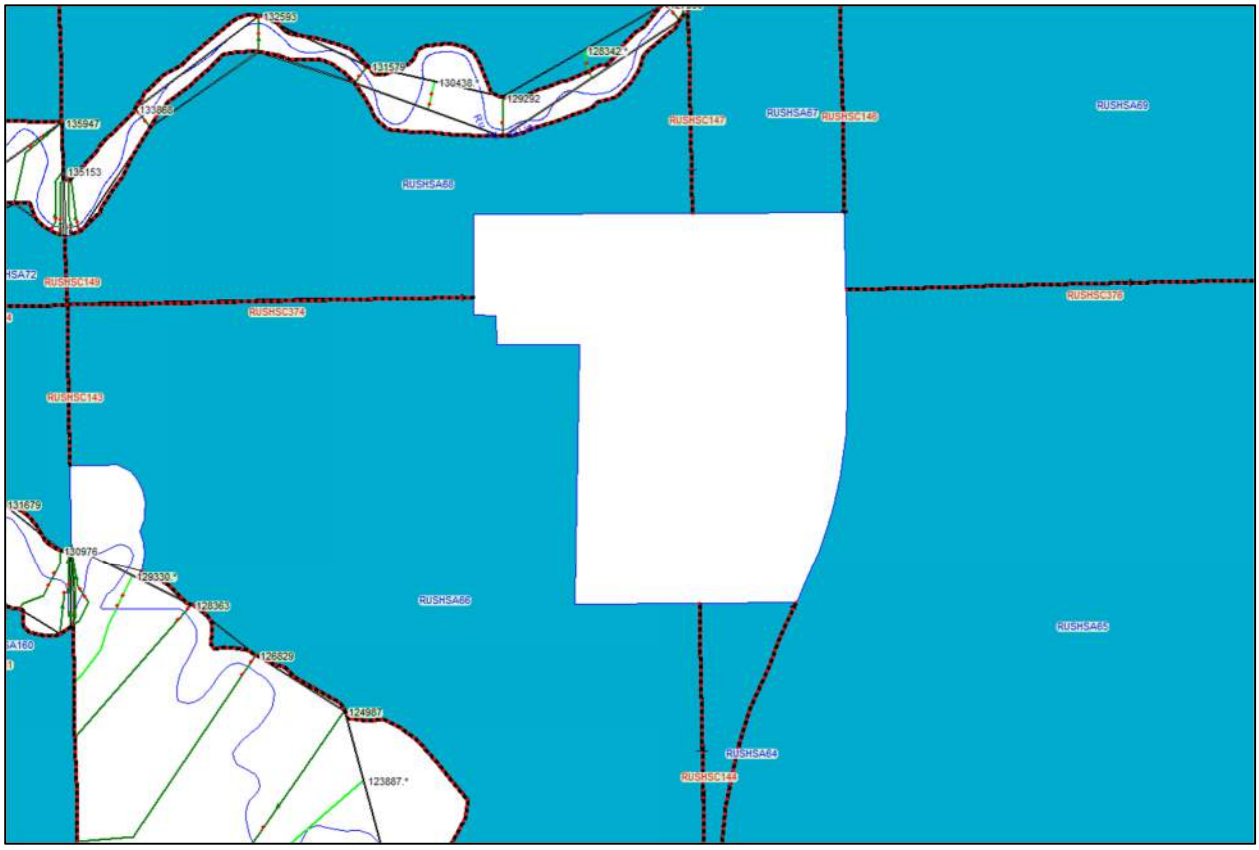


Figure 2-2 - HEC-RAS Geometry Layout - Alternative 1

2.1.2 Alternative 2 – HEC-RAS Modifications

Lateral Structures on the Rush River reach Amenia to Sheyenne at stations 138236.8, 135004.8, and 127152.8 were modified to simulate a levee by raising the embankment elevation to a level where the 1% annual chance event modeled flows would no longer break out. Figure 2.3 shows the HEC-RAS model configuration.

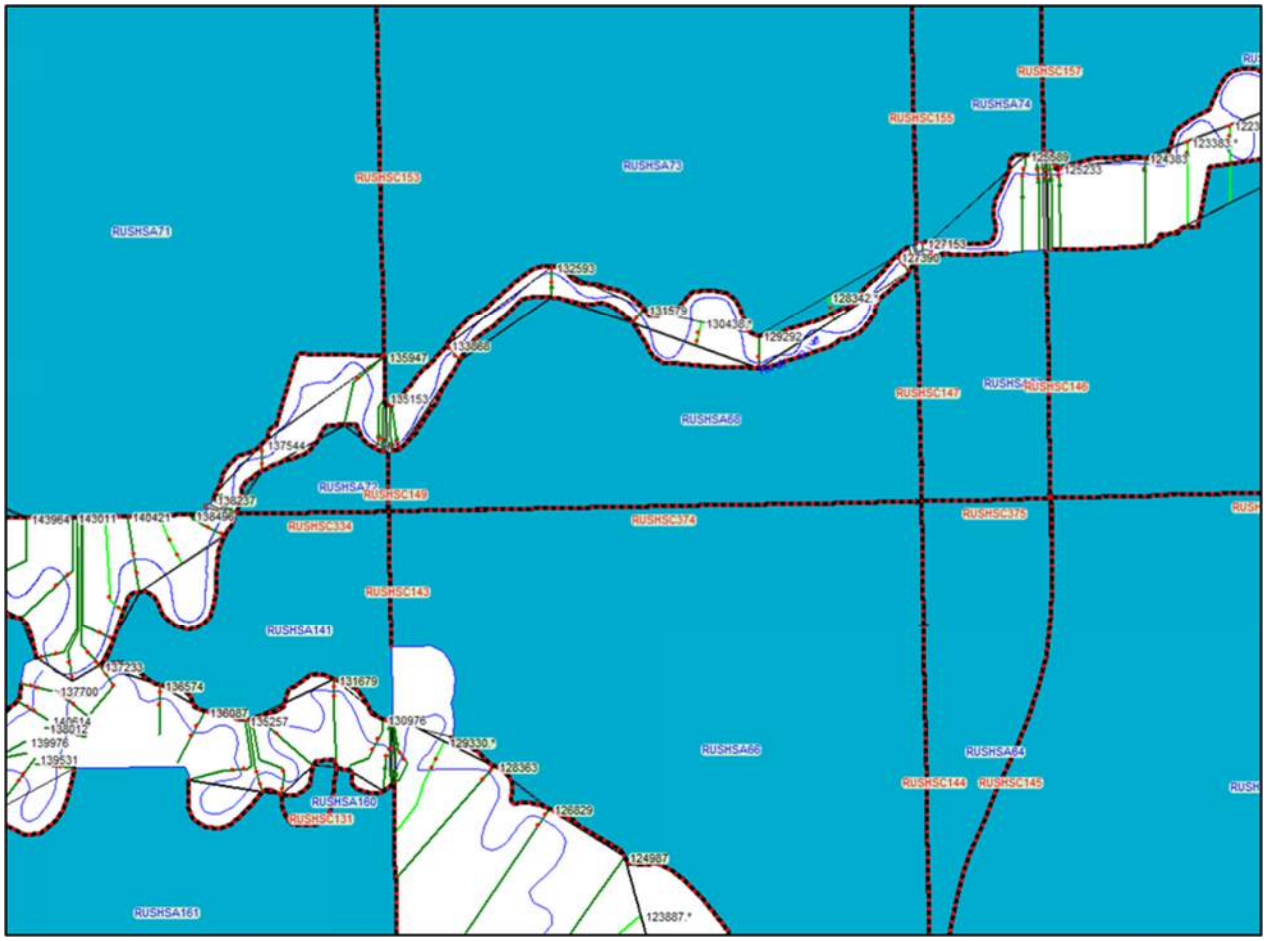


Figure 2-3 - HEC-RAS Geometry Layout - Alternative 2

3. Design Considerations

3.1 Datum

Coordinate System and Projection: North American Datum 1983 (NAD83), Universal Transverse Mercator Coordinate System, Zone 14N

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88-Geoid 09)

3.2 Levee Design

Detailed drawings showing the proposed project alternatives are shown in Appendix B and Appendix C.

3.2.1 Geotechnical

Barr Engineering Company was retained by Moore to complete a preliminary geotechnical investigation and evaluation of levee alternatives 1 and 2. Their report titled," Preliminary Geotechnical Engineering Report Rush River Watershed - Amenia Levee Alternative Sites Alt1 and Alt2 Cass County, North Dakota" contains their analyses. [3] The analysis results show long-term settlement estimated at 5 to 7 inches. After taking into account immediate elastic settlement, the actual settlement will likely be 7 to 9 inches.

A levee cross section with 4H:1V side slopes and a 10 foot top was analyzed for seepage and slope stability for Alternative 1 and determined to be generally suitable. Further lab testing to confirm the drained shear strength of the embankment and foundation soil will confirm the results. Alternative 2 utilized a 4H:1V on the north side and a 5H:1V on the south side to address low factor of safety. Alternative 2 also has a top width of 10 feet.

The geotechnical report recommended that slope protection such as vegetation, riprap, or turf reinforcement be used for the constructed levee embankment, particularly for any slope exposed to moving water during flood events. Barr recommended the latter two on the upstream slope due to the rural location and limited inspection anticipated for the project once constructed. However, both levees will be within half a mile of the city of Amenia and are expected to be inspected annually as well as during flood events. After construction, the city will be eligible to apply for the USACE Non-Federal Levee Program, which will require annual inspections and provide additional federal support. Therefore, vegetation is recommended for slope protection.

3.2.2 Levee Certification

In order for FEMA to accredit a levee as providing a 1% annual chance level of protection, the levee systems must meet, and continue to meet, the National Flood Insurance Program (NFIP) requirements described in Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR 65.10). This requires that levees have at least 3 feet of freeboard above the 1% annual chance event, or Base Flood Elevation (BFE) and be 3.5 feet above the BFE at the upstream end. Levees must also be 4 feet above the BFE within 100 feet of structures such as bridges.

Alternative 1 levee was set to an elevation of 959.0. This elevation is 4 feet above the elevation identified for the flood elevation from modeling and mapping using LiDAR. Only 3 feet is required to meet FEMA requirements. However, an additional foot was added to account for settlement and spreading of topsoil. In addition to the levee, the project would include constructing removable features during a flood to act as temporary levees over three road crossings and one railroad crossing. For paved road crossings, the

asphalt pavement would be cut out during levee construction and roadbed prepared such that a concrete sleeper slab could be placed. The concrete sleeper slab would replace the asphalt as a traversable surface but would act as support for the temporary placement of clay fill at the road crossings to bring the levee up to the design elevation during flood scenarios, while removing pervious material from the levee alignment. Once the flood recedes, the temporary clay fill would be removed and the road would be passable with no additional work. For gravel roads, the gravel overlying the roadbed would be removed and the roadbed would be reconstructed in a similar fashion to the levee as to make it congruent in material and compaction. Upon completion of the roadbed, the gravel would be reestablished for normal use. Under a flood scenario, the gravel would be removed and a clay fill temporarily added to bring the levee up to the design elevation. Once the flood recedes, the temporary clay fill would be removed and the gravel layer would be reestablished. The railroad would receive similar treatment to the gravel roadway, differing only in the need for the railroad company to remove the tracks and ballasts during a flood before clay fill is brought in.

A road raise is avoided because of the amount of pavement needed to be removed to allow for a vertical curve for the roadway design speed limit could result in hundreds of feet of pavement needing to be removed and replaced. The sleeper slab minimizes costs while allowing a suitable base for a temporary levee that limits seepage during a flood.

Alternative 2 levee was set to an elevation of 969.0 on the upstream side and 959.0 on the downstream and graded along the profile between those two points. The elevations were set to 4 feet above the flood elevations determined. The additional foot was added to account for settlement and spreading of topsoil. In addition to the levee, the project would include constructing removable features during a flood to act as temporary levees over one road crossings and one railroad crossing. The road crossing would be at an existing gravel road. The gravel overlying the roadbed would be removed and the roadbed would be reconstructed in a similar fashion to the levee as to make it congruent in material and compaction. Upon completion of the roadbed, the gravel would be reestablished for normal use. Under a flood scenario, the gravel would be removed and a clay fill temporarily added to bring the levee up to the design elevation. Once the flood recedes, the temporary clay fill would be removed and the gravel layer would be reestablished. The railroad would receive similar treatment to the gravel roadway, differing only in the need for the railroad company to remove the tracks and ballast during a flood before clay fill is brought in.

A road raise to 154th Avenue SE is avoided because of an existing bridge over the river. In order to minimize the length of the levee, the crossing would occur near the river. A road raise would require the road to be raised approximately four feet above the existing roadway. In order to not replace the bridge and to avoid steep roadway slopes, a temporary levee crossing would be utilized.

3.2.3 Pond Design

A.1 Interior Drainage Analysis

The City of Amenia currently has no requirements for sizing storm water runoff systems. This analysis was based on knowledge of other municipalities in the region along with some basic assumptions that will be further evaluated during final design. The original sizing of the pump was determined by calculating the existing runoff from the protected area. This analysis was based on runoff generated by the area assuming residential development with group C soils and impervious surfaces of 20% and 12% for Alternatives 1 and 2, respectively. This results in an NRCS Curve Number (CN) of 79 and 77,

respectively. As a preliminary starting point, the 10-year rainfall was analyzed to size the pumps. Municipalities vary in that some require post project conditions cannot exceed the existing conditions 2-year and others the 5-year. The 10-year peak runoff is conservative in that the pumps may be larger and can potentially be downsized in the future based on input from the City. That scenario may require a larger pond; however, additional material is necessary to construct the levee. The existing conditions peak discharge was approximately 35 cfs which was generated using AutoCAD Storm and Sanitary Analysis (SSA). It was assumed that a peak pumping capacity for the system was 28 cfs. By not exceeding 28 cfs, the proposed project would not have an adverse impact to people downstream above what would happen if this project were not constructed. The required stormwater pond capacity was determined by creating enough storage to not exceed a peak discharge of 28 cubic feet per second (cfs) while minimizing the chances of internal flooding during the 100-Year recurrence rain event during a Rush River spring flood.

By having the Alternative 1 ring levee and Alternative 2 river levee options use the same pump sizes, then the cost comparison between levee options would assume both levee options would have the same lift station costs. Then the difference in costs would be mainly due to earthwork. Figure 3-1 and Figure 3-2 show drainage maps used in the modeling of Alternatives 1 and 2, respectively, with the boundary of the model's subcatchments shown. The maps show the boundary of a possible ring levee and the boundary of the area protected by a levee along the Rush River.

Figure 3-1 - Alternative 1 Drainage Map

Figure 3-2 - Alternative 2 Drainage Map

A.2 Hydrology

The procedures outlined in EM 1110-2-1413 were used to analyze historic river stage and rainfall records to determine coincident rainfall amounts during blocked gravity outlet conditions [2].

Historic rainfall data was obtained from the NOAA's National Climatic Data Center for the rainfall gage at Hector International Airport, where daily rainfall data has been recorded since 1891. This is the closest rainfall gage for this project. This rainfall data was correlated with stream gaging records from the USGS Gage 05060500, Rush River at Amenia, ND. Stream gage data for this location is available from August 1946 until the present. This produces 73 years of combined streamflow and rainfall records from 1946 through 2018. The top 10 largest historic flood events were chosen from the daily USGS data. These top 10 flood events occurred from March 17th to April 19th, with an average date of April 7th. The peak daily rainfall data were analyzed using a 6-week window centered on April 7th.

The approximate 1% coincident rainfall amount is determined by creating a rainfall – frequency plot based on Weibull plotting positions of the historic coincident events in the data set as follows:

$P = m/(N+1)$
P = plotting position
m = ranking of individual events in the data set, 1 being the highest N = number of events in the dataset

Confirmed records for rainfall and river stage were both available for the period from 1946-2018, or 73 years. Therefore, the 1% coincident rainfall amount was extrapolated based on the available data on the Weibull's plot. Figure 3.4 shows the 1% coincident rainfall amount of 2.8 inches estimated from the Weibull plot.

This is the expected 100-Year rainfall recurrence event that would occur during spring flooding from a snow melt. The modeled utilized a rainfall distribution developed using NOAA Atlas 14 [5] per Part 650 Chapter 4 of the National Engineering Handbook. [6] For the synthetic storm distribution, the NRCS has four rainfall distribution patterns, Type I, Type IA, Type II, and Type III, which are specific to different regions of the continental United States. At the project location, the Type II distribution has typically been deemed appropriate. However, with Atlas 14 data available, a nested rainfall distribution can be developed directly from the point rainfall information. The advantage of using a nested distribution is that each interval shown in Figure 3-3 is placed symmetrically around the center of the distribution. This way, each time duration is modeled in a single model run and the critical duration for pond design is included, eliminating the need to model different durations for each recurrence interval.

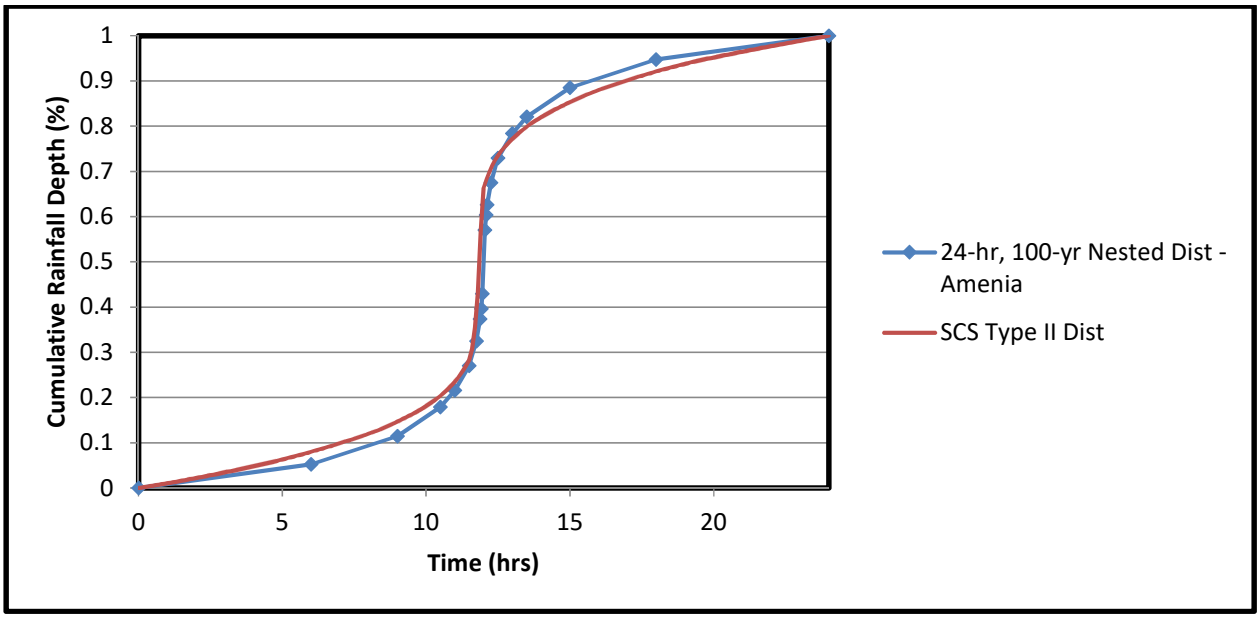


Figure 3-3 24-Hour Nested Distribution vs. SCS Type II Distribution

A.3 Pond Modeling

Modeling was completed utilizing Autodesk Storm and Sanitary Analysis 2019 (SSA) software. SSA allows the use of a hydrodynamic link routing method. The hydrology runoff method used SCS TR-55. The model scenario discussed in this report assumes a free discharge at the outlet of the system. The model does not consider tailwater effects at the outfall due to the discharge forcemain having to be at or above the levee freeboard, per U.S. Army Corps of Engineers (USACE) requirements. The forcemain piping would be constructed in the levee freeboard, which represents lifting the discharge above the water surface elevation of river flooding, which would result in the tailwater condition having no impact.

The coincident rainfall event occurs in March-April. During this time period, the frost is typically coming out of the ground. We evaluated a number of alternatives to represent the changes in soil conditions at this

time period. One alternative that was considered was to utilize soils group C with an antecedent moisture condition III. However, that produced a curve number that was in the low 90s which was considered high. Another alternative was to increase the impervious percentage, but the percentage was defined based on existing conditions. Ultimately, it was a curve number of 84 and 82 that was utilized which is reflective of soils group D, due to the fact it would allow for more runoff, but it would not act as relatively impervious. The proposed peak discharge for post project conditions was based on runoff generated by the area assuming residential development with curve numbers of 84 and 82 and impervious surfaces of 20% and 12% for Alternatives 1 and 2, respectively. The total runoff generated by the area in question was modeled with all runoff reaching a storm lift station with two pumps. The project watershed was modeled as a single subcatchment. The Time of Concentration (Tc) was calculated by inputs to SSA. The Tc is expected to be 240 minutes for Alternative 1 and 324 minutes for Alternative 2. The high Tc for Alternative 1 is due to very flat ground for initial sheet flow along with the length of street ditches and their flat slopes.

The ponds are presently modeled as a wet pond. The bottom of pond was assumed to be at an elevation of 934 with a normal water level elevation of 942. This elevation was assumed based on the assumption that the normal ground water level is within the top 10 feet of the soils as discussed in Section 3.2 of the Preliminary Geotechnical Engineering Report. This is to use the ponds as a "wet well", to minimize pump cycles, extending the expected service life of the pumps. A wet pond also minimizes the fouling of the pumps from sediment or floating debris. The pond volume used in the stormwater model assumed the ponds had a uniform side slope of 5H:1V, from pond bottom to top. During final design, the pond could have a different slope below normal water and above normal water level. The normal water level may change based on further evaluation during final design. The actual pond would likely have a bench at the normal water level.

A.4 Results

The duplex storm lift station was modeled with the pumps using the pump curves of Prime Pump model 16A at 880 RPM with a 10 degree impeller. Figure 3-5 and Figure 3-6 show the bounce of the pond for the 100-year storm event for Alternative 1 and 2, respectively. The pumps will take longer to drain the total volume of Alternative 2 due to the larger tributary area draining to the pond.

The Alternative 1 pond size of 300x500x16ft would result in less material being excavated than would be required to construct the ring levee, and thus would require import material. The offsite location and haul distance are not presently known for the borrow site, which could raise the cost of the levee. In order to minimize the amount of import material needed, the pond could be oversized from what is presently modeled. A larger pond could result in being able to reduce the size of the pumps, since more stormwater storage would be available. This could lower the cost of the lift station.

The Alternative 2 pond size of 650x1,500x16ft would produce more material than needed to construct the river levee, requiring that excess material be hauled away. This would also raise the cost of the levee since the borrow site location and haul distance are not presently known. In order to minimize the amount of export material, the pond could be reduced in size, but then the lift station would need to have a larger capacity than the ring levee option. Either Alternative 2 pond option would then have a higher construction cost than Alternative 1.

The storm pumps combined peak discharge rates for each alternative are shown in Table 3.1. Both proposed project discharge rates are less than the calculated existing discharge rate of 28 cubic feet per

second. The expected pond bounce is also shown in the table and are less than 5 five feet, the maximum amount of bounce desired.

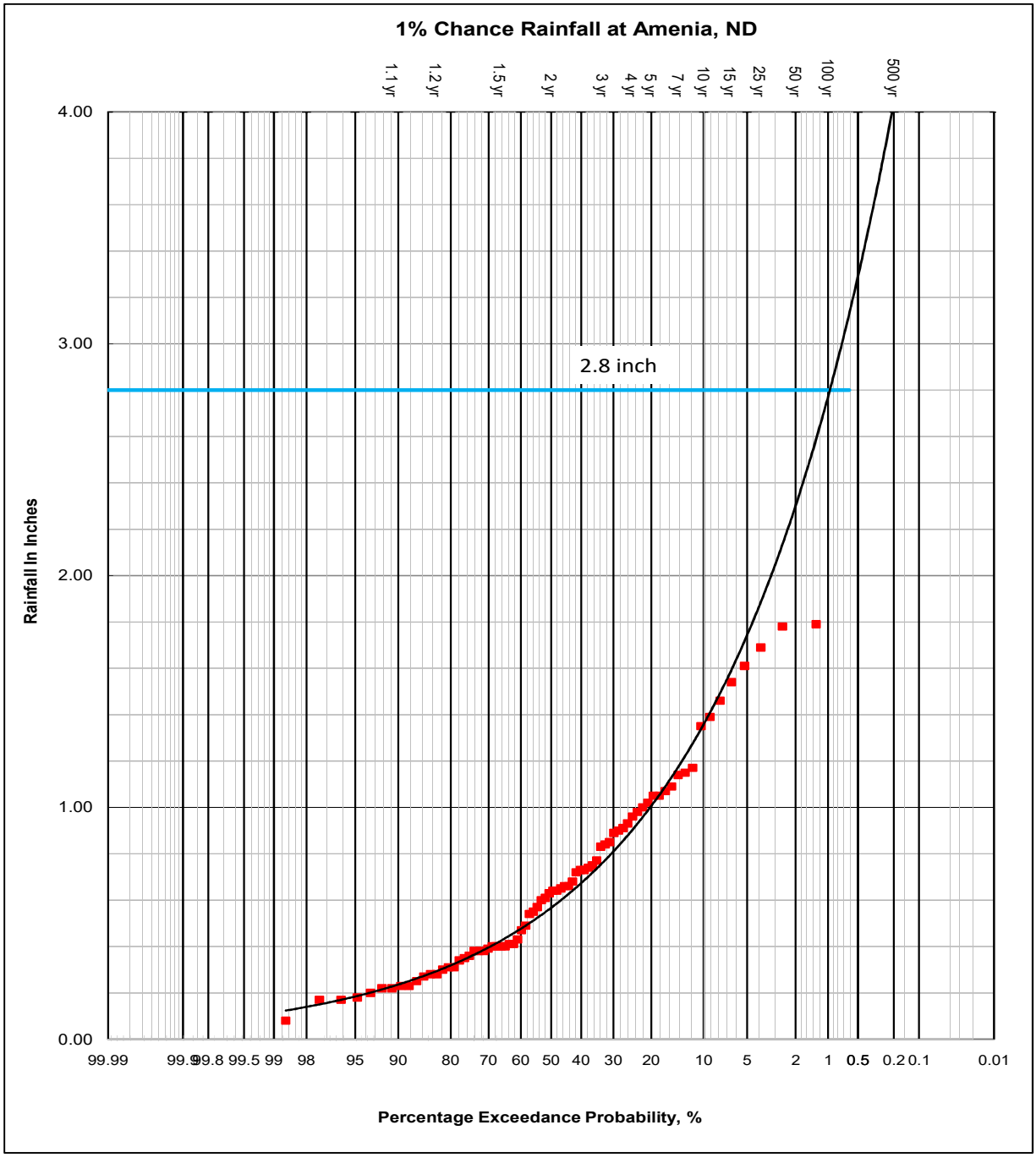


Figure 3-4 - 1% Coincident Rainfall Estimation

Table 3.1 also shows the subcatchment area, expected total runoff, total runoff volume, and the time needed to pump the runoff volume. Both alternatives show continuity with the model since the total volume pumped equals the total runoff volume.

Table 3.1 - Comparison of Alternatives 1 and 2 Pump and Pond Data

	Alternative 1	**Alternative 2**
Pump Combined Peak Discharge (cfs)	24.45	24.55
Pond Bounce (ft)	3.21	3.27
Subcatchment area (ac)	183	860
100-year Storm Total Runoff (in)	1.35	1.22
Total Runoff Volume (ft^3)	896,800	3,809,000
Runoff Volume Pump Time (hrs)	12	43

The pond storage curves and pump curves for Alternatives 1 and 2 are shown in Figure 3-7 through Figure 3-10.

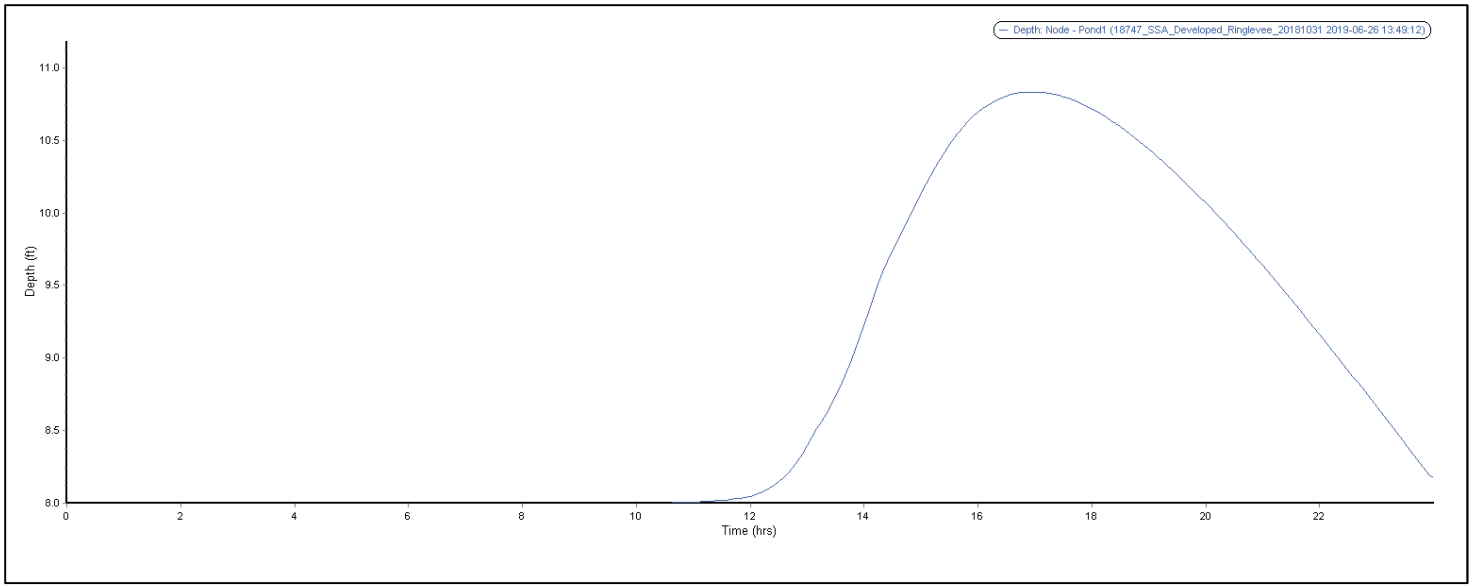


Figure 3-5 - 100-year Pond Bounce Hydrograph - Alternative 1

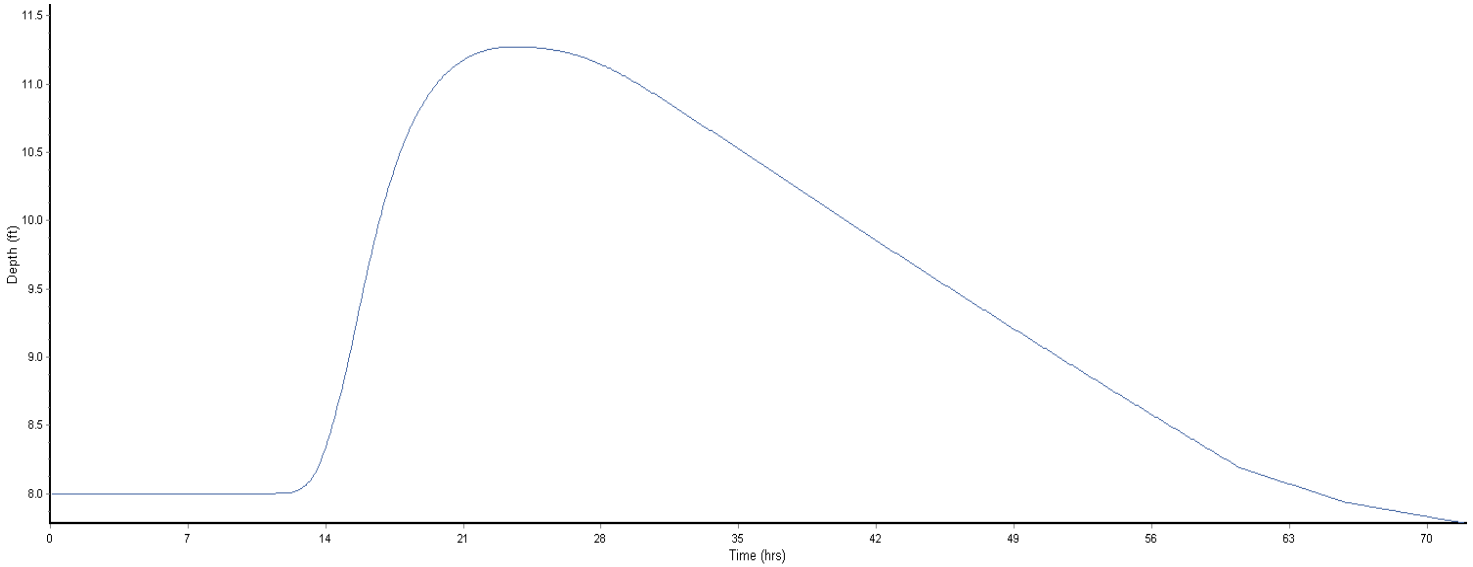


Figure 3-6 - 100-year Pond Bounce Hydrograph - Alternative 2

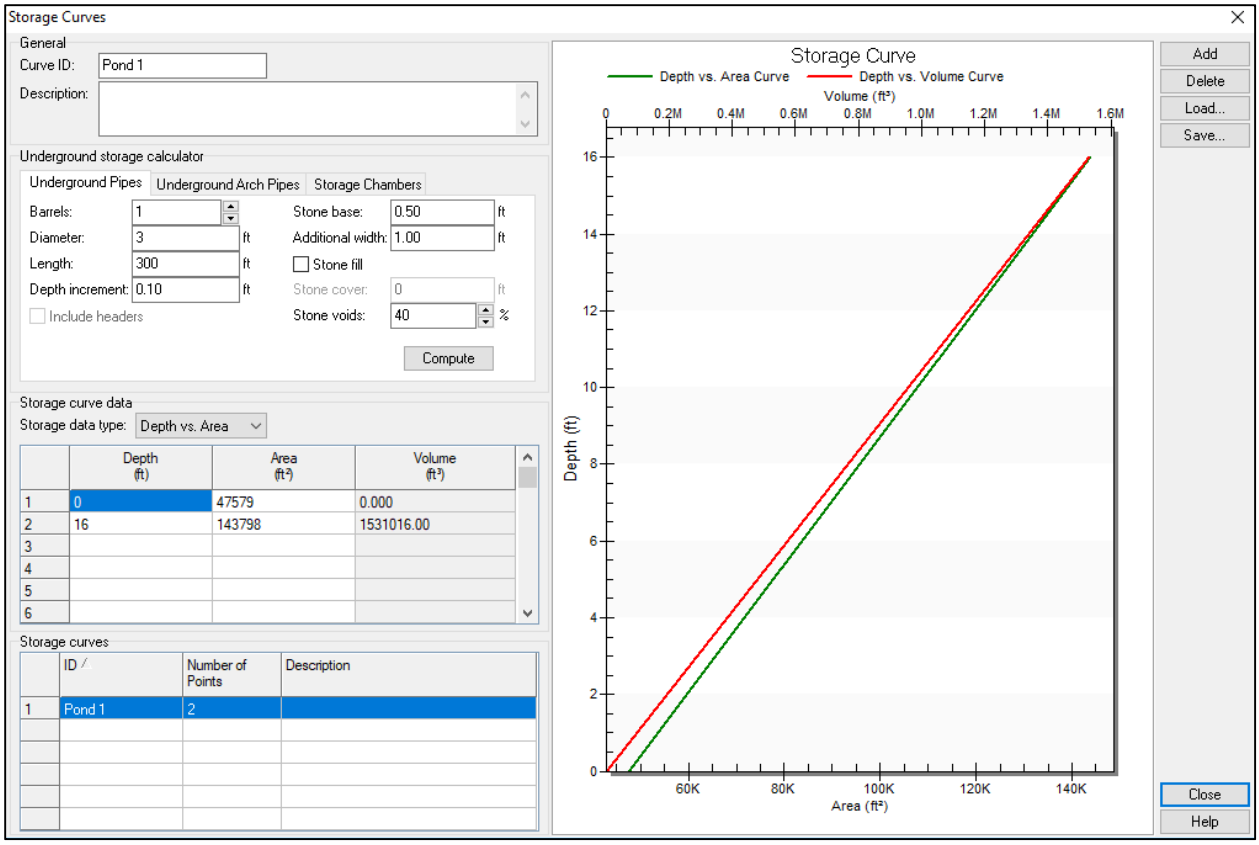


Figure 3-7 - Pond Storage Curve - Alternative 1

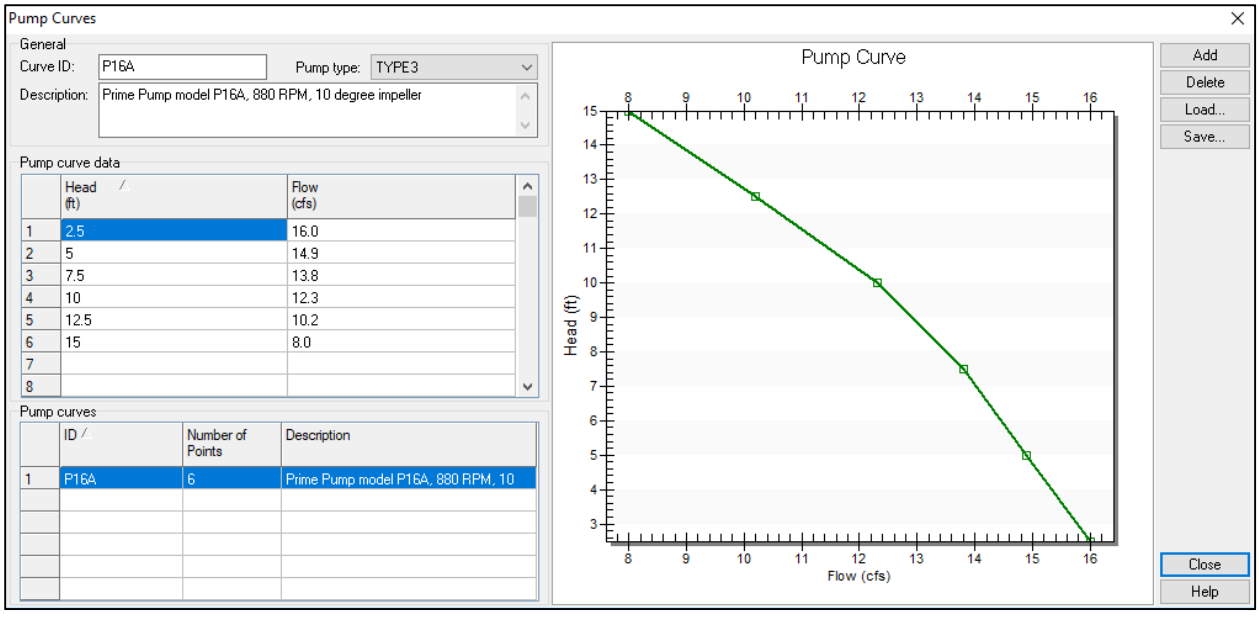


Figure 3-8 - Pump Curve - Alternative 1

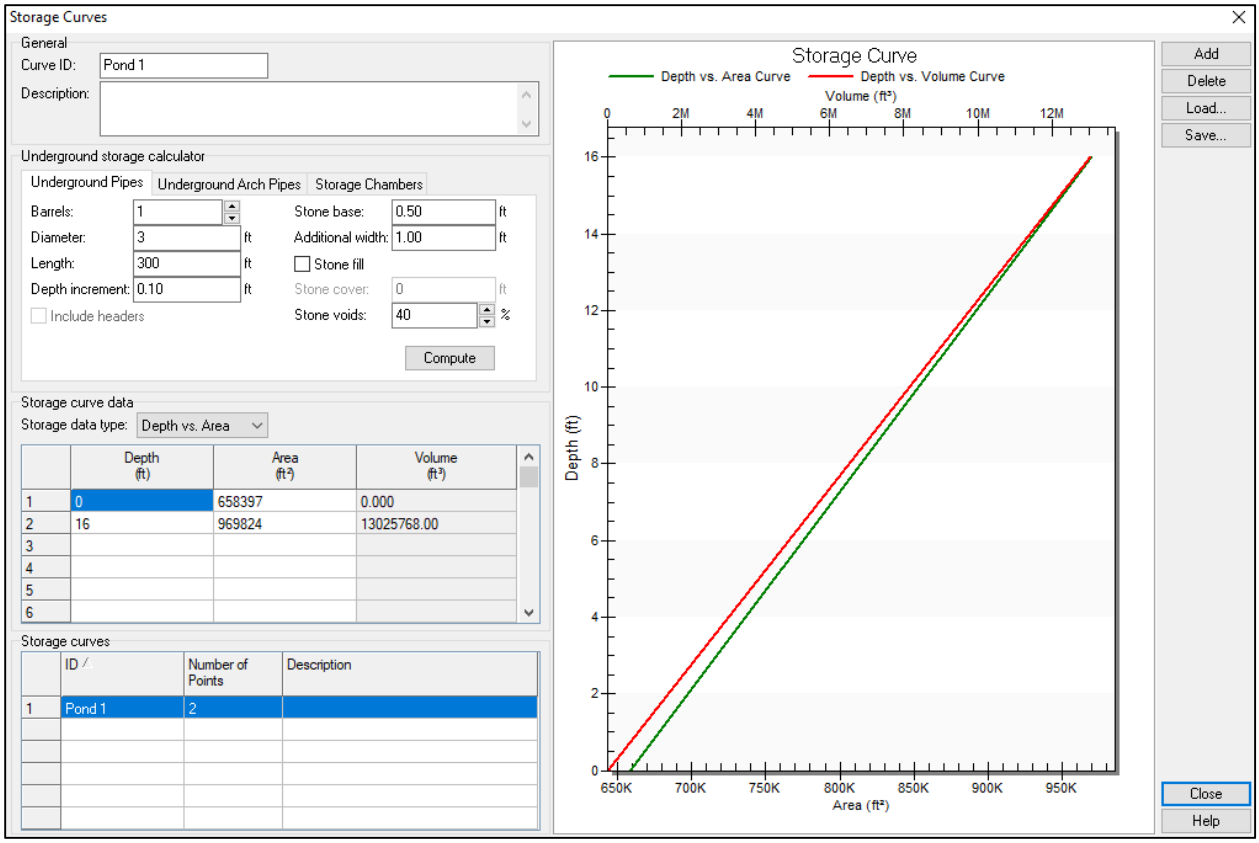


Figure 3-9- Pond Storage Curve - Alternative 2

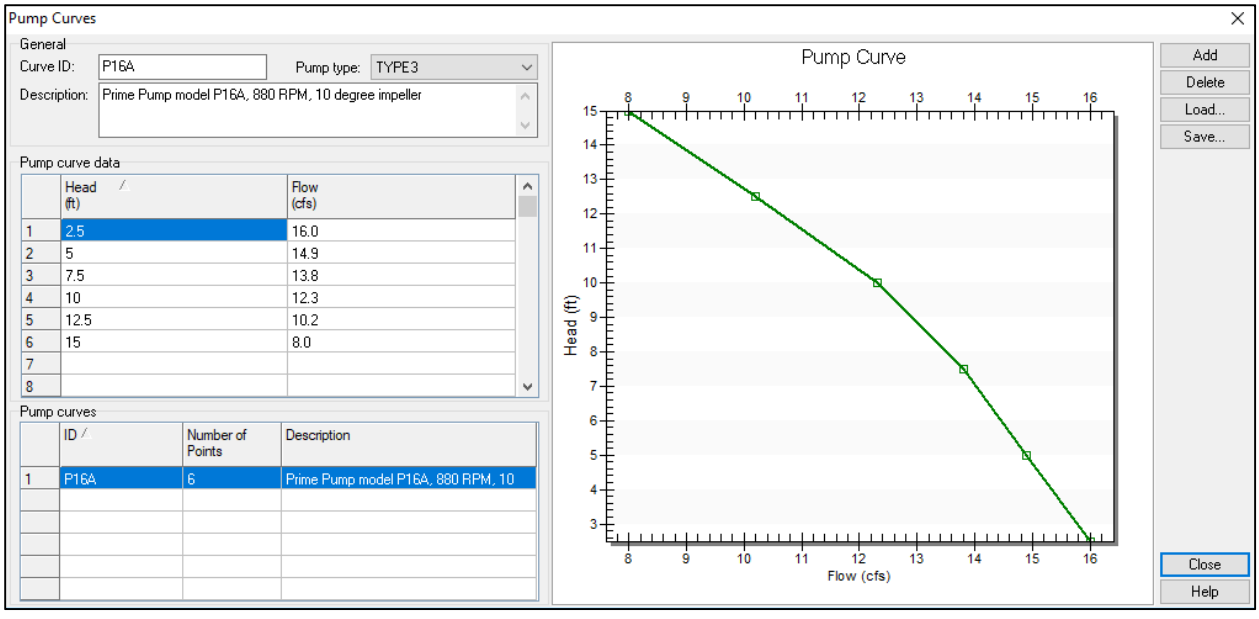


Figure 3-10 - Pump Curve - Alternative 2

3.3 Hazard Classification

It is assumed for this design that the levee alternatives would be classified as Significant Hazard Potential projects based on the definitions presented in section 520.21 E of the NRCS Title 210 National Engineering Manual [3] that defines Significant Hazard Potential as "where failure may damage isolated homes, main highways, or minor railroads, or interrupt service of relatively important public utilities."

A failure of the embankment of either alternative during the 1% annual chance event would not result in the high velocity and volume of discharge present in a typical dam breach scenario due to the relatively small volumes of water and shallow depths of pooling on the exterior of the levee for Alternative 1, and the remoteness of the levee embankment of Alternative 2. The volume of water that reaches the city of Amenia during the 1% annual chance event would not be significantly altered from existing conditions. Inundation from a breach would result in similar inundation as shown on the FIRM maps. Figure 3-11

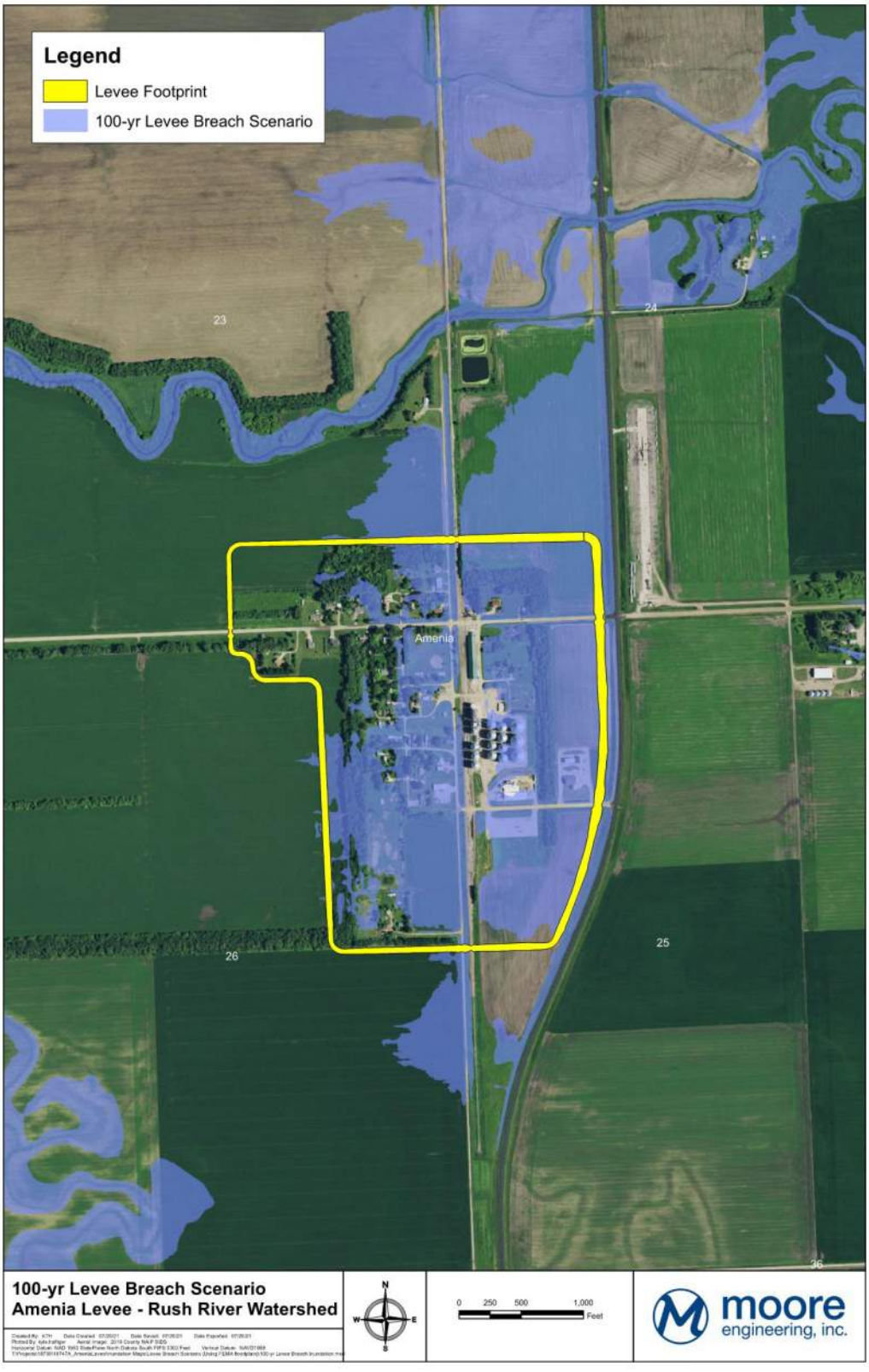


Figure 3-11 - Levee Breach

A simulation of the pump station failing was conducted using a coincident rainfall event. Should the pump fail during a 1 percent-chance event and a coincident rainfall event, water would begin to inundate the town and would impact approximately two commercial structures, one public structure and five private structures. Figure 3-12 shows the inundation resulting from pump failure Emergency response to a pump failure could be addressed by removable pumps brought in on a temporary basis until pump station can be repaired.

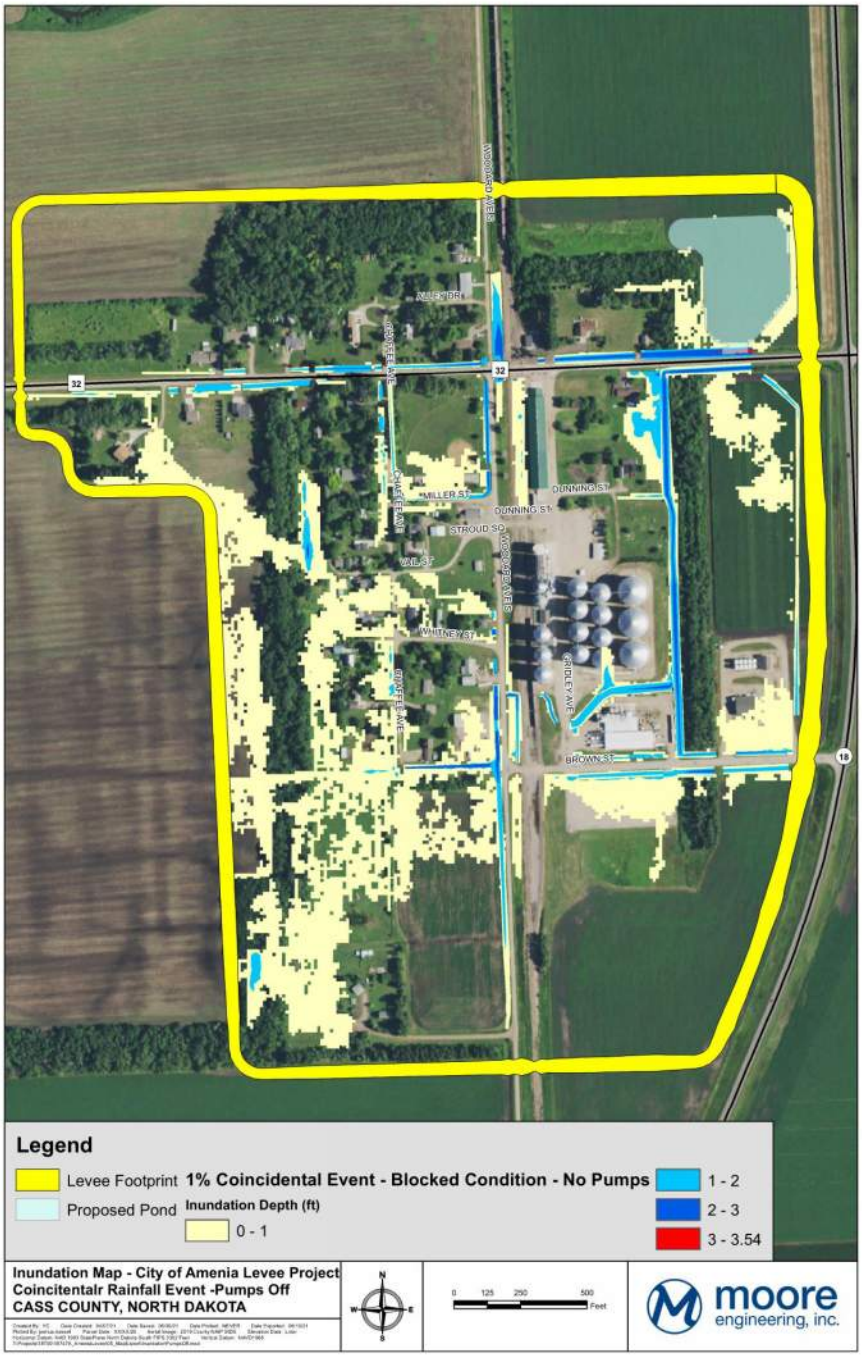


Figure 3-12 - Pump Failure

3.4 Cost Estimate

A comparison of the cost for Alternatives 1 and 2 is shown below in Table 3.2.

Table 3.2 - Levee Alternatives Cost Estimate Comparison

Item	Levee Alternative 1	Levee Alternative 2
Construction	$2,149,800	$4,105,755
Engineering – Civil Design	$353,200	$663,245
NRCS – Technical Assistance	$40,000	-
Land Surveying	$40,000	$40,000
CLOMR/LOMR	$130,000	$130,000
Utility Relocation	$175,000	$0.00
Right-of-Way Acquisition	$212,000	$378,000
Wetland Mitigation	$67,200	$68,000
Legal & Adm. Fees	$50,000	$50,000
Right-of-Way Negotiations	$20,000	$20,000
Permitting	$5,000	$5,000
Fiscal	$40,000	$40,000
Total Project Cost	**$3,282,000**	**$5,445,000**

3.5 Operation & Maintenance

Operation & maintenance activities will occur over the life of the project. All activities will be completed by the Project Owner, or a designated representative with experience in these activities. Specific responsibilities will be identified and further defined with the Project Owner during final design. Annual maintenance items that have been factored into these costs are mowing, rodent abatement, lift station maintenance and electricity costs. In addition, the operation and maintenance costs include the replacement of the lift station pumps after 25 years or half of the design life. Lastly, it is assumed that temporary road closures will be utilized once in the lifetime of the project and will be depended on water surface elevations on the exterior side of the levee. It is assumed that annual inspections will occur regardless of a flood event to identify potential issues. The frequency of inspection during a flood will likely be daily or more frequent depending on the water surface elevation adjacent to the levee.

Table 3.3 - Annual Maintenance Cost

Item	Cost
Mowing	$5,000
Rodent Abatement	$1,000
Lift Station Maintenance	$3,000
Electricity	$1,000
Lift Station – Pump Replacement (every 25 years)	$50,000
Temporary Road Closure	$25,000
Total Annualized	**$13,050**

4. Project Impacts (Results)

Alternative 1 results in the elimination of the flooding seen in the city of Amenia for the 1% chance event within the protected area of the levee. This option reduces the flood risk for approximately 93 acres, while increasing the risk on 72 acres of undeveloped agricultural land, for a net decrease of 21 acres from the floodplain. The areas directly adjacent to the levee see between 0.3 to 0.67 feet of impacts during the 1% chance event due to a reduction in the available storage from the levee. The largest impacts seen in areas not adjacent to the levee were less than 0.1 feet. Peak water surface elevations and areas impacted during the 1% event for alternative 1 can be seen in Figure 4-1 and Figure 4-2.

Alternative 2 results in a significant reduction to the peak 1% chance event water surface elevations within Amenia. A small volume of water is still reaching Amenia with this alternative from breakout flows from the Lower Rush River southwest of Amenia. This alternative results in impacts to lands in the vicinity of the levee due to the elimination of breakout flow from the Rush River that results in the flooding seen in the city of Amenia for the existing conditions. There is a reduced risk for approximately 188 acres, and an increase in risk for 140 acres, for a net decrease of 48 acres from the floodplain. The largest impacts present occur directly to the north of the alternative levee where a 0.33 foot increase occurs during the 1% event. Peak water surface elevations and areas impacted during the 1% event for alternative 2 can be seen in Figure 4-3 and Figure 4-4.

The effects of the alternatives on the flow rates at the Rush River at Amenia USGS gage were also analyzed. Figure 4-5 shows little difference between existing conditions and Alternative 1 with the ring levee around Amenia. However, Alternative 2 restricts the channel flow from breaking out, so more flow is reaching the USGS gage.

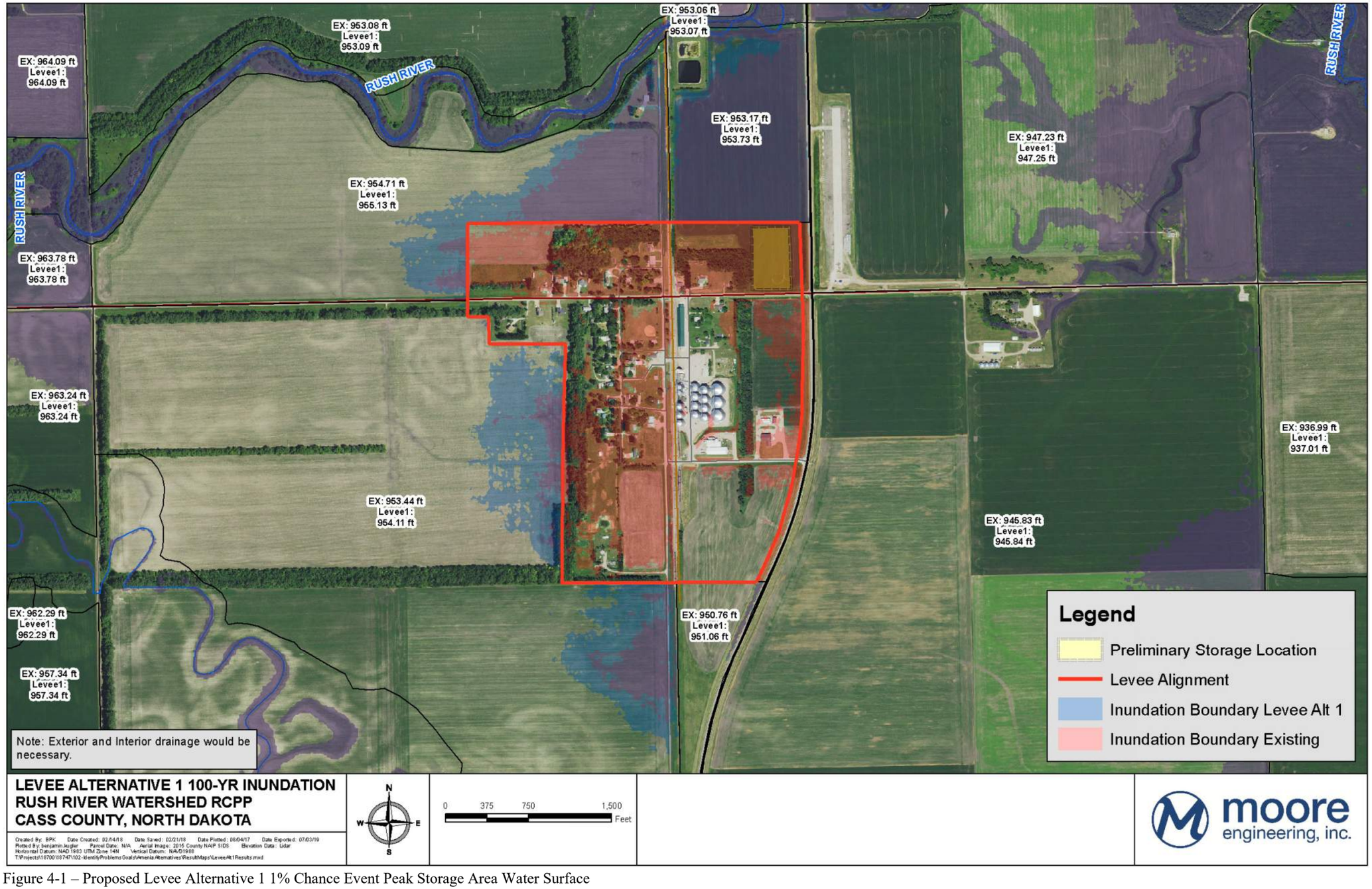


Figure 4-1 – Proposed Levee Alternative 1 1% Chance Event Peak Storage Area Water Surface

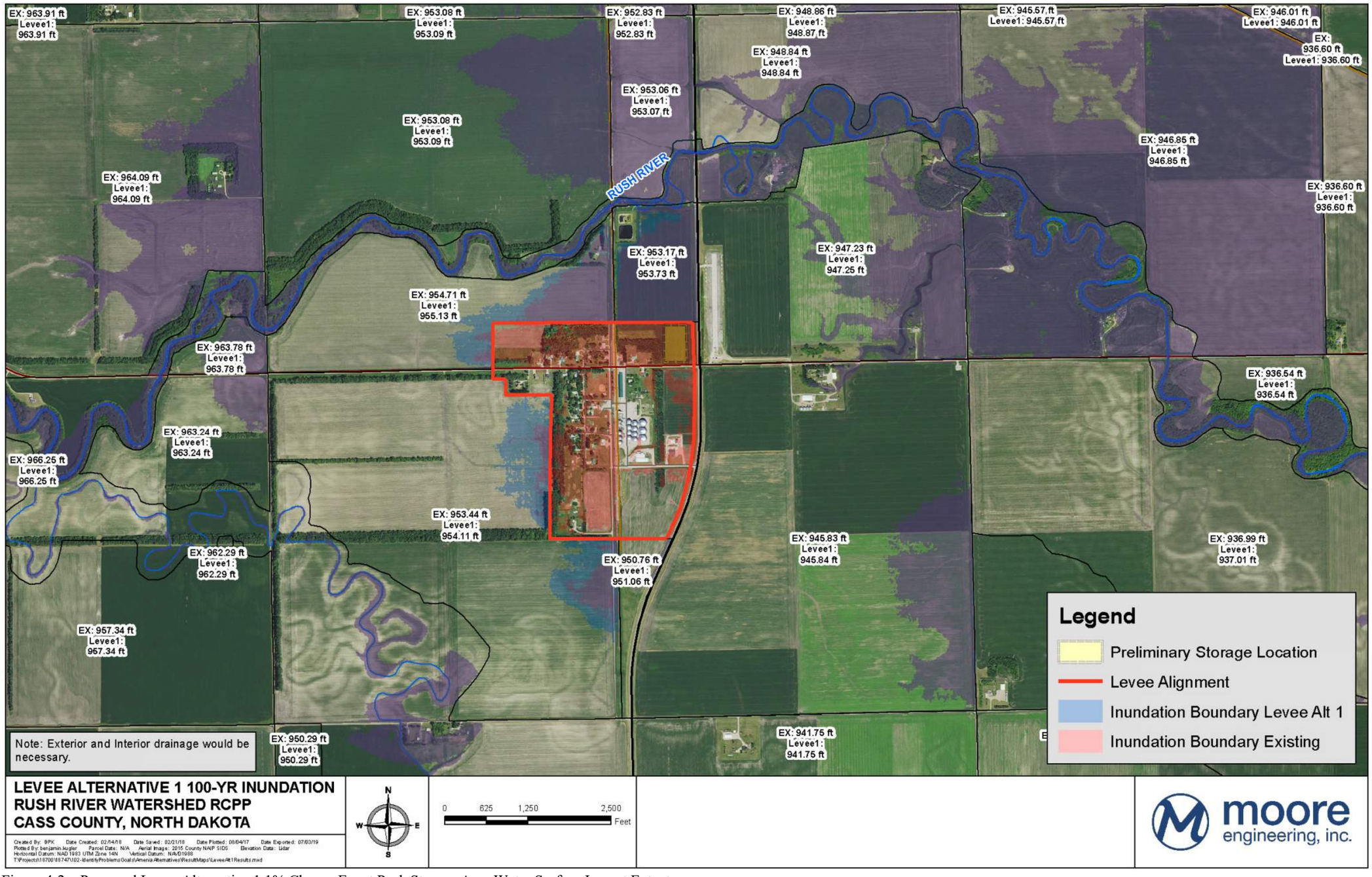


Figure 4-2 – Proposed Levee Alternative 1 1% Chance Event Peak Storage Area Water Surface Impact Extents

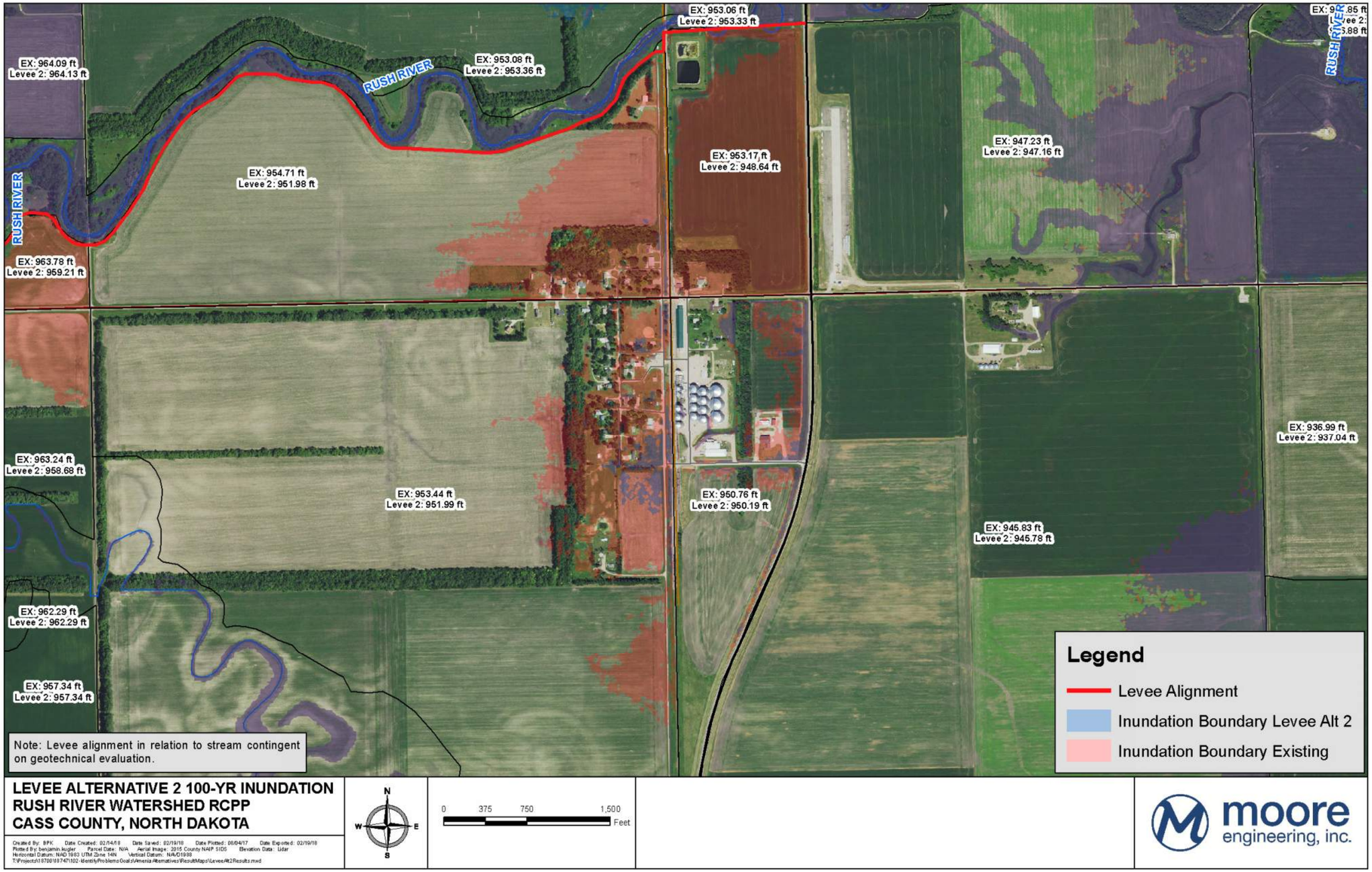


Figure 4-3 – Proposed Levee Alternative 2 1% Chance Event Peak Storage Area Water Surface

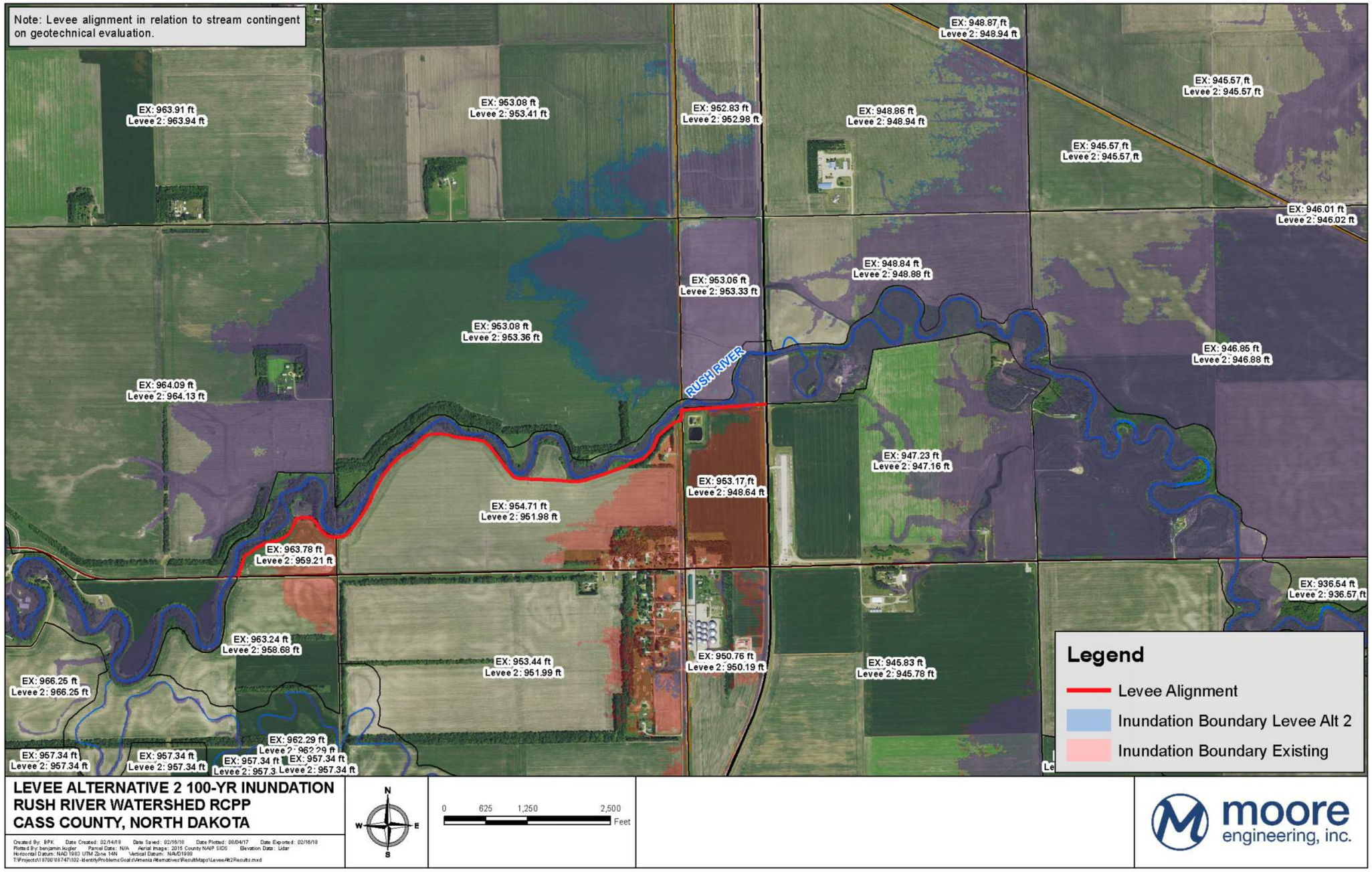


Figure 4-4 – Proposed Levee Alternative 2 1% Chance Event Peak Storage Area Water Surface Impact Extents

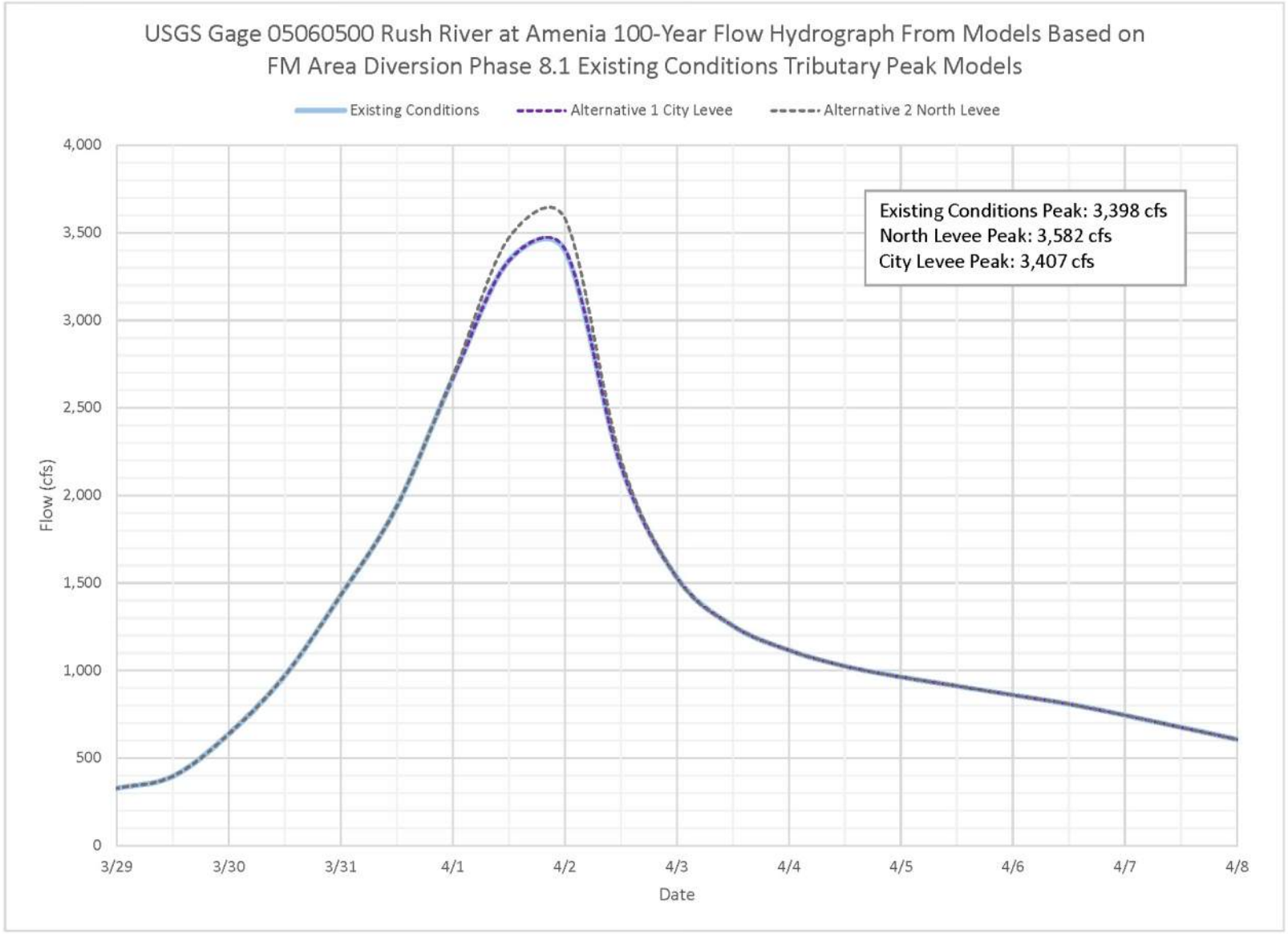


Figure 4-5 – Proposed Levee Alternatives 1% Chance Event Hydrograph at USGS Gage Rush River at Amenia

5. Bibliography

[1] US Army Corps of Engineers, "Supplemental Draft Feasibility Report and Environmental Impact Statement - Appendix A-4b: Hydrology," St Paul, MN, April 2011.

[2] U.S. Army Corps of Engineers, "EM-1110-2-1413 - Hydrologic Analysis of Interior Areas," 1987.

[3] NRCS, "Title 210 - National Engineering Manual Part 520 - Soil and Water Resource Development Subpart C - Dams," 2017.

[4] FM Diversion Authority, "FM Diversion CLOMR Submittal," 2017.

[5] Barr Engineering Company, "Preliminary Geotechnical Engineering Report Rush River Watershed - Amenia Levee Alternative Sites Alt1 and Alt2 Cass County, North Dakota," 2019.

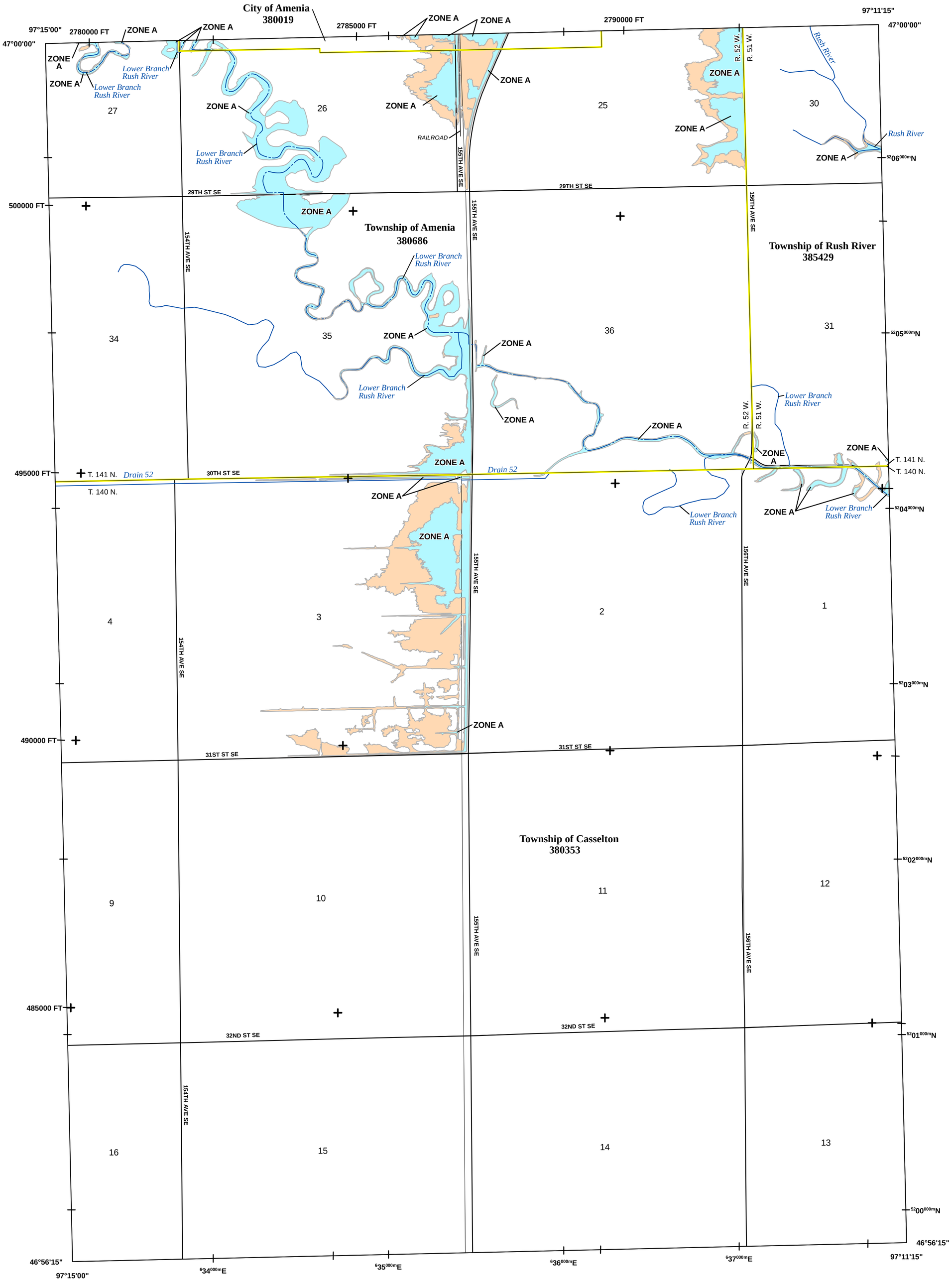
[6] NWS NOAA, "NOAA Atlas 14 Point Precipitation Frequency Estimates," 2020. [Online]. Available: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html.

[7] USDA NRCS, "National Engineering Handbook Chapter 4 Storm Rainfall Depth and Distribution," 2019.

[8] MnDOT Bridge Hydraulics, "Tips for Using Atlas 14 - Precipitation Data Frequency Server," 5 April 2013. [Online]. Available: http://www.dot.state.mn.us/bridge/pdf/hydraulics/Atlas14_PrecipitationDataFrequencyServer.pdf. [Accessed 15 January 2014].

Appendix A Preliminary FEMA Flood Insurance Rate Maps

Appendix D-1-A



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTP://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*

OTHER AREAS
- NO SCREEN Areas of Minimal Flood Hazard *Zone X*
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert or Storm Sewer
- Levee, Dike or Floodwall

OTHER FEATURES
- 18.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation (BFE)
- 8 Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

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SCALE

N

Map Projection:
Universal Transverse Mercator Zone 14N; North American Datum 1983; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 1,000 feet 1:12,000

0 1,000 2,000 4,000 feet

0 250 500 1,000 meters

PANEL LOCATOR

*PANEL NOT PRINTED

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

CASS COUNTY, NORTH DAKOTA
(All Jurisdictions)

PANEL 505 OF 995

FEMA

Panel Contains:

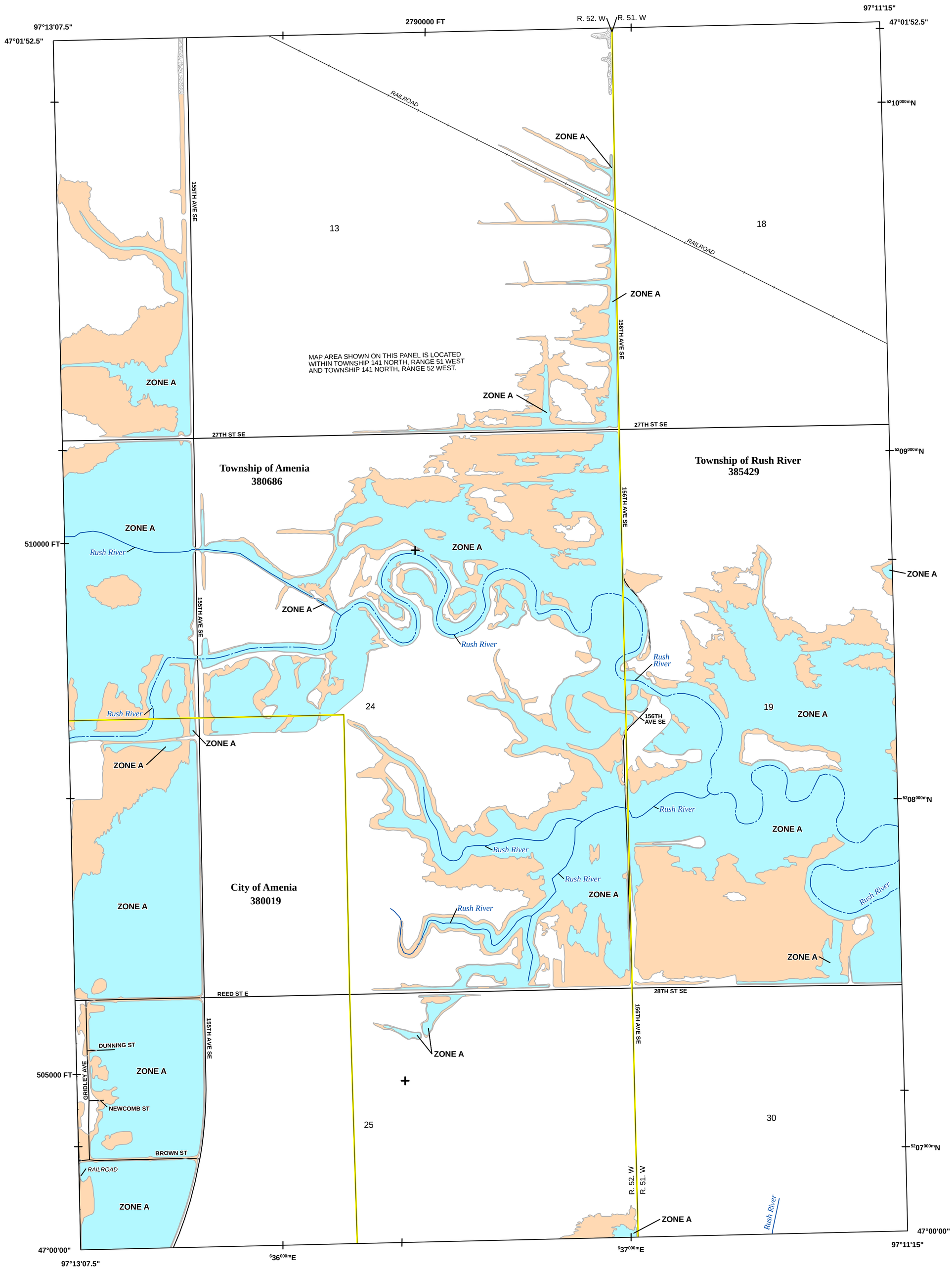
COMMUNITY	NUMBER	PANEL	SUFFIX
AMENIA, CITY OF	380019	0505	H
AMENIA, TOWNSHIP OF	380686	0505	H
CASSELTON, TOWNSHIP OF	380353	0505	H
RUSH RIVER, TOWNSHIP OF	385429	0505	H

REVISED PRELIMINARY 7/18/2018

VERSION NUMBER
2.3.3.2

MAP NUMBER
38017C0505H

MAP REVISED



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- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
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- 513 — Base Flood Elevation Line (BFE)
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SCALE

N

Map Projection:
Universal Transverse Mercator Zone 14N; North American Datum 1983; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 250 500 750 1,000 2,000 feet

0 125 250 500 meters

PANEL LOCATOR

*PANEL NOT PRINTED

FEMA National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

CASS COUNTY, NORTH DAKOTA
(All Jurisdictions)

PANEL 314 OF 995

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
AMENIA, CITY OF	380019	0314	H
AMENIA, TOWNSHIP OF	380686	0314	H
RUSH RIVER, TOWNSHIP OF	385429	0314	H

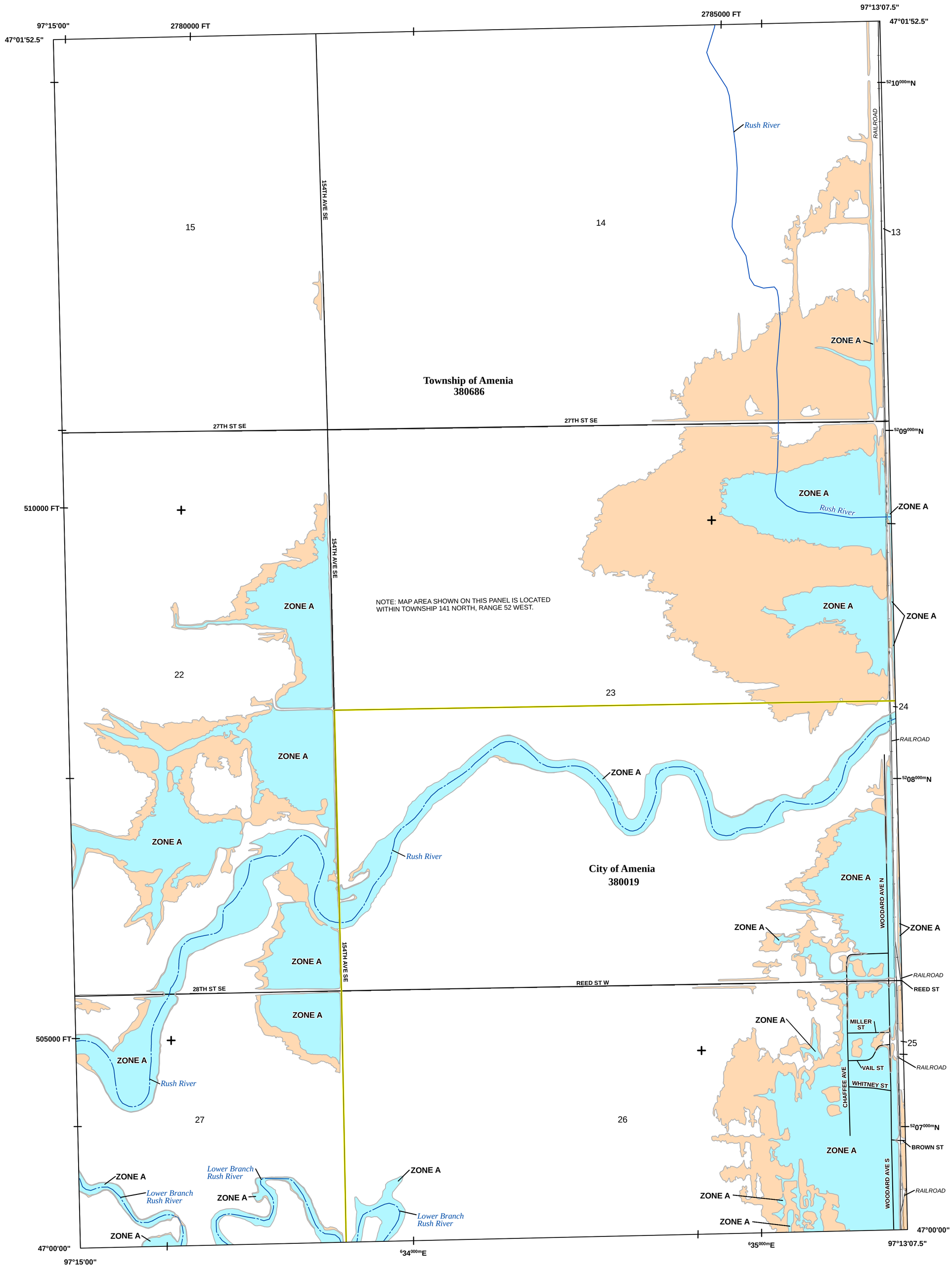
REVISED PRELIMINARY 7/18/2018

VERSION NUMBER
2.3.3.2

MAP NUMBER
38017C0314H

MAP REVISED

D-1-A-2



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SCALE

N

Map Projection:
Universal Transverse Mercator Zone 14N; North American Datum 1983; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 250 500 750 1,000 2,000 feet

0 125 250 500 meters

PANEL LOCATOR

*PANEL NOT PRINTED

FEMA National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

CASS COUNTY, NORTH DAKOTA
(All Jurisdictions)

PANEL 313 OF 995

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
AMENIA, CITY OF	380019	0313	H
AMENIA, TOWNSHIP OF	380686	0313	H

REVISED PRELIMINARY 7/18/2018

VERSION NUMBER
2.3.3.2

MAP NUMBER
38017C0313H

MAP REVISED

D-1-A-3

Appendix B Alternative 1 Plans & Cost Estimate

Appendix D-1-B

FILE LOCATION: R:\Civil 3D Projects\18747\DRAWINGS\DESIGN\18747-SOUTH-LEVEE-ALT.dwg

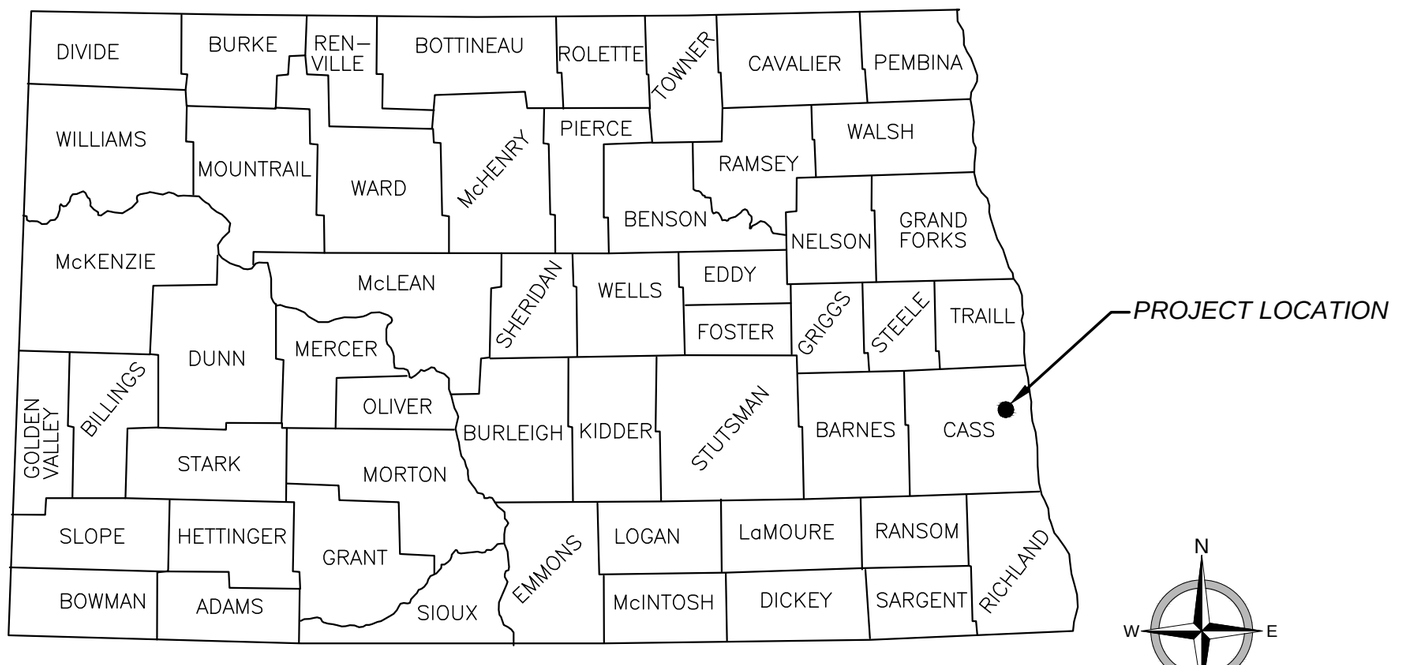
RCPP/PL566
RUSH RIVER - AMENIA
SOUTH LEVEE ALTERNATIVE

CASS COUNTY JOINT
WATER RESOURCE DISTRICT

CASS COUNTY, NORTH DAKOTA

moore engineering, inc.
Consulting Engineering • Land Surveying
925 10th Avenue East • West Fargo, North Dakota
www.mooreengineeringinc.com

VICINITY MAP



D-1-B-1

PRELIMINARY

PROJECT No. 18747

FILE LOCATION: R:\Civil 3D Projects\18747\DRAWINGS\DESIGN\18747-SOUTH-LEVEE-ALT.dwg

TABLE OF CONTENTS

PRELIMINARY

moore engineering, inc.

TABLE OF CONTENTS
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
TABLE OF CONTENTS

DATE:	01.24.19
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

G-002

SHEET 2 OF 2

D-1-B-2

CIVIL LEGEND

- BENCHMARK
- IRON MONUMENT FOUND
- EXISTING GAS LINE MARKER
- EXISTING GAS GATE VALVE
- EXISTING POWER POLE
- EXISTING LIGHT POLE
- EXISTING LIGHT POLE W/SIGN
- EXISTING GUY WIRE
- EXISTING TRAFFIC SIGNAL ARM
- EXISTING SIGN
- EXISTING CULVERT W/FLARED END SECTION (F.E.S.)
- EXISTING FLARED END SECTION (F.E.S.)
- EXISTING CURB STOP
- EXISTING HYDRANT W/GATE VALVE
- EXISTING GATE VALVE
- EXISTING FITTINGS
- EXISTING PLUG
- EXISTING PROPANE TANK
- EXISTING SANITARY SEWER MANHOLE
- EXISTING SANITARY SEWER CLEANOUT
- EXISTING STORM SEWER CATCH BASIN
- EXISTING STORM SEWER MANHOLE
- W — EXISTING WATER MAIN
- EXISTING WATER SERVICE W/CURB STOP
- SS — EXISTING SANITARY SEWER
- SS–FM — EXISTING SANITARY FORCEMAIN
- EXISTING SANITARY SEWER SERVICE
- ST — EXISTING STORM SEWER
- ST–FM — EXISTING STORM SEWER FORCEMAIN
- STEAM — EXISTING STEAM PIPE
- EXISTING AIR CONDITIONER
- U — EXISTING UTILITY PEDESTAL
- EXISTING UTILITY MANHOLE
- C — EXISTING UNDERGROUND COMMUNICATIONS
- F — EXISTING UNDERGROUND FIBER
- T — EXISTING UNDERGROUND TELEPHONE
- OHT — EXISTING OVERHEAD TELEPHONE
- TV — EXISTING UNDERGROUND TELEVISION
- OHTV — EXISTING OVERHEAD TELEVISION
- G — EXISTING UNDERGROUND GAS
- E — EXISTING UNDERGROUND ELECTRIC
- OHP — EXISTING OVERHEAD POWER
- X — EXISTING BARBED WIRE FENCE
- EXISTING CHAIN LINK/STEEL FENCE
- EXISTING PVC/WOOD FENCE
- EXISTING SHRUB
- EXISTING STUMP
- EXISTING TREE/TREE CLUSTER
- EXISTING SPRINKLER HEAD
- 12 — EXISTING CLUSTER BOX UNIT (CBU)
- EXISTING MAILBOX
- EXISTING CURB AND GUTTER
- CURB AND GUTTER REMOVAL & REPLACEMENT
- REMOVE EXISTING SURFACE
- EXISTING ASPHALT SURFACE
- EXISTING CONCRETE SURFACE
- EXISTING DECORATIVE COLORED CONCRETE
- EXISTING GRANULAR SURFACE
- EXISTING SIDEWALK/MULTI–USE PATH (UNKNOWN SURFACE)
- EXISTING LANDSCAPING
- EXISTING RIPRAP
- EXISTING WETLANDS
- EXISTING PERMANENT POOL

- NEW LIGHT POLE
- NEW LIGHT POLE W/SIGN
- NEW GUY WIRE
- NEW SIGN
- TRAFFIC CONTROL – DRUM
- TRAFFIC CONTROL – TUBULAR MARKER
- NEW CULVERT W/FLARED END SECTION (F.E.S.)
- NEW FLARED END SECTION (F.E.S.)
- NEW CURB STOP
- NEW HYDRANT W/GATE VALVE
- NEW GATE VALVE
- NEW TAPPING SLEEVE
- NEW FITTINGS
- NEW PLUG
- NEW SANITARY SEWER MANHOLE
- NEW SANITARY SEWER CLEANOUT
- NEW STORM SEWER CATCH BASIN
- NEW STORM SEWER MANHOLE
- W — NEW WATER MAIN
- NEW WATER SERVICE W/CURB STOP (S.B. ELEV.)
- SS — NEW SANITARY SEWER
- SS–FM — NEW SANITARY FORCEMAIN
- NEW SANITARY SEWER SERVICE (S.S. ELEV.)
- ST — NEW STORM SEWER
- ST–FM — NEW STORM SEWER FORCEMAIN
- STEAM — NEW STEAM PIPE
- IN — INSULATION PER DETAIL
- X — NEW BARBED WIRE FENCE
- NEW CHAIN LINK/STEEL FENCE
- NEW PVC/WOOD FENCE
- NEW INFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW OUTFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW INFLOW CURB AND GUTTER (HIGHBACK)
- NEW OUTFLOW CURB AND GUTTER (HIGHBACK)
- NEW CURB PAINT
- NEW ASPHALT SURFACE
- NEW CONCRETE SURFACE
- NEW CONCRETE APPROACH/DRIVEWAY
- NEW DECORATIVE COLORED CONCRETE
- NEW GRANULAR SURFACE
- NEW CRUSHED CONCRETE SURFACE
- NEW CONCRETE SIDEWALK/MULTI–USE PATH
- NEW DETECTABLE WARNING PANEL
- NEW RIPRAP
- NEW PERMANENT POOL
- NEW LANDSCAPING
- MILLING – 2" UNIFORM
- MILLING – 2" TAPERED
- ASPHALT PATCH
- LEVELING COURSE
- OVERLAY
- CHIPSEAL AND FOG COAT
- NEW CONCRETE VALLEY GUTTER
- NEW MEDIAN NOSE APRON
- NEW ADA RAMP W/WARNING PANEL
- 12 — NEW CLUSTER BOX UNIT (CBU)
- NEW MAILBOX
- NEW LARGE DECIDUOUS TREE
- NEW SMALL DECIDUOUS TREE
- NEW SHRUB
- NEW LARGE EVERGREEN TREE
- NEW SMALL EVERGREEN TREE

- DRAINAGE BREAK LINE
- EXISTING DRAINAGE DIRECTION
- 2.0% — FINISHED DRAINAGE DIRECTION & SLOPE
- 4:1 — FINISHED GRADE
- 895 — EXISTING CONTOUR ELEVATION
- 895 — FINISHED CONTOUR ELEVATION
- 900.07 FL — GRADE ELEVATIONS
- GRASS BUFFER
- PERMANENT STABILIZATION AREA
- SEDIMENTATION CONTROL WATTLE
- SEDIMENTATION CONTROL FENCE
- ROCK CHECK
- S.C.E. — STABILIZED CONSTRUCTION ENTRANCE
- CONCRETE WASHOUT
- INLET PROTECTION DEVICE

ABBREVIATIONS:

BOC = BACK OF CURB
BOW = BACK OF WALK
C = COMMUNICATION
CB# = STORM SEWER CATCH BASIN
CL = CENTERLINE
CSP = CORRUGATED STEEL PIPE
CO# = SANITARY SEWER CLEANOUT
CS# = CONTROL STRUCTURE
DIA = DIAMETER
DIP = DUCTILE IRON PIPE
E = ELECTRICAL
ECC = EDGE OF CRUSHED CONCRETE
EG = EXISTING GRADE
EOC = EDGE OF CONCRETE
EOP = EDGE OF PAVEMENT
EOW = EDGE OF WALK
EG= EXISTING GRADE
EX = EXISTING
F = FIBER OPTIC
FES = FLARED END SECTION
FG = FINISHED GRADE
FL = FLOWLINE
FM = FORCEMAIN
G = GAS LINE
HP = HIGH POINT
INV = INVERT
LP = LOW POINT
MATCH = MATCH
M# = STORM SEWER MANHOLE
MT# = STORM SEWER TEE MANHOLE
MM# = STORM SEWER MULTI–MANHOLE
MC = MIDPOINT OF CURVE
OHP = OVERHEAD POWER
OHT = OVERHEAD TELEPHONE
OHTV = OVERHEAD TELEVISION
PC = POINT OF CURVATURE
PRC = POINT OF REVERSE CURVE
PVC = POLYVINYL CHLORIDE PIPE
PT = POINT OF TANGENCY
RIM = RIM OF STRUCTURE
S# = SANITARY SEWER MANHOLE
S.B. ELEV. = STOP BOX ELEVATION
S.S. ELEV. = SANITARY SEWER SERVICE INVERT
S.S. = SANITARY SEWER
S.T. = STORM SEWER
STA = ALIGNMENT STATION
T = TELEPHONE
TOC = TOP OF CONCRETE
TOP = TOP OF PAVEMENT
TOP = TOP OF PIPE
TOW = TOP OF WALK
TR# = SANITARY TELEVISING RISER
TRANS = TRANSFORMER
TV = TELEVISION
U = UTILITY (UNKNOWN UTILITY)

D-1-B-3

PRELIMINARY

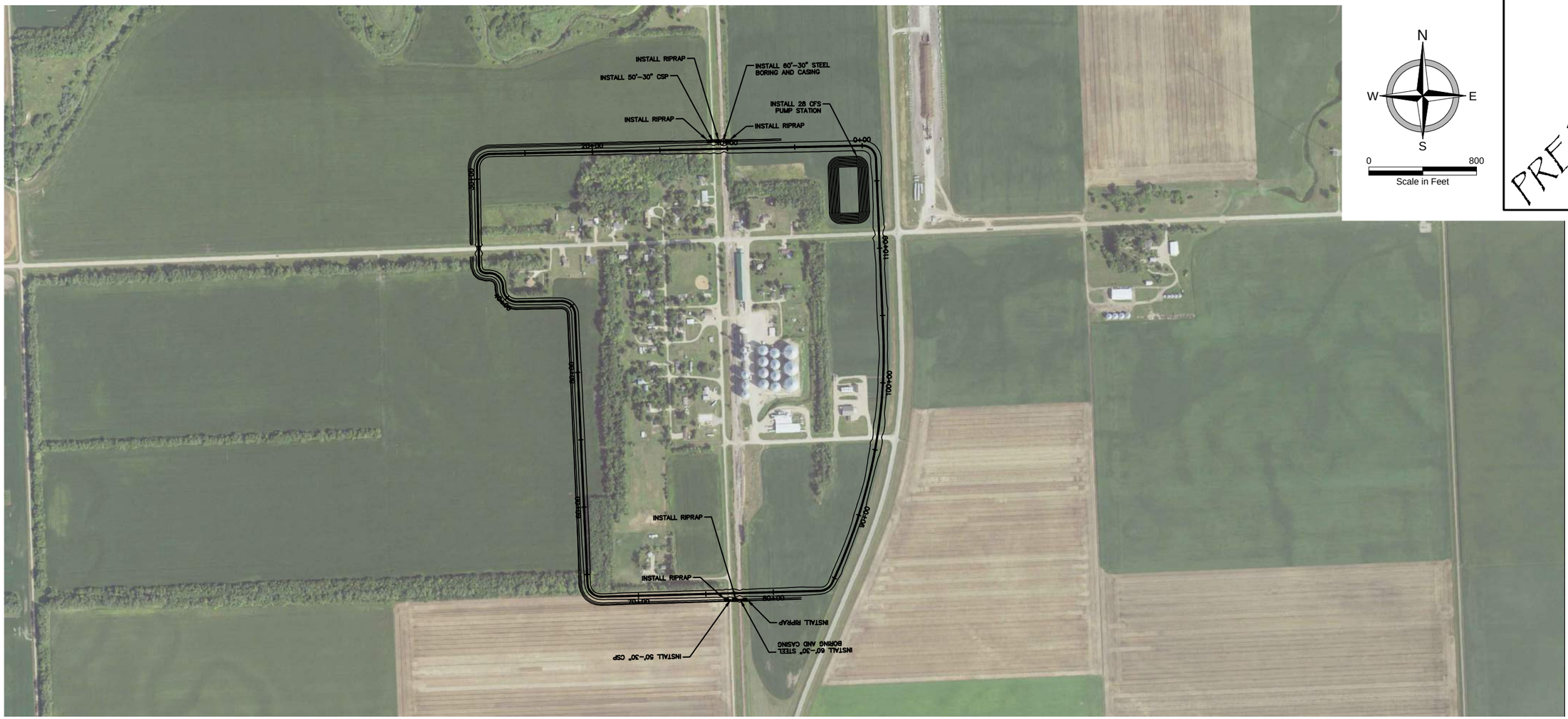
moore engineering, inc.

CIVIL LEGEND
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
CIVIL LEGEND

DATE:	01.24.19
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-001

SHEET 1 OF 10



N
W
E
S
0
800
Scale in Feet

PRELIMINARY

moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
ALIGNMENTS, LINE AND CURVE TABLES AND SURVEY CONTROL

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998875
ALL COORDINATES ARE CASS COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

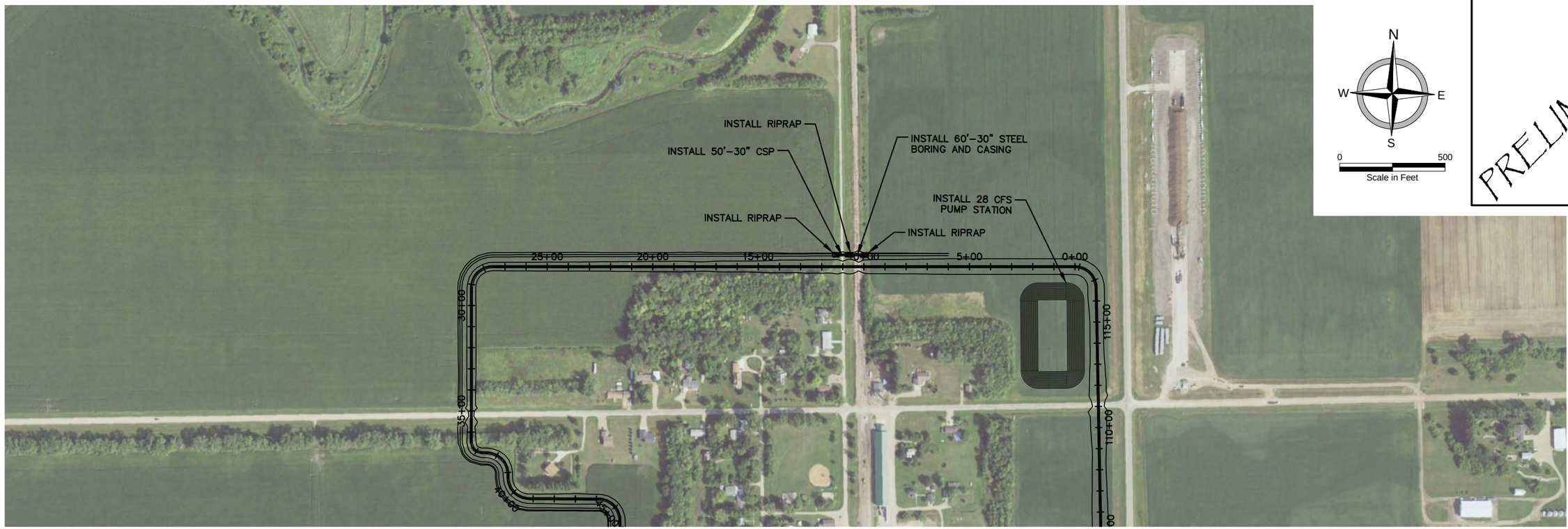
PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

D-1-B-4

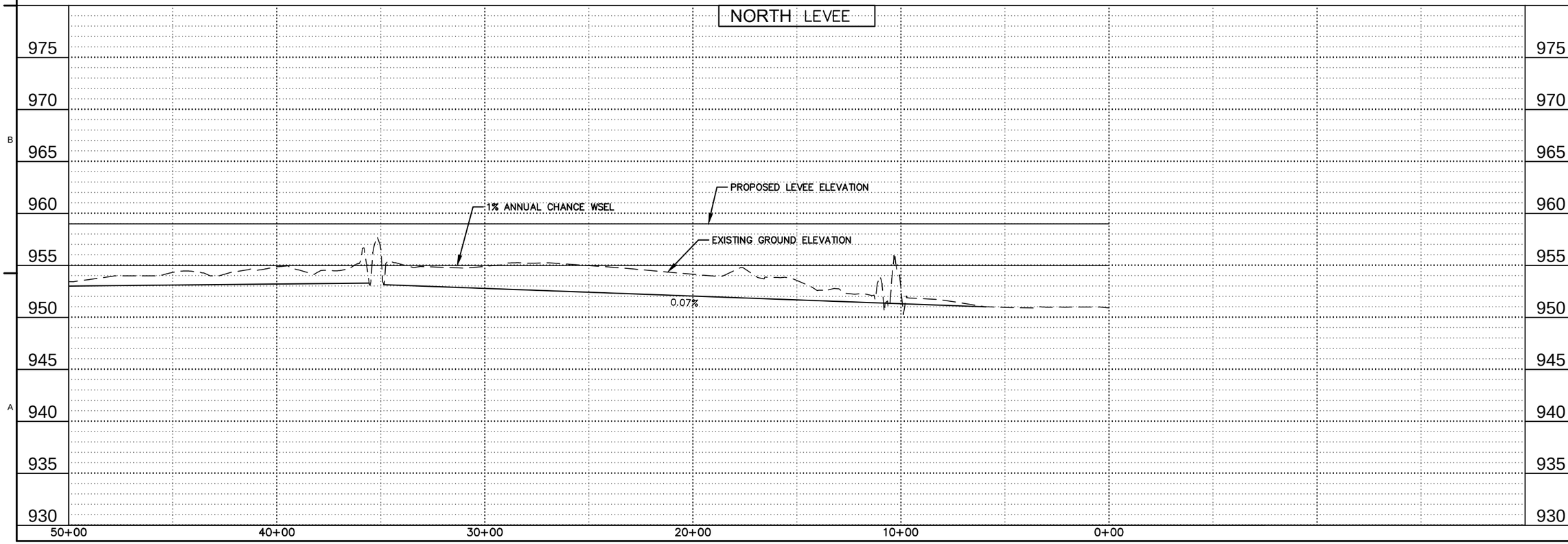
DATE:	01.24.19
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-101

SHEET 2 OF 10



PRELIMINARY



moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
SOUTH LEVEE

DATE:	01.24.19
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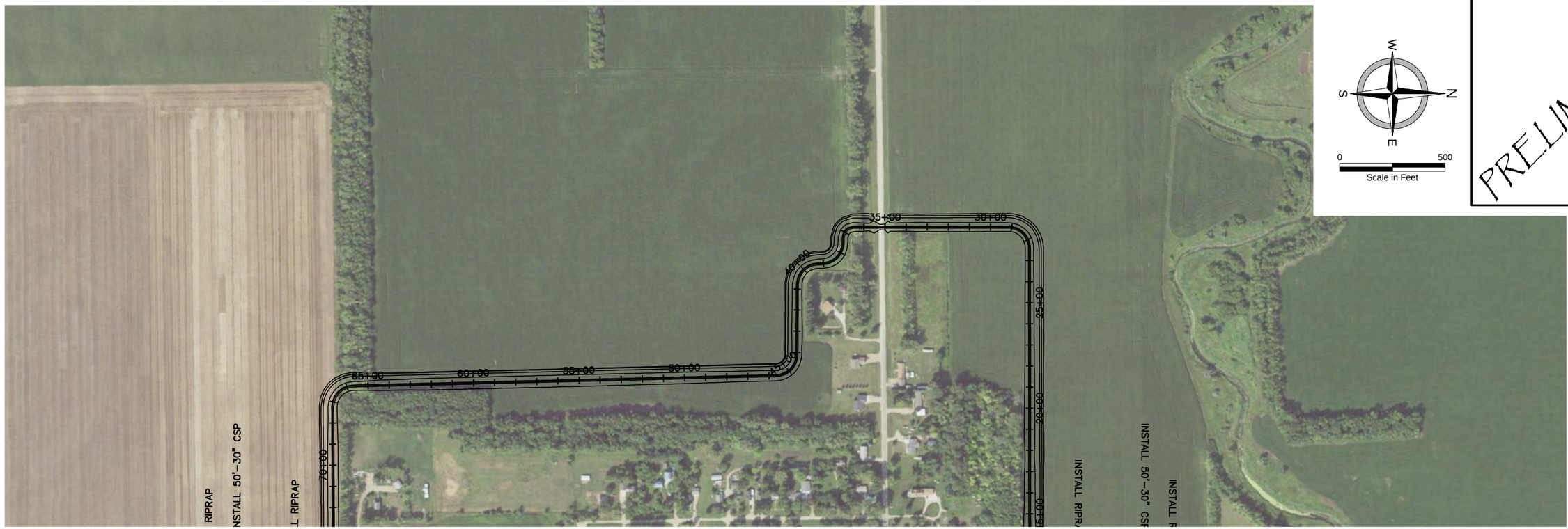
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-201

SHEET 3 OF 10

FILE LOCATION: R:\Civil 3D Projects\18747\DRAWINGS\DESIGN\18747-SOUTH-LEVEE-ALT.dwg



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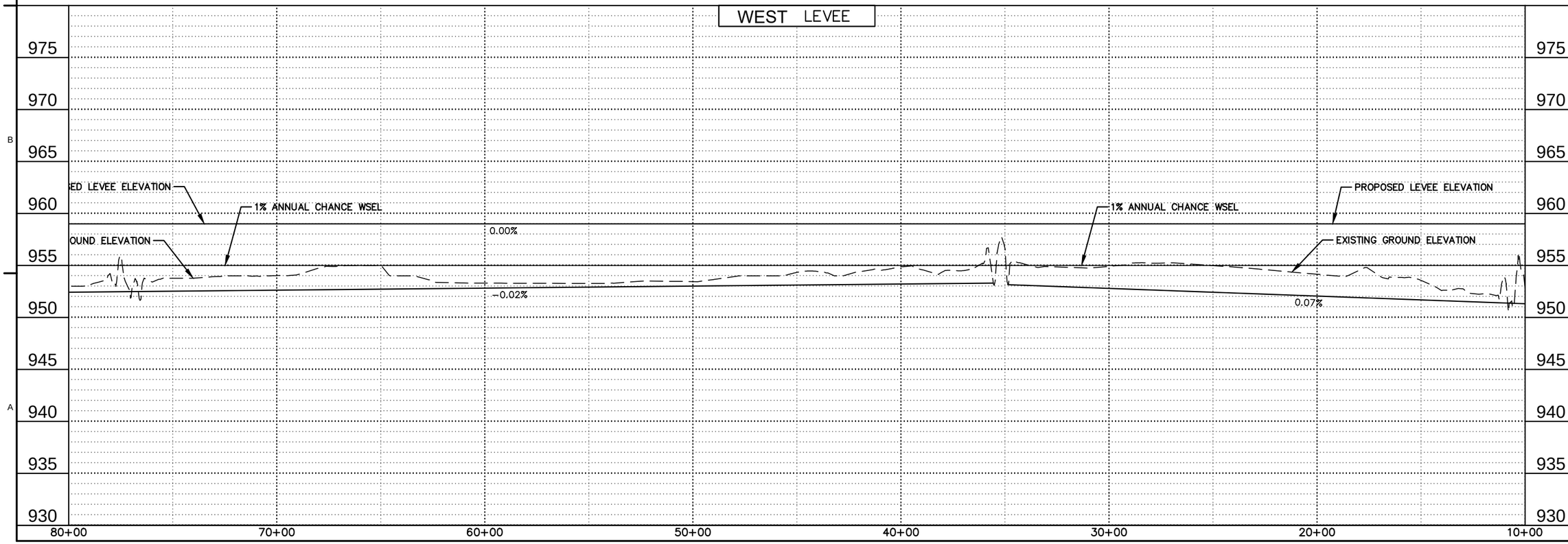

moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
SOUTH LEVEE

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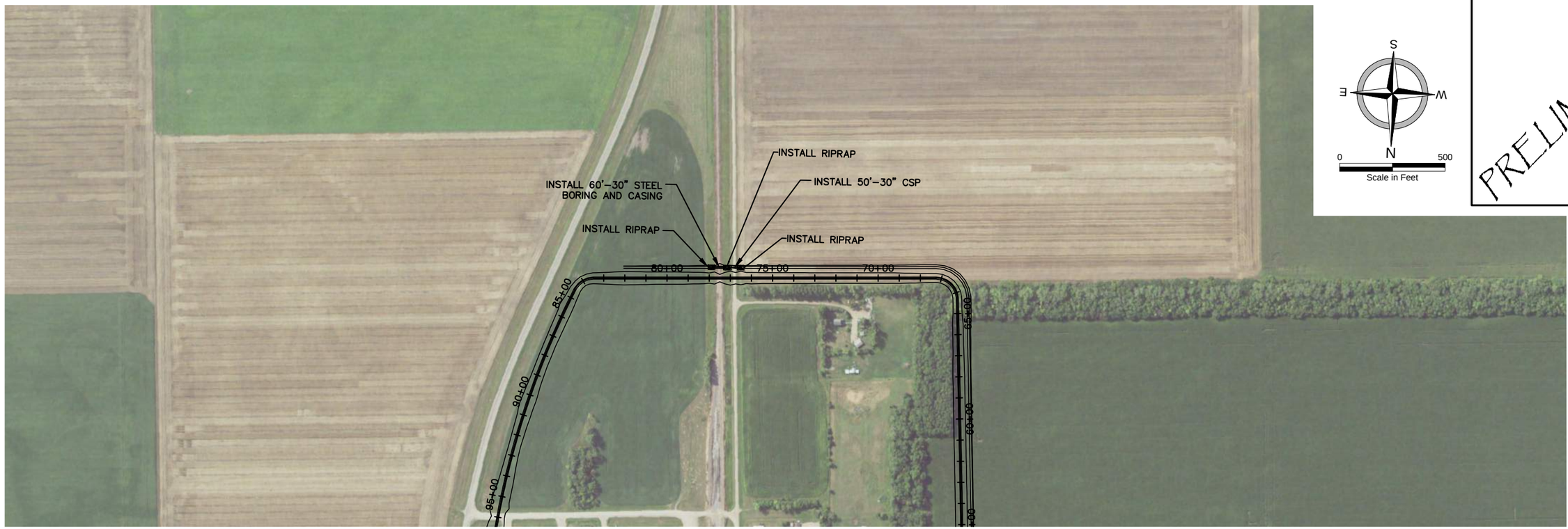
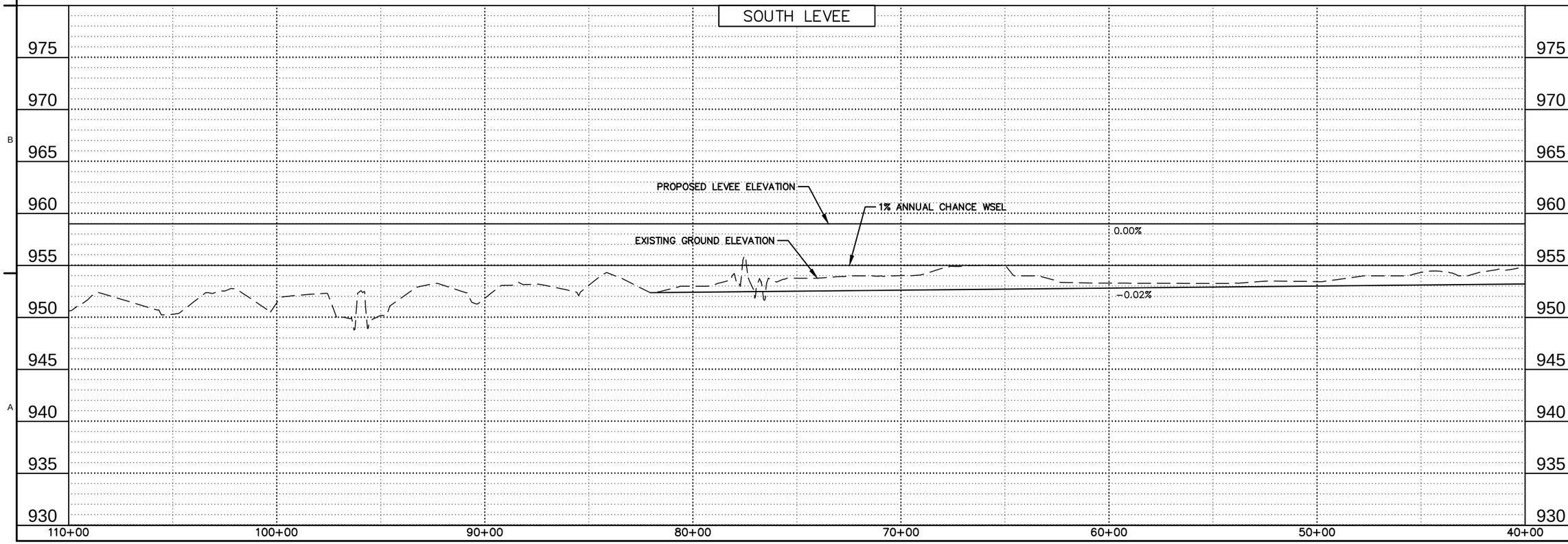
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-202

SHEET 4 OF 10



PRELIMINARY



moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
SOUTH LEVEE

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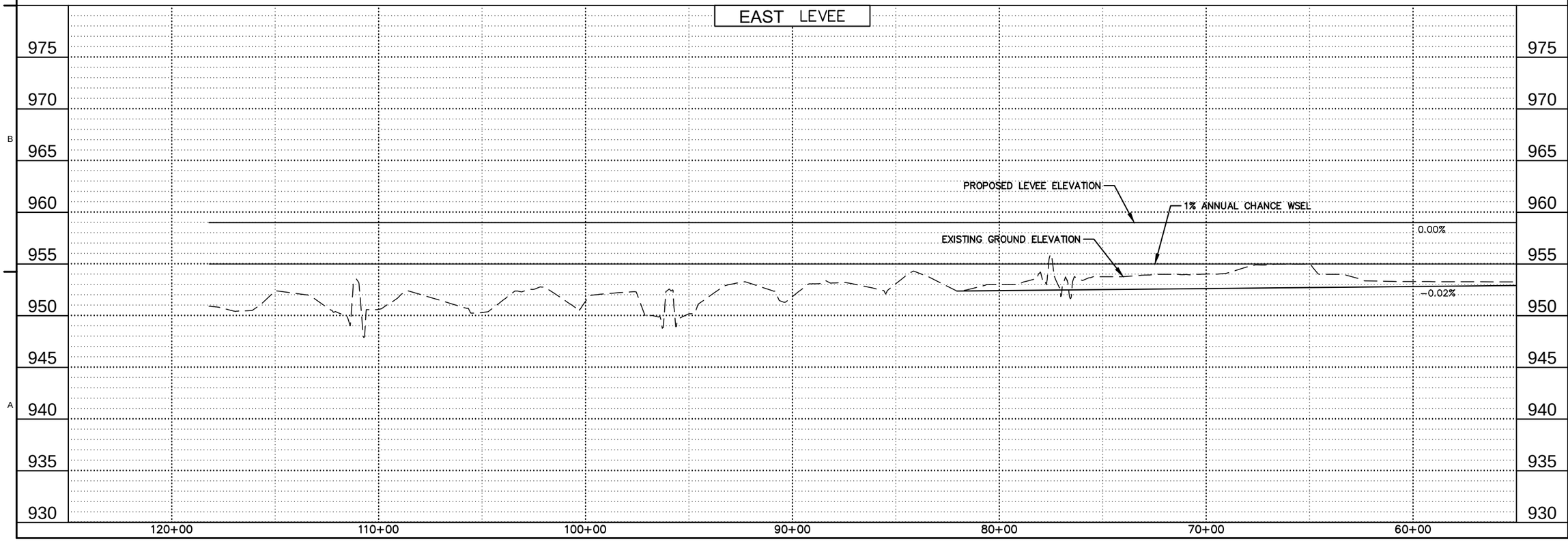
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-203

SHEET 5 OF 10

FILE LOCATION: R:\Civil 3D Projects\18747\DRAWINGS\DESIGN\18747-SOUTH-LEVEE-ALT.dwg

PRELIMINARY



moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
SOUTH LEVEE

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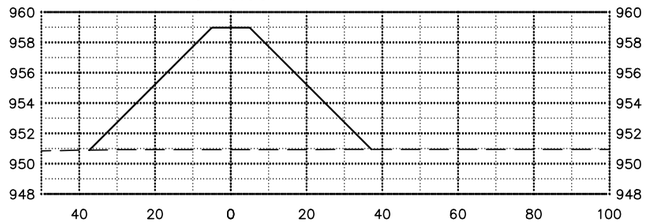
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-204

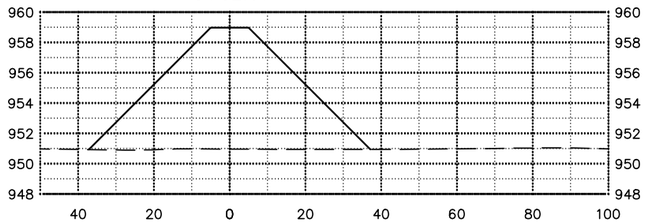
SHEET 6 OF 10

FILE LOCATION: R:\Civil 3D Projects\18747\DRAWINGS\DESIGN\18747-SOUTH-LEVEE-ALT.dwg

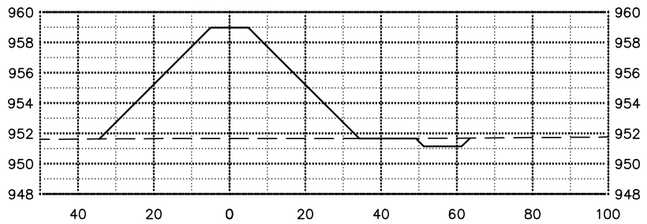
0+19.95



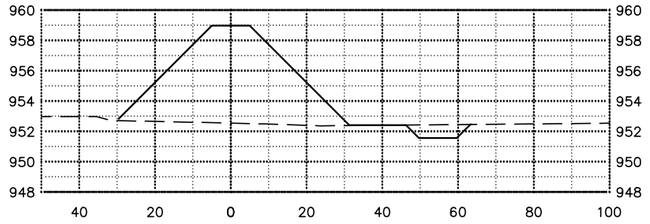
3+02.61



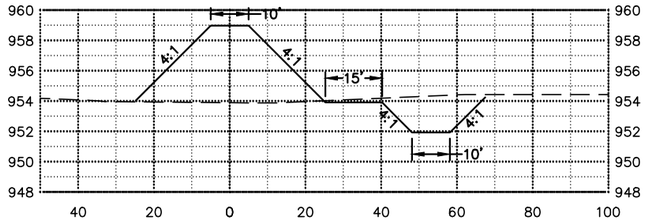
8+03.41



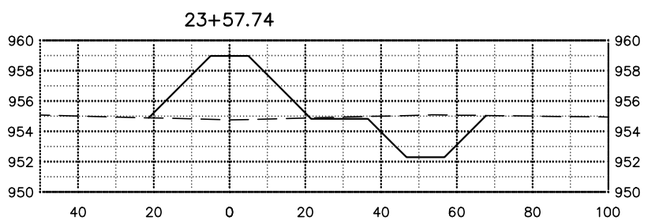
13+57.46



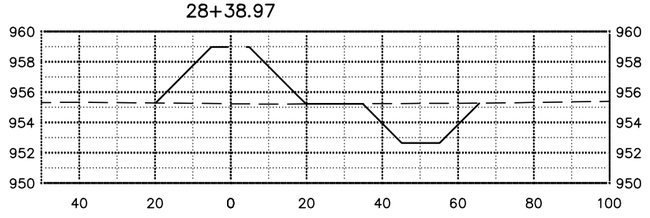
18+66.47



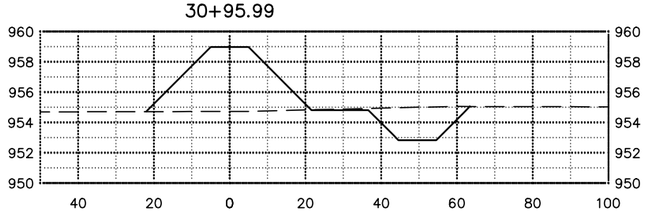
23+57.74



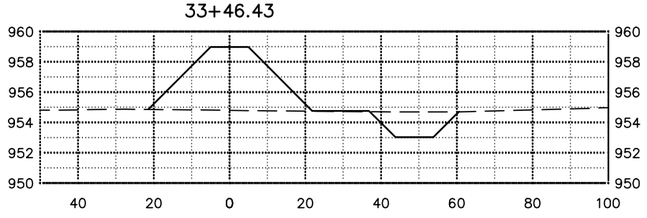
28+38.97



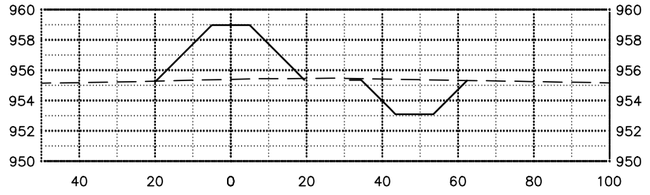
30+95.99



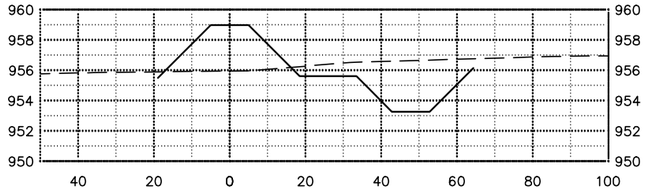
33+46.43



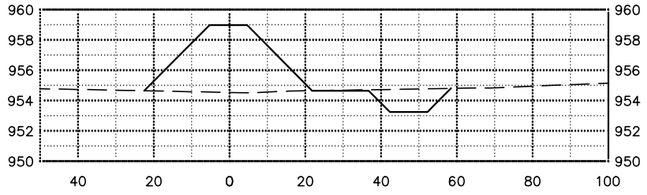
34+54.99



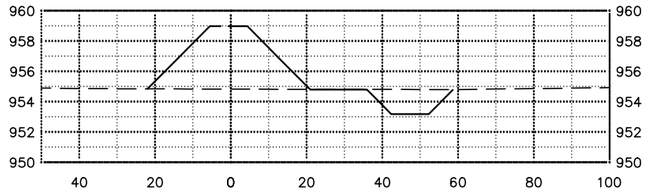
35+91.86



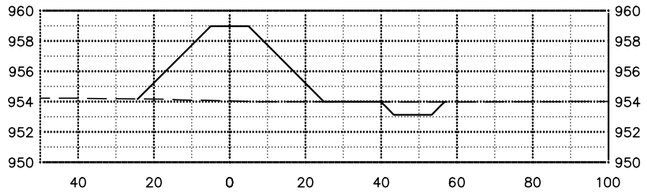
36+82.38



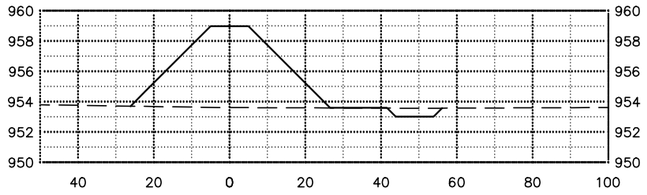
40+12.26



42+66.42



49+04.47



PRELIMINARY

moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
CROSS SECTIONS

DATE:	01.24.19
REVISED:	----
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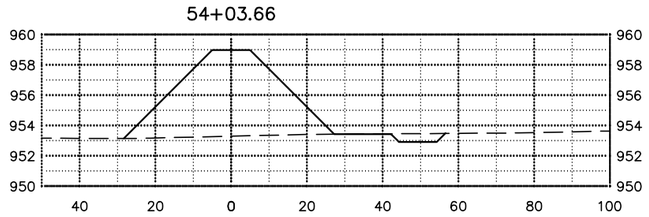
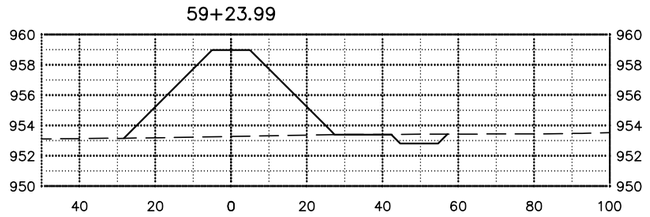
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

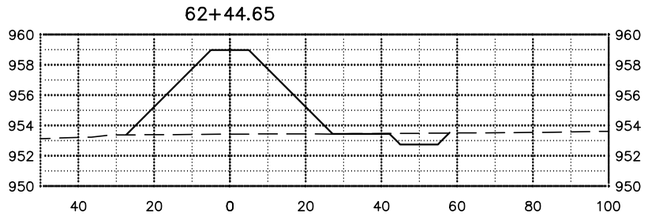
C-301

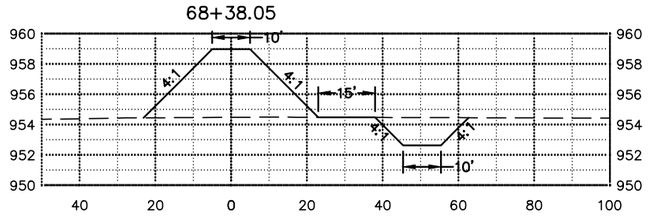
SHEET 7 OF 10

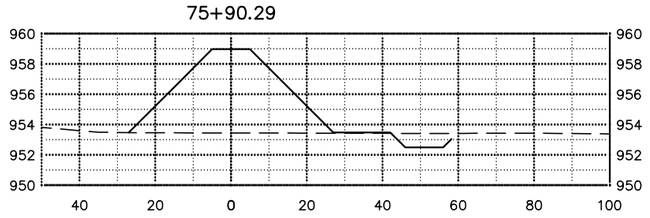
D-1-B-9

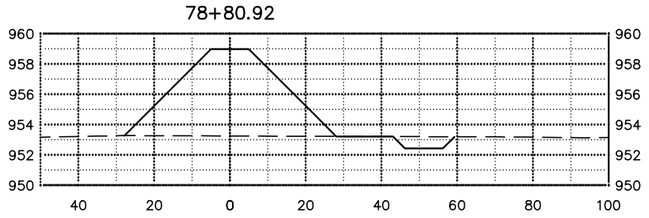


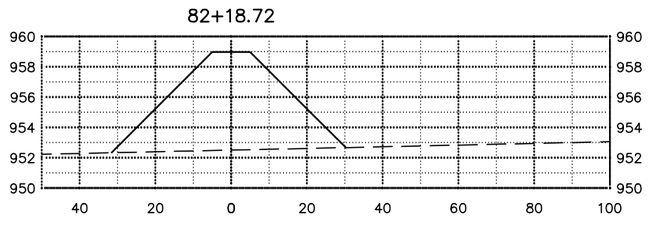


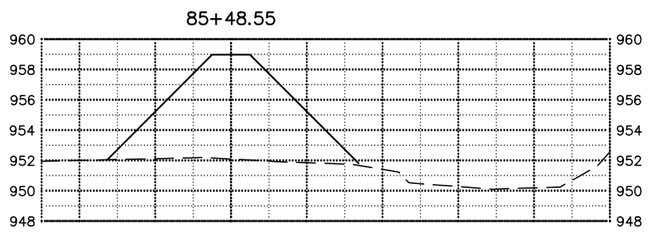


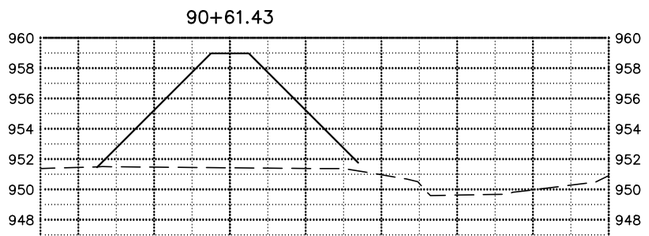


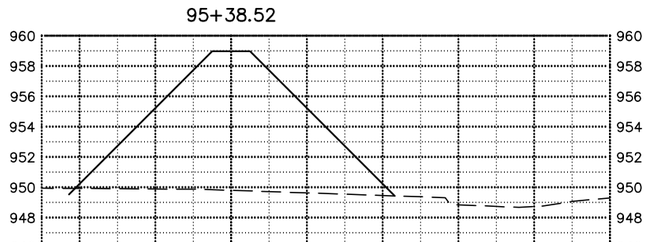


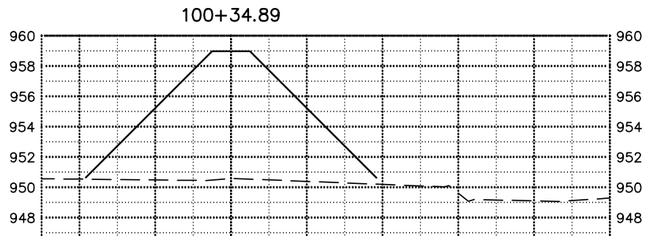


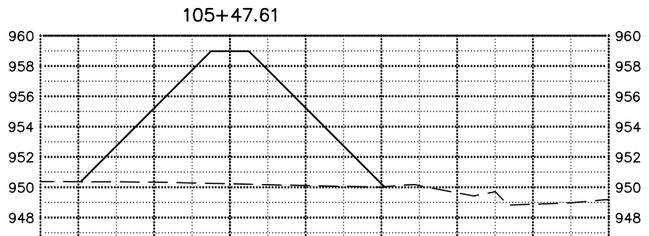












PRELIMINARY

moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
CROSS SECTIONS

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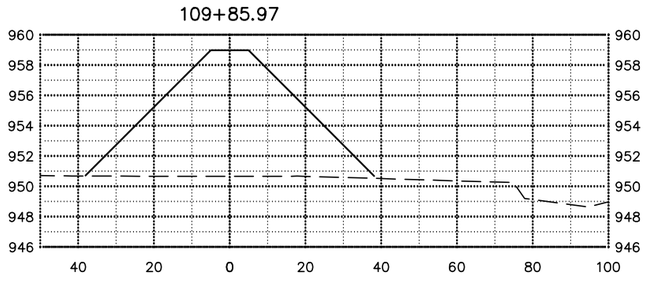
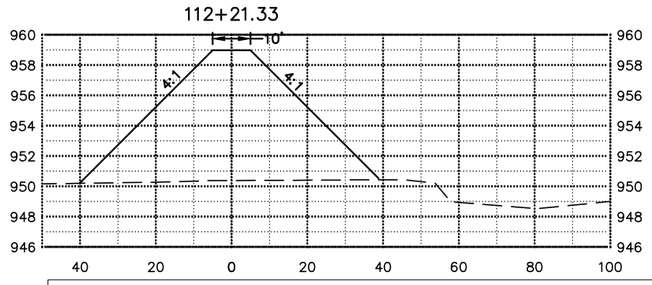
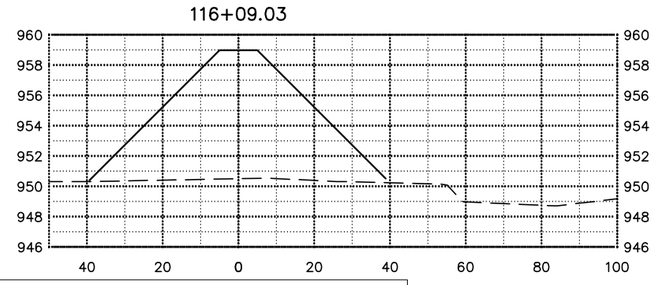
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

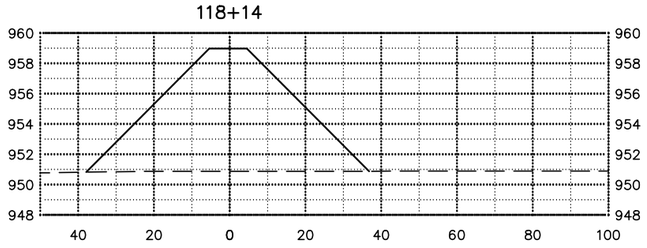
C-302

SHEET 8 OF 10









EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+19.95	0.00	339.39	0.00	0.00	0.00	0.00
3+02.61	0.00	338.32	0.00	3547.43	0.00	3547.43
8+03.41	6.52	287.23	60.48	5801.49	60.48	9348.92
13+57.46	11.88	230.45	188.80	5311.50	249.28	14660.42
18+66.47	49.67	152.82	580.14	3612.77	829.42	18273.19
23+57.74	59.39	110.44	992.18	2395.11	1821.60	20668.30
28+38.97	53.46	74.35	1090.83	1646.34	2912.42	22314.64
30+95.99	41.29	113.88	518.06	895.20	3430.48	23209.84
33+46.43	27.92	112.00	320.99	1047.63	3751.47	24257.46
34+54.99	43.99	87.31	144.58	400.70	3896.05	24658.16
35+91.86	89.57	65.77	338.52	388.01	4234.57	25046.17
36+82.38	24.45	120.33	257.33	311.22	4491.90	25357.39
40+12.26	26.79	100.92	321.68	1351.27	4813.58	26708.66
42+66.42	11.35	145.85	202.37	1161.53	5015.95	27870.19
49+04.47	6.83	168.18	189.62	3708.31	5205.57	31578.50
54+03.66	6.75	186.33	125.48	3277.11	5331.05	34855.61
59+23.99	7.77	187.01	139.85	3597.46	5470.90	38453.07
62+44.65	9.64	179.16	103.38	2174.39	5574.28	40627.46
68+38.05	31.64	126.27	513.19	3355.69	6087.48	43983.15
75+90.29	12.49	178.58	614.73	4246.62	6702.21	48229.77
78+80.92	10.16	188.74	121.89	1976.94	6824.09	50206.71
82+18.72	0.00	232.58	63.53	2635.54	6887.63	52842.25
85+48.55	0.00	264.20	0.00	3035.17	6887.63	55877.42
90+61.43	0.00	303.36	0.02	5391.07	6887.65	61268.49
95+38.52	0.33	432.69	2.88	6503.73	6890.52	67772.21
100+34.89	0.00	376.25	2.97	7436.79	6893.49	75209.01
105+47.61	0.00	394.70	0.00	7320.70	6893.49	82529.70
109+85.97	0.00	360.80	0.00	6132.95	6893.49	88662.65
112+21.33	0.00	384.29	0.00	3247.47	6893.49	91910.12
116+09.03	0.00	379.80	0.00	5485.92	6893.49	97396.04
118+14	0.00	342.13	0.00	2736.48	6893.49	100132.52

PRELIMINARY

moore
engineering, inc.

CROSS SECTIONS
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CASS COUNTY JOINT WATER RESOURCE DISTRICT
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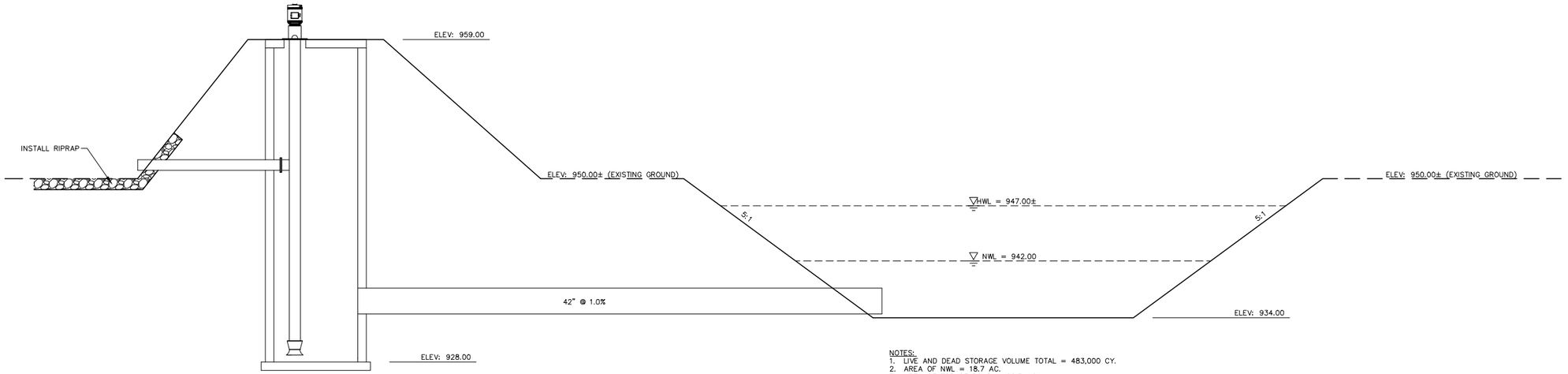
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-303

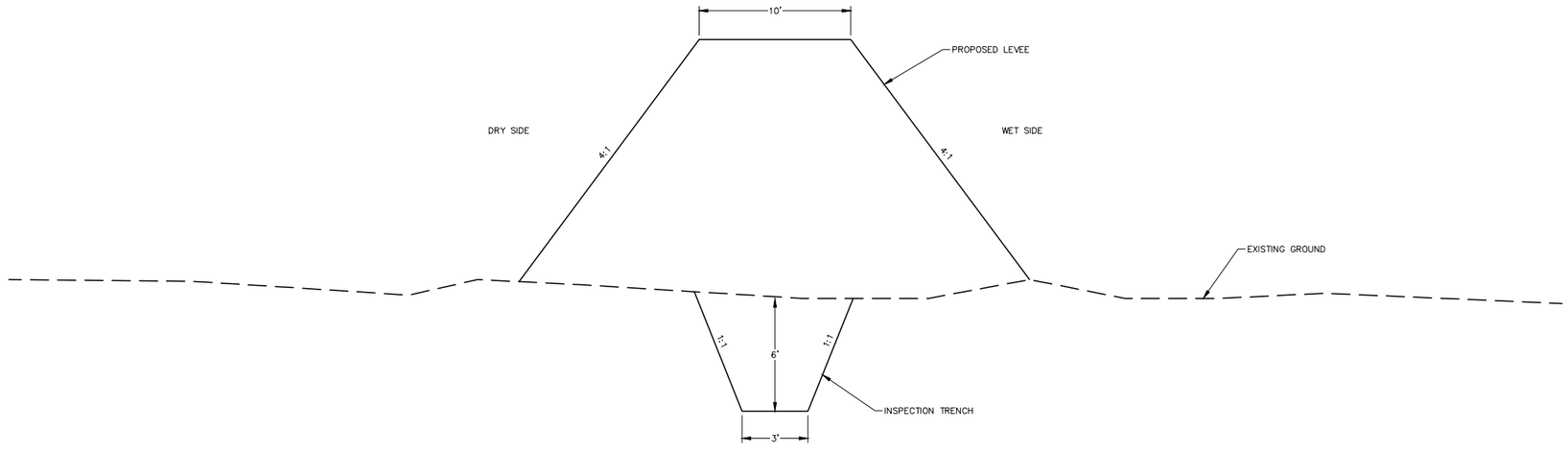
SHEET 9 OF 10



NOTES:
1. LIVE AND DEAD STORAGE VOLUME TOTAL = 483,000 CY.
2. AREA OF NWL = 18.7 AC.
3. AREA OF TOP OF POND = 22.3 AC.
4. DUPLEX LIFT STATION WITH PEAK FLOW = 28 CFS.
5. 1% CHANCE RAINFALL DURING FLOOD = 2.8"/24 HR.
6. CONSTRUCT INTERNAL DRAINAGE DITCH TO FLOW INTO POND PER PLANS.

STORM POND DETAIL - SOUTH LEVEE ALTERNATIVE

NO SCALE



TYPICAL LEVEE SECTION

NO SCALE

PRELIMINARY

moore engineering, inc.

TYPICAL DETAILS
RCPP/PL566 RUSH RIVER - AMENIA SOUTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
TYPICAL DETAILS

DATE:	01.24.19
REVISED:	----
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PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JHM
DRAFTER:	RJK
REVIEWER:	KRL

C-501

SHEET 10 OF 10

moore engineering, inc.

Amenia Flood Risk Reduction

Amenia, ND

Rush River RCPP

2/13/2020

Engineer's Preliminary Opinion of Probable Cost - Low Estimate

Alternate 1- Certified Levee Around City of Amenia

						POTENTIAL FUNDING SOURCES			
	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL	Federal	NDSWC	County Sales Tax	LOCAL
	Levee								
1.	Inspection Trench	CY	21,000	$6.00	$126,000.00	$126,000.00	$0.00	$0.00	$0.00
2.	Excavation - Pond	CY	100,135	$2.40	$240,324.00	$240,324.00	$0.00	$0.00	$0.00
3.	Embankment - Levee	CY	100,135	$3.60	$360,486.00	$360,486.00	$0.00	$0.00	$0.00
4.	Gatewell Structure	EA	2	$180,000.00	$360,000.00	$360,000.00	$0.00	$0.00	$0.00
5.	Storm Sewer - 48" RCP	LF	100	$150.00	$15,000.00	$15,000.00	$0.00	$0.00	$0.00
6.	Storm Sewer - 48" Flapgate	EA	2	$6,000.00	$12,000.00	$12,000.00	$0.00	$0.00	$0.00
7.	Lift Station - 1	LS	1	$420,000.00	$420,000.00	$420,000.00	$0.00	$0.00	$0.00
	Road Crossings								
8.	Remove Pavement All Thickness Asphalt	SY	175	$18.00	$3,150.00	$3,150.00	$0.00	$0.00	$0.00
9.	Gravel - Stripping and Spreading	CY	60	$36.00	$2,160.00	$2,160.00	$0.00	$0.00	$0.00
10.	Geotextile Fabric	SY	425	$3.60	$1,530.00	$1,530.00	$0.00	$0.00	$0.00
11.	Concrete Pavement - 8"	SY	60	$120.00	$7,200.00	$7,200.00	$0.00	$0.00	$0.00
12.	Sleeper Slab	LS	2	$6,000.00	$12,000.00	$12,000.00	$0.00	$0.00	$0.00
13.	Storm Sewer - 30" CMP	LF	100	$60.00	$6,000.00	$6,000.00	$0.00	$0.00	$0.00
14.	Storm Sewer - 30" Flapgate	EA	2	$1,200.00	$2,400.00	$2,400.00	$0.00	$0.00	$0.00
15.	Road Crossing - Gravel - Keyway	EA	2	$6,000.00	$12,000.00	$12,000.00	$0.00	$0.00	$0.00
	General Items								
16.	Railroad Crossing - Keyway	EA	2	$6,000.00	$12,000.00	$12,000.00	$0.00	$0.00	$0.00
17.	Boring - 30" Steel Casing	LF	120	$1,020.00	$122,400.00	$122,400.00	$0.00	$0.00	$0.00
18.	Mobilization	LS	1	$11,530.00	$11,530.00	$11,530.00	$0.00	$0.00	$0.00
19.	Ditching - Internal	LS	1	$120,000.00	$120,000.00	$120,000.00	$0.00	$0.00	$0.00
20.	Ditching - External	CY	7,250	$12.00	$87,000.00	$87,000.00	$0.00	$0.00	$0.00
21.	Sanitary Sewer Gate Valve & Box - 6"	EA	2	$4,200.00	$8,400.00	$8,400.00	$0.00	$0.00	$0.00
22.	Water Main Gate Valve & Box - 6"	EA	2	$4,200.00	$8,400.00	$8,400.00	$0.00	$0.00	$0.00
23.	Riprap - Class III	CY	50	$120.00	$6,000.00	$6,000.00	$0.00	$0.00	$0.00
24.	Riprap Filter Blanket	SY	120	$6.00	$720.00	$720.00	$0.00	$0.00	$0.00
25.	Topsoil Stripping and Spreading	AC	50	$1,800.00	$90,000.00	$90,000.00	$0.00	$0.00	$0.00
26.	Rock Check - Temporary	EA	5	$2,400.00	$12,000.00	$12,000.00	$0.00	$0.00	$0.00
27.	Seeding - Type III	AC	50	$912.00	$45,600.00	$45,600.00	$0.00	$0.00	$0.00
28.	Silt Fence - Standard	LF	1,000	$3.50	$3,500.00	$3,500.00	$0.00	$0.00	$0.00
29.	Storm Water Management	LS	1	$6,000.00	$6,000.00	$6,000.00	$0.00	$0.00	$0.00
30.	Traffic Control	LS	1	$6,000.00	$6,000.00	$6,000.00	$0.00	$0.00	$0.00
31.	Material Testing	Invoice	Allowance	$30,000.00	$30,000.00	$30,000.00	$0.00	$0.00	$0.00
				Total Construction	$2,149,800.00	$2,149,800.00	$0.00	$0.00	$0.00
				Engineering - Design & Construction	$353,200.00	$353,200.00	$0.00	$0.00	$0.00
				NRCS - Technical Assistance	$40,000.00	$40,000.00	$0.00	$0.00	$0.00
				Land Surveying	$40,000.00	$0.00	$20,000.00	$15,000.00	$5,000.00
				CLOMR/LOMR	$130,000.00	$0.00	$65,000.00	$48,750.00	$16,250.00
				Utility Relocation	$175,000.00	$175,000.00	$0.00	$0.00	$0.00
				Real Property Rights Acquisition	$212,000.00	$0.00	$106,000.00	$79,500.00	$26,500.00
				Wetland Mitigation	$67,200.00	$33,600.00	$16,800.00	$12,600.00	$4,200.00
				Legal & Adm. Fees	$50,000.00	$0.00	$25,000.00	$18,750.00	$6,250.00
				Real Property Rights Negotiations	$20,000.00	$0.00	$10,000.00	$7,500.00	$2,500.00
				Permitting	$5,000.00	$0.00	$2,500.00	$1,875.00	$625.00
				Fiscal	$40,000.00	$0.00	$20,000.00	$15,000.00	$5,000.00
				TOTAL PROJECT COST	**$3,282,200.00**	**$2,751,600.00**	**$265,300.00**	**$198,975.00**	**$66,325.00**

Assumptions:

1) Unit prices reflect estimated 2019 prices.
2) Federal cost share assumed at 100% for construction and engineering costs and 50% for wetland mitigation costs.
3) North Dakota State Water Commission cost share of 50% for eligible construction costs of remaining costs.
4) Cass County Flood Sales Tax will cover 75% of local cost share.
5) Excavated pond material will be suitable for levee material.
6) Project design includes no new storm sewer or improvements to the existing system internally in the City of Amenia.
7) Construction Engineering fee assumes full time Resident Project Representative (inspector) will be provided. One construction season.
8) The levee footprint was assumed to include a 150 foot wide corridor which includes the levee, drainage ditches and 15-foot clear zone on each side of levee.
9) Estimated right-of-way aquisition cost assumes 50 acres of land will be needed for levee and pond at purchase price of $4,107 per acre and 15 acres of temporary construction easement at $400 per acre.
10) Fiscal costs are the estimated cost for financing.
11) Cost opinion is based on a conceptual design only. Unit prices were selected based on past projects and contingencies were estimated at 20% in an effort to have estimated costs slightly conservative. Actual costs could be higher or lower than estimated.
12) Pond and ditch excavation material is suitable for levee material. Unit price to include placing the material for the levee.
13) Wetland mitigation costs assumed to be purchased credits at $60,000 per acre for 1.12 acres.
14) Utility relocation cost assumed for the relocation of private (Cass Rural Water, Otter Tail Power and Centurylink) utilities.

Appendix C Alternative 2 Plans & Cost Estimate

Appendix D-1-C

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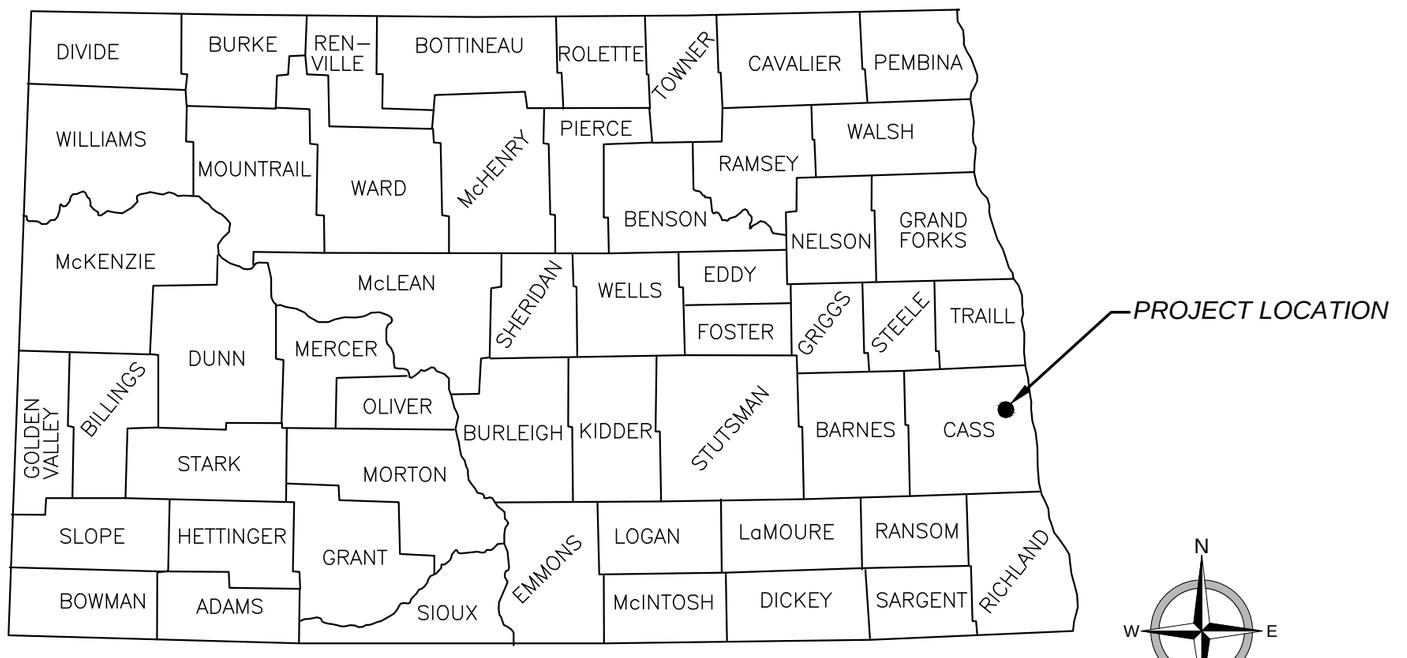
RCPP/PL566
RUSH RIVER - AMENIA
NORTH LEVEE ALTERNATIVE

CASS COUNTY JOINT
WATER RESOURCE DISTRICT

CASS COUNTY, NORTH DAKOTA

moore engineering, inc.
Consulting Engineering • Land Surveying
925 10th Avenue East • West Fargo, North Dakota
www.mooreengineeringinc.com

VICINITY MAP



PROJECT No. 18747

PRELIMINARY

FILE LOCATION: R:\Civil 3D Projects\18747\DRAWINGS\DESIGN\18747-NORTH-LEVEE-ALT.dwg

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PRELIMINARY

moore
engineering, inc.

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CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
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MANAGER:	MMO
DESIGNER:	JMH
DRAFTER:	RJK
REVIEWER:	KRL

G-002

SHEET 2 OF 2

CIVIL LEGEND

- BENCHMARK
- IRON MONUMENT FOUND
- EXISTING GAS LINE MARKER
- EXISTING GAS GATE VALVE
- EXISTING POWER POLE
- EXISTING LIGHT POLE
- EXISTING LIGHT POLE W/SIGN
- EXISTING GUY WIRE
- EXISTING TRAFFIC SIGNAL ARM
- EXISTING SIGN
- EXISTING CULVERT W/FLARED END SECTION (F.E.S.)
- EXISTING FLARED END SECTION (F.E.S.)
- EXISTING CURB STOP
- EXISTING HYDRANT W/GATE VALVE
- EXISTING GATE VALVE
- EXISTING FITTINGS
- EXISTING PLUG
- EXISTING PROPANE TANK
- EXISTING SANITARY SEWER MANHOLE
- EXISTING SANITARY SEWER CLEANOUT
- EXISTING STORM SEWER CATCH BASIN
- EXISTING STORM SEWER MANHOLE
- W — EXISTING WATER MAIN
- EXISTING WATER SERVICE W/CURB STOP
- SS — EXISTING SANITARY SEWER
- SS-FM — EXISTING SANITARY FORCEMAIN
- EXISTING SANITARY SEWER SERVICE
- ST — EXISTING STORM SEWER
- ST-FM — EXISTING STORM SEWER FORCEMAIN
- STEAM — EXISTING STEAM PIPE
- EXISTING AIR CONDITIONER
- U — EXISTING UTILITY PEDESTAL
- EXISTING UTILITY MANHOLE
- C — EXISTING UNDERGROUND COMMUNICATIONS
- F — EXISTING UNDERGROUND FIBER
- T — EXISTING UNDERGROUND TELEPHONE
- OHT — EXISTING OVERHEAD TELEPHONE
- TV — EXISTING UNDERGROUND TELEVISION
- OHTV — EXISTING OVERHEAD TELEVISION
- G — EXISTING UNDERGROUND GAS
- E — EXISTING UNDERGROUND ELECTRIC
- OHP — EXISTING OVERHEAD POWER
- X — EXISTING BARBED WIRE FENCE
- EXISTING CHAIN LINK/STEEL FENCE
- EXISTING PVC/WOOD FENCE
- EXISTING SHRUB
- EXISTING STUMP
- EXISTING TREE/TREE CLUSTER
- EXISTING SPRINKLER HEAD
- 12 — EXISTING CLUSTER BOX UNIT (CBU)
- EXISTING MAILBOX
- EXISTING CURB AND GUTTER
- CURB AND GUTTER REMOVAL & REPLACEMENT
- REMOVE EXISTING SURFACE
- EXISTING ASPHALT SURFACE
- EXISTING CONCRETE SURFACE
- EXISTING DECORATIVE COLORED CONCRETE
- EXISTING GRANULAR SURFACE
- EXISTING SIDEWALK/MULTI-USE PATH (UNKNOWN SURFACE)
- EXISTING LANDSCAPING
- EXISTING RIPRAP
- EXISTING WETLANDS
- EXISTING PERMANENT POOL

- NEW LIGHT POLE
- NEW LIGHT POLE W/SIGN
- NEW GUY WIRE
- NEW SIGN
- TRAFFIC CONTROL - DRUM
- TRAFFIC CONTROL - TUBULAR MARKER
- NEW CULVERT W/FLARED END SECTION (F.E.S.)
- NEW FLARED END SECTION (F.E.S.)
- NEW CURB STOP
- NEW HYDRANT W/GATE VALVE
- NEW GATE VALVE
- NEW TAPPING SLEEVE
- NEW FITTINGS
- NEW PLUG
- NEW SANITARY SEWER MANHOLE
- NEW SANITARY SEWER CLEANOUT
- NEW STORM SEWER CATCH BASIN
- NEW STORM SEWER MANHOLE
- W — NEW WATER MAIN
- NEW WATER SERVICE W/CURB STOP (S.B. ELEV.)
- SS — NEW SANITARY SEWER
- SS-FM — NEW SANITARY FORCEMAIN
- NEW SANITARY SEWER SERVICE (S.S. ELEV.)
- ST — NEW STORM SEWER
- ST-FM — NEW STORM SEWER FORCEMAIN
- STEAM — NEW STEAM PIPE
- IN — INSULATION PER DETAIL
- X — NEW BARBED WIRE FENCE
- NEW CHAIN LINK/STEEL FENCE
- NEW PVC/WOOD FENCE
- NEW INFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW OUTFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW INFLOW CURB AND GUTTER (HIGHBACK)
- NEW OUTFLOW CURB AND GUTTER (HIGHBACK)
- NEW CURB PAINT
- NEW ASPHALT SURFACE
- NEW CONCRETE SURFACE
- NEW CONCRETE APPROACH/DRIVEWAY
- NEW DECORATIVE COLORED CONCRETE
- NEW GRANULAR SURFACE
- NEW CRUSHED CONCRETE SURFACE
- NEW CONCRETE SIDEWALK/MULTI-USE PATH
- NEW DETECTABLE WARNING PANEL
- NEW RIPRAP
- NEW PERMANENT POOL
- NEW LANDSCAPING
- MILLING - 2" UNIFORM
- MILLING - 2" TAPERED
- ASPHALT PATCH
- LEVELING COURSE
- OVERLAY
- CHIPSEAL AND FOG COAT
- NEW CONCRETE VALLEY GUTTER
- NEW MEDIAN NOSE APRON
- NEW ADA RAMP W/WARNING PANEL
- 12 — NEW CLUSTER BOX UNIT (CBU)
- NEW MAILBOX
- NEW LARGE DECIDUOUS TREE
- NEW SMALL DECIDUOUS TREE
- NEW SHRUB
- NEW LARGE EVERGREEN TREE
- NEW SMALL EVERGREEN TREE

- DRAINAGE BREAK LINE
- EXISTING DRAINAGE DIRECTION
- 2.0% — FINISHED DRAINAGE DIRECTION & SLOPE
- 4:1 — FINISHED GRADE
- 895 — EXISTING CONTOUR ELEVATION
- 895 — FINISHED CONTOUR ELEVATION
- 900.07 FL — GRADE ELEVATIONS
- GRASS BUFFER
- PERMANENT STABILIZATION AREA
- SEDIMENTATION CONTROL WATTLE
- SEDIMENTATION CONTROL FENCE
- ROCK CHECK
- S.C.E. — STABILIZED CONSTRUCTION ENTRANCE
- CONCRETE WASHOUT
- INLET PROTECTION DEVICE

ABBREVIATIONS:

BOC = BACK OF CURB
BOW = BACK OF WALK
C = COMMUNICATION
CB# = STORM SEWER CATCH BASIN
CL = CENTERLINE
CSP = CORRUGATED STEEL PIPE
CO# = SANITARY SEWER CLEANOUT
CS# = CONTROL STRUCTURE
DIA = DIAMETER
DIP = DUCTILE IRON PIPE
E = ELECTRICAL
ECC = EDGE OF CRUSHED CONCRETE
EG = EXISTING GRADE
EOC = EDGE OF CONCRETE
EOP = EDGE OF PAVEMENT
EOW = EDGE OF WALK
EG= EXISTING GRADE
EX = EXISTING
F = FIBER OPTIC
FES = FLARED END SECTION
FG = FINISHED GRADE
FL = FLOWLINE
FM = FORCEMAIN
G = GAS LINE
HP = HIGH POINT
INV = INVERT
LP = LOW POINT
MATCH = MATCH
M# = STORM SEWER MANHOLE
MT# = STORM SEWER TEE MANHOLE
MM# = STORM SEWER MULTI-MANHOLE
MC = MIDPOINT OF CURVE
OHP = OVERHEAD POWER
OHT = OVERHEAD TELEPHONE
OHTV = OVERHEAD TELEVISION
PC = POINT OF CURVATURE
PRC = POINT OF REVERSE CURVE
PVC = POLYVINYL CHLORIDE PIPE
PT = POINT OF TANGENCY
RIM = RIM OF STRUCTURE
S# = SANITARY SEWER MANHOLE
S.B. ELEV. = STOP BOX ELEVATION
S.S. ELEV. = SANITARY SEWER SERVICE INVERT
S.S. = SANITARY SEWER
S.T. = STORM SEWER
STA = ALIGNMENT STATION
T = TELEPHONE
TOC = TOP OF CONCRETE
TOP = TOP OF PAVEMENT
TOP = TOP OF PIPE
TOW = TOP OF WALK
TR# = SANITARY TELEVISING RISER
TRANS = TRANSFORMER
TV = TELEVISION
U = UTILITY (UNKNOWN UTILITY)

PRELIMINARY

moore engineering, inc.

CIVIL LEGEND
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
CIVIL LEGEND

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DRAFTER:	RJK
REVIEWER:	KRL

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SHEET 1 OF 8

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Scale in Feet

PRELIMINARY

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ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
ALIGNMENTS, LINE AND CURVE TABLES, AND SURVEY CONTROL

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998875
ALL COORDINATES ARE CASS COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

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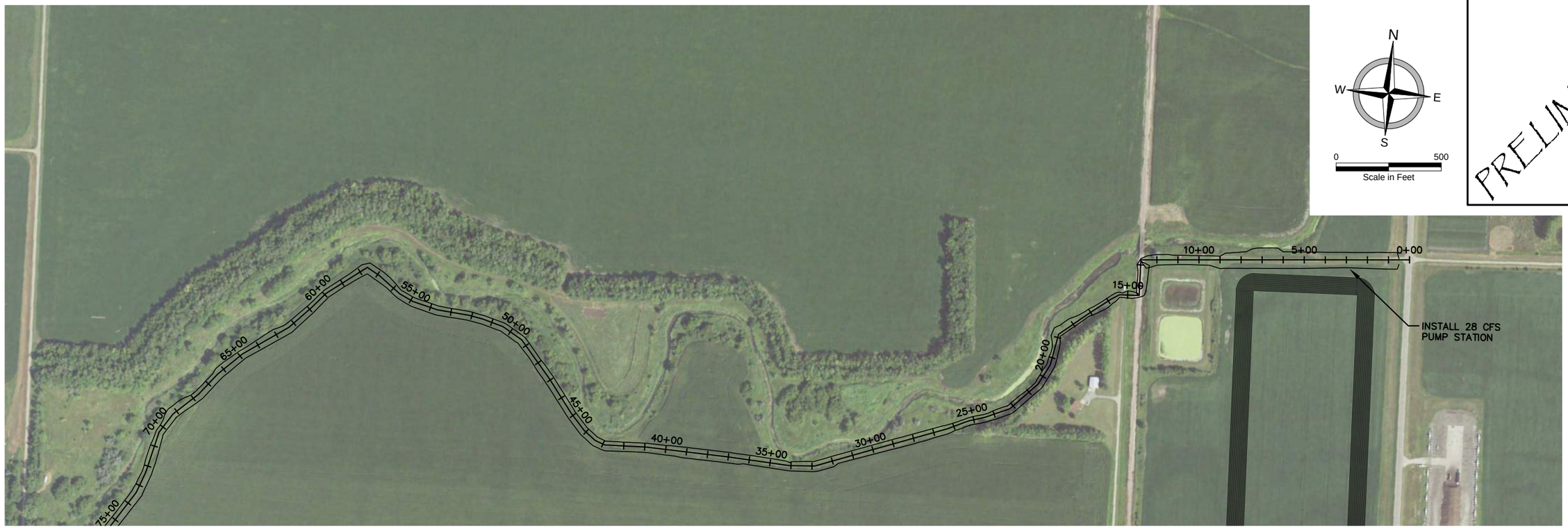

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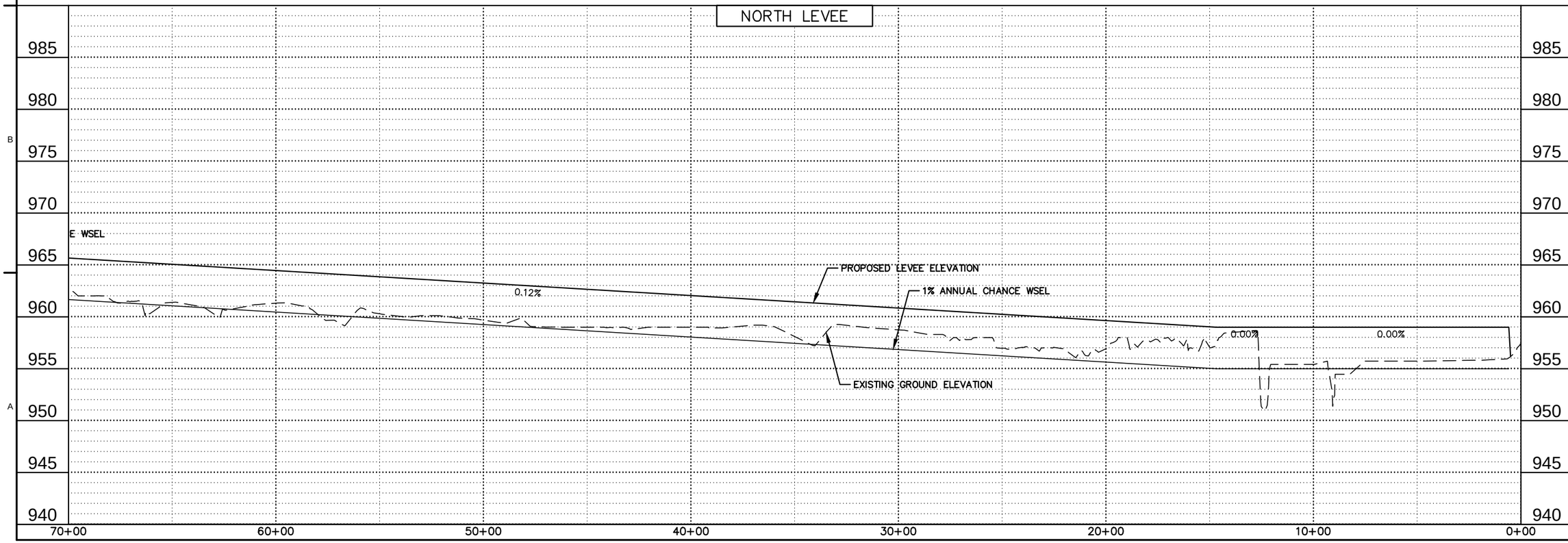

PLAN AND PROFILE
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
NORTH LEVEE

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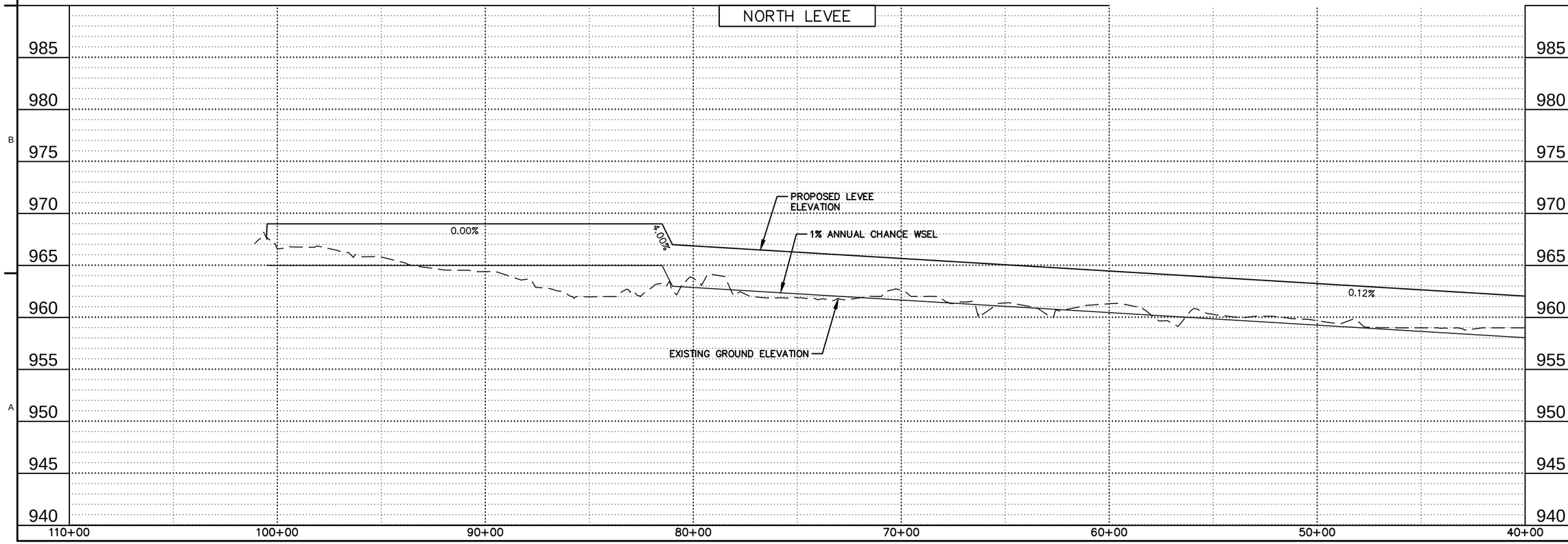

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PLAN AND PROFILE
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
NORTH LEVEE

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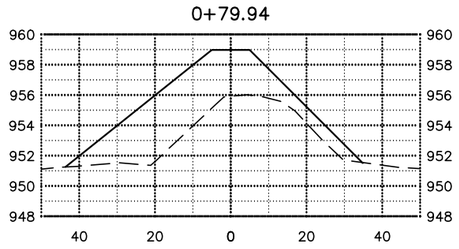
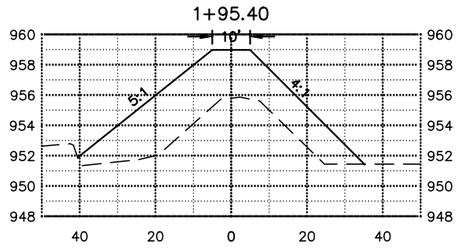
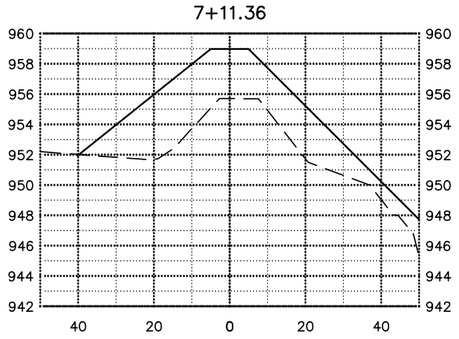
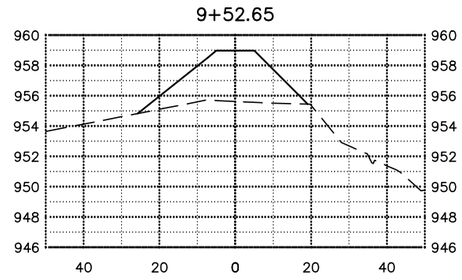
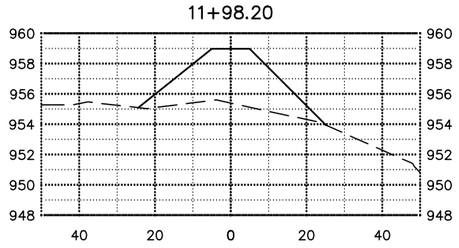
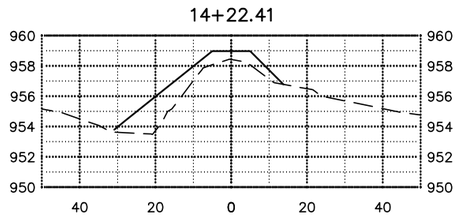


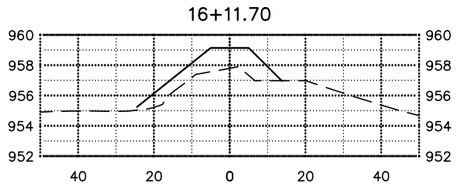


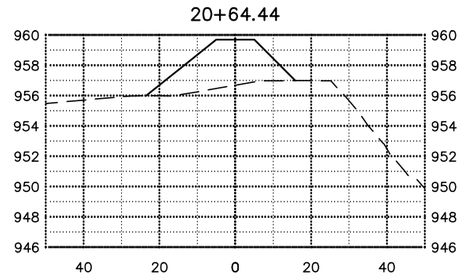


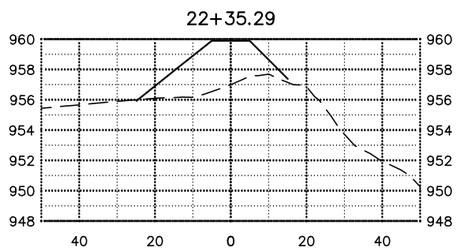


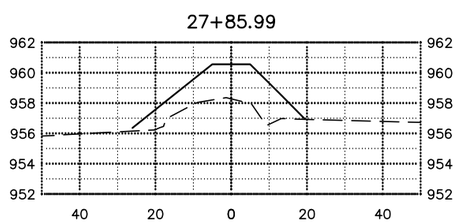


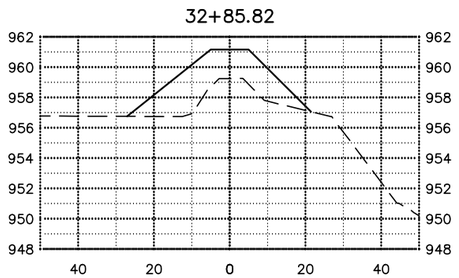


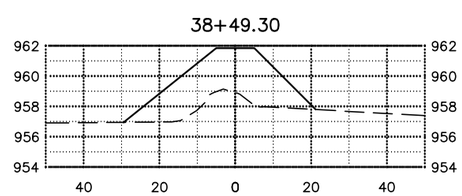


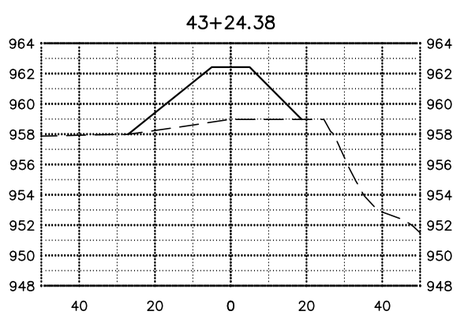


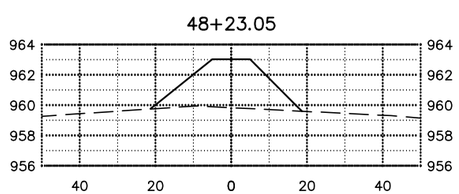


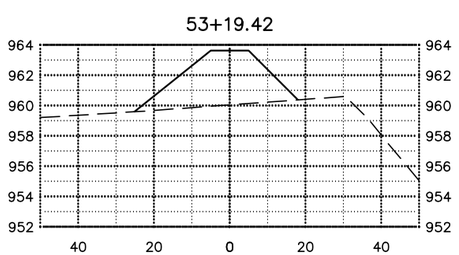


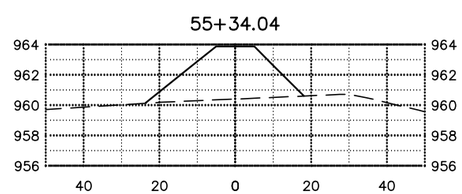












PRELIMINARY

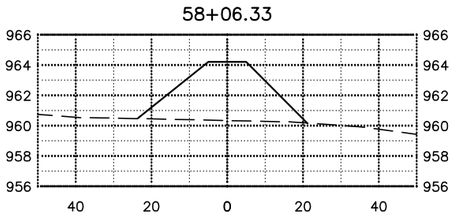
moore engineering, inc.

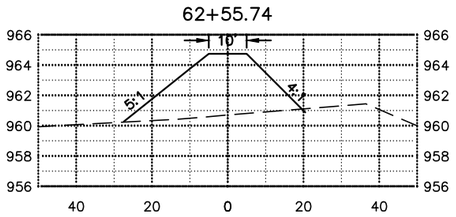
CROSS SECTIONS
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
CROSS SECTIONS

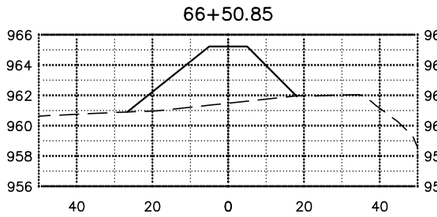
DATE:	01.24.19
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JMH
DRAFTER:	RJK
REVIEWER:	KRL

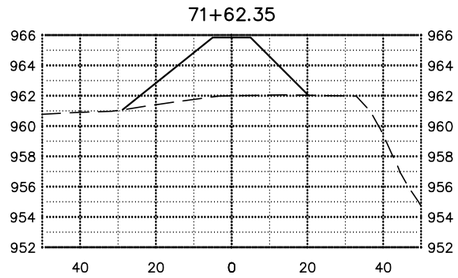
C-301

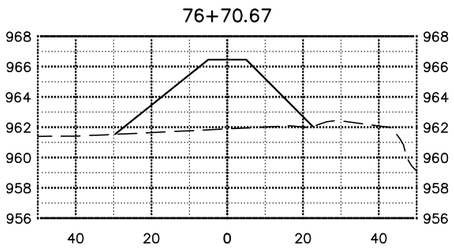
SHEET 5 OF 8

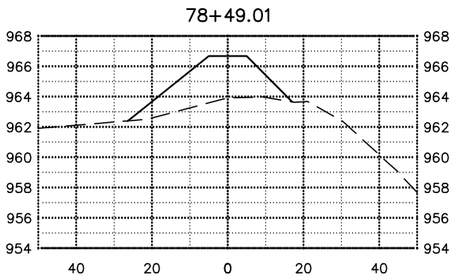


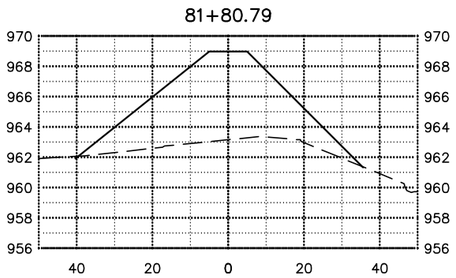


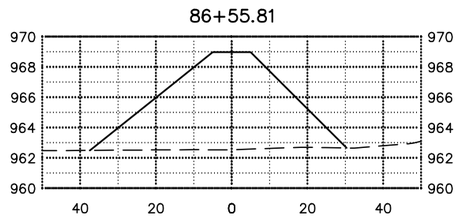


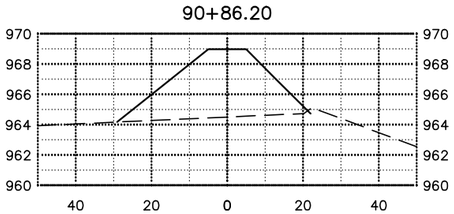


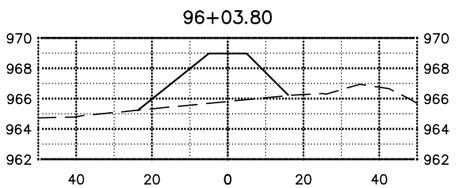


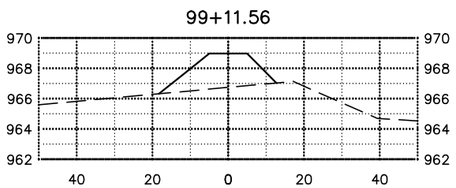












PRELIMINARY

moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
CROSS SECTIONS

DATE:	01.24.19
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RECORD:	----
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JMH
DRAFTER:	RJK
REVIEWER:	KRL

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SHEET 6 OF 8

FILE LOCATION: R:\Civil 3D Projects\18747\DRAWINGS\DESIGN\18747-NORTH-LEVEE-ALT.dwg

PRELIMINARY

EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+79.94	0.00	184.04	0.00	0.00	0.00	0.00
1+95.40	0.00	206.11	0.01	834.19	0.01	834.19
7+11.36	0.01	243.35	0.14	4294.48	0.15	5128.68
9+52.65	0.00	90.44	0.05	1491.51	0.20	6620.19
11+98.20	0.00	107.93	0.00	902.02	0.20	7522.21
14+22.41	0.00	45.96	0.00	623.88	0.20	8146.09
16+11.70	0.00	42.12	0.00	321.99	0.20	8468.07
20+64.44	0.00	76.64	0.02	992.32	0.22	9460.40
22+35.29	0.02	74.90	0.05	482.44	0.27	9942.84
27+85.99	0.00	77.57	0.16	1558.51	0.44	11501.35
32+85.82	0.00	87.16	0.00	1524.75	0.44	13026.10
38+49.30	0.00	111.88	0.00	2081.92	0.44	15108.02
43+24.38	0.00	98.93	0.00	1858.56	0.44	16966.58
48+23.05	0.00	79.10	0.00	1647.05	0.44	18613.63
53+19.42	0.00	95.46	0.00	1600.71	0.44	20214.33
55+34.04	0.00	90.31	0.00	740.91	0.44	20955.25
58+06.33	0.00	105.53	0.01	982.58	0.45	21937.83
62+55.74	0.11	116.61	0.91	1848.98	1.36	23786.81
66+50.85	0.00	103.64	0.82	1608.18	2.18	25394.99
71+62.35	0.00	113.79	0.02	2054.40	2.19	27449.39
76+70.67	0.00	141.80	0.00	2410.16	2.19	29859.55
78+49.01	0.00	78.72	0.00	729.10	2.19	30588.66
81+80.79	0.07	235.85	0.47	1950.36	2.67	32539.02
86+55.81	0.00	248.29	0.61	4257.67	3.27	36796.69
90+86.20	0.12	136.22	1.02	3055.13	4.29	39851.82
96+03.80	0.00	78.99	1.20	2061.68	5.50	41913.50
99+11.56	0.00	46.03	0.00	708.53	5.50	42622.03

moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
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CASS COUNTY, NORTH DAKOTA
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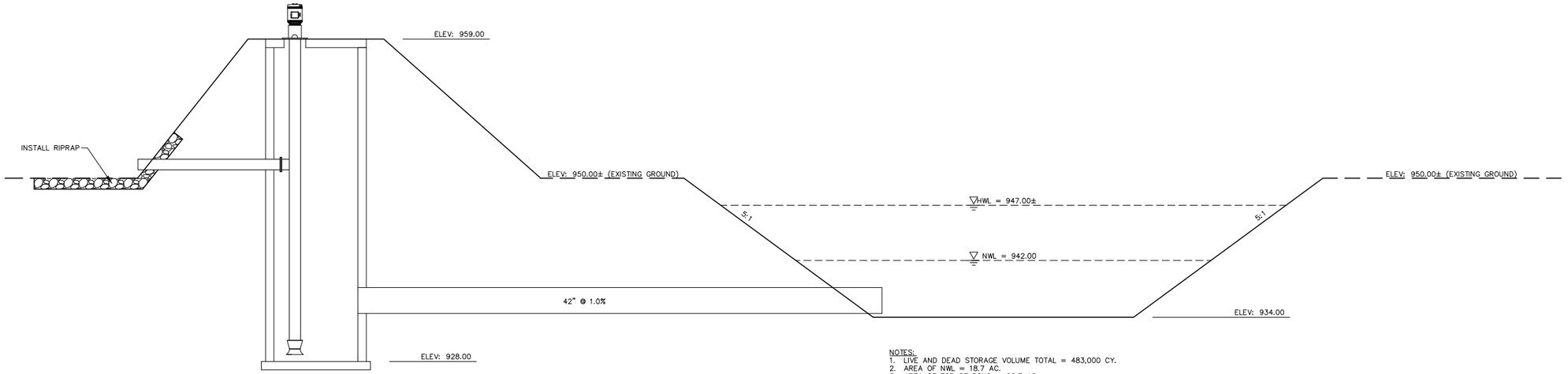
PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JMH
DRAFTER:	RJK
REVIEWER:	KRL

C-303

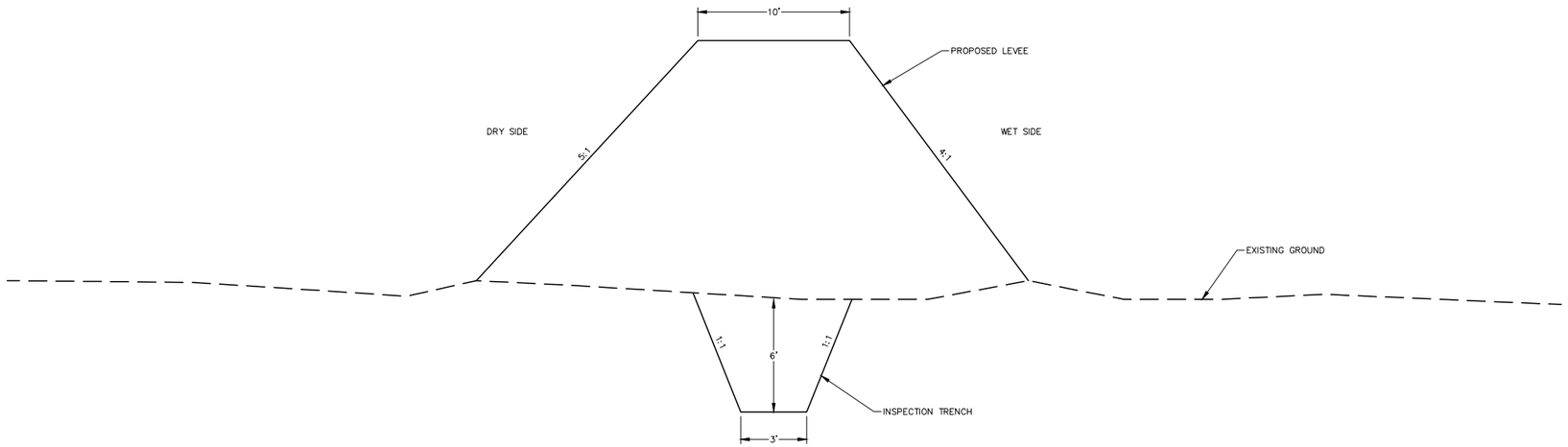
SHEET 7 OF 8



NOTES:
1. LIVE AND DEAD STORAGE VOLUME TOTAL = 483,000 CY.
2. AREA OF NWL = 18.7 AC.
3. AREA OF TOP OF POND = 22.3 AC.
4. DUPLEX LIFT STATION WITH PEAK FLOW = 28 CFS.
5. 1% CHANCE RAINFALL DURING FLOOD = 2.8"/24 HR.
6. CONSTRUCT INTERNAL DRAINAGE DITCH TO FLOW INTO POND PER PLANS.

STORM POND DETAIL - NORTH LEVEE ALTERNATIVE

NO SCALE



TYPICAL LEVEE SECTION

NO SCALE

PRELIMINARY

moore engineering, inc.

TYPICAL DETAILS
RCPP/PL566 RUSH RIVER - AMENIA NORTH LEVEE ALTERNATIVE
CASS COUNTY JOINT WATER RESOURCE DISTRICT
CASS COUNTY, NORTH DAKOTA
TYPICAL DETAILS

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PROJECT No.	18747
MANAGER:	MMO
DESIGNER:	JMH
DRAFTER:	RJK
REVIEWER:	KRL

C-501

SHEET 8 OF 8

moore engineering, inc.

Amenia Flood Risk Reduction

Amenia, ND

Rush River RCPP

3/1/2019

Engineer's Preliminary Opinion of Probable Cost - Low Estimate

Alternate 2- Certified Levee Along River - Larger Pond, Smaller Lift Station

						POTENTIAL FUNDING SOURCES			
	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL	Federal	NDSWC	County Sales Tax	LOCAL
	Levee								
1.	Inspection Trench	CY	7,820	$5.00	$39,100.00	$25,415.00	$6,842.50	$3,421.25	$3,421.25
2.	Excavation - Pond	CY	482,450	$2.00	$964,900.00	$482,450.00	$241,225.00	$120,612.50	$120,612.50
3.	Excavation - Pond - Stockpile On Site	CY	451,600	$3.00	$1,354,800.00	$677,400.00	$338,700.00	$169,350.00	$169,350.00
4.	Embankment - Levee	CY	30,850	$3.00	$92,550.00	$46,275.00	$23,137.50	$11,568.75	$11,568.75
5.	Gatewell Structure	EA	3	$150,000.00	$450,000.00	$225,000.00	$112,500.00	$56,250.00	$56,250.00
6.	Storm Sewer - 48" RCP	LF	150	$125.00	$18,750.00	$9,375.00	$4,687.50	$2,343.75	$2,343.75
7.	Storm Sewer - 48" Flapgate	EA	3	$5,000.00	$15,000.00	$7,500.00	$3,750.00	$1,875.00	$1,875.00
8.	Lift Station - 1	LS	1	$350,000.00	$350,000.00	$175,000.00	$87,500.00	$43,750.00	$43,750.00
	Road Crossing								
9.	Gravel - Stripping and Spreading	CY	20	$30.00	$600.00	$300.00	$150.00	$75.00	$75.00
10.	Geotextile Fabric	SY	80	$3.00	$240.00	$120.00	$60.00	$30.00	$30.00
	General Items								
11.	Railroad Crossing - Keyway	EA	1	$5,000.00	$5,000.00	$2,500.00	$1,250.00	$625.00	$625.00
12.	Mobilization	LS	1	$10,000.00	$10,000.00	$5,000.00	$2,500.00	$1,250.00	$1,250.00
13.	Ditching - Internal	LS	1	$150,000.00	$150,000.00	$75,000.00	$37,500.00	$18,750.00	$18,750.00
14.	Riprap - Class III	CY	30	$100.00	$3,000.00	$1,500.00	$750.00	$375.00	$375.00
15.	Riprap Filter Blanket	SY	80	$5.00	$400.00	$200.00	$100.00	$50.00	$50.00
16.	Topsoil Stripping and Spreading	AC	90	$1,500.00	$135,000.00	$67,500.00	$33,750.00	$16,875.00	$16,875.00
17.	Rock Check - Temporary	EA	5	$2,000.00	$10,000.00	$5,000.00	$2,500.00	$1,250.00	$1,250.00
18.	Seeding - Type III	AC	90	$760.00	$68,400.00	$34,200.00	$17,100.00	$8,550.00	$8,550.00
19.	Silt Fence - Standard	LF	10,000	$3.00	$30,000.00	$15,000.00	$7,500.00	$3,750.00	$3,750.00
20.	Storm Water Management	LS	1	$5,000.00	$5,000.00	$2,500.00	$1,250.00	$625.00	$625.00
21.	Traffic Control	LS	1	$5,000.00	$5,000.00	$2,500.00	$1,250.00	$625.00	$625.00
22.	Material Testing	Invoice	Allowance	$25,000.00	$25,000.00	$12,500.00	$6,250.00	$3,125.00	$3,125.00
				Total Construction	$3,732,740.00	$1,872,235.00	$930,252.50	$465,126.25	$465,126.25
				Contingencies (10%)	$373,021.60	$242,464.04	$65,278.78	$32,639.39	$32,639.39
				Project Development/Funding	$30,000.00	$19,500.00	$5,250.00	$2,625.00	$2,625.00
				Engineering - Civil Design	$298,619.20	$194,102.48	$52,258.36	$26,129.18	$26,129.18
				Geotechnical Engineering	$15,000.00	$9,750.00	$2,625.00	$1,312.50	$1,312.50
				Structural Engineering	$15,000.00	$9,750.00	$2,625.00	$1,312.50	$1,312.50
				Electrical Engineering	$6,000.00	$3,900.00	$1,050.00	$525.00	$525.00
				Construction Engineering	$298,619.20	$194,102.48	$52,258.36	$26,129.18	$26,129.18
				Land Surveying	$40,000.00	$26,000.00	$7,000.00	$3,500.00	$3,500.00
				CLOMR/LOMR	$130,000.00	$84,500.00	$22,750.00	$11,375.00	$11,375.00
				Right-of-Way Acquisition	$378,000.00	$245,700.00	$66,150.00	$33,075.00	$33,075.00
				Wetland Mitigation	$13,000.00	$8,450.00	$2,275.00	$1,137.50	$1,137.50
				Legal & Adm. Fees	$50,000.00	$32,500.00	$8,750.00	$4,375.00	$4,375.00
				Right-of-Way Negotiations	$20,000.00	$13,000.00	$3,500.00	$1,750.00	$1,750.00
				Permitting	$5,000.00	$3,250.00	$875.00	$437.50	$437.50
				Fiscal	$40,000.00	$26,000.00	$7,000.00	$3,500.00	$3,500.00
				TOTAL PROJECT COST	**$5,445,000.00**	**$2,985,000.00**	**$1,230,000.00**	**$615,000.00**	**$615,000.00**

Assumptions:

1) Unit prices reflect estimated 2019 prices.
2) Federal cost share assumed at 65% North Dakota State Water Commission cost share of 50% for eligible construction costs of remaining costs.
3) Cass County Flood Sales Tax will cover 50% of local cost share.
4) Excavated pond material will be suitable for levee material.
5) Project design includes no new storm sewer or improvements to the existing system internally in the City of Amenia.
6) Construction Engineering fee assumes full time Resident Project Representative (inspector) will be provided. One construction season.
7) The levee footprint was assumed to include a 150 foot wide corridor which includes the levee, drainage ditches and 15-foot clear zone on each side of levee.
8) Estimated right-of-way aquisition cost assumes 90 acres of land will be needed for levee and pond at purchase price of $4,107 per acre and 25 acres of temporary construction easement at $400 per acre.
9) Fiscal costs are the estimated cost for financing.
10) Cost opinion is based on a conceptual design only. Unit prices were selected based on past projects and contingencies were estimated at 20% in an effort to have estimated costs slightly conservative. Actual costs could be higher or lower than estimated.
11) Wetland Mitigation - estimated disturbed area 0.25 acres, with 2 to 1 mitigation area required, at $26,000/acre.